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SUB-SEABED DISPOSAL OF RADIOACTIVE WASTE: PREVENTION OR MANAGEMENT?

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David A. Deese

December 1977

DOCTORAL DISSERTATION

Prepared for the U.S. Energy Research and Development Administration under Contract EY-77-S-02-4172.A000, the Fletcher School of Law and Diplomacy, Harvard University, the International Union for the Conservation of Nature and the Woods Hole Oceanographic Institution's Marine Policy and Ocean Management Program, which is supported in part by the Pew Memorial Trust and by the Department of Commerce, NOAA Office of Sea Grant under grant #04-7-158-44104.

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Approved for Distribution: Robert W. Morse

Robert W. Morse
Dean of Graduate Studies

ABSTRACT

The most important prerequisite for understanding the legal, political, and organizational implications of the possible option of radioactive waste disposal deep within the seabed (sub-seabed disposal) is a basic grasp of the status of nuclear activities worldwide which are creating radioactive wastes. Chapter I analyzes the technical, legal, political, and managerial elements of nuclear energy, especially radioactive waste management, to the degree necessary to provide background and perspective for understanding the sub-seabed disposal concept. Next is the need, addressed in Chapter II, for an awareness of the history of worldwide marine disposal practices involving very hazardous materials, and the recent national and international responses to these practices. Attention is focused on the new attitudes toward protecting the marine environment, especially on the emerging trend of phasing out disposals posing danger to man or the environment.

With this background and perspective established for radioactive waste management and marine disposal practices, the thesis investigates the legal and political elements in the U.S., other countries, and international organizations, of the possible sub-seabed disposal of radioactive wastes. Chapter III analyzes the related domestic legal postures of the U.S. and several other nations with nuclear energy

programs; Chapter IV includes detailed consideration of the international legal situation surrounding sub-seabed disposal. The existing and projected political responses to sub-seabed disposal from the U.S., other countries, and the related international organizations are discussed in Chapter V. A start is made in Chapter VI toward outlining and evaluating some of the ethical questions raised by sub-seabed disposal. Many of the existing institutional aspects are most appropriately included in the discussion of closely related legal and political elements in Chapters III - V. The future institutional possibilities for the management and prevention of sub-seabed disposal are analyzed separately in Chapter VII.

The research approach used is largely reflected in the structure of the manuscript. The author first developed an understanding of the technical realities of the commercial and military nuclear activities creating significant radioactive wastes, and the possible options for radioactive waste disposal. Detailed study was then done on the science and technology of the sub-seabed disposal concept.

The legal and policy research which followed was designed to uncover all potentially applicable information for a very new technological possibility. The general approach consisted of:

1) An inductive process, i.e., analyzing all existing information and making reasonable forecasts and predictions; and
2) A deductive process, i.e., looking ahead to the 1980's

and 1990's, and making the best possible judgments as to likely events and situations.

The deductive approach was most important in establishing likely institutional possibilities for the management and prevention of sub-seabed disposal in Chapter VII.

Detailed legal research was necessary for Chapters III and IV on the national and international legal aspects, respectively, of the sub-seabed disposal of radioactive waste. To this was added a major search of journals, news-letters on science, government, environment, energy, etc., and the general literature of various countries in the fields of:

1) Energy policy, law, and research and development, especially for nuclear energy;
2) General environmental protection; and
3) Specific elements of marine pollution control, especially law of the sea.

Important data was drawn from numerous interviews with academics, industrialists, government officials, international civil servants, scientists, and environmentalists, various national and international conferences, symposia, and working groups, and numerous unpublished manuscripts from national governments, international agencies, and academics.

A summary of the research findings and a number of conclusions and recommendations are presented in Chapter VIII. From the legal viewpoint, it is important to note both that:

1) The implementation of sub-seabed disposal of radioactive

waste is enmeshed in a complex legislative and regulatory situation in the leading nuclear nations; the situation is not, at least for now, as complex as that confronting land-based disposal possibilities; and the situation is changing since various nations have criteria and standards development processes underway in the area of radioactive waste management. And,

2) The legislative and regulatory framework now available is inadequate for implementing an international program for the sub-seabed disposal of radioactive waste, although this framework appears to be adequate for preventing unilateral implementation of sub-seabed disposal while the national and international R & D programs continue; it is still sufficiently early in the R & D process on sub-seabed disposal to have time for developing the legal and institutional structures necessary for effective implementation.

In the closely associated area of political responses: sub-seabed disposal presents special problems for international environmental protection and international control of radioactive material transport, liability, etc. It also offers unique opportunities for international cooperation on controlling nuclear activities, especially radioactive waste management (including spent reactor fuel storage, handling, and disposal) and nuclear non-proliferation (as part of an international regime to control the back-end of the nuclear energy production process).

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CHAPTER I

INTRODUCTION

The Radioactive Waste Problem

Even an abrupt halt tomorrow to all uses of nuclear energy would not fundamentally change the radioactive waste management[1] problem. It would still be a serious and confused issue with important international security, energy, and environmental implications. We must remember that nuclear power stations--both developed and promoted largely by the United States--are now creating spent fuel bundles worldwide and that military and commercial nuclear fuel reprocessing operations are producing high-level reprocessing wastes in several countries.

There is no nuclear fuel "cycle" in most countries--whole pieces, such as reprocessing, recycling and waste disposal are missing. Figure 1 shows the light water nuclear fuel cycle as it now operates (solid lines) and how it could operate (broken lines) if either: (1) plutonium and/or

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[1]All aspects of handling, storing, transporting, processing and packaging, and disposal of radioactive wastes will be included under the general category of radioactive waste management. As long as the official American policy is to indefinitely defer reprocessing, the management of spent fuel must also be considered to be an aspect of radioactive waste management. Spent nuclear fuel is now a possible (or even a likely) waste product in at least the U.S.

uranium were removed (referred to as spent fuel reprocessing) from the spent fuel for recycling and the resultant wastes were sent to a final disposal facility; or (2) the spent fuel were packaged and sent directly to final disposal (referred to as the throwaway fuel cycle). The interim storage step for spent fuel (as a major separate facility in addition to the temporary facility available at each reactor) is necessary when the decision has not been made as to whether there should be a reprocess and recycle or a throwaway fuel cycle.

Radioactive wastes are created at every step in this process. Mining, milling, enriching, fabricating, and burning nuclear fuel, and storing and reprocessing spent fuel create various gaseous, liquid, and solid waste products.[1] Table 1 shows the types of wastes, methods of disposal, and approximate quantities (by volume and radioactivity) of wastes produced at each step, starting with milling, or production. These are the quantities which are, or would be, produced over the period of one year.

High-level radioactive materials are generated by the operation of nuclear reactors (spent fuel bundles) and of military and commercial spent fuel reprocessing facilities

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[1]While the discussion refers to light water reactor operations, it is also generally applicable to other types of plants, such as heavy water, high-temperature gas-cooled, and liquid metal fast breeder reactors. Heavy water reactors burn natural uranium and thus avoid the need for the uranium enrichment step.

(high-level reprocessing wastes) (Table 1). These contain fission products--which must be isolated for 600 to 1000 years--and the transuranic or actinide elements--which require isolation for up to a million years. [1] Since spent fuel bundles contain all the uranium and plutonium, their actinide content is considerably higher than that of high-level reprocessing wastes. Table 2 lists the half-lives of some of the major constituents of radioactive waste. The general rule of thumb is that these constituents must be isolated for periods of time equalling or exceeding ten to twenty of their half-lives.

High-level radioactive materials are generally considered to be those with radioactivity concentrations of hundreds to thousands of curies (the basic unit of radioactivity intensity, or 37 billion disintegrations per second)

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[1]The elements actinium, protactinium, thorium, uranium, neptunium, americium, curium, and all elements heavier than curium are called actinides. Neptunium and all heavier elements are transuranics. Radioactive elements are most often characterized by their half-lives--the time required for their radioactivity to decrease by one half--and by the type of radiation they emit. The 600 to 1000 and one million year numbers are commonly used estimates of the time required for the elements to decay to fairly innocuous levels. Gamma rays (energy waves) and beta particles (electrons) (both mainly from the radiodecay of fission products) are generally very penetrating and intense heat producers; gamma radiation is the most difficult to stop with shielding; alpha radiation from the transuranics is not very penetrating, but it continues for extremely long periods of time. All are dangerous and highly toxic, yet unless inhaled alpha particles are much less likely to harm man or other organisms; see, for example, D. R. Inglis, Nuclear Energy--Its Physics and Its Social Challenge (Reading, Mass.: Addison-Wesley Pub. Co., 1973); R. A. Frosch, "Disposing of High-Level Radioactive Waste," Oceanus 20 (Winter 1977): 5; and J. T. Edsall, "Toxicity of Plutonium and some other Actinides," Bull. of Atomic Scientists, September 1976, p. 27.

per gallon or cubic foot.[1] They require heavy shielding for handling, nearly permanent isolation, and long-term (about 90 to 200 years) arrangements for heat removal or dissipation which match the thermal capacity of the isolation system. Without some form of cooling or stirring, the radioactive decay produces enough heat to start high-level wastes in liquid form boiling and spewing into the airspace above them.

It is useful to describe the level of heat generated by the radiodecay of high-level radioactive wastes (both spent fuel and high-level reprocessing wastes) using three approximate time periods. During the first period, which lasts about three to six months, the heat output is high enough to complicate even remote handling. This is the time when the wastes are maintained in interim storage facilities to allow for the initial rapid decay of the short-lived fission products.

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[1]The official U.S. definition of high-level liquid radioactive waste (40 C.F.R. 227.74 (1975)) is still ". . . those aqueous waste resulting from the operation of the first cycle solvent extraction system. . . and the concentrated wastes from subsequent extraction cycles . . . in a facility for reprocessing irradiated reactor fuels." Yet the U.S. Nuclear Regulatory Commission (NRC) and most U.S. government agencies now also include spent fuel rods under the category of high-level radioactive wastes for policy-making purposes. For the purpose of controlling ocean dumping (see Chapter 3, below), the U.S., as a Party to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (29 December 1972; in force 30 August 1975; in ILM 11 (1972): 1291, [hereinafter cited as the London Convention]), must ultimately abide by its ban (Article 4 and Annex 1) on the sea dumping of high-level radioactive wastes, as defined by the Int'l. Atomic Energy Agency (IAEA). Although there is a binding provisional definition, the final IAEA definition is still under development (see Chapter 4, below).

Continued high heat generation with easier remote handling characterize the second period. This period lasts about six hundred years for high-level wastes from reprocessing and thousands to tens of thousands of years for spent fuel bundles. There is a relatively rapid drop in the heat generation by the fission products at the two to six hundred year point. Since the high-level waste from reprocessing are made up largely of fission products (the uranium and plutonium have been removed), the heat generation drops rapidly between two and six hundred years. Since the spent fuel bundles contain large quantities of the long-lived uranium and plutonium elements, as well as the fission products, the heat generation remains very high for thousands of years.

The final period begins when most of the fission products have decayed significantly and heat generation is no longer a problem. This extends over most of the life of high-level waste from reprocessing and over the later stages of decay of spent fuel bundles. The major differences in lengths of the second and third time periods for the two types of high-level wastes have an important implication for final disposal: the period of high heat generation for spent fuel bundles will extend well beyond the several hundreds of years for which specially designed man-made structures might be expected to last.

The category of so-called low-level wastes generally includes the equipment and materials contaminated at all stages of the nuclear energy and weapons production processes.

Most of it is slightly contaminated materials from handling and reactor coolant cleanup operations. They generally have radioactivity concentrations of about one microcurie per gallon or cubic foot.

The large volume of low-level wastes (Table 1) is often divided into two categories:

1) Low-level non-transuranic wastes, or those with less than ten nanocuries (one nanocurie = 1×10^{-9} curies) per gram of transuranic nuclides; and
2) Low-level transuranic wastes, or those contaminated with greater than ten nonocuries per gram of the very long-lived alpha emitters.

The former category has generally been considered suitable for disposal by shallow land burial. The latter has usually been incinerated, compacted, and immobilized--often by mixing with cement--prior to storage in steel drums.

A final category of medium or intermediate-level wastes has often been used for the enormous range of materials which falls between low-level transuranic waste and high-level waste in activity level. The higher radiation levels of these materials compared to those of low-level wastes dictate remote handling or shielding. The heat generation levels are low relative to high-level wastes and the overall volume produced is small compared to low-level wastes. Medium-level wastes are stored in a solid form. They will probably be deemed to require disposal along the lines of that necessary for high-level wastes.[1]

Four assumptions have frequently been made in the areas of radioactive waste management. First, that the real waste management problem is the extremely hot (both radioactively and thermally), highly toxic, and penetrating high-level wastes with most of the fission products. This is not as true as most past writings and presentations would have us believe.

The management, especially disposal, of even low-level wastes--about 90% of the total waste volume--has become troublesome. Its long-lived alpha components are increasingly considered unsuitable for the traditional disposal method--burial in twenty-foot-deep covered trenches. Large quantities of radioactivity (curies) from buried low-level materials accummulate in the trenches, and infiltrated water and erosion have, in some cases, caused seepage from sites into surface and ground waters.[2] A recent government report in the United

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[1]For more detailed description, it is useful to further identify low (transuranic and non-transuranic), medium and high-level radioactive wastes as military or commercial in origin, but for present purposes these three categories will, unless further specified, refer to wastes of both military and commercial origin. Appendix 1 to this paper contains a recent and complete list of radioactive waste definitions.

[2]The West Valley, N.Y. commercial burial site for low-level waste, for example, held over 300,000 curies after 12 years of operation. After the N.Y. Department of Environmental Conservation detected leaking from three trenches in 1975, burial was stopped; see New York Times, 10 February 1977, p. 27 and 13 February 1977, p. 4; R. K. Lester and D. J. Rose, "The Nuclear Wastes at West Valley, New York", Technology Review 79 (May 1977): 20; and C. G. Robertson, "West Valley Waste Burial Area Problems Correlated to Operating Practices," and C. G. Robertson and R. E. Berlin, "Waste Trench Cap Study of Remedial Work for West Valley," Transactions of the Amer. Nuc. Soc. 1977 Annual Meeting (La Grange Park, Ill.: Amer. Nuc. Soc., 1977), p. 290.

States criticizes the management of the entire shallow-land burial program.[1] Serious consideration is now being given to requiring all alpha-contaminated wastes to have the same permanent isolation as high-level materials.[2]

Next is the assumption that there is a clear dividing line between the high, medium and low-level radioactive waste categories for health, safety, and general management purposes. It is increasingly clear both that there are no such certain lines drawn in the usage of different countries (or even within countries) and that it is impossible to rely on the traditionally assumed management practices for each waste category.[3] Although there is fairly wide usage of

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[1] U.S. Nuclear Regulatory Commission, NRC Task Force Report on Review of the Federal/State Program for Regulation of Commercial Low-Level Radioactive Waste Burial Grounds, NUREG-0217 (Wash., D.C.: U.S. NRC, March 1977).

[2] This is a ruling expected from the U.S. NRC in 1977.

[3] An IAEA technical report of November, 1967 established, for the eleven countries surveyed, that each country--and often each organization within a country--has a different radioactive waste classification system. The IAEA-recommended categories of wastes are liquid, solid, and gas, with sub-categories based on activity levels; see IAEA, "Standardization of Radioactive Waste Categories," Technical Report Series No. 10 (Vienna: IAEA, 1970). Several other "standard" classification systems have been recommended by organizations and individuals in the 1960's and 1970's. With the assistance of the Lawrence Livermore Laboratory in California, the NRC is developing a badly needed system for classifying radioactive wastes in the U.S. Although still in an interim report stage, the recommended waste classification system will apparently be based on the type of disposal required for a radioactive waste. Wastes would be termed "innocuous" if suitable for direct release to the biosphere, "low-level" if suitable for storage and some minimal release, and "high-level" if isolation for geologic time periods is required.

quantities of approximately one thousand curies per liter for high-level wastes and less than one microcurie per liter for low-level wastes, these are not applied consistently in practice. And this approach leaves a huge range of materials under the medium-level category.

There are at least two major problems with the past establishment of specific management practices for each waste category. First is the arbitrary nature--from a radiobiological perspective--of treating medium and low-level (especially transuranic-contaminated materials) wastes as less important than high-level wastes since large quantities of less radioactive substances can be at least as dangerous as more highly concentrated sources. This is the rationale behind the emerging U.S. requirement to dispose of transuranic-contaminated wastes in the same way as high-level wastes.

Second is the past focusing of most attention, in the area of high-level wastes, on the materials from fuel reprocessing operations and, in the area of low-level wastes, on the wastes from nuclear reactor operations. Waste management must now include major consideration of the high-level spent fuel waste problem and of the problems raised by low-level materials from steps other than reactor operations in the fuel cycle, such as the large amounts of tailings left over from the milling of uranium ore.

The third assumption is that high-level wastes are solely those resulting from the reprocessing of spent reactor fuel, i.e., that spent fuel is a resource. Given the major policy shift in 1976 by then President Ford not to regard spent fuel reprocessing as a ". . . necessary and inevitable step in the nuclear fuel cycle," and the recent Carter Administration thrust to indefinitely delay both the reprocessing of spent fuel and the use of the breeder reactor,[1] we must reorient the definition of high-level waste to take into account the possibility of covering many unreprocessed fuel bundles, as well as the high-level materials from commercial and military reprocessing operations. Table 3 offers a comparison, by volume, of the cumulative radioactive waste inventory with (U Recycle) and without (No Recycle) spent fuel reprocessing and the recycling of the uranium for fuel.

Carter's fiscal year 1978 budget cuts in the breeder reactor program further reduce the momentum to reprocess since the only way to provide adequate plutonium to fuel breeder reactors is by reprocessing commercial spent fuel. Cutting back on the breeder program helps eliminate the market for plutonium fuel and the major incentive to reprocess.

Finally, since the 1950's the general trend in the United States has been to assume that reprocessing simplifies the radioactive waste management problem. This was a standard

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[1]See, for example, Executive Office of the President, Statement by the President on Nuclear Policy of 27 October 1976; (Wash., D.C.: n.p., 1976) Report of the Nuclear Energy Policy Study Group (Ford Foundation), Nuclear Power: Issues and Choices (Cambridge, Mass.: Ballinger Pub. Co., 1977); Executive Office of the President, The National Energy Plan (Wash., D.C.: U.S. G.P.O., April 1977); and President Carter's recent statements on energy policy and nuclear energy.

justification for reprocessing in the United States--and still is elsewhere[1] -- until recent findings that it could actually add cost, handling, and disposal complications.[2]

> While it has been commonly believed, particularly abroad, that reprocessing to remove plutonium decreases the long-term hazards of waste, we have concluded that any reduction in long-term risks is small in comparison with the more immediate risks potentially arising in reprocessing and in the use of plutonium in the active fuel cycle. . . we have concluded that the international and social costs (of reprocessing and recycle) far outweigh economic benefits, which are very small even under optimistic assumptions.[3]

This introduces the relationship of waste management to the earlier steps in the nuclear power generation process. For many years, the waste management component of nuclear energy and weapons programs in this country and elsewhere received very low priority treatment in management decisions and resource allocation. Low-level wastes

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[1] "One must remember that reprocessing operations are the only way to safely manage future generated wastes," J. Couture, "A New Situation has Arisen in the Fuel Reprocessing Field," Proc. of the First Pacific Basin Conf. on Nuclear Power Development and the Fuel Cycle (Hinsdale, Ill.: Amer. Nuc. Soc., 1976), p. 556; this is still the trend in at least France and West Germany.

[2] See, for example, R. Krymm, "A New Look at Nuclear Power Costs," Int'l. Atomic Energy Agency Bull. no. 2 (1976), p. 2; and Institute of Int'l. Studies, Univ. of California, Berkeley, for U.S. Arms Control and Disarmament Agency, "Non-Proliferation and Nuclear Waste Management," Berkeley, 1977.

[3] Nuclear Energy Policy Study Group, Nuclear Power: Issues and Choices, p. 31. It should be noted that breeder reactors have a much higher burnup rate for their core fuels. This means that reprocessing spent breeder fuel will yield high-level wastes with even more transuranics than those in wastes from light water reactors. They would thus pose an even greater long-term hazard than the high-level wastes from light water reactors.

were dumped into the sea (the U.S., U.K. and other European countries) or buried in shallow land trenches, and high-level wastes were stored in large steel tanks. There was little, if any, consideration given to designing weapons, naval reactor, or energy production operations to make the final waste products more manageable.

On the contrary, wastes from U.S. military reprocessing at Hanford, Washington, and Savannah River, South Carolina, were chemically neutralized--greatly increasing the overall volume--for storage in relatively inexpensive carbon steel tanks. This was continued throughout the 1960's despite the availability of a calcining process used successfully at the Atomic Energy Commission's [1] Idaho Falls National Engineering Laboratory near Idaho Falls, Idaho, to reduce the volume by 9 or 10 times and leave the waste in a much more manageable form.

A Hanford program started in 1965 to remove the principal heat-generating elements and to reduce leakage from failing storage tanks by solidification is well advanced. Yet even this now appears to have been a very short-sighted, although then inexpensive, move because it has greatly complicated the problem of removing the wastes from the tanks and

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[1] The Atomic Energy Commission (AEC) was replaced by the Energy Research and Development Administration (ERDA) and the NRC in 1974-1975; see the Energy Reorganization Act of 1974, 42 U.S.C. 5814(a) (Supp. IV, 1974). As of 19 January 1975, all licensing and regulatory responsibilities were transferred to the NRC, 42 U.S.C. 5814(f) (Supp. IV, 1974).

preparing them for final disposal. A now often cited cost for only recovering and solidifying all existing high-level military wastes (created between 1946 and 1977) is 20 billion dollars.[1]

What are the potential waste management options? Figure 2 outlines the ones which the U.S. has considered.[2] The partitioning of the wastes into different fractions and recycling of certain elements for use as heat sources and for irradiating sewage present some interesting possibilities, but this only addresses a small portion of the wastes, and only on a temporary basis. Partitioning and transmutation--reburning in specially designed reactors--can transform many of the long-lived radionuclides into shorter-lived elements. Launch into space could completely eliminate some of the wastes. But serious economic, technical, safety, and net energy problems remain with the transmutation and space options.

Given the existing level of environmental and political pressures and technical constraints, it appears that two basic and complementary choices--fully retrievable storage on or in the earth's surface and geologic disposal in

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[1] See, for example, L. J. Carter, "Radioactive Wastes: Some Urgent Unfinished Business," Science 195 (18 February 1977): 661.

[2] For the most complete description of the search for disposal options in the U.S., see U.S. ERDA, Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle, Vol. 5 of 5 (Springfield, Va.: Nat'l. Tech. Info. Ser., Dept. of Commerce, 1976); see also Study Group on Nuclear Fuel Cycles and Waste Management, Report to the American Physical Society (n.p.: A.P.S., 1977).

salt, clays (on land or in the seabed), or rock [1] --will be available for radioactive waste management over the next ten to twenty years. While surface storage is well within reach technically, [2] and it will be required in some form for commercial spent fuel during at least the 1980's and into the 1990's, it is widely rejected as a final disposal option on social, economic, environmental, political, and institutional grounds. [3]

With the constraints on and limitations of the waste recycling and elimination options, geologic disposal has become the focus of waste management programs worldwide. [4] The

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[1] Serious potential scientific and technical problems--beyond the legal and political obstacles--seems to point to exclusion of ice sheet disposal as a possible alternative. These include, primarily, the possible existence of large "lakes" of water deep within the ice, the probable lack of geologic predictability (stability and movement of the ice) over the necessary time period, and the difficulty of emplacement at a precisely pre-determined depth and location in the ice.

[2] See, for example, Nat'l. Academy of Sciences, Interim Storage of Solidified High-Level Radioactive Wastes (Wash., D.C.: N.A.S., 1975).

[3] See Nuclear Energy Policy Study Group, Nuclear Power: Issues and Choices, p. 254; T. P. Lash, et al., Citizen's Guide: The National Debate on the Handling of Radioactive Wastes (Palo Alto, Calif.: Natural Resources Defense Council, 1975), p. 25; H. M. Parker, "Radioactive Waste Management in Selected Foreign Countries," Nuclear Technology 24 (December 1974): 305; and generally, Proc. of the Int'l. Symposium on the Management of Wastes from the LWR Fuel Cycle (Denver: U.S. ERDA, July 1976); and Report of the Meeting of the Int'l. Working Group on High-Level and Alpha-Bearing Wastes, 3 pts. (Vienna: IAEA, 1974).

[4] See, for example, the recent article by G. de Marsily, et al., "Nuclear Waste Disposal: Can the Geologist Guarantee Isolation?," Science 197 (5 August 1977): 519.

containment media of primary interest include salt, shale, granite, and clays. As illustrated in Figure 3 below, the concept depends on a multiple barrier system: first in line are man-made barriers--the form of the waste and the container; next are the natural barriers--the surrounding geologic media. Over the long-term the system succeeds or fails based on whether the geologic media--salt, rocks, or clay on land and clay sediments in the seabed--can be shown to isolate all the radionuclides in the wastes for the required periods of time.[1] All of the leading land-based possibilities would involve the mining out of a major underground facility along the lines of that shown in Figure 4.

We can expect vociferous debate over the isolation time which will have to be demonstrated for man-made barriers to be politically, as well as technically, acceptable. Claims may be made that assured isolation for the first few hundred years is sufficient since this is when the strong heat will pose the greatest threat to natural barriers. But, since expressions of confidence regarding technology for isolating wastes which will be toxic for hundreds of thousands of years are likely to be received ill by a skeptical public, serious exchanges will have to focus on the merits and demerits of the natural rather than the man-made barriers.

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[1] It is important to remember that the decay products of some of the radionuclides are elements (daughters) which are of even greater biological concern than their parents.

A Sub-Seabed Disposal Option?

For the past three years a team of U.S. scientists and engineers has been investigating the possibility of geologic disposal of high-level radioactive wastes within the deep seabed. Their results to date have been encouraging, but all statements of findings have been made cautiously.[1] Although they do not yet recommend implementing the concept, they suggest, in their continuing feasibility study, that certain clayey deep seabed sediments have strong potential for nearly permanent isolation of high-level wastes for man and the environment. Sub-seabed disposal of medium, or even low-level radioactive wastes and troublesome chemical wastes also seems to be a possibility.

Their focus is on very flat, inaccessible and relatively unproductive deep ocean floor areas in the

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[1]The most concise source of information on the oceanographic part of the U.S. ERDA Sub-seabed Assessment Program is Oceanus 20 (Winter, 1977); for more complete coverage, see the seabed study described in W. P. Bishop and C. D. Hollister, "Seabed Disposal--Where to Look," Nuclear Technology 24 (December, 1974): 425; Bishop and Hollister, "Nuclear Wastes Beneath the Deep Sea Floor," Proceedings of the Third Int'l. Ocean Development Conference (Tokyo: Seino Printing Co., 1975); D. R. Anderson, et al., "Release Pathways for Deep Seabed Disposal of Radioactive Waste," Proceedings of the Int'l. Symposium on Radiological Impacts of Releases from Nuclear Facilities into Aquatic Environments (Otaniemi, Finland: n.p., 1975); W. P. Bishop, ed., Seabed Disposal Program: A First Year Report (New Mexico: Sandia Labs, 1975); and D. M. Talbert, ed., Seabed Disposal Program: Annual Report (New Mexico: Sandia Labs, 1976).

central regions of tectonic plates.[1] These areas are believed to be more seismically inactive than any others on the ocean floor and possibly than any place on earth. The potential for environmental predictability over the geologic time scale required for isolation is thus perhaps available.

What must be established to a degree acceptable to both the public and the scientists is that:

> 1. The sediments have large enough sorption coefficients to prevent each radionuclide from escaping to the ocean.
> 2. The permeability of the sediments is so low as to minimize migration of the waste products when they are leached eventually into the pore water.
> 3. The first two factors, when taken together, will effectively isolate the waste within the geological medium for a period of at least several million years.
> 4. Geologic processes over the disposal area have been uniform and further that the site has suffered little or no environmental disturbance over the last ten million years.
> 5. The emplacement technique itself or the heat generated by the waste will not seriously affect the necessary containment.[2]

Perhaps the single most important factor is the amount of each radioactive element which is absorbed (sorption coefficient) by the particles of sediment from the surrounding

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[1] For the background and details, see W. Sullivan, Continents in Motion: The New Earth Debate (N.Y.: McGraw-Hill, 1974); for a layman's outline of tectonic plate theory, see A. Hallam, "Alfred Wegener and the Hypothesis of Continental Drift," Scientific American 232 (February 1975): 88; P. M. Hurley, "The Confirmation of Continental Drift," Scientific American 218 (April 1968): 52; J. W. Dewey, "Plate Tectonics," Scientific American 226 (May 1972): 56; and P. A. Rona, "Plate Tectonics and Mineral Resources," Scientific American 229 (July 1973): 86.

[2] C. D. Hollister, "The Seabed Option," Oceanus 20 (Winter 1977): 21.

water. This is crucial because only the radioactive particles which are not absorbed--and thus remain dissolved in the surrounding water--are available to be diffused outward through the sediments. It is so far clear that there is a high rate of absorption of the dissolved radioactive waste components of interest by the deep-sea sediments. Preliminary results indicate that some of the key radioactive elements would diffuse over about one to one hundred feet of deep-sea sediments in ten million years.[1]

It is also known that these sediments have low permeability (penetration by fluids is difficult) and that they are visco-elastic (they are self-healing after they have been disturbed). A series of laboratory simulation experiments on hole closure by the sediments indicate that ". . . closure of [a hole from] a completely penetrating projectile would be immediate and total, but closure of a hole left open by an emplacement rod would be gradual."[2]

Where would the sites be located? While most work so far has been done in a study area about 600 miles north of Hawaii, it is still too early to focus on specific sites. And present efforts are designed to determine only if the type of clay from this study area will provide the required

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[1] G. R. Heath, "Barriers to Radioactive Waste Migration," Oceanus 20 (Winter 1977): 28.

[2] A. J. Silva, "Physical Processes in Deep-Sea Clays," Oceanus 20 (Winter 1977): 39.

isolation. The next step is to identify the best submarine geologic formations and then to locate appropriate areas for further in situ study.

In addition to the scientific breakthrough in plate tectonics--which underlies the sub-seabed disposal concept--the recent engineering advances in open ocean and deep sea-bed operations are important for this program. Figure 5 shows the possible emplacement techniques for sub-seabed disposal. It now appears that the most reliable and accurate method for emplacing waste canisters would be a penetrometer--a streamlined, ballistic shaped container--which could be lowered from a winch and released just far enough above the seabed as to reach the velocity needed to penetrate to the depth determined to be required for isolation. A combination of weapons and deep sea technologies would allow highly accurate placement of a penetrometer at a pre-determined depth in these visco-elastic sediments. As noted above, experiments are being conducted to determine how the disturbed sediments react to this form of emplacement. There do not appear to be any real technical constraints on whatever monitoring, site location and marking operations are deemed necessary. Yet, if flaws appear later, retrieval of large numbers of penetrometers after a pilot project stage--though not impossible--can be expected to be very expensive and difficult.

Several differences between ERDA's Seabed Assessment Program and ERDA's land-based programs should be noted.

First, although the really serious U.S. efforts on land-based disposal options started only in 1975-76, data has been collected--especially on salt bed disposal--since the 1960's.[1] So the Seabed Program, which started only in 1973, is relatively new and not designed to produce an operational repository in the 1980's. This removes some of the environmental and political pressures for immediate answers.

Funding levels and management organizations are also different. About $3 to 4 million will be spent on the seabed study in fiscal year 1978, as opposed to about $78 million for land-based options. The Seabed Program is conducted by a group of independent scientists at universities and research institutions around the U.S.; it is managed by Sandia Laboratories (run by Western Electric for the U.S. ERDA) and funded by the U.S. ERDA's Assistant Administrator for Environment and Safety (rather than the Assistant Administrator for Nuclear Energy). The Office of Waste Isolation--Oak Ridge, Tennessee--of the Union Carbide Corporation

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[1] The disastrous performance (blundering managerial decisions and missing important facts) of the U.S. Atomic Energy Commission during the attempt to establish a high-level radioactive waste disposal repository in Lyons, Kansas, in 1970-1972 does create a public credibility problem concerning the quality of some of this data. For accounts of the ill-fated proposal to bury wastes in the salt beds at Lyons, see D. S. Metlay, "History and Interpretation of Radioactive Waste Management in the U.S.," Proposed Goals for Nuclear Waste Management: A Report to the U.S. NRC (Wash., D.C.: U.S. NRC, December 1976), pp. D-8 to D-14; Lash, pp. 34, 35; and Carter, p. 664.

manages the land-based disposal programs. ERDA's Oak Ridge Operations Office directs the programs under the ERDA Assistant Administrator for Nuclear Energy (Figure 6).

Finally, the Seabed Assessment Program presents legal, political, and scientific obstacles and opportunities on an international scale. Since implanting high-level radioactive waste in the seabed effectivelv withdraws from common use an area hitherto available to all on equal terms, the seabed is not likely to be available for unilateral use by any country--or at least not without serious international, legal and political consequences. It is entirely possible that the U.S. may be forced to abandon the program on international political or legal grounds.

The international political and legal constraints, however, could also turn out to have some advantageous aspects. It now seems extremely unlikely that any other country could or would use this disposal method without an arrangement involving the U.S. and certain international organizations. This would demand serious international discussion of high-level waste disposal.

Most important among the potential opportunities raised are international cooperation on radioactive waste management and on nuclear non-proliferation. The seabed disposal program now seems more likely to address the global aspects of the high-level waste disposal problem than land disposal options. This is due largely to the international cooperative and management arrangements necessary to the implementation of disposal in the deep seabed and the wide availability of such arrangements to many countries. It also seems to be one of the leading possibilities for international waste disposal plans under broader arrangements to control the further spread of nuclear weapons production capabilities.[1]

The Worldwide Radioactive Waste Situation: Present Waste Inventories and Future Trends in Nuclear Energy Production

The worldwide high-level radioactive materials inventory consists of the high-level liquid wastes from reprocessing plants operated for weapons production and for commercial nuclear energy programs, and the spent fuel from commercial power reactors. In the past governments often claimed (and many continue to claim) that spent fuel could not be included in the waste inventory since it was a resource. This is now misleading both because it is increasingly unlikely that all spent fuel will be reprocessed and because countries which go abroad for reprocessing services must count on having the wastes returned. Most countries must begin to consider unreprocessed spent fuel bundles as part of their high-level waste inventory.

The result--the U.S. is not alone in the disposal problem. There are approximately eighty million gallons of

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[1] An Associated Press by-line (NO27) of May 1977 by A. Gaushon noted that part of the Carter Administration's nuclear non-proliferation strategy will involve international sites for nuclear waste disposal. Sub-seabed disposal was cited as the leading possibility for such international cooperation. See, also, Chaps. 5 and 7, below. Personal communications with various U.S. government officials have since confirmed this information.

high-level wastes from military and commercial reprocessing operations in the U.S., or about one-half of the total world inventory of this form of high-level wastes (Table 4). Military wastes still constitute by far the largest part of these wastes which are now ready for direct disposal. They are somewhat less radioactive per unit volume than commercial wastes, but handling--at least in the U.S.--will be more difficult due to short-sighted past actions, such as the above noted chemical neutralization at Hanford which greatly increased the overall volume. The final disposal requirement for these wastes--almost permanent isolation--is identical to that for commercial wastes.

There are considerable quantities of high-level wastes from reprocessing in other countries with reprocessing programs for weapons and commercial applications, such as the U.S.S.R., France, and the U.K. The U.K., for example, has about 0.2 million gallons of liquid high-level waste, and expects to have about 0.5 and 2.0 million gallons by 1985 and 2000 respectively. Small, but increasing, quantities are accumulating in nations with pilot reprocessing facilities. Figure 7 provides an overview of the primary non-Communist nuclear fuel reprocessing projects. This shows which countries must handle this form of high-level radioactive wastes.

Every country operating nuclear reactors for energy (Figure 8) has, or will soon have, the other form of high-level wastes--spent fuel bundles--in storage pools and various low-level waste streams. And any country which mines, mills, fabricates, or enriches nuclear fuel faces the low-level waste problem.[1]

As measured in curies, the quantity of spent commercial fuel in the U.S. can now be considered as about equivalent to that of all military wastes.[2] Despite the enormous problem posed by the old military wastes at Hanford[3] in the U.S. and the major increases expected in weapons inventories worldwide, the overriding future problem will be the commercial wastes. This is due to the fact that the inventory of high-level commercial materials in most countries with nuclear energy programs will increase very rapidly in the 1980's and 1990's (the

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[1] U.S. commercial (low-level) transuranic-contaminated wastes alone present a major disposal problem. By the year 2000, they could, for example, amount to more than 700,000 55-gallon drums. It is now likely that these will have to be isolated in essentially the same way as high-level wastes.

[2] See W. P. Bishop, "The NRC and Nuclear Waste: The Process for Decisions," paper presented at the Atomic Industrial Forum Fuel Cycle Conference, April 1977.

[3] The handling, processing, and transportation problems are so severe that a forthcoming report by the National Academy of Sciences (Committee on Radioactive Waste Management) will apparently recommend final disposal in some form on site in Hanford, Washington.

doubling time will be about three years).[1]

It is clear that almost all nations with commitments to nuclear energy programs have many more reactors under construction, on order, or announced (letter of intent) than they now have in operation (Figure 9). The same generally holds true for worldwide spent fuel reprocessing facilities (Figure 7). And nuclear weapons production programs will continue to create significant quantities of wastes. These rapidly increasing commitments have crucial implications for the rest of this paper.

Yet the international nuclear energy situation has changed dramatically since about 1974. Estimates of program expansion in the leading nuclear energy nations have been greatly reduced. As of late 1976, projections of installed nuclear capacity by 1985 were running about 25% to 40% behind those made in 1974. Expected post Arab oil embargo increases in nuclear programs were outweighed by the decrease demand for energy during the worldwide economic recession in the mid 1970's, the newly arisen political and legal barriers in key countries to licensing new

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[1] See J. O. Blomeke, et al., Projections of Radioactive Wastes to be Generated by the U.S. Nuclear Power Industry (Oak Ridge, Tenn.: Oak Ridge Nat'l. Laboratory, February 1974); Expert Group of the Organization for Economic Cooperation and Development, Reprocessing of Spent Nuclear Fuel in OECD Countries (Paris: OECD, January 1977); and Y. Nishiwaki, "Preliminary Data on Waste Arising from the World's Projected Nuclear Power Programme Based on OECD/NEA and UNSCEAR Documents," working paper for IAEA advisory group meeting, Vienna, March 1977.

nuclear power plants, and the increased cost of nuclear power plants.[1] This has especially been the case in the U.S., Canada, and Japan, and in Western European nations such as France, Sweden, England, West Germany, Finland, Austria, Switzerland, Italy, and Belgium. Petitions, referenda, demonstrations, strikes, site takeovers, sabotage, bombings, and general environmental-political opposition have forced governments to completely reassess their nuclear policies.[2]

Virtual moratoria on new nuclear plant building or operating exist in several countries. England has not commissioned a power reactor since 1970. West German plans in 1973-1974 for 35 reactors by 1985 were cut to 25.[3] They face double capital costs for new reactors--since opposition groups have forced the use of expensive containment vessels--and major opposition to the siting of a reprocessing/high-level waste disposal facility. By

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[1] See, for example, "Europe's Nuclear Turn," New York Times, 26 August 1976, p. 32; the higher costs of nuclear power plants are largely a result of the construction and licensing delays which have been brought on by opposition to nuclear energy.

[2] See, for example, the clear shift in U.S. nuclear energy policy in: Executive Office of the President, The Nat'l. Energy Plan.

[3] See "Enthusiasm About Nuclear Power Turns to Anxiety in West Germany," New York Times, 7 February 1977, p. 8, col. 2; "Nuclear energy--its teething troubles and its promise for the future," German Tribune, 7 November 1976, no. 760, p. 8, col. 1; and "Opposition to Nuclear Power Growing in Western Europe," International Herald Tribune, 6 October 1976, p. 5, col. 3.

early 1977, West German administrative courts had halted new construction.[1]

Even in Japan, problems with uranium supply, enrichment, reprocessing, and waste disposal services, and siting have led the government and industry to reassess the feasibility of increased use of coal and oil. Japan and West Germany have been joined by Sweden in requiring utilities to have arrangements for reprocessing and high-level waste disposal before nuclear plant operating licenses are granted. An ongoing study by a government energy commission in Sweden must convince the Parliament, by 1978, of the feasibility of waste disposal if the nuclear energy program is to continue.

Plans to build the first power stations in Ireland, Norway, and Denmark have been postponed. Belgium has decided not to build any reactors on the coast or on artificial islands in the North Sea.[2] And many other countries have postponed decisions on whether to build new stations.

In almost all cases, this nuclear opposition has been based--at least in part--on perceived waste management problems. Most often the focus is on a lack of proven plans for high-level and other waste disposal, the

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[1] "Building of Nuclear Plants Halted in West Germany," New York Times, 15 March 1977, p. 8, col. 2.

[2] World Env. Rpt. 2 (30 August 1976): 2; and World Env. Rpt. 1 (27 October 1975): 2.

possibility of cross-border pollution or contamination, or some local operation--usually reprocessing--involving wastes from other countries.[1] Waste management problems have been largely responsible for virtually halting the expansion of nuclear programs in Sweden, Japan, West Germany, and the U.S.

Outspoken criticism arose in the U.K. over government plans to keep the wastes arising from the reprocessing of Japanese fuel. Subsequently, the British Energy Secretary announced that foreign reprocessing contracts must allow for the possible return of resulting wastes and British citizens, scientists, politicians, and environmental groups raised a huge protest against an expansion of the Windscale reprocessing facility. The protest was based largely on important international issues of radioactive waste management, i.e., increased discharges of liquid wastes into the Irish Sea (and thus into the North Sea) and of gaseous wastes into the atmosphere, and increased storage of foreign wastes in the U.K.[2]

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[1]For a detailed review of nuclear opposition in the U.S., West Germany, France, Japan, and Sweden, see J. Surrey and C. Huggett, "Opposition to Nuclear Power," Energy Policy 4 (December 1976): 286-307; open debate over final high-level waste disposal has occurred in at least the U.S., France, West Germany, Sweden, and Japan. In France opposition among scientists, environmental groups, trade unions, and politicians has been heightened by press reports and information leaks from government and industry on radioactive waste releases and houses which have been constructed on radioactive wastes.

[2]See "Radiation Contamination in the Irish Sea," Marine Pollution Bull. 8 (1977): 51; and S. Bonney, "Windscale--Power versus Pollution," Marine Pollution Bull. 8 (1977): 7.

Strong nuclear opposition in Switzerland led to a major report in 1975 by the federal Energy Department and the establishment of an investigation of local rock formations for radioactive waste disposal.[1] This study has since been halted by communities which refuse to permit further coring even for laboratory samples, of candidate rock types. In Belgium the Eurochemic (joint European reprocessing venture) waste management problem serves as a conspicuous example of similar failure on the international level. Operational, financial, and legal responsibility for the waste was not arranged from the start. Now there is real confusion over where and how disposal will be done.

Three characteristics of this opposition to nuclear energy development merit careful consideration.

1) First is the particular sensitivity of national groups to the prospect of offering territory to be used as a repository for another nation's wastes.

2) Second is the highly interactive nature of the international system on nuclear opposition issues.[2] Environmental and political groups in Switzerland, for example, are directly affected by nuclear events in France. Opposi-

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[1]The Department of Geology at the University of Zurich was conducting the study for the government using cores taken from favorable rock types.

[2]See, generally, Surrey and Huggett; H. Wasserman, "The Clamshell Alliance: Getting it Together," and W. Hines, "Anti-Nuclear Ferment in Europe," The Progressive, September 1977, pp. 14-21.

tion movements against a reactor in Lyon (France) draw protestors from Switzerland, West Germany and Italy. Press releases on the recent report of the U.K.'s Royal Commission on Pollution[1] had impacts on nuclear energy programs in at least the U.S., Japan and Western Europe. Bureaucrats, politicians and industrialists are thus very sensitive to the import of nuclear opposition, especially from the U.S., and the problems of international cooperation on nuclear waste management.

3) Finally, there seems to be a consistent progression to the public opposition. The first public reactions are often based on specific siting proposals. As nuclear programs grow, opposition movements coalesce and broaden their issue base. This is the point at which the political process begins to be influenced and waste disposal often becomes a central issue.

Apparently unscathed by such public opposition, the Soviet Union's nuclear power program is advancing rapidly.[2] With only five civilian nuclear stations operating by 1975,

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[1] Royal Commission on Environmental Pollution, Nuclear Power and the Environment, Sixth Report (London: HMSO, September 1976).

[2] This is despite the reported thermal explosion in a Soviet shallow land burial site for radioactive waste in the Urals. In December of 1976, the exiled Soviet Scientist Z. A. Medvedev stated that the 1958 explosion killed hundreds of people and caused thousands of cases of radiation sickness; see New York Times, 7 December 1976, p. 18, col. 1; and "ABC Evening News," 7 December 1976.

the Soviet Union had maintained a very low level commitment. But plans now call for major expansion in the late 1970's and the 1980's. Development is concentrated in European areas, especially the Ukraine, since it has most of the industry and population and little of the fossil fuel.[1] By 1980 the overall Soviet capacity should be about equivalent to that in France or West Germany. This should heighten Soviet interest in and efforts on high-level waste disposal.

Eastern European nuclear energy programs are also accelerating. Czechoslovakia, Bulgaria and East Germany have plants in operation and more under construction and planned (Figure 9). Construction has started on at least one station and plans have been made for further additions in Hungary, Poland, Rumania and Yugoslavia. Spent fuel from most of these countries, Finland, and elsewhere when reactors were supplied by the U.S.S.R. is apparently returned to the Soviet Union.

Many of the relatively wealthy LDC's, such as South Korea, the Philippines, Iran, Mexico, Argentina, Brazil, Taiwan, and India have ambitious nuclear programs underway. With three reactors now in operation, India is the unquestioned leader in nuclear energy development and the only one participating widely in international meetings on radioactive waste management. Argentina and Pakistan each have

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[1] See, for example, "Soviet Union Steps Up Installation of Nuclear Power Plants," New York Times, 14 January 1977, p. D1, col. 2.

one power reactor in operation.

It is difficult to discern clear trends in nuclear energy development in the LDC's. The establishment and expansion of national programs is encouraged by the specific demonstration effect of India's major nuclear capabilities (including the weapons production capability), and by drives for regional political power, international prestige, and weapons production capabilities. Dramatically increased oil import bills in the LDC's. excess production capacity in supplier nations' nuclear industries (due to the major slow-down in nuclear expansion in Western Europe and the U.S.), and promotional efforts by the International Atomic Energy Agency are also contributing to the drive for nuclear energy stations in the LDC's. A number of factors, such as the large increases in capital and operating costs of nuclear plants and the lack of foreign exchange--despite the often very easy financial terms offered, inhibit such national development. In any case, an increasing number of LDC's--perhaps as many as 20 by 1985--will have major nuclear power stations in operation.

Despite the slow-downs in the rate of expansion of industrialized nations' nuclear programs, the industry has considerable inertia. Existing commitments worldwide thus already guarantee that dramatic increases in low-level waste and spent fuel inventories will occur in the 1980's and 1990's and that the high-level waste problem will be dominated by commercial nuclear programs by the 1980's. These levels of existing and planned national commitment to nuclear energy will largely determine the degree of effort put into addressing the high-level waste disposal problem.

National Radioactive Waste Management Programs and Plans

Because many national waste management programs and plans are similar, it is possible to sketch the general practices and to note any distinctive features on an individual country basis. National programs and plans are most advanced in the areas of short-term concern, e.g., storage, processing, and transport. Least developed is the long-term and problematical step of final disposal.

Low-Level Radioactive Wastes

Though there are serious efforts underway to remove accumulative elements, such as ^{85}Kr, iodine, and tritium from gaseous wastes, they are largely a problem of the future. Particular attention must be devoted to the design of large capacity reprocessing plants, since gaseous wastes from these will become a problem.[1]

A large volume of miscellaneous solid low-level wastes is compacted--and often burned--prior to containment in steel drums. These are stored on land, buried in shallow

[1]There is an exception: radon gas and radioactive dust have always been a serious health hazard for uranium miners. See, for example, K. Z. Morgan, "Adequacy of Present Radiation Standards," The Environmental and Ecological Forum 1970-1971 (n.p.: TID-25857, June 1972), p. 105 and Lash, pp. 9-11, 15-17.

trenches, or dumped into the sea. Before dumping in steel drums they are generally encased in concrete or bitumen.[1] Since land storage is only an interim measure, and burial and dumping--especially of transuranic-contaminated low-level trash--face increasing problems and opposition, there is a general movement toward better processing and containment with disposal in fewer and more manageable sites.

Enormous volumes of very low-level liquid wastes are continually released to rivers and oceans worldwide. Reactor operations on nuclear-powered ships and in electrical generating stations discharge very low-level, but measurable amounts. Pipeline disposal of fuel reprocessing wastes takes place in the U.K., France, India, Italy, and West Germany. In both quantity and type of radioactive release, reprocessing plants pose by far the most serious problem.[2] Nations generally plan to reduce radionuclide release rates. Yet at least the British are increasing the limits for pipeline disposal from reprocessing plants. Definitions of "lowest practicable level" vary. And overall volumes of liquids released will increase dramatically.

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[1] This is not always the case. The Nuclear Energy Agency dumping operations of June, 1976, were suspended after one container broke open as it hit the water--scattering radioactive trash on the surface--and one floated. Both were from the Eurochemic operations at Mol, Belgium; see <u>World Env. Rpt.</u> 2 (30 August 1976): 5.

[2] See V. T. Bowen, "Non-USA Disposal of Radioactive Waste in the Oceans: Past and Ongoing," Woods Hole, Mass., 1976. (Mimeographed.)

"It is quite likely, although difficult to prove, that this category of low-level wastes will lead to more environmental exposure than all the rest combined." [1]

Medium-Level Wastes

Some countries establish a category of medium or intermediate-level wastes. They are either converted to high-level solids and low-level liquids or concentrated and neutralized--perhaps in a bitumen form--for tank storage. Most countries have no real plan for solid trash--often called medium-level, such as parts of decommissioned reactors.

High-Level Wastes

Most of the high-level liquid waste from spent fuel reprocessing operations still sits in steel storage tanks in a liquid or sludge form. Leaks and other problems with old steel tanks have led to general use of double-walled stainless steel tanks. This is now widely accepted to be an interim step at best. Each country has its own processing method under investigation for high-level wastes from reprocessing. The idea is to allow a few months (corresponding to heat generation period one, as described above) or even years for initial cooling (while many of the short-lived radioactive elements decay) and then to solidify for safer storage, handling, and transport.

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[1] H. M. Parker, "Radioactive Waste Management in Selected Foreign Countries," Nuclear Technology 24 (December 1974): 305.

Solidification by calcination, often but not necessarily followed by vitrification, is a common plan. There is still considerable debate over the integrity and long-term nature of vitrified high-level waste, but the material could be almost insoluble over the short-term and would dissolve very slowly over thousands of years.

There is also serious investigation underway in some nations of processes which would separate certain parts of the high-level reprocessing wastes. Removal of fission products such as strontium and cesium greatly eases the heat generation problem over the first few hundred years (corresponding to heat generation period two, as described above) and allows their use as heat sources. These separation processes are based on national plans to reprocess. The management of the other source of high-level waste--spent fuel bundles--has not, in general, been seriously considered. Many future studies of the best way to encapsulate, store, and dispose of spent fuel can be expected, expecially in the U.S.

Some countries such as India and Canada plan on periods of retrievable storage for as long as 20 to 30 years (similar to that now planned in the U.S.). But there is general agreement that solidified and/or encapsulated high-level wastes must be permanently isolated from the biosphere. The accepted isolation medium is stable geologic formations with the highest potential for radionuclide retention and the longest possible record of undisturbed (unfractured, aseismic) existence. Most nations have programs to assess salt, rock or clay (land or deep seabed) formations.

Radioactive Waste Management Programs and Plans in the U.S.

The large increase in the United States ERDA waste management budget for 1976-1977 is evidence of a very recent transition to a program receiving high-interest within the the Federal Government (Figure 10). This does not, however, address the general confusion over federal-state relations in commercial low-level waste disposal, the 600,000 gallons of commercial high-level waste at West Valley, N.Y., the siting of high-level waste disposal facilities and other aspects of radioactive waste management in the U.S. It also stops far short of the waste disposal corporation recommended by ERDA critics.[1]

The distinctive feature of U.S. low-level waste disposal practice is that it has been done as a commercial business on six state-owned sites under the overall supervision of the NRC, the Environmental Protection Agency (EPA), and other federal agencies.[2] Recently identified problems

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[1]See M. Willrich, "Institutional Arrangements for Radioactive Waste Management," and W. O. Doub, "Problems of Organizational Structure in the Federal/State System," Proc. of Conference on Public Policy Issues in Nuclear Waste Management (Wash., D.C.: MITRE Corp., 1977) pp. 176-190.

[2]U.S. NRC, Task Force Report; "Under Section 274 of the Atomic Energy Act [42 U.S.C. 2011 et. seq. (1972)], individual states may assume regulatory and licensing jurisdiction over by-product, source, and special nuclear material in quantities not sufficient to form a critical mass. As of December 1975, NRC had concluded agreements for cooperation with 25 states. . . . The NRC and EPA, among other Federal agencies, supervise state-licensed commercial facilities." (Doub, p. 182.) A major problem is the lack of uniform criteria for the NRC-state agreements. The result is wide variation in the regulations among the involved states, as well as between the states and the Federal government. This limited function is the only area of direct state authority in the regulation of nuclear energy.

with this practice and the changing attitudes toward disposal requirements for transuranic-contaminated low-level wastes have led to the pending NRC rule change which would establish ERDA custody over most transuranic-contaminated low-level wastes. If the rule passes, ERDA is expected to require permanent geologic containment for the huge volumes of transuranic wastes.[1]

One reason for the Federal government's growing interest is that radioactive waste management has become one of the two or three major issues raised by opponents of nuclear energy. Many groups are now focusing on high-level waste disposal as the primary defect in increased reliance on this power source. The situation is clearly aggravated by the past record with the management of high-level military wastes.[2] Severe pressure has developed on the federal agencies with energy-related responsibilities to demonstrate waste disposal technologies. This is a direct consequence of environmental and political opposition to the construction and operation of more nuclear power plants prior to

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[1]For interpretive histories of the U.S. governmental efforts in radioactive waste management, see, generally, Carter; Lash; and Metlay.

[2]"The growing international awareness of the dangers inherent in commercial nuclear wastes undoubtedly has been influenced by the fact that, after 30 years of manufacturing plutonium for nuclear weapons, the United States has not firmly established management plans for the final disposal of millions of gallons of high-level wastes produced for military programs," Frosch, p. 5.

the solution of waste management, especially disposal problems.

Proposals to bury high-level radioactive wastes at land sites around the United States are now advancing rapidly. In December of 1976, ERDA announced that six waste repositories in salt beds, shale, or granite would be established by the year 2000. A decision on the first site, which is scheduled to be an operational repository by 1985, is expected to be made by early 1979. Two similar repositories are planned for the disposal of military wastes. The technologies for packaging, transporting, and disposing of spent fuel bundles are supposed to be in operation by 1985.

But the nuclear energy interests in the Federal government are continuing to encounter opposition from environmental groups, federal agencies with other responsibilities, resource-based industries (with salt bed interests), states, counties, cities, and towns. Most salient of the opposition to the siting of high-level waste disposal repositories in the U.S. has been that by states and counties. Kansas, for example, was successful in the early 1970's in terminating an effort to use its salt beds for high-level waste disposal.

During 1976 a number of states enacted legislation on radioactive waste disposal. Three states passed laws initiating formal studies of the problem; a study in California was accompanied by a ban on further nuclear power plant construction pending state certification and federal approval of a high-level waste disposal technique.[1] The Hawaiian legislature passed a resolution expressing concern over the study of the disposal of radioactive waste in the Pacific Ocean--confusing this with the U.S. ERDA Seabed Assessment Program for studying sub-seabed disposal.[2]

Despite their clear defeat (the average was 2 to 1) in all cases, nuclear opponents in six western and mid-western states succeeded in getting nuclear initiatives on the 2 November 1976 ballot. The initiatives included, among other things, provisions making all future construction of nuclear plants contingent on prior state legislative review and approval of federal waste disposal systems. Also on 2 November 1976, non-binding advisory referenda in two counties in Michigan's upper peninsula separately rejected (by 2 to 1) any further siting there of federal high-level waste disposal repositories.[3]

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[1] Cal. Pub. Res. CODE, Sec. 25524.2 (West 1976).

[2] SR-68 SD-1 (1976); this concurrent resolution, passed by the Hawaiian Legislature on 5 April 1976, also requested the U.S. EPA to halt any plans for "undersea" disposal until their safety is "proven beyond any shadow of doubt."

[3] See L. J. Carter, "Nuclear Initiatives: Two Sides Disagree on Meaning of Defeat," Science 194 (19 November 1976): 811, 812; and Sierra Club, "Nuclear Initiatives: Six Down," Nat'l. News Report, no. 36 (5 November 1976); the opposition in Michigan started in the Spring of 1976 when it became apparent that ERDA intended to conduct exploratory drilling in local salt deposits. After this became a major issue with the local press, officials, and congressmen, ERDA abandoned, at least temporarily, its plans; see Carter, "Radioactive Wastes," p. 665.

By late Fall of 1976, the U.S. ERDA had sent letters concerning its intention to conduct local radioactive waste disposal studies to thirty states. Nearly complete state veto power in the siting decision for disposal facilities was guaranteed. The legal basis of such assurances is limited. Ultimately, federal preemption would probably be established for the siting--at least on federal land--of high-level nuclear waste disposal repositories.[1]

Yet these guarantees of vital state participation in the siting process reflect a federal awareness that state

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[1] As noted above, p. 37, Section 274 of the Atomic Energy Act of 1954 enabled the AEC (now the NRC) to turn over federal regulatory authority to the states in the area of commercial low-level radioactive waste management. This, however, has been a carefully circumscribed exemption from a long and consistent history, built upon constitutional, statutory, and administrative elements, of federal preemption in the area. Without such a specific agreement states have no authority to regulate radiological matters. Federal preemption over the siting of high-level waste disposal repositories is confirmed by both Secs. 5842(3) and (4) of the Energy Reorganization Act of 1974 (42 U.S.C. 5801-5891 (1974)), which reiterates that the management of high-level waste is exclusively a federal concern, and the case law. Despite the ruling in Huron Cement Co. v. City of Detroit (362 U.S. 440 (1960)) that a state's interest in local pollution may allow regulation of federally licensed ships, the situation remains very different in nuclear energy. Northern States Power Co. v. Minnesota (447 F.2d 1143, 1 ELR 20451 (8th Cir. 1971), aff'd. 405 U.S. 1035 (1972)) held that a state statute enacting stricter pollution control standards (for effluent discharges from nuclear plants) than those set under federal legislation was preempted by the Atomic Energy Act. Among the factors relied upon, the need for exclusive federal regulation in the area and the pervasiveness of the federal regulatory regime are especially persuasive. This leading case has been confirmed by administrative practice and the state courts.

legal, but especially political, powers over local radioactive waste disposal are not insignificant. The states involved, through procedural delays and transportation restrictions (at least on a temporary basis), can make such siting an extremely difficult exercise with serious political implications for the ERDA waste disposal program.

State responses have been rapid to ERDA's formal announcement, in early 1977, of an expanded study of geologic formations for high-level waste disposal, leading to the selection of two sites by early 1979. As of July 1977, two states had enacted flat bans on such disposal within their borders; nine other states had similar bills pending. Three states had passed laws requiring prior authorization of such disposal by the legislatures; at least three had similar bills pending. Almost all of these states are on ERDA's list of candidate locations for a repository. Numerous other state laws restricting some aspect of local radioactive waste disposal were passed or proposed in 1977. And various states passed resolutions expressing opposition to the local siting of any radioactive waste storage or disposal facilities.[1] Many cities and towns have placed severe restrictions or complete bans on the local transport of radioactive wastes.

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[1] See, generally, Office of State Programs, U.S. NRC, Information Report on State Legislation 3 (1977).

Thus while ERDA officials are optimistic about finding acceptable high-level waste disposal sites, technically and politically speaking it is nowhere near a certainty that acceptable sites can be found. This is particularly true as long as state and local officials seem to have strong political, if only limited legal, power over siting decisions. Additionally, the Nuclear Regulatory Commission (NRC) is still in the process of formulating goals on high-level waste disposal. An NRC Workshop on nuclear waste disposal repository siting in November of 1976 in Keystone, Colorado ("Resource Potential and Environmental Stability of the Planet Earth for the Next Million Years") concluded that potentially suitable sites exist in northern North America, Canada, and Western Australia (pre-Cambrian granite shield rocks), and the mid-plate region of ocean tectonic plates. Site suitability criteria for high-level waste disposal are being established by the NRC in 1977-78.

All the concerted pressure for a disposal solution on the part of environmentalists and others could have a negative effect on developing a sensible waste management program. The present race by ERDA to solve the disposal problem might curtail a careful investigation, testing, and evaluation of all serious options. It also could lead to inadequate demonstration of technologies before implementation, and to delays and errors that would further heighten public distrust. Thus, the NRC and the public should be brought into the decision-making process at a very early stage.[1]

British Waste Management Plans

Confused responsibilities and a lack of clear priorities and policies have also plagued the British waste management program. The report in 1976 by the Royal Commission on Environmental Pollution,[2] which was released just before the major report on legal and institutional aspects of radioactive waste management in the U.S.,[3] recommended the establishment of a National Waste Disposal Corporation

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[1]Sec. 552(a) of the Administrative Procedure Act (APA) (5 U.S.C. 551 _et seq._, 701 _et seq._ (1970), ELR 41001) establishes public access to most major rulings and decisions by federal agencies, such as ERDA, and the NRC (through the Atomic Energy Act of 1954, sec. 181, 42 U.S.C. 2231 (1970)). The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321-4349 (1970), ELR 41009), especially as interpreted by the courts (see, for example, Hanly v. Kleindienst (Hanly II), 471 F.2d 823 (1970), 2 ELR at 20723), goes even further in requiring public access to, and some participation in (through comment and hearing procedures), major federal actions, such as radioactive waste management facility siting, which significantly affect the environment. In the case of siting radioactive waste disposal facilities, however, it is increasingly clear that detailed procedural arrangements (even beyond those formally required by the APA and NEPA) for public participation in the formulation of criteria and standards and in siting decisions will be essential to effective federal regulation and policy.

[2]See, generally, Royal Commission on Environmental Pollution, _Nuclear Power and the Environment_.

[3]This same conclusion was reached for the U.S. in M. Willrich, "Radioactive Waste Management and Regulation," Report to the U.S. ERDA (Cambridge: M.I.T. Energy Lab., 1977).

to correct the situation. It was highly critical of waste management practices and the apparent lack of interest in the high-level waste disposal problem. Major programs were recommended on the ". . . two reasonable options for the permanent disposal of high-level vitrified waste, namely geological formations on land and below the ocean floor in stable areas.[1]

A hostile response by the U.K. Atomic Energy Agency and a forthcoming government White Paper on nuclear policy indicate that the British Royal Commission Report may not represent official policy. The Report does, however, confirm the fact that British programs and plans rely heavily on future ocean disposal for several categories of radioactive waste. After a few years of storage, medium-level reprocessing wastes at Windscale are to be piped to sea. Corroded drums of 1950's weapons wastes, large volumes of plutonium-contaminated solid wastes, increasing quantities of low and medium-level materials and possibly even blocks of vitrified high-level wastes are apparently destined for ocean dumping.[2] British Nuclear Fuels Limited plans to seek permission for increases, by two orders of magnitude, in the ocean dumping of radioactive wastes conducted through the annual Nuclear Energy Agency sponsored operations.

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[1] Royal Commission on Environmental Pollution, pp. 150-152.

[2] Ibid., pp. 136-142.

As recent converts to the belief that solidification and geologic isolation programs are necessary, the British now plan on a long-term program to develop geologic high-level waste disposal options.[1] Surveys of clay and crystalline rock formations have been started. A package of research proposals from the Natural Environmental Research Council (NERC) on disposal in land formations, in the seabed and on the seabed has recently been circulated within the government. But badly splintered governmental responsibilities among British Nuclear Fuels Limited, the Atomic Energy Authority, the National Radiological Protection Board, the NERC (sponsoring work by the Institute of Oceanographic Sciences and the Institute of Geological Sciences), the Ministry of Agriculture, Fisheries and Food, and the Department of Environment leave a major leadership vacuum. There does appear to be a real willingness to support, or even to lead, the international research and development effort on sub-seabed disposal which is being conducted through the Radioactive Waste Management Committee of the Nuclear Energy Agency.[2] What could jeopardize the value of British efforts here and perhaps even the entire

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[1] According to statements by various British officials, during the Second Int'l. Workshop on Seabed Disposal of Radioactive Waste, Wash., D.C., March 1977 (in which this author participated), from organizations with major nuclear waste management responsibilities, an operational repository is expected by the year 2000.

[2] _Ibid_.

international seabed disposal program is the yet unresolved debate over whether the British should mount a serious study of high-level waste disposal onto the surface of the sea floor. The political and legal problems of this concept will be discussed in later chapters.

Waste Management in France

Unique to the French program are advanced processes for waste segregation and compaction, incineration of transuranic wastes, and bituminization and vitrification of high-level liquid wastes. A major shift has occurred in the period of 1975-1977 in their perspective on waste management. Instead of the local, fully manageable nature of the problem, they now stress the global implications and serious need for international cooperation.[1]

As in the U.K., national and regional/international reprocessing operations are underway and assumed to be an integral part of the future program. As of early 1976, the high-level wastes from reprocessing were to be solidified, stored for 20-30 years, separated from the transuranics, and disposed of geologically. More recently the French plan includes land-based storage or disposal for the fission products and sub-seabed disposal for the transuranics. French goals of permanent isolation and international cooperation for high-level waste disposal seem to

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[1] Ibid.; see, generally, Report of the Meeting of the Int'l. Working Group; and G. de Marsily.

be very similar to those of the U.S.[1]

Waste Management in West Germany

West German waste management programs are relatively well advanced in the non-high-level waste disposal areas. Most distinctive is the existence of the world's only fully operational low and medium-level waste disposal facility at Asse. Abandoned caverns in an old salt and potash mine at 500-700 meters are filled with radioactive waste and sealed off with salt. The medium-level operations are all done remotely. A recent excavation is designed for medium/high-level materials, but recent salt movement and stress measurements, predictions that the mine may ultimately be flooded, and other chemical and geologic limitations on this site have led to an announced exclusion of high-level wastes.[2] This could eventually have serious implications for the U.S. salt bed disposal efforts.

Disposal plans for higher transuranic content and fission product wastes include individually bored holes or mined cavities in salt domes to be located under a reprocessing facility. But environmental and political opposition--sometimes violent since 1975--now threatens

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[1] Ibid.; and C. Frejacques, "The French Program," Proc. of the Int'l. Symposium on the Management of LWR Wastes, p. 18.

[2] See K. Kuhn and J. Hamstra, "Geologic Isolation of Radioactive Wastes in the Federal Republic of Germany and the Respective Program of The Netherlands," Proc. of the Int'l. Symposium on the Management of LWR Wastes, pp. 586, 594; and W. J. Schmidt-Kuster, "The German Program and Objectives for Management of Wastes from the LWR Fuel Cycle," Proc. of the Int'l. Symposium, pp. 22-27.

both this disposal plan and the siting of a reprocessing plant. Local petition and referendum rights, powers of the courts, and confused responsibilities between the states and the Federal government have caused delays and major policy shifts.[1] In early 1977 the largest and most densely populated state, North Rhine--Westphalia, adopted a policy of requiring the solution of the spent fuel disposal problem prior to power plant licensing. The governor of Lower Saxony, the state with the salt domes and the intended reprocessing site, stated publically to the Federal government that such nuclear wastes should be sent to the U.S.[2] Chancellor Schmidt has since announced that construction permits for new nuclear plants will not be granted without prior arrangements for spent fuel reprocessing and waste disposal.[3] This forces the issues of reprocessing and waste management since the pressures for continued expansion of the nuclear energy program are severe. The policy is based on one of the invalid assumptions discussed above, i.e., that the reprocessing of spent fuel is, in part, necessary because it simplifies waste management.

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[1]See "Opposition to Nuclear Power," Energy Policy 4 (December 1976): 286-307.

[2]See "Enthusiasm about Nuclear Power Turns to Anxiety in West Germany," New York Times, 7 February 1977, p. 8; the governor did not say how the wastes should be transported or what the U.S. should do with them.

[3]See, for example, "Germany's Sales of Nuclear Reactors Sparking Discord," New York Times, 30 January 1977, p. 10.

Waste Management in Japan

Japan's proposed waste management program and plans are best described by Figures 11 and 12. No land burial of low-level wastes is allowed, although 15 sites are being evaluated for possible future use. Land-based disposal efforts for low and high-level wastes shown on Figures 11 and 12 are not expected to produce any acceptable options. So there is strong interest in ocean dumping for low-level materials and any option for high-level disposal outside of Japan; they are participating in the international R & D effort on sub-seabed disposal and are interested in island disposal or any international reprocessing and disposal arrangement.

A recent proposal from the Nuclear Energy Advisory Subcommittee of the Japanese Ministry of International Trade and Industry included actions to reduce Japan's heavy dependence on other countries for waste disposal and reprocessing.[1] But this is not easy. Japan's radioactive waste management situation is even more problematical than those of the European nations. Memories of Hiroshima and Nagasaki, mercury poisoning and other pollution threats, problems with the nuclear-powered ship MUTSU, local public (including very powerful fishermen and farmer groups) and governmental opposition to facility sitings

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[1] See Energy Users Report--Current Report, no. 81, 27 January 1977.

and transport or handling of radioactive materials, tightly constrained fishing, agricultural, population settlement, and seismic situations, and cultural tendencies toward satisfying any and all public objections make the problem extremely complex. Earlier arrangements with the U.K. have been changed: the wastes from reprocessing Japanese fuel in the U.K. can now be returned to Japan by a future U.K. government. This would add to the large amount of reprocessing wastes which will have to be handled in Japan after 1980.

Waste Management in Canada

Since the Candian CANDU, or near breeder reactor system, was never premised on a need for reprocessing the natural uranium fuel, the waste management program has focused on interim spent fuel storage. Throughout the 1960's and early 1970's, the policy was that there were no high-level wastes in Canada since a decision on reprocessing--based on whether it ever became economical--was years off.

Dramatically increased environmental and political opposition to nuclear energy since 1975 has led to some changes. Long-term spent fuel storage in cooling ponds within reactor buildings seems to be giving way to Ontario Hydro plans for a central fuel storage facility by 1985.[1]

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[1]S. A. Mayman, et al., "The Canadian Program for Storage and Disposal of Spent Fuel and High-Level Wastes," (IAEA-SM-207/91) Proc. of the IAEA and NEA Symposium on Management of Radioactive Wastes from the Nuclear Fuel Cycle (Vienna, March 1976), p. 49.

And the close monitoring of the U.S. salt bed disposal studies has been expanded to a full geologic disposal program, especially on the granite Canadian shield.[1] Canada now seems to favor high-level waste disposal in a cavity mined into hard rock, with salt beds as a second choice. There is also come interest in the possibility of building a disposal repository on an offshore island. They are following the international seabed disposal program closely and carefully monitoring research conducted in other countries on ocean disposal methods.[2]

Waste Management in the Soviet Union

There is a limited quantity of information available on the Soviet program. It is known that they have made a practice of injecting all levels of liquid and gaseous wastes into deep--1000-1500 meters--and permeable geologic strata. This does not, however, seem to be their plan for disposing of future high-level waste. An industrial scale operation now involves storing evaporated high-level liquids in stainless steel tanks on an interim basis. Plans call for vitrification--an area of serious work--and then long-term use of surface storage facilities. It now seems clear

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[1] See P. J. Dyne, "Canadian Geologic Isolation Program," Proc. of the Int'l. Symposium on the Management of LWR Wastes, p. 601; and W. W. Morgan, "The Management of Spent CANDU fuel," Nuclear Technology 24 (December 1974): 60.

[2] See G. Vilks, "The Disposal of High Level Nuclear Waste in the Oceans," Geoscience Canada 3 (November 1976): 295; very recently there have been indications of Canadian interest in participation, as an observer, in the international R and D program on sub-seabed disposal.

that they are also in search of an acceptable final high-level waste disposal option.[1] Other plans call for bituminization of medium-level wastes and no shipment of high-level liquids. Given their long record of condemning radioactive waste dumping into the sea,[2] they would presumably not use this disposal method. Yet there is some evidence that they used to dump packaged solid wastes into the Pacific and they did participate in a joint international scientific search for a suitable dumping site in the North Atlantic Ocean in 1960.[3]

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[1]The deep injection, vitrification, and other Soviet practices and plans are described in several sources; see Parker, p. 305; V. K. Tolpygo and B. Friedrich, "Co-operation between Member States of the Council for Mutual Economic Assistance (CMEA) in Radioactive Waste Treatment and Burial," (IAEA-SM-207/112) Proc. of IAEA and NEA Symposium on Management of Radioactive Wastes from the Nuclear Fuel Cycle (Vienna: March 1976), p. 77; W. L. Lennemann, "Radioactive Waste Management," briefing prepared for U.S. Nat'l. Academy of Sciences/Nat'l. Research Council Radioactive Waste Management Committee, Wash., D.C., 15 February 1977, p. 7 and Table 3.

[2]The Soviet Union has been an outspoken critic of past U.S. and European, especially British, dumping practices. It has accused the U.S., U.K., and France of polluting the Atlantic, while emphasizing the view--arising from military and political objectives--that radioactive contamination is perhaps the most dangerous type of marine pollution. In 1976 the president of the Soviet Academy of Sciences called for an international agreement banning the ocean dumping of nuclear wastes, see World Env. Rpt. 2 (2 August 1976): 8. For further Soviet criticism of radioactive pollution of the oceans, see A. Ostrovskii, "Int'l. Legal Protection of the Seas from Pollution," Ocean Development and Int'l. L. 3 (1976): 287; and A. Skarkov, "Environmental Protection and Int'l. Cooperation," Int'l. Affairs 6 (Moscow, 1976): 62.

[3]New York Times, 17 February 1960, p. 12.

Waste Management in Eastern Europe

East Germany is investigating the incorporation of medium-level waste into concrete and the use of old salt mines for disposal. They will study the injection of gaseous wastes into deep geological strata and the storage of solidified high-level wastes.[1] Bulgaria, Poland, Hungary, and Czechoslovakia are working on processes for concentration and bituminization of low and medium-level materials. High-level waste vitrification studies are going on in Poland.[2]

Waste Management in Sweden

Waste management pressure is building again in Sweden. By 8 October 1976--only weeks after the 19 September election in which the new Prime Minister Falldin had campaigned to end all use of nuclear energy--government policy on nuclear development was already shifting back to support previously planned expansion under stricter controls.[3]

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[1] Tolpygo and Friedrich, p. 79.

[2] Ibid., p. 77; see World Env. Rpt. 2 (6 December 1976): 1, for an announcement that Czechoslovakia has an industrial process to mix radioactive waste and cement to form large blocks suitable for buildings!

[3] This is regardless of the fact that Sweden seems to have a relatively strong record for airing, discussing, and acting on nuclear energy issues through national education and consultation programs; see I.C. Bupp and J. C. Derian, "Nuclear Reactor Safety: The Twilight of Probability," (Cambridge: Harvard Univ. Graduate School of Business Admin., December 1975), pp. 4, 49.

Tentative reprocessing plans now call for using British services in the 1980's, possibly starting national operations in the 1990's, and storing all wastes from reprocessing and unreprocessed spent fuel.[1]

The result of opposition to further nuclear development was a Riksdag decision in 1975 not to authorize new nuclear plants until reactor safety and waste disposal problems had been completely reviewed. Reports in 1976 from a government committee on radioactive waste management which was formed in response to the Riksdag action are optimistic as to the use of bedrock at 300-400 meters depth for disposal. Recent recommendations of this committee include:

1) a detailed geologic search for a bedrock formation--preferably near the reprocessing plant--capable of containing all levels of wastes (utilities presently have a five-year capacity to store all wastes on site since no land burial is used);
2) strong regional/international cooperation on waste management, especially for geologic studies, R & D and reprocessing;
3) a unified plan and a central governmental body responsible for spent fuel and radioactive waste management, especially for R & D;
4) a special unit in the Nuclear Power Inspectorate

[1]The U.S. decision to defer reprocessing of spent nuclear fuel has been partially responsible for the reassessment of nuclear policy now underway in Sweden.

for control of, and R & D on, safety work for radioactive waste; and

5) a special fund to cover all future waste management costs (utilities are to pay for all spent fuel and radioactive waste management, including R & D).[1]

Waste Management at Eurochemic/Belgium

Eurochemic operations at Mol, Belgium, have created considerable quantities of high and especially medium-level wastes which are now being solidified. They will be stored on an interim basis--perhaps as long as 50 to 100 years--in surface facilities. Final disposal plans remain uncertain, but Belgium has made it clear that the Mol center will not become a permanent disposal site. Local clays are being cored and one plan is to dispose of medium-level and alpha wastes in a large cavity to be mined in clay.[2] Belgium has

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[1] See, for example, Spent Nuclear Fuel and Radioactive Waste: A Summary of a Report Given by the Swedish Government Committee on Radioactive Waste, (Stockholm: n.p., 1976); a very recently passed Swedish law (originally the Swedish Nuclear Power Stipulations Bill, January 1977) places strict conditions on the six nuclear reactors which are under construction or on order in Sweden. Operating permits can be granted only if the utility has either produced a contract for reprocessing the spent fuel and shown how and where high-level reprocessing wastes can be disposed of "with absolute safety," or has shown how and where the spent fuel can be "finally stored with absolute safety."

[2] F. Gera, "Geologic Isolation Programs in Other Countries," Proc. of the Int'l. Symposium on the Management of LWR Wastes, p. 609; and Report of the Meeting of the Int'l. Working Group, pt. 2, p. 85.

participated in seven of the eight NEA-sponsored ocean dumping operations conducted since 1967 as one means of radioactive waste disposal.[1]

Waste Management in India

India's waste management program consists of a low-level liquid waste treatment plan and a solid waste burial site at the Bhabha Atomic Research Center (Bombay)--in operation since 1966, various storage facilities at other centers, and major efforts on high-level reprocessing wastes.[2] High-level solid wastes from reprocessing are compacted, drummed and stored underground in steel and concrete-lined holes which at certain times of the year are twelve feet into the water table. Steel tanks within concrete vaults are used--as an interim measure--to store high-level liquids.

Plans for high-level liquids in India include solidification by calcination, vitrification after three years, and engineered storage for 20 to 30 years at each reprocessing site. Geologic disposal is planned in igneous or sedimentary formations, but these cover a huge range of

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[1] The Nuclear Energy Agency-sponsored dumping operations are described in detail in Chapter 2, below.

[2] See M. P. S. Ramani, et al., "Operational Experience and Development Activities in Waste Management at Trombay," N. S. Sunder, et al., "Long-Term Planning for Management of Aqueous Wastes from Fuel Reprocessing Plants," and K. Balu, "Management of Highly Active Decladding Zircaloy Solid Wastes from a Fuel Reprocessing Plant," Proc. of IAEA and NEA Symposium, pp. 153, 15, and 179; and Report of the Meeting of the Int'l. Working Group, p. 24.

possibilities. Sites are being evaluated in the deserts of Kajasthan (sandy areas in the northwest, west of Delhi and near Pakistan) and in the Deccan trap of Southern India (old quarries and mines in basalts). India participates in many of the IAEA programs on radioactive waste management, including the International Working Group on High-Level and Alpha-Bearing Wastes.

Various other countries--such as the Netherlands, Spain, Italy, Switzerland and Taiwan--have recently started to investigate available geologic formations which seem to hold some promise for radioactive waste disposal.[1] Italy is focusing its attention on possible high-level waste disposal in clay, especially in the south. They are also surveying salt formations. Spain has studies underway on salt, clay, anhydrite and crystalline formations. From the geologic viewpoint, anhydrite formations are seen as the only possibility in Switzerland. This is why Switzerland does not want any curtailment of the ongoing practice of ocean dumping through the NEA annual operations.[2] Austria, Denmark, and Finland plan to conduct similar assessments of local geologic formations.[3]

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[1] See, generally, Gera.

[2] R. McManus, "Report of the U.S. Delegation to the First Consultative Meeting of the Parties to the London Convention," U.S. Dept. of State, Wash., D.C., September 1976. (Mimeographed.)

[3] See, generally, Gera; and Lennemann, "The Int'l. Aspects of Radioactive Waste Management," Table 3.

Waste Management in Taiwan

Taiwan expects to have 50,000 drums of low-level solidified wastes by the time all six of its reactors are operating in 1985.[1] Existing spent fuel storage ponds in reactor buildings are being expanded.[2] A survey of nearby islands led to the selection of a small island at 22°04'N and 121°32'E--75 km from Taiwan's east coast--to be the site for a national waste repository. All radioactive waste produced in Taiwan over the next 100 years is to be disposed of--after solidification--in these earth and concrete trenches, heavy vaults, and steel and concrete-lined holes. Disposal operations are to begin in 1980.[3]

Taiwan has also proposed the establishment of an international organization in the Pacific Basin to manage radioactive waste disposal into the sea, since they foresee a possible need for ocean dumping.[4]

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[1] C. M. Tsai, et al., "The Perspective of Radioactive Waste Management in the Republic of China," Proc. of the First Pacific Basin Conf., p. 503.

[2] D. S. L. Chu, "Developing a Nat'l. Nuclear Power Program in Taiwan," Proc. of the First Pacific Basin Conf., p. 117.

[3] Tsai, p. 512.

[4] Ibid., p. 513.

Waste Management in Mexico

Mexico also plans to have rapid development of nuclear energy--perhaps 15 to 20 reactors--before 1990. They expect to have a complete fuel cycle, including reprocessing--which is justified on grounds that spent fuel disposal is more costly and complicated. High-level liquid wastes from present activities will be stored in underground stainless-steel tanks until a solidification process is available. Medium-level materials will be put into concrete and stored in drums. There is apparently no plan for final disposal of present and future wastes.[1]

Summary of National Waste Management Programs

The general situation of national waste management programs and plans reveals some trends which may help in the prediciton of events in countries just entering the nuclear power business. National nuclear energy authorities tend to ignore the problem--especially high-level waste disposal--as long as possible. Some action is usually necessary quite early in the nuclear energy development process towards handling low and medium-level wastes, since they have to go somewhere. But many countries are unwilling to be specific on their high-level waste plans. In general they

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[1] See, generally, F. Kaufman, "Mexican Projects on the Back End of the Fuel Cycle," Proc. of the First Pacific Basin Conf., pp. 565-572.

seek the policy flexibility of retaining the option to reprocess without increasing the pressure on disposal arrangements.

Spent fuel accumulating in and, in some cases, forcing expansion of storage ponds and/or local opposition to nuclear energy usually force action. A national drive to develop local disposal options is generally mounted to address environmental and political criticism and to protect the nuclear energy program. Countries focus--to a degree which is directly proportional to their level of commitment to nuclear energy--on local disposal options, regardless of the likelihood of ever having a local disposal site.

Governments are uniformly optimistic about the prospects for being able to handle reprocessing and waste management needs. Yet the full implications of high-level waste disposal needs and of reprocessing for future waste management are, in almost every case, inadequately assessed. There may be increasing movement now--following the examples set by West Germany, Japan and Sweden--toward forcing rapid solutions to reprocessing and waste disposal problems by requiring utilities to have appropriate arrangements before they are granted operating permits for nuclear power stations. Placing almost all of the responsibility squarely on the utilities generating the wastes may be the best possible policy, especially for countries without a major prior military commitment to nuclear development. But sound solutions to reprocessing and high-level waste problems still demand serious and cautious development over a reasonable period of time rather than short-term scrambles to cope with the increasing economic and political heat generated by plant licensing decisions. Furthermore, most countries are adopting the attitude that some other country will solve the high-level waste disposal problem. Many seem to be waiting for American leadership in developing and selecting high-level waste disposal options before commiting themselves to a national policy.

CHAPTER II

PAST MARINE DISPOSAL PRACTICE: THE FREEDOM TO POLLUTE

With the background established on the nature of the radioactive waste management problem and associated national practices and plans, it is necessary to contend with a matter of great political and legal import for the sub-seabed disposal concept. The record of disposal practice with very hazardous substances in the marine environment is distressing to even the casual observer. Despite an apparent lack of cases concerning disposal of toxic materials by emplacement beneath the seabed, dumping into the oceans/onto the seafloor has for many years been a routine disposal solution for some of the most toxic and persistent of man-made materials. We should, in order to gain proper perspective, consider several examples of the practices which set part of the legal and political scene for any future emplacement of radioactive waste beneath the seabed.

Ocean Dumping of Non-Nuclear Hazardous Substances

Nerve Gas/Munitions Dumping

In the category of non-nuclear disposals by governments, it is instructive to recall dumpings of discarded weapons, a hazardous and persistent category of wastes. Between 1955 and 1957 the British Defense Ministry packed the holds of obsolete navy ships with 67 tons of captured German nerve gas and 8000 tons of British mustard gas, and sank the ships in the Atlantic 250 miles west of Scotland. No further disposals were made after 1957, but the first British announcement on this practice did not come until 1970 during the major controversy over similar U.S. dumping.[1]

During 1967 and 1968 the U.S. Army disposed of 1,706 concrete vaults containing 12,540 nerve gas rockets by packing them in old hulks and sinking them in an international munitions dumping ground off Earle, N.J.[2] Public outcry caused the Army to cancel a plan to dump 418 more vaults there in 1969 and to re-schedule it for 1970 in a much deeper munitions disposal area 282 miles east of Cape Kennedy.[3] This was in the area of one of the strongest bottom current systems in the Atlantic Ocean--the Western Boundary Under Current.[4] Despite a highly skeptical, at times hostile set

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[1] See Washington Post, 12 August 1970, p. A19.

[2] U.S. Congress, Senate, Com. on Commerce, Hearings on Dumping of Nerve Gas Rockets in the Ocean before the Subcomm. on Oceanography, 91st Cong., 1st Sess., ser. 76, 1970, pp. 10, 17.

[3] For the facts see E. D. Brown, appendix to "International Law and Marine Pollution," Natural Res. J. 11 (1971): 249.

[4] The strong bottom currents in this area are described in B. C. Heezen, et. al., "Shaping of the Continental Rise by Deep Geostrophic Contour Currents," Science 152 (22 April 1966): 502.

of Congressional hearings on the Army procedures [1] and a Defense Department policy change, including assurances by Secretary Laird that it would not happen again, the Environmental Defense Fund (EDF) brought action for a permanent injunction against dumping the gas at sea. The district judge expressed strong misgivings over the gas dump and the negative international reaction and issued a request that the Army use a shallower site since the pressure at the intended site could implode the containers. Yet EDF and the Governor of Florida lost in their joint attempt to enjoin the dump because of the Army's claim of danger to the local population if the tanker and its deadly cargo were held in port. [2] Despite the judge's request, the dump was conducted at the deeper site.

In this case neither the U.S. court nor the Congress seemed to have had much leeway because all studies indicated that time had run out on the containers and that the hazard to human life on land was such that immediate disposal was

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[1] U.S., Congress, House, Comm. on Foreign Affairs, Hearings on the International Implications of Dumping Poisonous Gas and Waste into Oceans before the Subcomm. on Int'l. Organizations and Movements, 91st Cong., 1st Sess., 1969; U.S. Congress, Senate, Comm. on Commerce, Hearings on Dumping of Nerve Gas Rockets in the Ocean; U.S., Congress, House, Comm. on Merchant Marine and Fisheries, Hearings on Ocean Disposal of Unserviceable Chemical Munitions (Operation Chase) before the Subcomm. on Oceanography, 91st Cong., 2d Sess., ser. 31, 1970.

[2] Washington Post, 17 August 1970, pp. A1, A7; and Washington Post, 16 August 1970, p. A1; district court judge June Green's order denying the injunction and her request for a change in site were never reported.

required. But only the court cases brought out the fact that the substances in question included VX, a much more toxic (on land) and persistent agent, as well as GB, which formed the basis for all scientific discussion at the hearings and elsewhere. This additional factor could have (and perhaps should have) changed the entire basis for the hazard assessment, especially for the damage to marine ecosystems.[1]

Beyond private and public action in the U.S., other states requested information. and complained or protested to the U.S. bilaterally,[2] through diplomatic channels or in the U.N., and the U.N. Secretary General and Seabed Committee both objected.[3] The Bahamas issued its first "protest" ever when the U.K., constrained by her own past and continuing ocean disposal practices, would not act for her beyond sending a team of experts to investigate the matter.

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[1] GB, which is extremely deadly, is neutralized relatively rapidly--over a few days to weeks--in seawater. VX, which is 200 to 400 times stronger than GB, is apparently less toxic than GB in seawater, but persists for up to twenty years. See 116 CONG. REC. 5-13338 (daily ed. 12 August 1970).

[2] Washington Post, 16 August 1970, p. A3; S. A. Bleicher, "An Overview of International Environmental Regulation," Ecol. L. Qtrly 2 (1972): 54; Kirgis, p. 299; Brown, p. 250; and R. P. Cundick, "Army Nerve Gas Dumping," Mil. L. R. 56 (1972): 209.

[3] Times (London), 17 August 1970, p. 1; United Nations Press Release SG/SM 1314, 7 August 1970; United Nations, Press Release SB/11, 20 August 1970, p. 1; and United Nations, General Assembly, Report of the Committee on the Peaceful Uses of the Sea-Bed and Ocean Floor Beyond the Limits of National Jurisdiction (A/8021), 1970, p. 8.

Iceland issued a formal protest and Bermuda expressed strong concern.

The U.S. claim that there was no violation of the 1958 High Seas Convention,[1] general international law,[2] or obligations to any international organization[3] was apparently based on a narrow interpretation of the Convention similar to that espoused by the U.S. Army lawyers, i.e., that "...ocean disposal of inherently hazardous substances remains, and ought to remain, permissible under proper conditions, those conditions finding their root in the rule of reasonableness.[4] But this ignores the U.N Secretary General's charge that the U.S. violated the Convention's Article 25(2)[5] call for cooperation with competent international

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[1] Convention on the High Seas, 19 April 1958; in force 1962; 2 U.S.T. 2312, T.I.A.S. no. 5200, 450 U.N.T.S. 82. Only Article 2 was discussed.

[2] Testimony of Mr. Rhinelander, Deputy Legal Adviser of the U.S. Department of State, Hearings on Dumping of Nerve Gas Rockets in the Ocean, p. 65.

[3] U.S., Department of State, Telegram 128547 from U.S. Secretary of State, Wash., D. C., to all diplomatic posts, 8 August 1970; and U.S., Department of State, Letter from Acting Secretary of State to President of the Senate, 30 July 1970, pursuant to Pub. L. 91-121 sec. 409(c)(2) in Dept. of State Bull. 63 (7 September 1970): 283.

[4] Cundick, p. 209; Cundick held that there was no violation of general or conventional int'l. law; see pp. 199-205; he based this finding on the contention that the overall, unilaterally determined standard of reasonableness was fulfilled in this case.

[5] United Nations, Press Release SG/SM 1314, 7 August 1970; also in agreement with this charge were Senator Pell, Representative McCarthy, an editorial in the New York Times, and Brown, p. 254.

organizations to prevent marine pollution. E. D. Brown and S. A. Bleicher argue convincingly that the Secretary General's charge was probably well based in Convention Article 25(2).[1]

Despite the strong case made for U.S. violation of Article 25(2) and obligations to the various international agencies competent in this case, the imprecise standard which existed in 1970 for the dumping of non-high-level nuclear waste into the high seas made it very difficult to argue that the U.S. violated any rule of general international law. Critics of the nerve gas dump thus generally steered clear of the general international law point and focused on Article 25(2). Those defending the practice, contrastingly, relied on the general international legal standard of reasonableness to the almost complete exclusion of the Article 25(2) and possible obligations to international organizations.

The 1969 U.S. Military Procurement Act[2] must have been quite troublesome for the U.S. Executive in this case. It bans funds for any disposal which:

1) involves chemical or biological warfare agents;

2) is conducted beyond U.S. territorial limits; and

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[1] For a similar opinion, see the argument of Mr. Lennon, Chairman of the Subcomm. on Oceanography, in <u>Hearings on the International Implications of Dumping</u>, p. 105.

[2] Pub. L. No. 91-121, sec. 409(c)(2), 83 Stat. 204, as amended in October 1970, by Pub. L. No. 91-441, 84 Stat. 912, to ban munitions disposal in international waters; codified in 50 U.S.C. 1513 (1971).

environment.[1]

The overall effectiveness of this response, which was limited and delayed as a result of U.S. pressures, may be best measured against a World Health Organization resolution, adopted nine years earlier, which urgently requested". . . all the Members. . .to prohibit all discharge of radioactive waste into watercourses or the sea, to the extent that the safety of such discharge has not been proved . . ."[2] This prior proof standard, which was rejected by the U.S. in 1961 and 1970, is a strong and useful guideline for toxic waste disposal at sea. It will be further compared below to both the burden of proof that a given sea disposal is safer than that possible on land and the reasonableness criterion.

Two days after the U.S. nerve gas dump, and on the same day of the Seabed Committee's urgent request, the U.S. sank another hulk. This time a cargo of 5000 tons of discarded bombs was dumped onto the continental slope, 135 miles off the Maryland coast.[3] The bomb laden Liberty ship, which prior to strong public opposition was to have been

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[1] United Nations, Press Release SB/11, 20 August 1970, p. 1; and United Nations, General Assembly, Report of the Sea-Bed Committee, p. 8.

[2] United Nations, World Health Organization, W.H.O. Res. WHA/14.56 (W.H.A., Official Records, vol. 14, no. 110, pt. 1), 1961, p. 24. (Emphasis added.)

[3] Washington Post, 21 August 1970, p. C3.

scuttled off New Jersey near two sunken ships containing mustard gas, blew up when it struck bottom at 7,100 feet.[1]

This is illustrative of the very common practice of disposing of old ammunition and explosives in the forty munitions dumping grounds off U.S. coasts. Many of these sites are on the biologically productive and often bottom current-swept continental slope or rise, rather than on the more tranquil deep seabed of the abyss. Beyond the environmental threat, this practice could also threaten the freedom of navigation on the high seas above. The normal rule of international law forbids the use of even state territory (and the continental slope belongs to the coastal state only for economic/resource exploitation

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[1] Planned disposals such as the above examples must also consider that accidents with very hazardous substances are inevitable. One example is the 29 September 1973, sinking of the West German cargo ship VIGGO HINRICHSEN near Swedish Oeland Island in the Baltic, which resulted in the dumping of many barrels of highly toxic chrome acid. The six Swedish customs vessels and an aircraft which patrolled the area, the Swedish Shipping Board order to salvage the cargo before 5 October, and the charge of deficient seamanship against the captain all did little for the significant section of the Baltic and shores of Oeland Island which were turned yellow by the corrosive acid (Times (London), 2 October 1973, p. 8; and 4 October 1973, p. 8). There have, of course, been many other intentional dumps of highly toxic substances; for reports of the large quantities of explosives, nerve gas, arsenic, mercury, and other military and industrial wastes which have been dumped into the Baltic, see Weichart, "Industrielle Abfallstoffe gefahrden die Nordsee, Umschau," Wissenschaft und Technik 19 (1969): 28; Fishermen in the Baltic were burned in 1969 by fish contaminated with dumped mustard gas, see Marine Pollution Problems and Remedies, UNITAR Research Report No. 4 (1971), p. 34, and p. 74, citing Times (London), 10 August 1969.

purposes) to limit the rights of others.[1]

There have probably been many other unrecorded disposals at sea of significant quantities of munitions. And the U.S. Navy is generally reticent in taking the time to conduct its disposals beyond the biologically and otherwise very active continental margin.[2] Navigation charts are still littered with indications of unexploded weapons and spoil areas.

Industrial Waste Dumping

Highly toxic industrial wastes, such as those from refineries, paper mills, laboratories and chemical manufacturers, have also been routinely dumped in many sites off U.S. coasts.[3] In 1971, an American company prepared

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[1] "There has been general recognition of the rule that a State must not permit the use of its territory for purposes injurious to the interests of other States in a manner contrary to international law." United Nations, Secretariat, Survey of International Law (A/CN.4/1/Rev.1), 1949, p. 34; an important basis for this rule is the general principle of international law, as cited in the Corfu Channel Case by the International Court of Justice, that every State is obliged ". . . not to allow knowingly its territory to be used for acts contrary to the rights of other states." (I.C.J. Rep. 4 (1949): 22.) See, also, Georgia v. Tennessee Copper Co., 206 U.S. 230 (1907); the Trail Smelter Arbitration, U.N. Rep. Int'l. Arb. Awards 3 (1949): 1905; Am. J. Int'l. L. 35 (1941): 684; and A. P. Rubin, "Pollution by Analogy: The Trail Smelter Arbitration," Oregon L. R. 50 (1971): 272.

[2] This is based on several years of this author's experience; and A. C. Vine, interviews held at the Woods Hole Oceanographic Institution, 1976-1977.

[3] Council on Environmental Quality, Ocean Dumping--A National Policy, October 1970, pp. 2-4.

to dump seventy tons of arsenic compound into the Atlantic fifty miles from the East Coast. On the basis of reports that the company had booked a ship to carry the waste, the administrator of the Environmental Protection Agency (EPA) sent a telegram on 12 March requesting that the company suspend the arrangements and investigate alternative disposal methods in consultation with the EPA. The telegram made two key points: first, the discharge of the waste would have deleterious and probably lethal effects on fish and other aquatic biota, and the concentration of such material in marine fauna and flora might cause long-term damage; and second, the 1970 report on ocean dumping by the Council on Environmental Quality, which set forth U.S. policy, stated that the dumping of materials clearly identified as harmful to the marine environment or man should be stopped. Also on 12 March, Congressman C. W. Sandman filed a suit in the Federal district court in Philadelphia for, and won, a temporary injunction barring the ocean disposal. On 15 March the company president, despite the stated firm conviction that there was no "environmental" danger, announced that the dumping would be stopped pending Government review. The temporary restraining order was removed (as it was no longer necessary) on the basis of the company announcement.[1]

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[1] See Environment Rep., Curr. Dev. 47 (1971): 1276; the case brought by Congressman Sandman against Whitmayor Laboratories (a subsidiary of Rohm and Haas, Co.) was not reported.

The Finnish oil company tanker, ENSKERI, sailed on 17 March 1975, with 690 barrels of arsenic poison to be dumped in the South Atlantic Ocean.[1] Despite statements by the Interior Ministry and the environmentalists that the intended dump would violate Finnish policy, but that there was no legal means to stop the ship, the government ruled on 18 March that prior permission was required in accordance with Finnish intentions to ratify the Oslo and London Conventions.[2] ENSKERI was recalled and the company was prevented from dumping in an extremely remote ocean area by a government acting without any overt international pressure.

On 22 July 1971, a Dutch chemical company recalled its tanker STELLA MARIS, after strong objections from the Norwegian government over initial plans to dump 600 tons of a toxic, persistent and accumulative chemical into the Norwegian Sea, and from the U.K., Ireland, and Iceland

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[1] See New York Times, 18 March 1975, p. 40.

[2] Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, done at Oslo, October 1971; in force 15 February 1972. U.N. Doc. A/Conf.48/IWGMP. 11/W.P.VI; in Int'l. Legal Materials 11 (1972): 262, (hereinafter cited as the Oslo Convention); and the London Convention; U.S. Dept. of State records indicate that Finland had signed, but not ratified the London Convention as of July 1975.

protesting the backup site in the Atlantic.[1] Despite official Dutch statements that the dump was forbidden by neither national nor international law, the government seemed to play a strong role in the company's decision that "international complications" should be avoided in this case. Norway specifically requested that the Netherlands stop the disposal if harm would be done to the marine environment. Ireland was prepared to intercept the ship with warships and the U.K. had ordered Scottish harbor authorities not to refuel it. At the request of the Dutch government the company director made the final announcement on television and in writing.[2]

During the same year there was a general call by Sweden, Norway, Finland, Denmark and Iceland for the termination of the dumping of harmful chemical and industrial wastes into international waters. Sweden and Norway had soon thereafter enacted supporting legislation and the others announced plans to follow suit.[3]

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[1]The October 1970 report of the U.S. Council on Environmental Quality is entitled Ocean Dumping--A National Policy. There are conflicting reports over which countries reacted and whether or not they made official protests. It appears that Norway, Denmark, Sweden, the U.K., and Iceland probably lodged protests. See, for example, New York Times, 26 July 1971, p. 66; and Netherlands Yearbook Int'l. Law 3 (1972): 164, 226.

[2]Times (London), 23 July 1971, p. 1; New York Times, 26 July 1971, p. 66.

[3]See, for example, Washington Post, 13 November 1971, p. A4; and Times (London), 28 April 1971, p. 1.

Chemical waste (especially antimony compounds) dumpings in the Gulf of Mexico from 1969 to 1974 led to a major controversy and a court battle over U.S. EPA permits. DuPont held both that no harm would occur to the marine environment and that no acceptable alternative to barging the contaminated wastewater to sea was available.[1] Under the pressure of prior complaints from Texas and Louisiana and an injunction sought by Florida, the EPA revoked its permit and ended the dumping on the grounds that it could not be shown to be safe.[2]

Radiological Contamination of the Oceans

The public concern and increasingly stringent legal control today over ocean dumping are also based on past and present sources of radiological contamination of the marine environment. Low-level radioactive wastes have been introduced into the oceans from the atmosphere (worldwide fallout from nuclear weapons tests); from nuclear ships (operational discharges); from industrial discharges (from nuclear power and reprocessing plants) into rivers, tidal estuaries, and coastal waters; and from

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[1] U.S., EPA, Application of DuPont for an Ocean Dumping Permit for its Belle (West Va.) Plant, hearings conducted by EPA, Pensacola, Florida, beginning 22 July 1974.

[2] See P. B. Stam, "Intentional Ocean Dumping of Industrial Chemical Waste," S. W. Wurfel, ed., Legal Measures Concerning Marine Pollution (Sea Grant Pub. UNC-SG-75-04, February 1975), p. 71.

dumping (packaged solids) at sea. Although now of decreasing importance over time, fallout from nuclear weapons testing is still the largest source of marine contamination from transuranic (long-lived) radionuclides--about 2×10^5 curies of ^{239}Pu had accumulated in the oceans through 1970.[1] Data is not available on the amount of activity introduced by commercial and military ships powered by nuclear reactors, but this is likely to be an increasingly important source.[2] Most troublesome of the industrial land-based sources is that from reprocessing plants in the U.K., France, India, and Italy.[3] This is now both qualitatively and quantitatively the most serious problem of radiological contamination of the oceans because of the nature of the elements released and because the releases are into coastal waters, and the rates of

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[1]"A critical assumption is that atmospheric testing of nuclear weapons will continue at an indeterminable but presumably diminished rate. Therefore, a continuing global source of plutonium through atmospheric testing is anticipated." (National Academy of Sciences, Assessing Potential Ocean Pollutants (Wash., D.C.: N.A.S., 1975), p. 35). Recent Atmospheric Testing by the French and Chinese has contributed less than 10% of the total radioactivity introduced into the oceans from earlier testing. Whereas French atmospheric testing seems to have been stopped as of 1974, Chinese testing (of relatively small weapons) continued as of late 1976 (H. D. Livingston, interviews held at the Woods Hole Oceanographic Institution, Woods Hole, Mass., 1977).

[2]See Council on Environmental Quality, Ocean Dumping, p. 11; and "Quiet Violence," Special Report, Supp. to Calypso Log, 3 (1976): 4.

[3]V. T. Bowen, interviews held at the Woods Hole Oceanographic Institution, Woods Hole, Mass., 1975-1977.

release are increasing over time. The British discharge limits for the Windscale facility have been sharply increased on the basis of an oceanographic model which is now widely accepted to be unrealistic as well as misleading.[1]

Most important for present purposes is the very controversial practice of ocean dumping. Japanese and Russian wastes have apparently been dumped into the Pacific, and the French attempted to dump in the Mediterranean in 1960. The U.S., the U.K., and other Western European countries have conducted the vast majority of this dumping. As shown in Table 5, most of the unilateral dumping by the U.S. and the U.K. occurred in the 1940's, 1950's, and early 1960's. Since 1967 the so-called NEA operations, largely comprised of British wastes, have been the major contributor.

Between 1946 and 1970, the U.S. Atomic Energy Commission (replaced by ERDA and NRC in 1975) licensed the dumping of almost 95,000 curies into the Atlantic (about 80,000) and Pacific (about 15,000) Oceans. Precise records of amounts and locations are not available.[2] The

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[1] See Chapter 4, below.

[2] Almost all of this waste was packaged in 55-gallon drums filled with concrete or similar materials. Drums were thrown over in water depths from 3,000 to 9,000 feet; most of the dumping was done in two areas--at 3,000 and 6,000 feet in the Pacific Ocean near the Farallon Islands (about 50 miles from San Francisco) and in an abandoned munitions disposal site at 8,000-9,000 feet in the Atlantic (120 miles from the Maryland-Delaware border). See

only real opposition came from U.S. coastal areas upset by certain shallow water dumps and misunderstandings over scientific recommendations.[1]

Just as U.S. practice with obsolete munitions disposal changed drastically after other states became involved, the disposal of radioactive wastes at sea by the U.S. decreased sharply after a protest by Mexico in June 1959.[2] The specific case involved a license for a proposed dump into the Gulf of Mexico which was eventually not issued despite findings by a National Academy of Science study that there were several acceptable disposal sites in the Gulf for packaged low-level wastes,[3] and a ruling by U.S. AEC experts that this dump would be completely "safe".[4] The final recommendation of the AEC and the State Department not to issue the license, the strong opposition of Mexico and groups near the approved sites,[5] and the overall effect of extensive congressional

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R. S. Dyer, "Ocean Disposal of Radioactive Wastes," EPA Journal 7 (July/August 1975): 4; and Council on Environmental Quality, Ocean Dumping, pp. 2, 3.

[1]U.S., Congress, Joint Comm. on Atomic Energy, Hearings in the Matter of Industrial Waste Disposal Corporation, vol. 5, before the Special Subcomm. on Radiation, 86th Cong., 1st Sess., 1959, pp. 3059, 3142.

[2]Ibid., vol. 4.

[3]Ibid., vol. 2, p. 1432.

[4]Ibid., vol. 4, p. 3049.

[5]Ibid., vol. 5, p. 3059.

hearings led the U.S. AEC to end the licensing of commercial disposal operations at sea and to severely curtail all other radioactive waste disposal at sea.[1]

There were at least two key differences between this situation (1959-62) and the one concerning nerve gas (1970) which was discussed above. First, in 1959-62 the U.S. was faced with neither the apparent lack of technical solutions which existed in 1970, nor the perceived necessity to dispose of the material immediately; and second, there was a long period (1959 to 1962) of investigation[2] and even serious prior international consultation over the radioactive waste dumping. Such investigation and consultation were explicitly avoided by the U.S. in the nerve gas case of 1970.

The U.S. practice of dumping radioactive waste into the sea was completely phased out in 1971 because of the prospect of acceptable--very cheap--land-based disposal

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[1]See R. A. Shinn, The International Politics of Marine Pollution Control (N.Y.: Praeger, 1974), p. 21, for a table showing the dramatic drop in containers and activity of wastes dumped after 1962; and Kirgis, p. 297, and W. T. Burke and M. S. McDougal, The Public Order of the Oceans (New Haven: Yale Press, 1962), p. 860, for discussion of the significance attached to the U.S. decision not to issue the license.

[2]During this period the World Health Organization resolution of 1961 (discussed above, pp. 35, 36) was issued and the 1958 U.N. Law of the Sea Conference, in which Mexico helped to lead the movement for stricter control of radioactive waste disposal at sea, was being discussed in the U.S. The 1958 High Seas Convention was also about to enter into force for the U.S.

alternatives. Yet, as noted above, shallow land burial of low-level wastes now faces very serious problems in the U.S.[1] It is not, thus, inconceivable that the U.S. government would wish to start ocean dumping of contained radioactive wastes again in the near future.[2]

Britain dumped about 45,000 curies of low-level wastes into the Atlantic from 1951 through 1966.[3] Shallow sites (in the Channel) were used until the early 1960's when there were several shifts to progressively deeper water. Starting in 1967, Britain has conducted its dumping under the auspices of the NEA.

In 1960 the French government announced its intention to dump 6,500 containers of low-level waste into the Mediterranean 50 miles off Corsica. This plan was dropped after considerable opposition developed in southern areas of France and in Corsica.[4] As in the case of U.S. cancellation of weapons dumps off New Jersey, this explicitly

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[1] This was noted in greater detail in Chapter 1, above, p. 2.

[2] The U.S. EPA program to assess old U.S. dump sites--in case the practice should be used again with more effective containers and other safeguards--will be described below.

[3] One expert observer's figure for curies dumped by the British between 1965 and 1968--91,000--is much higher than those reported by other sources; see C. Polvani, "Radioactive Solid Waste Disposal into the Oceans: Implications and Perspectives," Proc. of the Symposium on the Int'l. Regime of the Sea-Bed, Rome, 30 June - 5 July 1969.

[4] New York Times, 11 October 1960, p. 4; and 13 October 1960, p. 20.

acknowledged the importance of coastal interests in protecting marine areas.

The NEA, which before 1972 was known as the European Nuclear Energy Agency, is a body associated with the Organization for Economic Cooperation and Development (OECD). It supervised dumping operations in 1967, 1968, 1969, and from 1971 to 1976 with solid wastes packaged in 55 gallon drums from varying combinations of eight European countries (Table 6). They have involved almost 300,000 curies of low-level and medium-level wastes. While three different sites in the northeast Atlantic have been used, the current one is about 1,000 kilometers from the European coasts (circle of 70 nautical miles diameter centered on 46°15'N and 17°25'W) and has an average depth of 4.5 kilometers. A U.S. company's ship recently laid transatlantic cable number six through this site. Although this was apparently done without knowledge of the existence of the NEA dump site, the 1958 Geneva Convention on the High Seas[1] clearly establishes cable laying as a basic freedom of the high

[1]High Seas Convention Article 2 specifically lists the "freedom to lay submarine cables and pipelines" as a freedom of the high seas; Article 26(1) provides that: "All States shall be entitled to lay submarine cables and pipelines on the bed of the high seas."

seas.[1] Cable laying in the area is thus a right of all states regardless of the NEA use. In order to avoid the recently established procedure for getting approval within the NEA and its member states for a new site, the participating NEA countries for 1977 will apparently re-designate the part of the circle not crossed by the cable as the dumping area.[2]

Nuclear weapons tests, especially the series of 43 run by the U.S. in the Enewetak Atoll from 1948 to 1958, and accidents with nuclear weapons and plutonium power supplies have temporarily caused relatively high levels of local radiological contamination of the oceans. They have also been a continuing source of the long-lived transuranic elements. A long history of weapons testing in the oceans, including the recent and controversial French Pacific trials, often leads people to associate all radioactivity at sea with military programs. Documented accidents include the atmospheric burn-up of a nuclear weapon

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[1]All such freedoms on the high seas must be exercised ". . . with reasonable regard to the interests of other States in their exercise of the freedom of the high seas." In this case, however, cable laying could not have violated the reasonable regard standard since the NEA dumping practice was not widely publicized and there was no prior notification to the U.S. telephone company which laid the cable.

[2]This is part of the recent effort, to be described further in Chapters 4, 5 and 7, to establish meaningful NEA regulations and control over the annual NEA sponsored, European radioactive waste dumping operations in the Atlantic.

(after a B-52 crashed) near Thule, Greenland, the ocean disposal of the Sea-Wolf Submarine reactor vessel, the loss of nuclear submarines at sea, and the release of plutonium for small power generators in 1964 and 1970.[1] In addition to the importance of these events to public attitudes toward things nuclear at sea, all sources of radioactivity must be considered for calculating the total radioactive loading on the oceans.[2]

The Changing Perspective

This small sample of disposal practices and cases shows both that governmental and industrial bodies had developed ocean dumping of very hazardous substances into standard operating procedure, and that local, state, national and international movement had begun to ban, or at least to limit, this practice. In each case the non-nuclear dumping was stopped[3] when confronted with local,

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[1]The nuclear weapon and power generator accidents are mentioned in N.A.S., Assessing Potential Ocean Pollutants, pp. 44, 45; and V. T. Bowen, "Transuranic Elements in Marine Environments," paper presented at the Amer. Nuc. Soc. Winter Meeting, Washington, D.C., 1974.

[2]See United Nations, Int'l. Atomic Energy Agency, The Revision of the Oceanographic Basis of the IAEA Provisional Definition and Recommendations Concerning High-level Radioactive Waste Unsuitable for Dumping at Sea, AG-141 (Vienna: IAEA, April 1977), p. 45.

[3]Most of the continuing industrial dumping involves acid wastes. Land-based alternatives are generally being developed. For the recent land-based destruction of nerve gas bombs, see New York Times, 3 April 1977, p. 26.

national, or international public opposition. By 1970 a significant level of expectations had grown up around the need to scrutinize closely at national and international levels the marine disposal of hazardous materials. An increasing tendency to respond positively to national opposition and international protests based on broad environmental concern was becoming evident.

The deliberate disposal at sea of nuclear matter has increased in all areas except nuclear weapons testing, which has decreased markedly since the mid-1960's (but which is now increasing again). Proposed French and long-term American dumping practices have been halted in the past, and the annual European dumping now faces strong political opposition and increasing legal control.

Despite the continuation of European dumping and the relatively low level of national interests involved in the U.S. decision of 1962 not to dump packaged radioactive wastes into the Gulf of Mexico and the French decision of 1960 not to dump in the Mediterranean, it is clear that an institutionalized international requirement for significant prior consultation over environmental issues, even when governments' experts determine action to be fully safe, could be crucial to the mobilization of local, national, and international interests, and thus to the direction of ultimate state decisions.[1]

In most of the above cases the rallying point for local, national or international opposition to the proposed disposal was the potential or expected hazard to man. Yet several of the cases were eventually resolved on the international level either explicitly or implicitly on grounds of probable damage to the environment. While there was no utilization, in these instances, of formal consultation mechanisms and the state determined standards, procedures, and thresholds unilaterally, there was a start toward both compliance with treaty-based and building non-treaty-based expectations for prior international consultation and unilateral action away from disposal which would probably cause significant environmental damage to the seas.

There has been enough worldwide concern over the disposal of noxious substances in the oceans to produce two important philosophical shifts in the last five years: (1) a solid start toward considering the marine environ-

[1]Unintentional and unlikely events involving nuclear materials must also be expected. Fishermen at work off the coast of Oregon are reported to have trawled up a steel waste drum of radioactive laboratory materials which the U.S. A.E.C. had dumped into the Atlantic (Cundick, p. 166); there have been other reports of containers of radioactive wastes being recovered accidently from the bottom and washing up on the shore. On 24 September 1973 the U.K. issued a radioactivity warning to coastal areas after a small Irish ship sank forty miles out to sea with a deck cargo of six containers marked "Dangerous Radioactive Explosives," Times (London), 25 September 1973, p. 1.

ment as one that should be protected in the same way as continental areas; and

(2) a distinct trend in thinking toward isolation of toxic substances from the biosphere rather than dilution and dispersal within it.

CHAPTER III

NATIONAL REGULATORY POSTURES AND THEIR IMPACT ON SUB-SEABED DISPOSAL OF RADIOACTIVE WASTE

Legislative and Regulatory Situation in the U.S.

The sub-seabed disposal of radioactive waste is enmeshed in a complex U.S. legislative and regulatory situation. A number of laws establish regulatory authority for agencies which have already issued, or are in the process of developing or revising, regulations applicable to sub-seabed disposal. The applicable legislation can be divided into three general categories:

1) Nuclear energy;
2) General environmental protection; and
3) Marine pollution.

In the case of a concept such as sub-seabed disposal, which may move progressively from the R & D stage to demonstration and then to implementation, the applicability of this legislation and the associated regulations will change over time. The first category of legislation, nuclear energy, is generally triggered first. It sets the authority and responsibility for national radioactive waste management. This is followed by general environmental protection legislation during the middle and latter portions of the R and D effort, and by marine pollution legislation in the demonstration and early implementation stages.

This thus forms one means of structuring an overview both of the existing U.S. legislative and regulatory climate for sub-seabed disposal and of the possible direction of future changes thereto. It is, however, important to bear in mind two distinctions throughout this section. It must first remain clear that this overview consists of two basic, though closely related, parts:

1) The distribution of agency authority (or jurisdiction) under the various laws applicable to sub-seabed disposal; and
2) The regulations issued by the various agencies under their differing authorities.

The other distinction to be made is between the existing situation and that which is now, or will soon be, under development. There are several areas affecting sub-seabed disposal where nuclear, environmental, or marine policies or technologies have created a demand for legislative and/or regulatory action. This is especially the case, as of 1977, for criteria and standards to control high-level radioactive waste disposal.

<u>Nuclear Energy: Legislative Authority and Regulations Affecting Sub-Seabed Disposal of Radioactive Waste</u>

The old Atomic Energy Commission had jurisdiction over the possession, use, and disposal of almost all radioactive materials.[1] This jurisdiction was transferred to the NRC as of January 1975 under Title II of the Energy Reorganization Act of 1974.[2] There are, however, three important limitations on NRC's actual authority to regulate radioactive waste disposal.

NRC's authority is first limited by the exemption, under both the Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974, of ERDA and its prime contractors from NRC licensing and regulation. This exemption means that ERDA has not only primary R and D and management authority for radioactive waste disposal but also considerable self-regulatory authority in the area.[3] There was, however, an important change introduced by section

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[1] 42 U.S.C. 2201 (b) and (j) (Supp. IV, 1974); NRC conducts licensing of waste disposal activities through a permit program (10 C.F.R. 20.301-20.305 (1975)).

[2] See Chapter 1, above, p. 12, n. 1.

[3] The Atomic Energy Act of 1954 included demonstration projects under the general category of R and D. This means that, with the exception of some confirmatory research authority held by the NRC and EPA for regulatory purposes, ERDA can carry high-level waste disposal programs into final demonstration stages (including major irreversible decisions and commitments) before coming directly under NRC licensing requirements. For commercial radioactive waste, except low-level, non-transuranic materials, industry generally manages everything up to the point of final disposal, which is handled by ERDA. ERDA conducts all aspects of most military waste management. For details on the complex balance of authority for regulation and operational management of radioactive waste, see M. Willrich, "Radioactive Waste Management and Regulation," pp. 4-3 to 4-23.

202 of the 1974 Act. NRC was granted licensing authority over:

> (1) Facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from licensed activities; [and]
> (2) Retrievable Surface Storage Facilities and other facilities [with the exception of existing facilities] authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by the Administration, which are not used for, or are part of, research and development activities.[1]

The second limitation on NRC's authority over the regulation of radioactive waste disposal is that imposed by the complex set of agreements with the states,[2] which were in existence as of 1974, for turning over federal regulatory authority concerning commercial low-level waste disposal. The final limitation consists of the areas of authority granted to other federal agencies, primarily the EPA and the Department of Transportation (DOT), for regulating nuclear energy. NRC and EPA share regulatory authority over both radiation protection and ocean disposal

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[1]Section 202 raises two further serious problems for NRC's authority to regulate high-level waste disposal. First, since the official definition of high-level waste (Chapter 1, above, p. 4, n. 1) does not include spent fuel bundles or transuranic-contaminated wastes, these materials could--as it now stands--be disposed of by ERDA without NRC licensing. And second, spent fuel bundles returned to the U.S. and stored or disposed of by ERDA would probably not fall under NRC licensing authority.

[2]This was described in Chapter 1, above, p. 37, n. 2 and p. 41, n. 1.

of radioactive waste. But the division of authority in both areas is unclear. NRC and DOT share fairly well-defined authority over the transport of radioactive materials.

The core of NRC's structure for regulating radiation exposure is its Standards for Protection Against Radiation.[1] These standards are focused on setting permissible radiation exposure levels within a licensee's premises. Under the President's Reorganization Plan No. 3 of 1970[2] EPA assumed authority for controlling radiation exposure beyond a licensee's premises and for providing radiation protection guidance to all federal agencies.

In the area of radioactive waste management, EPA has recently initiated a major program to develop standards and criteria that will provide general guidance or environmental acceptability.[3] In the case of sub-seabed disposal, these standards and criteria would be employed by

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[1] 10 C.F.R. 20; Fed. Reg. 109141, 17 November 1960; Amended as shown C.F.R., vol. 10, revised as of 10 January 1976; and Fed. Reg. 16445, 19 April 1975; 41 Fed. Reg. 18301, 3 May 1976; and 41 Fed. Reg. 52300, 29 November 1976.

[2] 84 Stat. 2086 (1970); 42 U.S.C. 4321 (1970), ELR 41009.

[3] See U.S., EPA, Program Statement, EPA-520/7-76-007 (Wash., D.C.: U.S. EPA, 1976), especially Table 6, p. 21; U.S., EPA, Procs.: Workshop on Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, ORP/CSD-77-1 (Wash., D.C.: U.S. EPA, February 1977); and U.S., EPA, Procs.: A Workshop on Policy and Technical Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, ORP/CSD-77-2 (Wash., D.C.: U.S. EPA, April 1977).

the NRC as an aid in evaluating the methodology, the sites selected, and the operational aspects.[1] To date there is no clear division of authority or formal agreement between the EPA and the NRC in the area of radiation protection.

NRC's existing rule on radioactive waste disposal consists, in part, of two licensing requirements corresponding to disposal on land and disposal at sea, respectively.

> (b) The Commission will not approve any application for a license to receive licensed material from other persons for disposal on land not owned by the Federal government or by a State government.
> (c) The Commission will not approve any application for a license for disposal of licensed material at sea unless the applicant shows that sea disposal offers less harm to man or the environment than other practical alternative methods of disposal.[2]

The requirement on use of federal or state land reflects a long standing federal policy designed to help ensure complete isolation of the wastes from the biosphere and to avoid a proliferation of disposal sites. Placing the burden of proof, as of 1971, on the applicant for sea disposal was stated to reflect the Atomic Energy Commission's policy to phase out sea disposal (although it was specifically stated that this did not mean sea disposal

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[1]See the statement of R. Strelow, Assistant Administrator for Air and Waste Management, EPA, in U.S., Congress, Joint Comm. on Atomic Energy, Hearings on Nuclear Waste Management, 94th Cong., 1st Sess., 1976.

[2]Secs. 20.302 (b) and (c) of Standards for Protection Against Radiation.

was an unsafe practice) and the executive branch thrust to control ocean dumping, the availability of alternative waste disposal methods, and the lack of impact on the nuclear industry.

The NRC now has major efforts underway in the very new regulatory area of high-level radioactive waste disposal. It is clear that NRC criteria and standards for ERDA high-level waste disposal facilities must be ready soon if they are to influence planning and development, as well as final implementation. To date it is expected that:

> New regulations will be structured to require conformance with a fixed set of minimum acceptable performance standards (technical, social, and environmental) for waste management activities, while providing for flexibility in technological approach.[1]

While specific criteria and standards for new regulations are still to be developed, recently proposed NRC goals include:

(1) "isolation of radioactive wastes from man and his environment for sufficient periods to assure public health and safety, and preservation of environmental values"; and

(2) "reduction to as low as reasonable achievable, of

(a) the risk to public health both from chronic

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[1]This is according to testimony by NRC Chairman Rowden in U.S., Congress, Joint Comm. on Atomic Energy, Hearings on Nuclear Waste Management, 94th Cong., 1st Sess., 1976.

exposure associated with waste management operations, and possible accidental releases of radioactive materials from waste storage, processing, handling or disposal"; and reduction of

(b) "long-term commitments (land use withdrawal, resource commitment, surveillance requirements, proliferations, etc.)".[1]

Thus, the ultimate evaluation of the potential ERDA sub-seabed disposal concept by the NRC must be made with a specific set of technical, social, and environmental standards in mind.

With respect specifically to sub-seabed disposal, the NRC has requested the U.S. National Academy of Sciences (NAS) Committee on Radioactive Waste Management to conduct a complete independent review of ERDA's Seabed Assessment Program during 1977-1978. While the results of such a review (this is one of the primary functions of committees established by the NAS) have no legal effect, they can be highly influential in the formulation of future policies. They also form an important scientific and technical basis, especially for such a potentially controversial radioactive waste disposal concept, for future regulation.

Regulation of Radioactive Waste Transport

The old AEC and the DOT reached formal agreement in

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[1] Ibid.

1973 on the balance of regulatory duties for the transport of radioactive waste.[1] This was based largely on prior legislation which granted authority to the DOT for the regulation of explosives and other hazardous materials transport. The agreement, which now applies to both ERDA and NRC (both have incorporated the applicable portions of the AEC regulations into their own rules), gives general authority to DOT for the development of both standards for packaging radioactive materials and regulations for carriers and shippers. ERDA and NRC have limited authority to set standards for packaging major quantities of radioactive materials, such as high-level wastes.[2] Both ERDA and NRC apply to shippers of radioactive materials a registration and approval framework similar to that established by DOT.

The Coast Guard (which is part of DOT)[3] makes use

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[1] U.S., DOT and AEC, Memorandum of Understanding Between the U.S. Department of Transportation and the U.S. Atomic Energy Commission for Regulation of Safety in the Transportation of Radioactive Materials Under the Jurisdiction of the Department of Transportation and of the Atomic Energy Commission, 38 Fed. Reg. 8466 (1973); under the general category of hazardous material transport, other federal agencies play minor roles in regulating the transport of radioactive materials.

[2] 10 C.F.R. 1(3)(1973); under the AEC-DOT agreement NRC must license any facilities used for the storage or disposal of spent fuel, high-level wastes from reprocessing, or transuranic-contaminated wastes; and EPA's generally applicable environmental standards for radiation protection apply to all radioactive material transport beyond ERDA and NRC facilities.

[3] 49 U.S.C. 1655 (1970).

of the applicable NRC rules[1] in the program established under its authority to regulate the sea transport of radioactive materials.[2] It requires tests and inspections for ships carrying radioactive materials.[3] These would be particularly applicable in the case of sub-seabed disposal in any stage beyond a demonstration project.[4]

In addition to the number of recent incidents[5] in the U.S. concerning the transport of radioactive waste, the problems with restrictions being set by U.S. railroads (and resultant disputes between federal agencies and the railroads), restrictions and bans enacted by states and cities,[6] and criticism of areas of DOT regulations which are not as strict as those of ERDA and NRC,[7] U.S. transport regulation is now inconsistent with the widely accepted IAEA Regulations for the Safe Transport of Radio-

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[1] 46 C.F.R. 37.15-1 (1972).

[2] 46 C.F.R. 146.03-8 (1972).

[3] 46 C.F.R. 37.10-1, 61, 71, 79, and 99.

[4] For further details on the regulation of radioactive material transport, see, for example, M. Willrich, "Radioactive Waste Management and Regulation," Chapter 4; and H. P. Green and C. Fridkis, "Radiation and the Environment;" E. L. Dolgin and T. G. P. Guilbert, ed., for the Environmental Law Institute, Federal Environmental Law (St. Paul, Minn.: West Pub. Co., 1974), pp. 1050-53.

[5] See, for example, Chapter 5, nn. 123, 124 and accompanying text.

[6] See Chapter 1, below, pp. 39-42.

[7] Green and Fridkis, pp. 1051, 1052.

active Materials (1974 Revised Edition).[1] While the transport and packaging requirements in the U.S., as of 1968, were the same as those established by the IAEA in 1961, the IAEA completed a major revision of its regulations in 1973/1974. ERDA and NRC have standards revision processes underway in this area,[2] but four years have now passed since the IAEA revision was essentially complete without formal action by the U.S. in this area.

Environmental Protection: Legislative Authority and Regulations Affecting Sub-Seabed Disposal of Radioactive Waste

ERDA, or the Department of Energy as of 1 October 1977, is responsible under the National Environmental Policy Act (NEPA) of 1969 for the detailed environmental assessment of ". . . every recommendation or report on proposals for legislation and other major actions significantly affecting the quality of the human environment. . ." The NEPA also provides that the federal agencies must ". . . utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences. . ."[3] For U.S. R and D programs, the final Council on Environmental Quality (CEQ) guidelines

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[1] See Chapter 4, below, p. 152.

[2] NRC is also conducting major development efforts on risk analysis and environmental impact for radioactive waste transport.

[3] 42 U.S.C. 4332(2)(A) and (C) (1970), ELR 41010.

on preparing environmental impact statements (EISs)[1] require the timing of EISs to be ". . . late enough in the development process to contain meaningful information, but early enough so that this information can practically serve as input in the decision-making process. . ."[2]

Waste disposal operations licensed or contracted for by the federal government and the associated standard-setting are major actions within the purview of NEPA. A combination of various court decisions and sets of federal agency regulations have established detailed procedural requirements for EISs and public participation, especially through hearings, in such actions. Generic EISs on the ERDA management and NRC regulatory programs for radioactive waste are clearly necessary; this is still uncertain for the EPA regulatory program. The overriding importance of the site characteristics to the success or failure of each high-level waste disposal repository and the long-term and controversial commitment made at each site would seem to call for separate statements by ERDA and NRC for each site.

Once the preliminary impact statement is completed, both the CEQ and the EPA have specific review and recommendation authority. The CEQ receives a copy of all

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[1] 40 Fed. Reg. 16813 (1975).

[2] 40 C.F.R. 1500.6(d)(2); this guideline is originally from Scientists' Institute for Public Information v. Atomic Energy Commission (481 F.2d 1079, 3 ELR 20525 (D.C. Cir. 1973).

statements and makes recommendations to the President after reviewing and appraising the federal program in light of NEPA policy. [1] The EPA Administrator receives all statements applicable to his duties--in this case, the generally applicable environmental radiation criteria and standards--and makes comments to the CEQ on all unsatisfactory ones. [2] The EPA also has a rating program for impact statements which is highly influential in future executive branch and congressional support of a program, and in any applicable future court rulings.

NEPA also requires the federal agency considering an action to consult with, and obtain comments from, federal and federal-state agencies with specific expertise or jurisdiction in the area. [3] As identified in the CEQ guidelines, under the categories of "Water" (Marine Pollution), "Radiation," or "Hazardous Substances" (Transportation and handling), the following major agencies (beyond CEQ, EPA, and NRC) are likely to be included for assessment of ERDA's Seabed Assessment Program:

Department of Commerce
Department of Defense
Department of Health, Education, and Welfare
Department of the Interior
Department of Transportation
National Aeronautics and Space Administration

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[1] 42 U.S.C. 4332(2)(C) (1970).

[2] Sec. 309 of the Clean Air Act, as amended (42 U.S.C. 1857h-7); and sec. 1500.9(b) of the CEQ guidelines.

[3] 42 U.S.C. 4332(2)(C).

The Department of State must be formally consulted, according to the CEQ guidelines, where a proposed action will have significant international environmental effects.[1]

The CEQ has issued a policy that significant impacts outside of the U.S. must also be considered in impact statements.[2] All EISs by ERDA, NRC, and EPA will thus have to consider the international implications of U.S. participation in a sub-seabed disposal program. International implications will include all significant environmental impacts in the deep seabed, high seas, and foreign countries.

Marine Pollution: Legislative Authority and Regulations Affecting Sub-Seabed Disposal of Radioactive Waste

The U.S., after many years of being a leading contributor to the pollution of the marine environment, has now taken a principal role in some fields involving its protection. This new interest took root in 1970, when the CEQ forwarded a report to President Nixon.[3] This

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[1]Within the Department of State, both the Office of Oceans and Int'l. Environmental and Scientific Affairs and the Office of the Under Secretary for Security Assistance will play major roles in any consultation process over sub-seabed disposal.

[2]U.S., CEQ, Council on Environmental Quality Memorandum to U.S. Agencies on Applying the Environmental Impact Statement Requirement to Environmental Impacts Abroad (24 September 1976); in ILM 15 (1976): 1426.

[3]U.S., CEQ, Ocean Dumping: A National Policy, A Report to the President (Wash., D.C.: CEQ, 1970).

report served as the basis for national legislation and international proposals on the prevention of marine pollution by dumping. One important result was the U.S. Marine Protection, Research, and Sanctuaries Act of 23 October 1972 (the Ocean Dumping Act).[1]

The definition of "dumping" included in this Act is: ". . . a disposition of material"; material specifically includes radioactive substances. One of the activities excluded from the Act's definition of dumping--in order to avoid conflict with useful federal programs--is

> . . . the intentional placement of any device in ocean waters or on or in the submerged land beneath such waters, for a purpose other than disposal, when such . . . placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State Program. (Emphasis added.)[2]

Since the placement of radioactive wastes into the submerged land, or seabed, for disposal is not included in

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[1] 33 U.S.C. 1401 *et seq.* (Supp. IV, 1974); hereinafter referred to as the Ocean Dumping Act; the U.S. Act was amended in March 1974 to make the minor adjustments needed to bring it in line with the London Convention of 1972. The London Convention established a uniform international system for prohibiting the dumping of specifically listed substances (including high-level radioactive materials defined by the IAEA as unsuitable for dumping; Article 4, and Annex 1) and for requiring a prior permit from the appropriate national authority for all other dumping (Article 4). Substances listed in Annex 2, including all non-high-level radioactive materials, require a prior special permit for dumping which can be issued only after careful consideration of factors listed in Annex 3, including waste and site characteristics, possible environmental effects, and available alternatives. Further details are included in Chapter 4, below.

[2] 33 U.S.C. 1402(f).

the exclusion, it must be construed, by reverse reasoning, to be included in the Act's definition of dumping.[1] This means that sub-seabed disposal, even through an ERDA program, is dumping under U.S. law.

The Act prohibits the dumping of any material into ocean waters without a permit from the EPA.[2] While the EPA has the specific authority under the Act to issue permits for the dumping of low and medium-level radioactive wastes, it has no similar control over high-level wastes, " . . . for which no permit may be issued. . . ."[3] The Act bans the transport to sea for dumping of high-level radioactive wastes.[4] High-level wastes were among the specifically black-listed substances

[1] This exclusion may, on the other hand, be construed to exempt an experimental high-level radioactive waste disposal project from the Act's definition of dumping if the wastes were emplaced in the deep seabed for testing in a retrievable form.

[2] 33 U.S.C. 1411; this changes the prior legislative situation, under which the old AEC had exercised complete control over the dumping of radioactive waste; this was done on a case-by-case basis through its licensing procedures--Atomic Energy Act, as amended, 42 U.S.C. 2011.

[3] 33 U.S.C. 1412(a) (Supp. IV, 1974).

[4] 33 U.S.C. 1413(a) (Supp. IV, 1974); the U.S. Act, like the Norwegian and Finnish laws and unlike the Dutch and Canadian ones (these are all described below) is not geographically limited. It skirts the still controversial law of the sea question of jurisdiction over foreign flag vessels on the high seas by regulating all transportation from the U.S., as well as all transportation from all locations by U.S. vessels, aircraft, or agencies.

considered by Congress to " . . . pose a hazard of unknown but substantial dimensions. . . ." [1]

Congress established a goal of conducting research and ". . . studies for the purpose of determining means of minimizing or ending all dumping of materials within five years of the effective date. . . ." of the act. [2] This comes due in October 1977. Since sub-seabed disposal is a form of dumping, and the intent is to minimize all dumping (the EPA interprets the intent to be strict regulation rather than elimination of dumping) [3] it could be difficult for even a federal agency to obtain an EPA

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[1] U.S., Congress, House, H.R. REP. No. 361, 92nd Cong., 1st Sess., 1971, p. 13; as noted in Chapter 1, above, p. 4, n. 1, and described in further detail in Chapter 4, below, the U.S. is bound, under the London Convention, by the IAEA definition of high-level radioactive materials which cannot be dumped at sea. Since the reason for the U.S. ban on high-level waste dumping is, in part, a lack of knowledge, it could eventually be argued that sub-seabed disposal should be considered on its own merits, i.e., on the validity of new scientific and technical findings.

[2] 33 U.S.C. 1443 (Supp. IV, 1974).

[3] "It is our interpretation of the statute that it is the intent of the Congress that, with the exception of the prohibited materials, ocean dumping should not be banned, but should be strictly regulated. . . ." (U.S., Congress, Senate, Comm. on Commerce, Hearings on the Marine Protection, Research and Sanctuaries Act of 1972 before the Subcomm. on Oceans and Atmosphere, 94th Cong., 1st Sess., ser. 32, 1975, p. 29).

permit for sub-seabed disposal of low or medium-level radioactive wastes. And Congress could be very hesitant to amend the act to allow sub-seabed disposal of high-level wastes.[1]

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[1]Some congressional hearings have already dealt directly with ERDA's Seabed Assessment Program; for example, see, generally, U.S., Congress, House, Comm. on Interior and Insular Affairs, Radiological Contamination of the Oceans, oversight hearings before the Subcomm. on Energy and the Environment, 94th Cong., 2d Sess., ser. 94-69, 1976. The continuing competition among Congressional committees over energy-related responsibilities leaves open the question of exactly which committees would be involved with a sub-seabed disposal program. It is clear that the following committees could play important roles:

- A. Energy/environment responsibilities
  - 1. House:
    - a. Science and Technology (Subcomm. on Fossil Fuels and Nuclear Energy Research, Development and Demonstration)
    - b. Interior and Insular Affairs (Subcomm. on Energy and the Environment)
    - c. Government Operations (Subcomm. on Environment, Energy, and Natural Resources)
  - 2. Senate:
    - a. Energy and Natural Resources (Subcomm. on Energy Research and Development)
    - b. Environment and Public Works (Subcomm. on Nuclear Regulation)
    - c. Commerce, Science, and Transportation
- B. Foreign relations/ocean responsibilities
  - 1. House:
    - a. International Relations
    - b. Merchant Marine and Fisheries
  - 2. Senate
    - a. Foreign Relations (Subcomm. on Oceans and International Environment)
    - b. Commerce, Science and Transportation.

The jurisdiction, of course, of these committees will change over time if the program moves into the demonstration and implementation stages. Responses to date to sub-seabed disposal have been neutral--essentially the wait and see attitude of the Environment Office in the Department of State.

Conducting a major R and D program, but at a very low funding level when compared to the land-based disposal programs, on a concept which could not now be implemented under U.S. law raises a key issue. Should we be seriously pursuing this option given existing legal constraints? Congress can, of course, authorize R and D without commiting itself to enacting a program that the R and D will not support. So a continued ban on sub-seabed disposal is consistent with full completion of the necessary R and D for a future program.

There may be some real advantages--from a social and political viewpoint--to having a legal ban on this high-level waste disposal option while it is under development. Then, if the public and the Federal government eventually support use of seabed disposal, the required legal adjustments could be made as final decisions on the program were formulated. It would require open and explicit public, congressional, and executive decisions. This cautious approach would also provide a clear signal of our wait and see intentions to other nations.

In this area (ocean dumping) where EPA has specific authority, under the Ocean Dumping Act, over radioactive waste disposal it apparently also claims to have primary authority. ". . . Ocean disposal and deep bed ocean emplacement of radioactive wastes are . . . areas in which EPA is involved and has primary regulatory authority. . . ."[1] Although EPA's authority under the Act is exclusive and it has established a major ocean dumping permit program,[2] it is not clear, especially for sub-seabed disposal of high-level wastes, that EPA would have primary regulatory authority. NRC would clearly be required to license any sub-seabed disposal of non-low-level radioactive materials. In any case, precise jurisdictional arrangements for EPA and NRC should be established early so as to avoid major inter-agency competition.

Based on present work and trends within the EPA, the primary criterion for any decision on radioactive waste disposal in the marine environment would be effective isolation from the biosphere for some number of half-lives of the material such that all future releases would be within acceptable limits.

> The EPA concept of dumping envisions a system of containment on or in the ocean bottom rather than in dry land. The same rules for waste isolation should apply in the ocean as on the land . . . We see the ocean not as a waste dilution media but as a disposal location which will assure undisturbed isolation and containment.[3]

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[1]U.S., EPA, Program Statement, p. 14.

[2]See 38 Fed. Reg. 28609 (1973), the final EPA regulations governing the ocean dumping permit program.

[3]U.S., Congress, House, Comm. on Interior and Insular Affairs, Radiological Contamination of the Oceans, p. 48.

Under the Ocean Dumping Act of 1972, EPA's Office of Radiation Programs published the following two initial requirements for ocean dumping of non-prohibited wastes:

(1) Radioactive wastes should be containerized; and

(2) The wastes must radiodecay to innocuous levels within the life expectancy of the containers and/or their inert matrix. While no permits for dumping radioactive wastes have been issued, since 1974 the EPA has conducted field studies--of the old U.S. radioactive waste dump sites--designed to amplify these requirements. [1]

Sub-seabed disposal of radioactive wastes is banned under the Ocean Dumping Act of 1972 for high-level materials, and strictly regulated for other radioactive substances. Implementation of a sub-seabed disposal program for non-high-level wastes is possible now under the EPA's ocean disposal permit program. Sub-seabed disposal of high-level wastes would, as with any final disposal program for high-level wastes, require a complete review through NEPA, major public participation, compliance with EPA general radiation standards and NRC licensing criteria, and compliance with all NRC, ERDA, DOT, and

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[1] See Dyer, "Ocean Disposal of Radioactive Wastes," p. 4; any radioactive waste dumping would apparently require a special permit via the following steps:

(1) Site designation: draft EIS, public comment, and final EIS;

(2) Completed application showing containment and isolation of radioactivity;

(3) Newspaper publication, hearings, final permit decision; and

(4) Site monitoring.

Coast Guard transportation rules. It would, in addition, require approval under some form of ocean disposal program--presumably involving EPA and NRC. It would avoid much of the complication presented by state intentions to play regulatory roles in siting decisions since disposal would be conducted in international areas; at the same time it would add various international complications.

Though now inadequate for implementation of sub-seabed disposal, the U.S. regulatory posture is under development in several applicable areas. Increasingly regulatory input will be required for the development of an acceptable sub-seabed disposal option, but no immediate legislative action should be necessary. A crucial objective should be the avoidance of confusion and competition among the various agencies and congressional committees involved in development and regulation. Strong leadership from some mechanism, such as the applicable office of the Department of Energy or an inter-agency committee (despite their poor past record), would be important from the beginning of any regulatory development process for sub-seabed disposal.

It is still too early to predict how adaptable these controls would or should be to new scientific and technical development. Decisions here should depend heavily on the extent of regional and international management and control which is developed over the international sub-seabed disposal program. U.S. legal restrictions certainly provide assurance of a full public debate prior to any national participation in the implementation of a sub-seabed disposal program.

Legislative and Regulatory Situation in Other Nations

It should ultimately be possible to rely heavily on regional and broad international regulation of a sub-seabed disposal option. But even if there is significant international development in this area, it is unwise to count on complete international enforcement of regulations for the deep seabed. It is also important to determine the regulatory and enforcement capabilities in key countries for managing or preventing sub-seabed disposal while it is under development.

Prior to 1969 few countries had enacted any legislation, beyond vague (for the purpose of high-level radioactive waste disposal) nuclear energy controls acts, which would be useful in establishing regulatory authority over radioactive waste disposal in the seabed. Now this situation is changing.

Growing environmental awareness in the 1970's has been reflected in the laws and policies of many countries; laws on water and marine pollution control, general environmental protection, waste management, and radioactive substances are now more common.

Countries with nuclear power programs increasingly seem to be following a regulatory pattern similar to that in the U.S.--a complex and layered set of laws from several or all of the above noted categories. A potentially important innovation, especially for countries without strict ocean dumping legislation, is the extension of national jurisdictions by a variety of methods to cover actions on the high seas.

This legislation has introduced an array of institutional responsibilities and jurisdictions. While some countries have attempted to consolidate functions somewhat--the U.K., for example, is transferring all radioactive waste management responsibility to the Department of Environment--numerous ministries and institutes would inevitably become involved in seabed disposal; at least the foreign affairs, transportation, health, labor, fisheries, and atomic energy (or industry) ministries, and the energy R & D institutes will in some countries attempt to establish a direct role.

The further confusion added, especially in the case of land-based disposal programs, by state and local jurisdictions would be greatly reduced by centralized authority in the case of sub-seabed disposal. Federal governments must, in general, control participation in high seas transport and sub-seabed emplacement of radioactive waste, because of the international implications of this disposal option. State and local authorities could still have important control over some transport and handling operations, but their largest role in a sub-seabed disposal option will, at least in the U.S., probably be indirect.

Where the opposition to land-based disposal options is greatest, the relative political attractiveness of seabed disposal will increase.

For present purposes it is not necessary to do a comprehensive survey--except in the area of ocean dumping laws--of potentially applicable national legislation.

The objective here is to determine the national regulatory and enforcement structures for sub-seabed disposal that are now available to nations. This is useful both as an indication of likely legal and political responses and as a source of guidance for future international action. Yet even in the area of ocean dumping regulation it is too early to fully assess states' interpretations and practices under the London Convention of 1972. Furthermore, future legislation or regulations specifically addressing sub-seabed disposal must be expected if the concept is determined to be technically sound.

Marine Pollution Legislation and Regulations

Ocean Dumping

In general, states directly control actions taken by their national ships on the oceans with marine pollution or ocean dumping acts. The earliest example is the Finnish Marine Pollution Prevention Law of 1965.[1] It bans

[1] Law No. 146 of 5 March 1965; Finsk Forfattnings-samling 1965, and U.N. Doc. ST/LEG/SER.B/15 (1970), p. 486;

the disposal in the sea from Finnish ships of substances which may cause, either directly or indirectly, harmful pollution of the high seas. It specifically prohibits any discharge of high-level radioactive waste into the sea and of other radioactive materials which may cause harm or damage to, or expose to danger, human beings, the environment, or marine living resources. Solid or contained radioactive material must be disposed of in ocean depths of over 2000 meters, and permits to dump radioactive material must be obtained case-by-case from the Finnish Water Rights Court. Three of the six articles in the law deal exclusively with radioactive materials. This establishes a clear and comprehensive national regulatory regime for radioactive waste disposal at sea.

Japan's <u>Marine Pollution Prevention Law</u> of 1970 is designed to "prevent marine pollution by controlling the discharge to the ocean of oil and wastes from a ship and an offshore facility." [1] The operative prohibition is that "no one shall discharge (meaning "to set afloat or drop anything to the ocean") wastes from a ship on the ocean areas." (Art. 10(1) and Art. 3(3)). Exemptions

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also see E. Bohme, "The Use of the Seabed as a Dumping Site," From the <u>Law of the Sea Toward an Ocean Space Regime</u> (Rome: FAO, 1970).

[1] Law No. 136 of 1970, Amended by Law No. 137 of 1970, Article 1. (Mimeographed copy.)

are provided for discharges licensed under the Public Water's Reclamation Law [1] and the Waste Disposal and Public Cleansing Law.[2]

Pursuant to the Water Pollution Law of 1970,[3] Norway issued Regulations Concerning the Discharge or Dumping of Certain Substances Having Harmful Effect on Marine Life or Human Health on 11 June 1971.[4] Section I prohibits ships from discharging listed persistent or toxic materials in international waters. A year later another set of regulations

was enacted to prohibit dumping "from ships into the high seas" without a permit from the supervisory authority, and to rule out permits for black-listed, or prohibited materials.[5] Although these banned the dumping of "substances considered likely to be carcinogenic," they followed earlier legislation in omitting any specific reference to radioactive materials.

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[1] Law No. 57 of 1921, Art. 2 and Art. 42, para. 2. (Mimeographed copy.)

[2] Law No. 137 of 1970, Art. 6, para. 3 or Art. 12, para. 2. (Mimeographed copy.)

[3] Act Concerning Protection Against Water Pollution, Law No. 75 of 26 June 1970, in Int'l. Dig. Hlth Leg. 23 (1972): 307.

[4] See S. H. Lay, et al., New Directions in the Law of the Sea, Vol. 2 of 3 (N.Y.: Oceana, 1973-1975), p. 677.

[5] N.L. No. 24 of 15 Aug. 1972, p. 969; by A Crown Resolution and pursuant to the Water Pollution Law of 1970.

Sweden's Marine Dumping Prohibition Act of 1971 [1] prohibits the "discharge (dumping) of waste matter into water." The ban applies to all ships in its territorial sea and Swedish vessels on the high seas. [2]

As part of its policy to prevent pollution of the sea by oil and other harmful substances, Denmark released the Notice of 18 January Issued by the Ministry of Pollution Control Prohibiting the Dumping of Certain Materials from Ships. [3] Danish ships are prohibited from dumping in the sea any materials that "could have harmful effects on marine animal or plant life," or "cause serious inconvenience to navigation and fisheries and other lawful uses of the sea." No specific mention is made of radioactive materials in the two technical annexes.

Additional laws on pollution of the sea by substances other than oil were passed in 1972 and 1975 to

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[1] Act No. 1154 of 17 December 1971 (Swedish Code of Statutes, 28 December 1971; in force 1 January 1972); Amended by Act of 2 June 1972 (Swedish Code, 15 June 1972; in force 15 June 1972); see Int'l. Dig. Hlth. Leg. 2 (1973): 399.

[2] Ibid., Art. 1.

[3] Pursuant to Art. 10(a) of the Act Concerning Measures to Prevent Pollution of the Sea by Oil and Other Materials (cf. Statute Notice No. 124 of 7 April 1976, as amended by Art. No. 49 of 3 February 1971); see ST/LEG/SER. B/16 (1974).

implement, respectively, the Oslo and Helsinki Conventions.[1] "Dumping" is "any disposal of . . . materials by discharging, emptying or sinking in the sea from . . . ships" or platforms. All unauthorized dumping from platforms in the Danish continental shelf area and from Danish-owned vessels in specific areas of the Arctic Sea and Atlantic Ocean is banned. Listed materials cannot be dumped from Danish-owned vessels in all remaining parts of the oceans. Dumping licenses are issued by the Danish Environment Board; dumping of materials with "significant" amounts of Radioactivity cannot be licensed for the Baltic Sea.[2]

In order to enable ratification of international dumping conventions, New Zealand and the U.K..passed legislation in 1974 which was similar to the Norwegian and Swedish acts. New Zealand's law defines

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[1]Act No. 290 of 7 June 1972 on Measures Against Pollution of the Sea by Substances other than Oil (Lovtidende A. No. 28, 11 July 1972, text 290, p. 593); see UN Doc. ST/LEG/SER. B/16 (1974), p. 207; and Law No. 312 of 26 June 1975, amending Law No. 290 (Lovtidende A. No. 29, 10 July 1975, pp. 868-869); the Oslo Convention of 1971 is analyzed in Chapter IV below, p. ; the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 22 March 1974, in ILM 13 (1974): 546 [hereinafter cited as the Helsinki Convention]; this strong regional agreement--which is primarily focused on land-based sources of marine pollution--bans all ocean dumping in the Baltic Sea area; see Chapter IV below, p. .

[2]Law No. 312, Annex 3.

"dumping" as "the deliberate disposal into the sea of the waste or other matter."[1] The definition of "pollution damage" is restricted to damage in New Zealand's waters caused by a pollutant dumped into the sea. This very restrictive definition and the provision that any ships or classes of ships may be exempted absolutely or otherwise by the appropriate Minister[2] limit the overall effectiveness of the legislation.

The U.K. Dumping at Sea Act of 1974[3]

set legal underpinning to what had been only voluntary dumping controls. Yet its definition of "dumping" as "permanently deposited in the sea. . . ." is narrow and somewhat problematical in its interpretation. "Permanently" is apparently designed to reflect the intent of the dumper rather than the ultimate disposition of the materials, since "dumped" wastes can certainly return to the surface or land, and the Act does not make the dumper liable for such accidental returns.

[1] The Marine Pollution Act 1974, Act No. 14 of 6 April 1974 (The Statutes of New Zealand, 1974, 1975, Vol. 1, pp. 729-801; in force 1 July 1974); see Int'l. Dig. Hlth. Leg. 27 (1976): 391; amended by the Marine Pollution Amendment Act 1974 (The Statutes of N.Z., 1974, 1975, Vol. 2, pp. 1791-1792.

[2] Ibid., Sec. 66.

[3] An Act to Control Dumping in the Sea, 1974 Chap. 20, 27 June 1974.

The overall strength of the 1974 Act is greatly reduced by the broad discretion granted to the licensing authority and the lack of the technical annexes approach with lists of banned and special care materials, and detailed considerations for licensing. The authority need only "have regard to the need . . ." for environmental and resource protection, and as appears necessary, include related conditions in a license.[1]

The Main Pollution Decree of 1974,[2] the applicable Philippine legislation, only bans discharges "from or out of any ship . . . [of] any refuse matter . . ." into navigable and territorial Philippine waters.[3] "Dumping" is "any deliberate disposal at sea . . . from vessels . . . at sea," yet this is

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[1]Ibid., Art. 2(1): "In determining whether to grant a license a licensing authority shall consider the need to protect the marine environment and its living resources from any adverse consequences of dumping the substances to be covered by any license; and the authority shall include such conditions in a license as appear necessary to protect the environment and its resources."

[2]Presidential Decree No. 600 of 9 December 1974 (Official Gazette, Vol. 70, 30 December 1974, No. 52, pp. 10770-10773. in Int'l. Dig. Hlth. Leg. 27 (1976): 626.

[3]Ibid., Secs. 4, 5.

not even of any potential use for seabed disposal as long as it does not apply to the high seas.

Pollution Control Zones

Between 1969 and 1974 the Netherlands, Canada, the U.S.S.R., and Oman, among others, departed from the usual course of asserting dumping jurisdiction over ships loaded, registered, or owned nationally by establishing pollution control zones in specific areas of the high seas beyond national waters for all ships.

These pollution control zones do not at first appear to be as useful for controlling sub-seabed disposal as for the regulation of ships on the high seas. They could, however, form the basis for later national or international jurisdictional regimes which would assert control over all high seas activities posing some form of pollution threat to broad ocean areas. This could eventually form a major source of coastal state jurisdiction to supplement or even equal the jurisdiction available to flag and loading states.

The Dutch Pollution of the Surface Waters Act of 13 November 1969 (Stb 536) as implemented by the Royal Decree of 6 June 1972 (Stb 350) prohibits the transport of pollutants or noxious materials, unless licensed by the appropriate ministry, through territorial waters if the intent is to discharge them into specific areas of the

North Sea and the Channel.[1] An annexed Explanatory Note provides that:

> Whether or not discharge can be permitted within this area will have to be considered in each individual case. It depends on the type and quantity of waste material, and on the manner in which and the place where it would be discharged.[2]

While this ban is limited to the prevention of injury to Dutch territorial interests, especially coastal waters, from disposal into the high seas, by applying to vessels of foreign registry it establishes a limited advance, beyond the twelve mile "contiguous zone" limit of the 1958 Convention on the Territorial Sea and the Contiguous Zone,[3] in coastal state pollution control regimes over the high seas.

The Canadian Arctic Waters Pollution Prevention Act[4] of 1970 bans the deposit of any waste, which has been defined at a relatively low threshold, into arctic

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[1] Article 1(4); see Netherlands Yr. BK. of Int'l. L. 4 (1973): 435, and H. F. van Panhuys, "In Search of an International Law of Emergency," Netherlands Yr. Bk. of Int'l. L. 3 (1972): 162, for discussion of the legality of enforcing the Act on the high seas.

[2] Netherlands Yr. Bk. of Int'l. L. 4 (1973): 436.

[3] 29 April 1958 [1964] 15 U.S.T. 1606, T.I.A.S. 5639, 516 U.N.T.S. 205.

[4] Arctic Waters Pollution Prevention Act (Statutes of Canada, 1969-1970, Chap. 47; assent, 26 June 1970); Also in ILM 9, (1970): 598; see also ILM 10 (1971): 437; for the U.S. response, see Morin, Canad. Yrbk. (1970): 206; Fawcett, Ann. Survey of Commonwealth Law (1970): 418; Bilder, Mich. L.R. 69 (1970-1971): 1; and Green, Oregon L.R. 50 (1971): 462.

waters within 100 miles of Canadian territory. The Act goes significantly beyond all other examples in the degree of regulation of foreign flag ships on the high seas, but is also founded a strong, new attitude that the marine environment sometimes rates top priority consideration, a highly skillful application of international legal assertion against a very limited counter-interest, and a controversial, but potentially persuasive position of self-defense built in part on the need for quick action given the demonstrated slow pace of legal development in this area.

The prior Canadian attempts, especially through the Inter-Governmental Maritime Consultative Organization (IMCO), to bring about similar legal action on the international level, the fragility of the arctic environment, and the intentional delay by Canada of any actual enforcement action under the new Act all lend support to its position. The precedent value of the unilateral Act is limited by the highly vulnerable nature of the area of the environment covered, but it does establish the idea of coastal state "self-defense" by preventive regulation when it perceives "its" waters as being seriously threatened.

More recently, Canada passed its Ocean Dumping Control Act of 1975. [1] This is clearly the most compre-

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[1] Statutes of Canada, 1975, Ch. 55; in force 6 June 1976.

hensive and exacting piece of dumping legislation in existence. Its definition of "dumping": "any deliberate disposal from ships . . . at sea of any substance,"[1] is comprehensive.

Disposal at sea on ice is banned.[2] And ocean incineration is specifically labelled as dumping.[3] The prohibition without a permit, of dumping by <u>all ships</u> extends to all national waters, "any fishing zone prescribed pursuant to the <u>Territorial Sea and Fishing Zones Act</u>," "the arctic waters within the meaning of the <u>Arctic Waters Pollution Prevention Act</u>", and any area of the sea adjacent to these waters as may be prescribed.[4] There is no indication given as to how far out into the high seas "adjacent" may be prescribed to apply. Schedules for prohibited and restricted substances cover high-level radioactive materials and all other radioactive matter, respectively.

The U.S.S.R. <u>Statute of the Administration of the Northern Sea Route Attached to the Ministry of Maritime Fleet</u> (16 September 1971) gives strong powers to the

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[1] <u>Ibid</u>., Art. 2(1).

[2] <u>Ibid</u>., Art. 6.

[3] <u>Ibid</u>., Art. 2(4).

[4] <u>Ibid</u>., Art. 2(2).

administrator to help prevent and eliminate the consequences of pollution of the marine environment in the Arctic area[1] and the northern coast. But no definition of pollution, list of pollutants, or specific activities are included. Later legislation (1974) covers Soviet ships on the high seas by making it a criminal offense to discharge substances[2] harmful to human health or to living resources of the sea. A separate decree raised the penalties for Soviet ships polluting the high seas in violation of Russian commitments under international agreements.[3] The decree also stresses the intensified control measures to be taken against pollution of the high seas by harmful substances.

Oman's Marine Pollution Control Law of 1974 establishes a "pollution-free zone" in the territorial seas and waters extending 38 miles further seaward.[4] There are to be no discharges of "pollutants"

into the zone by any vessel or into any waters

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[1]See S. H. Lay, p. 710.

[2]Decree No. 118 of 14 February 1974 of the Council of Ministers of the U.S.S.R. Relating to Greater Efforts to Counter Pollution of the Sea by Substances Harmful to Human Health or to the Living Resources of the Sea; see UN Doc. ST/LEG/SER.B/18, p. 92.

[3]Decree No. 5590-8 of 26 February 1974 of the Presidium of the Supreme Soviet of the U.S.S.R. Relating to Greater Responsibility for Pollution of the Sea by Substances Harmful to Human Health or to the Living Resources of the Sea; see ST/LEG/SER.B/18, p. 91.

[4]See ST/LEG/SER.B/18 (1976), p. 74.

beyond the zone by vessels registered in Oman. A "pollutant" is oil or any dangerous or noxious substance which would degrade or alter the waters to the detriment of man, or of any animal, fish or plant useful to man.[1]

In comparison to U.S. legislation, only Canada has implemented ocean dumping provisions which are at least as strict and comprehensive.

They also contain a distinction between high-level radioactive waste and all other radioactive substances. Finland's law of 1965 provided the only earlier example of a similarly restrictive regime for radioactivity in the oceans. It is difficult to determine the real value of Denmark's ban on dumping "significant" levels of radioactivity into the Baltic.[2] All other marine pollution and ocean dumping laws, with the exception of Britain, could cover radioactive materials under the generally defined category of toxic, noxious, or carcinogenic substances. But this approach forms a key loophole around

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[1] See also, the Syrian Act. No. 10 relative to the pollution of Syrian Arab regional waters and of adjacent international waters of 26 March 1972; R.L. No. 4, April 1972, p. 42; while the U.S. sub-seabed disposal program has specifically excluded all continental shelves from seabed areas to be considered as sites, international regulatory efforts may eventually find national laws on the prevention of pollution of continental shelves useful as background from which they can draw elements of substance and approach. (Norway: 1965; U.S.S.R.: 1968).

[2] This vague form was also adopted for all land-based sources of radioactive materials in the Helsinki Convention of 1974 (Article 6 and Annex II) for the Baltic Sea area. It, however, prohibits all dumping (including radioactive materials) in the area (Art. 9).

the still difficult and controversial question of defining the level at which radioactivity becomes "toxic."

Considering the nearly complete absence as of 1970, of national laws to control ocean dumping beyond territorial limits,[1] development in this area has been rapid. But crucial problems remain. Many countries, including some with major fleets, have not enacted any domestic legislation on ocean dumping. Some of the existing laws fall short of the London Convention approach,[2] including some which form the basis for ratification. The London Convention approach involves an international agreement under which states agree to exercise their national law-making and law-enforcing authority to forbid the discharge into the sea of substances listed in an annex that is negotiated by scientists from the parties, and to regulate less dangerous substances listed in another, similarly negotiated annex. Full use should now be made of the latest IAEA guidelines on radioactive waste disposal at sea since these reflect the most up to date information available on the behavior of radionuclides in the marine environment. In most cases definitions of "dumping" would not appear to cover sub-seabed disposal, so eventually either new legislation or amendments to the dumping laws would

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[1]See Bohme, p. 101.

[2]The London Convention framework was outlined briefly above, p. 102, n.1; it is described in detail below, pp. 156-165.

be required to regulate sub-seabed disposal. Finally, the highly complex and expensive task of enforcing these dumping laws must receive enormously increased attention if this is to be the mechanism used to control sub-seabed disposal.

Other Categories of Applicable Legislation and Regulations

The other three categories of potentially useful national legislation (general environmental protection; waste management; and radioactive substances control) vary from country to country in their degree of applicability to sub-seabed disposal.

If this legis[illegible] be useful for regulating sub-seabed disposal, the oceans and deep seabed must be addressed, at least to the extent of asserting jurisdiction over nationally owned, [illegible] and loaded vessels. In all cases, since [illegible] are controlled by government monopoly, such legislation would solve all jurisdictional problems, i.e., there is no need for territorial restrictions if all nuclear wastes are carried on vessels which, by their national laws, are forbidden to dump or implant without a license.

General environmental protection legislation can provide the framework for early consideration of the broader implications of scientific and technological development. Some acts, such as the East German Environmental Protection Act (1970) and the British Control of Pollution Act (1974), form umbrellas for specific sets of regulations on water, air, noise, and solid waste pollution. Some exempt specific types of pollution from their coverage; the Swedish Environment Protection Act (1969), for example, exempts ionizing radiation and the dumping of waste in water. The U.S. National Environmental Policy Act (1969) and Australian Environmental Protection (Impact of Proposals) Act focus on environmental awareness in governmental decision-making processes, but do not themselves prohibit polluting activities. They require environmental impact statements for major federal programs and projects. Most such laws create a board or governmental department to oversee the implementation of environmental protection objectives.

This category of laws forms the only existing vehicle for most governments to consider national policies, legal structures, and institutional responsibilities for a program such as sub-seabed disposal early in the research and development process. Without this impetus, science and technology will continue to race ahead of social management, laws and policies will continue to be formulated at the last minute to flatly accept or reject the technology, and agencies and organizations will continue to overlook key problems and compete for the sole right to deal with others.

Solid waste management acts often exempt (the West German Waste Disposal Act of 1972), or deal only tangentially with, radioactive materials. Yet, increasingly, toxic or dangerous wastes are either covered by specific legislation (Belgian Law on Toxic Wastes of 1974) or included in broader waste disposal or waste management frameworks (Swiss Law on the Disposal of Wastes of 1966). In many cases waste management forms one section of a broader environmental protection act (British Control of Pollution Act of 1974, Part I). Some waste management laws (such as those in the U.S. and Britain) call for comprehensive national plans or systems for waste disposal sites. State or provincial authorities are often delegated the authority to establish the regulations which implement the national law. [1]

The Belgian Law of 22 July 1974 on Toxic Wastes covers all potentially toxic industrial or commercial byproducts. [2] It prohibits abandonment of these substances without a license, or without prior notification under

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[1] See, for example, The Bavarian Wastes Law of 25 June 1973 (Sammelblatt für Rechtsvorschriften des Bundes und der Länder, Vol. 2, 17 Aug. 1973, No. 33. pp. 1173-1177): or Regulations of 15 Oct. 1974 for the implementation of the law on the disposal of wastes (Recueil authentique des lois et actes du Gouvernement de la République et Canton de Geneve, Vol. 160, 1974, 1975, pp. 425-435).

[2] Moniteur belge, 1 March 1975, No. 43, pp. 2365-2371.

certain circumstances. Industries creating toxic wastes must pay all disposal costs. And if disposal takes place in Belgium, but outside of the original industrial site, it must be done at an approved center. This law, as with many other similar ones, might be useful for assisting in the regulation of sub-seabed disposal if it were extended to cover disposal in international areas.

Though still very important for licensed materials such as spent nuclear fuel or high-level wastes from reprocessing, atomic energy or radioactive substances control laws are no longer necessarily the overriding source of regulation for radioactive waste disposal. This is especially the case for a future application of deep sub-seabed disposal. Disposal methods and sites will certainly require exemptions or licenses under atomic energy regimes, but, unless exempted by new legislation fixing special rules, permits and authorizations under the other three general categories of national laws and institutions will also be essential for the implementation of sub-seabed disposal.

For reasons discussed in Chapter 1 above, exemptions are unlikely. The traditional federal preemption of most aspects of radioactive material use, handling, and disposal, which is now giving way to some state and local powers in many countries, will hold to a much greater extent for any disposal in international areas than it would for use of land sites. And many fewer permits and approvals can be expected for sub-seabed disposal. The publication, hearings, objection, and intervention procedures now beginning to appear in nuclear energy legislation and regulations,[1] or in applicable environmental protection legislation or regulations,[2] will not always be applicable for disposal in the deep seabed since public participation is often required only for states and communities where facilities are to be sited. Yet state and local public participation rights in some areas, such as the transport of radioactive materials, may be triggered for sub-seabed disposal. And certain permits, such as those from fisheries or marine pollution departments, would impose cautions and complications not involved in land-based disposal. This, of course, addresses only the national and not the international requirements which would have to be fulfilled.

The key in the area of radioactive materials control legislation for sub-seabed disposal will be establishing

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[1]A relatively early example is the Dutch Decree of 10 September 1969 (Stb. 404; Staatsblad van het Koninkrijk der Nederlanden, 1969, pp. 929-938; in Int. Dig. Hlth. Leg. 1 (1972): 86-89) which modifies the basic nuclear energy law's licensing process for use and disposal of radioactive substances; it requires prior notification of the involved province and commune, local public announcement, and a three-week public objection period. Two more recent examples are laws in Denmark (Act of 4 May 1976 on Measures of Safety and Environmental Protection Relating to Nuclear Installations ETC; Nuc. L. Bull. 18 (December 1976): 8) and in West Germany (Nuclear Installations Ordinance of 18 February 1977; Federal Gazette of 23 February 1977 (BGBl. I, p. 280): in Nuc. L. Bull. 19 (May 1977): 6, and Supp.) which establish new licensing procedures for nuclear installations, pursuant to the basic nuclear energy legislation. The procedures have detailed requirements for public notifications, objections, and hearings.

[2]See, for example, the U.S. provisions in Chapter 1, above, p. 44, n. 1.

consistent national regimes which fit tightly together with the international nuclear law framework. As the internat-ional regulations grow in complexity or substance, many national laws will need updating. Guides published by the International Atomic Energy Agency must be considered to offer the minimum level of protection acceptable to many countries. Sub-seabed disposal, as with any international disposal effort, will require some degree of uniformity in participating nations' regulations and international oversight for radioactive waste proces-sing, transportation, and storage. The joint establish-ment of strict, or preferably absolute, liability[1] provisions for the groups of nuclear operators from participating countries will be essential. And comprehensive national and international enforcement responsibilities and means will have to be specified.

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[1]The difference between strict and absolute liabil-ity as applied here is that outlined by L. F. E. Goldie in "Pollution and Liability Problems Connected with Deep-Sea Mining," A. E. Utton, ed., Environmental Policy: Con-cepts and International Implications (N.Y.: Praeger Pub., 1972), p. 160. He employs "absolute liability" ". . . to indicate a more rigorous form of liability than that usu-ally labeled strict, as for example, that formulated in the nuclear liability treaties. . . . These agreements utilize the principle of channeling, . . . which traces liability back to the nuclear operator, no matter how long the chain of causation, nor how novel the interven-ing factors (other than a limited number of exculpatory facts). . . ."

Worldwide Trends

The national structures now available to nations which might eventually participate in a sub-seabed disposal program are not yet adequate for the task of effective regulation and enforcement. Yet it is still early in the U.S. research process; the U.S. ERDA Seabed Assessment Program[1] is still only a feasibility study until 1980. Important development has occured in the 1970's but much remains to be done. Although formal legal action on sub-seabed disposal can wait for further scientific development, it is particularly important to start work now on national regulatory and enforcement structures which will complement and assist in the formulation of strict international agreements, such as on the transportation of spent nuclear fuel and high-level reprocessing wastes. Early consideration must also be given to the possible need for international storage and/ or disposal of spent fuel--the high-level waste from a once-through fuel cycle.

If sub-seabed disposal becomes a scientifically validated option for radioactive waste disposal, nations will have to choose between legal management or prevention. Either will most likely be accomplished with a combination of marine pollution and atomic energy legal measures, including some use of environmental protection and waste

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[1]See Chapter 1 above, p. 16, n. 1.

management legal regimes. Rulings will be necessary under marine pollution acts as to whether "dumping" should be defined in terms of the disposer's location, the location where wastes are placed, pollution of the seas and seabed, or the level of threat to the marine environment. If sub-seabed disposal is "dumping" and thus illegal for high-level radioactive materials and licenseable for non-high-level materials--as under U.S. and Canadian law, it may be possible to control high-level radioactive waste disposal within the framework of dumping laws and treaties by forbidding "dumping," but permitting disposal that does not reach the threshold of dumping through effective containerization and site selection. In this case, much wider ratification of the London Convention of 1972,or something similar, and more complete implementation in corresponding national legislation, would be essential to the effective regulation and control of sub-seabed disposal. If it is not--as under the legislation in various countries, earlier action on new marine pollution control provisions will be necessary for adequate regulation and enforcement of such disposal. This may eventually be taken care of for some nations by ratification and implementation under national law of a new law of the sea treaty.

Specifically applicable regulations could be enacted under general atomic energy acts. In this case the most effective control is likely to be achieved through the designation of one or two ministries or agencies, such as the NRC or EPA in the U.S., the Department of the Environment in the U.K., the Institute for Protection and Nuclear Safety or the Ministry of the Quality of Life in France, the State Office for Nuclear Safety and Radiation Protection in East Germany, and the Federal Institute of Physics and Technology in West Germany, to oversee national participation in (or rejection of) sub-seabed disposal. These regulations would have to equal or exceed international standards for waste processing and containment, and international site suitability criteria in order to establish an acceptable regime for implementing sub-seabed disposal.

National waste management acts, with considerably more updating and coverage of radioactive materials, could establish a broader framework for sub-seabed disposal. This is one method for determining if and or how sub-seabed disposal should fit into the overall national plan for disposal of radioactive wastes, or perhaps of highly toxic and persistent materials in general.

CHAPTER IV

INTERNATIONAL LAW AND THE SUB-SEABED DISPOSAL OF RADIOACTIVE WASTES

The rules of international law, limiting the discretion of states in the seabed commons, will obviously be crucial to the development and implementation of any proposal to emplant radioactive wastes beneath areas of the international seabed. Less obvious is the fact that an international sub-seabed disposal program will affect other aspects of the international consensus regulating use generally of the deep seabed, protection of the environment, and control of nuclear energy.

Fundamental social and political attitudes towards both the nature of the high-level radioactive waste disposal problem and the use of the commons for such waste disposal are critical to the legality of sub-seabed disposal by states or by international organizations. The questions which must be addressed for use of the commons for sub-seabed disposal number at least three:

1) To what extent is high-level radioactive waste disposal regarded as a national responsibility;
2) Is there now--or could there soon be--a consensus that use of the commons for high-level radioactive waste disposal is forbidden; and
3) If such disposal is not forbidden, how can it be effec-

tively controlled and managed?

The international aspects of radioactive waste disposal, especially of high-level wastes, cannot be avoided. Spent reactor fuel is already commonly transported internationally and the number of shipments will increase dramatically (indeed, a central part of U.S. nuclear non-proliferation strategy is to establish a system through which all spent fuel will be returned continuously to supplier nations in the future); the wastes from spent fuel reprocessing operations may be returned to countries using external reprocessing services in the future; various nations with nuclear power programs, and some with major nuclear commitments, are unlikely to ever have any fully accepted national options for high-level waste disposal; and many, or perhaps all, nations have a stake in assuring the nearly permanent isolation of high-level, and increasingly other types, of radioactive wastes from the biosphere.

The question of international legality may ultimately reduce largely to the extent of availability of alternatives to using sub-seabed disposal. If other acceptable options are available to all nations within national borders (either locally or within other countries), the legal regime might best turn to preventing the use of sub-seabed disposal. If it turns out both that sub-seabed disposal is scientifically sound and that a nation or several nations have no other choice, or that the sub-seabed option would be clearly the safest choice, a good case could be made for using such disposal under an international control regime. In practice, of course, the worldwide availability and priority of disposal options will not be this clear cut. One complication, for example, now seems very likely to arise. Some nations and organizations seem to be leaning towards the probably sound decision that the safest path is to guard against being caught with a system failure by using more than one basic option for final disposal and thus reducing the consequences of a single failure, while perhaps increasing its likelihood.

This chapter focuses on international legal elements, leaving most political and institutional considerations for later chapters. The initial section examines the prevailing international definition of "marine pollution" and its potential application to the sub-seabed disposal of radioactive waste. This is followed by an analysis of principles, rules, and treaties in the area of marine pollution control which will affect sub-seabed disposal. Pertinent multilateral controls in the areas of atomic energy and general environmental protection are analyzed in the final section.

Establishing a Definition of "Marine Pollution" and a Framework for Measuring the Definition Against Sub-Seabed Disposal

A crucial first step is to establish a generally acceptable definition of "pollution of the marine environment" and a means for determining if sub-seabed disposal would constitute such pollution. This will introduce the section on marine pollution control structures which may be available for application to a sub-seabed disposal program. International nuclear and environmental law fields will then be analyzed. And, finally, the overall international legal situation will be assessed.

Approaches to Defining "Pollution"

Pollution control in the law of the sea has developed a long way from the U.N. Charter mandate to help solve "social" and "health" problems [1] and the 1958 High Sea Convention "reasonable regard" standard, [2] which maintains initial discretion in the state acting on the high seas in ways that might interfere with another state's rights to equivalent use. But this development has occurred largely since 1971. The difference between the traditional test of "reasonableness" and the presently developing concept that "states have the obligation to protect and preserve the mar-

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[1] United Nations, UN Charter Article 55(b).

[2] Convention on the High Seas of 1958:

Article 2

The high seas being open to all nations, no State may validly purport to subject any part of them to its sovereignty. Freedom of the high seas is exercised under the conditions laid down by these articles and by other rules of international law. It comprises, *inter alia*, both for coastal and non-coastal States:

(1) Freedom of navigation;
(2) Freedom of fishing;
(3) Freedom to lay submarine cables and pipelines;
(4) Freedom to fly over the high seas.

These freedoms, and others which are recognized by the general principles of international law, shall be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas.

ine environment"[1] deserves careful consideration.

One recent analysis of past use of the label "pollution" in international law demonstrates clearly that at least five significantly different approaches have been applied.[2] Two approaches are offered only as extreme cases: that almost any change in the existing environment is pollution and that no environmental change within national borders, regardless of extra-territorial effects up to a very high threshold of legal concern, is pollution.[3] But three others provide a useful framework for applicationto disposal practice in the marine environment. The first of those three is defining pollution as the introduction of material or energy in a quantity that exceeds the assimilative capacity of the environment. Part of the evidence has already been presented that law of the sea has moved, in the area of highly toxic substances, to forbid "pollution" as so defined.[4] Further examination

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[1] United Nations, General Assembly, Third UN Law of the Sea Conference, Revised Single Negotiating Text, Part III, p. 2, Art. 2, (A/CONF.62/WP.8/Rev. 1) [Hereinafter cited as the RSNT] As of June 1977, the RSNT was the document accepted as a common basis for further negotiation in the Law of the Sea Conference; it is an important indication of what most countries of the world may eventually adopt as the consensus on law of the sea matters, especially the sections which are now generally accepted. Yet is is in no way legally binding on the participating states, or even on the negotiating delegations at the Conference.

[2] A. L. Springer, "Towards a Meaningful Concept of Pollution in International Law," (M.A.L.D. Thesis, The Fletcher School of Law & Diplomacy, 1975; forthcoming in the Int'l. and Comparative L. Quarterly); see also, H. A. Cole, "What to Protect--A Matter of Definition," Marine Pollution Bull. 8 (1977): 1.

[3] Springer, p. 1.

[4] See, generally, Chapter II, above.

will follow of the evidence that the complexities, risks, and unknowns have led almost all states to reject this approach for at least materials which are as toxic, persistent and accumulative as high-level radioactive wastes.

The second approach, that of pollution as interference with other uses of the environment, includes concepts such as "equitable utilization" and the "reasonableness" test. This approach will, by itself, also be shown to be inadequate for regulation of toxic waste disposal in the marine environment, but it is one important element of many of the cases and documents analyzed below. Reasonableness, as codified in Article 2 of the 1958 High Seas Convention and as elaborated by McDougal and Burke in 1959,[1] is a commonly applied measure for determining validity with respect to the law of the sea, and an effective guideline when used carefully and in addition to Articles 24 and 25 of the High Seas Convention.[2] But a serious problem arises on the frequent

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[1] M. S. McDougal and W. T. Burke, The Public Order of the Oceans (New Haven: Yale Univ. Press, 1962), p. 863.

[2] Article 24

Every State shall draw up regulations to prevent pollution of the seas by the discharge of oil from ships or pipelines or resulting from the exploitation and exploration of the seabed and its subsoil, taking account of existing treaty provisions on the subject.

Article 25

1. Every State shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations.

occasions when reasonableness is applied in an incomplete and/or isolated fashion.

Cundick concluded that the U.S. nerve gas dump in 1970 was clearly acceptable with respect to the law of the sea, that reasonableness was, is and should continue to be applied where clear conventional law is not available, and that the key factor in disposal cases is the present availability or unavailability of reasonable alternatives.[1] As will be further discussed in a moment, available alternatives is only one of the five considerations offered by McDougal and Burke for assessment of the "reasonableness" of a specific ocean disposal of radioactive waste.

"Reasonableness" as an international standard is not satisfied by unilateral decisions and actions which ignore the requirements of Articles 24 and 25 of the 1958 High Seas Convention for regulation to prevent pollution of the seas by use of the seabed or by dumping of radioactive waste, and for cooperation with appropriate international organizations to prevent pollution of the sea by radioactive and other harmful materials. Too often the reasonableness test (as determined by consensus through correspondence, protest, justifying statements, etc.) becomes a rationale for avoiding prior

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2. All States shall co-operate with the competent international organizations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.

[1]Cundick, pp. 205, 209.

consultation and relying on the level of negative reaction, i.e., objections or protests, for measuring the legality of unilateral action which is presented as a *fait accompli*. While the reasonableness test (as codified in Article 2) is probably all that general international law requires, Articles 24 and 25 (which go further) are binding requirements for all parties to the 1958 High Seas Convention. Non-parties, however, are not bound by Articles 24 and 25. The Conventions of 1958 are now of doubtful legal force in light of the recent law of the sea negotiations and resultant negotiating texts.

Reasonableness, just as the "equitable utilization" measure which is prominent in the Helsinki Rules on international river waters,[1] has inherent flaws in the area of toxic substances. Prior to assessing risks of harm according to *existing* information, it is necessary to determine if there is, or soon will be, an adequate data base. States relying on these concepts tend to put off both serious consideration of the complexities and unknowns beyond present science and technology, and the protection of the marine environment by proving safety of practice, for what appear in short-term evaluations to be important present uses. This leaves no room for evaluation of possible or even probable hazards, beyond the immediate context, to man, his property

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[1] Int'l. Law Association, *Helsinki Rules on the Uses of the Waters of International Rivers*, adopted by the ILA at the 52nd Conference, August 1966 (London: n.p., 1967).

or the closely inter-related marine environment.[1]

The final general approach to defining pollution is that of damage or injury which has been or may, in the future, be done to man, his property, or the environment. It is incorporated in the factors set out by McDougal and Burke to the extent that the possibility of harm according to the existing information must be considered.[2] The need only to establish the possibility of future damage fell under the area of developing law in 1959, but by 1969 the international community had developed, and to some extent codified this approach for damage from dumping of toxic wastes. It has also become very clear that existing information is frequently inadequate because of unanticipated, often undesirable side effects. The damage prediction factor has become increasingly influential relative to the other factors in transnational practice.

The single definition of "pollution of the marine environment" that has been reached in exhaustive negotiations during the last five years is:

> The introduction by man, directly or indirectly, of substances or energy into the marine environment . . . which results or is likely to result in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing and other legitimate uses of the sea, impairment of quality

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[1] See testimony by H. Sanders in U.S., Congress, Senate, Comm. on Commerce, Hearings on Nerve Gas Dumping.

[2] McDougal and Burke, p. 863.

> of use of sea water and reduction of amenities.[1] (Emphasis added.)

The definition is based squarely on the second and third approaches to defining "damage/injury"--hazard to man and harm to living resources, and "uses"--hindrance to marine activities and impairment of quality of use of sea water.

The phrase, "is likely to result," does two important things. First, it significantly lowers the legally enforceable threshold by requiring only that a probability of harm be shown to living resources, etc. And second, it frequently places the burden of proof on the alleged polluter rather than on the victim or affected party; once the statistical likelihood is shown that a possibility of harm will sooner or later produce the harm, prior proof of safety will often be required to show no probability of damage.

While the focus of current research on sub-seabed disposal for radioactive waste is on rates of release versus rates of decay, the question of whether or not harm to living resources or hazard to human health is likely is also being addressed. If the wastes can be shown, beyond reasonable doubt, to be isolated within the seabed, there will be no harm or hazard. If isolation cannot be sufficiently demonstrated, the program should be largely abandoned.[2] In

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[1]RSNT, Article 1.

[2]Any part of the program which can help monitor and assess ongoing and planned disposal practices of other countries might usefully be continued.

any case, the problem will ultimately amount to determining the operational, specific meaning of "likely to result" in scientific, economic, legal and public perception terms: What will be an acceptable level of risk of harm or hazard? For any high-level radioactive waste disposal method this includes complete assessment of the likelihood of future accidental or intentional intrusion by man as well as of natural breaches.

A Framework for Measuring Sub-Seabed Disposal Against the Definition of Marine Pollution

An evaluation based on the five factors proposed by McDougal and Burke is useful, though certainly not sufficient, for measuring sub-seabed disposal against the definition of marine pollution. The five factors for assessing the reasonableness of ocean disposal of radioactive materials include:

1) "The scope and intensity of prior investigation of a proposed site;"
2) "the possibility of harm according to existing information;"
3) "prior use of the area;"
4) "effects on such prior uses and on potential uses;" and
5) "available alternatives for the disposing state."[1]

The prior investigation of each proposed site will very clearly have to be intensive and comprehensive in order to

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[1] McDougal and Burke, p. 863.

meet scientific and engineering needs. The possibility of unacceptable radionuclide leakage beyond the immediate surrounding areas of deep seabed must be shown to be vanishingly small before the system would be developed into the pilot-plant phase. This means that the probability of harm to anything in the water column or top few meters of the seabed, according to all existing and foreseeable information, must be very low. It now seems to be a simple matter to pick study areas and candidate disposal sites which have no record of previous use and very low probability of any projected future uses.

If this isolation system for radioactive wastes conforms to some acceptable national and international performance level in an unused area of the seabed before it becomes an option, it might still be labeled pollution as a hindrance to marine activities, e.g., mining of manganese nodules. Overflight and surface navigation would be affected only to the extent that navigation charts would need appropriate informational notations. Five to six kilometers of water is beyond the research and exploitation interests of all projections and speculation on fishing and sub-surface navigation uses. But, more important, no restrictions should be necessary regardless of future development in this area.

The situation could be different for uses involving the seabed, such as laying submarine cables and pipelines, conducting scientific research, and mining manganese nodules. Such uses, especially ones imposing only temporary commitments of the seabed, i.e., research and mining, could probably continue in a sub-seabed disposal site without presenting any technical problems. For management purposes, however, it now seems prudent to prohibit such uses in these areas if international agreement to this effect can be reached. The prohibition of longer term uses, such as laying cables, would seem to be necessary for any effective disposal program.

Sites could probably be selected which were far removed from any foreseeable submarine cable and pipeline routes, but the restriction of the future exercise of these rights could lead to protests from concerned nations. Submarine cable and pipeline laying is such a well-established right of all nations that it could become necessary to avoid all areas designated, with reasonable justification, by any countries as prospective cable or pipeline routes.

The potential loss of any real value in natural resources, with the possible exception of manganese nodules, from these areas so far seems unlikely. Concentrations of metals in test samples of nodules in the North Pacific study area are well below present economic mining levels,[1] and areas with nodules which are potentially minable could be avoided. There could be some small change in the predicted availability of natural resources, if all of the better nodules were used up, but this seems unlikely due to the vastness of these ore bodies in areas containing richer nodules.

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[1]See Bishop, A First Year Report, p. 235.

Potential mid-plate sites in the deep seabed have been inherently unattractive to scientists due to the slowness of processes, general lack of gradients, and general remoteness. But any restriction on future research in the areas could also be protested, perhaps justifiably, by nations not involved in a sub-seabed disposal program. Again, however, the persuasiveness of such protests might be limited by the vastness of very similar areas of the deep seabed which would still be available for scientific research purposes.

The effects of sub-seabed disposal on possible uses of the seabed and oceans appear to be minimal. Yet even minor restrictions, especially those on cable laying and scientific research, should be expected to require some form of broad international consent, or at least consultation, to address the future limitation of well-established rights to use of the commons. It is certainly not clear, as will be further discussed below, that one or even several nations can permanently restrict rights to use areas of the international seabed. It is also possible, however, that a sub-seabed disposal program managed by several countries which included prior notification and consultation might not lead to any major protests or objections over use restriction.

It is still too early to evaluate fully the final factor: alternatives available to the disposing state or states. We have already noted that to be accepted under U.S. NRC regulations the sub-seabed disposal program must be a superior or somehow very important option. This could become a model for future international guidelines. But right now the crucial point is that there is no other operationally proven option for the ultimate disposal of high-level radioactive wastes. And although many experts and government officials feel that the U.S. and most other countries will certainly be able to develop at least one option that is acceptable technically, socially, and politically, this is still to be demonstrated. Furthermore, some expert observers feel that it will be much later than 1985 before even the U.S. has demonstrated its capacity to operate an accepted repository. And this may not help address the low probability, which in some cases approaches zero, that countries such as Japan, Taiwan, the Philippines, Switzerland, Belgium, and Britain will ever have a stable and permanent disposal option within their borders for high-level radioactive wastes. If options become available in the U.S., U.S.S.R., and West Germany, for example, it may be possible for other nations to export materials there for final disposal, but this is a long way off. And so far, it seems to be very difficult politically (outside of Eastern Europe) to even consider providing final disposal services for other nations' high-level wastes. This is with the possible exception of the U.S.--where at least the Executive Branch of the government seems willing to manage foreign spent fuel as wastes. All that can really be stated at this point is that sub-seabed disposal, in a form found acceptable to the U.S., France, U.K., and Japan (which now constitute the Seabed Working Group [1] in the international research effort on sub-seabed disposal), could turn out to be an alternative available to many countries.

Yet evaluation of seabed disposal with these five factors is only of limited value. One potential problem with this evaluation is the fact that it is based on the regime of the high seas as opposed to that of the seabed and subsoil. While dumping has inevitably affected the seabed, the practice has usually been analyzed in terms of its effect on the water column, and especially the potential effects on man. Article 3 of the 1958 Geneva Convention on the Continental Shelf establishes two clearly distinct regimes; the strong coastal state rights in the shelf do not affect the legal status of the high seas.

<u>Article 3</u>

> The rights of the coastal State over the continental shelf do not affect the legal status of the superjacent waters as high seas, . . . [2]

Many states would vest the same type of rights to the deep seabed in an International Seabed Authority. [3] It is highly likely, however, that at least initially any Authority acceptable to the nuclear states will have limited and strictly prescribed rights to the seabed.

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[1] As established at the Second International Workshop on the Seabed Disposal of High-Level Radioactive Wastes, Wash., D.C., 1977.

[2] <u>Convention on the Continental Shelf</u>, 29 April 1958, [1964] 15 U.S.T. 475, T.I.A.S. 5578, 450 U.N.T.S. 311.

[3] RSNT, Articles 21 and 22.

Also somewhat troublesome is the idea of committing even these relatively very small areas in a very permanent sense. A large body of precedent exists for setting aside air space, high seas, or sea floor special purpose zones, in particular for military exercise zones, air defense warning zones, sea lanes for shipping, cable and pipeline crossing areas, and various types of spoil or disposal areas. But even an international munitions disposal area can be converted very quickly into an area for any new unforeseen, and vital seabed uses which may arise; while high-level radioactive waste disposal sites cannot.[1]

A final problem may be that of changes in the international law definition of pollution. We know that societal values vary among regions and countries and over time. As states gradually move to the adoption of approaches to pollution which employ stricter concepts of preventing damage to the marine environment, at low thresholds, such as any "unfavorable alteration,"[2] or any change in the "predicted

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[1]Professor W. T. Burke has raised the vital point that we must expect such uses, based on criteria similar of identical to those employed in this plan (especially the seismic stability), to arise regardless of our present range of foreseeable options (interview held at the University of Washington, Seattle, August 1975). This then becomes one factor which must be considered in future decisions.

[2]U.S., Department of Commerce, National Oceanic and Atmospheric Administration, "Report to the Congress on Ocean Dumping and Other Man-Induced Changes to the Ocean Ecosystems" (March 1974), p. 6.

availability" of natural resources,[1] the idea of carefully assessing each of sequential barriers between emplaced high-level radioactive waste and man may succeed in scientific and technical terms but fail on other grounds as the law of the sea changes to reflect other environmental values. The question would then become one of assessing the certain, probable and possible levels of "damage" to the subsoil and risks to man from this "pollution" against the perceived importance of implementing the geologic disposal plan at any time.

One potential solution to this future use problem in addition to minimizing size and carefully selecting sites, is to apply Article 7 of International Law Association's Helsinki Rules for river basins by analogy to the seabed and subsoil. According to that rule,

> A basin state may not be denied the present reasonable use of the waters of an international drainage basin to reserve for a co-basin state a future use of such water.[2]

Given a proven, planned use of the seabed/subsoil, especially if proposed by a group of states, this widely accepted and applied regime for equitable utilization of common international river waters may lend precedent for unknown future uses to give way. But the de-

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[1] See A. P. Rubin, "Pollution by Analogy: The Trail Smelter Arbitration," Oregon Law Review 50 (1971): 272.

[2] See ILA, Helsinki Rules.

termination of what constitutes a "present reasonable use" brings us back to problems discussed above, and the international drainage basin situation may not be a sound analogy for the seabed commons.

Implementation through Agreement: International Conventions which may Influence Sub-Seabed Disposal

Here we will begin the analysis of marine pollution control law by examining the Oslo and London Conventions, IAEA responsibilities and actions under the London Convention, and five regional conventions concluded in the 1970's. As noted above, these conventions and associated agreements have a direct influence on the course of international legal development in this area. The London Convention and the IAEA response are important because they could, depending on how they are interpreted, ban sub-seabed disposal of high-level wastes by labelling it dumping. They could also assist in determining both the most appropriate category of "pollution" which might be applied to sub-seabed disposal, and an effective means of regulation and control. The regional conventions offer both a guide as to what regional control structures are available or under development, and ideas for future approaches to regional and international regulations of sub-seabed disposal.

Oslo and London Conventions

Early U.S. practice in ocean disposal of radioactive wastes was similar to that in Japan and the U.K., i.e., private contractors and government agencies were licensed for individual sea disposal operations with limited quantities of low-level materials. As this U.S. practice was being phased out, the Federal Task Force of the Council on Environmental Quality gathered the materials for the October 1970 report to the President. [1] The initiative of the U.S. Executive eventually resulted in the U.S. Ocean Dumping Act of 1972.

Throughout 1971 and 1972 and particularly in preparation for the Stockholm Conference of 1972 there was a strong push for international agreements on ocean dumping. The outcome: the Oslo Convention of 15 February 1972 and the London Convention of 29 December 1972. [2]

The Oslo Convention was at least partially inspired by the U.S. proposal before the U.N. Intergovernmental Working Group on Marine Pollution in June 1971 for an international

[1] U.S., CEQ, Ocean Dumping: A National Policy; see Chapter III, above.

[2] For detailed background of the Oslo and London Conventions, see A.S.I.L., "The Question of an Ocean Dumping Convention," Studies in Transnational Legal Policy, no. 2 (Wash., D.C.: ASIL, 1972).

ocean dumping convention. It established a clear model for the London Convention and other regional agreements. It defines dumping (Article 19) as "any deliberate disposal of substances and materials into the sea by or from ships. . . ."

In the area of contributions to marine pollution control through treaty law were the introduction of the black and grey lists (Annexes I and II as adopted by the London Convention) of prohibited and special care substances for ocean dumping permits, the coverage of national ships in the North Sea, North Atlantic, and Arctic Oceans, the inclusion of seven European states besides the four Scandinavian states, and the establishment of a permanent commission. The commission was designed to supervise the permit program and general implementation, to monitor marine areas, to recommend annex changes, and to register the details of dumping. The exclusion of radioactive materials from coverage in the Annexes, the ambiguities in listed substances, and the delegation of all enforcement responsibilities to national authorities are key aspects limiting the effectiveness of the document as a basis for a general ocean dumping regime.

The London Convention was developed in a series of four inter-governmental meetings in 1971 and 1972, and a conference in October and November, 1972.[1]

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[1]See U.S., Congress, House, H. R. REP No. 568, 90th Cong., 1st Sess., 1972, p. 3; and U.S., Congress, Senate, S. REP. No. 726, 92d Cong., 2d Sess., 1974, p. 3. A draft convention was submitted by the U.S. at the first meeting in June 1971. The Conference on Ocean Dumping was scheduled through a resolution at the UN Conference on the Human Environment. There were no

With fifteen ratifications or accessions it entered into force on 30 August 1975, and, as of 12 May 1977, thirty-two countries had ratified or acceded to the Convention, including the United States, the Soviet Union, France, Britain, Canada, Norway, Sweden, Panama, Spain, and Mexico. A number of other countries such as Japan, seem to be in the process of ratifying. At an informal meeting of the Parties (December 1975) IMCO was designated as the formal Secretarial for the Convention. Some countries also wanted UNEP to have a formal role.

Despite the overall marine environmental protection approach of its preamble and Articles 1 and 12,[1] the London Convention of 1972 is a model example of the *ad hoc* approach to pollution control, i.e., seizing on a specific aspect of a problem when agreement on its regulation seems to be reachable. In the sense that it finally cuts away at the long standing freedom of waste disposal into the high seas, and

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formal conference proceedings, but there is a set of documents available; see *Documents of the Final Drafting Conference for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, London, 1972. See also, unpublished Master of Laws thesis by J. Morgan, *The Ocean Dumping Convention* (Int'l. Legal Studies, Harvard Law School, 1973). Th Conference was attended by 80 nations; 27 signed the final document on 29 December 1972.

[1]Article 1 states that "Contracting Parties shall individually and collectively promote the effective control of all sources of pollution of the marine environment....;" in Article 12 Contracting Parties pledge to promote measures to protect the marine environment against pollution from a list of important potential sources, including "radioactive pollutants from all sources, including vessels."

that it incorporates all three of the above approaches to defining pollution, it is "a hopeful beginning" for this area of marine pollution control.[1] It was both a result of and further motivation for individual national and regional attempts at regulation of ocean dumping.

The exemptions for emergencies at sea which constitute "a danger to human life or a real threat to vessels,"[2] other emergencies which pose "unacceptable risk relating to human health and admitting no other feasible solution,"[3] and situations involving "those vessels and aircraft entitled to sovereign immunity under international law,"[4] and the Article 4/Annex 1 regime, which bans the dumping of high-level radioactive waste as defined by the IAEA,[5] present possible loop-

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[1] See T. Leitzel, "The Ocean Dumping Convention; A Hopeful Beginning," <u>San Diego L. Rev</u>. 10 (1973): 502.

[2] London Convention Art. 5(1); this was originally proposed by the U.S.

[3] <u>Ibid</u>., Art. 5(2); this was also initiated by the U.S., probably with cases such as that of U.S. nerve gas in 1971 in mind. The original U.S. proposal was in a <u>much less restrictive form</u>.

[4] <u>Ibid</u>., Art. 7(4). The U.S. took a strong position that public vessels must be explicitly exempted from international regulatory authority; this was stated to be based on the precedent set by other pollution control treaties and the coverage of the matter under U.S. national law. Many nations do not have equivalent national legislation.

[5] Art. 4, in part, provides that:

1. ...Contracting Parties shall prohibit the dumping of any wastes or other matter in whatever form or condition except as otherwise specified below:
   a. The dumping of wastes or other matter listed in Annex I is prohibited;
   b. The dumping of wastes or other matter listed in Annex II requires a prior special permit;

holes which are not available in the U.S. law with respect to high-level radioactive waste materials. The flat U.S. ban on high-level radioactive waste dumping intentionally leaves no room for definitional flexibility or unilaterally determined "emergencies." Under presently foreseeable circumstances, however, none of these possible loopholes seems likely to be used by any parties for routine radioactive waste disposal, especially for high-level wastes.

The Article 6 mandate to designate an appropriate national authority to supervise the system, including the submission of reports on all dumping, monitoring, and dumping criteria and requirements, is a strong measure, but Article 7 makes it clear that enforcement will be exclusively a national matter. Articles 7(3), 8 and 9 lend important encouragement to regional cooperation for regulation and enforcement, and for solving waste disposal problems.[1]

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c. The dumping of all other wastes or matter requires a prior general permit.

2. Any permit shall be issued only after careful consideration of all factors set forth in Annex III, including prior studies of the characteristics of the dumping site as set forth in Section B and C of that Annex. . . .

The applicable section of Annex 1 will be analyzed in a moment.

[1]In Article 7(3) "[t]he Parties agree to co-operate in the development of procedures for the effective application of [the] Convention particularly on the high seas, including procedures for the reporting of vessels and aircraft observed dumping in contravention of the Convention." Art. 8 encourages geographic regions to conclude regional anti-pollution agreements and Contracting Parties to co-operate in harmonizing procedures with parties to regional agreements. Just as in Arts. 4,5 and 7, with respect to national action and laws, the establishment of stricter regional arrangements is encouraged. Art. 9 calls for the promotion of relevant technology transfer, including help with the treatment and disposal of wastes.

The Article 11 obligation to consider dispute settlement procedures for interpreting and applying the Convention was avoided in 1976 at the first meeting of the Parties by putting the matter off until the Third UN Law of the Sea Conference was completed. It did seem clear that some form of compulsory third party settlement procedures would eventually be adopted by the London Convention parties. Spain is now preparing a proposal for their next meeting in late 1977.[1]

The London Convention did not follow the U.S. draft and the Oslo Convention examples in exempting radioactive materials. Instead, it adopted the technical annexes approach with procedures for relatively quick amendments to the annexes.[2] The annexes are the pivotal parts of the Convention. Annex I, which covers all materials prohibited by Article 4(1)(a), includes

> High-level radioactive wastes or other high-level radioactive matter, defined on public health, biological or other grounds by the competent international body in this field, at present the International Atomic Energy Agency, as unsuitable for dumping at sea.

It was the special Spanish and Portuguese concern over European radioactive waste dumping in Iberian areas of the Atlantic that led to coverage of non-high-level wastes and

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[1]Article 14 of the London Convention provides for meetings of the parties to continually review the implementation and the possible need for updating of the Convention. Consultative meetings are to be held at least once every two years; special meetings occur " . . . at anytime on the request of two-thirds of the Parties."

[2]Amendments to the annexes are self executing to the extent that once they are approved, based on scientific and technical considerations, by two-thirds of thoses states present at a consultative meeting, they enter into force for all parties within 100 days unless a negative declaration is filed for individual states.

the requirement for study of dumping zones prior to use. Without the proposed Spanish amendment, only high-level radioactive materials would have been included. Annex 2, which includes materials requiring a special permit from the national authority for dumping, covers all radioactive wastes not included in Annex 1 and calls for full consideration of the recommendations of "the competent international body in this field, at present the International Atomic Energy Agency."

Important guidelines for establishing national criteria for issuing dumping permits are provided in Annex 3. Section A calls for a detailed listing of the characteristics of the wastes proposed to be dumped. Section B does the same for the proposed dumping site, including consideration of ". . . whether an adequate scientific basis exists for assessing the consequences of such dumping . . . ." And Section C includes the "General Considerations and Conditions":

1) Possible effects on amenities . . .
2) Possible effects on marine life . . .
3) Possible effects on other uses of the sea . . .[and]
4) The practical availability of alternative land-based methods of treatment to render the matter less harmful for dumping at sea.

Though the "release of toxic . . . substances. . . . by dumping" (RSNT Article 4(3), see below, p. 207) would not apply to an acceptable radioactive waste isolation system within the seabed, "dumping" may apply, depending on how nations interpret the London Convention. The Convention (Article 3) defines dumping as "any deliberate disposal at sea of wastes . . .from vessels. . .at sea" (emphasis added.) There are at least two possible interpretations of the wording of the first "at sea" in this context:

1) that it refers to the location of the disposing party, i.e., any disposal from vessels that are at sea constitutes dumping, regardless of whether there is any possibility of the wastes eventually reaching the water (thus, sub-seabed disposal would be dumping); and

2) that any disposal from vessels resulting in the discharge of wastes, whether containerized or not, into the water and/or onto the seabed constitutes dumping (sub-seabed disposal would not be dumping).

The first possibility means that any disposal from a ship--even if it is launched into space or emplanted in the seabed--is dumping. This is the broadest possible definition and the way at least U.S. environmental legislation has often been interpreted. The second follows the "into the oceans" meaning used in almost all prior international work in this area since 1956, most existing national dumping legislation, and the Oslo Convention of 1972.

If the Parties eventually reach a consensus that the Convention's definition of dumping is legally ambiguous vis-a-vis sub-seabed disposal, there are other points of possible assistance in its interpretation. It is possible that the specific exemption from coverage under the London Convention of all disposal from exploitation and processing of seabed minerals (Art. 3(1)(c)) is an indication that the Parties may exclude other specific uses of the seabed. On the other hand, the lack of Parties' support for the Spanish view (offered at the first consultative meeting in 1976) that ocean incineration was not "dumping" may be instructive. The apparent consensus to adopt special provisions under the London Convention on ocean incineration may be indicative of a desire to apply a broad interpretation to the dumping definition. Yet disposal by incineration does result in the direct discharge of wastes from the air into the ocean, so this would also be termed "dumping" under either of the possible interpretations analyzed above.

During the set of U.S. congressional hearings and follow-up questions on radiological contamination of the oceans in 1976,[1] specific inquiries were made as to the legality of high-level radioactive waste disposal on or in the seabed. Three U.S. agencies and two experts responded. The U.S. EPA and ERDA submitted internal agency memoranda. The EPA memorandum of May 1976 notes that sub-seabed emplacement falls under the U.S. Ocean Dumping Act of 1972, and that disposal of non-high-level radioactive wastes must be done under the EPA ocean dumping permit system (high-level wastes cannot be dumped).[2] ERDA's internal legal opinion of August 1976 concurs with the EPA ruling that sub-seabed disposal would be dumping under the U.S. Act and adds that the London Convention prohibition on "dumping" high-level wastes "can be

[1] U.S., Congress, House, Comm. on Interior and Insular Affairs, Hearings on Radiological Contamination of the Oceans.

[2] Ibid., p. 813.

interpreted in the same manner as the statutory prohibition, i.e., that "dumping" includes deep seabed emplacement for disposal." [1] This is unclear as to whether "can be interpreted" is used in the permissive sense of "may" or the obligatory sense of "must". It concludes that:

> Since the dumping of <u>all</u> radioactive wastes defined as high-level by the [U.S.]. . . Act would not appear to be prohibited by the Convention, Congress would have discretion to amend the Act to allow the granting of a permit for the dumping of high-level. . .wastes as long as such amendment is consistent with Convention standards.

A letter from the Department of State is the most authoritative source since it comes from the part of the U.S. government responsible for treaty interpretation and it is a direct response to the congressional request. It takes a wait and see approach to the question of whether the London Convention prohibits sub-seabed disposal. This opinion provides that:

> Under these [London Convention] definitions [of dumping and prohibited high-level wastes], disposal of high-level radioactive wastes upon the ocean bottom falls within the Convention's prohibition, as will disposal under the ocean bottom if it poses <u>a</u> threat of pollution to the marine environment. [2] (Emphasis added.)

This is of course conditional on future definition of what constitutes a "threat of pollution."

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[1] <u>Ibid</u>., pp. 816, 817; it is curious that this statement was not included in the original ERDA legal opinion of 4 August 1976. It was apparently added at some point later in August or September 1976.

[2] <u>Ibid</u>., pp. 798, 799.

The opinion continues as follows:

> We note that the concept of seabed emplacement is a novel one. No concrete proposal has yet been made for such a method of disposal, and there exists the possibility that new technologies may be developed which would permit the emplacement of wastes in the seabed with little or no danger to the marine environment. The Department would wish to examine the question of applicability of the Ocean Dumping Convention to such a technology if it were proposed.

In his testimony, Robert Stein (of the International Institute for Environment and Development) says, with respect to "the proposal for possible dumping, or placement of high-level radioactive wastes under the sea floor," "in my view the 1972 Ocean Dumping Convention prohibits such disposal."[1] No reasons for or explanation of this interpretation were offered. Testimony submitted by this author[2] was similar to that given by the Department of State, i.e., it took the position that it is not yet clear whether the London Convention's definition of dumping apples to all methods of disposal under the seabed.

The IAEA Response to the London Convention of 1972

The London Convention assigned to the IAEA the tasks of:

--Defining high-level radioactive material unsuitable for dumping at sea; and

--Establishing recommendations to be fully

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[1] *Ibid.*, p. 15.

[2] *Ibid.*, pp. 18, 820-820.

taken into account by states party to the Convention in issuing special permits for dumping other radioactive material.

The first draft of the IAEA definition, since superseded, included the following comment on the sub-seabed disposal of wastes:

> Certain methods of radioactive waste disposal although not feasible at this time, may eventually be developed technically to the point of proposing the long-term isolation of wastes by emplacement beneath the seabed. Such methods should be evaluated as variations of deep geological burial on land and are excluded from the scope of this document because they will not contribute to the radioactivity of the sea.[1]

The IAEA tasks were started in early 1973 and provisionally completed in 1974. The Agency's Provisional Definition and Recommendations were endorsed by the Board of Governors (September 1974) and determined to be legally binding by the First Consultative Meeting of the Parties to the London Convention (September 1976). Yet since they were based on a scientifically unrealistic and probably midleading oceanographic model, they were immediately scheduled to undergo a complete review process.[2]

The IAEA review process started in early 1975. But

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[1] IAEA, GOV/1622, Appendix p. 7, 3 September 1973; in IAEA Doc. Pl-540 (1976), p. 81.

[2] The original model was apparently created to justify ongoing British radioactive waste disposal practices, without input from the national oceanographic community.

the Advisory Group on the Development of a Generalized Oceanographic Model Related to the Dumping of Radioactive Waste at Sea could not reach agreement on a new scientific framework. There was consensus that the model and safety factors which formed part of the basis for the IAEA provisional Definition and Recommendations were inadequate. The basic question was and is a matter of two conflicting philosophies: that of "dilution and dispersal" of the wastes, which has been the basis of most past practice and regulation; and that of "isolation and containment" of the wastes from the biosphere, which has increasingly been seen by some countries as the only answer for wastes with very persistent, toxic and transportable elements, such as plutonium.[1]

Unfortunately, the work of this group, which has vital implications for the degree of international regulation of future site selection, disposal, and monitoring of radioactive waste in the marine environment, was caught up in political considerations, especially firm commitments of certain of the Nuclear Energy Agency member states and the

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[1] Dr. V. T. Bowen, a U.S. expert at the February 1975 meeting, appended an individual contribution which makes it quite clear that recent studies of transport and resuspension of actinides like plutonium and americium, and many unknowns about effects on waters and biologic communities call for a complete reassessment of any model which suggests that millions of tons/year of radioactive waste can be safely dumped into the deep ocean (Dr. V. T. Bowen, interviews held at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 1975). See also, NAS, Assessing Potential Ocean Pollutants, p. 45.

O.E.C.D. to the asserted safety of past practice. This put the IAEA in a very awkward position and temporily broke down its capability to fully execute its responsibilities under the London Convention.[1]

A series of three advisory group meetings, running from December 1976 to March 1977, has developed an acceptable oceanographic basis for the IAEA Definition and Recommendations on Radioactive Waste Disposal at Sea.[2] A radiological dose assessment panel recently carried out the radiological protection part of the task. A final technical and political advisory group meeting is scheduled for late 1977. Present intentions are to have a fully accepted definition of high-level waste unsuitable for dumping for submission to the IAEA Board of Governors and the parties to the London Convention in 1978.

The oceanographic basis for IAEA's regulation of radioactive waste disposal at sea was developed with several disposal methods in mind. These included depositing waste containers on the seabed, within the seabed sediments, or beneath the sediments. The applicable section of the revised oceanographic basis reads as follows:

> We have kept in mind throughout that several methods for the disposal of wastes into the

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[1]This is based on a series of observations and interviews held by this author at international conferences and meetings during 1975-1976.

[2]IAEA, The Revision of the Oceanographic Basis of the IAEA Provisional Definition and Recommendations Concerning High-Level Radioactive Waste Unsuitable for Dumping at Sea, AG-141(Vienna: IAEA,April 1977).

deep sea have been used or proposed. The waste may be encapsulated in a container designed to last for very long periods of time, or it may be merely packaged in such a way as to ensure its uneventful arrival on the seabed. It might be emplaced within or even beneath the sediments of the seabed, or merely deposited upon them.

If radioactive wastes can be isolated or contained before they are released to the marine environment, then radioactive decay within the container will reduce the amounts of radioactivity which are eventually released.

We regard containment however as part of an overall strategy rather than as an alternative strategy, since if the dose limit for man is not zero, and if marine organisms can tolerate some additional radiation without unacceptable damage, then some quantity of waste may be permitted to be released. It is not therefore necessary to achieve complete isolation (i.e., perfect containment).

If good containment can be demonstrated, then it should be possible to make allowance for *in situ* decay. This allowance factor will be particularly important if the emplacement of waste canisters into or even beneath seabed sediments is considered (Ref. *Oceanus* Vol. 20, No.1) because such emplacement would provide additional containment.

Once waste has been released to the environment, it is in general preferable if it is rapidly dispersed and diluted, since this reduces the maximum dose to man. Collective dose however must also be taken into consideration.[1]

The Parties to the London Convention are monitoring and influencing the revision process through their annual meetings and the permanent secretariat at the Intergovernmental Maritime Consultative Organization (IMCO). At their first con-

[1] *Ibid.*, p. 10, the conclusions and recommendations of this document are attached below as Appendix 2.

sultative meeting, agenda item 10 (Definition and Recommendations of IAEA Concerning Radioactive Wastes and Other Matters) turned out to be the most important, time consuming, and difficult issue.[1] In addition to U.S. objections, Canada, Portugal, Denmark, and Sweden were not at all content with the IAEA Provisional Definition and Recommendations. Despite stated preferences for avoiding all nuclear waste dumping, they recognized that some countries have no other existing option. Their price for continued dumping is the establishment of strong prior notification and consultation procedures to ensure full consideration of all possible land-based alternatives.

Two major steps were taken by the Parties: first, they took note of and formally requested circulation and improvement of, IAEA's Provisional Definition and Recommendations; and second, they requested the Secretariat (IMCO) to study, in cooperation with IAEA, the OECD and other international organizations, and report on notification and prior consultation for radioactive waste dumping. This second area of work is likely to lean heavily on the draft OECD/NEA document which would establish within the Nuclear Energy Agency an in-

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[1] See R. McManus, "Report of the U.S. Delegation to the First Consultative Meeting of the Parties to the London Convention," to the Secretary of State, Wash., D.C., 1976 (Mimeographed); the debate was largely over the U.S. position—rejected by the meeting—that the provisional IAEA definition was not yet legally binding under the London Convention. Although this position, if adopted, would have applied even stronger pressure on IAEA to revise the definition, it also would have meant that there would be no legally operative definition for at least two years.

ternational consultation and surveillance mechanism for radioactive waste dumping. The draft, which has apparently been at least informally accepted by key member states, but which is not yet available publically, would make crucial improvements in the regulatory and enforcement role of the NEA in radioactive waste dumping. It might also help satisfy many of the objections made to existing dumping practice by London Convention Parties and provide a major step towards establishing the regime required for any sub-seabed disposal.

A final indication of how the London Convention definition on dumping will be interpreted can be drawn from the national dumping legislation passed by countries which have ratified the London Convention.[1] The Canadian definition--"any deliberate disposal from ships . . . at sea of any substance"--would certainly include the seabed disposal of wastes. The wording of the British definition--". . . permanently deposited in the sea"--would seem to exclude sub-seabed disposal. Earlier legislation from Finland, Norway, Sweden, Denmark, Japan, Netherlands and New Zealand would probably not define sub-seabed disposal as dumping because of the use of the phrase "disposal or discharge into the high seas." Finally, the European Economic Community (EEC) seems to be moving toward a definition that would exclude sub-seabed disposal. It would consider "any deliberate disposal of substances and materials into the sea . . . ." as constituting

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[1]This legislation was examined in Chapter 3, above.

dumping.

Summary

Dumping thus may or may not include the sub-seabed disposal of radioactive waste under existing international treaty law. If it does, more immediate international legal control is available, but if a group of nations later desire to use this disposal method, it could be difficult to amend the Convention. If it does not, the seeds for a new international control regime must be sown as soon as possible. Informal correspondence between states and the further development of general international law in this area are necessary. One further question is whether seabed exploitation or dumping or both should be interpreted as including sub-seabed disposal, or whether a specific category for such disposal (or its prevention) should be created. In any case, legal development must keep pace with the science and technology. The risk of unilateral use of sub-seabed disposal by other countries seems to be held to a very low level by political, as well as legal, constraints. Governmental attitudes toward just participating in an international research and development program on seabed disposal are very cautious.

Regional Pollution Control Conventions (1974-1976) and Sub-Seabed Disposal

Article 8 of the London Convention obliges Parties in geographic regions with common interests in marine environmental protection to endeavor to establish regional marine pollution prevention agreements, especially on monitoring and scientific research. While various efforts along these lines are now being established, we will briefly examine four complete arrangements:

The 1974 Scandinavian Convention on the Protection of the Environment,[1] which is applicable to the continental shelves of the parties, include in its definition of "environmentally harmful activities" the

> use of the seabed in any . . . way which entails, or may entail environmental nuisance by water pollution or any other effect on water conditions, . . . changes in temperature, [or] ionizing radiation, . . .[2]

The exact meaning of "environmental nuisance" created by the effects of ionizing radiation certainly needs further refinement but the extremely low and comprehensive threshold of legal concern (any change of radioactivity level in water) establishes a framework for comprehensive controls.

This model might be of use to an International Seabed Authority in establishing environmental oversight or licensing criteria for seabed activities.

The 1974 Paris Convention for the Prevention of Marine Pollution from Land-Based Sources,[3] deals exclusively with

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[1] ILM 13 (1974): 591

[2] Ibid., Art. 1, p. 591.

[3] 21 February 1974, in ILM 13 (1974): 352 [Hereinafter cited as the Paris Convention]; fourteen European States participated in the drafting conference.

by far the largest single source of marine pollution. A familiar pledge to investigate the best ways of removing the need for marine disposal of noxious substances, which is applied specifically to radioactive substances, represents further evidence of a common practice of ending at least "non-essential" marine disposal, even from land-based sources. Radioactive substances are covered by:

1) a special provision in the annexes which explains that, although they are similar in nature to black-listed materials and should be subject to stringent controls to prevent pollution, they are already being acted on by several international bodies; and

2) Article 5, under which Parties

> undertake to adopt measures to forestall and, as appropriate, eliminate pollution of the maritime area from land-based sources of radioactive substances . . . .

A prime example of the type of regional agreement, including the participation of many regional and international bodies and a wide political diversity of states, which might be applicable to a sub-seabed disposal program is the 1974 Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area.[1] This Convention, which specifically applies to the protection of the seabed's living resources and other marine life, takes the unprecedented step of prohibiting virtually all dumping into the waters of

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[1] 22 March 1974, in ILM 13 (1974): 546; signatories included: Denmark, Finland, Sweden, the F.R.G., G.D.R., Poland, and U.S.S.R.

the Baltic Sea Area.[1] Its other significant new development is a regulatory regime for land-based pollution. As expected, the obligation accepted for radioactive materials from land-based sources is weaker than that in the 1972 London Convention for ocean dumping. No radioactive materials are listed in the black list of Annex I, and while they are all covered by the "special care" list, Annex II, the obligation on states is only not to introduce them into the marine environment in significant quantities without a special permit, and to take all appropriate measures to control and strictly limit pollution by noxious substances. The particular environmental vulnerability of the Baltic Sea Area limits the precedent value of this agreement somewhat (as with the Canadian pollution prevention zone legislation) but the international agreement to regulate the highly political "land-based pollution sources" remains a key evidence of developing law. And the flat ban on dumping is indicative of a new attitude towards marine pollution control.

The 1975 UNEP sponsored Intergovernmental Meeting on the Protection of the Mediterranean in Barcelona considered three important drafts[2] which served the basic documents for the 1976 Conference of Coastal States of the Mediterranean Sea in Barcelona. On 13 February 1976 the Conference,

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[1] Ibid., Art. 9; dumping is defined as in the London Convention.

[2] Report of the meeting, from UN, UN Environment Program UNEP/WG.2/5 of 11 February 1975; in ILM 14 (1975): 464.

which included sixteen of the eighteen invited coastal states, adopted the Convention for the Protection of the Mediterranean Sea against Pollution, the Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft, and the Protocol concerning the Cooperation in Combatting Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency, and various resolutions.[1]

The Barcelona Convention functions as an umbrella document for all existing and future protocols and annexes. It establishes comprehensive coverage of marine pollution sources with coordinated regional and international monitoring and research programs. Also significant for present purposes are the designation of the United Nations Environmental Program (UNEP) to perform secretariat duties and the establishment of a requirement for a three-fourths majority vote of the Contracting Parties to amend the annexes or protocols.

The Barcelona Dumping Protocol is very similar in content and structure to the 1972 London Convention. The Article 3 definition of dumping is essentially identical to that in the London Convention.

One major difference in the annexes, which reinforces the trend noted above toward the isolation and containment

[1] ILM 15 (1976): 285 [Hereinafter cited as the Barcelona Convention, Barcelona Dumping Protocol, and the Barcelona Emergency Protocol, respectively]; by January 1977, 14 States and the ECC had signed the Convention and Emergency Protocol, and 13 States and the EEC had signed the Dumping Protocol; the Convention enters into force when one of the Protocols comes into force with six ratifications.

philosophy for toxic wastes, is the inclusion of

> High- and medium- and low-level radioactive wastes or other high- and medium- and low-level radioactive matter to be defined by the International Atomic Energy Agency . . . .[1]

in the prohibited list under Annex I. Under the Annex II list of "special case" substances Parties are exhorted to take full account of IAEA recommendations in the issuance of dumping permits for any radioactive materials not covered by Annex I.

The IAEA is apparently seeking financial support from the UNEP for these new responsibilities and planning to coordinate this with the ongoing revision of the Provisional Definition and Recommendations under the London Convention. It has, however, already indicated informally to UNEP that it will probably be unable to provide a legally acceptable definition of radioactive materials not covered by the high, medium, and low-level categories.[2] This is due to the very controversial nature of establishing a so-called "innocuous" category of radioactivity which includes all radioactive materials not in the above categories.

Summary

It is still so early in the scientific research program on sub-seabed disposal that the applicability of the

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[1] Ibid., The Barcelona Dumping Protocol, Annex I(A)(7).

[2] S. Keckes and R. Helmut, interview held at UNEP's Geneva office, March 1977; UNEP is now sponsoring meetings of experts to settle new problems over the inclusion of low-level materials in Annex I. Spain is apparently concerned that this might restrict discharges from future coastal nuclear power plants.

London Convention and the IAEA response remain uncertain. Disposal within the seabed is most logically governed under the pollution prevention category of "uses of the seabed." In its existing form, however, the pollution category of "dumping" comes closer to sub-seabed disposal than the category of "exploration and exploitation" of deep seabed minerals. Thus, in a sense, it would appear permissible to investigate the technical feasibility of action that may be banned on legal grounds.

The international and regional dumping framework offers one potential tool for preventing any sub-seabed disposal. If a unilateral or untested version is proposed or adopted by states without strict national regulation and enforcement, Denmark, Canada, Sweden, or the U.S., states which have indicated by their joining in the London Convention that they consider unregulated dumping of radioactive wastes to be illegal, could take the international lead in protesting it. Non-parties to the Convention may not be bound by the formula of words in that Convention, but they can nonetheless be argued to be violating an underlying general international law codified or acknowledged to exist by many states in the diplomatic negotiations surrounding the conclusions of the Convention and the Barcelona Dumping Protocol.

Although there appears to be no such threat from any states (parties or not to the London Convention) with mounting quantities of high-level wastes, general international law would now seem to require at least thorough prior consultation with concerned countries and appropriate international organizations. This requirement is supported by the dumping cases cited in Chapter 2, above, the law of the sea treaties and negotiations analyzed above, and the differential and strict treatment of high-level nuclear wastes in the London Convention and the Barcelona Dumping Protocol. Strong political and diplomatic pressure could also be expected to restrict unilateral state actions—especially with high-level wastes—in the interim.

Management, contrastingly, of sub-seabed disposal might also be accomplished, in part, through the dumping framework. The periodic (as necessary or every 3-5 years) IAEA revision process for the oceanographic basis of regulating radioactive waste disposal at sea and the annual meetings of the London Convention Parties, as well as diplomatic correspondence and the development of general international law, represent agreement on the major questions of principle. A protocol to the London Convention on sub-seabed disposal could provide the necessary elaboration of regulatory and enforcement powers.

General Marine Pollution Control and Sub-Seabed Disposal

One driving element of international law and politics for sub-seabed disposal will be law of the sea. Most crucial for legal purposes are general law of the sea and the recently developed text (Revised Single Negotiating Text or RSNT) from the Third UN Conference on the Law of the Sea. General principles of law are also important since the regime of the deep seabed, especially uses of the underlying "subsoil," is not yet elaborated enough to answer detailed questions. Before examining the customary and conventional law, and the general principles, it is necessary to consider briefly some of their background and development.

From the start of the International Law Commission discussion on the disposal of radioactive waste at sea in 1956 through the conclusion of the UN Conference of the Law of the Sea in 1958, two significant trends dominated all codification efforts in this area. First, the East-West clash, which was at heart over weapons production and capabilities, resulted in a strong Western position that the waste disposal problem could and should be considered separately from that of weapons testing. The East held that all such dangerous activities should be prohibited.[1] The U.S. and the U.K.

[1] On the entanglement of waste disposal and weapons testing from 1956 to 1962, see McDougal and Burke, p. 864.

made strong attempts to refer the question of regulating radioactive wastes in the marine environment to the IAEA, in order to remove from law of the sea all matters of international atomic energy use and nuclear law. Second, there was a strong movement among Third World and some Western European states without nuclear programs to strictly regulate, or even ban, all weapons testing and disposal of radioactive material at sea.

It remains crystal clear that the production of electricity from nuclear energy is inextricably bound up in military associations arising from the origin and development of the nuclear energy industry in some countries and from its inherent military applications. There are now easier and cheaper routes to weapons capabilities available than a full scale nuclear energy program, but such a program still provides all the basic tools.[1] And this is especially the case for countries developing a heavy water-natural uranium nuclear industry.

There are, however, compelling reasons--which have recently grown stronger--for removing the high-level radioactive waste disposal problem from the military context or association. First, whether military or commercial, the wastes must

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[1]See "French Report on a Nuclear Fuel Than Cannot be Used for Bombs," New York Times, 6 May 1977, p. A2; many questions and problems remain with the French claim that a uranium enrichment process exists which would provide countries with the capabilities to enrich their own fuel to the 3-4% necessary for power reactors without allowing any weapons-grade enrichment.

be permanently removed from the environment. Second, by radioactivity content the commercial applications have already produced roughly the same amount of products (largely spent fuel now) which have come out of weapons operations since the early 1950's (the volume of military materials is still much greater). And the future problem will be dominated by commercial wastes. Third, many groups, especially the U.S. Natural Resources Defense Council, fear that separate handling/disposal approaches would leave the military waste disposal problem under less strict and publicly-tested regulations. Finally, other countries are most likely to participate in cooperative efforts on radioactive waste storage or disposal if the weapons states are full participants, i.e., if there is some degree of shared international oversight of all high-level radioactive wastes.

General Law of the Sea Principles and Rules Applicable to Sub-Seabed Disposal

While the law of the sea principles and rules will be important, since they apply to all categories of radioactive wastes and since many will apply directly to sub-seabed disposal, this is not to imply that they are more important than the specific international marine pollution control agreements analyzed above. On the contrary, it is likely that international agreements such as the London Convention will, through their influence on general international law,[1] have a major impact on the prevention or management of sub-seabed disposal. This impact is especially important in light of the very unsettled situation in current law of the sea negotiations. Whether or not the impact from these conventions is more important over the longer term than that from the more general law of the sea development efforts will depend on both how existing treaties are interpreted in the future and how successful current efforts are at codifying and creating new treaty law for the oceans.

First UN Conference on the Law of the Sea (1958)

The 1958 Conference was the culmination of several years of work in the International Law Commission and the UN General Assembly. Of the four conventions adopted, the High Seas Convention (with 56 parties by January 1977), which came the closest to being generally declaratory of established principles of international law, deals most directly with radioactive pollution of the oceans. Article 25 (1) provides that:

> Every state shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations.

This somewhat vague call for action, without any specific definition of terms, is the least common denominator result of

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[1] See R. R. Baxter, "Treaties as Evidence of International Law," Hague Academy, Recueil des Cours 1 (1970): 25.

the already noted debate over radioactive waste disposal at sea. As a compromise between interests led by India and Eastern Europe to ban such disposal practice,[1] and British and U.S. attempts to remove all reference to the matter in the Convention and to pass it to the IAEA through a resolution,[2] it is doubtful that Article 25 (1) was considered to declaratory, as of 1958, of established principles of international law. Without offering much of an enforceable obligation, the resulting declaration both indicates that law of the sea forums may deal with the problem and leaves open the possibility that such dumping may be permissible under closely regulated conditions.[3] It also provides a basis in treaty for strong regulatory action in this area by organizations such as the IAEA, UNEP, WHO, FAO and ICRP.

Starting in 1958, states responded actively, through the IAEA to calls from other international forums for standards and guidelines to cover the disposal of radioactive materials into the sea. The 1958 UN Law of the Sea Confer-

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[1]This would have gone even further than the International Law Commission draft Article 48(2), "All States shall draw up regulations to prevent pollution of the seas from the dumping of radioactive waste," which was adopted without dissent (ILC Yearbook 1 (1956): 62, para. 46).

[2]The proposed resolution recommended that the IAEA do the necessary studies and assist States in controlling, and preventing pollution from, discharges of radioactive materials to the sea; U.N. Doc. A/CONF.13/L. 53; U.N. Conference on the Law of the Sea Plenary Meetings 2 (1959): 143, 144.

[3]As could be predicted, States such as the Soviet Union have since interpreted the provision as banning all radioactive waste dumping, and States such as the U.K. have interpreted it as allowing controlled disposal.

ence led to a flurry of activity. The now well known scientific Brynielsson Panel (established by the IAEA in October 1958) prepared a report (1960), which contained

> . . . recommendations which could serve as a basis of international agreement to insure that any disposal of radioactive waste into the sea involves no unacceptable degree of hazard to man,[1]

and which still reflects, in part, the most authoritative and comprehensive guidelines available. It does not deal with hazards to the marine environment, but it recommends:

1) no release of high-level radioactive waste;
2) disposal of low and intermediate-level waste only under controlled and specified conditions;
3) use only of waste-disposal sites designated by a responsible national or international authority;
4) licensing, registering and monitoring of all disposal by national authorities with registration and standardization of monitoring also done by the IAEA; and
5) annual reports to IAEA on sites, licensing and disposals, and periodic review by IAEA of associated problems.

In following its statute mandate to establish or adopt standards of safety for protection of health and minimization

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[1] "Radioactive Waste Disposal into the Sea," Report of the Ad Hoc Panel Under the Chairmanship of Mr. H. Brynielsson, February 1960 (IAEA, TO/HS/21, 6 April 1960) p. 4; published as IAEA, Radioactive Waste Disposal into the Sea, Safety Series No. 5, 1961.

of danger to life and property, the IAEA then convened the Rousseau Panel to consider legal and institutional implications and potential action based on the Brynielsson Report. Despite the four meetings from 1961 - 1963 and the final report of 1963,[1] this panel of lawyers could not reach agreement. An East-West split parallel to that in the 1958 LOS Conference occurred with the Eastern minority insisting on an absolute prohibition of all radioactive disposal in the sea. And the draft articles, which were intended to become IAEA recommendations and eventually a convention, were adopted only by the majority of the Panel. This was partially because the draft articles go considerably beyond all existing national and international frameworks in effectiveness and comprehensiveness for controlling sea dumping of radioactive waste.

The draft articles define "disposal" as the direct introduction into the sea waters of radioactive material. Various provisions call for

1) no "disposal" of high-level wastes (there was unanimous agreement based on existent knowledge);

2) forwarding of complete data on past and intended disposals of low and intermediate-level radioactive wastes by states to the IAEA Director-General, with six months lead-time required for future disposal;

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[1] "Legal Implications of the Disposal of Radioactive Waste into the Sea," IAEA, DG/WDS/L.19 Rousseau Panel, 14 June 1963.

3) prerogative for the Director-General to distribute all data, consult, investigate independently, object to the disposal or transmit affected state's objections, advise against disposal pending consultation, and help guide negotiations or mediation between involved states; and

4) monitoring, reports, and registration in accordance with the Brynielsson Report.

While the Brynielsson provisions were under development through the IAEA, Hydeman and Berman were formulating a strong set of recommendations [1] (1959-1960) in the U.S. for an IAEA draft convention on radioactive waste disposal into the sea. The IAEA panel stopped short of including three recommendations made by Hydeman and Berman, namely:

1) authorize IAEA to independently monitor all national sites and inspect all disposal activities at the sites;

2) report violations to IAEA, which can comment on them and authorize functional sanctions; and

3) authorize IAEA to assist states in evaluation of sites, setting regulations, inspecting and monitoring.

Despite obvious problems in gaining state acceptance of such IAEA functions--especially parts of 1 and 2, they generally remain legally desireable steps. And they would be particularly effective steps for controlling the sub-seabed disposal of radioactive wastes.

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[1] International Control of Nuclear Maritime Activities (Ann Arbor: Univ. of Michigan Law School, 1960), pp. 381, 382.

It is important to note the conclusion of an international lawyer in 1969 concerning the nature of efforts by the IAEA-sponsored panels: " . . . It should be made clear that the subject of those discussions was pollution of the sea water and not the seabed."[1] But while designed to control the dumping of non-high-level radioactive waste into the sea, the Brynielsson, Rousseau, and Hydeman and Berman recommendations also form an important, although incomplete, basis for an internationally regulated program for sub-seabed disposal of radioactive waste. While the intended international agreement never came about, the London Convention of 1972 did finally translate into treaty law for the parties recommendations 1, 2, 3 and part of 4 from the Brynielsson Report.

The other three conventions from the 1958 Conference on the Law of the Sea laid parts of the groundwork for the seaward expansion of states rights and duties to control marine pollution. Narrow but important expansions of rights came first. Article 24(1) of the Convention on the Territorial Sea and the Contiguous Zone provides that:

> In a zone of the high seas contiguous to its territorial sea [not to exceed 12 miles beyond the territorial sea], the coastal state may exercise the control necessary to:

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[1] Summary of Discussion of Working Group II on the Economic Resources of the Sea-Bed, in Sztucki, ed., Symposium on the International Regime of the Sea-Bed (Rome: FAO, 1970), p. 230; the name of the international lawyer was not given.

(a) Prevent infringement of its customs, fiscal, immigration or sanitary regulations within its territory or territorial sea;

(b) Punish infringement of the above regulations committed within its territory or territorial sea.[1] (Emphasis added.)

As of 1973, Brownlie held that it was by no means clear that sanitary zones could be used as a basis to create pollution prevention zones or measures,[2] because states were approaching marine pollution problems primarily through multilateral conventions. But that reason is not at all persuasive now since States are no longer approaching problems of pollution from oil or other substances primarily by means of multilateral conventions. Unilateral and regional pollution control zones are increasingly common, and many more can be expected soon since a comprehensive law of the sea treaty seems to be unreachable in 1974-1977. Increasingly it seems that such measures beyond the contiguous zone, and in some cases even beyond a prospective 200 mile "economic zone," may not have to be based on a particular environmental vulnerability.

Based on Article 6(1) of the 1958 Convention on Fishing

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[1] Convention on the Territorial Sea and Contiguous Zone, 29 April 1958 [1964] 15 U.S.T. 1606, T.I.A.S. 5639, 516 U.N. T.S. 205; although the concept of contiguous zones was only confirmed by consistent State practice in the 1950's and 1960's, much development of special defense, fisheries, and pollution control zones has occurred in the 1970's.

[2] I. Brownlie, Principles of Public International Law (Oxford: Oxford Univ. Press, 1973), p. 213.

and Conservation of the Living Resources of the High Seas,[1] which provides that "a coastal State has a special interest in the maintenance of the productivity of the living resources in any area of the high seas adjacent to its territorial sea," many fisheries regimes were concluded in the 1960's and 1970's.[2] Recent fisheries conservation and management may well be setting some precedent for pollution control measures and zones in the high seas. When this evidence of state behavior in fixing regulations to limit the "rights" of all states to exploit the resources of the commons is combined with developing rules for the control of pollution from vessels, from exploration and exploitation of the deep seabed, and from the exploration of the continental shelf and the exploitation of its natural resources,[3] the overall trend certainly seems to be toward increasing national and international assertions of rights to control activities on, and areas of, the high seas in order to reduce or prevent pollution.

Article 5 of the Convention on the Continental Shelf offers important qualification of coastal state rights to use the shelf. Sub-sections (1) and (7) provide, respectively, the conservation of living resources must not be unjustifiably

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[1] 29 April 1958, T.I.A.S. 5969, 559 U.N.T.S. 285.

[2] See, generally, B. Ruster and B. Simma, comp. and ed., International Protection of the Environment (Treaties and Related Documents), 10 vols. (Dobbs Ferry, N.Y.: Oceana Pubs., 1975-1977).

[3] Vessel source and deep seabed pollution control are covered in Part III of the RSNT, which is discussed later in this chapter.

hampered and that living resources in any created safety zone around shelf installations must be protected. This trend of setting regulations for high sea activities will be further elaborated below in discussions of the Stockholm Conference of 1972 and the recent law of the sea negotiations.

General Principles of Law Relevant to Use of the Deep Seabed

So far we have found little in the way of treaty, customary, or judicial sources of law of the sea which seem to be directly applicable to sub-seabed disposal. There are some guiding principles for use of the deep seabed that should help us in judging the international acceptability of nuclear waste disposal in this area. There is wide agreement among nearly all countries in the UN that the seabed beyond the limits of national jurisdiction (or "Area"):[1]

1) should be managed internationally;
2) must be used in accordance with international law and the UN charter;
3) must be reserved for peaceful purposes; and
4) is the common heritage of mankind.

These principles have been derived from the work of the UN General Assembly and have been reinforced during the Third UN Conference on the Law of the Sea. It must be remembered, however, both that these principles have not been accepted by several key countries, including the U.S., and that they

[1] The "Area" refers to the international seabed, or the part that lies beyond the (yet to be determined) limits of national jurisdiction.

will be interpreted in varying ways by states faced with specific cases of deep seabed usage. There is a real limit to their usefulness. And it will be some time before they become well specified since uses of the deep seabed and their regulation are still relatively undeveloped.

International Management

International management has so far been narrowly defined in Law of the Sea (LOS) negotiations due to an obsession with the issue of potential mining of manganese nodules. Though this part of the LOS negotiating text is unsettled, it appears certain that any International Seabed Authority (ISA) would have jurisdiction only over "activities in the Area," or all exploration for, and exploitation of resources. Furthermore, the definition of resources would be limited to in situ minerals.[1]

While waste disposal does not fall under exploiting minerals, there are three avenues by which an ISA might acquire some role in a potential sub-seabed disposal program for high-level radioactive waste.

1. The general coverage of scientific research in the Area. A sub-seabed disposal program for high-level radioactive waste would involve detailed work at each site for

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[1]There have been specific compromises made between the LDC's and the major powers which result in dropping from the jurisdiction of the ISA "all uses" and including only control of the "exploration and exploitation" of mineral resources in the deep seabed.

several years and some form of monitoring for long periods. Nothing in the very general treatment of the RSNT appeared to restrict this type of research.[1]

The latest LOS text, the Informal Composite Negotiating Text (ICNT),[2] seems to establish even less authority for the possible future control of scientific research in the Area by the proposed ISA. The applicable article (143) in Part XI on the Area provides, in part, that:

> 1. Marine scientific research in the Area shall be carried out exclusively for peaceful purposes and for the benefit of mankind as a whole, in accordance with Part XII [Protection and Preservation of the Marine Environment] of the Present Convention.

The reference to Part XII replaces a sentence from Article 10 of the RSNT that obliged the Authority to ". . . promote and encourage the conduct of scientific research in the Area." Furthermore, another sentence, which provided that "The Authority may itself conduct scientific research in the Area and may enter into agreements for that purpose," has not been included in the ICNT. When combined with the applicable articles (257 and 258) from Part XIII--Marine Scientific Research--of the ICNT, which provide, in part, that:

> States, . . . as well as competent international organizations, shall have the right, in conformity with the provisions of Part XI of the present Convention, to conduct marine scientific research in the Area; [and]

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[1]RSNT, Part I, Article 10.

[2]U.N. General Assembly, A/CONF.62/W.P.10, 15 July 1977.

> States, . . . as well as competent international organizations, shall have the right, in conformity with the present Convention, to conduct marine scientific research in the water column beyond the limits of the exclusive economic zone[or 200 miles from the coast],

it seems clear that research on the possible sub-seabed disposal of radioactive wastes by states and international organizations will not be restricted.

2. The need to protect the marine environment. The preamble of the 1967 UN General Assembly resolution establishing an Ad Hoc Seabed Committee expresses ". . . the importance of preserving the sea-bed and ocean floor, and the subsoil thereof. . . from actions and uses which might be detrimental to the common interests of mankind."[1] The unanimously adopted General Assembly resolution of 1968 which followed the Ad Hoc Seabed Committee's final report significantly limited the mandate for future work (1968-1973) of the new and larger Seabed Committee[2] in the area of marine pollution control. The Seabed Committee was instructed to examine measures which might prevent marine pollution from the exploration and exploitation of seabed resources. While emplanting wastes within the seabed might under a broad inter-

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[1]UN GA Res. 2340 (XXII), 18 December 1967; The Ad Hoc Seabed Committee, composed of representatives from thirty-five countries, was established by the UN General Assembly with the very broad mandate to study the peaceful uses of the seabed beyond national jurisdictions and to make recommendations on promoting international cooperation in its exploration, conservation, and use.

[2]UN GA Res. 2467(A)(XXIII) of 21 December 1968 created a slightly larger (forty-two nation) Seabed Committee with a very similar mandate and the same very limited authority to "study" the use and regulation of the deep seabed and "make recommendations to the General Assembly."

pretation logically be considered to be an "exploitation" of one of the Area's "resources," i.e., stability, the meaning of "resources" in this context has been specifically limited to *in situ* minerals.

The 1970 U.S. Draft Convention on the International Sea-Bed Area required the ISA to prescribe rules and recommended practices over all exploration and exploitation of seabed resources for protecting the marine environment and preventing injury to living marine organisms.[1] Prompted by the U.S. nerve gas case,[2] the State Department Legal Advisor told the Seabed Committee that the U.S. Draft provided for bringing parties before the proposed LOS Tribunal for a binding decision if a proposed disposal involved a potentially "harmful material." Together these provisions would appear to demonstrate a desire to extend ISA purview over marine pollution somewhat beyond the scope of the Seabed Committee mandate, but subsequent events have shown that the U.S. position corresponds more closely to inclusion of only pollution caused by exploration and exploitation of the Area resources.

Important discussion continued in the UN Seabed Com-

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[1]United Nations, General Assembly, UN G.A.O.R., vol. 25, Supp. 21 (Doc. A/8021) (1970), Articles 9, 23(1) (a) and (b), and 68(1) (d) and (e).

[2]See Chapter II, above, pp. 63-70.

mittee with the "Group of 77" states,[1] in particular, advocating ISA jurisdiction over all uses of the seabed and associated uses of the high seas. One key example is the proposal in the 1972 Declaration of Santo Domingo[2] for ISA powers to prevent pollution and preserve the Area's environment. The exact degree of environmental jurisdiction, the closely related question of power to deal only with seabed resource uses or to harmonize uses of the seabed and superjacent waters, and the idea of providing for expansion of ISA powers as its competence developed, were all left unsettled by the UN Seabed Committee. By late 1973, however, when the UN Seabed Committee had been dissolved, there seemed to be agreement among represented states that: 1) a joint state - international community regulatory system could effectively draw on state environmental control experience from exploration and exploitation of the continental shelf, and 2) the ISA should cover only non-living, i.e., mineral, resources of the seabed, but it was recognized that protection of living resources against pollution from seabed activities was one of the central factors in regulating seabed activities.

At heart it becomes a question of the mix of national and international regulation of poorly identified hazards to

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[1]The "Group of 77" states was initiated by the LDC's as a negotiating subgroup designed to increase their bargaining power in various international conferences. By 1974 it had grown to be an extremely large and heterogeneous group of over 100 states in the Third UN Conference on the Law of the Sea.

[2]UN Doc. A/AC. 138/80 (1972).

the marine environment, and of the *ad hoc* as opposed to the overall approach. The USSR, and some of the U.S. special interest groups, especially those having deep seabed mining interests, stress national regulation of pollution from exploration and exploitation of the seabed. Denmark calls for adoption of separate specific anti-pollution agreements in cooperation with appropriate specialized agencies, and in certain cases on a regional basis.[1] Canada, which considers environmental management to be inseparable from resource management, calls for an integrated international environmental regulatory system with shared responsibility for preservation of the marine environment.[2] It is of course true that individual state, or even regional, action does not constitute the essential cumulative response to global environmental challenges, but specific, *ad hoc* arrangements are often the only manner in which states seem to be able to manage immediate and vital problems.

To date the negotiating text from the UN Conference on the Law of the Sea offers only very specific coverage of harmful effects from "activities in the Area." It appears that the ISA will not receive, at least initially, a strong and comprehensive mandate to protect this section of the

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[1]United Nations Doc. A/CONF.62/C.3/SR.3/SR.3, para. 20, p. 312 (1974).

[2]United Nations Doc. A/CONF.62/C.3/SR.21, p. 3 (1975).

marine environment. [1]

3. An obligation to accommodate other activities in the marine environment with mining activities. Though the Authority will probably not be given jurisdiction here, this obligation means that use of any parts of the Area for sub-seabed disposal cannot unreasonably restrict other uses, including resource development. [2]

Use of the Seabed in Accordance with International Law and UN Charter

As referred to at the beginning of this section, the second guiding principle--use of the seabed in accordance with international law and the UN charter--is even less developed than that of international management. There is, however, a significant body of developing international law, including increasing evidence of a relatively high-level commitment to protect the marine environment. One basis of this developing law, largely contained in the results to date of the Third UN Law of the Sea Conference, is the recent recognition by many states at the UN Conference on the Human Environment (or Stockholm Conference) that

> a growing class of environmental problems because they are regional or global in extent or because they affect the common international realm, will require extensive

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[1] RSNT, Articles 12, 28, 31 and 32; see also, generally R. A. Frank, Deepsea Mining and the Environment, A Report of the Working Group on Environmental Regulation of Deepsea Mining for the ASIL (Wash., D.C.: West Pub. Co., 1976).

[2] RSNT, Part I, Article 16; this again raises the inherently undefinable concept of reasonableness.

> cooperation among nations and action by international organizations in the common interest. [1]

The ultimate disposal of high-level radioactive waste is clearly within this class of problems both because it is global in extent and because it could very well affect the "common interest" in various ways.

Principles 21 and 22 from the Stockholm Conference of 1972, which are unique for their definitive application to the seabed and subsoil, establish a vital extension of international purview to state actions in international (beyond national jurisdiction) areas and an obligation for state responsibility and cooperation to develop liability for actions in, and damage to, the Area environment. The Principles were part of a document from the Stockholm Conference which was not legally binding on the participating countries, but as generally accepted principles for international environmental protection they form one source of international law persuasive to statesmen and legal propositions.

Principle 21

> States have, in accordance with the Charter of the United Nations and the principles of international law, . . .the re-

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[1] UN, General Assembly, Report of the U.N. Conference on the Human Environment, UN DOC. A/CONF.48/14, pp. 2-65, and Corr. 1 (1972), Preamble, para. 7.

> sponsibility to ensure that <u>activities within their jurisdiction or control do not cause damage to the environment</u> of other states or <u>of areas beyond the limits of national jurisdiction</u>. (Emphasis added.)

The exact interpretation of "activities within their control" is important because although it

> applies clearly to citizens of a state, to ships flying its flag, and perhaps even to corporations incorporated in its territory, it is more doubtful whether it applies to residents of a state, to ships owned by its nationals but flying other countries' flags, or to foreign subsidiaries controlled by corporations incorporated in the state.[1]

This offers further evidence of the relatively strong obligations which states are willing to undertake for damage to the common marine environment. Yet the practical problem remains in every specific application of determining the threshold up to which pollution (or change) can occur without legally significant damage, and beyond which pollution should be prohibited.

Principle 22

> States shall co-operate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such states to areas beyond their jurisdiction. (Emphasis added.)

The principle 22 idea of a developing international liability for "harm" to the commons is very relevant for the geologic disposal plan, but a much more specific, immediate

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[1] L. B. Sohn, "The Stockholm Declaration on the Human Environment," <u>Harvard Intl. L.J</u>. 14 (1973): 493.

commitment to prior warning or consultation in cases of potential damage to the commons could not be worked out prior to or during Stockholm, or afterwards in the UN General Assembly.[1] There is, regardless, a strong trend developing toward the obligation for prior exchange of information and views with appropriate states and international bodies, and the right of affected states and in some limited cases international bodies, to request and be granted adequate opportunity for this prior exchange. The evidence of this trend may be found in the negotiations leading to the Stockholm Declaration, the Stockholm Preamble (as quoted above, p. 198), the obligation in Stockholm Principle 25:

> States shall ensure that international organizations play a coordinated, efficient and dynamic role for the protection and improvement of the environment,

the dumping cases cited above,[2] the NEA sponsored draft agreement on ocean dumping of radioactive waste that seems to be acceptable to involved states,[3] and other obligations such as Article 25(2) in the High Seas Convention of 1958 (as quoted above, p. 142). The developing and developed rules of international law for use of the international seabed area will be discussed in greater detail in a moment.

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[1] For a complete description of the attempt to develop this principle "22A", see Sohn, pp. 496-502.

[2] See Chapter II, above.

[3] This draft agreement has not yet been released for public inspection by the involved governments.

Use of the Seabed for Peaceful Purposes

The third guiding principle--that use of the Area should be reserved for "peaceful purposes" remains undeveloped because of disagreement over interpretations. Neither the call for further study embodied in General Assembly Resolution 2467(XXIII) of 21 December 1968, nor the statement in General Assembly (principles) Resolution 2749(XXV) of 17 December 1970 that one or more international agreements would soon effectively implement the principle has led to further clarification of "peaceful purposes", i.e., the scope of prohibited seabed activities. Widely varying positions in both the Legal Sub-Committee of the UN Seabed Committee [1] and the First Committee of the UNGA [2] indicated that consensus was not within reach on the substantive and procedural issues of "peaceful purposes."

If one accepts the interpretation that military uses in pursuit of "peaceful" aims or in fulfillment of "peaceful" intents, consistent with the UN Charter and international law, constitute use for peaceful purposes,the principle of peaceful use poses no obstacle to the sub-seabed disposal of military and commercial high-level radioactive waste. If "peaceful use" completely excludes all military uses (a rather extreme interpretation), then there may be

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[1] See, for example, UN Monthly Chronicle 6 (1969): 127.

[2] See, for example, UN Monthly Chronicle 5 (1968): 60.

some doubt as to whether sub-seabed disposal of high-level radioactive wastes should be permitted.

Article 3 of the 1970 U.S. Draft Convention specifically provided that the Area must be open to all uses except exploration and exploitation of designated resources by all states. This explicit protection of other uses, which would also cover a disposal program, has since 1967 been an inflexible element of the negotiating position of various States, especially those with strong interests in using the seabed for purposes, such as a platform for listening devices, which are not banned by any treaty. Despite the large number of States in the Group of 77 which are strongly opposed to any military use of the seabed, there is usually at least implicit acknowledgement of the vital nature of this issue to some States, especially the U.S., for strategic deterrence purposes.

The Common Heritage of Mankind

The final principle--that the Area is the common heritage of mankind--is the vaguest of all. Although it has never been formally accepted by the United States, there is general agreement that this principle, in a more specific and refined form would entail sharing potential mineral resources, furthering an international communal interest, and banning any national appropriation of the Area.[1]

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[1] RSNT, Part I, Art. 3 provides that "The Area and its resources are the common heritage of mankind."

A key issue is the degree of state, regional, and international control needed over the seabed for an acceptable radioactive waste disposal program. One observer, Robert Stein, of the International Institute for Environment and Development, has testified that, in his opinion, sub-seabed disposal would involve the appropriation of portions of the deep seabed.[1] This assertion is not persuasive as long as the common heritage principle remains in its presently vague form. Furthermore, since nearly all norms of general international law begin as unilateral assertions, it is impossible to determine in advance if states would respond by labeling sub-seabed disposal as national appropriation of the seabed. Determination of whether sub-seabed disposal would constitute "national appropriation" must be based on factors such as:

1) Which other uses of the ocean or seabed would be restricted, and to what degree; and
2) What are the responses by countries and regional and broad international organizations to the announcement or execution of such a program.

Given that four countries are already participating in the international research effort and that international regulation is assumed to be essential to effective implementation, it now seems unlikely to involve "national appropriation" of the seabed. Yet it is really too early to make any definitive judgment on this question since four countries

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[1]U.S., Congress, House, Comm. on Interior and Insular Affairs, Hearings on Radiological Contamination of the Oceans, before the Subcomm. on Energy and Environment, 94th Cong., 2d Sess., ser. 94-69, 1970, p. 23.

hardly constitute a persuasive movement against 150 others which may well view sub-seabed disposal as "national appropriation" by each of the participants.

Despite the very general, at times vague, language of the international legal principles governing use of the deep seabed, there are already some rules developed and the ongoing law of the sea negotiations and state practice will eventually formulate and solidify more. In addition to the legal constraints on sub-seabed disposal of radioactive waste, strong political and diplomatic pressure can also be expected to restrict unilateral state actions in the interim.

Third UN Conference on the Law of the Sea (1973-1977)

Intensive work on the marine environment and scientific research from 1970 to 1973 by a subcommittee of the UN General Assembly's Seabed Committee and from 1974 to 1976 by Committee III of the Third UN Conference on the Law of the Sea have produced Part III of the Revised Single Negotiating Text (RSNT) on environmental protection. Similarly, efforts in the UN Seabed Committed from 1970 to 1973 and in Committee I of the LOS Conference from 1974 to 1976 produced Part I of the RSNT on controlling resource exploitation in the international seabed area.[1] The full significance of the RSNT cannot be known until the Conference ends, but even without an accepted treaty the RSNT, representing the closest states seem able to come to consensus at this time, would

[1] As noted above, an ICNT (July 1977) resulted from the latest session (May-July 1977, N.Y.) of the LOS Conference. With the exceptions noted above regarding scientific research, and below regarding environmental protection, there are only minor drafting differences between the applicable sections of the RSNT (1976) and the new ICNT (1977).

form an important basis for future state practice, judicial proceedings, and writings. And these will lead to the adoption of some of the text, if not as a treaty law, then through practice and diplomatic correspondence as general international law. This may hold particularly well for Chapter 1 of Part III on the marine environment since it seems now widely accepted. This Chapter (47 articles), Protection and Preservation of the Marine Environment, is the focus of the present analysis, although the Part I text of the RSNT on the deep seabed beyond the limits of national jurisdiction will also be analyzed.

The RSNT provides important evidence of developing and existing trends which will impact directly on any subseabed disposal program. But it must be remembered that this disposal concept has never been a formal topic of discussion at the Conference of 1973-1977 and that the seabed disposal program only started in 1973-1974. Only articles of the RSNT which have not already been addressed will be discussed below.

Part III Protection and Preservation of the Marine Environment

The Part III text on "Protection and Preservation of the Marine Environment" (Chapter I) is largely new and developing law based on the 1971 Intergovernmental Working Group on Marine Pollution Guidelines and the 1972 Stockholm Declaration, but there are also certain principles, standards and other provisions which have acquired the force of law from practice built on the 1958 Conventions, more recent conventions, and other bases.

While the text of Chapter 1 of Part III, with the exception of certain questions of standards and enforcement, is relatively well settled, the substance of the rights and duties contained therein is still very limited. This is a function, <u>inter alia</u>, of the very recent nature of almost all the articles and the perceived necessity for attempting to formulate a comprehensive set of overarching environmental guidelines.

Section 1 -- <u>general provisions</u>. The important, yet very general, Article 2 statement that "States have the obligation to protect and preserve the marine environment" is amplified by Article 4, which provides, in part, that:

> 1. States shall take all necessary measures consistent with this Convention to prevent, reduce and control pollution of the marine environment from any source . . . .
> 3. The measures taken pursuant to this Chapter of the Convention shall deal with all sources whatsoever of pollution of the marine environment. These measures shall include, <u>inter alia</u>, those designed to minimize to the fullest possible extent:
>
> (a) Release of toxic, harmful and noxious substances, especially those which are persistent:
>
> (i) from land-based sources
>
> (ii) from or through the atmosphere
>
> (iii) by dumping
>
> (b) Pollution from vessels . . .
>
> (c) Pollution from installations and devices used in the exploration and exploitation of the natural resources of the sea-bed and sub-soil . . .
>
> (d) <u>Pollution from all other installations and devices operating in the marine environment</u>. . .

> 4. In taking measures to prevent, reduce or control pollution of the marine environment States shall refrain from unjustifiable interference with activities in pursuance of the rights and duties of other States exercised in conformity with this Convention.

While sections 4(1) and (3) show that the Chapter applies to all sources of marine pollution, it is important for the purposes of later articles to determine if any of the specifically listed types of pollution apply to sub-seabed disposal. "Release . . . by dumping" in section 3(a) would not seem to apply to a system designed to isolate the wastes until they decay to acceptable levels. Section 3(b) covers operational discharges from vessels. As already explained above, section 3(c) does not seem to apply since natural resources have been specifically restricted to _in situ_ minerals. Finally, although section 3(d) could be construed to cover sub-seabed disposal, there is no later article expanding on the international rules and national legislation obligations for this general category of pollution similar to those for the other listed categories. Section 4 is the direct application of the "reasonable regard" rule from the _Convention on the High Seas_ of 1958 to pollution control measures taken by states.

Article 6 of the RSNT provides, in part, that:

> States shall take all necessary measures to prevent, reduce, and control the use of technologies under their jurisdiction or control . . . _alien or new to a particular part of the marine environment which may cause significant and harmful changes thereto_.
> (Emphasis added.)

When combined with Article 4 this forms a strong set of obligations for all States.[1] They could both apply directly to sub-seabed disposal.

Section 2 - global and regional cooperation. Articles 7, 10 and 11 confirm further familiar obligations of all states. A relatively common and consistent body of practice has developed around the cooperation of states, both directly and through regional and international organizations, on:

(1) acquiring knowledge for the assessment of pollution and its pathways, risks, and remedies (Article 10);

(2) formulating scientific criteria upon which to base pollution regulation (Article 11); and

(3) establishing and elaborating international rules, standards, and practices to prevent marine pollution, taking into account characteristics regional features (Article 7).

Articles 8 and 9 set up notification and action procedures for cases of "imminent danger" of damage to the marine environment. These probably are not relevant for a program such as sub-seabed disposal, with the possible exception of the potential situation where some version is about to be implemented unilat-

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[1] It is important to remember that almost all of the articles in Chapter 1 (environment protection) of Part III would establish universal obligations, i.e., they would purport to be declaratory of international law binding on all nations, even those not adhering to the Convention.

erally and without any prior notification and consultation. They would, however, apply to any accidents threatening the release of radioactivity during or after the emplacement of wastes into the seabed.

Section 4 - monitoring. Article 14 offers a highly qualified, universal obligation to monitor the risks and effects of marine pollution:

> 1. States shall, consistent with the rights of other States, endeavor, as far as practicable, individually or collectively through the competent international organizations, to observe, measure, evaluate and analyze, by recognized methods the risks or effects of pollution of the marine environment;

and, much more significant, a specific obligation for states to monitor their marine activities:

> 2. In particular, States shall keep under surveillance the effect of any activities which they permit or in which they engage to determine whether these activities are likely to pollute the marine environment.

Both sections of Article 14 appear to be applicable to any sub-seabed disposal program. Closely related is the Article 15 obligation for publishing or distributing related reports:

> States shall publish reports of the results obtained relating to risks or effects of pollution of the marine environment, or provide at appropriate intervals such reports to the competent international or regional organizations, which should make them available to all States.

Section 5 - environmental assessment. The U.S. environment impact statement process formed the basis for Article 16 of the RSNT:

Article 16

> When States have reasonable grounds for expecting that planned activities under their jurisdiction or control may cause substantial pollution of, or significant and harmful changes to, the marine environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment and shall communicate reports of such assessments in the manner provided in Article 15. . . . (Emphasis added.)

The phases "substantial pollution" and "significant and harmful changes" make this assessment obligation very weak. The addition of "substantial" before "pollution" and the need for changes which are both "significant" and "harmful" greatly raise the legally enforceable threshold. And the use of "as far as practicable" to qualify the obligation to assess activities opens a major loophole for deep seabed activities.

Section 6 - international rules and national legislation. Though this chapter, from Articles 17 to 22, has generally been the toughest negotiating issue in Part III, the potentially relevant area of dumping in Article 20 is relatively well accepted due to the results of the Working Group on Pollution in Geneva (1975). The general approach has been to vest environment rights and duties with the state which has jurisdiction over the subject actors.

Article 20 expands on the "dumping" category of pollution which was listed in Article 4(3), as outlined above.

Article 20

1. States shall establish national laws and regulations to prevent, reduce and control pollution of the marine environment from dumping of wastes and other matter. ["Dumping" is construed as in the London Convention of 1972.]

2. States shall also take other measures as may be necessary to prevent, reduce and control such pollution.

3. Such laws, regulations and measures shall ensure that dumping is not carried out without the permission of the competent authorities of States.

4. States, acting in particular through competent international organizations or diplomatic conference, shall endeavor to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment by dumping of wastes and other matter. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.

5. Dumping of wastes and other matter, within the territorial sea and the economic zone or onto the continental shelf shall not be carried out without the express prior approval of the coastal State, which has the right to permit, regulate and control such dumping after due consultation with other States which by reason of their geographical situation may be adversely affected thereby.

6. National laws, regulations and measures shall be no less effective in preventing, reducing and controlling pollution from dumping than global rules and standards.

The basic state obligations and jurisdiction for rule-making and enforcement follow the pattern established by the London Convention dumping regime.

If seabed disposal is eventually determined to be "dumping" under international law,[1] this article will be applicable. But diplomatic correspondence based on Article 20, especially sections 1 and 4-6, leading to the development of related general international law could be at least as effective and important as this part of the RSNT.

Article 19 calls for States to regulate seabed activities and refers us to Part I.

<u>Article 19</u>

> States, acting in accordance with the provisions of Part One of this Convention, shall establish rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from activities concerning exploration and exploitation of the international seabed area. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.[2]

Section 10 - <u>responsibility and liability</u>. Under an earlier text (the Informal Single Negotiating Text of 1975), states were specifically to be responsible and liable for damage to international areas of the marine environment along the lines of principle 22 of the Stockholm Conference (1972).

Article 44 of the RSNT now provides that:

> 1. States are responsible for the fulfillment of their international obligations concerning the protection and preservation of the marine environment. They shall be liable in accordance with international law for damage attributable to them resulting from violations of these obligations.

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[1]See above, pp. 161-166.

[2]The ICNT of 1977 (Article 210) also calls for the establishment, in accordance with the part of the Convention on the Area, of international rules, standards, etc.

> 2. States shall ensure that recourse is available in accordance with their legal systems for prompt and adequate compensation or other relief in respect of damage caused by pollution of the marine environment by persons, natural and juridical, under their jurisdiction.
>
> 3. States shall co-operate in the development of international law relating to criteria and procedures for the determination of liability, the assessment of damage, the payment of compensation and the settlement of related disputes.

This is unclear as to:

1. What the threshold is for "damage" attributable to States; and, 2. When and how States are obliged to cooperate in establishing such liability, assessment, and payments. But it does establish the required basic principles. The specific rules of international law, applicable to deep seabed activities, indicating precisely what states are to be responsible and liable for, are lacking. We will see below, for example, that there are not even any proposed provisions for deep seabed activities not involving mining. Yet concerned states can take advantage of the fact that international law does not develop through treaties alone. States can greatly accelerate the process of developing general international law on responsibility and liability for pollution from deep seabed activities by frequently citing and acting consistently with principles related to more effective control of pollution in the commons.

Part IV: Dispute Settlement

While still subject to major revisions, the Part IV text on dispute settlement is also highly relevant to the question at hand. The potential need for interpretation and other questions of law would be especially high in the unsettled area of jurisdiction and functions of the ISA (Part I) and the new and developing area of environmental protection (Part III). Under Article 12 of this Part and Article 26 of the annexed Statute, a Law of the Sea Tribunal would have the power, if requested, to prescribe provisional measures "to prevent serious harm to the marine environment." Article 14(2) of the Tribunal's Statute allows it to form chambers of members with special expertise for disputes of a particular category, such as pollution. Article 16 makes provision for two or more technical assessors and of a fact-finding board to assist in disputes involving technical questions.

The Special Procedures section on pollution, in an annex to the dispute settlement Chapter, allows a Party to request submission of a dispute to a five member special committee of experts on scientific and technical marine pollution problems. The committee has the same power to prescribe binding provisional measures as the Tribunal. While normal decisions are binding, if requested the committee can also investigate related factual aspects and make recommendations to Parties. This procedure, however, will only apply to disputes over interpretation or application of certain Convention articles which are yet to be designated.

Part I: the Deep Seabed and the Potential International Seabed Authority (ISA)

Part I of the RSNT is designed to control competition in deep seabed resource exploitation. As noted above in the discussion of the general principle calling for "international management" of the Area, the proposed ISA is not, according to the RSNT, designed to control anything beyond the exploration and exploitation of seabed minerals, and possibly directly associated aspects such as scientific research and environmental protection. Although Part I deals with the most controversial and least settled area of the RSNT, it is important to establish its potential impact, or lack thereof, on sub-seabed disposal, especially its relationship to Part III and environmental protection of the Area.

The entire issue of general environmental protection for the seabed beyond national jurisdiction in Part I is dealt with in one article (Article 12) which reads as follows:

> With respect to activities in the Area, necessary measures shall be taken in order to ensure effective protection for the marine environment from harmful effects which may arise from such activities. To that end the Authority shall adopt appropriate rules, regulations, and procedures for inter alia:[1]
>
> (a) The prevention of pollution and contamination, and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from the consequences of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installa-

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[1] Even this reference to the Authority has been eliminated. In the ICNT of 1977, this sentence is replaced with the phrase " . . . in accordance with Part XII [on environmental protection] of the present Convention . . . ."

> tions, pipelines and other devices related to such activities;
>
> (b) The protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment. (Emphasis added.)

This is a strong obligation on the ISA with elements of the assimilative, damage, and use interference approaches. But the ISA is only directed to take "necessary measures" with respect to the exploration for, and exploitation of in situ mineral resources. As expected from the limited function of the ISA, environmental protection for all other seabed uses is not included. The net result is a general lack of any specific attention--even to the degree given to nodule mining--to non-mining uses of the international seabed.

Article 17 assigns to states parties or international organizations specific responsibility for ensuring that all their activities in the Area comply with the Convention. But damage resulting from violations by state-sponsored persons does not entail state liability under the Convention if the state has taken all "necessary and appropriate measures to secure effective compliance." For high-level nuclear wastes, this loophole should not be a problem, since federal governments will be directly responsible.

Articles 27, 31 and 32 establish the Council, Technical Commission, and Rules and Regulations Commission as the bodies to control and supervise all activities in the Area. The Council's functions (Article 28) of approving all work plans and regulating all activities in the Area give it strong influence over environmental protection. The Technical Commission prepares environmental impact assessments, reviews work plans, supervises all Area operations, takes into account the views of experts in environmental protection, and issues emergency orders (which may include suspending operations to prevent serious harm to the marine environment).[1] Assistance in impact assessment is provided by the Rules and Regulations Commission, which then considers the environmental implications, takes into account expert views, and recommends rules and regulations to the Council. All rules and regulations are ineffective until adopted and implemented provisionally (pending final adoption by the Assembly) by the Council. The qualifications called for in members of these bodies combined with the inclusion of special interests and equitable geographic distribution selection criteria, portend a strong mining-development orientation. It seems that within these bodies significant expertise in marine environmental protection for even nodule mining may be limited.

The crucial underlying problem of establishing strong authority for overall environmental protection for deep seabed activities has been submerged by very powerful mining

[1] Article 31(1) also allows the Technical Commission to "disapprove contract areas in cases where substantial evidence indicates the risk of irreparable harm to a unique environment." The meaning of "irreparable harm" and "unique environment" are left completely open.

interests. The U.S. and other countries which often lead the drive for stronger environmental protection are here restricted, at least in negotiations over Part I, by their position that the ISA should have very strictly defined and limited powers. Part III offers important general provisions for protecting the marine environment which are clearly applicable to radioactive waste disposal within the deep seabed. But the Part III reliance on Part I for more specific controls over deep seabed uses, when combined with the strictly limited function of the ISA established in Part I, results in a lack of more specific and detailed provisions on environmental protection for non-mining uses of the seabed.

Summary

Law of the sea, with some qualifications, thus offers some important developed and developing rules and regulations for sub-seabed disposal. Existing treaty law offers some useful provisions, but equally important is the groundwork established by treaty law for states to initiate diplomatic correspondence and develop general international law concerning protection of the marine environment. With the exception of the early IAEA work done in response to the High Seas Convention of 1958, none of these efforts on marine pollution control distinguish between low-level and high-level nuclear wastes. Most of this law covers radioactive wastes under the general categories of toxic, persistent, or hazardous materials. With respect to definitions of pollution, principles for seabed use, and the RSNT, a crucial question for the future is whether or not sub-seabed disposal would significantly restrict other possible future uses of the deep seabed. We have seen the increasing national and international assertion of rights to control activities on and areas of the high seas for pollution prevention. It seems possible that sub-seabed disposal applied unilaterally in the future could justifiably be protested as an unacceptable form of appropriation of international seabed. While the RSNT section on environmental protection lays a general basis for international regulation and state control of sub-seabed disposal, there is little regulatory authority for any potential International Seabed Authority in its present proposed form.

Multilateral Atomic Energy and Environmental Controls

This section will provide a broad look at the availability and adequacy of international nuclear and environmental controls for sub-seabed disposal. Broad international and regional—European—organizational frameworks will be examined. Although it is necessary to analyze various institutional authorities and responsibilities here, most comment on future institutional possibilities will be reserved for Chapter 7.

Atomic Energy Controls and Sub-Seabed Disposal

Internationally, regulatory and minimal enforcement powers are available through the IAEA, the specialized agencies, and other bodies associated with the UN. The CEC/EURATOM and NEA (OECD) offer some regional models and control structures. Taken together they represent an important—though generally non-binding—source of potential international influence over the development and use of sub-seabed disposal.

What international legal authority does the IAEA have over nuclear waste management? One of the functions established in its Statute (Article 3(A)(6)) is:

> To establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property . . . and to provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of atomic energy.[1]

On this basis the Agency develops and applies standards and recommendations to govern radioactive waste disposal worldwide.

The traditionally assumed distinction, with respect to radioactive waste management, between the IAEA health and safety function and the function of establishing and administering safeguards against military uses (Art. 3(A)(5))[2] is fading. It is no longer clear that health and safety concerns can be

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[1]In J. Barros and D. M. Johnston, The Int'l Law of Pollution (N.Y.: The Free Press, 1974), p. 405.

[2]See P. Szasz, The Law and Practices of the IAEA (Vienna: IAEA, 1970) pp. 659, 660; the international interest in health and safety is held to be "somewhat tenuous and speculative." "Consequently, while the safeguards function is focused on the

controlled exclusively by states (traditional assumptions are no longer universally accepted that the risks are low and mainly local in nature)[1] or even that waste management is essentially a matter of health and safety. Waste management increasingly involves major safeguards and other international implications, including problems such as spent nuclear fuel storage or disposal for countries delaying or cancelling spent fuel reprocessing. Nuclear safeguards against military uses and radioactive waste management are now tightly interlocked, especially if there is no reprocessing and spent fuel becomes a waste. The implications for IAEA: an increasingly direct role rather than one of developing, and sometimes recommending and applying international standards will be essential to its future effectiveness in this area. Safeguards against military uses as well as health and safety should be firmly established as bases for IAEA action in the area of high-level radioactive waste management.

IAEA's present responsibilities which are directly applicable to sub-seabed disposal may be specified as follows: 1) establishment of safety standards and publication of recommendations on radiological protection and waste management

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exercise of controls, and the development of the "system" is only of ancillary import—the health and safety activities consist primarily of the establishment of standards to be applied to nuclear operations, secondarily of arrangements to apply these standards to particular operations, and only tertiarily of the control of the effectiveness of this application—in effect a direct reversal of the priorities relating to safeguards."

[1]See Chapter 1, above.

--legal/administrative measures for control of radioactive waste disposal into seas and oceans

--studies on the effects of radioactivity on aquatic organisms and ecosystems, and the interaction of radioactive contaminants with constituents of the marine environment

--development of guidelines for geologic disposal of high-level and alpha-bearing wastes

2) recommendations on safe transport of radioactive materials

3) regional training and technical assistance

--grant of research contracts and agreements on marine science and pollution

--special missions on siting of nuclear facilities on sea coasts and offshore.[1]

> By far the most distinctive element of most contemporary action being taken both in the United Nations itself and its specialized organizations is the promulgation of common international standards and recommendations by which radioactive and other sources of environmental radiation are monitored and hopefully controlled . . . The concept of international standards is not a new one. They have long been a part of numerous multilateral arrangements . . . but they are now beginning to emerge as a distinct type of norm characterized by a high degree of flexibility and adaptability, and so far accepted by States as techniques that do not intervene in the exercise of domestic jurisdiction . . . Voluntary standards can sometimes be worked into a system with well defined uniform legal consequences.[2]

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[1]Adapted from "U.N. and the Sea," U.N.I.T.A.R. News 6 (1974): 8; and UN DOC. E/5003 (1971), sec. 4.

[2]H. L. Dickstein, "Environmental Hazards and Law," Int'l. Comp. L. Q. 23 (1974): 436, 437.

We have already seen one important case where such standards can become obligatory for States. IAEA's Definition and Recommendations on radioactive waste disposal at sea under the London Convention are binding for all Parties and highly persuasive for all States. This is a prime example of a way to gain state acceptance of mandatory international regulations, even if enforcement remains in the hands of national authorities. One central ingredient is the use of a criteria and regulations development process with groups of individual scientific and social scientific experts which meet prior to the groups of governmental representatives. Another important element is starting out at a low level of national commitments to such international mechanisms.

> The IAEA has a fairly well established process for producing widely acceptable standards, codes and guide documents in those areas of nuclear technology where a great wealth of technical information has already been generated by Member States. Though the detailed procedures vary, the general approach is to convene an "advisory group" of expert consultants who draft a code of practice . . . for a certain area of technology. Following this a meeting is held of a larger "review committee" which represents as widely as feasible the nations with a developed capability in the particular area. This group revises the draft document into a form that, implicitly, represents a broad consensus. Some codes are published at this state, or they may proceed through further review processes including distribution for comment to Member States. Finally the code is brought before the Board of Governors for approval, after which the Director General promulgates it to Member States with the recommendation that it be taken into consideration in formulating the countries' own codes in this area of technology. [1]

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[1]C. H. Millar, "Int'l. Aspects of Waste Management," Proc. of the Int'l. Symposium on the Management of Wastes from the LWR Fuel Cycle. (Denver, Colorado: U.S. ERDA, July 1976), p. 28.

Once developed these codes are usually reviewed and revised every few years. Sometimes they are built into a draft convention or protocol and they are generally persuasive for countries formulating related legislation.

There are, however, problems for effective international legal development — in addition to the usual lack of implementation and enforcement powers — in this process. The process is often halted at an early stage or slowed to an inadequate pace by problems in reaching a consensus on scientific and technical issues, low interest of, or lack of support from, governments, inter-agency competition, or inability of governments of the Board of Governors to reach agreement due to political differences. It often takes five years, and sometimes ten or fifteen, to develop a widely accepted set of standards. And great care is essential to avoid the adoption of a least common denominator document.

At least among any nations that are interested in implementation, sub-seabed disposal is likely to draw international cooperation, especially among experts, in a standard development process. This is due to the need to bring together all scientific and socio-economic information available worldwide on sub-seabed disposal and the apparent requirement for strong international guidelines on any future implementation. Yet even if a consensus can be reached on the science of sub-seabed disposal, there could be major political complications introduced into the standards development process.

A paper presented in 1976 by the Director of IAEA's Division of Nuclear Safety and Environmental Protection helps explain how these standards for nuclear energy are enforced internationally.

> While no effective international police force exists to enforce these codes, there is a considerable moral pressure both nationally and internationally to operate to standards that are no less stringent than those in the internationally publicized IAEA codes. In many cases, however, — and this is particularly true with the developing nations — nuclear projects require some assistance either financial or technical from the IAEA or other Agencies within the United Nations' family. Here acceptance of appropriate Agency standards can be made a condition of granting such aid, and more and more this mechanism is proving an effective form of international enforcement of a code. And, going one step further, vendors of nuclear goods and services in the developed nations must bring their products' standards up to the level of the IAEA code if they wish to compete for this business.

His explanation of the international situation for regulating radioactive waste management is much less optimistic.

> However, the situation is not so well advanced in the field of waste management. While small-scale and interim measures have been adopted for handling low- and intermediate-level wastes arising from reactor operation, the lack of adequate reprocessing plants has delayed the major impact of the flow of high-level wastes from reprocessed fuels which in the long term will constitute the main concern of waste management. Most major nuclear states have expended some development efforts along various lines of waste management . . . but there is far from any consensus on a long term waste management scheme that seems at all acceptable to today's concerned public. As a consequence, there is at the present time little possibility that the IAEA could produce an agreed set of standards for waste management and disposal. Thus the Agency's current role is to use its limited resources to

> co-ordinate, and hopefully accelerate, the advancement of the technology.[1]

This seems to be an overly pessimistic assessment of waste management regulation status and prospects. In addition to IAEA efforts which have already been launched to develop site selection criteria for high-level waste disposal and guidelines for geologic disposal of nuclear waste, there is a strong chance that an agreed set of standards for waste disposal at sea (the final IAEA Definition and Recommendations based on the Provisional Definition and Recommendations discussed above) will be available in 1978. There are also widely accepted regulations for transportation of nuclear materials, a vital part of waste management. And there would seem to be major opportunities, if the Agency and its leading member states do not shy away from all areas of political controversy, for developing international guidelines on at least spent fuel storage and high-level waste solidification.

Furthermore, an IAEA role which is limited to coordinating technical development addresses only a part of the problem. We can now observe clearly in many countries that the radioactive waste management problem which must be addressed by the IAEA involves not only technological development but also the development of socio-economic and even political criteria to support international waste management standards and regulations. If the problem is largely political in nature, it will not be solved by skirting the policy issues.

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[1] *Ibid.*, p. 29.

International Liability for Nuclear Damage

There are three primary agreements governing potentially applicable areas of international liability for nuclear damage: the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960, its Additional Protocol (1964) (both in force, with 12 Parties as of 1976),[1] and the 1963 Convention Supplementary to the Paris Convention (in force, 1974; 7 Parties as of 1976); the Vienna Convention on Civil Liability for Nuclear Damage of 1963 (in force, 1966; 7 Parties as of 1971);[2] and the (Brussels) Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material of 1971 (in force, 1975; 6 Parties as of 1976).[3] The Paris Convention establishes the basic regime of absolute and exclusive liability of the operator of the nuclear facility up to a relatively low fixed limit of 15 million dollars.

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[1] IAEA, International Conventions on Civil Liability for Nuclear Damage, Legal Series No. 4 (Vienna: IAEA, 1966), pp. 21, 47.

[2] Ibid., p. 3; see, also, P. Strohl, "The Concept of Nuclear Third Party Liability and its Implementation by Legislation in OECD Member Countries," IAEA, ed., Experience and Trends in Nuclear Law, Legal Series No. 8 (Vienna: IAEA, 1972), p. 69.

[3] UN, IMCO, International Legal Conference on Maritime Carriage of Nuclear Substances, 1971: Final Act of the Conference including the text of the adopted Convention (London: IMCO, 1972); see, also P. Strohl, "Maritime Carriage of Nuclear Substances: Harmonization of Nuclear and Maritime Conventions," IAEA, ed., Experience and Trends in Nuclear Law, p. 89.

Its Supplementary Convention increases the liability limit to 120 million dollars and extends it to damage suffered on or over the high seas on board a Party's ship. The Additional Protocol was simply concluded to avoid any possible conflict between the Paris Convention and the Vienna Convention of 1963. The Vienna Convention of 1963, as drafted in a major international conference in Vienna (1963), was essentially designed to extend the liability framework of the Paris Convention to all civil uses of nuclear energy worldwide. It updates and adds considerable detail to the Paris Convention framework, including allowance for individual countries to set much higher limits for, or even unlimited, liability of the nuclear operator (Article 5).

The Brussels Convention ensures that the nuclear installation operator is exclusively liable for damage from a nuclear incident at sea. The intent was to cancel all shipowner liability for nuclear damage established under maritime law, as long as the nuclear operator is liable under the Paris or Vienna Conventions, or under national law. Shipowners are also free from liability for damage to vessels or nuclear installations.[1]

One obvious problem with this liability coverage is the small number of Parties. The U.S. and Soviet Union are not participants in any of the three main conventions. And the key agreement for maritime transport, the Brussels Con-

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[1] See Nuc. L. Bull. 16 (1975): 42.

vention, had only six Parties as of 1976 (these do not include key countries in the area of maritime transport of nuclear materials such as Japan and the U.K.).

Another serious problem is the very low limits of liability. While the Paris (1960) and Vienna (1963) Conventions allow lower or higher limits of liability to be set by national legislation (as long as the limit is not less than five million dollars), national limits are uniformly low. The U.K. sets a limit of fifty million pounds, with only five million to be provided by the commercial insurance companies. This covers all spent fuel transported on the high seas. A 560 million dollar limit for a single nuclear incident under U.S. law does not extend beyond national territory. Nuclear incidents include shipments of materials between licensees in the U.S. if they are transported beyond territorial waters, but the limit is then dropped to 100 million dollars.

Finally, none of these conventions applies to damage to the means of transport, e.g., ships transporting radioactive materials at sea; although they do apply to radioactive wastes, it is not clear if they apply at all to the situation of ships transporting radioactive materials specifically for disposal at sea. And there is clearly no coverage of damage to the marine environment or its resources from radioactive materials.[1] Although specific prior arrangements are now

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[1]There is no apparent remedy for either of these deficiencies in the new NEA draft agreement for controlling ocean dumping of radioactive wastes.

made for every ship transporting such wastes for disposal at sea, the conventions do provide a strong precedent for the application of absolute liability to the carriage of all nuclear materials at sea. Any future liability for pollution or damage from pollution will probably have to be provided through diplomatic correspondence and supplementary claims. With respect to sub-seabed disposal, it is still too early in the development process to envision how, where, and by whom the liability regime would be established. But there is an immediate need for all involved countries to develop international liability for all aspects of ongoing radioactive waste disposal at sea, including environmental damage.

International Regulation of Radioactive Material Transport

An extremely important area for all methods of high-level, and other waste disposal and for the application of international standards is transportation, both national and international. This is a model area for the adoption of international safety standards in national and international law. IAEA's Regulations for the Safe Transport of Radioactive Materials (1974 Revised Edition),[1] developed from 1958 to 1961 and revised frequently in the 1960's and 1970's, have been incorporated very widely into national legislation and international standards. This is an area where IAEA standards are binding on other international organizations[2] and where nuclear countries rely heavily on international standards. A strong record of international organization practice backs this up in codes, regulations

[1]Safety Series No. 6 (Vienna: IAEA, 1974).

[2]Szasz, p. 683.

and recommendations on transport by rail, road, waterway, and air.[1] Among these is the IMCO *International Maritime Dangerous Goods Code* of 1972, with a major revision of the section on radioactive materials as of 1974-1975.[2]

We can assume that both high-level wastes from spent fuel reprocessing operations and spent fuel bundles (some countries will reprocess and others will not) will eventually be transported to final disposal sites. This is a problem which will soon confront many nations since most spent fuel worldwide is still being stored in cooling ponds within reactor buildings. Even after months or years of cooling, spent fuel bundles require massive shipping containers with self-contained shielding and cooling. In the U.S. this means that a full tractor-trailer truckload is one shipping container with three spent fuel bundles. All such U.S. containers must conform to IAEA standards for "Class B" (the most durable) packages, with a demonstrated ability to maintain integrity through impact tests--for up to a 30 mph crash--followed by an intense fire for half an hour.[3]

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[1] *Ibid.*, p. 684; this includes a list of the int'l agreements which have incorporated the IAEA transport regulations.

[2] 3 vols. (London: IMCO, 1972), pp. 7000-7057; and *Supp. 1974-1975* (London: IMCO, 1972), pp. 7000-7062. See, also, IAEA, *The Physical Protection of Nuclear Material*, INFCIRC/225 (Vienna: IAEA, 1975).

[3] There remain crucial questions to be addressed for rail, air, and truck transport; for a critique of U.S. transport procedures, see S. Turner, "The Public Issue that Won't Go Away" *Boston Sunday Globe* (New England), 8 May 1977, pp. 14-16.

A frequently cited deficiency in these container integrity tests is that they only have to be conducted on a prototype model traveling at relatively low speeds. The recent report by the British Royal Commission on Environmental Pollution expressed it as follows:

> . . . we were surprised to learn that the tests are conducted only on models, and since the containers travel on ordinary freight trains which may be expected to travel at speeds up to twice that assumed in the tests (with kinetic energy four times that assumed), we were not wholly reassured.

They were particularly concerned with respect to irradiated (spent) fast reactor fuel, which has very high heat generation. The report goes on to conclude that there are some key issues to be reviewed.

> We formed the impression that, although the present practices did not appear to give rise to a significant public hazard, this might not be so in the future when the numbers of flask movements may well be much greater, and active cooling has to be provided even for fuel travelling within the U.K. . . . There seem to be a number of issues requiring review, such as whether all future nuclear power stations should be provided with a railhead to avoid transfers from road to rail, whether underwater loading . . . should cease, and whether there should be regular checks . . . of fuel flasks. We have concluded that since a flask is in effect a small-scale nuclear installation, with fuel, moderator, and coolant, the transport of irradiated fuel should formally require the approval of the Health and Safety Executive . . . There should be a system of regular inspections of the flasks, including those imported from abroad. These are at present monitored upon arrival by BNFL [British Nuclear Fuels Limited] staff; we considered that there should also be some checks by DOE [Department of the Environment] as guardians of the environment. [1]

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[1] <u>Nuclear Power and the Environment</u>, pp. 160, 161.

While some of the problems of transportation for subseabed disposal as opposed to those for land-based disposal will be assessed in the next chapter, the international legal situation for maritime transport and liability for carriage of nuclear wastes must be addressed here. Most sea transport has been since the 1960's for reprocessing in Britain, to and from Japan, Australia, India, Canada, South Africa, Europe, and the Mediterranean area.[1] Conventional cargo ships are usually chartered to carry spent fuel. No special requirements are called for beyond the normal ship certification and seaworthiness criteria and the IAEA Regulations for the Safe Transport of Radioactive Materials.[2] This includes, in the case of international transport, endorsements on container certifications by countries of transit and receipt, as well as the usual certification by the country of origin.

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[1] See M. T. Kavanagh and S. Shimoyama, "Irradiated Nuclear Fuel Transport from Japan to Europe," Proc. of the First Pacific Basin Conf., p. 332.

[2] Maritime shipment of radioactive materials is also governed by the general framework of safety regulations, developed by IAEA, IMCO, and ICRP, and revised continuously, which is included in the International Convention for the Safety of Life at Sea (SOLAS) of 1974 (in ILM 14 (1975): 959). The 1960 SOLAS Convention entered into force in 1965 and had been ratified by 89 countries as of January 1975. The 1974 Convention (in force, 1977) notes the rapid increase in the carriage of dangerous goods and "the need to ensure the safe and economical transport of dangerous goods by unification of national and international rules . . . ." It then recommends that IMCO and other organizations attempt to develop an Int'l. Convention on the Carriage of Dangerous Goods by all Modes of Transport.

It is somewhat surprising to find that there are no special ship design requirements for spent fuel carriers. The reason is that such requirements have been considered unnecessary since the containers are supposed to be completely safe as self-contained units. While breakdowns in cooling equipment to maintain low hold temperature may not be crucial, problems with ship mounted cooling systems required for certain forms of spent fuel and with structural integrity of ordinary cargo ships could have very serious consequences. Given the cooling requirements and extremely high weight per unit volume of spent fuel containers, it seems that there should at least be strict international regulations for cooling systems, special load spreading design and tiedown equipment on such ships, and for all handling equipment used to load and unload the containers.

The very small size of cargo ships--and thus the high vulnerability to high seas and the serious consequences of collision--operated by the British to pick up spent fuel in small Japanese ports, [1] and the dramatic future increase expected in sea transport of fuel, would appear to call for the use of specially designed ships. The Japanese have already passed a

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[1] They are using the minimum ship size considered safe for such transport by their insurance companies.

special set of recommendations for ships carrying spent fuel between Japanese ports. These include major design requirements to increase hull strength, provide 100% backup capacities for cooling and electrical systems, and include navigational, monitoring, decontamination, and emergency equipment.[1]

Regulation by Regional Nuclear Energy Organizations

Between 1957 and 1959 three regional nuclear energy organizations were created. All have formal agreements of relationship with the IAEA. The Inter-American Nuclear Energy Commission does not have a significant regulatory role for radioactive waste disposal. Both the European Atomic Energy Community (EURATOM) and the Nuclear Energy Agency (NEA) have some powers to regulate and, to a much more limited extent, to enforce radioactive waste guidelines in Member States.

While EURATOM has not come close to reaching its original nuclear integration goals,[2] its structure and mandate provide the strongest example of a regional regulatory model. Its Commission is charged with establishing basic standards, including

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[1] Kavanagh and Shimoyama, p. 339.

[2] See, for example, M. Willrich, Global Politics of Nuclear Energy (N.Y.: Praeger, 1971), p. 51.

maximum permissible public and occupational radiological dose commitments. Member States must implement and enforce these nationally, with reports to the Commission on procedures established.

Enforcement powers for the Commission include inspecting national facilities, recommending overall dose levels and specific national actions, and ordering the use of measures to comply with basic standards within a given time limit. Direct referrals to the European Court can be made if a member does not comply within the time limit.

Article 37 of the EURATOM Treaty of 1959 [1] obliges Member States

> . . . to submit to the Commission (at least six months before implementation) such general data concerning any plan for the disposal of any kind of radioactive waste as will enable the Commission to determine whether the implementation of such a plan is likely to involve radioactive contamination of the water, soil, or airspace of another Member State.

The Commission gives its opinion on the proposed disposal and may, in urgent cases, refer violations to the Court. This strong influence over any potential high-level waste disposal plan comes the closest of any existing frameworks to the recommendations of Hydeman and Berman, and the Rousseau Panel, as analyzed earlier in this Chapter.

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[1] 298 U.N.T.S. 185, (1958).

But the 1959 EURATOM basic standards for radiological concentration levels in water and air, issued for implementation by members, were not substantially compiled with by most members until 1967. And a reassessment of the standards which began in 1967 was still not completed by 1974.[1] So there is a real problem of timely response to rapid technological development. There is also a real limitation on at least the direct usefulness of Article 37 to regulate proposed action in the deep seabed, since it would be extremely difficult to show likely radioactive contamination of any national territory.

The NEA was established in 1957 with a role which now overlaps those of EURATOM and IAEA, including standardizing national laws, formulating regional regulations, and executing joint radioactive waste disposal projects.[2] NEA has been more successful than EURATOM with some of its joint efforts, recommended practices, and other activities. Yet its formal regulatory role has so far been restricted to quite innocuous areas of radiological protection, such as emissions from watch dials, where it works with the IAEA and ICRP. It has traditionally been a body devoted to the promotion of technical development in nuclear energy, with

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[1] See Dickstein, p. 444.

[2] NEA was the European NEA (ENEA) until Japan joined in 1972; it is legally, but not financially, autonomous from the OECD, although some operational activities have separate budgets, with about 47 staff members; while EURATOM includes only France, the F.R.G., Italy, and the three Benelux nations, NEA has twenty-three member states, including the U.S. (as of 1976).

little capability or willingness generally to become involved in the sticky, politically controversial task of regulating nuclear energy.

NEA has been manipulated by participating countries and heavily criticized by non-participants for its role in the European radioactive waste dumping operations.[1] This may be changing. As already noted, there is now a draft agreement which would establish NEA as an international consultation and surveillance mechanism for ocean dumping of radioactive waste. If formally accepted by the participants, this structure could become an important model for similar potential structures on a broader international level.

The agreement would generally establish the NEA, alongside the IAEA and the London Convention guidelines, as the regulatory mechanism tasked with ensuring that all radioactive waste transport and disposal at sea by members is done safely. All of the basic powers granted to EURATOM, short of ordering member nations to comply, would be vested in the NEA. There would be prior notification of the NEA and all participating nations (through the NEA). If implemented effectively, the agreement would provide some enforcement powers through NEA rights to consult with other groups, to receive reports on how any such advice is used by a participating country, and to appoint an NEA representative, with key police powers, to accompany every ocean dumping operation.

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[1] See Chapter 2, above.

In a form accepted by all NEA members which continue to dump radioactive waste at sea, this agreement would cover all such operations now being conducted worldwide. There are, however, some crucial deficiencies. First, NEA regulation and national actions are only done "taking into account" the London Convention and IAEA guidelines rather than using these prior agreements as strict minimum requirements. Second, the notification and consultation must, in order to satisfy various countries, include all concerned countries and appropriate international organizations rather than only participating countries and NEA committees. This is very important to the solution of past problems and complaints on these dumping operations. Next, there must be formal and direct roles for IAEA, and perhaps even UNEP, if the procedures are to meet minimum international standards of conduct in this field. Finally, prior arrangements for responsibility and liability for all aspects of the operations, including environmental pollution, should be required in the general agreement.

Summary

With the exception of the EURATOM regime, which has not been effectively implemented, the most developed and adequate international nuclear energy controls for radioactive waste disposal are those for ocean dumping. IAEA and NEA efforts in this area are laying much of the groundwork required for regulating a sub-seabed disposal program. Similarly, although existing international regulatory frameworks for transportation and liability are clearly inadequate now for implementing sub-seabed disposal, they offer important models and precedents for governing any future sub-seabed disposal.

Basic interpretations and decisions on regulatory approaches are still required because all past international regulation of ocean disposal has involved low or medium-level wastes. This has been based on the philosophy of dilution and dispersal in the oceans. And a sub-seabed disposal program would be founded on the concept of isolating radioactive wastes outside of the biosphere.

Multilateral Environmental Controls and Sub-Seabed Disposal

Reference should also be made to the international environmental controls potentially available for application to sub-seabed disposal. Since we have already analyzed the applicable sections of the documents from the UN Conference on the Human Environment of 1972 and the ongoing law of the sea conference, we will here consider the general availability of regulatory powers and precedents for environmental protection through international organizations, broad international treaties, an international legal case, and an international arbitral decision.

International Organizations and Environmental Controls for Sub-Seabed Disposal

Of major future importance to any sub-seabed disposal program is the UNEP. At Stockholm in 1972 is was

> recommended that any mechanism for coordinating and stimulating the actions of the different UN organs in connection with environmental problems include among its functions

> over-all responsibility for ensuring that needed advice on marine pollution problems shall be provided to Governments.[1]

UNEP's explicit function is to assess, review and coordinate the ongoing environmental activities. It is designed to be a catalyst for work through other mechanisms and to provide an essential overview for environmental protection worldwide.

One of its earliest policy objectives was to detect serious threats to the health of the oceans and to initiate or encourage action to prevent them.[2] By 1974 the oceans had been designated a priority action area with stress on coordination of the many existing agency activities.[3] Regulatory work was to be focused on supporting regional marine protection agreements, contributing to the ongoing law of the sea effort, and studying, or assessing the study of, the effects of pollution on living marine organisms.

Inevitably, there has been considerable opposition from existing international agencies to the execution of these new and broad UNEP responsibilities. The resentment of this new overview agency by IAEA, IMCO, FAO, and other bodies has slowed the progress of regulatory efforts. Most apparent has been the antagonism from the many international agencies which play a role in some aspect of environmental

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[1] See UN, General Assembly, Report of the U.N. Conference on the Human Environment, recommendation 93.

[2] UN, General Assembly, G.A.O.R., vol. 23, Supp. 25, UN DOC. A/9025 (1973).

[3] UN, UNEP, UN DOC. UNEP/GC/26, Annex I (1974), in ILM 13 (1974): 1035.

protection. There is disagreement, for example, between UNEP and the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the body primarily responsible for planning, conducting, and evaluating the worldwide collection of date on radioactive contamination, over the priorities to be assigned to specific radionuclides and sources in the global environmental monitoring system.[1] UNEP is now closely involved in assessing the international monitoring of radionuclides in the oceans.[2]

In connection with its review of the impact of energy production and use on the environment, UNEP is also most interested in the progress of IAEA's environmental and waste management program.

> Particular attention must be given to nuclear energy; the increasing commitment to its use meant that many countries might find themselves irrevocably dependent on nuclear power before related environmental and health risks had been adequately evaluated.[3]

The intended concerted effort of UNEP with IAEA is to be on the environmental impact of nuclear energy, with particular reference to nuclear safety and the management of radioactive

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[1] UNSCEAR has 87 scientists from 15 countries. It has held 20 meetings since its establishment in 1955. It issues reports periodically; it submitted a working paper on nuclear radiation to the 1972 UN Conference on the Human Environment; its major focus is on the nuclear weapons tests sources of radioactivity.

[2] See the UN, UNEP, Report of the Executive Director, UN DOC. UNEP/GC/31, Add. 2, p. 5 and Annexes II, III (1975).

[3] UN, UNEP, UN DOC. UNEP/GC/55, p. 7 (1975).

wastes. In 1975 the UNEP Governing Council specifically asserted that it supported the Executive Director's intention

> . . . to bring to the attention of IAEA any proposed requirements for environmental considerations relating to standards on nuclear safety, management and handling of nuclear processes.[1]

As of 1975 UNEP considered the law of the sea efforts and the regulation of nuclear energy to be key areas of unsatisfactory progress in environmental protection, so continued strong interest in both of these problems should be expected.[2]

The International Commission on Radiological Protection published a comprehensive set of recommendations in 1966, with updates in 1969, 1971, and 1977.[3] The ICRP addresses the restriction of exposure from the release of radioactive materials into the environment, including the disposal of solid wastes. Specific regulatory and dose assessment pro-

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[1] UN, UNEP, UN DOC. UNEP/GC/31/Add. 1, p. 2 (1975).

[2] The IAEA did reluctantly take part in the major UNEP review of environmental impacts from energy use by doing the section on nuclear energy. From the start the IAEA has stalled and held back on allowing UNEP to become involved with the environmental aspects of nuclear energy. UNEP attempts to establish exchanges and a joint group of experts on radioactive waste management have been largely frustrated by the IAEA; R. A. Frosch, interviews held at the Woods Hole Oceanographic Institution, Woods Hole, Mass., 1976-1977. Regardless, there must eventually be a direct and major role for UNEP in the prevention or management of sub-seabed disposal; see C. R. O'Neal "The Environment: IAEA Co-operation with UNEP" _IAEA Bull._, vol. 18, no. 2, p. 19 (1976).

[3] This is a body of not more than 13 experts which meets annually. The criterion for selection of the experts is clear recognition in the fields of medical radiology, radiation protection, health physics, biology, genetics, biochemistry, and biophysics; see _The Recommendations of the ICRP_ (ICRP Pub. 26, February 1977).

cedures are outlined. They also cover direct external exposure from industrial sources and the monitoring of exposure after planned and accidental releases of radioactivity into the environment.

The ICRP has formal relationships with the IAEA and the World Health Organization. It often works with UNSCEAR, UNEP, NEA, the EEC, and the International Labor Organization. Many international organizations and countries have adopted the ICRP standards and approaches.

Specialized agencies of the UN system, such as the WHO, the World Meteorological Organization, and the Food and Agricultural Organization have health and safety mandates in their statutes similar to that of the IAEA. The ILO, for example, plays a direct role in regulating occupational exposure. They become involved in radioactive waste disposal through the monitoring of radioactivity and the establishment of recommended practices. Their recommendations are sometimes self executing for member nations and often adopted into national law.

Recommendations 87-91 from the Stockholm Conference of 1972 provide important incentives for governments, the UN, the IAEA and the specialized agencies, especially FAO, WMO, WHO, IMCO, and UNESCO, to continue to do the research, monitoring, and cooperative exchanges which are essential to effective national and international marine environment regulation. The specific work of these and other bodies gives them expertise and influence to set recommended standards and practices, and to comment on state practice. The FAO has expressed deep concern, especially for effects on living resources, over use of deep sea trenches for dumping radioactive wastes and many other chemicals (1971).[1] It assists IAEA in studying radioactive waste disposal in marine areas, and its Committee on Fisheries and regional fisheries councils and commissions help develop long-term data on the effect of pollution on commercial fisheries. There is a particularly close relationship between UNEP and FAO over the Mediterranean regime since the FAO is very concerned about the new UNEP initiatives in this area.

IMCO, the UN Secretariat, the UN Economic and Social Council, and the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) have all studied the environmental effects of seabed exploration and exploitation. IMCO, in addition to serving as Secretariat to the London Convention of 1972, created a Marine Environment Protection Committee in 1973 to ensure that it maintained all possible functions and jurisdiction in this area as UNEP was being set up. GESAMP has done important work on ocean dumping, including a report on site selection.[2] Under the auspices of UNESCO the Intergovernmental Oceanographic Commission investigates

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[1] UN, FAO, UN DOC. E/5003 (1971).

[2] See UN, FAO, Scientific Criteria for the Selection of Sites for Dumping Wastes into the Sea, Reports and Studies No. 3-1975 (Rome: FAO, 1975); but GESAMP has so far steered clear of any work specifically on radioactivity.

the routes, fates, and effects of pollutants in the marine environment. The WHO International Referral Center on Waste Disposal is building a long-term R & D program on the storage, treatment, reuse, and final disposal of liquid and solid wastes. There are various other bodies and global monitoring systems which are doing or could do related work. So just as national approaches are varied and layered, the research, recommendation, and regulatory authority on the international level is an extremely complex arrangement of overlapping, often competing bodies, all or most of which can be expected to play some role in the potential use of the Area for sub-seabed disposal of radioactive waste.

Controlling Pollution of International Areas: Broad International Treaties and the International Court of Justice

There are at least four treaties which may help establish a general environmental principle on preventing the pollution of international areas. They offer evidence of increasing state commitments to environmental protection and national responsibility for environmental damage in international areas. When combined with general international law on environmental protection, treaties and principles from law of the sea, and international nuclear law principles and precedents, such as absolute liability for nuclear activities on the high seas, they offer evidence of emerging rules of general international law restricting environmental damage to international areas from radioactive pollution.

The 1959 Antarctica Treaty[1] specifically bans radioactive waste disposal, freezes all national claims, and implements joint management by the users. It serves as an early indication of a strong desire to prevent radioactive pollution of at least this shared area. This is now what may be best adjudged a commons area which offers an example of a limited partnership approach to managing "peaceful" activities. Article 7 provides that Parties may designate observers or use aerial observation to inspect any or all areas of Antarctica at any time with complete freedom of access. This type of access is not possible now on technical, economic, and political grounds for deep seabed activities, but it may be applicable in some form to ships or facilities which conduct future activities in the Area.

By 1963 there was a widely accepted Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water.[2] It had 107 parties by 1977, although some important nuclear waste producers and potential producers, such as France and China are not parties. The second of its two primary goals is the desire "to put an end to the contamination of man's environment by radioactive substances." This builds on the concerns expressed over nuclear pollution on the high seas (1958) and in Antarctica (1959) and extends

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[1] 1 December 1959, [1961] 12 U.S.T. 794; T.I.A.S. 4780; 402 U.N.T.S. 71; A.J.I.L. 477 (1971). For recent developments, see Bull. of the Atomic Scientists, no. 10, 1970; Antarctica Journal 10 (1975): 195; and U.S., Dept. of State, Report of the U.S. Delegation to the Eighth Antarctic Treaty Consultative Meeting (Oslo, June 1975), December 1975, Rec. 8-12 (Mimeographed.) There were 19 parties as of 1977.

[2] 5 August 1963, [1963] 14 U.S.T. 1313; T.I.A.S. 5433; 480 U.N.T.S. 43; there were 107 parties as of 1977.

them to the entire biosphere, except within the ground and the seabed.

Outer space received more comprehensive protection in 1967. The Treaty on Principles Governing State Activity in Outer Space bans nuclear weapons, but not nuclear waste disposal.[1] It had 73 parties as of 1977. Article 9 obliges States Parties to

> pursue studies of outer space. . . and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth. . . and, where necessary, . . . adopt appropriate measures for this purpose.

This is important evidence of a developing obligation to avoid the introduction of new technologies into international areas in a way which might cause harmful contamination. Article 6 establishes a clear State responsibility for all national activities in these areas. And Parties must consult if planned activities might ". . . cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space."

Finally, the 1971 Seabed Weapons Treaty (with 61 parties as of 1977, excluding some important nuclear states, such as France and China) extends the concerns for new technologies and nuclear pollution to the international seabed.[2] It

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[1]Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 27 January 1967, [1967] 18 U.S.T. 2410; T.I.A.S. 6347; 610 U.N.T.S. 205; there were 73 parties as of 1977.

[2]Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and the Subsoil Thereof, 11 February 1971, Article 3 [1972]; 23 U.S.T. 701; T.I.A.S. 7337; there were 61 parties as of 1977.

establishes strong peaceful use and mutual consultation principles for the entire seabed beyond 12 miles from Parties' coasts. It also implements a mutual observation procedure which can be escalated into various levels of inquiry, inspection, and use of the UN Security Council. The system of progressive steps is a very useful concept for satisfying doubts over compliance and ensuring effectiveness by starting out at a very low level of commitment.

The precedent value of the Antarctica, Outer Space, and Seabed agreements is limited somewhat by the novelty of the area or use, i.e., there was little, if anything, foregone by states in the way of prior uses or practices. The atmospheric test ban, however, did involve some real derogation from the prior practices of those states willing to become parties. Prior waste disposal uses were particularly well established in the high seas. Yet this is changing rapidly; and it is not clear that this prior use of the high seas applies to disposal within the deep seabed. In this area we may be dealing with a case somewhat similar to that in the Antarctica, Outer Space, and Seabed Weapons Treaties.

Evidence of an emerging rule of general international law requiring the avoidance of environmental damage, especially by radioactive pollution, to international areas may also be found in the abuse of rights principle as implied in an important joint dissent in the <u>Nuclear Tests Case</u> (Australia

v. France).[1] This dissent implies that the International Court of Justice (ICJ) may find that the establishment of a nuclear weapon testing zone in the high seas or the alleged pollution of the high seas with radioactive fall-out from the actual weapons tests violates certain " . . . long-established--indeed elemental--rights . . . " (such as those based on the freedom of the high seas).[2] This type of possible violation of rights could provide a useful tool for an arbitral tribunal or court to employ in questions of potential risk of damage and potential violation of the freedom of the high seas from future activities in the international seabed.

Just as the potential Law of the Sea Tribunal, the ICJ can grant provisional measures to an applicant who demonstrates urgency, impending danger, and prima facie substantive jurisdiction. But the question of standing to protect the international seabed, where international organizations cannot be parties before the Court,[4] and the demonstration of some measure of danger are both serious obstacles. The most pervasive problem with international forums is that of establishing standing for potential long-term environmental damage to the Area. This now requires a demonstration of impending danger to some specific national property or direct interest.[5]

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[1] 20 December 1974, I.C.J. Reports 1974, p. 63; joint dissent of Onyeama, Dillard, Arechaga, and Waldock.

[2] Ibid., para. 113, p. 118.

[3] Ibid., paras. 113-118, pp. 118-122.

[4] I.C.J. Statute, Art. 34(1).

[5] Barcelona Traction, Light and Power Company, Limited, Second Phase, I.C.J. Reports 1970, p. 32.

One indication, however, of changing state attitudes in this area is reflected in a widely accepted objective from a preparatory document for the Stockholm Conference of 1972 (adopted and quoted by the Conference) which provided that

> the marine environment and all the living organisms which it supports are of vital importance to humanity and all people have an interest in assuring that this environment is so managed that its quality and resources are not impaired.[1] (Emphasis added.)

This same document, which was also the basis for much of the environmental section of the RSNT from the Third UN Conference on the Law of the Sea, lists as its first principle that

> every state has a duty to protect and preserve the marine environment and, in particular, to prevent pollution that may affect areas where an internationally shared resource is located.[2] (Emphasis added.)

Such declarations and resolutions will not, by themselves, establish standing before an international tribunal for a nation concerned about some prospective activity in the deep seabed. But together with their repetition in various regional and broad international conventions, state

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[1] See UN, General Assembly, Report of the U.N. Conference on the Human Environment.

[2] Intergovernmental Working Group on Marine Pollution; Report of the Ottawa IWGMP Meeting, A/CONF.48/IWGMP. II/5, 1971, Principle 1; this concept of protecting, especially conserving, shared resources has been reiterated in U.N. G.A. Res. 3129(XXII)(1973), other such resolutions, various treaties, and decisions of international organizations, including the UNEP Governing Council (April, May 1975); it has so far been applied mainly to regional resources, but it clearly applies to the oceans and deep seabed.

practice, and other principles and cases, they may already be cited by states and organizations as evidence of the substantive law even if the binding force that applies to ICJ decisions under UN Charter Article 94 is not available. Pressures based on assertions of law may certainly be mounted even where standing to present a formal action is lacking. There may now be a wide expectation that major--potentially polluting--activities in the deep seabed require prior notification and consultation with concerned States and appropriate international organizations. This is especially the case for any activity which involves high-level nuclear materials and/or inherently controversial issues.

Elaborating on the precedent value of the Trail Smelter decisions of 1938 and 1941 (the famous, yet often misquoted international arbitral holdings in which the U.S. was awarded compensation for clearly demonstrated damage in its territory from air pollution originating in Canada)[1] for activities beyond all national borders, one observer contends

> . . . whenever there is a significant threat of harm to the res communis, an international legal order lacking institutions capable of effective public representation cannot require a showing of unique interest on the part of objecting states as a prerequisite to standing. This [he claims] is particularly so when the claim is preventive rather than pecuniary, since the problem of allocating compensation among claimants does not arise.[2]

The need for such standing, unfortunately, has not brought us to this point in practice. Some direct interest not just

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[1]United States v. Canada, preliminary decision (1938), UN Reports of Int. Arb. Awards 3: 1911; A.J.I.L. 33 (1939): 182; final dec. (1941), UN Reports of Int. Arb. Awards 3: 1938; A.J.I.L. 35 (1941): 684.

[2]Kirgis, p. 293; for discussion of the applicability of universal jurisdiction to regulating pollution in int'l areas, see C.O. Okidi: The Prospects for Establishment of Regulatory Arrangements for the Control of Pollution of the Sea, doctoral dissertation, Fletcher School of Law and Diplomacy, Medford, Mass., 1975, pp. 215, 474.

in the environment but in national property of holdings is still required by State practice.[1] There is, of course, the possibility that some direct recourse could eventually be available through a law of the sea tribunal, or beyond normal diplomatic correspondence, even through the UNEP.[2] This may be less of a problem for sub-seabed disposal since the U.S. and increasingly other countries require complete environmental impact statements on such major activities beyond national borders.[3] The wide availability of such detailed information at a relatively early stage would address part of the problem.

Most crucial for sub-seabed disposal will be the assessment of the prospective level of hazard posed to the marine environment. It is clearly impossible to require that concerned states wait until after implementation because enormous amounts of radioactivity would already be emplaced and any unanticipated effects might not occur or be discovered

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[1] See, generally, G. Stutzin, "Should we Recognize Nature's Claim to Legal Rights? An Essay" Env. Policy and Law 2 (1976): 129; Stone, "Should Trees Have Standing?—Toward Legal Rights for Natural Objects" S. Cal. L. Rev. 45 (1972): 450; and "The Revival of the Standing Defense in Env. Litigation" Env. L. Rev. 7 (1977): 131; on the serious problem, even in the U.S., of establishing standing for environmental protection without a unique interest or special citizen suit provision.

[2] The American Society of Int'l. Law sponsored a conference on potential international environmental dispute settlement roles for the UNEP in 1974; see, A. Chayes and R. E. Stein, Summary of the Discussion of the (1974) Conference on the Avoidance and Adjustment of Environmental Disputes, for the ASIL, (Bellagio, Italy: ASIL, 1975), p. 3.

[3] See Chapter III, above.

for thousands of years. And even if the Trail Smelter case can be extended "to cases in which the likelihood . . . of injury is established by clear and convincing evidence,"[1] this legally enforceable threshold is probably too high to be of use for sub-seabed disposal. An approach which considers the number of proposed disposing states, the level of need and safety shown for the disposal, and the reaction of other states, related international organizations and expert groups will be required.

Regional Environmental Pollution Control

One growing source of international legal control over pollution of international areas is regional agreements and mechanisms.[2] In addition to the regional marine pollution control conventions already examined above, the European Community's environmental protection efforts should be mentioned. The E.E.C. Declaration on the Environmental Action Program of 1973,[3] instead of offering a strong basis for new EURATOM and NEA action, only superimposes certain rather general guidelines for the "European solution" of "European problems" on top of existing structures and policies. It

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[1] Kirgis, p. 294.

[2] See, generally, Okidi, on the prospects for regional assistance in controlling pollution of the high seas.

[3] 22 November 1973, in ILM 13 (1974): 164; this has been incorporated into the "Environment and Regional Planning" area of the Council of Europe 5-Year Plan (1976-1980), see Council of Europe Press Release B (76) 311d.

fails to deal effectively and comprehensively with radioactive pollution in general.

It excludes radioactive materials from the list of priority pollutants (since Annex I of the Oslo Convention is used for the marine pollution list) and the list of priority areas for standard setting. The Declaration does include a separate section on radioactive waste which identifies the complexities, the differing existing approaches, and the need to pool ideas and experience on the ultimate "storage" of waste. [1] Though the Declaration identifies the crucial need for answers which will

> ensure equal protection of man and his environment independently of the technological solutions adopted according to the particular characteristics of the national territories, [2]

it offers no commitment to standardize procedures, and no form of obligation to improve national and community regulations.

Action has now been taken (under Articles 100 and 235) on protecting the Communities' aquatic environment, out to and including territorial seas, from certain dangerous substances. [3] Although there is a conspicuous absence of radio-

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[1] Ibid., ch. 7 sec. 2; the January 1975 Parliamentary Assembly of the Council of Europe annual debate on environmental problems dealt heavily with the "serious," "complex," and "unsolved" problem of radioactive waste management. Several countries called for int'l. cooperation on developing solutions, see "Council of Europe Opts for Nuclear Power" Env. Policy and Law 1 (1975), p. 15.

[2] See ILM 13 (1974): 169.

[3] Council Directive of 4 May 1976 on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic

active materials from either the banned (List I) or special caution (List II) lists, the preamble and Article 2 do oblige members to end pollution from the discharge of List I substances. And List I does include the general category of substances proved to possess carcinogenic properties in aquatic environments, which must be considered to include radioactive wastes.

This Directive would have been adopted in the October 1975 Council meeting, had it not been for British rejection--by an 8 to 1 vote--based on the "inappropriateness" of uniform standards for such a "geographically diverse Community." There was strong reaction against what was deemed as British reliance upon nature to handle highly toxic materials.[1] But even as passed, the Directive is of no direct value for international areas since it stops short at the outer boundary of the territorial seas.

Summary

Just as with international nuclear law, there is still considerable development of international environmental law required for governing any use of sub-seabed disposal. When combined with the commitments and principles established by treaties for international areas, documents from the prepara-

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Environment of the Community (Official Journal of the European Communities, Vol. 19, No. L 129 of 18 May 1976) in ILM 15 (1976): 1113.

[1] See "British Demur to Environmental Controls" Env. Law & Policy 1 (1975): 144.

tion for and proceedings of the Stockholm Conference, and the Nuclear Test Cases, the ongoing work of UNEP, the ICRP, the specialized agencies and the CEC is laying important groundwork. We can already cite strong evidence that at least prior notification and consultation is an international obligation for states planning to introduce the use of major new, especially controversial, technologies into the deep seabed. New national requirements for environmental impact assessments seem to be catching on at the international level. And there is growing evidence that international law requires the study and monitoring of potentially harmful activities in international areas. There may be principles establishing both State responsibility and liability for serious pollution of the international seabed and standing for concerned States which are attempting to prevent such pollution through international forums. But these two areas need much more development.

CHAPTER V

THE POLITICAL PRESSURES: IMPACTS OF U.S. AND FOREIGN POLICIES ON THE SUB-SEABED DISPOSAL OF RADIOACTIVE WASTE

Based on the assessments of the technical, marine disposal, and national and international legal problems of sub-seabed disposal in preceding chapters, it is now time to consider the policy issues. Regardless of the importance of involved scientific and technological aspects and the fact that some policy issues are best handled by taking no action, if the radioactive waste problem is largely (or even significantly) political in nature, it will not be solved by skirting the major policy issues. Fundamental political problems will remain to be addressed even if all technical problems can be solved; and vice versa, policy may force sub-seabed disposal at severe risk even if the technical problems have not, or cannot be solved. It is entirely possible that the central driving force in the sub-seabed disposal concept will turn out to be the policy issues. And just as with the pace of legal development, there is a fine line to be tread between keeping work on the policy implications of such research and development programs up with--but not significantly beyond--the level of scientific and technological development.

The General Policy Context for Sub-Seabed Disposal

While public attitudes and governmental responses often vary widely over a period of years, the handling of the sub-seabed disposal efforts in the late 1970's and early 1980's will set some important trends. Part of the context is already fixed. Nuclear energy is in serious trouble in the U.S. and elsewhere; this is partially due to the poor governmental and industrial track record in nuclear waste management and the low level of associated public understanding.

Closely coupled with the past governmental and industrial record is the growing nuclear opposition in many countries from environmental, consumer, and other interest groups with complex sets of motives. As described above, especially in Chapter I, these groups are particularly sensitive to both:
1) the use of local, state, or national territory for radioactive wastes produced in other areas or countries; and
2) the activities of other groups and related events in other areas and countries.
U.S. land-based disposal programs--for all types of radioactive wastes--have already encountered serious political difficulties in finding technically acceptable waste disposal repositories. Local, regional, and state restrictions and bans on nuclear waste transport and disposal, even in forms which may not hold up legally against federal preemp-

tion in this area, must be taken seriously on political grounds.[1]

A crucial question thus overshadows this chapter: To what extent will radioactive waste management be recognized as a serious problem in its own right? This consideration affects not only the pace of nuclear energy development but also affects the disposal of large amounts of already existing military and commercial radioactive wastes. A more specific related consideration is: To what extent will (and for how long should) the potential sub-seabed disposal option be evaluated on the basis of its own prospects and problems as opposed to those of the overall waste management program and the other disposal options? Regardless of the result, of course, there must be full comparative evaluation of all possible disposal options over the next decade.

There are at least three central objectives for this chapter and later work in the area: First, to determine if sub-seabed disposal could be a politically feasible option, or at least to find out if it appears to be ruled out on political grounds for the 1990's and beyond; next, to begin to understand how politics could and should affect sub-seabed

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[1]See Chapter I, above, pp. 39-44.

disposal programs; and, finally, to see how the option can be kept open politically, if this is judged to be desirable.

This chapter is organized around three closely related areas of political response: domestic (U.S.), other countries, and international bodies. American public and governmental response to sub-seabed disposal is emphasized because of its pivotal importance to decisions world-wide. Much of the analysis of the U.S. situation also applies to other countries. After analyzing these three areas of political response, the overall policy implications of sub-seabed disposal and its immediate radioactive waste management/nuclear policy context will be assessed.

High-Level Radioactive Waste Disposal in the U.S.: Approach and Timing

The political implications of sub-seabed disposal in the U.S. will be heavily influenced by the broader waste management, nuclear energy and overall energy contexts. Regardless of the fact that there increasingly seems to be wide acknowledgement of the importance of waste management as a problem in its own right,[1] the sub-seabed disposal program is still an integrated part of the broader situation. If the Carter energy plan builds even more opposition to nuclear energy, it could well become difficult to establish any

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[1] See, generally, Proc. of Conference on Policy Issues in Nuclear Waste Management (Wash., D.C.: MITRE Corp., 1977).

disposal facilities in the 1980's or 1990's.[1] The planned operational date for the first U.S. repository is now 1985. If reprocessing and the breeder reactor are indefinitely delayed (the thrust of existing U.S. nuclear policy, but with considerable opposition), and if the new (1 October 1977) Department of Energy (DOE) develops public credibility and an accepted nuclear policy, it will probably be easier to start some waste disposal operations. The prospects for developing credibility in the DOE, although still uncertain, appear to be much better, over the next few years, than those for establishing an accepted nuclear policy. The level of credibility established in the DOE will depend largely on who is appointed to head nuclear waste management. For nuclear power policy, at least on the major issue of setting the procedures and pace for new nuclear plant construction, there seems to be very little flexibility in the positions of nuclear opposition groups.

Within the overall radioactive waste disposal context, the level of trust or hostility established toward land-based disposal programs will also affect the sub-seabed disposal program image. It is not completely clear, however, whether

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[1]The progress in waste management also directly affects nuclear energy development. It could become necessary to halt all nuclear expansion while we attempt to deal with waste management problems. The conclusion reached by the Ford Foundation-sponsored report (<u>Nuclear Power: Issues and Choices</u>, p. 262), that we have time to study waste management problems <u>without an appreciable increase in risk since the magnitude of the problem will not double over the next 5 to 10 years</u>, seems inconsistent with the nature of the problem, on both the national and international levels, as analyzed in Chapter 1, above.

new blunders in salt or rock programs, such as the Lyons, Kansas debacle of 1970-71,[1] would shift more emphasis on the sub-seabed or lead to a rejection of all disposal options for longer-term interim storage. The best possible speculation might be that new problems with land-based options would lead to a shift of more policy emphasis on sub-seabed disposal.

The disposal programs may be partially inter-dependent since the options actually implemented could turn out to be somewhat different for present military wastes, spent fuel bundles, high-level commercial reprocessing wastes, and transuranic-contaminated wastes. Additionally, there seems to be fairly wide agreement in the technical and social fields that at least two basically different disposal options should be developed to the demonstration stage. Even putting aside the discouraging past record of the U.S. Atomic Energy Commission in radioactive waste management, it does not seem to be prudent from systems engineering and political viewpoints to focus on only one answer to such a long-term and complex problem.[2]

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[1]See Chapter I, above, pp. 20, 39.

[2]See, for example, APS, Report to the American Physical Society by the Study Group on Nuclear Fuel Cycles and Waste Management, (APS, 1977); Rochlin, and, generally, U.S., Congress, House, Comm. on Interior and Insular Affairs, Hearings on Radioactive Waste Management, before the Subcomm. on Energy and the Environment, 95th Cong., 1st Sess. (16 & 17 May 1977).

Also crucial are future policy decisions on the timing of establishing high-level waste disposal options. As noted in Chapter I, above, we must now be careful not only to maintain the high priority on developing acceptable disposal methods but also avoid hasty solutions formulated to remove the tremendous pressure on the nuclear energy program. Critical policy choices will have to be made for avoiding both rapid and potentially careless approaches, and stalled, overly cautious procedures. Advocates of a disposal method should be required to show the detailed reasoning behind its preference over other choices; critics of a method must spell out their recommendations--with priorities--for alternatives, unless they see no feasible alternatives. At least for the time being, there do not seem to be any objections to maintaining the spectrum of seriously studied disposal options broad enough to inclued sub-seabed disposal.[1]

U.S. Nuclear Policy and Sub-Seabed Disposal

President Carter's new nuclear policy is essentially a gamble on a two part trade-off.[2] First, it offers to the nuclear opponents an indefinite delay on reprocessing spent

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[1]This may not, however, fairly represent the views of some nuclear scientists, engineers, and administrators who are convinced that salt beds are so certain to work that all other options only "confuse" the public; see, for example, B.L. Cohen, "the Disposal of Radioactive Wastes from Fission Reactors," Scientific American 236(1977): 21.

[2]See, for example, U.S., Executive Office of the President, Statement by the President on Nuclear Policy of 27 October 1976; Ford Foundation, Nuclear Power: Issues and Choices; "Amid Confusion, a Primer on Nuclear Energy Policy," New York Times, 9 April 1977, p. 25; and New York Times, 28 April 1977, p. 1.

fuel, recycling the plutonium and uranium, and developing the breeder reactor,[1] with hopes for nuclear proponents that this will allow "more efficient" (quicker) licensing of reactors and increased reliance on the light water reactor. And second, it attempts to assure other nations that the U.S. will be both a reliable supplier of enriched uranium fuel (or perhaps even that there can be a stockpile of reactor-grade fuel established) and a leader in solving the international spent fuel storage and high-level waste disposal programs. The price for U.S. fuel supply to non-nuclear weapon countries would be a crucial requirement for the application of IAEA safeguards to all nuclear materials and equipment.

Since the federal agencies, especially ERDA, have done very little to anticipate the possibility of dropping reprocessing and of disposing of spent fuel, there is now a major thrust underway to assess the problems and implications of spent fuel storage and disposal. The first data are just now becoming available, and few people--even among government leaders--realize that after the first 100 - 200 years the heat output of spent fuel will be 6 to 8 (or perhaps even 10) times greater than that of high-level wastes from

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[1] In addition to the criticism abroad, there has been considerable foot-dragging and outright opposition in the U.S.; Congress is refunding part of the cuts in the breeder program; environmentalists are concerned about the stress on light water reactors; for the somewhat surprising opposition of Senator Church, see New York Times, 3 May 1977, p. 24. The NRC decision on whether to allow the recycling of plutonium is still pending.

reprocessing.[1] This could have major implications for disposal methods since heat may be an important factor in the failure of containment by geologic media. Heat will probably also determine the spacing requirements of spent fuel within geologic media, especially in salt.

How does this new policy affect sub-seabed disposal? There are at least three crucial questions to be asked: Is sub-seabed disposal as acceptable as other options for a "stowaway" fuel cycle, i.e. spent fuel storage for as long as 20-30 years followed by reprocessing and high-level waste disposal, or by direct spent fuel disposal? Is it as acceptable for a throw-away fuel cycle, i.e., spent fuel disposal in the near future? And, how does it rank with other disposal options based on the need for international arrangements to control plutonium?[2]

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[1] Interviews held with R. Anderson and D. Talbert, Woods Hole, Mass., 1977; these experts clearly disagree with statements such as that made in the recent Ford Foundation report (Nuclear Power: Issues and Choices, p. 259) that the heat generated by high-level reprocessing wastes is about the same as that from spent fuel, except in the first 100 years.

[2] This question is partially addressed by the prior two questions, but it also involves other considerations. Some of these will be addressed below. Some should include the technical and political criteria for evaluating non-proliferation policies, as developed by G.W. Rathjens and A. Carnesale, in "The Nuclear Fuel Cycle and Nuclear Proliferation," paper prepared for a Pugwash Symposium on International Arrangements for the Nuclear Fuel Cycle, Racine, Wisc., 1976, pp. 26-27; and the set of objectives for evaluating a multinational fuel cycle center, as included in C.B. Smith and A.J. Chayes , "Institutional Arrangements for a Multinational Reprocessing Plant," paper delivered at the Pugwash Symposium, Racine, Wisc., 1976, pp. 1-3. All of these criteria and objectives relate to slowing or preventing the decision by, and capability of, other countries or groups to acquire nuclear weapons.

Interim storage of spent fuel could be done through use of expanded cooling pond facilities at individual reactor sites, expanded facilities at the inactive Barnwell, South Carolina reprocessing plant, a new retrievable surface storage facility (RSSF), or the same (or similar) geologic formations to be used for disposal. None of these are particularly attractive because:

1) Keeping all spent fuel on reactor sites places the entire burden of interim storage on the utilities that own the reactors. This would represent a major government policy reversal and involve contract negotiations and serious related political and financial problems. It would also seem to create an unnecessary security and health hazard especially if the storage is to be for 20-30 years. On the other hand, this new hazard may be less than the risks from any increase in transportation and handling due to a separate interim off-reactor site storage step before final disposal or later reprocessing.

2) Expanding the Barnwell facility could be costly for the taxpayer, and the later for the consumer. Storage of spent fuel there would involve transportation risks and would put another step into the process between on-site storage and disposal.

3) The RSSF also creates another interim step for transport and handling. A primary problem with the RSSF is that it may remove the political pressure to find acceptable final disposal options. Furthermore, this leaves open the possibility that, by default, it could become a disposal site, or at

least a very long-term storage site. Additional transportation risks are also involved.

4) The major advantage of storage in geologic formations would be the elimination of all interim steps, if there is no reprocessing. But since it will be a number of years--at least the mid-1980's--before we could even start to store in geologic formations intended for disposal repositories, this option would entail some prior step, such as major expansions of on-site cooling pond storage at nuclear plants. If we add to this the facts that all the problems with the RSSF would also apply here, and that the first disposal repositories are scheduled to be in salt and salt appears to be a poor choice for interim storage purposes,[1] it does not appear, from this author's viewpoint, that storage in such geologic formations at least until the 1990's is very likely, or, if undertaken, likely to prove an adequate solution to the interim storage problem for spent fuel.

Based, then, on factors such as a minimum of transportation or other steps that might involve risks to health and safety, easy retrievability, maintaining pressure to develop final disposal options, and no chance of conversion--by default--to a less than acceptable long-term storage facility, it appears that interim storage in facilities such as Barnwell would be the wisest step. This would leave open the option of moving to storage in geologic formations if reprocessing

[1]This is due to the highly corrosive environment in salt beds, making it increasingly difficult effectively to retrieve the wastes--especially after about 10 years--and the problems with structural strength for such retrievable facilities; see, generally, U.S., Congress, House, Comm. on Interior and Insular Affairs, <u>Hearings on Radioactive Waste Management</u>.

continues to look unlikely and if acceptable long-term repositories become available.

Sub-seabed disposal is clearly not as satisfactory as other geologic options, such as salt and rock--in a mined cavity form, for the storage part of a stowaway fuel cycle. While it might prove useful to store some fuel and permanently dispose of some, if we want easy retrievability, we should rule out the sub-seabed. There will, however, eventually be either spent fuel or high-level reprocessing wastes (especially from military sources) for final disposal. And the stowaway cycle will allow more time for the full comparative assessment of all disposal possibilities.

It is still too early to answer definitively the overall question of the relative acceptability of the sub-seabed for the disposal step in a stowaway cycle, a throwaway cycle, or for international arrangements designed to control nuclear proliferation, but we can tentatively say that sub-seabed disposal appears to be as acceptable as land-based options for at least the final disposal step. The only major change apparent so far with a throwaway cycle is the heat factor noted above. To date we do not know the full consequences of heat on any of the potential waste disposal media. Yet we can see that the wider spacing required in the disposal media for spent fuel bundles will lead to more mining operations and expense for land-based options which use a mined cavity. Wider spacing will obviously not create any new problems for sub-seabed disposal.

One of the serious obstacles to developing an international spent fuel storage (or a disposal) site for nuclear non-proliferation purposes is the strong national opposition, even in the case of a host country for an international arrangement, which must be expected to accepting wastes, or even potential wastes, from other countries. From the political viewpoint, one expert observer finds sub-seabed disposal to be the most attractive of the high-level waste disposal options.[1] This is because sub-seabed disposal does not trigger the opposition to the local disposal of foreign wastes. Thus the sub-seabed could become an important part of an international effort to control plutonium. An Associated Press story of April 1977, for example, noted that part of the Carter Administration's nuclear non-proliferation strategy may involve international sites for radioactive waste (especially spent fuel) disposal. Sub-seabed disposal was cited as the leading possibility for such international cooperation.[2] So the sub-seabed disposal option for radioactive waste disposal might offer some unique advantages as a politically acceptable site for establishing an international waste disposal arrangement as part of a broader nuclear non-proliferation plan. It is, however, still impossible to say what the exact U.S. and foreign political reactions to this concept and to international disposal sites on land will be.[3]

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[1]Harvey Brooks, "The Public Concern in Radioactive Waste Management," p. 57.

[2]Associated Press release NO27 of 21 April 1977.

[3]The nuclear non-proliferation aspects are developed in further detail in Chapter 7, below.

Comparison of Sub-Seabed Disposal to Other Options on Socio-Economic Grounds

We clearly do not yet know enough to do the essential comparative evaluations of high-level waste disposal options. Although such evaluation is implicit in the daily budgetary and program development decisions of the ERDA, there is little evidence that a systematic and comprehensive assessment has even been done. Indeed, given the intra and inter-agency program pressures in the Executive Branch and the scrambles for energy authority in the Congress, there is little reason to believe that it will ever be done. It is therefore crucial that the regulatory agencies--the NRC and EPA--the public interest and other related groups, and the key independent expert study groups do in depth analyses of the pros and cons of full scale use of each disposal method.

The intent here is only to help establish the framework for assessing sub-seabed disposal and comparing it to other methods on socio-economic grounds. Again, the objective is not necessarily to select one disposal option. There seems to be a strong chance that a combination of methods or a disposal system may eventually be needed to deal with even the wastes generated in the U.S. Thus comparative assessment must also be keyed to identify complementary methods.

Brief consideration will be given to six factors which should be helpful in evaluating seabed disposal individually and comparatively. These include public attitudes, transportation and emplacement, construction and operations, physical security, the social and economic costs and the response from other countries and the international agencies. This analysis is obviously very tentative since we do not yet even know if there are any feasible ways to dispose of high-level wastes.

Public Attitudes

There has apparently never been a survey in the U.S. of public attitudes towards the various possible high-level nuclear waste disposal options. Although it is still very early, such a project could be very useful for the federal agencies involved in radioactive waste management. The limiting factor is that such public attitudes could be outdated quickly since both the disposal possibilities and the individual responses must be expected to change over time.[1]

At a more general level, we do know many important views on radioactive waste management and nuclear energy. Radioactive waste disposal is very clearly perceived to be one of the major problems with nuclear energy; key groups, such as political and business leaders, regulators, and environmentalists, feel that it is the number one problem.[2]

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[1] P. Slovic, personal communication, 26 May 1977; and Proposed Goals for Nuclear Waste Management (A Report to the US NRC by the Task Group on Radioactive Waste Management, 1977.)

[2] L. Harris & Associates, Inc., "A Second Survey"; a major public criterion for having more nuclear plants is that they meet tough government standards for radioactive waste disposal.

We should combine with this the clear public confidence in scientists (followed by the NRC, ERDA, leading environmentalists, and the President) relative to that in other groups for views and information on nuclear-related matters.[1] This makes it extremely important to reach a consensus among the scientific community on disposal methods. Yet, we can expect this to be very difficult, and perhaps especially hard for sub-seabed disposal, since there will be reluctance among scientists and government officials in energy-related agencies advocating salt disposal to adopt an unconventional approach.[2]

It has also become very clear that no one wants nuclear waste disposal in his own immediate area.[3] This raises the question of the equitable balance of costs and benefits, at least in part, to the national level because the wastes will have to be transported and disposed of somewhere. In addition to the concern for geographic equity, there is a need for inter-generational equity. There seems to

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[1] Ibid.

[2] B. L. Cohen, "The Disposal of Radioactive Wastes from Fission Reactors" Scientific American 236 (1977): 21.

[3] U.S. NRC, Proposed Goals, and P. Slovic, "Psychological Factors in the Perception and Acceptability of Risk," Proc. of Conference on Public Policy Issues in Nuclear Waste Management; and W.S. Maynard, et al., "Public Values Associated with Nuclear Waste Disposal," A report to the U.S. ERDA (Seattle, Wash.: Battelle Memorial Institute, 1976).

be agreement that the risks should be minimized for present and future generations, and that most of the responsibility for waste management should be assumed now. But as of 1976, most people did not think that the generation using nuclear power should take all the risks for waste disposal.[1]

Combining the public attitude of avoiding waste disposal in the "backyard" and the clear need to avoid areas with significant existing or potential population densities, the result may inevitably be geographical inequity. Either states such as Nevada, Utah, Colorado or New Mexico--which receive little of the benefit from nuclear energy--assume most of the risks for the U.S. salt or rock disposal, or the entire international community--in some sense--suffers the risks of sub-seabed disposal for the countries using nuclear energy.

But there are at least five unique characteristics of sub-seabed disposal in this respect.

1) As noted above, it could be much more acceptable to national publics since it does not threaten any local constituency.[2] This would tend to increase its chances of being available as a final disposal option.

2) It is an option which requires approval and cooperation beyond just the national level. But this requirement could

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[1]Maynard, p. 82.

[2]Nuclear power is much more acceptable to the U.S. public if the plants are located offshore or in an isolated area; this pyschological distance is the single most important factor in eliciting a willingness to have a nuclear plant in the neighborhood, L. Harris & Associates, Inc., "A Second Survey."

turn out to have some positive implications for public acceptance of international cooperation on radioactive waste management and on nuclear proliferation.

3) Since there is no local constituency--even with a comprehensive law of the sea treaty--great care must be taken to avoid "out of sight, out of mind" practices.

4) It could offer a disposal solution to the several countries which are unlikely to have acceptable national sites, i.e., the public acceptance in some countries might be increased by the clear need of other countries for some final disposal option for high-level radioactive wastes.

We do have one additional hint at public attitudes on the relative importance of four composite aspects of nuclear waste disposal. A preliminary survey indicates that: 1) long-term safety (all risks after wastes are emplaced); 2) short-term safety (storage, transport and emplacement risks); 3) accident detection and recovery are, respectively, seen as the most import aspects; and 4) dollar costs of a given disposal method were very clearly seen to be the least importance.[1] Although the order of presentation of the first three of the four composite aspects represents an order of priority with statistical significance, the authors were unable to find any practical difference in importance among the first three aspects.

Short-term safety and accident detection and recovery may well become public opinion problems for sub-seabed dis-

[1] Maynard, p. 32.

posal. The oceans, and especially the abyss, are still a major source of myth and mystery for even the well informed American layman. Most people would be astounded to know the scientific and technological capabilities now available in the ocean environment. So it could be very difficult to inspire public confidence in relatively simple capabilities like returning to precisely the same spot on the high seas or picking something off the bottom in five kilometers of water. There also seems to be a general feeling that sub-seabed disposal would have to be more expensive than land-based disposal. Yet we really have little data to go on so far. A seabed penetrometer emplacement technique could well turn out to be cheaper than most rock disposal methods.

Transport and Emplacement

Transportation and emplacement are sometimes cited by experts as the critical elements of any sub-seabed disposal program,[1] although such comments on emplacement appear to be directed at the deep drilling technique. It may in fact be that the major risks of accidents, sabotage, or theft, which could lead to serious consequences from any disposal method would occur during these stages. It is not at all

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[1]Most recently, see the Ford Foundation report (Nuclear Power: Issues and Choices, p. 255) comment that key uncertainties include the "risks associated with extended sea transport and emplacement in water of 5 kilometers depth." The latter risk apparently refers largely to a drilled emplacement method.

clear, however, that these risks over several decades exceed those from the long-term safety aspect over several hundreds of thousands of years. In any case, it remains too early to make any useful comparative evaluation of disposal methods on this basis.

We first need some reasonable idea of at least:

1) where spent fuel would be encapsulated and finally shipped from and/or where high-level reprocessing wastes would finally be shipped, including other countries;
2) which shipping methods would be available;
3) where possible land-based and sub-seabed disposal sites would be;
4) what emplacement methods would be used;
5) what the short and long-term site monitoring requirements will be.

Given spent fuel storage and waste encapsulation well inland in the U.S., extra transportation and handling could be expected for sub-seabed disposal. Use of spent fuel storage and waste encapsulation facilities on or near coasts could lead to less transportation and handling for a sub-seabed option. Preliminary disposal choices should perhaps influence the choice of locations for interim spent fuel storage. However, if acceptable land and sub-seabed disposal is available, transportation distances could be a major determinant of where different facilities send their wastes.

A key advantage of using ocean transport is that it is less likely to immediately endanger densely populated areas--such as the major cities transited by rail or truck. One key risk to be investigated, however, is the possibility of an accident in loading or unloading, or even of losing an entire ship at sea. Safe transportation may not, in a broader sense, be as much as question of technical feasibility as it is one of social or public acceptability. The question may ultimately focus on the relative risks of different types of land and sea transport[1] and on logistical requirements such as highways and shipping containers.

One general comment on emplacement is that seabed disposal is obviously designed to rely very heavily on nature. A mined cavity in salt or rock may offer some advantage in ease of retrieval from a demonstration plant stage for five to ten years. For long-term safety, however, the mined cavity concept relies much more heavily on man's engineering capabilities and guarantees. It already seems clear that, in general, the more a disposal method relies on natural con-

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[1]W.B. Silker and M.R. Peterson did a preliminary study of the sea transit phase of a seabed disposal program ("Implications of Seabed Disposal of Radioactive Wastes," unpublished report, Bettelle Memorial Institute, 1975). They found that "the disposal of high-level radioactive waste to the seabed appears very attractive from all aspects considered." The basic conclusion was that risks could readily be reduced to very acceptable levels with special precautions. This was, however, very general and speculative in nature, with only brief treatment of possibilities such as fire and sinking at sea. Much more work must be done in this area; one key question is whether or not ships should specifically designed to transport, emplace, and monitor (over the period immediately after emplacement) the containers.

tainment, the more difficult it is to retrieve the wastes.[1]

Two criteria, technical irreversibility and site multiplicity, have been suggested for evaluating nuclear waste disposal methods on the basis of long-term safety.[2] Technical irreversibility, the emphasized criterion, is defined as "the degree to which emplaced wastes are resistant [both socially and physically] to recovery or release either by accident or by the deliberate application of technology."[3] On a very preliminary analysis, seabed disposal is ranked as quite irreversible since it is predicted to remain isolated through social and natural uncertainty.

Regardless of the number of basic disposal methods chosen, there is always the possibility of using a number of sites (site multiplicity) to decrease the level of risk from failures at a single site. Site multiplicity may thus increase the technical irreversibility of a disposal option. Seabed disposal is accurately ranked as very strong in this area since it is expected to be very easy to increase the number of sites. The red clay sediments of primary interest for sub-seabed disposal are the most widespread geologic formation on the planet, i.e., they are available over about

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[1] The Ford Foundation report (Nuclear Power: Issues and Choices) echoes the British Royal Commission's report, (Nuclear Power and the Environment) on the advantages of seabed disposal, namely "security from inadvertent retrieval and a very stable geological environment."

[2] Rochlin, p. 24; long-term safety is assumed to be the overriding concern.

[3] *Ibid.*, p. 26.

one quarter of the earth's surface.

Long-term management--largely for monitoring and restricting some seabed uses--is likely to be the only limiting factor for the number of such disposal sites.[1] These criteria need to be refined and applied frequently as disposal options are developed. Special attention must be given to new storage needs, transportation aspects, emplacement methods, and potential future resources in the vicinity of any site. Yet, at this stage seabed disposal is, by these criteria, a preferable choice to the use of mines in salt or rock.

Construction and Operations

Assessments of construction and operational requirements are, of course, largely dependent on more detailed knowledge of disposal methods.[2] Based on assumptions of penetrometer emplacement from a specially designed ship, the construction would consist mainly of a port loading facility and the ship, with no permanent on site facility except for

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[1] One of the conclusions of a public workshop on nuclear waste management sponsored by the EPA (Office of Radiation Programs) was that: "There will probably be a net advantage to having multiple waste repository sites, but further technical consideration is necessary:" (A Workshop on Policy and Technical Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, US EPA, 14 April 1977).

[2] Detailed information on transportation, construction, and costs is contained in BNWL, High-Level Radioactive Waste Management Alternatives, BNWL-1900 (Seattle: BNWL, 1974), especially Vol. 3, Sec. 6--Seabed Disposal, but this is based on drilled emplacement (p. 35), which is no longer necessarily the leading engineering concept, and other very outdated information.

bottom moored remote monitoring devices. Other options will need some form of permanent and secure on-site facilities on the surface and underground (for a mined-cavity concept). Operationally, sub-seabed disposal will at times be restricted, on a temporary basis, by weather, but this is unlikely to be of any real consequence unless the time consuming deep drilled emplacement is used in areas of frequent storm occurrence. Land-based methods would involve major drilling and mining-backfilling operations. One foreseeable difference of importance is that one ship and port facility could service several sub-seabed disposal seaports, whereas all construction and operational aspects of land-based options would be necessary at each such site.

Physical Security

Physical security for sub-seabed disposal, just as with land-based disposal methods, must be carefully assessed based on a number of factors, such as types of transport used and lengths of routes. It will be dependent on whether reprocessing wastes (no threat) or spent fuel is carried for disposal. Even if we dispose of spent fuel, the level of concern about the possibility of spent fuel theft and subsequent reprocessing must be determined. Long-term security from both unintentional and intentional human intrusion may turn out to be a major advantage for seabed disposal--along the lines of the above noted technical irreversibility criterion. If the primary future threat of human intrusion into disposal repositories is determined to be from resource exploitation, seabed disposal might rank very high on security.

Social and Economic Costs

Social and economic costs may be the aspect which is most sensitive to the need for more detailed information on disposal options. Until the research and development process is far enough along to answer at least the basic questions on technologies to be used--perhaps by 1980 or 1981--cost estimates will be very speculative. Nevertheless, it is now possible to begin to determine exactly what information is necessary for such estimates. We can also begin to discount the long-held claim that waste management costs will be relatively insignificant.

One basic problem is determining what are and are not the costs of waste management. U.S. Federal government policy for the last few years has been that the utilities should pay the full costs of managing the wastes produced in their nuclear power stations. Yet it is virtually impossible to calculate even past costs incurred from government involvement in all phases of radioactive waste management. And the costs for handling existing federal wastes from military applications alone will be extremely high relative to those for all existing commercial spent fuel. Now, assuming a stowaway fuel cycle in the U.S. (in accordance with new U.S. nuclear policy), we must find the cost of storage by an un-determined means for an unknown length of time (which could now be up to 20 to 30 years), including transportation and processing. Then we must know if spent fuel will be reprocessed prior to disposal, or if there will be direct disposal. Finally, there must be some idea of the timing, means, and location of disposal.

The problem is further complicated by the question of whether waste management R and D costs should be included. ERDA's budget for commercial waste management became a significant number by 1976-1977, [1] and it continues to grow very rapidly. How much of this expenditure, which represents an increasingly significant subsidy to the utilities, should be passed along to the waste producers--and thus to the electricity consumers? And when should the bill come due? One way to charge utilities and consumers now using nuclear power for managing their wastes is through the use of an escrow fund or similar arrangement; this could require annual payment by the utilities to a Federally established fund of the best possible estimate--which is certain to be way too low--of the costs to manage all spent fuel produced that year. [2]

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[1] See Chapter I, above, pp. 36, 37, and Figure 10.

[2] This becomes even more complex if we attempt to calculate full resource values. If we do not reprocess spent fuel, how much more uranium will be used up, and what extra charges should thus be made for more rapid depletion of a non-renewable resource? Or can we balance out this cost to future energy consumers with the prospect of less spent fuel reprocessing and a slower spread of worldwide nuclear weapons production capabilities?

Past estimates of sub-seabed disposal costs have been based on a drilled emplacement technique. Since penetrometer emplacement may be favored, the expensive drilling ship and open ocean platform may not be necessary. This would lead to major decreases in capital and operating costs.

Major expenditures will be a function of how many and what kind of ships and port facilities are needed. The same potential advantage to construction and operational needs of one port facility and ship serving various disposal sites could also help keep costs down. Additionally, the ongoing international seabed disposal program may cut R and D costs to the U.S., and the need for international participation in the operational phase could further reduce individual countries' costs.[1]

Claims that we should not be concerned about the costs of waste management since they will constitute such a small fraction of overall expenditures on nuclear energy are very unconvincing. Yet it is crucial to further investigate the initial finding that the public ranks costs well below safety in waste disposal. It seems to be of the utmost importance to establish that, even if waste management becomes a significant economic burden, <u>the overriding priority must be placed on developing the safest possible means for pro-</u>

[1] If an international site were to be operated as part of an effective overall nuclear non-proliferation effort, we should count on it being more expensive for the leading countries, such as the U.S. and the U.S.S.R., than it would be with wastes from only nations with major nuclear energy programs. Yet, this type of arrangement would certainly seem to be worth any extra direct economic costs.

cessing, storing and especially transporting and disposing, of nuclear wastes. It is important that leaders in the U.S. Congress and Executive Branch be convinced that costs relative to protecting future generations should have a low priority.

The Response from Other Countries and the International Agencies

Our final concern in assessing the political response to sub-seabed disposal in the U.S. is that of the political influence of responses from other countries and related international agencies. American public and governmental attitudes will be based, in part, on the reactions from other countries, regions, and international organizations. In the next few years the tone of these reactions may largely depend on the attitudes of countries and organizations directly involved in the international R and D program on seabed disposal. U.S. attitudes will be shaped by the success or failure of this effort to attract interest and financial support from involved nations and to expand its base of participating, or at least interested, nations. On the international level, we should expect an increasing interdependence in two respects: first, the problems and prospects of nuclear non-proliferation and of nuclear waste management will be more and more difficult to separate, especially for seabed disposal; and second, the nuclear policy decisions and events in one country will have even greater influence on those in other countries.[1]

The Political Pressures on Sub-Seabed Disposal from Other Countries

In many countries there are several scientists with some basic understanding of the risks and benefits of sub-seabed disposal--as presented in an international meeting or conference paper or published in the scientific literature. But no nation has yet made any formal foreign policy statement on the possible sub-seabed disposal of radioactive wastes. Indeed, relatively few countries are even fully aware on an official level of the existence of the U.S. or international seabed disposal programs. Naturally, then, it is now quite difficult to predict national political responses.

There are however, a number of nations--beyond the four participants in the international program--France, Japan, the United Kingdom, and the U.S., that have informally indicated some degree of interest in the concept. Australia, Canada, and West Germany were also represented in the first International Workshop on Seabed Disposal of High-Level Wastes, which was held in Woods Hole (Massachusetts) during February of 1976. And several other Western European nations seem to be following the program closely. All of the Western European nations and most of those in Eastern Europe are at least aware, through the NEA, IEA, and IAEA, of the sub-seabed disposal studies. Several other nations in Asia, the Middle East, and South America have had some contact through inter-

[1] See Chapter I, above.

national conferences.

The purpose here is to examine present and prospective attitudes of key countries and identify the broader factors and trends that will determine the international political climate for sub-seabed disposal. In general, of course, we can expect more support from nations which use, or are about to use, nuclear power. This would be a group of roughly 50 nations by the year 2000. But there will be major differences within this group. Most important among the reasons behind this variation will be the number and types of politically and geologically acceptable waste disposal options, if any, that are available to nations.[1] Countries with little or no possibility of developing local disposal methods can be expected to support at least R and D on sub-seabed disposal. Those with very large land masses and/or public commitments to specific types of land-based disposal will, in general, indicate less interest or perhaps some degree of opposition.[2]

Among the three nations which have joined the U.S. in the R and D effort, Britain is the strongest supporter. But along with their real need in the waste disposal area and their strong oceanographic capabilities, the British carry

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[1]This refers mainly, although not exclusively, to options for the disposal of high-level materials. Another crucial, and closely related, factor will be the extent of the country's dependence on and plans for nuclear energy.

[2]Neutral or negative attitudes may become more positive if the U.S. national and the international R & D efforts continue to be successful.

the leading international record of radioactive waste disposal, by dilution and dispersal, in the oceans.[1] Their general record of opposition to more stringent marine pollution control may not encourage countries concerned about the British contribution to the development and control of sub-seabed disposal through the international program. But the real problem is more complex.

Just as with the U.S. political situation, the most important factor in gaining international political acceptability may be the extent to which national governments comprehend and respond on the basis of the major scientific and technological differences between the concept of long-term isolation inherent in sub-seabed disposal and the past, present, and proposed disposal by dilution in the oceans. If the sub-seabed program is seen as another category of the geologic disposal options, it could eventually prove to be more acceptable than any land-based alternative. If on the other hand, it is categorized as just another form of ocean dumping, sub-seabed disposal of radioactive waste must be expected to encounter strong opposition from at least Eastern Europe--led by the Soviet Union, the outspoken critic of past U.S.

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[1]The U.S., with a comparable past dumping record, does not pipe reprocessing wastes--the most serious source of radioactivity--into the oceans. And it will probably never again use marine disposal of solid/packaged wastes by dilution and dispersal.

and European, especially British, dumping practices.[1] It could also be extremely difficult for many European environmental groups to switch gears and accept seabed disposal after a long and continuing battle to end radioactive waste dumping at sea.[2]

British investigators of the concept of dumping vitrified high-level radioactive wastes onto the seabed may be greatly complicating the international political situation for sub-seabed disposal. Under the auspices of the International Seabed Disposal Program--established jointly to assess the feasibility of isolating radioactive waste underneath the seafloor, they are apparently attempting to establish high-level radioactive waste disposal onto, as well as

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[1]The Soviet Union has, from time to time, accused the U.S., U.K., and France of polluting the Atlantic, while emphasizing the view--arising from military and political objectives--that radioactive contamination is perhaps the most dangerous type of marine pollution. In 1976 the president of the Soviet Academy of Sciences called for an international agreement banning the ocean dumping of nuclear wastes, see World Env. Rpt. 2 (2 August 1976): 8. For further Soviet criticism of radioactive pollution of the oceans, see A. Ostrovskii, "Int'l. Legal Protection of the Seas from Pollution" Ocean Devel. and Int'l. L. 3 (1976): 287; and A. Skarkov, "Environmental Protection and Int'l. Cooperation" Int'l. Affairs (Moscow) 6 (1976): 62.

[2]Due to their proximity to NEA disposal sites, Spain, Portugal, and Ireland have generally been skeptical of, or flatly opposed to, radioactive waste dumping; see, for example, World Env. Rpt. 1 (8 December 1975): 7; at the First Consultative Meeting of the Parties to the London Convention in 1976 Denmark, Sweden, Portugal, and Canada expressed their desire to avoid all ocean dumping of radioactive wastes; on British contamination of the North Sea with reprocessing wastes, see generally, the Marine Pollution Bull. Major hearings were held in the Summer and Fall of 1977 in Britain on the proposed expansion of the Windscale reprocessing facility; the Isle of Man (in the Irish Sea), as one intervenor, is extremely concerned about the prospect of increased discharge of radioactivity to the Irish Sea.

into, the seabed as a viable option under the same heading.[1] This is, of course, completely at odds with both the early conclusion of the ERDA Seabed Assessment team that the water column cannot be relied on as a major barrier to the migration of radioactivity and the recent conclusion of the U.K.'s Royal Commission on Environmental Pollution that the two reasonable options for the permanent disposal of vitrified wastes are geologic formations on land and below the ocean floor.[2] It is also completely impractical from the legal, political, and social viewpoints since early results in this area indicate that high-level waste dumping onto the seabed could never be a nationally or internationally acceptable option.[3] This has been further

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[1]This has involved applying the label of "seabed disposal" to their dilution and dispersal concept as well as to the isolation concept for which it was developed.

[2]Report of the Royal Commission on Environmental Pollution (Nuclear Power and the Environment), pp. 150, 152, and 203; recently formulated British research proposals include study of on the seabed disposal, (Proposals for Research on the Aspects of Nuclear Power, the Natural Environmental Research Council, January, 1977).

[3]In 1971 E. D. Brown concluded, with respect to nuclear pollution, that ". . . any discharge carried out in disregard of the substantial safety recommendations of the Brynielsson Report [which cites unanimous agreement against any high-level radioactive waste dumping into the sea, p. 77]--even though these are not binding *per se*--would be *prima facie* evidence of a breach of the required standard of care," "International Law and Marine Pollution," *Natural Res. J.* 11 (1971): 249. The IAEA's Rousseau panel report, also done directly in response to a request from the 1958 UN Conference on the Law of the Sea and under Article 25(1) of the Convention, reached the same clear conclusion against high-level waste dumping. And this standard has been strengthened considerably since 1971 by numerous events and treaties covered herein, especially the entry into force--and ratification by 32 countries--of the London Convention of 1972. Its complete ban on high-level waste dumping and the special concern of the Parties at later meetings over even low-level radioactive waste dumping offer further confirmation.

confirmed by recent work at the IAEA on regulating radioactive waste disposal at sea. A broad international group of oceanographers (including some from the U.K.) working under the IAEA has rejected the dilution and dispersal model on which this British work was based and has replaced it with a new oceanographic basis for regulating radioactive waste disposal at sea.[1] Public and governmental association of an on the seabed dilution and dispersal option with the sub-seabed isolation concept could pose a real political and legal problem for the ERDA Seabed Assessment Program and the International Seabed Disposal Program. This type of work would further blur the distinction, in public perception terms, between the philosophies of isolation within the seabed and dilution and dispersal in the water. Since the U.K.'s Department of the Environment (DOE) is soon to assume the responsibility for radioactive waste management, there is certainly a chance that policies will change.

Nevertheless, the U.S. ERDA study of sub-seabed isolation is contributing to the growing movement toward isolation for high-level as well as low-level radioactive waste as an international guideline or rule for all radioactive waste disposal at sea. And all involved countries, except the U.K., seem to be behind the isolation concept as the only safe alternative, at least for high-level materials, and in-

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[1] See Chapter I, above.

creasingly for all radioactive matter above innocuous levels.

The Soviet Union is extremely interested in international cooperation on marine sciences and deep sea technologies,[1] as well as on nuclear non-proliferation, and is well advanced in studying radioactivity in the marine environment. An independent Soviet assessment of the science and technologies of the sub-seabed disposal concept would certainly be feasible. Although they have not participated in the recent IAEA revision of the oceanographic basis for regulating radioactive waste disposal at sea,[2] they did offer comments on this process at the First Consultative Meeting of the Parties to the London Convention in September, 1976. Rather than advocating a ban on ocean dumping of radioactive waste, they pressed for improving the oceanographic model, and the containers and matrices used in dumping.

French plans, at least for now, seem to be to separate their high-level radioactive waste into fission products--for land disposal and transuranics for sub-seabed disposal.[3] This is the closest that any country has come to an apparent policy of using sub-seabed disposal. If this carries over

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[1] See, for example, U.S. Congress, Senate, Comm. on Commerce, Soviet Oceans Development, 94th Cong., 2d Sess. (October 1976).

[2] There was a scientist from Poland at the IAEA Advisory Group Meeting (March 1977) on revising the oceanographic basis for the IAEA guidelines on radioactive waste disposal at sea.

[3] Statement by A. Barbreau, French representative at the Second Int'l. Workshop on Seabed Disposal of Radioactive Waste, March 1977; Wash., D.C.

into a significant R and D effort, a pivotal nuclear nation (which also plans to rely heavily on nuclear power to help supply its future energy needs) with an important role in oceanography and global environmental protection will have offered its firm support. Key international agencies, such as NEA (OECD) and IEA, and environmental groups are also based in France. And France is also an important link between the Western developed countries and Eastern Europe, and between the industrialized countries and the LDC's.

Of concern to the French, as well as to the U.S. however, is the apparent British attempt to twist the joint R and D effort to meet its own national objectives, i.e., to retain the option to dispose--by dilution and dispersal--of increasing quantities of radionuclides by dumping at sea and by piping reprocessing wastes into coastal waters. And the French are clearly no more willing than the U.S. to provide any appearance of international support for the British concept of disposal on the seabed. [1] Yet, it is important, for assessing the consequences of accidents or release, during sub-seabed disposal to study the movement in the water and sediments of radionuclides <u>on</u> the seabed. An evaluation of such a containment disposal method must include all possible

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[1] This is precisely what happened, starting in 1967, when the NEA sponsored the "European" dumping operation (which was very largely for British wastes). This enabled Britain to continue the unilateral dumping, which ended in 1966, under international auspices in 1967, 1969, and 1971-1977. Yet the future concept of high-level waste disposal <u>on</u> the seabed is, even in the U.K., apparently seen to be inferior to geologic disposal under land or the seabed.

knowledge of the results of accidents or errors.

Japan seems to be following its now familiar pattern in nuclear matters--cautious participation in and support of sub-seabed disposal until some consensus develops, at least among European nations, either for or against the concept. Given that Japan is the only country to acknowledge openly the impossibility of land-based high-level waste disposal, and that one of the key Japanese nuclear policy goals is the reduction of dependence on other countries for nuclear fuel, reprocessing, and waste disposal, Japan would certainly welcome a disposal option which did not depend completely on some other country. While there is no concrete policy on high-level waste disposal, a major proposal for future low-level disposal is ocean dumping. The oceanographic basis for participation in the joint R and D program on sub-seabed disposal is certainly sufficient, and much of the work and equipment already available for low-level waste disposal is applicable to studying sub-seabed disposal.

It is especially difficult to predict the Japanese response. A very serious problem of nuclear waste disposal gnaws away at broad and deep sensitivities to things both nuclear and marine. Both the public and the government are vividly aware of unpredicted or unknown results from introducing noxious substances into the marine environment.[1]

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[1]Mercury poisoning is but one of the serious examples; interview held with Mr. Hisashi Owada (Head Treatees Div., Japanese Foreign Office), Tokyo, August 1975.

One particular advantage of Japanese participation in the sub-seabed disposal study is their heightened awareness of the problem of liability for unexpected future results from the disposal of very persistent substances.[1]

The West German situation combines elements of U.S. and Japanese problems. Strong public commitments to salt disposal for radioactive wastes, similar to those made--and to some extent still existing--in the U.S., were made before new problems appeared. The operational Asse mine disposal site was declared unacceptable for high-level wastes and severe opposition was encountered to the siting of a joint reprocessing plant--disposal facility over the salt beds of Lower Saxony.[2] Just as in Japan, the government has softened its strong plans for nuclear power until some decision is reached on high-level waste disposal.

There is, thus, enormous pressure-similar to that in Japan, Sweden, and the U.S.--to find an acceptable disposal option.[3] But this is coupled with some fear in the nuclear community of "confusing the public" with non-salt disposal options. The fear is at least partially due to the fact that West Germany is relatively well advanced in radioactive waste management, with major political and technical commitments already made to developing salt dome disposal methods. There

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[1]Owada, August 1975.

[2]Chapter I, above and Science 195(1977): 962.

[3]In addition to future nuclear energy plans, the West Germans are in close competition with the English, French, Americans, and even the Canadians and Japanese, over various aspects of the future international nuclear market.

is thus some hesitation, despite the uncertain status of salt options for high-level waste disposal, and the apparently ongoing internal considerations of other possibilities, over any change in focus at this point in time. The result for sub-seabed disposal has so far been a careful monitoring of all research activities, without any indication of immediate interest. It has, however, been noted informally that an accepted disposal option <u>beyond</u> national borders would be more than welcome by West Germany.

Canada, of course, has a land mass on the scale of the U.S. and U.S.S.R. Additionally, the natural uranium fuel cycle has been publicized as less subject to the problems now being experienced with back-end operations by the enriched uranium fuel cycle. Yet strong opposition to nuclear energy has forced more serious attention to waste disposal. The granite of the Canadian Shield may offer a solution for high-level wastes, but they are also carefully monitoring the sub-seabed studies. Major plans for reliance on nuclear energy--both for national energy and for international exports--demand the development of some disposal options. Canada is also an international leader for protecting the marine environment, with strong capabilities in the ocean sciences. So their opposition to such uses of the deep seabed could start a movement which would prevent its use. Their support, on the other hand, might help convince many nations that it is a sound concept.

As another leading nation in environmental protection, Sweden is also likely to influence other nations' future policies on sub-seabed disposal. The 1976 report by the Swedish government committee on radioactive waste recommended both shipment by rail or boat, whenever possible, for high-level materials and disposal in bedrock. [1] A central fuel storage facility was estimated to be necessary by 1982, and a disposal repository by 1990-1995. Although somewhat confident that disposal in bedrock will be possible, they seem to be seriously concerned about future ground water movement and resource exploitation as obstacles to demonstrating a full disposal capability.

Given the new U.S. policy on nuclear fuel reprocessing and the growing opposition to nuclear energy in Sweden, it is very possible that they will never do their own reprocessing. This and the somewhat unstable political situation vis-a-vis nuclear energy [2] leave future policies even more unsettled. A report, in 1978, by the Swedish State Energy Committee is to recommend policies on nuclear waste disposal. This must satisfy the government that radioactive wastes can

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[1] Interest is high in the Canadian program on rock disposal; bilateral cooperation has been started. See <u>Spent Nuclear Fuel and Radioactive Waste</u>, p. 55.

[2] The recent reversal of the Prime Minister's once strong stand against nuclear energy has molified the coalition parties, but not many of his supporters in the 1976 election. So it is not certain how long he can stay in office with the now established policy of expanded nuclear energy use under tighter restrictions.

be safely handled if plans for nuclear energy are to continue.[1] It is still too early to say if this report will recommend any policy on sub-seabed disposal.[2]

Other countries, such as Switzerland, Finland, and Austria, which have no reprocessing plans would be very happy to see international arrangements for spent fuel storage and waste disposal, but they do not yet have any policy on sub-seabed disposal. Countries with serious national and budding international plans for nuclear energy, such as Belgium and India, will be hesitant to raise their disposal problems to the international level. Yet an international arrangement for at least waste disposal and perhaps even spent fuel storage beyond these borders could become an attractive option.

Since India is the LDC with the most developed nuclear waste management program, its policies on sub-seabed disposal can be expected to be very influential in Asia, Africa, and Latin America. But widely varying interests will be involved among other LDC's. Countries with nuclear energy programs, such as Brazil, Argentina, Mexico, South Korea, Taiwan, the Philippines, Pakistan and Iran, would probably be interested in an international waste disposal facility, but their re-

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[1] Interview held with L. Daleus (Information Secretary, The Royal Swedish Academy of Sciences), Woods Hole, Mass., 2 June 1977; since the power industry is one half state owned, there are serious public, as well as private, interests at stake.

[2] The recommendations of the British Royal Commission on Environmental Pollution report (Nuclear Power and the Environment) on the sub-seabed disposal will certainly be considered.

actions to sub-seabed disposal are largely unpredictable.[1] The Eastern European countries can be expected to oppose seabed disposal as long as disposal options are available in neighboring countries. Pivotal countries in the law of the sea negotiations, such as Mexico and Peru, will be highly skeptical of such use of the seabed. They can be expected to support its control by the proposed International Seabed Authority. Perceptions of the impact, if any, of sub-seabed disposal on the exploration of manganese nodules will be a crucial factor. Most LDC's will be interested only to the extent that there is some perceived impact on future resources. Crosscutting interests and commitments to nuclear energy development will also play a role in their policies. Many countries will not be interested one way or the other.

The general reaction of LDC's to use of the sub-seabed for radioactive waste disposal should be expected to be hostility. This will, however, be tempered by procedural, as well as substantive, aspects. If the sub-seabed disposal concept is introduced in its early stages--perhaps between 1978 and 1980--by organizations like the IAEA, IMCO, and UNEP, rather than later in its development by a few industrialized countries, there will be much less opposition. Such organi-

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[1] The IAEA estimates that 37 countries will have large commercial nuclear energy plants in operation by 1990, with about one half of these representing LDC's; M. Rosen, "The Critical Issue of Nuclear Power Plant Safety in Developing Countries" IAEA Bull. 19 (April 1977): 12. It is increasingly difficult to interest countries in international cooperative arrangements for waste disposal as they build up political and economic commitments to national waste management programs.

zations--or others--must have the international image of presenting expert and neutral opinions and of involving significant LDC participation. Absolutely crucial is the difference between a concept perceived as another very high technology use of the deep seabed by a very few industrialized countries, and one perceived as a legitimate, non-exploitive, and strictly peaceful use of the seabed open to many or all countries.

Since relatively few countries have the scientific and technological bases for conducting, or even confirming, a full seabed disposal R & D program, its acceptability or rejection internationally will also hinge on the process of gaining wide acceptance in the international scientific community, especially among nuclear, geologic and oceanographic scientists and engineers. An important aspect of this acceptability will be the degree to which clear procedures and opportunities are established for LDC participation in both the joint R & D effort and any actual disposal program. Despite the lack of widespread R & D capabilities in this area, the technology for actual emplacement--at least for the penetrometer-type methods--would be widely available. If by 1980 the sub-seabed disposal concept looks acceptable, the level of willingness of nations and international organizations to provide technical assistance in this area to the LDC's will be an important influence on their response to the concept.

Nuclear non-proliferation is not a cause that raises much excitement outside of a few countries. Yet the Soviet

Union, Eastern Europe, the U.S., Canada, Australia, and increasingly a number of LDC's and Western European countries (such as Sweden and Austria) would be much more receptive to sub-seabed disposal if it were part of a broader non-proliferation arrangement. Since the Carter Administration already seems to be trying to link the two, this could become a key to the international political acceptability of sub-seabed disposal--especially for the USSR, which is probably more interested in nuclear non-proliferation than any other country in the world. After all, why else should the U.S.S.R. be willing to help ease the nuclear waste disposal problem in the U.S. and Western Europe, when there is no presently apparent Soviet need to use areas beyond its own borders? Perhaps the only other reason would be Soviet interest in catering to a desire by many LDC's to take advantage of sub-seabed disposal. Excluding Eastern Europe, the LDC's projected to have operational nuclear power stations by 1990 are: Argentina, Brazil, Egypt, India, Israel, Iran, Pakistan, Philippines, South Africa, South Korea, Taiwan, Thailand, Turkey, and Yugoslavia.

The Response of International Organizations to Sub-Seabed Disposal: Hesitancy to Enter the Political Realm

Now that we have a sense of the U.S. and foreign political setting for a sub-seabed disposal program, it is necessary to turn to the international level. Little if any explicit policy on sub-seabed disposal should, in general, be expected for some time from the international organizations involved in nuclear energy. They will wait for further scientific and political development in member nations. Furthermore, they will generally be very hesitant to enter the political realm or to add to the growing perception that nuclear waste management is a serious problem.[1] Sub-seabed disposal presents a threat since it both obviously involves major policy issues beyond nuclear energy, such as law of the sea, marine policy, and environmental protection, which involve competition among the list of related international organizations, and it seems to acknowledge implicitly the growing international nature of nuclear waste management (and thus a further problem with nuclear energy use).

Despite the very conservative, often least common denominator, approach to policy-making in this area, we have seen that the International Energy Agency--through the Nuclear Energy Agency (OECD)--is sponsoring a joint R&D program on sub-seabed disposal. The NEA's approach seems to be towards conducting a low visibility program since there is no political consensus on the concept among the members. Since the NEA is not a policy oriented agency--and the IAE is, the political acceptance or rejection of seabed disposal by

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[1] There seems to be recognition, at least internally, by related international agencies, that the primary problems are social, political, and institutional, but the apparent belief that their organizations cannot become involved in such areas keeps them from participating in some of these important areas.

the industrial nations, as a group, will probably come from the IEA. IEA's reaction can be expected to rest on the success or failure of the joint R&D program. Despite the general problems with the IEA program on long-term cooperation in energy,[1] nuclear waste disposal is one of the biggest of the obstacles impeding the accelerated development of national energy resources which members have devoted themselves to removing. Additionally, France--while not an IEA member--is participating in the sub-seabed program through the NEA and the other European nations are extremely interested in and largely dependent on maintaining the nuclear option. Finally, the joint R&D program on sub-seabed disposal needs a broad multilateral forum to work from; as long as there is no formal agreement among participants, the IEA/NEA framework seems to be the only alternative. And it is probably preferable, at least temporarily, to a formal agreement since it makes it very easy for other countries and agencies to participate, or at least to be observers.[2]

Political responses from organizations such as the IAEA, IMCO and UNEP will be considerably more important in

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[1] See M. Willrich and M. A. Conant, "The Int'l. Energy Agency: An Interpretation and Assessment" A.J.I.L. 71 (1977): 222.

[2] Since the sub-seabed disposal concept faces the same general problem as the IEA, i.e., that it was brought into existence by, and still depends largely on, the U.S., a key measure of political success or failure will be the level of funding and effort devoted by other countries over the next few years.

the future since their membership is worldwide. Their views will include those of the LDC's and Eastern Europe. While UNEP and IMCO may be willing to tolerate new approaches to the waste disposal problem, the IAEA must be expected to be hesitant to do anything beyond including sub-seabed disposal on the list of possible future options. As long as the belief prevails that there is no technical waste management problem, i.e., that every nation with nuclear energy can manage the scientific and technical parts of disposal within its own borders, it is hard to recognize any need to look to the sub-seabed. There does now seem to be an acknowledged concern among at least some at the IAEA over the capability of each country to handle its own nuclear health and safety problems.[1] Yet just as with the NEA, we should expect the IAEA to quietly discourage major work on sub-seabed disposal unless a broader consensus of support develops among its members.[2] All such organizations will be strongly influenced by the responses of regional international bodies such as the (Eastern European) Council for Mutual Economic Assistance (CMEA), NEA, and CEC.[3]

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[1]See, generally, Rosen.

[2]Any perceived opposition, for instance, from the Soviet Union could prevent an active IAEA role in this area.

[3]The level of political influence of IMCO and UNEP remains an open question. If eventually regulated under the London Convention framework, sub-seabed disposal would be the responsibility of the IAEA, but IMCO would exert influence as the Secretariat for the Convention. The UNEP role depends on what level of involvement it is able to carve in nuclear energy. Its initial reaction to sub-seabed disposal

International agencies, like national governments, will also be influenced by the procedural aspects of political acceptance. Early notification and consultation with all the bodies likely to play a role will greatly enhance the political acceptance; surprises via last minute announcements will certainly increase any inherent opposition. Involvement of some organizations will lead to steps by others to prevent any such use of the sub-seabed.

Policy Implications of the Sub-Seabed Disposal of Radioactive Waste

Our past shortcomings in nuclear waste management are probably surpassed by our shortcomings in managing uses of the oceans. The 1970's have been a time of heightened awareness both of our abuse of the oceans and of the possible consequences of marine pollution for man and the environment. Despite this new environmental awareness, there seems to be wide public interest only in preventing pollution with direct, obvious impacts on man. Still prevalent is an attitude of "out of sight, out of mind" towards much of the open ocean pollution.

Yet, only a few years after we ended the ocean dumping of radioactive wastes and of old nerve gas, and started to restrict other dumping, we now have serious problems with

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can be expected to be at least highly skeptical, yet UNEP is clearly more willing than energy development related agencies to acknowledge the international nature of the radioactive waste disposal problem.

the disposal of such substances on land. Shallow land burial of even low-level radioactive wastes is, at least in its present form, clearly unacceptable on technical, political and institutional grounds.

Institutional Responses: Policies for Sub-Seabed Disposal of Radioactive Waste

Given our new thrust to protect the oceans, could we turn to some form of disposal of low-level wastes on the seabed? This is one of the alternatives to be considered by ERDA and the NRC.[1] In a form which would ensure isolation until the wastes decay to innocuous levels, the EPA is not ruling it out as a future option.[2] It is certainly not at all clear that this practice could ever be politically acceptable in the U.S. But if it does become U.S. policy, there will be a regulatory and political regime in place for radioactive waste disposal--by isolation--in the marine environment.[3]

With or without U.S. disposal of low-level wastes at sea, sub-seabed disposal of high-level wastes would require Congressional review and possibly amendment of the U.S. Ocean Dumping Act.[4]

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[1] See Chapter I, above.

[2] See Chapter III, above.

[3] One logical possibility might be to add a larger margin of safety by simply designing the containers to penetrate a few meters into the sea floor sediments.

[4] See Chapter III, above.

It is extremely difficult to predict the chances of such action, but it may be possible to establish some baseline requirements. The prospective Department of Energy (DOE), or whatever body assumes the responsibility for developing high-level/spent fuel waste disposal options, would have to accept, either on its own or with the urging of interest groups, the Congress, or other government agencies, sub-seabed disposal as a desired option. Independent evaluations by the NRC and EPA would have to confirm the DOE's acceptance. And strong overall backing from the other key executive branch departments and agencies, especially the State Department and the CEQ, would be essential. To date the NRC, EPA, CEQ and State Department seem to be withholding formal opinions pending the resolution of scientific and engineering questions.

But much more will be needed for Congressional approval. Sub-seabed disposal would have to be perceived, at least by key environmental groups--such as the Union for Concerned Scientists, the Sierra Club, the Environmental Defense Fund, and the Natural Resources Defense Council--and by other independent groups--such as the National Academy of Sciences, the American Physical Society, the American Society of International Law, and related foundation studies, as a new and different geologic disposal option which has been developed in an open and constructive manner. The procedures of developing legislation on sub-seabed disposal will be as important as substance for political purposes. Related interest groups and agencies must be involved as and when appropriate.

Is it possible to develop a sub-seabed disposal program acceptable to the congressional committees with the major jurisdictional responsibilities for the nuclear fuel cycle?[1] As the originator of the U.S. dumping legislation, we would certainly expect the House Merchant Marine and Fisheries Committee (especially the Subcommittees on Oceanography, and on Fisheries, Wildlife Conservation and the Environment) to make a large part of the determination of whether the law should be amended, interpreted, or otherwise adapted to permit the use of sub-seabed disposal. While the Oceanography Subcommittee might respond favorably to wide support from all the U.S. oceanographic institutions.(if that could be achieved), the Fisheries Subcommittee would probably be closely atuned to feelings of the leading environmental groups. In the only hearing to date which dealt directly with sub-seabed disposal, the House Sub-Committee on Energy and the Environment adopted a wait and see attitude. The only major concern expressed was that the concept did not involve any dilution and dispersal of radioactivity in the oceans. It is just too difficult now to predict the outcome, but it might not be an easy task, especially with congressional thrusts to phase out all major U.S. ocean dumping activities by the early 1980's.

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[1] It is almost impossible to be sure which committees would play the leading roles. The committees likely to play some role were outlined in Chapter III, above, p. 105.

The Need for Public Scrutiny of R & D on Sub-seabed Disposal

In view of the public attitudes and political implications of radioactive waste disposal programs, it is absolutely essential to conduct the sub-seabed disposal program in a completely open fashion, especially in the U.S. Even further, initiative must be taken from the inside to explain and discuss ongoing research efforts with a variety of groups at all stages of development.[1] A key goal should be the prevention of any surprises or misunderstandings. Given the highly controversial nature of the concept and the already established mystique surrounding the deep ocean, this openness is doubly important. But it will also be difficult; this type of process is highly suspect within the scientific community and elsewhere, and even careful explanation of such a program will sometimes be interpreted as advocacy. One way to tread the fine line between openness and advocacy is through the frequent use of independent review groups which provide recommendations for program participants, funding agencies, key congressional committees,

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[1]It could be very useful to set aside funding devoted not to public relations but rather to public understanding of the research efforts. Even the individual researchers in such a program could productively apply a limited part of their time to informal research reports for interested citizens' groups. When we consider "A Second Survey of Public and Leadership Attitudes Toward Nuclear Power Development in the United States," by L. Harris & Associates, Inc. for Ebasco Services, Inc., November 1976, it is clear that scientists inspire by far the most public confidence on matters concerning nuclear energy. Crucial, of course, is both that the scientists reach a consensus on these matters and that they remain very weary about comments on questions beyond their fields.

and the public (to the extent that the press, and program participants and their sponsoring universities and institutions can gain full release and wide circulation of such review results beyond only the intra and inter-agency and committee level).

Other Policy Implications of Sub-Seabed Disposal

A further necessity is the early inclusion in the planning for sub-seabed disposal of socio-economic, political, legal, and institutional research efforts. The U.S. NEPA (of 1969) requirement for an inter-disciplinary approach with "the integrated use of the natural and social sciences" must be fully met in all attempts to develop high-level waste management options. This should involve the use of all available public opinion data on radioactive waste management and, eventually, the taking of opinion data on individual disposal options and comparative assessments.

Research efforts in these areas have already made it clear that the radioactive waste management problem, including sub-seabed disposal specifically, must now be fully considered as a part of establishing overall nuclear policies. This is especially the case for spent fuel management. A further policy implication which has surfaced involves the pacing of parallel technical and political research efforts: the establishment of sub-seabed disposal of radioactive waste as a policy option should not rush ahead of scientific and technical validation efforts; and sub-seabed disposal, on the other hand, should not be ruled out on political grounds before there is opportunity to test its scientific and technical validity as its ultimate political acceptability and public concerns are answered.

The Political Pressures on Sub-Seabed Disposal:
A Summary

The overall state of national and international policies toward sub-seabed disposal are clearly inadequate at this time for effective implementation of a rational sub-seabed disposal program for radioactive waste. Research is far enough along on nuclear waste disposal possibilities to justify at least a serious start towards setting out policy priorities and decision criteria for this concept. Even in the U.S. there are few policy-makers who understand the waste disposal problem, especially the international implications, and the possible options. And this falls far short of having a balanced understanding of the positive and negative aspects of each disposal possibility under serious study.

At least waste management is understood to be a serious problem--with major social and political implications-- in the U.S. This is not the case in many countries and some international organizations. Governments, generally, and the specifically related international agencies, should be preparing to evaluate radioactive waste disposal options on the basis of carefully established priorities and criteria. Priorities should, for example, be assigned to:

1) the long-term development of nuclear energy relative to that of alternative energy sources, based on factors that include radioactive waste management; and
2) the level of attention to be devoted to waste management relative to other parts of the nuclear production process.

Criteria for evaluating waste disposal options must include:

Technical--

1) Environmental predictability (geologic stability--aseismic, unfractured, and not affected by future glacial upheaval, as based on a long, uniform record of past stability);
2) High absorption and low transmission or dispersal rates of radionuclides of interest by surrounding geologic media;
3) Very low probability of any future intrusion into the surrounding media by ground water;
4) High resistance of media to local heat sources; and
5) Minimal disturbance of natural media by waste emplacement technique.

Social--

1) Very low existing and future resource potential;
2) Maximum physical isolation from unintentional and intentional human intrusion;
3) Minimal or no active security or management requirements over the long-term (including resistance to changes in political systems);

4) Resistance to or isolation from effects of potential future warfare;

5) Minimal socioeconomic costs, especially risks such as those associated with transport and handling operations; and

6) Adaptability to use of many disposal sites to minimize consequences of failure at any one site, and complementary to possible use with other disposal techniques (e.g., may handle certain wastes which cannot be handled by other methods).

Sub-seabed disposal must be evaluated politically by governments in the context of all available possibilities for managing nuclear wastes. It would be preferable to have this comparative evaluation follow careful individual assessment of the sub-seabed concept, and other options, but countries will offer real support only if it is perceived to be necessary for national wastes, industries, or other clear interests. And sub-seabed disposal could eventually receive more emphasis than it merits from countries with no other choice.

Assuming technical feasibility and desirability, it remains too early to determine if it is politically feasible to bury high-level wastes within the deep seabed. The most important initial decisions must come from the U.S. Early foreign and international political responses--which have been mixed--will influence U.S. policy. Whether or not American support of sub-seabed disposal would influence many other nations depends on future events in law of the sea, general nuclear policy, and nuclear non-proliferation efforts. Pending the development of national and international policy on whether, where and for how long spent nuclear fuel will be stored and/or reprocessed, it is at most possible to state that sub-seabed disposal does not seem to be ruled out--for now--on political grounds.

This is certainly an area of scientific and technological development where the final--and many of the interim--decisions must be based on policy considerations. As a minimum, careful and comprehensive political management is required. Prevention, through policy and law, could also prove necessary. If decisions are made, by default or otherwise, to keep the sub-seabed option open, early consultation with a large number of governments and agencies will be essential. The alternative of such consultation is a sub-seabed disposal option which may be technically acceptable but politically unworkable. Much of the political response will be determined by the extent to which appropriate institutional arrangements are available as development progresses. Sub-seabed disposal cannot be politically acceptable without a reliable international management structure.

CHAPTER VI

BEYOND LAW AND POLITICS - ETHICAL CONSIDERATIONS FOR THE SUB-SEABED DISPOSAL OF RADIOACTIVE WASTE

A start has recently been made towards analyzing some of the ethical issues involved with the management of radioactive waste.[1] Yet a much broader public discussion is clearly necessary, especially on the individual and comparative aspects of all high-level waste disposal options. Most of the issues raised here are specifically focused on sub-seabed disposal, although some will be important for other disposal methods as well.

Although quite difficult to assess for the sub-seabed disposal of radioactive waste at this early stage of development, there are several ethical considerations which should be introduced. Even if all technical, political, and legal problems with sub-seabed disposal are solved, these consider-

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[1] See, generally, Proc. of Conference on Public Policy Issues in Nuclear Waste Management, especially D. E. Abrahamson, "Social, Ethical and Moral Issues in the Implementation of Radioactive Waste Management Objectives," p. 221; Proc. from a Workshop on Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, ORP/SCD-77-1 (Wash., D.C.: U.S. EPA, 1977); and Proc. from a Workshop on Policy and Technical Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, (Wash., D.C.: U.S. EPA, 1977).

ations will remain. While they merit much more attention and development as the research and development on sub-seabed disposal proceeds, the goal, for the moment, is only to raise three of the important considerations or questions and to help set the framework for addressing them.

One general comment seems to be necessary. The now often applied mechanism of comparing the risks assumed in nuclear energy with other commonly assumed risks can be misleading and confusing. At some point the application of such scientific methodology must give way to, or at least be heavily influenced by, the feelings and reactions of the people assuming the risks. This may be particularly true for nuclear waste disposal as opposed to say reactor safety, since the preponderance of nuclear wastes (by activity level) remains in storage and there is still a clear choice about how and when final processing and disposal will occur. If all the disposal options seem to be too chancy, then it is still possible to conduct further testing, or even to investigate new possibilities--an option which should be an acknowledged choice. This must include the possibility that one or even several disposal options are considered to be adequate by the experts, but are rejected by a large segment of the population.

Certainly the first consideration for sub-seabed disposal is whether we can consider as reasonable behavior the permanent commitment of areas of the "international" seabed or commons as nuclear waste disposal repositories. Regardless of the past record of abuse of the oceans and the basic legal right of nations to use generally of the commons, we should consider that sub-seabed disposal would involve transferring some of the risks associated with radioactive wastes from the countries deriving the benefits from nuclear energy to others which gain few or none of the benefits. This consideration might not be a problem for a widely accepted sub-seabed disposal program in a form perceived as a legitimate use of the commons by many countries. But it could be very troublesome for a program proposed by either one or two nations, or even by several nations, in a form found unacceptable to the leading nations in the scientific fields of radioactive waste management and radionuclide behavior in the marine environment. As a bare minimum there should certainly be no mere transfer of the hazard from national to international areas, i.e., sub-seabed disposal should be the best option for all or part of the disposal problem associated with the proposed class of radioactive wastes.

The central aspect of this problem of making permanent commitments in the commons is that many LDC's still pin strong economic expectations to the prospective resources of the deep seabed. It is essential to consider that any perceived threat to what they believe to be "international" resources will be taken very seriously. Considering the relatively small size, however, of the deep seabed areas which would be required for sub-seabed disposal, the potential problem would likely be one of perceptions. Given early and careful attention, the problem of perceived threats to future resource exploitation could be largely a matter of explanation and consultation with countries on the specific nature of the sub-seabed disposal concept. As already noted above, it will be important to work closely with international agencies trusted by the LDC's in this explanation and consultation process.

A second question arises from the international and nearly permanent commitments involved with the radioactive waste management problem in general, and the sub-seabed disposal concept specifically. Would the use of sub-seabed disposal help or hinder the serious need to protect nations from other nations' radioactive waste disposal practices and future generations from the practices of existing populations. And, as part of protecting other nations, would the use of sub-seabed disposal, as opposed to other methods, help control the international spread of nuclear weapons production capabilities? These answers would hinge, at least in part, on the form in which sub-seabed disposal were carried out. Given that an acceptable sub-seabed program seems to require fairly broad multilateral participation,[1] it might eventually involve a greater degree of international oversight and control over radioactive waste (including spent reactor fuel) than land-based programs. In this sense,

[1] See Chapters IV and V, above.

sub-seabed disposal may provide more effective worldwide protection for other countries and future generations than the situation where each nation did its own radioactive waste disposal, or where a few nations conducted a joint land-based disposal.[1]

Another aspect of protecting existing and future generations from the danger of radioactive wastes is that of long-term management. It seems to be widely accepted that the least possible dependence on social institutions is best for radioactive waste disposal options.[2] This means that we should compare the sub-seabed concept with those on land on the basis of the least long-term needs for operational and physical security management, i.e., which options provide the most complete and assured isolation from man? Sub-seabed disposal would seem to rely more heavily on international institutions over the period of active monitoring and surveillance; it would also seem, due to the remoteness of the deep seabed, to rely less on institutions overall than land-based methods. Sub-seabed disposal would pro-

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[1]This is based on an assumption, similar to that implicit in M. Willrich, "Radioactive Waste Management and Regulation," Report to the U.S. ERDA (Cambridge: M.I.T. Energy Lab, 1977), that international review and approval, by some form of international body (Willrich recommends a radioactive waste commission to be established under the IAEA), of all nations' radioactive waste disposal practices will ensure safer disposal.

[2]See, generally, Proc. of Conference on Public Policy Issues in Nuclear Waste Management; Proc. from a Workshop on Environmental Protection Criteria for Radioactive Wastes; and Proc. from a Workshop on Policy and Technical Issues of Environmental Protection Criteria for Radioactive Wastes.

bably require very little, if any, operational or physical security management over the long-term.

A final consideration is whether or not--or to what degree--final radioactive waste disposal options should offer retrievability beyond the pilot plant stage. If we end up with direct disposal of spent reactor fuel, it may be important to have some minimum level of difficulty in retrieval to protect against unauthorized recovery for reprocessing and possible weapons production. Sub-seabed disposal would probably provide at least this level of difficulty.

A strong case can be made, however, that our minimum debt to future generations includes the option to correct our errors, i.e., to have retrievable disposal options. In this author's view, this should be based, at least in part, on the assumption that future generations will have even greater scientific and technological capabilities than those now available. While leaking canisters could--depending on the depth and method of emplacement--probably be recovered from the seabed, by present standards, it would be a costly and difficult operation. Since sub-seabed disposal thus constitutes an option which should perhaps be considered as final beyond the pilot plant stage, it creates a problem for any retrieval requirement.

Yet there seems to be a consensus developing, at least in the U.S., that we should now assume most of the responsibility for solving the radioactive waste disposal problem that we have created, including the minimization of the time between creation and disposal of all wastes.[1] In carrying out this responsibility for disposing of radioactive wastes, the possible need to assume finality for sub-seabed disposal may become a key part of the isolation or "technical irreversibility" criteria for radioactive waste disposal. It now seems that a lack of ease of retrieval--along the lines of the technical irreversibility criteria analyzed in Chapter V, above--may be one of the requirements for the most effective possible disposal. This could involve the use of disposal options that are not easily retrievable after the pilot plant stage. We may thus have to make some crucial trade-offs between the best possible final disposal method for long-term isolation and containment, and the ease of retrieval.

Summary

There are two distinct overall perspectives, based on these ethical considerations, that may be adopted towards the sub-seabed disposal of radioactive waste. It may be perceived as a potentially dangerous and inequitable use of the commons. It would certainly involve some level of hazard to a common area from the nuclear trash created in the

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[1] Ibid. The indefinite delay of spent reactor fuel reprocessing and plutonium recycle in the U.S. will, however, necessarily lengthen the period of time between removal of spent fuel rods from reactors and final disposal.

most advanced industrial and developing countries. Yet many of the LDC's which might most justifiably view it in this manner are also the ones aspiring to the use of nuclear energy for future economic development. It is thus difficult to predict their reactions.

Sub-seabed disposal, on the other hand, may also be viewed as a potential guarantee that man and the environment will be protected from the individual disposal practices of many countries, especially those which do not appear to have suitable local disposal options. This, of course, assumes some acceptable level of multilateral management and oversight. In this sense, sub-seabed disposal may be considered to be a very positive use of the commons to protect other countries and generations from our major international environmental and security problem.

CHAPTER VII

THE INSTITUTIONAL POSSIBILITIES FOR THE MANAGEMENT AND PREVENTION OF SUB-SEABED DISPOSAL OF RADIOACTIVE WASTES

Many of the existing and potential institutional frameworks of possible use for managing or preventing sub-seabed disposal, especially as related to the legal and political aspects, were considered in Chapters III, IV and V. International organizational aspects were emphasized. These institutional frameworks are tightly entwined with the political and legal aspects.

While adequate structures for implementation of an international sub-seabed disposal program are lacking, there are useful regulatory and supervisory mechanisms that could help provide guidance. The task at hand is to investigate the ways in which these existing mechanisms, or new ones, can be developed on a parallel basis with the science and technology. One means of such structuring is to consider the feasible scenarios, or management models, under which a sub-seabed disposal program might be conducted.

Possible Management Models for the Sub-Seabed Disposal of Radioactive Waste

The possible management models for sub-seabed disposal can be derived from a matrix which is based on:

1) the key characteristics of the institutional framework through which any such program would be implemented; and 2) the likely actors (Figure 13). Movement from left to right in the table represents increasing levels of international management and control.

Four possible management models result for a radioactive waste disposal program in the sub-seabed (Figure 14). The first (Model 1) involves the possibility that some form of sub-seabed disposal would be organized, operated, and regulated along private corporate lines (with significant governmental regulation). The second (Model 2) is heavily governmental in nature, with some influence from internationally established standards and regulations. Next (Model 3), is a regional plan with joint financing, development, and regulation coordinated by an international body. Finally, there is an international structure (Model 4) that would make use of political and geographic international regions to coordinate joint development, regulation, and control of a sub-seabed disposal program.

The models are complementary. It is quite conceivable, for example, that some form of corporate participation could be included in Models 2, 3, or 4. Moving from Model 1 toward the greater levels of international participation in Models 2, 3, and 4 should increase the probability of effective regulation and enforcement. It is impossible, however, to rule out responsible unilateral action.

MODEL 1

Unilateral or joint action in a corporate--Model 1--form must be expected to include a significant level of governmental regulation and responsibility. In most countries the government is not only responsible for high-level radioactive waste management but also for part or all of the electrical generating industry. Most likely would be the possibility of an intergovernmental agreement establishing contracts for several corporations jointly to operate a sub-seabed disposal site. This could be for wastes from spent fuel reprocessing, spent fuel, or other radioactive wastes, such as those contaminated with transuranic constituents.

Model 1 may offer the quickest and most effective way to operate such a disposal arrangement. EURODIF, the multinational company formed under French law by French, Belgian, Italian, Spanish, and Iranian entities for building a nuclear fuel enrichment plant, is an example of an arrangement which is primarily corporate in nature. While the five partners are either private companies or semi-independent government agencies, the management regime is strictly a corporate--Board of Directors--arrangement without an associated governmental committee.[1]

But the corporate model is the least likely--and pro-

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[1]See, for example, IAEA, Regional Nuclear Fuel Cycle Centre Study: Institutional--Legal Framework Aspects (Vienna: IAEA, 1976), p. 10.

bably least desireable--means of managing such an operation, especially for high-level radioactive wastes. For ethical, social, political, legal, institutional, and technical reasons, governments and international agencies will probably demand at least the level of involvement offered in Model 2.

MODEL 2

A governmental management structure--Model 2--for sub-seabed disposal is just as unlikely as a corporate one on a unilateral basis, but it is much more likely in a bilateral or multilateral form. This would correspond with the usual form of European technological collaboration and with most CEC/EURATOM, NEA, and IAEA efforts in cooperation on nuclear energy development and regulation. Some regional and international guidelines or regulations are applied--as in the NEA dumping operations, but operational and financial aspects are heavily governmental in nature. Though profitability decreases--or even turns into a deficit-based operation--corporate participation is still important.[1] Eurochemic--the joint venture by thirteen NEA members for establishing a nuclear fuel reprocessing plant--and URENCO--a joint European project on uranium enrichment--are examples of arrangements involving both intergovernmental agreements and private enterprises. Both incorporate elements of Models 1 and 2.

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[1] See University of California Berkeley (Institute of International Studies), "Non-Proliferation and Nuclear Waste Management," a report for the U.S. Arms Control and Disarmament Agency, Berkeley, 1977, pp. 156-158.

The governmental management model is generally quite easy to establish relative to Models 3 and 4. The problem is that the regional international, and especially broader international, involvement in sub-seabed disposal appears to be essential for political acceptance and adequate legal control.[1] Although there must certainly be strong governmental participation in any arrangement of this type, Model 2 would seem to leave far too much discretion to individual countries.

Model 3

Model 3, regional coordination, offers a range of medium to high levels of international control. It would be relatively difficult to establish, but could allow substantial international oversight. Under this model, strong national governmental roles would work within the bounds set by intergovernmental agreement and a small international institution. Both the CEC/EURATOM Treaty provision on international oversight of national radioactive waste disposal practice and the potential NEA role in the annual ocean dumping operations provide examples of the regional model.[2]

While such regional arrangements provide important operational, regulatory, and enforcement roles for an international body, sub-seabed disposal may require the involvement of a broader sampling of the international community.

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[1]See Chapters IV and V, above.

[2]See Chapter IV, above.

The CEC/EURATOM Treaty covers national plans for high-level radioactive waste disposal within national borders. The pending NEA agreement on ocean dumping involves national disposal of non-high-level wastes in international areas. Sub-seabed disposal would necessarily require a major step further than either of these, with high-level waste disposal in international areas. Stronger oversight by institutions representing most or all countries would be necessary since the seabed is available equally to all.

Model 4

An international management structure--Model 4--is thus very desireable. Its advantages and disadvantages are generally the opposite of those offered by a corporate arrangement. We must expect slow, inefficient action--at least in the R & D stage--with a great difficulty in negotiating national acceptance of relatively strong international agency powers. Until political, legal, and institutional commitments were quite clear it would be nearly impossible to establish financial and contractual agreements. Responsibility and liability for all long-term operational and financial aspects would have to be very clear from the start.[1] Implementation, in a tightly controlled international form, could be a long and cumbersome process.

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[1]See Chapter I, above; Eurochemic serves as a stark example of the consequences of not firmly establishing final radioactive waste management responsibilities in advance. A major burden can be placed on the host country or, in the case of an international area, on a commonly shared environment without anyone who must take final responsibility.

Model 4 is, on the other hand, quite adaptable to the use of a structure with elements from other models, especially governmental and regional management. It could be effectively combined with aspects of Models 1, 2 and 3 for use under a broader international plan for international storage and/or disposal of radioactive waste and spent fuel. It could also offer an opportunity to take advantage of important corporate and governmental capabilities while maintaining strict international oversight. One example might be the International Telecommunications Satellite Consortium (Intelsat), which was established on the basis of an American public company, Comsat. This broad international arrangement, based on an intergovernmental agreement, provides for hired contractors to perform various key roles.[1]

While Model 4 should appear to be clearly different from Models 1 and 2, it should be emphasized that it is also quite distinct from Model 3. The membership of Model 4 is necessarily most of the countries of the world, including, for example, at least all members of the IAEA, as contrasted to the regional membership of Model 3. The use of some funding from, and all applicable standards and regulations set by the IAEA and UNEP are particularly important distinguishing aspects of Model 4.

An incremental approach--starting from a lower level of governmental commitment such as Model 3--to developing a management structure resembling Model 4 is possible. It could be started, for example, with a regional international spent fuel storage arrangement and developed into a full

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[1]See IAEA, Regional Nuclear Fuel Cycle Centre Study, App. B, p. 4; and University of California, "Non-Proliferation and Nuclear Waste Management," pp. 157, 158.

scale international storage and disposal operation. But firm governmental, regional, and international financial and operational responsibilities would still have to be established at the outset, especially for final waste disposal, in order to avoid possible repetition of the Eurochemic experience with unclear and unsettled waste disposal responsibilities. A specific version of Model 4 for the sub-seabed disposal of radioactive waste will be recommended below.

Since the type of model used for the implementation of a sub-seabed disposal program could be expected to determine the potential for effective oversight and enforcement, the major function, in general, of all countries and international bodies in the non-technical areas of a sub-seabed disposal program as the implementation stage approaches should be expected to shift from opposition to support as the models shift from 1 to 4. For purposes of protecting the marine environment and ensuring isolation of the wastes it would be crucial to incorporate enforcement aspects from Models 3 and 4 to the maximum possible extent.

The Existing Situation: Basic Radioactive Waste Disposal Options Available to Countries and the Possible Roles of Sub-Seabed Disposal

Countries which are either concerned about nuclear non-proliferation and the international aspects of radioactive waste disposal or are unable to develop local solutions to their low, medium or high-level waste problems will face three options for the location of final disposal repositories: 1) in other countries with nuclear energy programs (probably

in a nuclear supplier state);
2) in countries without nuclear power programs; or
3) in some special international area, such as an island placed under international control or the sub-seabed. Any of these could occur through an international arrangement in the form of Models 3 or 4. But if spent fuel storage or disposal is involved, option 2) above might be ruled out on nuclear non-proliferation grounds. And option 3) above would probably require joint implementation with option 1), or with some other arrangement for interim storage of spent reactor fuel.

It would seem reasonable to have the country which supplied or reprocessed the fuel provide for final disposal. Yet these are the countries, generally, which face the most developed opposition to nuclear programs. Their populations are especially sensitive to the possibility of being a disposal site for other countries' wastes. Opposition to nuclear programs continues to transfer rapidly among countries. This has been highlighted lately by the refusal of reprocessing nations to accept, or to plan to accept, the resultant wastes. The Japan-U.K. contract[1] provides that a future British government can decide to return to Japan the wastes arising from the reprocessing of spent Japanese fuel; Belgium and West Germany have recently given indications that they plan to return all waste, if they ever reprocess foreign spent fuel.[2] Local, state, and congressional opposition in the U.S. might allow the storage of foreign spent fuel rods,

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[1]See, for example, S. Bonney, "Windscale--Power versus Pollution," Marine Poll. Bull. 8(1977): 7.

[2]Some of these indications were given during interviews of various Belgian and West German officials and experts which were held in Europe in October 1976 as research for the report by the Univ. of California, Berkeley, "Non-Proliferationa and Nuclear Waste Management."

as part of a broad nuclear non-proliferation plan, but the disposal of high-level foreign wastes is a considerably more difficult political problem.

The second option, disposal in countries without nuclear programs, might be arranged given sufficient economic incentive. But it raises serious questions regarding enforcement of strict radioactive waste disposal standards, international political responses, ethical norms for risk taking (should a government of a nation without weapons or electricity from nuclear sources assume the long-term risks of final disposal, saddling later generations with a burden for which they have received no benefit?), and international security (especially if the waste is spent fuel rods in retrievable form). There may be a few locations, such as Western Australia (Australia does have a uranium export trade), with some possibility for meeting at least some of the acceptability criteria for a final disposal site, as outlined in Chapter V, above.

Disposal in an international area presents the same issues as option two, with special stress on enforcing strict scientific, technical, and environmental standards.[1] Yet sub-seabed disposal may not be as much of a political and ethical problem as option two. We know, however, from the

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[1]Although in at least one case--Taiwan (See Chapter I, above)--island disposal of radioactive wastes is planned, this appears to generally be inadvisable from at least the geologic and hydrologic viewpoints. But islands placed under some form of international arrangement for the multilateral storage of spent fuel could be used effectively in combination with final disposal in the sub-seabed. Sub-seabed disposal could well require a prior international arrangement for spent fuel storage.

past record of marine disposal that there is still a strong "out of sight, out of mind" tendency to be overcome. The crucial problem for use of the seabed is gaining acceptance of strict international supervision. It might be possible to seek agreement now on an arrangement to store spent fuel in the U.S. and U.S.S.R. which would depend on the use of a combination of land and sub-seabed sites for later disposal. This would require early establishment of responsibilities and methods for final disposal of all radioactive wastes (including all stored spent fuel).

The key step at this point is to integrate the sub-seabed disposal possibility into ongoing and future studies of international spent fuel storage regimes. It is now very clear that neither radioactive waste management nor nuclear non-proliferation (in the horizontal sense, i.e., controlling the further spread of nuclear weapons production capabilities) will be addressed by any single plan or arrangement. Both are complex international issues, but solutions to both issues may be simplified somewhat by the use of overlapping institutional arrangements. Use of sub-seabed disposal, for example, in a Model 3 and 4 form could involve prior land storage of spent fuel, coupled with economic incentives and strong diplomatic pressure not to reprocess spent fuel. The problem of developing strong international oversight for sub-seabed disposal would be partially solved by its integration with prior international storage of spent fuel. Or, national policy permitting, foreign spent fuel returned to the supplier state under some international arrangement could be processed and shipped for disposal as soon as disposal was possible.

The Existing International Cooperative Framework for Sub-Seabed Disposal of Radioactive Waste

The institutional situation of international cooperation for sub-seabed disposal is still quite rudimentary, although a small international cooperative structure has been formally established. Based on a request of the NEA's Radioactive Waste Management Committee from its first meeting (October 1975), the First International Workshop on Seabed Disposal of High-Level Wastes was held (February 1976) to determine the research and development requirements for assessing seabed disposal of radioactive waste. Four working groups, with scientific and technical representatives from Australia, Canada, France, West Germany, Japan, the U.K., U.S., and the IAEA, NEA, and Commission of the European Communities, established a detailed proposal for an international, interdisciplinary research program on the feasibility of seabed disposal.[1]

At the Second International Workshop (March 1977) a Seabed Working Group was set up, under the NEA's Radioactive Waste Management Committee, with one representative each from

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[1]See D.R. Anderson, et al., eds., Report to the Radioactive Waste Management Committee on the First International Workshop on Seabed Disposal of High-Level Wastes, Woods Hole, Mass., February 1976 (Albuquerque, N.M.: Sandia Laboratories, 1976).

Japan, France, the U.K., and the U.S. The representatives are, in general, administrators with scientific backgrounds. They represent the U.S. ERDA, the French Institute of Nuclear Protection and Safety, the British Atomic Energy Research Establishment, and the Japanese Marine Science and Technology Center.

Seven task groups, with at least one scientist from each country, were formed to study the site selection criteria, systems analysis, the water column, the biology, the sediments and rock, the disposal container, and the most desireable form for the radioactive wastes. Task group leaders were assigned to coordinate oceanographic and engineering information exchange, workshops and planning sessions, the study of geographic areas near each country, cooperative cruises and experiments, sharing of samples and equipment, and the study of international policy issues. The program's ultimate goal is the establishment of one or two multilateral disposal sites. This is to be coordinated with the plans of national sub-seabed disposal programs, such as the U.S. plan to have a sub-seabed disposal pilot plant by 1990 and the British plan to have some operational disposal plant by the year 2000.

The extent to which significant joint research efforts, as opposed to only coordinated individual national efforts, are conducted will be largely dependent on the level of priority and funding established by each nation and the development of a mechanism, probably through the NEA, for jointly funded efforts. Major increases in the U.S. ERDA Seabed Assessment Program funding level have occurred since its inception in 1973 and more are planned. France has apparently started a national sub-seabed disposal program--along the lines of the U.S. Program in its earlier stage--with a thrust toward international cooperation. And Japan and the U.K. are apparently establishing national programs, with the flexibility to conduct research through the international program, but the specific funding commitments are still pending.[1]

The formal agreements between the NEA and the four participating countries (as NEA members) provide an adequate basis for this stage of the cooperative research effort. The question to be addressed is what the International Energy Agency(IEA)(policy-oriented)--NEA (technical development-oriented) framework for energy R & D can and cannot provide in the future.

Institutional Possibilities for International Cooperation on the Investigation and Implementation of Sub-Seabed Disposal

IEA and NEA goals and perspectives are limited. Cooperation on radioactive waste management is conducted within the broader framework of solving a problem that inhibits nuclear energy development, without the inclusion of significant emphasis on environmental protection and non-proliferation needs. Closely associated with this problem is the

[1]See University of California, "Non-Proliferation and Nuclear Waste Management," pp. 159-177.

apparent NEA attitude that it does not really matter if each country establishes its own criteria and standards for radioactive waste management without international oversight.

Furthermore, the direct involvement of the NEA, as sponsoring and now as oversight agency, in the still controversial annual European ocean dumping of radioactive waste lays it open to criticism from various key countries. The U.S.S.R., Denmark, Sweden, Portugal, and Canada are particularly concerned about this practice. One possible result of the NEA--ocean dumping linkage is the refusal of some countries on internal political grounds to become formally associated with the international research program on seabed disposal. Furthermore, this linkage aggravates the problem of building public understanding of the difference between disposal concepts based on dilution and dispersal and those based on isolation and containment.

The U.S. role as an initiator and supporter of new ideas and projects is important to both the IEA and NEA. The recently acquired (1976) full NEA membership offers an opportunity for the U.S. to promote joint investigations and projects. But the fears and hesitations induced among other countries by U.S. law and policy on open meetings and information flow are often an obstacle to the development of joint programs through the NEA.[1] Drives to protect national nuclear

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[1]See University of California, "Non-Proliferation and Nuclear Waste Management," pp. 159-177.

energy programs and commercial objectives, especially patent arrangements, make progress on cooperation in some radioactive waste management areas (such as the solidification of high-level waste from spent fuel reprocessing operations) very difficult.

There could be significant regulatory capabilities available if the new NEA oversight mechanism for ocean dumping is established. This would go beyond Model 2--approaching Model 3--capabilities in a form which might provide some precedent for the supervision of sub-seabed disposal. The direct application of international guidelines from agencies such as the IAEA and UNEP, and procedures for consultation and observation by any interested countries and agencies would have to be strict requirements of such an arrangement. Although this approach should only be a back-up for a broader international effort, it could provide a reasonable means for supervising a more limited international storage/disposal program with about five to eight participating countries.

Prevention or management on a broader international scale will almost certainly have to be conducted through, or in close cooperation with, structures established under the

IAEA, UNEP, and any future International Seabed Authority. The law of the sea negotiations are still so unsettled that it is unwise to include its proposed Authority in present plans. Strong initiatives from individual countries would probably be required to induce the necessary level of action by the IAEA and UNEP.

These considerations strongly suggest that the implementation of a sub-seabed disposal program could be prevented or delayed by various national and international legal and policy means. All of the earlier examples of marine disposal practice showed the growing trend toward unilateral, regional, and international action to prevent the disposal of hazardous wastes in the oceans.

If the definition of ocean dumping as interpreted or as established under international treaty law, or as it emerges in persuasive form from even incomplete negotiations, eventually covers sub-seabed disposal, the implementation of the concept could be legally banned, at least for all Parties to the London Convention of 1972. Implementation of an acceptable sub-seabed disposal program at a later date might be possible under the London Convention/IMCO/IAEA framework. If dumping is not interpreted to cover sub-seabed disposal, implementation could occur under various institutional frameworks. Action could be banned or regulated and controlled under a later UN conference on the law of the sea or under an international agreement specifically focused on the sub-seabed disposal of radioactive waste. This latter possibility would also allow agreement to ban the use of sub-seabed disposal (especially in the form of Models 1 or 2) pending future consensus by all concerned nations, or some specified majority, that this would be a safe, necessary, and acceptable use of the deep seabed. This might be accomplished through use of the ban on national appropriation of deep seabed areas or through interpretation of the definition of marine pollution to prohibit this type of action, pending the development of an international consensus on its acceptability.

It seems that a sub-seabed disposal program along the lines of Models 3 or 4 could be effectively supervised by groups of national governments, regional organizations and broader international organizations. The key ingredient is serious concern among nations over marine pollution, high-level radioactive waste disposal, nuclear non-proliferation, and deep seabed management problems which cannot be confined to national effects. This must include incorporation in any regime for sub-seabed disposal, of all widely accepted basic international law principles and rules for use of the deep seabed.

National and international research and development efforts can continue in the interim since, as in the U.S., cooperative agreements do not tie nations to participate in the implementation of a concept which the research will not support. Implementation of an international sub-seabed radioactive waste disposal program with safety, health, non-proliferation, and other safeguards would require levels of international cooperation unprecedented in the specific area of radioactive waste management. Yet the basic expertise and structures for supervising such a cooperative program either exist or are within reach--given sufficient priority on their development--over the next five to ten years. And since the pressure and priority on radioactive waste management have only very recently been established, it is not unreasonable to expect considerable development of international cooperation in this area over the next few years.

The central problem would be reaching agreement among participating countries on essential provisions. A significant portion of a draft treaty could be derived from work done by Hydeman and Berman in 1959-1960[1] and by the Bryniels-son and Rousseau panels under IAEA auspices from 1959 to 1963.[2] These efforts led to some of the most technically, legally, and politically acceptable recommendations ever made in the area of regulating and controlling low-level radioactive waste disposal into the oceans. They include provisions for national and international registration of all disposals, prior notification and consultation with affected nations and appropriate international agencies, and national and even international licensing of disposal sites and practices. They would establish independent authority for the IAEA to investigate and object to intended practices, assist nations with negotiations, site evaluation, and regulation and monitoring, monitor disposal sites and operations, and initiate certain penalties or sanctions.

The IAEA offers the broadest membership base and mandate for tackling the regulation and supervision of an international sub-seabed disposal program. It is also constrained

[1]See Chapter IV, above.

[2]Ibid.

by the political positions of the less-developed and Eastern European countries. And a major revision of its role in radioactive waste disposal at sea, beyond the newly assumed one of taking on what is considered to be the normal level of IAEA activity in nuclear safety and environmental concerns, i.e., preparing various codes and guides, would be required. Annual meetings and occasional panels for model criteria and standard development are important, but extremely limited devices. If the IAEA development process waits for further development of national programs, there will be no real input of social, institutional, legal, or even international political aspects. One national commitments are made to specific techniques it is extremely difficult to formulate international mechanisms for development and regulation. At heart it reduces to a question of either waiting for individual nations to act and then having the IAEA coordinate discussion about past activities, or, alternatively, acting early so as to have a role in the formulation of plans and policies. The former characterizes past activity on ocean disposal; the latter seems a suitable role for the future.

IAEA success by 1978 in the development of acceptable international regulations on radioactive waste disposal at sea could provide an important model for future multilateral standard setting in waste management. IAEA efforts in radioactive waste disposal at sea are particularly useful for sub-seabed disposal since the scientific and regulatory guidelines are universally respected,

and since all related regulations

formally accepted by the IAEA become international legal obligations for the parties to the London Convention of 1972 and persuasive international guidelines for states not party to the London Convention.

One clear necessity is a major change--through the initiative of the Agency and Member States--in the level of staffing and budget for IAEA's waste management program. The less then $400,000 which was allocated for all work in the area of radioactive waste treatment and disposal in 1976 hardly even represents the beginning of a serious effort, especially considering that one fully equipped oceanographic research ship costs about $4,000 to $6,000/day whether working on site or transiting to and from the work area. And the assignment of only one full time person for all effort on radioactive waste disposal at sea seems to be inadequate for this large and growing area of IAEA responsibility. Another change must occur in IAEA's willingness to act directly in radioactive waste management areas and to become involved in politically controversial problems.

Even the limited oversight role that UNEP seeks in radioactive waste management may be difficult to establish. Yet this role is crucial. While the specialized agencies of the UN, such as the FAO, have traditionally worked with the IAEA on specific aspects of nuclear energy which relate to waste management, only UNEP offers the broader perspective essential to balancing the various energy sources and their environmental impacts. Overall environmental policy guidance is inherently required in areas such as the solidification (in order to insure some minimum level of quality control <u>before</u> disposal) and disposal of radioactive waste and the assessment of radiological impacts on the marine environment.

UNEP--in coordination with the IAEA--could provide a forum for the essential international information exchange, notification, and consultation on sub-seabed disposal. Jointly funded international symposia on waste management could include some attention to reaching scientific and social scientific agreement on what sub-seabed disposal can and cannot do. This could be done under IAEA's efforts on geologic disposal cooperation and the joint IAEA/UNEP interests in radioactive waste disposal and studies of radioactivity in the marine environment.[1]

If the sub-seabed disposal program continues, the next step for IAEA and UNEP would be the formulation of ways for concerned nations to have full consultation rights with participating countries and related international bodies (such as IAEA, UNEP, IMCO, FAO, WHO, NEA, CEC, and EURATOM) and for international bodies (such as IAEA, UNEP, and IMCO) to have oversight duties and rights concerning the preparations for, and operation of, sub-seabed disposal. This is the basic framework, minus a system of liability and financial guarantees and incentives, and a joint commission at the regional or international agency level, which would pave the way for a Model 4 or 3-4 management structure.

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[1] See O'Neal, "The Environment: IAEA Co-operation with UNEP," p. 193.

A joint commission to control the sub-seabed disposal of radioactive waste might consist of IAEA personnel, perhaps from the "waste management sub-program" (which covers waste disposal into aquatic environments), UNEP personnel, such as those involved in the joint work with IAEA on establishing guidelines for a registry of radionuclide releases, storage, and disposal, and representatives from participating countries. Participation would also be expected by the related specialized agencies of the UN, regional bodies--such as the NEA and CEC, other interested countries, and possibly a future International Seabed Authority. The commission must contain a critical combination of expertise and authority on radioactive waste disposal, environmental protection, and marine sciences and resources.

CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

One thing has become very clear over the last three to four years concerning the presentation of the sub-seabed disposal concept to someone for the first time. If only a few minutes, say five or less, are available for this initial description, the likely result is an opponent who sees the whole concept of sub-seabed disposal as dubious at best. At this point in a presentation, oceanographers often respond, "not in my ocean." Given a longer period of time, say twenty minutes, the listener generally becomes very interested and responds with various questions. After several hours of contact (in the many fewer cases when this occurs) listeners often become enthusiastic about the concept, sometimes to the point of advocacy.

Advocacy is very far from the goal of anyone associated with the sub-seabed disposal program at this point in the R & D process. Yet this presentation/response phenomenon concerning sub-seabed disposal demonstrates an important point. What appears at first to be a very questionable and somewhat threatening idea often, with time for a reasonable description, is at least seen as one possible solution to a serious problem, i.e., radioactive waste disposal. Most environmentalists opposed to further nuclear energy development who are introduced to sub-seabed disposal for the first time respond with a cautious neutrality which includes the feeling that the concept should at least be fully tested on scientific and technical grounds.

Initial reactions to the political, legal, and institutional side of sub-seabed disposal of radioactive waste range from assertions that it could be implemented unilaterally by any technically capable country to statements that implementation would be banned under national and international legal and political constraints. More detailed investigation and analysis reveal that sub-seabed disposal is enmeshed in a complex legal, political, and institutional network. This part of Chapter 8 will offer a brief summary of this network as elaborated in the previous chapters. The final section of this Chapter will present recommendations for action on the legal, political, and institutional aspects of sub-seabed disposal.

In Chapter I we saw that nations have generally ignored the radioactive waste problem for as long as possible. This has especially been the case for plans and decisions on the disposition of high-level radioactive wastes. Environmental and political opposition to further nuclear energy development worldwide, but particularly in the U.S., Europe, and Japan, has increasingly been focused on the radioactive waste management problem.

Governments in nations with nuclear energy programs or plans, especially those concerned about the broader problems of providing adequate energy supplies and avoiding dependence on foreign energy sources, are very sensitive to any issue, such as the radioactive waste disposal problem, which might tend to disrupt these national programs and plans. The result for radioactive waste management has generally been the tendency of governments to focus on the quiet development of local radioactive waste disposal options and to remain very optimistic about the nature and timing of possible disposal options.

Past governmental assessments of the political and technical problems and prospects of radioactive waste management have been somewhat superficial. This has especially been the case in the area of the waste management implications of spent reactor fuel reprocessing, where it has been incorrectly assumed that reprocessing would simplify waste management problems and processes. Now, following the lead of Japan, West Germany, and Sweden, other countries are considering the possibility of requiring reprocessing and/or waste disposal arrangements as prerequisites to the issuance of new nuclear power plant operating licenses. Court decisions and administrative rulings have, in the interim, led to moratoria in various countries on building new nuclear power plants pending the resolution of the radioactive waste disposal issue.

Despite the tremendous pressure (resulting from broader energy problems) which has developed to find acceptable radioactive waste disposal options, the disposal problem, especially for high-level wastes, is only now being seriously addressed (in terms of financial and institutional support) by the leading nuclear nations. Furthermore, radioactive waste disposal is the type of problem which will require significant R & D efforts for a number of years. Fully acceptable disposal solutions may not be available until the 1990's.

The past record of marine disposal practice with very hazardous materials, as outlined in Chapter II, establishes an important part of the legal, political, and institutional framework upon which responses to sub-seabed disposal of radioactive waste will be formed. Very toxic and persistent weapons and industrial wastes, including various types of radioactive wastes, have routinely been dumped in the oceans. The "out of sight, out of mind" mentality continues to some degree for waste disposal in the deep oceans, but events in the 1970's have led to national and international expectations that this practice must be closely investigated and curtailed, if not banned.

All reported dumping of packaged radioactive wastes at sea was halted--the U.S., French, and British cases, with the exception of the NEA sponsored ocean dumping operations, which have been shifted to different sites and brought under tighter scientific scrutiny and legal control. The potential hazards to man and threats to other uses of the oceans, as assessed <u>prior to</u> dumping, remain the key factors in determining what should be labeled as unacceptable "pollution of the marine environment." But some dumping practices were halted, on both national and international levels, on the basis of potential hazards to the marine environment, e.g., the cases involving arsenic compounds in the Atlantic Ocean and the U.S. EPA (1971), the STELLA MARIS (1971), chemical wastes (DuPont) in the Gulf of Mexico (1974) and the EPA, and the ENSKERI (1975).

An important development occurred on the basis of various unilateral state actions involving ocean dumping and other nations' responses, and on protests and associated state responses, especially in the U.S. radioactive waste dumping (1959-1960), U.S. nerve gas (1971), and STELLA MARIS (1971) cases. A rule of general international law seemed to develop requiring prior notification and consultation with concerned nations and appropriate international organizations by states planning to dump very hazardous substances at sea. The underpinnings of this rule were, in part, the associated shifts in approach in the 1970's toward:
1) considering the marine environment as one that should be protected in the same way as continental areas; and
2) containing and isolating toxic substances instead of diluting them in the marine environment.

Both the recent emphasis on radioactive waste management (Chapter I) and the newly adopted attitudes toward marine pollution from ocean dumping (Chapter II) are reflected in the U.S. legislative and regulatory situation vis-a-vis sub-seabed disposal, as analyzed in Chapter III. Various legislative enactments in the areas of atomic energy control, general environmental protection, and marine pollution (especially ocean dumping) control establish a complex network of pertinent jurisdictions for the U.S. NRC, ERDA, EPA, DOT, Coast Guard, CEQ, and other federal agencies.

Some of the areas of regulatory efforts under these agency jurisdictions which are most important to the development and/or implementation of the sub-seabed disposal of radioactive wastes are now unsettled because major criteria and standards development programs are in progress and because the exact division of authority between some agencies is unclear. The NRC is now formulating criteria for radioactive waste disposal site selection and other aspects of radioactive waste management which will have an impact on sub-seabed disposal. The EPA has a major program underway to develop general environmental protection standards for radioactive waste disposal.

It seems clear that both the NRC, through its authority over the disposition of radioactive materials under the basic Atomic Energy Act of 1954, and the EPA, through its authority under the Ocean Dumping Act of 1972, would play central regulatory roles in the implementation of sub-seabed disposal. Yet the precise division of authority between the two bodies is unclear. And the division of NRC and ERDA authority over the development and implementation of radioactive waste disposal options is particularly complex and confused. While it presently appears that ERDA could carry a sub-seabed disposal development program through the demonstration stage without NRC licensing, NRC's authority at least extends to licensing any final disposal repositories.

Other U.S. federal bodies, such as the DOT and Coast Guard--in the area of transportation, and the CEQ and Department of State--in the area of assessing international environmental implications, will have important regulatory roles in both the environmental assessment and implementation stages. This includes a guarantee of adequate time for wide governmental and public discussion and assessment prior to implementation since sub-seabed disposal would be defined as "dumping" under the U.S. Ocean Dumping Act of 1972. The result is that:

1) the EPA could permit the sub-seabed disposal of non-high-level radioactive wastes after full assessment and public discussion; but
2) the EPA could not, without congressional approval, permit the sub-seabed disposal of high-level radioactive wastes.

The legislative and regulatory situation for sub-seabed disposal in other countries is also generally complex and somewhat unsettled. Nations with nuclear energy programs have general atomic energy legislation with radioactive material control provisions which could be further elaborated for sub-seabed disposal in future regulations, but there is a general lack of comprehensive legislative provisions and regulations addressing radioactive waste disposal. General environmental assessment and more specific marine disposal (especially ocean dumping) legislation can be found in a number of key countries, but this legislation is not at all uniform in its comprehensiveness and extent of activities prohibited. Just as in the U.S., however, many countries have efforts underway to develop legislation and regulations in these areas, especially for the control of marine pollution (and/or ocean dumping) and for radioactive waste disposal (including public participation in some decisions).

A general trend is that sub-seabed disposal seems to present a somewhat less complex legislative and regulatory situation than land-based radioactive waste disposal options since the use of sites beyond national borders eliminates participation by the state and localities where land sites are located. There will, however, still be a number of agencies with overlapping jurisdictions involved in the process of regulating the development and implementation of any sub-seabed disposal program. Legislation and/or regulations to control (or ban) the implementation of sub-seabed disposal during the next few years of R & D are important in countries with ocean dumping legislation which does not define sub-seabed disposal as "dumping."

The legal situation on the international level, as analyzed in Chapter IV, is particularly sensitive to the need to keep legal and technical development efforts in pace. Sound legal development must be based on reliable scientific and technological data, or at least judgments.

These data or judgments are often not fully--or even largely--available until a research and development program or project is relatively well advanced. It is not possible, however, to wait this long into the research and development process since the development of sound legal controls often lags behind the science and technology by several years. Furthermore, since technological projects and programs develop tremendous commitments and momentum, legal adjustment and regulation is much easier and more effective (when at least some reliable data is available) early in the development process, before overwhelming economic, political, and social commitments are made.[1] The law must thus tread the fine line which will keep it in pace with the science and technology without getting too far ahead of (and thus possibly closing out) potential technical options which may turn out to be quite useful, or even essential to social needs.

National and international studies of sub-seabed disposal are still very preliminary and low priority efforts relative to land-based programs, but they represent a new approach toward the solution for an extremely difficult problem. Assessment of the regulatory aspects was started at a very early stage, including the briefing of key environmental groups and governmental agencies in the United States.[2] National and international bodies should now

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[1] See, generally, Chayes and Stein.

[2] The Natural Resources Defense Council (especially the Palo Alto Office), the Union for Concerned Scientists, The Sierra Club, and various regional environmental and consumer

start a formal monitoring process.[1] National and international meetings and conferences on related topics should begin to take account of such a potential use of the deep seabed.

Overall, the international legal situation is now inadequate for implementing/managing sub-seabed disposal. This poses, however, no immediate threat to the environment since:

1) to date no one is even proposing sub-seabed disposal as an operational solution;

2) it is highly unlikely that any country would threaten to race ahead with unilateral implementation of sub-seabed disposal in the next several years; and

3) there seem to be adequate interim controls, at least for now, to prevent this use of the seabed, especially on a unilateral basis. Preventive action by state and international agencies could be based on the widely accepted definition of marine pollution and ocean dumping--including the London Convention regime, the widely applied classification of radioactive, especially high-level, materials as highly toxic and persistent substances which require extreme care, the impossibility of demonstrating the harmlessness of sub-seabed dis-

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groups have been briefed and updated periodically, as well as various congressional committees and numerous government agencies such as the EPA, CEQ, Department of State (Environment, Oceans, Nuclear Technology, and Security Assistance Offices), NRC, National Science Foundation, Office of Science and Technology Policy, and U.S. Geological Survey.

[1] At least UNEP, IAEA, IMCO, and the FAO are formally aware of the U.S. and int'l. sub-seabed assessment programs for radioactive waste disposal. This is in addition to the NEA/OECD, which sponsors the international program.

posal due to present gaps in scientific knowledge, and the international classification of the deep seabed as not subject to national appropriation.

Since the management of an internationally acceptable sub-seabed disposal program would not be required for several years--perhaps until 1990, or even 2000, there is time for considerable international legal development. If the scientific and technological results continue to be positive, and if the concept is not abandoned on political grounds, we can expect the law to grow and solidify based on future state practice. There are several sets of developed and developing guidelines and regulations from the fields of marine, nuclear, and environmental law which could be applied. Two particularly important frameworks are the draft treaty on sea disposal of radioactive wastes produced (but not adopted by the full group) through the IAEA in the early 1960's and the IAEA Provisional Definition and Recommendations on radioactive waste disposal at sea which are soon expected (1978) to be completely revised and implemented under the London Convention.

Development is specifically needed in the area of governing non-resource-related use of the deep seabed. Environmental assessment, pollution prevention, and state and international responsibility and liability rules are prime requirements. Very careful assessments must be conducted of foreseeable uses of the deep seabed and overlying oceans; potential interference with these uses from sub-seabed disposal must be analyzed. Comparative evaluations of all serious radioactive waste disposal options must be made based on potential use interference and environmental hazards from land-based disposal methods and from sub-seabed disposal.

A source of broader oversight and global perspective to synthesize and build on the available piecemeal approaches to pollution control is perhaps the greatest present need. Intelligent regulatory assessments of sub-seabed disposal should include global, as well as site-specific, criteria for environmental protection, resource potential, and radiological assessment aspects. Despite the intention of sub-seabed disposal to isolate all wastes, future probabilities of accidents and eventual releases of some radioactivity mean that the concept must be set within the broader context of the total amount of radioactivity allowed in the marine environment from all sources.

Overall release limits can only be established on the basis of models and calculations incorporating all present and expected sources of radioactive input into the oceans. In this context, regulatory development must also address the fundamental approaches of dilution within the oceans and isolation from the biosphere. This should include due consideration of the usefulness of controls based on disposal methods, types of site, types of radioactive particles primarily involved, and the total activity of individual waste units as opposed to, or in addition to, limits on different categories, such as low and high-level, of radioactive wastes.

Even if all the scientific and technical problems of the sub-seabed disposal of radioactive waste (as outlined in Chapter I) can be solved, fundamental political problems (as analyzed in Chapter V) will remain. Just as with legal research and development, efforts in the area of assessing policy implications of sub-seabed disposal, especially in the U.S., must keep pace with--without overrunning--development in science and technology. As the initiator of the first R & D program in this area, the U.S. will have particularly strong influence on the development of related policy.

It is still too early to set any concrete policies nationally or internationally on the implementation of the sub-seabed disposal concept. There are, however, some important interim conclusions to be made in related policy areas. Radioactive waste management, especially disposal, is becoming an important policy problem in its own right, as well as an increasingly influential factor in establishing overall nuclear policy. Since serious efforts in radioactive waste management have just started, high-level radioactive waste disposal concepts should be evaluated primarily on their own merits for the time being, especially if still in feasibility assessment stages of development, with comparative evaluations following in the 1980's (at least in the U.S.).

Although complex, the political situation does not appear to rule out the implementation of sub-seabed disposal for radioactive wastes. No country claims to have solved the radioactive waste disposal problem and many countries plan on increased use of nuclear energy. Sub-seabed disposal is of little apparent use for the interim storage of spent reactor fuel (the initial stage of a "stowaway" fuel cycle). But it seems to be at least as compatible with new U.S. policy on stricter control of nuclear energy and non-proliferation as other radioactive waste disposal concepts. In some respects, such as adaptability to international cooperative arrangements for high-level radioactive waste disposal and for nuclear non-proliferation, it may be even more supportive of U.S. nuclear policy than land-based disposal concepts. It is still impossible to do accurate and complete assessments of the socioeconomic considerations of the various radioactive waste disposal concepts, but it is clear that transportation and handling risks will merit greatly increased attention.

Responses from other countries to date can generally be characterized as cautious interest and participation. Strong British support must be carefully qualified with the complicating aspect of apparent insistence on maintaining the possible option of high-level radioactive waste disposal <u>on</u> the seabed. Yet the British are also likely to continue strong support of the R & D on sub-seabed disposal, and the U.S. and French opposition to the support of any <u>on</u> the seabed disposal concept will exert strong influence on the course of future decisions in this area. While it is very difficult to predict the stance of future Soviet policies in this area, it is clear that they will be a major determinant of the level of international political acceptability established for sub-seabed disposal.

As expected, the indications to date of policy stances on sub-seabed disposal from the related international organizations have been very cautious. While not opposed to R & D on new approaches to solving the radioactive waste disposal problem, the IAEA, for example is hesitant to:

1) take any initiative on such a concept such as a supporting policy stance until there is a better indication of what the consensus of its member states will be; and
2) take any action which might detract from the overall attractiveness of nuclear energy, e.g., broadening the search for acceptable waste disposal options and thus implicitly admitting that radioactive waste disposal is a real problem.

A policy stance of at least cautious neutrality by international bodies such as the IAEA and UNEP will be very important to the later responses of the LDC's to sub-seabed disposal.

While R & D priorities for radioactive waste disposal are still being set, there should be broad public discussion of ethical considerations, as raised on Chapter VI, of the sub-seabed disposal of radioactive waste. Some of these considerations include:

1) the reasonableness of transferring radioactive waste disposal risks to the commons, especially since they might involve perceived threats to future resource exploitation;
2) the role of sub-seabed disposal, relative to that of other disposal concepts, in protecting other nations and generations from future radioactive waste disposal practices;
3) the long-term management requirements of sub-seabed disposal relative to those of other radioactive waste disposal concepts; and
4) the trade-offs of retrievability, as opposed to the best long-term isolation for radioactive waste disposal concepts.

The minimum institutional requirements for implementation of sub-seabed disposal under any of the possible management models, as developed in Chapter VII, are not available. There are, however, some important structures for managing sub-seabed disposal in existence, such as the IAEA's responsibilities on radioactive waste disposal at sea under the London Convention of 1972, or under development, such as the NEA consultation and surveillance mechanism for radioactive waste dumping at sea.

Whether under the general ocean dumping framework of the London Convention of 1972, including the related IAEA and IMCO responsibilities and authorities, or under an international agreement specifically on sub-seabed disposal, it would be extremely useful for effective management to integrate the expertise and authority of UNEP on general environmental protection and regional marine pollution control, of IAEA on radioactive waste disposal, especially at sea, and of bodies associated with marine pollution control, such as the Joint Group of Experts on the Scientific Aspects of Marine Pollution (which works for the specialized agencies of the UN).

Recommendations

No U.S. legislative action specifically on the subseabed concept for radioactive waste disposal should be necessary in the near future, but sub-seabed disposal should be taken into account by the NRC, EPA, and other U.S. agencies in their ongoing criteria and standards development programs for radioactive waste management. The jurisdictions of the U.S. agencies, especially the NRC, ERDA, and EPA, involved in the broader area of radioactive waste management, including radioactive waste disposal at sea, should be clarified to help avoid inter-agency confusion and competition. Decisions by U.S. agencies on sub-seabed disposal, perhaps on maintaining a ban on use during the R & D stage and supporting implementation if the concept is scientifically validated, should be heavily influenced by the extent of international management and control which is developed.

Other countries should also consider the need for clarifying governmental agencies' jurisdictions in radioactive waste management, including waste disposal at sea.

Consideration should be given to the development of legislation on general environmental impact assessment, based, in part, on the need to evaluate the environmental implications of R & D programs such as sub-seabed disposal as they progress. This should include the assessment of the likely international environmental impacts. While specific licensing authority for disposal methods and sites should be established under the basic atomic energy control acts, general legislation on waste management is often an effective means for integrating radioactive waste disposal into the overall national waste disposal plan. Finally, action should be taken to establish legislation and regulations on ocean dumping which meet at least the requirements of the London Convention of 1972.

States could effectively follow a course similar to that adopted by the U.S. Department of State on the international legal aspects of sub-seabed disposal, i.e., withhold final positions on specific legal interpretations, especially on the applicability of the London Convention of 1972 to sub-seabed disposal, pending the resolution of the scientific and technical issues. This interim position should include the caveat that sub-seabed disposal would, in the interim, be "dumping" under the London Convention (and thus not possible for high-level radioactive wastes and possible for non-high-level wastes only under strict conditions) if it poses a threat of pollution to the marine environment. A similar stance should be supported through the IAEA and IMCO on all work concerning radioactive waste disposal at sea. Then, if isolation within the sub-seabed can be sufficiently demonstrated, it may be interpreted as a suitable method for radioactive waste disposal at sea and implemented under the London Convention and/or a specifically negotiated international agreement.

In the interim, special attention should be devoted to the regulation of the international transport of radioactive materials. This should include action by countries to revise or adopt national rules which are at least as strict as the latest international codes, and action through the IAEA to ensure that international guidelines measure up to the forthcoming demands on the international transport of radioactive materials, including broader liability coverage and more realistic limits of liability.

National and international organization policy stances on the sub-seabed disposal of radioactive waste should be consistent with those in the legal area, i.e., implementation of the concept should be banned while it is in the R & D stage and supported if eventually accepted by the scientific community, governmental agencies, and the public. Major commitments at the outset by countries participating in the international research program on sub-seabed disposal should not be expected. Yet, if the international effort is to be successful, it must receive a very significant percentage of all national resources devoted to the study of sub-seabed disposal. The international research program on sub-seabed disposal should remain open to participation, either as full participants or as observers, by additional countries. Concerned and politically or scientifically pivotal non-participants (nations and international organizations) should be updated regularly on the problems and progress of R & D on sub-seabed disposal.

Governments should not expect immediate answers or tangible near-term results from the international research effort on sub-seabed disposal. Long-term planning, including consideration of possible management structures to be developed, will be necessary for making the transition from R & D to implementation. The NEA's Radioactive Waste Management Committee should now, for example, involve at least the IAEA and UNEP in the appropriate meetings on sub-seabed disposal. Finally, governments and international organizations should include the possible use of sub-seabed disposal as one consideration in all international plans and negotiations on broader radioactive waste management and nuclear non-proliferation arrangements.

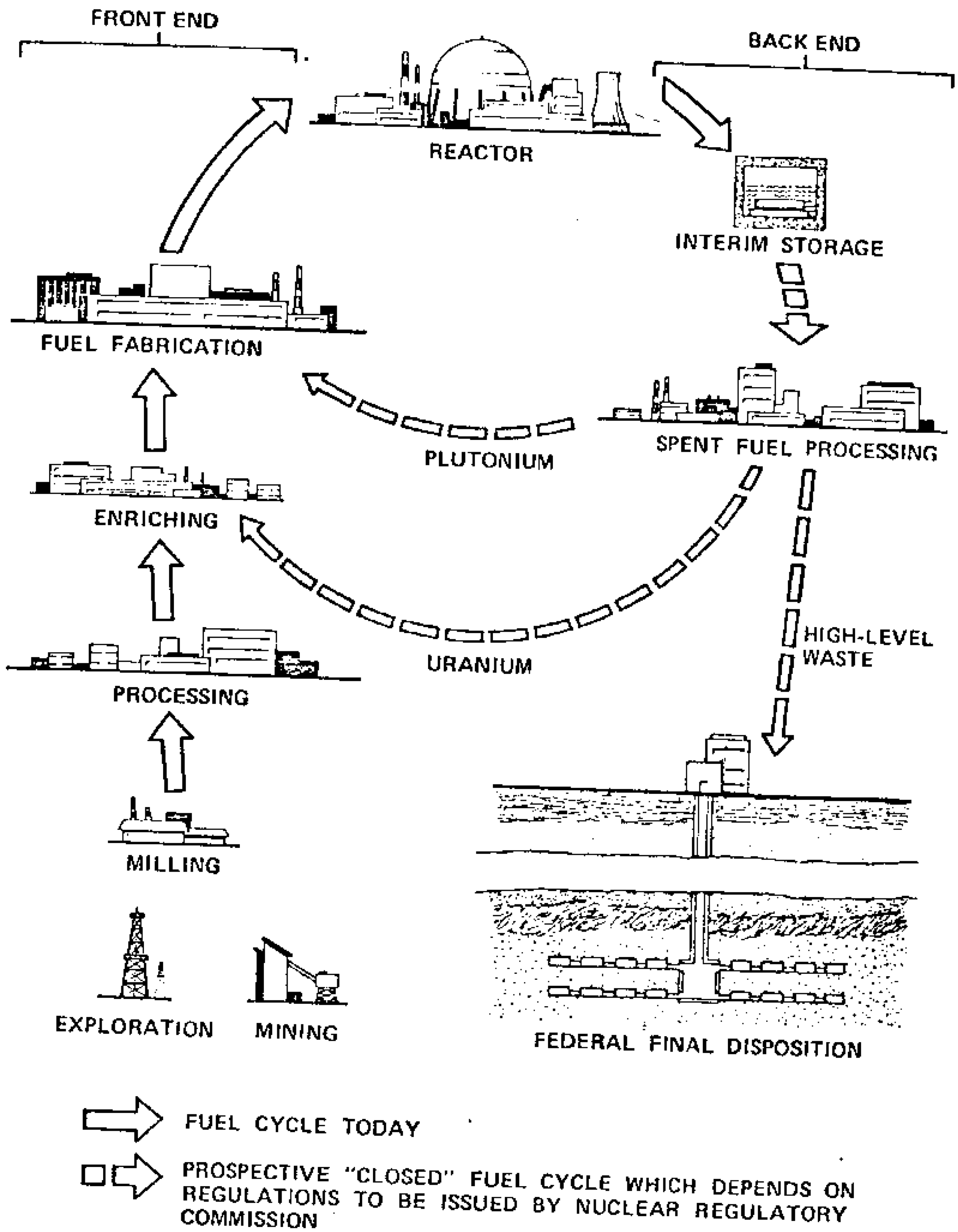


Fig. 1. The Light Water Reactor (LWR) Nuclear Fuel Cycle.

Source: U.S., ERDA, The Management and Storage of Commercial Power Reactor Wastes: A Summary Based on the ERDA Technical Alternatives Document (Wash., D.C.: U.S. ERDA, 1976), p. 3.

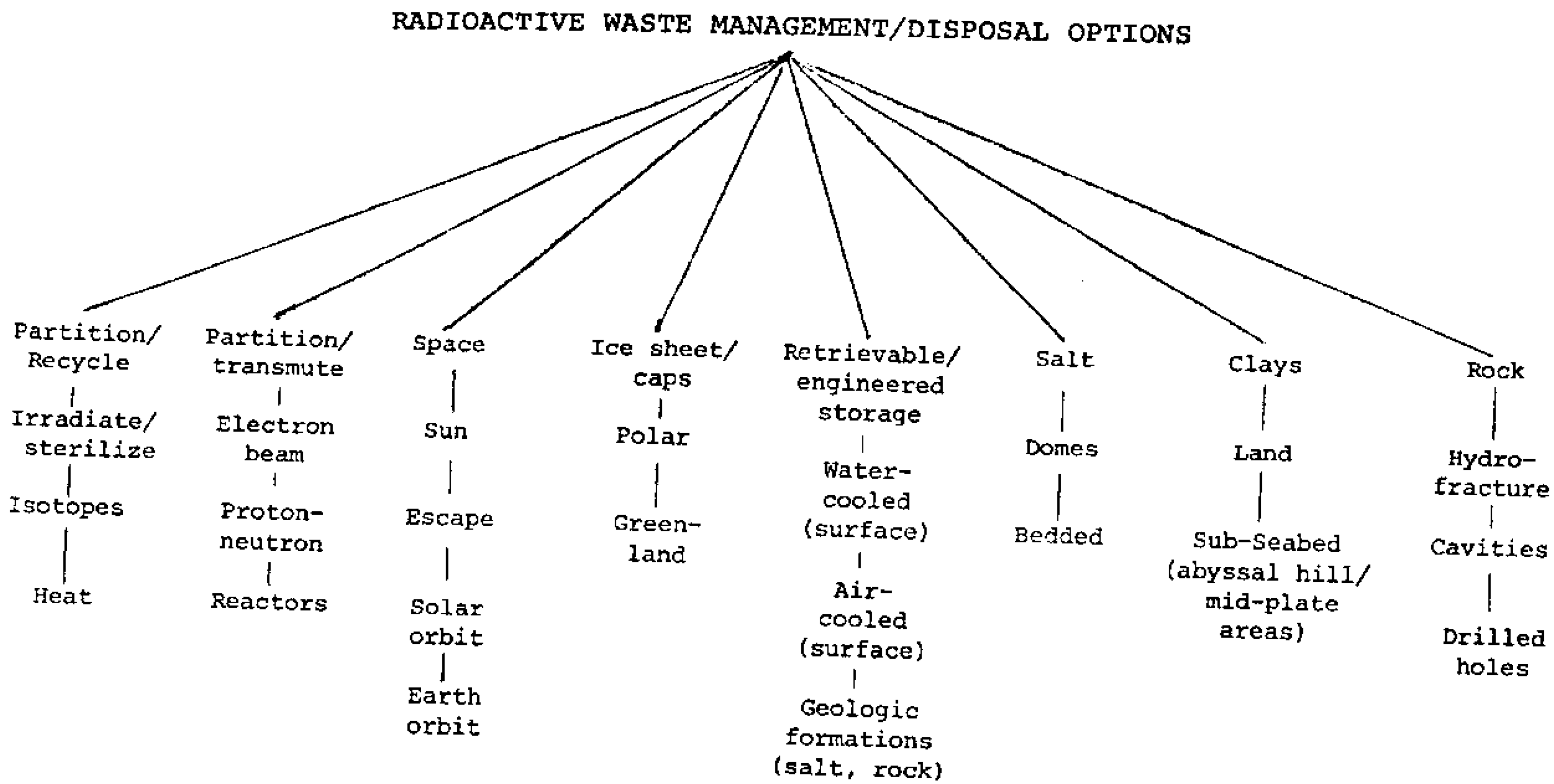


Fig. 2 Potential Radioactive Waste Management/Disposal Options

SOURCE: adapted from viewgraph produced by Waste Management Division, Sandia Laboratories, Albuquerque, New Mexico, 1977.

MULTIPLE BARRIER SYSTEM

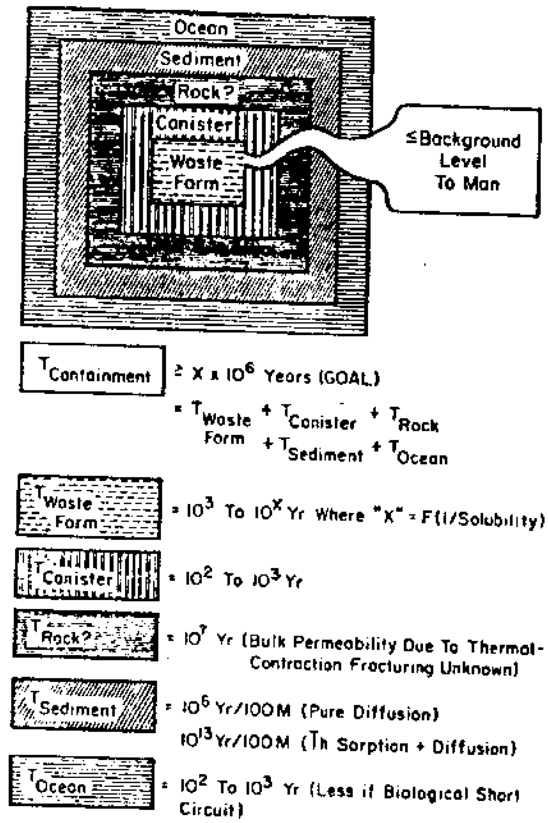


Fig. 3. Diagram of the containment/isolation model underlying the U.S. ERDA Seabed Assessment Program for radioactive waste disposal. This is basically the same model used in all geologic disposal studies.

Source: C. D. Hollister, "The Seabed Option," Oceanus 20 (Winter 1977): 21.

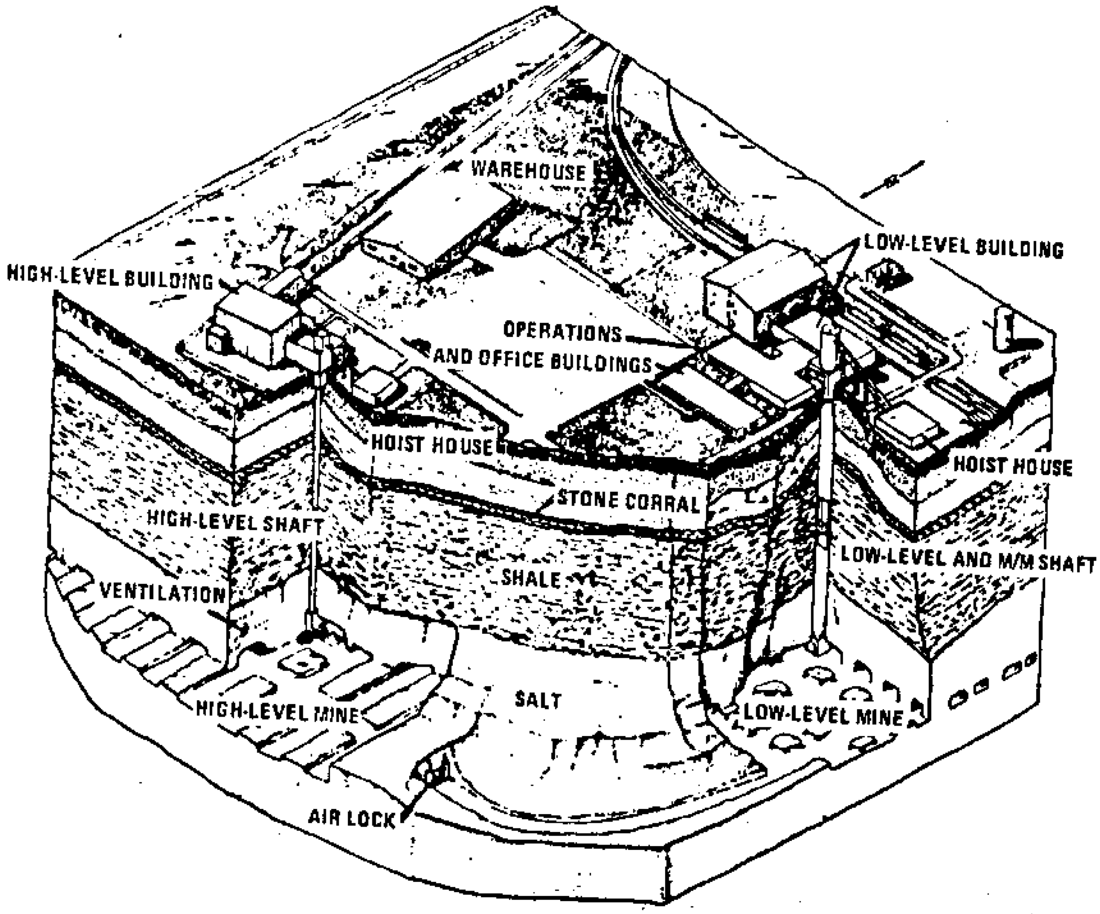


Fig. 4. Probable Layout of an Underground Facility Mined Out for Radioactive Waste Disposal (Bedded Salt)

Source: U.S., NRC, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle: A Task Force Report, NUREG-0116; Supp. 1 to WASH-1248 (Wash., D.C.: U.S. NRC, 1977), p. 4-78.

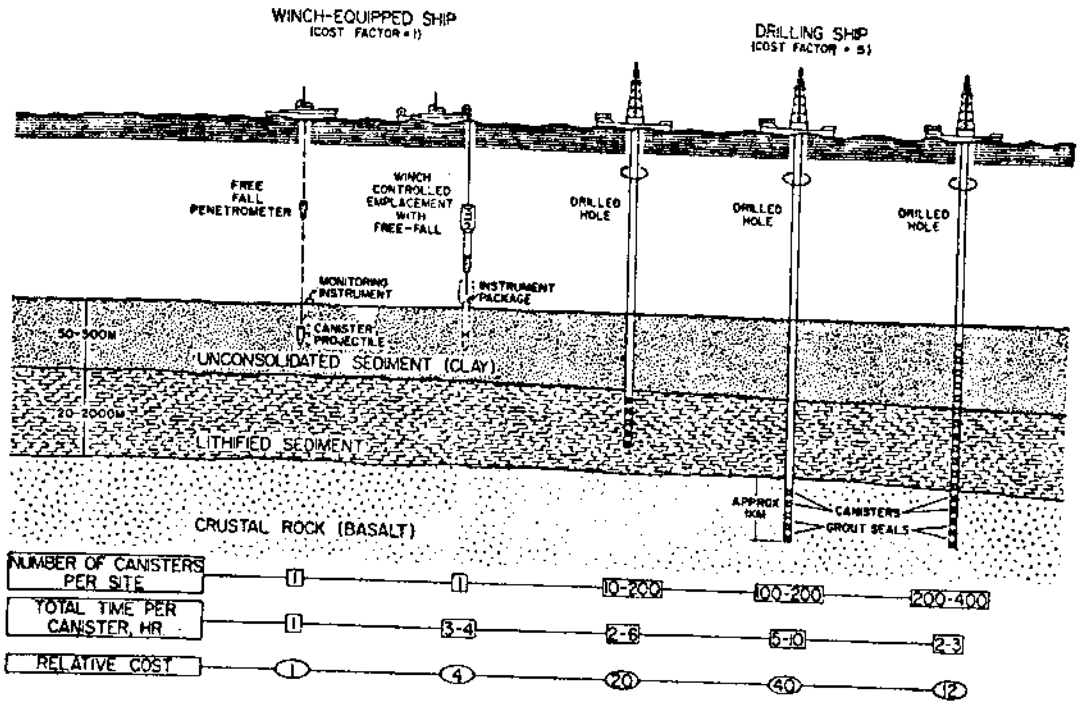


Fig. 5. Possible Emplacement Techniques for Sub-Seabed Disposal of Radioactive Waste Canisters.

Source: A. J. Silva, "Physical Processes in Deep-Sea Clays," Oceanus 20 (Winter 1977): 37.

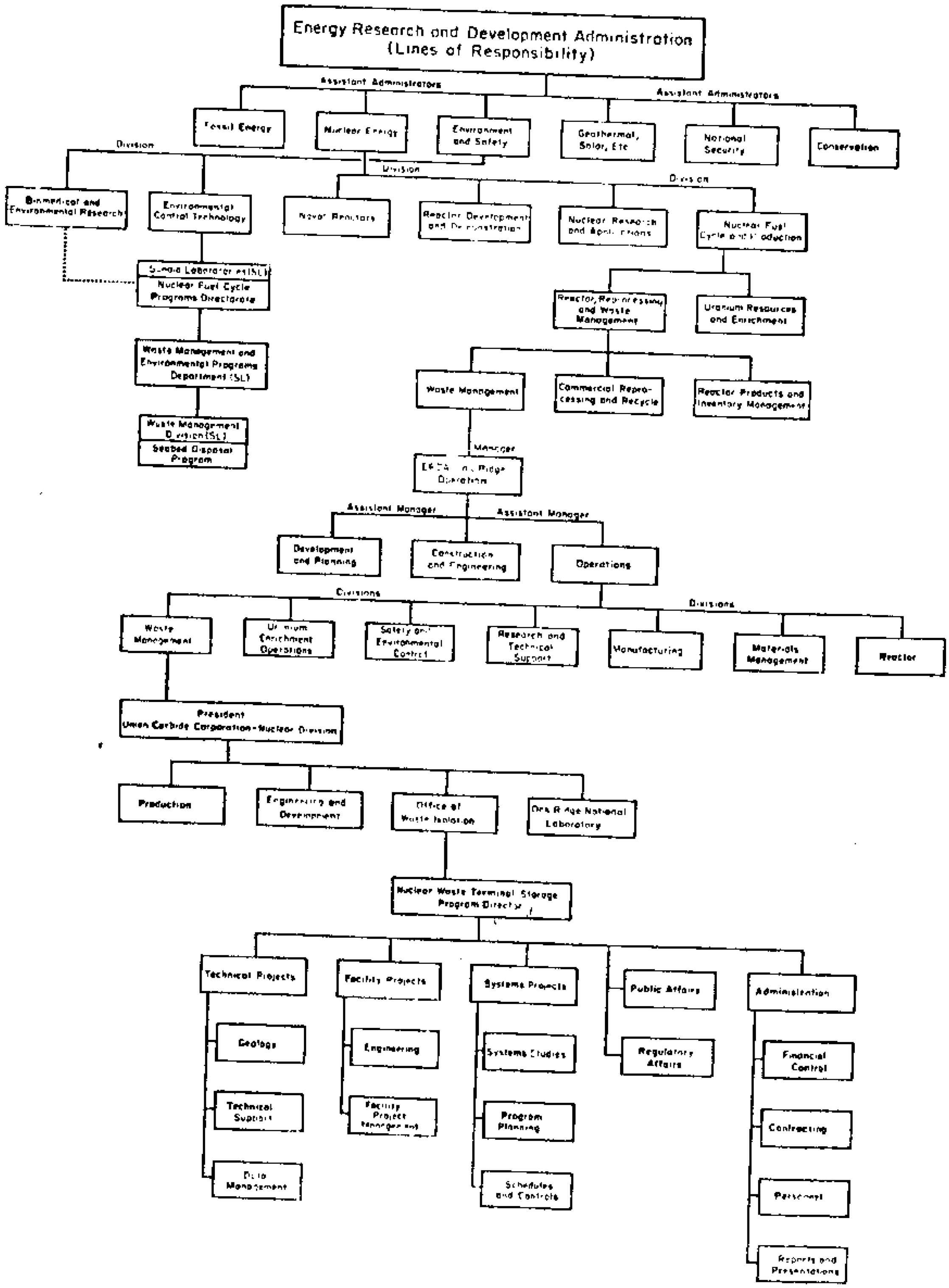


Fig. 6. The Energy Research and Development Administration Structure for Managing Radioactive Wastes.

Source: D. A. Deese, "Seabed Emplacement and Political Reality," Oceanus 20 (Winter 1977): 53, as published by Office of Waste Isolation, Oak Ridge, Tennessee, 7 December 1976.

Location	Capacity t/y	Date operational	Status
Argentina	200 Kg/y	1968	Small hot cell. Shut down. Scheduled for reactivation in 1977.
Belgium			
Mol	60	1966	Shut down. Eurochemic has terminated reprocessing operations in its first plant. Has been used for reprocessing development. 167 tons of uranium processed.
Brazil		1981	Site selection in progress. Pilot plant.
Britain			
Windscale	1500-2500	1964	Operating near full capacity. Head end improvement program in hand.
	300	1972-73	Operated but shut down for investigation of incident and subsequent modification. Processed 100 t.
	400	1977-78	Will feed into natural uranium separation plant depending on availability of capacity.
	1000	1984	For expected domestic requirements part of United Reprocessor's plan.
	1000	1987	Awaiting decision on public acceptability of overseas contracts.
France			
La Hague	800	1966	Main plant for reprocessing EdF natural uranium fuel but due to be changed over to oxide.
	150-180	1976	Phased build up feeding into existing separation plant.
	1000	1985	Detailed design just starting.
Marcoule	900-1200	1958	Early military plant. Will take over commercial natural uranium from La Hague.
Germany			
Karlsruhe WAK	40	1970	Operating with fuel of increasing burnup. 32 tons of uranium processed.
—	1500	1984	Design specification being prepared. Site to be selected.
India			
Trombay	80	1965	Data unavailable.
Tarapur	150		Conducting test operations.
Israel	—	—	Data unavailable.
Italy			
Saluggia Eurex 1	10	1969	Currently shut down for modification.
Japan			
Tokai Mura	200	1976	Non-active commissioning. Full operation expected 1978.
—	1000	late 1980s	Projected if site can be found.
Spain			
Moncla	100 Kg/y		Data unavailable.
Taiwan	100s grams/y		Small pilot plant.
United States			
West Valley,	300	1966-72	630 t processed before shut down for expansion.
N.Y.	750	early 1980s	Dependent on new construction permit.
Morris, Ill.	300	—	Inoperable in present form. Currently providing fuel storage.
Barnwell, S.C.	1500	1977-78	Depending on Nuclear Regulatory Commission decisions.
—	—	mid-1980s	Looking for site.

Fig. 7. Overview of the Primary non-Communist Nuclear Fuel Reprocessing Projects.

Source: D. A. Deese, "Seabed Emplacement and Political Reality," Oceanus 20 (Winter 1977): 49, as adapted from Nuclear Engineering International, February 1976.

COMMERCIAL NUCLEAR POWER REACTORS –

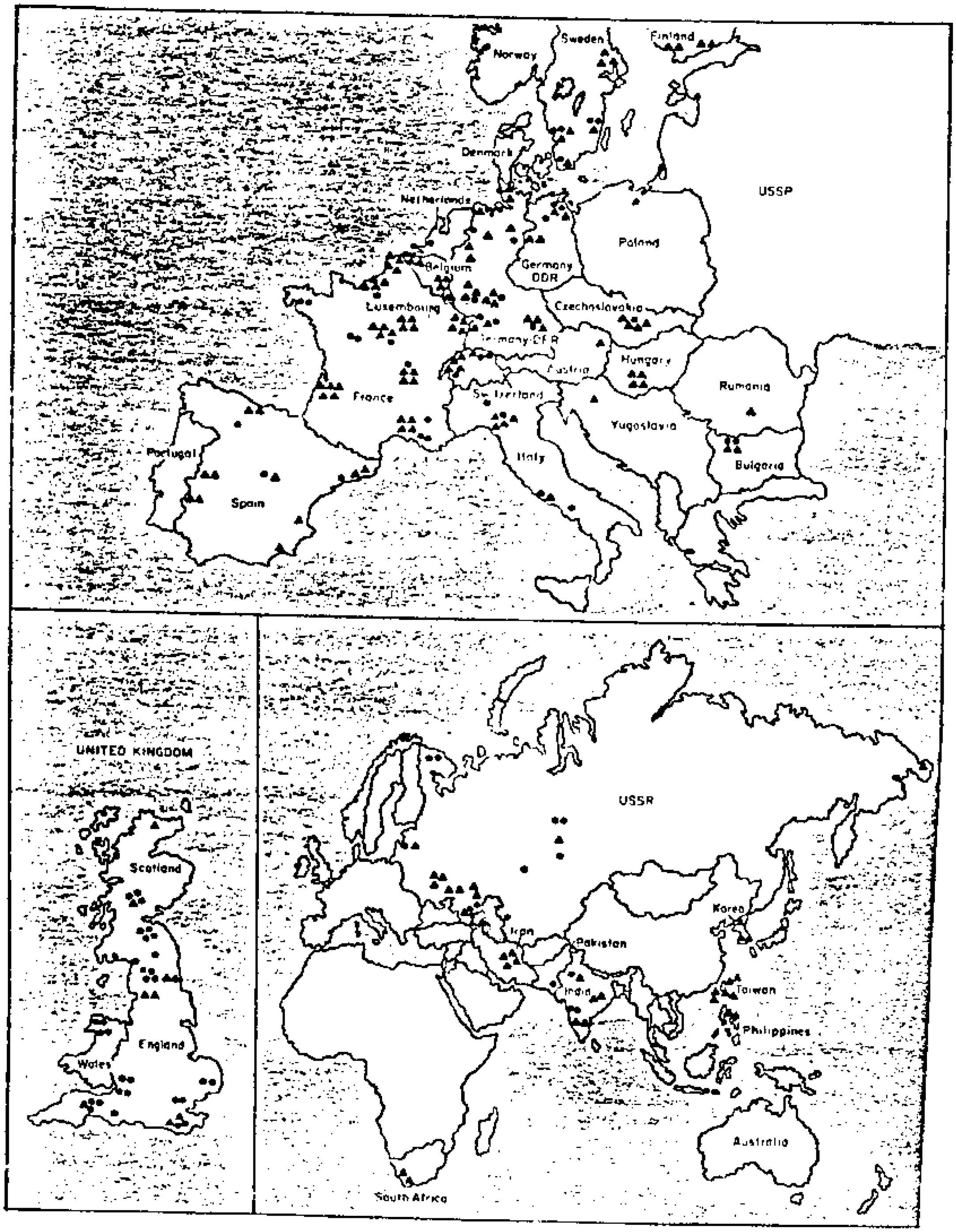
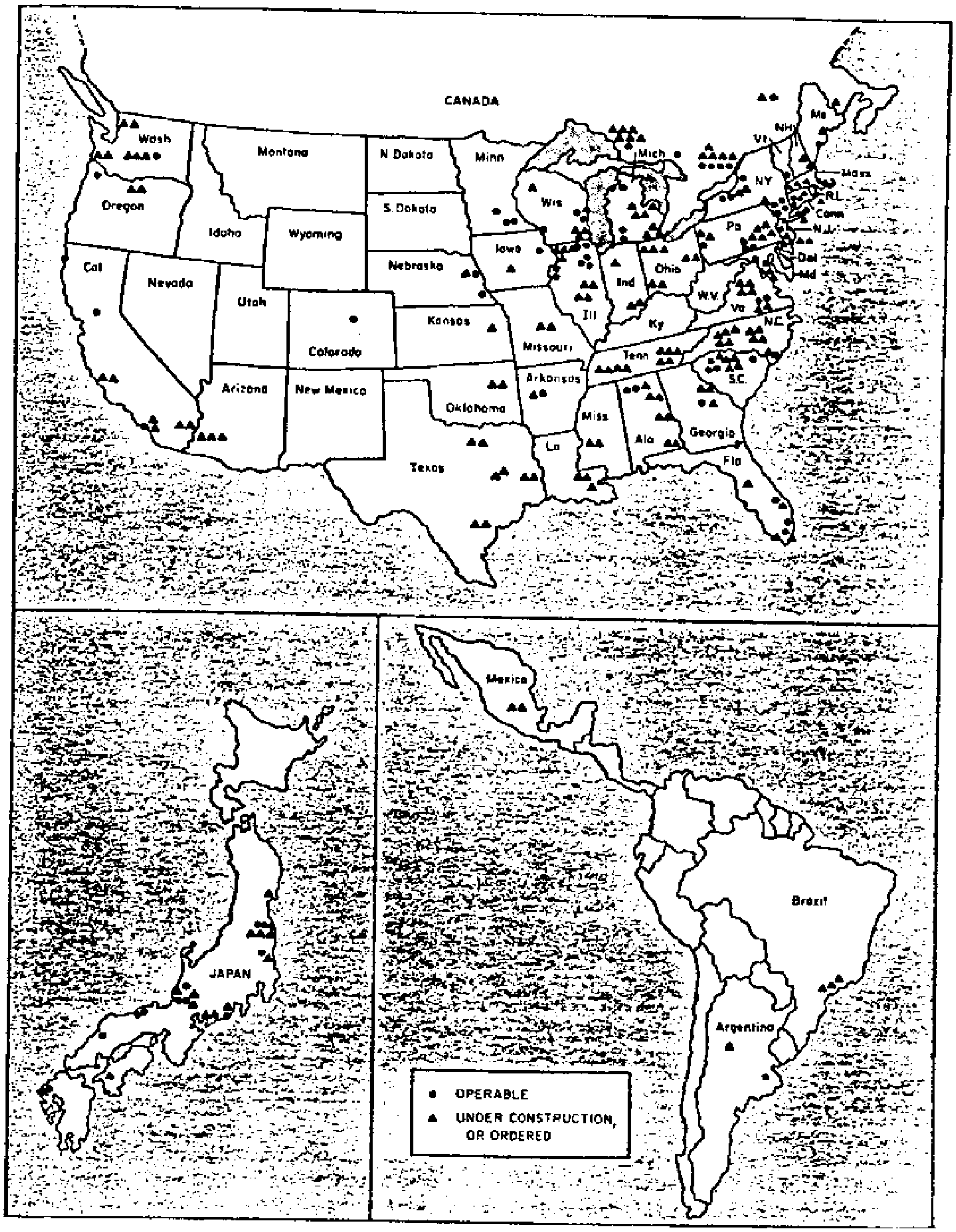


Fig. 8. All Countries Operating (or Soon to be Operating) Nuclear Reactors for Energy.

Source: D. A. Deese, "Seabed Emplacement and Political Reality," Oceanus 20 (Winter 1977): 56, 57, as adapted from data supplied by Nuclear News, September 1976 and from U.S. ERDA.

OPERABLE, UNDER CONSTRUCTION, OR ORDERED



Country	Units in commercial operation	Units under construction, on order, or letter of intent
Argentina	1	1
Austria	-	1
Belgium	3	4
Brazil	-	3
Bulgaria	2	2
Canada	6	14
Czechoslovakia	1	4
Finland	-	4
France	10	34
East Germany	3	4
West Germany	7	20
Hungary	-	4
India	3	5
Iran	-	4
Italy	4	5
Japan	12	13
Luxembourg	-	1
Mexico	-	2
The Netherlands	2	-
Pakistan	1	-
Philippines	-	2
Poland	-	1
Rumania	-	1
South Korea	-	3
Spain	3	11
Sweden	5	7
Switzerland	3	5
Taiwan	-	6
Britain	29 (10 under 100 MWe)	10
United States	56	155
Soviet Union	12	13
Yugoslavia	-	1

Fig. 9. Nuclear Energy Reactors in Operation and under Construction, on Order, or Announced, by Country.

Source: D. A. Deese, "Seabed Emplacement and Political Reality," Oceanus 20 (Winter 1977): 50, as adapted from Nuclear News, August 1976.

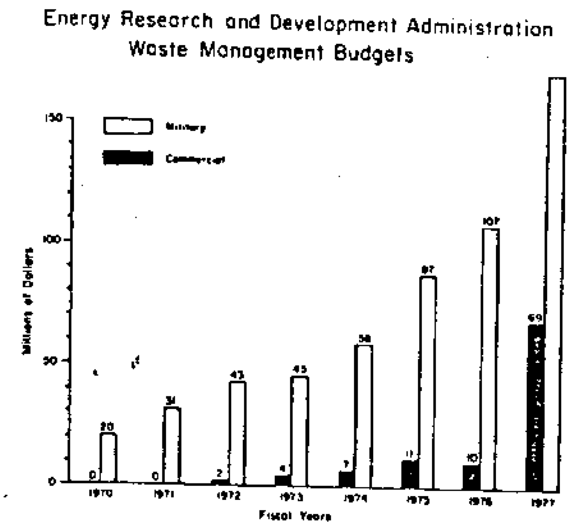


Fig. 10. The U.S. ERDA's Commercial and Military Waste Management Budgets for 1970-1977 (the Atomic Energy Commission was split into ERDA and the NRC in 1974).

Source: D. A. Deese, "Seabed Emplacement and Political Reality," <u>Oceanus</u> 20 (Winter 1977): 47, as produced from data provided by ERDA, 1977.

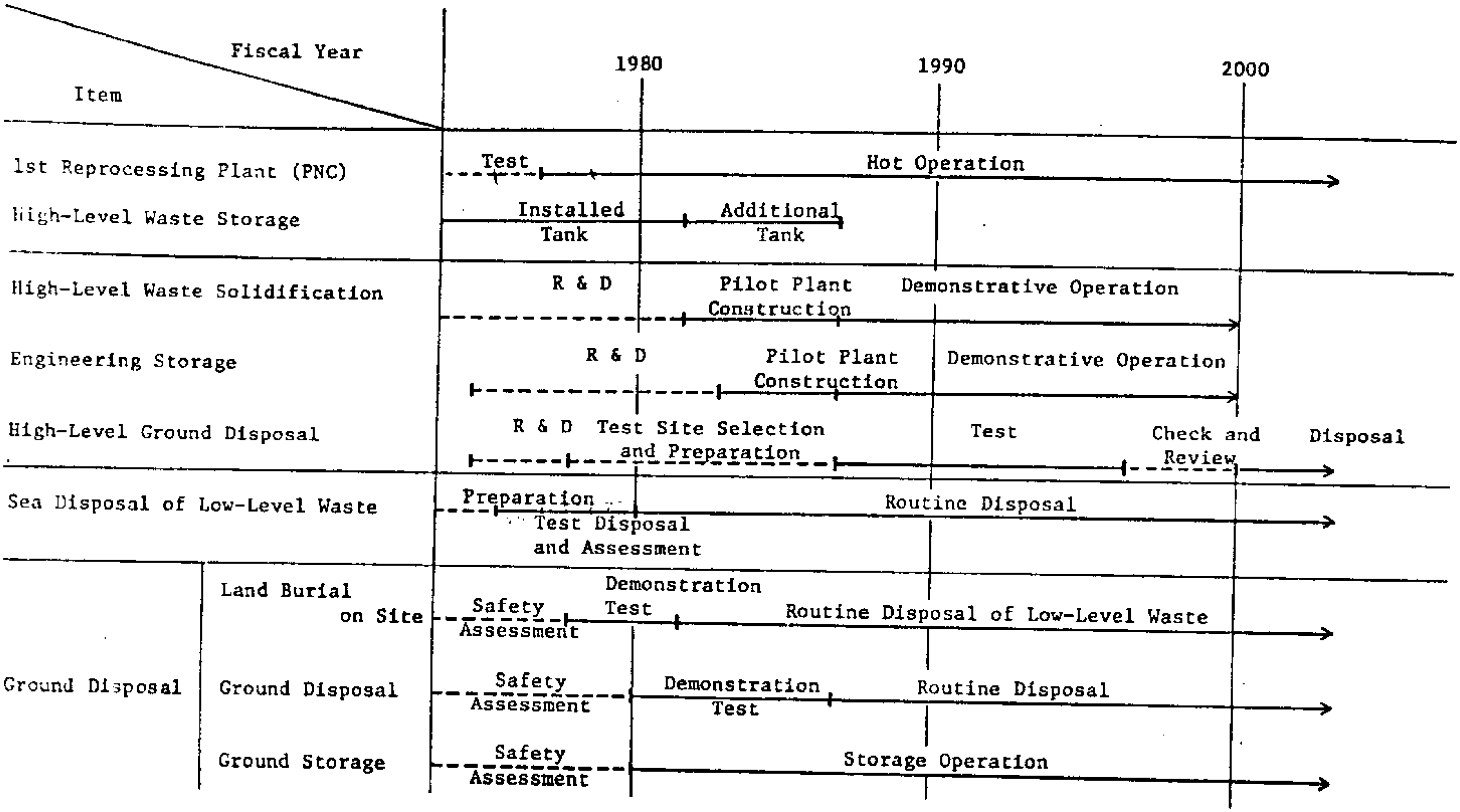


Fig. 11. Japanese Radioactive Waste Management Program and Plans: Progression of Research, Development, Demonstration, and Operation of Waste Management Facilities.

Source: Second Int'l. Workshop on Seabed Disposal of Radioactive Waste, Wash., D.C., March 1977. (Mimeographed.)

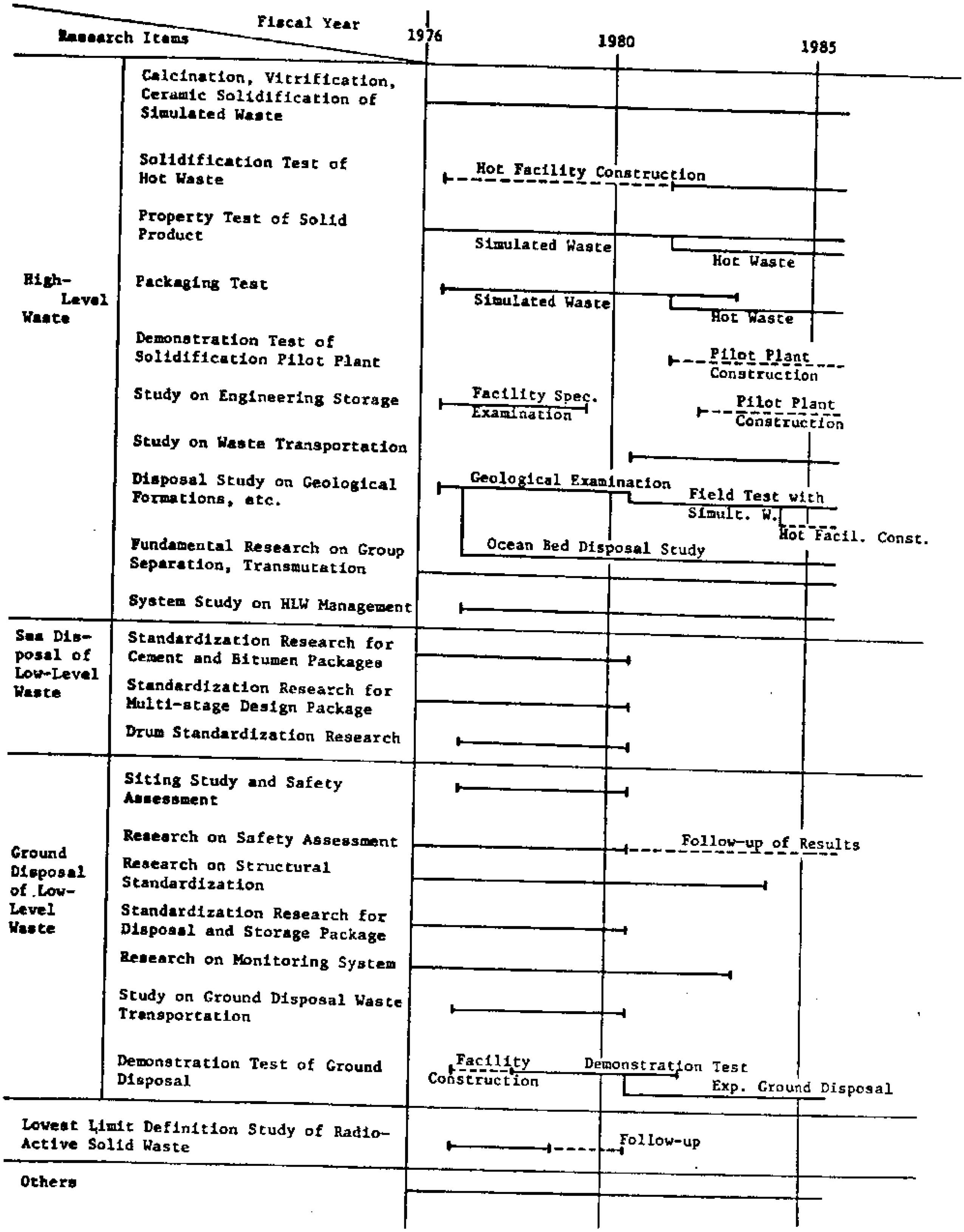


Fig. 12. Japanese Radioactive Waste Management Program and Plans: Research and Development Schedule for 1976 to 1985.

Source: Second Int'l. Workshop on Seabed Disposal of Radioactive Waste, Wash., D.C., March 1977. (Mimeographed.)

Key Characteristics	Likely Actors			
	Corporation(s)	Government(s)	Group(s) of Governments	Large Number of Governments
Source of Financing	Corporate	Governmental/ Corporate	Governmental/ Regional (NEA, IEA, etc.)	Governmental Regional International (IAEA, UNEP)
Technical Framework	Corporate (Individual Laboratories)	Governmental Corporate (National Laboratories)	Governmental/ Regional	Governmental Regional International (IAEA, UN Specialized Agencies)
Source of Standards and Regulations	Corporate/ Governmental	Governmental/ Regional International	Governmental/ Regional International (NEA, CEC, EURATOM)	International Regional Governmental (IAEA, UNEP)
Responsible and Liable Parties	Corporate/ Governmental	Governmental	Governmental Regional (Nations)	Governmental/ Regional International (nations and agencies)
Institutional Structures	Corporate Governmental (Board of Directors)	Governmental (Atomic Energy Commissions, Depts. of the Environment	Regional/ International (NEA's Radio-active Waste Management Committee)	International Regional

Key Characteristics	Likely Actors			
	Corporation(s)	Government(s)	Group(s) of Governments	Large Number of Governments
Source of Enforcement and Supervision	Corporate Governmental	Governmental	Governmental/ Regional (Regional Commissions, Governments, IAEA, Contractors)	Regional/ International (IAEA, Int'l. Commission, Governments, Contractors)

Increasing Levels of International Management

Figure 13. A Matrix Based on the Key Characteristics of the Institutional Framework through which a Sub-Seabed Disposal Program would be Implemented and the Likely Actors.

MODEL 1

Corporate

Largely corporate characteristics with significant governmental regulation if exclusively a private corporation.

MODEL 2

Governmental

Characteristics dominated by individual national governments; minimal direct regional/international influence.

MODEL 3

Regional

Joint financing, development, and regulation coordinated by regional (international) organization(s); regulatory and institutional aspects influenced directly by international agencies.

MODEL 4

International

Use of political and geographic international regions to coordinate broad international development, regulation, and control of sub-seabed disposal program; strong possibility of incorporation into broader international waste management or nonproliferation structure.

Fig. 14. Possible Management Models for the Sub-Seabed Disposal of Radioactive Waste.

TABLE 1

ANNUAL WASTE PRODUCTION FROM MODEL FUEL-CYCLE FACILITIES

Source	Types of Waste	Method of Disposal	Volume of Waste (Cubic Meters)	Radioactivity (Curies)
UF_6 Production Dry process	Low-level CaF_2; chemical waste	Buried onsite or in licensed burial facility	3,900	350
Wet process	Low-level CaF_2; sludge; chemical waste	Buried onsite or in licensed burial facility	2,480	350
Enrichment 4-Gaseous diffusion 2-Gas centrifuge	Low-level miscellaneous	Buried onsite or in licensed burial facility	1,900	Not estimated
Fuel Fabrication Enriched uranium	Low-level CaF_2; miscellaneous	Buried onsite or in licensed burial facility	1,225	Negligible
Mixed Oxide	Plutonium-bearing solids	Federal repository	290	7,200
Reactor Operation	Low-level miscellaneous	Buried in licensed burial	620	4,000
	Spent Fuel	Federal repository	35	11,000,000[a]
Spent Fuel Storage	Low-level miscellaneous	Buried in licensed burial	21	Not estimated

TABLE 1 - Continued

ANNUAL WASTE PRODUCTION FROM MODEL FUEL-CYCLE FACILITIES

Source	Types of Waste	Method of Disposal	Volume of Waste (Cubic Meters)	Radioactivity (Curies)
Fuel Reprocessing	Low-level miscellaneous	Buried in licensed burial	400	Neglibible
	High-level wastes	Federal repository	456	∿900,000,000
	Plutonium (30 gallon canisters)	Federal repository	310	∿5,000,000
	Miscellaneous transuranium solids (i.e., hulls, hardware, Pu-bearing solids, miscellaneous lab waste)	Federal repository	2,520	∿175,000,000

SOURCE: U.S., NRC, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle: A Task Force Report, NUREG-0116; Supp. 1 to WASH-1248 (Wash., D.C.: U.S. NRC, 1977), p. 3-13.

[a]For 10-year-old spent fuel.

TABLE 2

HALF-LIVES OF SOME OF THE MAJOR CONSTITUENTS OF RADIOACTIVE WASTE

Radionuclide	Half-Life (Years)
Americium — 241	460
Americium — 242	150
Cesium — 135	2×10^{6}
Cesium — 137	30
Curium — 242	.45
Curium — 243	32
Curium — 244	18
Iodine — 129	1.6×10^{7}
Neptunium — 237	2.1×10^{6}
Plutonium — 239	2.4×10^{4}
Plutonium — 241	13
Radon — 226	1600
Strontium — 90	28
Technicium — 99	2.0×10^{5}
Thorium — 230	7.6×10^{4}
Tritium	13

SOURCE: R. A. Frosch, "Disposing of High-Level Radioactive Waste," Oceanus 20 (Winter 1977): 10.

TABLE 3

CUMULATIVE VOLUMES OF WASTE INVENTORY

IN THE YEAR 2,000 (m^3)

Type of Waste	Fuel Cycle Option: No Recycle	Fuel Cycle Option: U Recycle
Mill Tailings	7.8×10^8	6.9×10^8
Spent Fuel	55,000[a]	6,000[c]
High-Level	b	6,500[d]
Transuranic	b	76,500[e]
Hulls and Hardware (Transuranic)	b	52,000
Low-Level Reactor Waste (Nontransuranic)	3.8×10^6	3.8×10^6
Other Low-Level (Nontransuranic)	310,000	300,000
Chemical	179,000	183,000

SOURCE: U. S. NRC, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle: A Task Force Report, NUREG-0116; Supp. 1 to WASH-1248 (Wash., D.C., U.S. NRC, 1977), pp. 3-16.

[a] 400,000 spent-fuel assemblies

[b] Not produced with no-recycle.

[c] 37,000 spent fuel assemblies in pool storage awaiting processing.

[d] Volume of high-level waste in 37,000 canisters.

[e] Includes plutonium wastes.

TABLE 4

HIGH-LEVEL RADIOACTIVE WASTES IN THE U.S. AS OF 1974 FROM MILITARY AND COMMERCIAL REPROCESSING OPERATIONS

(millions of gallons)

Site	Liquid	Solid (sludge & salt cake)
Hanford, WA	29.6	27.2
Savannah River, SC	10.9	8.7
Idaho Nat'l. Engineering Laboratory, Idaho Falls	2.2	0.3
West Valley, NY	0.6[a]	-
Total	43.3	36.2

SOURCE: Adapted from U.S., Congress, Joint Comm. on Atomic Energy, Hearings on ERDA Authorizing Legislation FY 1976, before the Subcomm. on Legislation, 94th Cong., 1st Sess., 1975, p. 1937.

[a]These are from commercial applications; all other numbers represent wastes which are primarily from military applications.

TABLE 5

SUMMARY OF REPORTED SEA DUMPING OF RADIOACTIVE WASTE

Country/ Organization	Period	Number of Containers or Tonnes Dumped*		Activity Dumped (Curies)
		Containers		
U.S.A.	1946-1960	76,201		93,690
	1961	4,087		275
	1962	6,120**		478
	1963	129		9
	1964	114		20
	1965	24		5
	1966	43		105
	1967	12		62
	1968	0		0
	1969	26***		26
	1970	2		3
Total	1946-1970	86,758		94,673
U.K.	1951-1966			45,000
NEA	1967-1976	113,870		293,880
		Tonnes	Alpha (Curies) Actinides	Beta-Gamma (Curies)
	1967	10,840	250	7,600
	1969	9,180	500	22,000
	1971	3,970	630	11,200
	1972	4,130	680	21,600
	1973	4,350	740	12,600
	1974	2,270	420	100,000
	1975	4,460	780	60,500
	1976	6,670	880	53,500
Total		45,970	4,880	289,000

SOURCE: IAEA, 1977.

* A reference container is a 200 liter drum.

** Between 1950 and 1962 52,011 containers were dumped in the Pacific (14,550 curies) and 33,928 in the Atlantic (79,443 curies).

*** Between 1963 and 1969 276 containers were dumped in the Pacific (185 curies) and 185 in the Atlantic (40 curies).

TABLE 6

PARTICIPATING NEA COUNTRIES

Country	1967	1969	1971	1972	1973	1974	1975	1976
Belgium	X	X	X	X	X		X	X
France	X	X						
F.R.G.	X							
Italy		X						
Netherlands	X		X	X	X	X	X	X
Sweden		X						
Switzerland		X	X	X		X	X	X
U.K.	X	X	X	X	X	X	X	X

SOURCE: IAEA, 1977.

APPENDIX 1

RADIOACTIVE WASTE DEFINITIONS PREPARED FOR SANDIA LABORATORIES AND U.S. ERDA MANAGEMENT PURPOSES (1977)*

Defense Waste

Low-Level Non-Transuranic Waste

Radioactive waste containing less than 10 nanocuries per gram of transuranic nuclides is designated low-level waste, and may be surface-buried in designated ERDA or commercial disposal sites. It consists of general process or laboratory trash, including paper, glass, metal, concrete-stabilized sludges, demineralizer resins, etc. For the last twenty years or so, all low-level liquid wastes have been sorbed or otherwise reduced to solid form before burial, but this is not universally true of older wastes. The WIPP [Waste Isolation Pilot Plant--as planned by the Oak Ridge Nat'l. Laboratory and the U.S. ERDA] does not incorporate a surface-burial facility for low-level non-transuranic waste.

Low-Level Transuranic Waste

Low-level transuranic waste is solid radioactive material, other than spent fuel and high-level waste, which is con-

*SOURCE: D. R. Anderson; Waste Management Research Sandia Laboratories; Albuquerque, NM (June 1977).

taminated with long-lived alpha emitters to a level greater than 10 nanocuries per gram, but which exhibits sufficiently low radiation levels (surface dose rates $\leq$500 millirem per hour, by WIPP definition) that it is amenable to handling by "contact" (as opposed to "remote") methods. In physical form it is similar to low-level waste, but also includes decommissioning waste (discarded process vessels, glove boxes, etc.). WIPP acceptance criteria will require that most low-level transuranic waste be processed to remove combustible and gas-producing materials, and will limit the extent to which unprocessed waste will be accepted for storage.

Intermediate-Level Waste

Intermediate-level waste is the broad spectrum of wastes which lie between low-level transuranic waste and high-level waste. These wastes exhibit sufficiently high radiation levels that handling in shielded containers or by remote methods is required. In general, the higher radiation levels are associated with fission product β-γ activity; therefore, virtually all of the ERDA-generated intermediate-level waste will come from the three reprocessing plants at Hanford, Idaho National Engineering Laboratory (INEL), and Savannah River rather than from the weapon-oriented plants such as Rocky Flats and Los Alamos. Heat generation in intermediate-level waste is low compared with that in high-level waste, and heat transfer is not a major consideration in its storage.

Intermediate-level waste has not yet been well characterized or even inventoried within the ERDA complex, but it is reasonable to assume that the volume will be only 10-20 percent of the volume of low-level transuranic waste. Typical waste forms are high β-γ process trash, discarded reactor core structure and coolants, and solidified intermediate-level reprocessing waste.

Intermediate-level wastes will be stored in the WIPP remote handling facility.

High-Level Wastes

By legal definition, high-level waste is the product of the first-cycle solvent extraction process by which spent fuel is reprocessed; in today's political climate, however, the definition must be extended to include unprocessed spent fuel.

The present WIPP charter, of course, specifies that high-level waste will be used only for experiments to define its behavior in a salt storage environment, and will be removed and shipped to a licensed repository at the conclusion of the experimental program.

High-level waste exhibits both high radiation levels and high thermal power generation rates, and shielding and heat transfer are primary considerations in the design of the WIPP remote handling facility.

Whatever the decision regarding commercial fuel reprocessing, there already exists some 80 million gallons of ERDA-generated liquid and semi-solid high-level waste; this is stored in tanks at Hanford, INEL, and Savannah River. Alternative documents which discuss the various cptions for the final solidification and disposal of these wastes are now in preparation. It is not expected that any ERDA high-level waste will be processed for ultimate disposal before 1990.

Commercial Waste

Low-Level Non-Transuranic Waste

The current interim definition of (low-level) nontransuranic waste is <10 nanocuries/gm of elements with Z > 92. Two task forces are currently evaluating this interim definition, and it may change in the future. All wastes which are not mill tailings, spent fuel or high-level waste, and meet this <10 nanocuries/gm criteria are defined as low-level nontransuranic wastes. Approximately 3/4 of this volume is generated by commercial power reactor operation (filter sludges, evaporator bottoms, spent resins, air filters, control rod blades, contaminated clothing and rags, etc.). The remainder is generated by medical use of isotopes, industrial and academic laboratory use of tracers, and discarded equipment from nonreactor nuclear fuel cycle facilities. Wet solid wastes (sludges and evaporator bottoms) are solidified in cement or urea-formaldehyde. Boric acid solutions are often absorbed on vermiculite. Compactible solid waste, along with small compactible wastes, are commonly pressed into 55 gallon drums. Large noncompactible wastes (discarded equipment) is cut up, if necessary, and packaged in wooden crates. In some cases the curie content of wet solid wastes can exceed 1 Ci/ft^3 and may require external shielding to meet transportation requirements. The average curie content of low-level nontransuranic waste buried in the last few years is approximately 0.1 Ci/ft^3.

Low-Level Transuranic Waste

This waste is either suspect, by reason of origin, or has been measured to have >10 nanocuries/gm of elements with $Z > 92$, and has a sufficiently low gamma emitting nuclide content to allow unshielded handling of the boxes or drums. It is sometimes called low gamma transuranic waste, and has in the past been called alpha waste. It would principally be generated at fuel reprocessing plants or mixed oxide fuel fabrication plants associated with recycle commercial fuel cycles. It would include failed equipment and general trash from contaminated or suspect areas, ventilation filters for effluent control, etc. Treatment alternatives include incineration of combustibles (including in some cases liquids) with fixation in cement, bitumen, or glass, and packaging with or without compaction for failed equipment and other noncombustible waste.

Intermediate-Level Transuranic Waste

This waste is like transuranic (contact handling) waste except that the external dose rates of the container are high enough to require shielded handling. Sheared segments of the zircaloy fuel element cladding, generated during fuel reprocessing, would be classified as an intermediate-level transuranic waste. Incinerated solvents used during reprocessing could also contribute to this waste category. Cladding hull treatment alternatives include mechanical compaction, blending with dry sand in a welded steel canister (to reduce the pyrophoricity of the zircaloy fines), and surface decontamination (since up to a few tenths of a percent of the fuel and fission products is assumed to remain with the cladding).

High-Level Waste

Appendix F to 10 C.F.R. 50 defines high-level wastes as "those aqueous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel." This high-level waste contains approximately 99 percent of the curie content of all fuel cycle wastes, and is characterized by intense penetrating radiation and high heat generation rates. Current regulations call for these wastes to be solidified within five years after generation and for the solid waste form to be shipped to a federal facility within ten years after the liquid waste is generated. Incorporation of the waste into a glass waste form is the anticipated solidification treatment. Currently no commercial solidified high-level waste exists in more than laboratory testing quantities. Spent fuel, resulting from the throwaway fuel cycle, although not included in the 10 C.F.R. 50 definition of high-level waste, has similar radiation and thermal properties. A spent fuel assembly has about three times the volume of the high-level waste resulting from the reprocessing and solidification of the high-level waste from the fuel assembly. Depending on the recycle fuel cycle mode, spent fuel may also contain approximately 200 times as much Pu as the corresponding amount of high-level waste.

APPENDIX 2

Conclusion and Recommendations of the IAEA Advisory Group (1976) on the Oceanographic Basis for Regulating Radioactive Waste Disposal at Sea

(1) The oceanographic basis of the provisional Definition and Recommendations is not satisfactory, and should be replaced.

(2) The provisional Definition and Recommendations should be improved, and should be reviewed.

(2a) We consider that our understanding of the deep oceans is insufficient to permit the construction of a single comprehensive model of the movement of radionuclides. Such a model would require much information that is not available and could lend a spurious appearance of accuracy to estimates that are not in fact reliable.

(3) The initial concentration of radioactivity in wastes dumped in the deep ocean is unlikely to be important in determining the hazards to man. However, the total activity in a canister may be of consequence to organisms within the immediate vicinity of the canister.

(4) The quantities of radioactivity released into the marine environment from all radioactive waste dumped in the

deep ocean should be strictly limited in accordance with the Recommendations below as well as other IAEA Recommendations.

(5) Rates of release of radioactivity to the oceans can be reduced by suitable containment and packaging of wastes. When it has been established that wastes can be contained for a given length of time, an allowance for decay *in situ*, relative to that time, may be considered.

(6) Emplacement of waste canisters into certain sea-floor sediments would provide additional long-term containment, and should be further investigated.

(7) The release of radionuclides to the ocean should be limited from the outset at rates not exceeding those which could be continued for periods comparable with the half-life of plutonium 239.

(8) The assessment of radiation doses to man and of possible damage to the ecosystem should be carried out. It should use the basis we have provided and take account of the physical and biological pathways that we have identified in Section 4.

(9) Release rate limits for a wide range of radionuclides should be calculated for various identifiable ocean basins containing potential disposal sites.

(10) We recommend that the calculations of the release rate limits should be undertaken by a suitably constituted group of consultants.

(11a) Both (a) the long-term average concentration in the bottom water for the appropriate part of the ocean basin (see 4.3.2) and (b) the appropriate maximum concentration arising from short-term events (see 4.3.4, 4.3.5 and 4.3.6) should be used in calculating release rate limits for all exposure pathways regardless of the depth at which they actually originate.

(11b) The long-term, large-scale processes lead to a release rate limit which applies to the total release from all sites in a basin whereas the short-term small-scale processes lead to a limit which applies to the releases from individual sites.

(11c) The single-site release rate limit is more restrictive for short-lived radionuclides so that partitioning of waste between sites would for such waste increase the overall limit for the basin as a whole.

(11d) The basin release rate limit is more restrictive for long-lived radionuclides so that in this case the partitioning of wastes between sites in a basin would not effect the limit for the basin as a whole.

(12) The possible role of sediments in reducing water phase concentrations should not be included in these calculations until more reliable information on their behavior is available.

(13) Nevertheless, the concentrations on sediments used as a basis for radiological assessments should be calculated on the assumption that all activity released is absorbed on the sediments, until more reliable information is available.

(14) The release rate limits are upper limits on the rates of release of radionuclides to the ocean environment. Actual rates of release should be controlled as far below these levels as is reasonably achievable and in no circumstances should the limits calculated be approached rapidly.

(15) The hydrography, geophysics, geochemistry and biology of possible disposal sites should be studied as carefully as possible, to provide reliable information for assessment as to their suitability.

(16) Estimates of the transfer of radionuclides from the depths of the interior of the large-scale oceanic gyres in the major oceanic basins presented in this document are based on present knowledge of the processes in these regions. In general, these estimates are inapplicable to regions of deep convection, such as exist to the poleward side of the major oceanic gyres, and to the marginal seas.

Dumping should only be carried out where water depths are greater than 4000 m at latitudes less than about 50^{o}. Deep sea disposal sites should not be located near continental margins, in marginal and in-land seas, nor should they be situated in areas where natural phenomena or other disturbances would make them unsuitable as disposal sites.

(17) The conclusions are based on the information available now. New information will become available, and certain areas of research should be explored. The assessment carried out here and the conclusions reached should be reviewed as and when this seems necessary, or at intervals of 3-5

years.

(18) Much research is needed to improve our knowledge of the physics, chemistry and biology of the deep oceans. The Agency may wish to consider how research relevant to its responsibilities may best be encouraged.

(19) The environmental concentrations arising from any radioactivity released should be investigated by appropriate scientific programmes.

(20) When making radiological assessments of dumping operations, the total input of radioactivity in the oceans should be taken into account.

(21) Future knowledge is likely to result in estimates of release rate limits being revised either upward or downward. The present conclusions and recommendations should not be used to justify a programme of dumping of radioactive wastes which cannot be modified or stopped.

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LIST OF ABBREVIATIONS

AEC	(U.S.) Atomic Energy Commission (divided into ERDA and NRC in 1974)
CEC	Commission of the European Communities
CEQ	(U.S.) Council on Environmental Quality
DOT	(U.S.) Department of Transportation
EEC	European Economic Community
EIS	Environmental Impact Statement
EPA	(U.S.) Environmental Protection Agency
ERDA	(U.S.) Energy Research & Development Administration
FAO	Food and Agricultural Organization
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Pollution
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
ICRP	International Commission on Radiological Protection
ILO	International Labor Organization
IMCO	Intergovernmental Maritime Consultative Organization
LOS	Law of the Sea (ongoing negotiations at UN; first conference 1958, second 1960, third and current 1973--)
NEA	Nuclear Energy Agency (formerly European Nuclear Energy Agency)
NEPA	(U.S.) National Environmental Policy Act (1969)
NRC	(U.S.) Nuclear Regulatory Commission
OECD	Organization for Economic Cooperation & Development

LIST OF ABBREVATIONS (Continued)

R & D	Research and Development
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization
WMO	World Meteorological Organization

September 1977

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Woods Hole Oceanographic Institution
WHOI-77-71

SUB-SEABED DISPOSAL OF RADIOACTIVE WASTE: PREVENTION OR MANAGEMENT? by David A. Deese. 436 pages. December 1977. Prepared for the U.S. Energy Research and Development Administration under Contract EY-77-S-02-4172.A000, the Fletcher School of Law and Diplomacy, Harvard University, the International Union for the Conservation of Nature and the Woods Hole Oceanographic Institution.

The most important prerequisite for understanding the legal, political, and organizational implications of the option of radioactive waste disposal deep within the seabed (sub-seabed disposal) is a basic grasp of the status of the worldwide nuclear activities which are creating such wastes. Chapter I analyzes the technical, legal, political, and managerial aspects of nuclear energy, especially radioactive waste management, in order to provide the necessary background and perspective for an examination of the sub-seabed disposal concept. Chapter II summarizes the history of worldwide marine disposal practices of very hazardous materials, as well as the recent national and international responses to these practices. Attention is focused on the new environmental attitudes, in particular, on the emerging trend of phasing out disposals which pose a danger to man or his environment.

The study then investigates the legal and political elements of sub-seabed disposal of radioactive wastes. Chapter III analyzes the domestic legal positions of the United States and other nations with nuclear energy programs, and Chapter IV includes a detailed

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2. Seabed
3. Disposal

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Chapter VIII summarizes the research findings and presents various conclusions and recommendations. From the legal viewpoint, it is important to note the following.

1) The implementation of sub-seabed disposal of radioactive waste in the leading nuclear nations is enmeshed in a complex legislative and regulatory situation; this situation is not, at least for the time being, as complicated as that confronting land-based disposal possibilities; and it is currently changing as various nations have initiated standards development processes in the area of radioactive waste management.
2) The existing legislative and regulatory framework is inadequate for the implementation of an international program for the sub-seabed disposal of radioactive waste. Even so, it seems to prevent unilateral implementation of sub-seabed disposal while the national and international R & D programs continue, and there is still time in the R & D process on sub-seabed disposal to develop the legal and institutional structures necessary for effective implementation.

In the closely associated area of political responses: sub-seabed disposal presents special international problems for environmental protection and supervision of radioactive material transport and handling. It also offers unique opportunities for international cooperative control of nuclear activities, especially radioactive waste management (including spent reactor fuel storage, handling, and disposal) and nuclear nonproliferation (as part of an international agreement to regulate the "back-end" of the nuclear energy production process).

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