

Nuclear Waste Management Activities in the Pacific Basin and Regional Cooperation on the Nuclear Fuel Cycle

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Abstract Pacific Ocean and island sites have been used since World War II for nuclear activities, including effluent discharges from nuclear facilities, sea dumping of packaged radioactive wastes, and testing of nuclear explosives. In the future, the amounts of radioactive wastes deliberately released into the Pacific Ocean may increase in connection with planned commercial-scale nuclear fuel reprocessing operations, recommencement of plutonium production for weapons purposes, and resumption of sea dumping of low-level wastes. Proposed storage of spent nuclear fuel on Pacific island sites or disposal of high-level wastes in the deep seabed of the Pacific could also expose the ocean to a risk of contamination by long-lived radionuclides. The consequences of all these activities should be assessed in practical terms—their likely effects on the living marine resources of the Pacific and the economic development of the societies benefited by them; in terms of the legal principles which govern activities such as marine radioactive waste disposal that could pollute the marine environment; and in relation to current and future organizational arrangements that could achieve political resolution of outstanding international nuclear

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energy issues. Despite the prospective dangers of marine nuclear activities, the use of relatively remote or extraterritorial marine locations including those in the Pacific basin for nuclear operations could provide a basis for international cooperation on management of the "back end" of the nuclear fuel cycle, including storage and reprocessing of spent fuel and high-level waste disposal. A broadly recognized international regime for the nuclear fuel cycle could be based on regional organization of such back-end operations, provided local acceptance could be obtained.

The Pacific basin has since the immediate postwar period been a major focus of military and civilian nuclear activities. While these activities, especially military ones, have generally declined in recent years, there is every indication that the Pacific basin will be the site of a range of new or expanded nuclear operations, including radioactive waste storage and disposal. This paper describes past, present, and projected nuclear activities in the Pacific basin (Part I); assesses the validity of these practices under existing general international law (Part II); recounts the special arrangements already made to control marine disposal of radioactive wastes, largely arising out of experience with European disposal operations in the North Atlantic (Part III); and suggests that the principles and procedures derived from existing global and North Atlantic regional controls should be applied in the analysis of similar developments in the Pacific (Parts III-IV). It argues, finally, (Parts IV-V) that special regional arrangements in the Pacific basin for the management of nuclear waste could be a desirable solution to technical and political issues associated with nuclear fuel reprocessing, stockpiling, interim storage, and ultimate disposal—but only if environmental safeguards are rigorously applied and regional acquiescence is obtained through an internationally negotiated settlement of outstanding nuclear fuel cycle issues.

I. Nuclear Activities in the Pacific Basin

The Pacific Ocean has been subject to the effects of nuclear activities since World War II. Artificial radionuclides first began to enter the marine environment in 1944, with the commencement of

effluent releases into the Columbia River from the military nuclear facilities at Hanford, Washington.¹ From 1946 to 1970, the United States allowed dumping of packaged radioactive wastes at offshore sites, with approximately 99 percent of the total dumping, or some 14,500 curies (Ci), being deposited near the Farallon Islands off California.² The Japanese government has recently revealed that dumping was also practiced in Japan from 1955 to 1969 at a shallow site only 40 km from Tokyo Bay, and it has recently been discovered that the Republic of Korea permitted dumping in its territorial sea 1968-1973.³ The operation of nuclear reactors in Pacific Rim countries, and especially potential commercial reprocessing facilities in Japan and similar military facilities in the United States, contribute to the total radioactivity in that ocean although their effects are generally significant only in coastal waters.⁴ The Pacific has also been subject to nuclear weapons testing programs, with the United States having conducted tests on Pacific islands from 1946 to 1958,⁵ the British from 1952 in conjunction with U.S. tests, and the French from 1966 to 1973 aboveground and from then onward below.⁶ The United States conducted a test underground in the Aleutian Islands in 1969 and canceled a similar test scheduled for 1971 as a result of domestic and international opposition.⁷ Planned French tests of enhanced radiation devices (neutron bombs) have triggered further protest.⁸ Concerns have been expressed recently about the geological stability of Mururoa Atoll—the French test site—including its ability to continue to contain radioactive debris from the tests.

Perhaps it is this nuclear legacy, especially the resettlements of Pacific island peoples due to weapons testing,⁹ that makes proposed nuclear activities in the Pacific so controversial. Recently announced Japanese plans to resume dumping at sea of low-level radioactive wastes have aroused considerable opposition from governments and citizens in the Pacific. These plans, formulated after a considerable program of study and assessment,¹⁰ would begin with an experimental operation involving 5-10,000 containers containing some 500 Ci of radioactivity¹¹ and could involve disposal of up to a million drums¹² over the decade—with an annual radioactive input of about 10^5 Ci during the operational phase.¹³ The proposed dumping would occur at a deepwater site

(over 6000 m in depth) about 900 nautical miles southeast of Tokyo and somewhat nearer to the Northern Marianas island chain.¹⁴ The Japanese plans have led to official protests or expressions of concern by several Pacific governments including the Pacific island states and territories of the United States,¹⁵ districts of the Micronesian Trust Territory,¹⁶ members of the South Pacific Congress (including Papua New Guinea),¹⁷ and New Zealand.¹⁸ The government of the Commonwealth of the Northern Marianas reportedly threatened to exclude Japanese vessels from its fishing zone should dumping operations be commenced,¹⁹ and the members of the United States Pacific Basin Development Council have demanded diplomatic action by the U.S. State Department.²⁰ A petition has been submitted to the Japanese Diet asking that the dumping plans be canceled, and the Japanese government appears to have postponed actual operations, including the experimental phase, for the present.²¹ The South Pacific Regional Environment Programme being developed by a number of Pacific organizations in conjunction with the United Nations Environment Program is expected to result in a declaration on the regional marine environment including inter alia a call for prevention of the release of nuclear wastes; the plan itself calls for developing a policy to prohibit nuclear waste disposal in the region.²²

Japanese low-level waste dumping plans have also been opposed by the Association of Chief Executives of the Pacific Basin in the most recent consultative meeting of the parties to the London Dumping Convention,²³ an international instrument controlling dumping of wastes at sea.²⁴ The Association, represented by the government of Kiribati at the meeting, stated the opposition of its members to the Japanese plans to dispose of low-level waste sea dumping, their "vehement" opposition to use of Pacific island sites for the interim storage of spent nuclear fuel, and their "dread" of existing research programs aimed at disposal of high-level radioactive waste in the ocean. The executives questioned the reliability of Japanese safety assessments of low-level waste dumping and the desirability of permitting such dumping in any circumstances.

In addition to the low-level waste dumping at sea which has

been the chief focus of recent concern, other planned activities will cause increased radioactive inputs into the Pacific, including spent fuel reprocessing operations releasing long-lived radionuclides. The composition and behavior of reprocessing effluents, but not necessarily their actual uptake and retention by affected coastal populations,²⁵ have been studied in connection with the operations of the Windscale plant in the United Kingdom.²⁶ But the actual amounts and types of effluents released would depend on the details of the chemical process and waste management measures used in connection with the reprocessing. In any event, expansion of reprocessing operations to commercial scale is expected at the Tokai Mura facility in Japan, and the United States has announced expansion of reprocessing operations at the Hanford Reservation in connection with a government decision to resume plutonium production for weapons purposes.²⁷

In addition to these plans, several other nuclear activities have been proposed for Pacific Ocean locations. The United States government has investigated the use of an isolated Pacific island—Palmyra—for interim storage of spent nuclear fuel, presumably returned to U.S. possession by Japan.²⁸ The United States Department of Energy is also continuing development of a “second generation” method for disposal of high-level radioactive wastes by emplacing them in the sediments of the deep seabed (“seabed emplacement”).²⁹ Two potential sites for establishment of a deep-seabed waste repository have been charted in areas of the North Pacific that are relatively remote from the edges of tectonic plates (hence removed from areas of geological instability) and the great current gyres around the ocean rim (removed from areas of biological productivity and fishing activity).³⁰ Although most studies connected with the seabed emplacement option have focused on the deep seabed in the Pacific, potential Atlantic Ocean sites have also been identified; such international waste disposal operations would probably be organized on a regional basis if seabed emplacement were chosen as a disposal strategy. Another high-level waste disposal possibility would involve engineering waste repositories on sea islands through mining.³¹ In addition to such storage and disposal activities, Pacific basin sites could be chosen for

other activities connected with international organization of the "back end" of the nuclear fuel cycles; these are discussed in a later section.³²

II. Nuclear Activities, Nuclear Marine Pollution, and International Law

It is assumed here that nuclear fission will make a substantial contribution to the energy needs of OECD and other technologically advanced countries³³ in spite of current constraints due to public opposition. Although nuclear power generation itself remains largely concentrated in developed countries,³⁴ access to the full range of civilian nuclear activities by states currently lacking the technology to develop nuclear explosives has become the center of controversy in international discussions of the role of nuclear energy in world development.³⁵ And, while uranium enrichment plants and research and power reactors can be used to obtain the nuclear materials for a weapons capability, the chief focus of efforts by the United States and other suppliers of nuclear technology—at least prior to Israel's preemptive raid on Iraq's research reactor, and the announcement of a new policy on nuclear non-proliferation by the Reagan administration³⁶ — has been on the "back end" of the civilian nuclear fuel cycle.³⁷ Back-end activities include all the operations required for the handling and treatment of spent nuclear fuel and equipment or substances that have come into direct physical or chemical contact with it.³⁸ Back-end activities include interim storage of spent reactor fuel; potential reprocessing of the spent fuel to recover its fissionable plutonium and uranium content; storage, refabrication, and resupply of mixed plutonium and uranium oxide (MO_x) fuel; further storage, conditioning, and ultimate disposal of the wastes.³⁹ "Closing" the back end of the nuclear fuel cycle through commercial-scale reprocessing and recycling of fissionable fuel nuclides would lead to what has been called a "plutonium economy" in which there would be substantial routine international and national handling of plutonium or plutonium-rich mixtures, suitable for the expeditious production of nuclear explosives⁴⁰ Technical⁴¹ and organizational⁴² means have been sought to reduce the attendant

risks of diversion of such weapons-grade material for weapons purposes.

Apart from the risk of nuclear proliferation, back-end operations result in waste substances for which proper disposal strategies must be found. Commercial reprocessing facilities, if they are expected to operate economically, will probably lead to discharges into inland or coastal waters of radiologically contaminated chemical waste streams which would contain a significant proportion of long-lived transuranic radionuclides.⁴³ Management of the retained wastes arising from nuclear energy activities would also require disposal of low-level radioactive wastes from all associated operations;⁴⁴ transuranic-contaminated (TRU) wastes, especially from reprocessing;⁴⁵ and high-level wastes (spent fuel⁴⁶ or chemical wastes resulting from direct contact with spent nuclear fuel⁴⁷). As in the case of liquid or gaseous effluent discharges, marine disposal methodologies are available for the retained wastes. Large quantities of low-level wastes, including TRU wastes, have been dumped at sea.⁴⁸ High-level wastes could be emplaced in the seabed,⁴⁹ or on the seafloor ("seafloor emplacement"),⁵⁰ with special precautions to prevent premature escape of waste nuclides.⁵¹ High-level waste could also be emplaced in islands⁵² or continental shelf geological strata.⁵³

Due to differences in methodology and location, each of these marine disposal methods—effluent discharge, low-level waste dumping, and high-level waste emplacement—as well as other nuclear activities affecting the marine environment, would be subject to distinctive legal principles.⁵⁴ Under the usual definition,⁵⁵ pollution of the marine environment 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 and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities." This definition, which is based primarily on harmful effects on human uses of the sea and its resources,⁵⁶ must be related to the interests of nation-states since if no state interest were violated—including the rights of citizens protected by a state—no claim could arise under international

law.⁵⁷ But state interests in natural resources arise from only four basic modes of jurisdiction:⁵⁸ state sovereignty or exclusive management authority (e.g., inland waters, territorial sea, and economic or resource zones);⁵⁹ joint control (e.g., shared resources such as international lakes and river systems,⁶⁰ and possibly enclosed or semi-enclosed seas⁶¹); common property (e.g., high seas resources);⁶² and potential international ownership (possibly including the seabed outside national jurisdiction).⁶³

A. Radioactive Effluent Discharges into Coastal Waters

In areas subject to state sovereignty, such as internal waters and the territorial sea, states are generally conceded to have "the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other [s]tates or of areas beyond the limits of national jurisdiction."⁶⁴ That is, states have permanent sovereignty over their own natural resources,⁶⁵ and the obligation to prevent transfrontier pollution resulting from activities within their territorial jurisdiction. With the development of extended national maritime jurisdiction over living marine resources, including current fisheries and economic zones and especially the concept of the exclusive economic zone (EEZ),⁶⁶ coastal states will enjoy primary resource management authority in a broad marine area outside the territorial sea. To what extent the rights and obligations inherent in the concept of sovereignty over natural resources will apply to activities in this area—including nuclear activities⁶⁷—is currently unclear.⁶⁸ It is known, however, that effluent discharges from nuclear reprocessing facilities are readily transported to the coastal waters of neighboring states and to the high seas; discharged wastes from the Windscale plant, for example, have been detected near France, Denmark, and Norway, and in the Baltic and North Seas and the Arctic Ocean.⁶⁹ While to date there is no evidence that such transfrontier effects have created cause for concern in neighboring states, the contributions of nuclear reprocessing effluents to the radiological exposure of critical populations (i.e., groups most likely to be exposed to waste nuclides

through known radiological pathways)⁷⁰ have often reached 10 percent and sometimes even 40 percent⁷¹ of the generally accepted international dose limitations,⁷² for certain population groups in the United Kingdom. In the North Pacific, discharges from the expansion of plutonium production operations at the Hanford military facility and the projected scaling-up of operations at the Tokai Mura commercial reprocessing plant could lead to effluent discharges that could have a significant regional effect on the quality of the marine environment and human radiological exposures derived from local fishery harvests. Such effects would be material under international law if they rose to a level at which they had to be seriously considered by affected nations in formulating harvesting and marketing strategies for fishery resources of their territorial seas, zones of extended jurisdiction, or high seas fishery operations, or if they influenced their policies with respect to other activities resulting in human radiological exposure.⁷³

B. Sea Dumping of Low-level Radioactive Wastes

Disposal of radioactive wastes at high seas locations, outside national jurisdiction, involves the legal interests of other states more directly than waste disposal within zones of national jurisdiction. The generally accepted legal principle⁷⁴ governing activities on the high seas that could affect the marine environment or marine resources is the "reasonable use" doctrine⁷⁵ derived from Article 2 of the Geneva Convention on the High Seas,⁷⁶ which provides a non-exhaustive list of the "freedoms" of the high seas and requires states to exercise them "with reasonable regard to the interests of other States in their exercise of the freedom of the high seas." Dumping of packaged low-level wastes at sea, beyond national jurisdiction, has traditionally been viewed as subject to this conventional regime applicable to activities on the high seas. The First United Nations Conference on the Law of the Sea (UNCLOS), which drafted the High Seas Convention, specifically included a reference in this Convention to radioactive waste dumping. UNCLOS I called upon states through Article 25 to take measures to prevent marine pollution from this source, taking into

account any standards and regulations that would be formulated by the competent international organization, and to cooperate with the organization (the International Atomic Energy Agency—IAEA)⁷⁷ to take measures to prevent pollution of the seas from any activities with radioactive materials. The ultimate legal significance of Article 25 is unclear,⁷⁸ but its adoption triggered early international cooperation on this issue through the IAEA, cooperation which continues in modified form today.⁷⁹

Japan now plans to commence dumping operations on the high seas,⁸⁰ and the United States Environmental Protection Agency is developing new regulations that may encourage U.S.-authorized dumping in the deep sea to recommence.⁸¹ As will be seen in the following section,⁸² the proposed Japanese operations would likely comply with the current standards of the IAEA⁸³ and would also conform to special administrative requirements adopted under the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter⁸⁴ and through a special procedural arrangement that has been adopted by the OECD Council.⁸⁵ The Japanese had planned an experimental dumping operation for 1981⁸⁶ and estimated that the resultant radioactive dose returned to human populations would be only one ten-millionth (1×10^{-7}) of the natural background radioactivity.⁸⁷ Of course, the quantities dumped would quickly increase after this initial operation.⁸⁸ The reliability and the accuracy of Japanese safety assessments have been challenged by one academic, Professor Davis, an ecologist from the University of California at Santa Cruz.⁸⁹ Professor Davis has served as an adviser to Pacific governments on the safety issue and has been successful in raising regional concerns about the proposed operations. His work, however, would generally appear not to be in accord with accepted scientific methods of assessing the impact of radioactive releases;⁹⁰ rather it emphasizes the uncertainties in the prevailing modes of analysis, especially concerning the biological transmission of waste nuclides from the sediments at a dump site.

The suitability of the proposed dump site, the monitoring and assessment program, and the magnitude and operational procedures for the Japanese operations are subject to review by the Nu-

clear Energy Agency (NEA) of the OECD.⁹¹ The NEA is currently preoccupied, however, with a continuing dispute between U.S. and European officials over operations at the NEA dump site in the Northeast Atlantic.⁹² Although considerable study of conditions at the proposed dump site and the likely transport of released waste nuclides has been conducted by the Japanese,⁹³ the rapid scale-up from experimental to full operations and the large amount of radioactivity proposed to be dumped annually⁹⁴ appear to call for serious international consultation on the technical level.

As an activity occurring on the high seas, radioactive waste dumping is subject to general substantive standards under international law. Such operations in the Pacific basin in areas outside zones of national jurisdiction should be conducted so as not to interfere unreasonably with the interests of other states in high seas resources, such as fisheries. They should also not cause sufficient nuclear contamination to enter the coastal waters of other states to influence in any significant way their domestic policies on the development of marine resources, especially fisheries,⁹⁵ or even radioactive doses attributable to other sources such as domestic medical care or nuclear power programs.⁹⁶ In addition, the nature of such activities may generate a special need for procedural cooperation, such as international technical and when necessary political and legal consultations.⁹⁷

C. Nuclear Fuel Cycle Activities at Oceanic Locations

The United States is continuing to study the concept of disposing of high-level radioactive wastes in sediments of the deep seabed, including areas of the North Pacific.⁹⁸ Plans have been aired, supported by cooperative international research agreements, to locate interim storage facilities for spent nuclear fuel on a Pacific island.⁹⁹ It has also been suggested that remote oceanic locations, including islands, could be used for nuclear fuel reprocessing facilities.¹⁰⁰ The factors leading to such proposals will be considered below.¹⁰¹ Such activities, involving major safety, environmental, and security concerns, must be considered from the legal and political viewpoint in novel ways which cannot be summarized in

such simple verbal formulas as permanent sovereignty over natural resources, avoidance of transfrontier pollution,¹⁰² or reasonable use of the high seas.¹⁰³

In the first place, while dumping of radioactive wastes beyond national zones has traditionally been considered solely as a use of the high seas even though it of course results in the deposition of waste containers and materials on the seabed, it is not clear that new proposals to use the seabed as a repository for high-level wastes would be similarly viewed by the international community. The seabed beyond national jurisdiction has been proclaimed the "common heritage" of mankind by several U.N. General Assembly resolutions,¹⁰⁴ and it is characterized as such in the Law of the Sea Convention of UNCLOS III.¹⁰⁵ The Convention states in particular that, "No State shall claim or exercise sovereignty or sovereign rights over any part of this Area or its resources, nor shall any State appropriate any part thereof."¹⁰⁶ A state emplacing high-level radioactive wastes in the deep seabed could be expected to exclude activities of or authorized by other states, unauthorized parties, or an international body that could disturb the wastes.¹⁰⁷ This result would be mitigated, however, by the fact that such activities would be unlikely due to the location and characteristics of the wastes¹⁰⁸ and since normal economic activities such as exploration for and recovery of manganese nodules could quite likely be conducted even directly atop a deeply buried repository in the seabed.

Secondly, back-end activities, such as interim storage of spent nuclear fuel, reprocessing, storage and resupply of recycled MO_x fuel and its components, and high level waste disposal—if conducted at remote oceanic locations—would expose the oceans to the risk of serious local, regional, or even global environmental hazards. Such activities would necessarily involve considerable maritime transportation of extremely toxic and long-lived substances,¹⁰⁹ although depending on the bilateral or multilateral arrangements that are made in the future for the back end of the nuclear fuel cycle, routine maritime shipments could occur in any event.¹¹⁰ Nevertheless, the release of concentrated isotopes, spent fuel, or high-level reprocessing wastes as a result of a maritime disaster, or the release of reprocessing wastes due to an accident

at a chemical reprocessing facility, could cause a major pollution incident of concern to neighboring states or even all the coastal states of an ocean basin. Affected states would probably view such activities even more skeptically than they do such relatively more familiar activities as low-level waste dumping.

Thirdly, broad issues of international equity are likely to enter any international consideration of such new nuclear and maritime developments. There is currently considerable antagonism between nuclear supplier and recipient states due to disagreement over arrangements for equitable international sharing of the benefits of nuclear energy, including access to all aspects of the nuclear fuel cycle.¹¹¹ As a result of the negotiations at UNCLOS III, furthermore, the less developed nations can be expected to react sharply to new technological uses of the oceans beyond national jurisdiction—especially those which may carry special environmental risks—which are primarily controlled by a limited group of technologically advanced and economically developed states. As a result of these factors, it can be predicted that proposals to take advantage of the special features of the deep oceans in organizing nuclear fuel cycle activities will be scrutinized more rigorously than under traditional law of the sea principles.

III. The International Organization of Marine Radioactive Waste Disposal

Although marine nuclear activities are subject to general principles arising from the international law on the environment and natural resources and the law of the sea, the focus of international consideration of existing marine disposal practices has been on the establishment by special agreement of essential technically-oriented standards and procedures. The basic legal instrument in this field is the London Dumping Convention,¹¹² which identifies and classifies certain potentially harmful substances in two Annexes. Dumping at sea of Annex I substances, including high-level radioactive wastes,¹¹³ is prohibited;¹¹⁴ dumping of Annex II substances, including all other radioactive waste,¹¹⁵ is permitted only pursuant to the issuance of a special permit¹¹⁶ by the responsible

national authority.¹¹⁷ The IAEA is authorized to define high-level radioactive wastes unsuitable for dumping at sea, for purposes of Annex I, on the basis of public health, biological, or other considerations,¹¹⁸ and to make recommendations concerning the dumping of other radioactive wastes.¹¹⁹

The IAEA first issued guidelines on sea dumping of radioactive waste in 1961,¹²⁰ upon request of UNCLOS I in a resolution¹²¹ accompanying its adoption of the High Seas Convention.¹²² It responded to the later mandate of the London Convention by developing a definition of high-level waste expressed in terms of a concentration of radioactivity per unit mass that, if dumped at a rate less than an assumed upper mass rate of dumping, would result in an acceptable return of radioactivity to man estimated on the basis of oceanographic and radiological modeling.¹²³ While this definition is not qualitative, it is thought to exclude wastes that would traditionally be considered high level.¹²⁴ The IAEA has also developed recommendations, including quantitative limits on wastes released into an ocean basin,¹²⁵ for dumping of low-level radioactive wastes.¹²⁶ Under the IAEA recommendations, marine areas of human use and biological productivity, specifically sites shallower than 4000 m and above 50° latitude, are excluded from dumping.¹²⁷ The IAEA has also recommended continued pursuit of an isolation and containment strategy for dumped wastes, through improved packaging,¹²⁸ and has stated that London Convention parties should develop environmental assessments¹²⁹ for dumping operations, to be transmitted along with their notifications of the issuance of special permits for Annex II substances.¹³⁰

The IAEA Definition and Recommendations¹³¹ provide a substantive basis for assessing the environmental effects of radioactive waste dumping.¹³² But organization and control of actual operations by nations currently involved in dumping as well as administrative functions associated with specific operations and programs have been carried out within a limited membership organization, the OECD Nuclear Energy Agency (NEA). The NEA organized collective dumping operations in Europe beginning in 1967,¹³³ and serves as a forum for technical consultations related to packaging,¹³⁴ operational procedures,¹³⁵ and designation and

continued use of dump sites, especially the North Atlantic Dump Site.¹³⁶

Since 1977, individual European countries have resumed organizing dumping operations on an individual or joint basis without direct NEA responsibility, under the Multilateral Consultation and Surveillance Mechanism adopted by the OECD Council.¹³⁷ The OECD mechanism provides for a system of prior notification and consultation on radioactive waste dumping, as well as supervision of actual operations. For routine operations, general information concerning a proposed operation is communicated six months, and operational details three months, in advance.¹³⁸ One year notice is required prior to use of a new dump site.¹³⁹ Expert advisement must be sought upon request of a consulting party or in case of use of a new site or unapproved equipment or techniques.¹⁴⁰ An NEA representative is to accompany the ship during operations; he has the power to suspend operations in case of a disagreement between him and the national escorting officer.¹⁴¹

Proposed nuclear activities in the Pacific basin raise several issues both under the London Convention framework and current OECD administrative arrangements. With regard to low-level waste dumping, Japan, which joined the NEA in 1972,¹⁴² has indicated that it will conduct its operations subject to the OECD mechanism.¹⁴³ But of all the coastal states of the Pacific, only Australia, Canada, Japan, New Zealand, and the United States are OECD members, although France and the United Kingdom also have governmental responsibilities in the Pacific.¹⁴⁴ And, despite a clause in the OECD mechanism that provides that participating countries do not necessarily recognize the legality of radioactive waste dumping,¹⁴⁵ Australia and New Zealand have declined to participate in the mechanism.

Japan became a party to the London Dumping Convention in October 1980,¹⁴⁶ and can be expected to comply with the provisions of the Convention and conform to the IAEA Definition and Recommendations.¹⁴⁷ (Its proposed dump site is in an area generally deeper than 6000 m and is apparently outside major fishing areas.)¹⁴⁸ A large number of nations—forty-seven—are currently parties to the London Convention.¹⁴⁹ The basic substantive terms

of the Convention, including the prohibition on dumping of high-level waste and careful control of low-level waste dumping under IAEA standards and guidelines, would therefore appear to possess considerable stature in international law. But of the London Convention parties, only a small number are coastal states of the Pacific (Canada, Chile, New Zealand, Papua New Guinea, France and the United Kingdom as representatives of Pacific island possessions, and Kiribati as an observer representing itself and the Association of Chief Executives of the Pacific Island Governments.)¹⁵⁰ The Association has indicated at the Sixth Consultative Meeting under the Convention in October 1981 that it would seek amendment of the Convention to prohibit dumping of low level radioactive wastes at sea.¹⁵¹ Despite current polarization on this issue, the Convention framework could serve as a forum for parties to resolve issues arising in connection with the proposed Japanese operations, either through special technical consultations, future consultative meetings of the parties, or formal dispute settlement under a recently adopted amendment to the Convention.¹⁵² The amendment authorizes referral of disputes, upon agreement, to adjudication by the World Court or to other dispute resolution procedures including arbitration. Eight countries, including Canada, France, Japan, the United Kingdom, and the United States, have so far accepted the amendment.

Furthermore, although the London Convention authorizes and encourages the formation of regional organizations to carry out functions under the Convention,¹⁵³ there is no such organization in the Pacific paralleling those already established for the North and Mediterranean Seas.¹⁵⁴ Consultation under the OECD mechanism, and within the NEA—as proposed by Japan¹⁵⁵—would not appear to qualify as an example of regional organization,¹⁵⁶ since the OECD and its agencies are not formed on a geographical basis.¹⁵⁷ In fact, the point has also been made at consultative meetings of the parties to the London Convention that the objectives of the NEA may not be fully consistent with the environmental objectives of the Convention.

The absence of a regional organization or organizations in the Pacific qualified under the London Convention, the nonaccession of most coastal states in the Pacific to the Convention, and the

exclusive nature of current consultations within the OECD group will certainly impede local review of, and potential acquiescence in, the operations currently proposed by Japan.¹⁵⁸ The schizoid status of the United States and other OECD members with governmental responsibilities in the Pacific basin will no doubt continue to cause friction for those governments as they attempt to reconcile their participation in Europe-oriented administrative frameworks with possibly differing technical and political requirements in the Pacific.¹⁵⁹

These organizational difficulties would be compounded in the case of seabed emplacement of high-level radioactive waste,¹⁶⁰ since dumping of high-level waste at sea has been discouraged since 1959¹⁶¹ and legally prohibited for London Convention parties since 1972.¹⁶² Furthermore, actions in international bodies such as the scientific committees or consultative meetings of the Convention parties or the IAEA would probably be required to legitimize this method of disposal.¹⁶³ It is not exactly clear whether seabed emplacement should be considered "dumping at sea" within the scope of the London Convention.¹⁶⁴ But it appears unlikely that the coverage of the Convention could be restrictively construed to exclude such an activity, especially in light of the environmental protection objectives of the Convention¹⁶⁵—at least in the absence of a superordinate international regime including such radioactive waste management responsibilities along with authority to control other aspects of the nuclear fuel cycle.¹⁶⁶ The recognition of any future actions within the London Convention framework to legitimize and regulate seabed emplacement, for operations in the Pacific, would be hindered by the nonaccession of most Pacific coastal states to the Convention. Furthermore, whatever the institutional path chosen by proponents of seabed emplacement, such an extraterritorial disposal scheme—especially one involving the oceans—would likely become subject to special scrutiny by third world nations, especially coastal states. Such a development, posing certain risks to the common marine environment, could be viewed as inequitably utilizing ocean resources for the benefit of the technologically advanced nations.¹⁶⁷ Therefore some form of direct international negotiations must be envisioned on such extraterritorial operations,¹⁶⁸ perhaps supplemented by re-

gional agreements among the most directly involved states,¹⁶⁹ before ocean disposal of high-level radioactive wastes would be politically acceptable.

IV. The Pacific Basin and Regional Organization of the Nuclear Fuel Cycle

Although the geographical focus of international attention on marine nuclear activities has historically been on the Northeast Atlantic due to continued dumping operations and related technical consultations there, future activities involving the Pacific Ocean may make it at least a coequal focus of concern. Proposed waste dumping by Japan and possible future dumping by the United States will extend the geographical scope of existing organizational arrangements to cover certain operations in the Pacific, but may in addition call into question the legitimacy of such existing arrangements when applied within the Pacific basin.¹⁷⁰ Novel concepts such as interim storage of spent nuclear fuel on a Pacific island¹⁷¹ or disposal of high-level radioactive waste in abyssal plains of the Pacific seabed¹⁷² will probably encounter a skeptical response by Pacific governments and peoples, who have been subjected to ill-conceived or maladministered nuclear activities in the past—including covert shallow-water dumping in Japan;¹⁷³ inexact and poorly recorded dumping practices on the Pacific coast of the United States;¹⁷⁴ forced relocations, inhumane maintenance, and controversial or aborted resettlement programs for Pacific island peoples whose lands were subject to nuclear weapons testing;¹⁷⁵ and also human radioactive exposures from such testing.¹⁷⁶

Pacific governments and peoples often appear to object automatically to nuclear activities as a result of this legacy. Nevertheless, future nuclear fuel cycle activities in the Pacific basin, if properly managed, could make a significant positive contribution to the intractable international problem of organizing the back end of the nuclear fuel cycle.¹⁷⁷ Regional organization could also improve the economic, environmental, and security situation in the Pacific basin assuming that commercial reprocessing becomes widespread and a "plutonium economy" develops.

Under the most synoptic approach suggested, back-end functions would be concentrated at a single distant marine location, such as a remote island or continental coastline.¹⁷⁸ This functional approach, called "colocation,"¹⁷⁹ would assemble to the extent practicable such back-end operations as interim spent fuel storage, reprocessing, inventorying of plutonium and uranium (U/Pu) and fuel refabrication, and high-level waste conditioning operations.¹⁸⁰ Additional concentration of functions could be achieved if high-level waste disposal could occur nearby,¹⁸¹ either in an engineered (mined) repository¹⁸² or in the deep seabed.¹⁸³ Such an organization of nuclear fuel cycle activities could result in advantages in terms of the distance, cost, and safety of transportation; physical security; public acceptability; and isolation of any acute or chronic nuclear release problems from large human populations.¹⁸⁴ Such a functional center could be managed by a national authority, a nationally licensed entity in the name of a national or international agency, or directly by an international organization.¹⁸⁵ In the latter case, either an enclave of international jurisdiction would have to be created in national home territory, or a segregated location such as an island could be chosen and administered by or ceded directly to the international body.¹⁸⁶

To obtain the advantages of siting at a distant marine location, not all back-end functions would have to be centralized. Depending on future assessments of relevant cost, safety and political factors, specific back-end functions could be located at a distant marine site. These could include spent fuel storage,¹⁸⁷ reprocessing, U/Pu stockpiling and MO_x fuel refabrication and resupply operations, or waste conditioning and disposal.¹⁸⁸ In so locating only specific functions, however, care should be taken that the location makes functional sense and is not merely motivated by political factors, such as public unwillingness to accept certain operations on national home territory. There could be cost and safety advantages in organizing international operations on such a regional basis,¹⁸⁹ perhaps one in each major ocean basin as a start.

Storage, chemical processing, mechanical handling, and disposal of dangerous nuclear substances in distant marine locations would have several general advantages. Transportation could be rationalized to minimize handling and shipping costs, the risks of

maritime accidents, or the possibility of diversion of critical substances at sea.¹⁹⁰ Security of actual operations could be increased since a complex and visible maritime effort would probably be required to breach the integrity of such a center.¹⁹¹ Long-term or low-level releases of nuclear substances from containment could be more easily monitored in the marine environment than on land,¹⁹² especially in view of the relative unpredictability of groundwater routes on the continents,¹⁹³ and if releases were discovered, they could be assessed objectively and appropriate action taken—all without possibly irrational political pressures that could occur if a release were found to occur in proximity to human populations.¹⁹⁴ Large or sudden releases or radioactivity due to maritime casualty or operational mishaps or massive failure of waste containment measures would also tend to occur at relatively remote locations, allowing time for response and in all likelihood averting possible catastrophe.¹⁹⁵ Irretrievably lost nuclear substances would be dispersed by the deep ocean.

It is probably premature to speculate about the political organization that would be necessary, or best adapted, to such a system. Various scenarios have been suggested,¹⁹⁶ including direct operation by a global or subglobal, universal, or limited membership organization, with a range of possible management authority; multilateral or national arrangements; and direct national or nationally-authorized operations. Regardless of the organizational form ultimately proposed, however, locating operations in remote marine areas could tend to favor the development of international and especially regional organization of the nuclear fuel cycle.¹⁹⁷ While the coastal states of an ocean basin would have legitimate concerns about the safety of such activities, full consideration of the alternatives for international management of the nuclear fuel cycle might bring them to believe that such an approach were actually the most desirable from the economic, environmental, health, safety, and security viewpoints. The concerns of coastal states could also ultimately have the beneficial effect of making the major nuclear suppliers more aware of the importance of incorporating the views of these nations into their decision-making on nuclear fuel cycle issues, potentially leading to more acceptable organizational as well as functional approaches.¹⁹⁸

V. Conclusion

Given the reaction of Pacific governments and peoples to past and currently proposed nuclear activities in the Pacific basin, it would appear unlikely that such activities—especially those directly connected with the back end of the nuclear fuel cycle—would be politically viable unless general consensus could be attained in the region. Development of such a consensus would probably require some form of regional organization of these activities, implemented after consultation and possibly formal agreement—in the presence of clear and demonstrated economic and environmental advantages for the coastal states of the Pacific. The existing international organization of marine radioactive waste disposal operations will probably not be sufficient to deal satisfactorily with novel marine-related nuclear activities as spent fuel storage, reprocessing, and high-level waste disposal, especially in the Pacific basin—and possibly not even for such relatively more familiar operations as low-level waste dumping.¹⁹⁹ If environmentally sound and economically beneficial arrangements are to be made for future nuclear activities in Pacific nations, new international institutions will have to be designed to administer nuclear fuel cycle functions, including radioactive waste management operations.²⁰⁰

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Notes

1. See C. L. Osterberg, "Radiological Impacts of Releases from Nuclear Facilities into Aquatic Environments — USA Views," in International Atomic Energy Agency (IAEA), *Impacts of Nuclear Releases*

into the Aquatic Environment (Proc. Symp. Otaniemi, Finland) (1975), pp. 3-15.

2. *Hearings before the Subcomm. on Oceanography of the House Comm. on Merchant Marine and Fisheries*. 96th Cong., 1st & 2nd Sess. 341 (1979 & 1980) (hereinafter "1980 Hearings") (statement of Roger Mattson).

3. 3 *Int'l Env't Rptr. (BNA)* 472 (1980) (Japan), 210 (1980) (Korea).

4. Civilian nuclear operations to date have contributed less than one thousandth the natural (background) radiation of the sea. Atmospheric nuclear tests have resulted in the largest artificial input to the radioactivity of the oceans, about a thousand times that of all other nuclear operations combined, of which civilian operations have thus far constituted a small fraction. See IAEA, "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter: The Definition Required by Annex I, paragraph 6 to the Convention, and the Recommendation Required by Annex II, Section D," IAEA Doc. INF-CIRC/205/Add.1/Rev.11 (Aug., 1978) (hereinafter "IAEA Definition and Recommendations"), Annex, par. 2.2.7. International Atomic Energy Agency, Vienna, 26 pp. While small in quantity, however, waste nuclide releases are localized and should be evaluated and controlled carefully. See *ibid.*, par. 2.2.5; see also text at notes 69-96, *infra*.

5. M. P. McDougal and W. Schlei, "The Hydrogen Bomb Tests in Perspective: Lawful Measures for Security," *Yale L. J.* 64: 648-725 (1955).

6. International Court of Justice (ICJ), *Nuclear Test Cases*. (Australia v. France), [1974] I.C.J. Rep. 253, 266; (New Zealand v. France), [1974] I.C.J. Rep. 457 (judgment). See generally I. Zander and R. Araskog, "Nuclear Explosions 1945-1972; Basic Data," Research Institute of National Defense [Sweden], April, 1973, 56 pp.

7. G. Handl, "An International Legal Perspective on the Conduct of Abnormally Dangerous Activities in Frontier Areas: The Case of Nuclear Power Plant Siting," *Ecol. L. Q.* 7: 1-50, at 21-23 (1978). The U.S. has also conducted underwater nuclear tests at its Pacific island test sites, and in fact in 1958 conducted such a test, "Wigwam," off the California coast. See I. Zander et al., *supra*, at 20.

8. *N. Y. Times*, Jul. 14, 1981, at A12, col. 2.

9. See, e.g., M. Weisgall, "The Nuclear Nomads of Bikini Atoll," *For. Pol'y* 39: 74-86 (1980).

10. A popular account of associated safety studies and planned precautions is given in Nuclear Safety Bureau, Science and Technology Agency [Japan] (hereinafter "Japan S & T Agency"), "Safety on [*sic*]

Sea Dumping of Low-Level Radioactive Wastes" (undated), 8 pp. A sample of technical papers produced in connection with Japanese plans to conduct dumping are contained in Organization for Economic Cooperation and Development (OECD), Nuclear Energy Agency (NEA), "Marine Radioecology" (Proc. Sem. Tokyo) (1980).

11. 3 *Int'l Env't Rptr. (BNA)* 411 (Sept. 10, 1980); *N.Y. Times*, Aug. 3, 1980, at 13, col. 5; Japan S & T Agency, "Low Level Radioactive Wastes: Dumping at [sic] the Pacific" (1980), 12 pp.

12. 3 *Int'l Env't Rptr. (BNA)* 411 (Sept. 10, 1980); *N.Y. Times*, Aug. 3, 1980, at 13, col. 5.

13. Japan S & T Agency, *supra* n. 11, at 8.

14. Notes 12-13, *supra*.

15. *N.Y. Times*, Oct. 5, 1980, at 13, col. 1.

16. *Far Eastern Eco. Rev.*, Nov. 7, 1980, at 80-81.

17. *Ibid.*, at 40.

18. *New Zealand Update*, Aug. 1980.

19. 3 *Int'l Env't Rptr. (BNA)* 411 (Sept. 10, 1980).

20. See note 12, *supra*. The Association of Chief Executives of the Pacific Basin have also appealed to the United States to withdraw from and oppose marine storage and disposal activities for nuclear wastes in the Pacific. See note 23, *infra*.

21. *N.Y. Times*, Mar. 18, 1981, at A7, col. 1. Current appropriations to the Japan S & T Agency include mostly funds for surveys and laboratory research; continued efforts to persuade Pacific governments of the acceptability of the Agency's plans are, however, expected. See *ibid.*

22. South Pacific Commission, with South Pacific Bureau for Economic Cooperation, Economic and Social Commission for Asia and the Pacific, and UNEP, South Pacific Regional Environment Programme Working Papers of a Conference on the Human Environment of the South Pacific, Rarotonga, March 8-11, 1982, 55 pp.

23. Nuclear Waste Management in Pacific Waters. Submitted by the Government of Kiribati, IMCO Doc. LDC VI/7/3 (18 Sept. 1981).

24. See text at notes 112-119, *infra*.

25. J. A. Hetherington et al., "Environmental and Public Health Consequences of the Controlled Disposal of Transuranic Elements to the Marine Environment," in *Transuranium Nuclides in the Environment* (Proc. Symp. San Francisco) (1976), pp. 139-154 (response to question from the floor).

26. See e.g., *ibid.*; A. Preston and N. T. Mitchell, "Evaluation of Public Radiation Exposure from the Controlled Marine Disposal of Radioactive Waste (With Special Reference to the United Kingdom)," in

IAEA, *Radioactive Contamination of the Marine Environment* (Proc. Symp. Seattle) (1972), pp. 575-593.

27. Department of Energy (DOE), "Compliance with the National Environmental Policy Act; Intent to Prepare an Environmental Impact Statement on Operation of PUREX and Uranium Oxide Plant Facilities at Hanford, Washington," 46 *Fed. Reg.* 7049 (Jan. 22, 1981).

28. *Hearings on S. 1119 before the Senate Comm. on Energy and Natural Resources*. 96th Cong., 1st Sess. (statement of Thomas R. Pickering). The United States on July 18, 1980 concluded an agreement with Japan to study interim storage of spent nuclear fuel on a Pacific island; a two-year work plan was agreed in November, 1980. See *1980 Hearings*, supra note 2, at 6-7 (testimony of Leslie H. Brown). These plans and studies have explicitly been criticized by the Pacific Basin Chief Executives. See note 23, supra.

29. See generally U.S. DOE, *Final Environmental Impact Statement. Management of Commercially Generated Radioactive Waste* (3 vols.; Oct., 1980) (hereinafter "DOE Generic EIS"), at 1.6, 6.67.

30. Sandia Laboratories (U.S. Dept. of Energy), Seabed Programs Division, Subseabed Disposal Program Plan (1980), 2 vols.

31. See DOE Generic EIS, supra note 29, at 6.48-6.61.

32. See text at notes 170-198, infra.

33. See, e.g., OECD, NEA, *Objectives, Concepts and Strategies for the Management of Radioactive Waste Arising from Nuclear Power Programs* (1977), (hereinafter "NEA study"), 71 pp., at 30-31.

34. T. Duderstadt and H. Kikuchi, *Nuclear Power: Technology on Trial* (1979), 150 pp., at 51, 124-125.

35. See, e.g., A. Lewis, "Talks End in Failure on Atom Weapons," *Int. Herald Trib.*, Sept. 8, 1980, at 1, col. 1; "Some Progress is Reported in Geneva Arms Talks," *N.Y. Times*, Sept. 8, 1980, at 45, col. 1. See also A. Lewis, "Short Fuses at the Nuclear Treaty Review," *N.Y. Times*, Aug. 18, 1980, at 4E, col. 4.

36. "Reagan Statement on Spread of Atomic Arms," *N.Y. Times*, July 17, 1981, at A4, col. 1; R. Walsh, "Reagan Outlines Nonproliferation Policy," *Sci.* 213: 522 (1981)

37. For a detailed political analysis of political issues involved in organizing the back end of the nuclear fuel cycle, see G. Rochlin, *Plutonium, Power, and Politics* (1979) Univ. of California Press, Berkeley, 397 pp., at 103-186. For a description of the basic Carter Administration position, see R. Walsh, "Fuel Reprocessing Still the Focus of U.S. Nonproliferation Policy," 3 *Sci.* 201: 692-697 (1978).

38. For a description of spent fuel reprocessing and associated ac-

tivities, see generally W. Bebbington, "The Reprocessing of Nuclear Fuels," *Sci. Amer.* 235(6): 30-41 (Dec., 1976).

39. See generally M. Willrich and R. Lester, *Radioactive Waste: Management and Regulation* (1977), Free Press, Macmillan Publ. Co., New York, 138 pp.

40. See generally T. Power, "The Carter Anti-Plutonium Policy," *Energy Pol'y*, 7(3): 215-231 (1980). A single commercial-scale reprocessing plant could generate 250 kilograms (kg) of plutonium per year; 1 kg is sufficient to construct a nuclear explosive. See Rochlin, *supra* note 38, at 139-142.

41. See generally IAEA, *International Fuel Cycle Evaluation (INFCE)*, 9 vols. (Vienna, 1980).

42. See generally Rochlin, *supra* note 37, at 189-306.

43. See Hetherington et al., *supra* note 25, at 139. See also United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), *Sources and Effects of Ionizing Radiation* (1977), Annex D at 202. The transuranics, elements with a higher atomic number than uranium, are a class of man-made radionuclides that are primarily alpha particle emitters. See Willrich and Lester, *supra* n. 39, 125-126.

44. Low-level wastes, which are produced in fantastic volumes as a result of nuclear activities—275 million cubic feet in the United States alone by the year 2000—include all substances which have become radioactive due to contact with or exposure to nuclear materials or processes, but not by direct mechanical or chemical contact with nuclear fuel, and which do not contain significant levels of transuranic contamination. (See note 46, *infra*.) See generally *Hearings Before the House Subcomm. on Oceanography and Fisheries and Wildlife Conservation and the Environment*, 95th Cong., 1st & 2nd Sess. (1978), at 196 (statement of John M. Deutch).

45. See Willrich and Lester, *supra* note 39, at 6, 12, 16-17.

46. In line with Carter Administration policies to impose a moratorium on reprocessing. See note 40, *supra*. U.S. government agencies have analyzed high-level waste disposal options as including potential disposal of spent fuel. See, e.g., DOE Generic EIS, *supra* note 29, at 4.11-4.13. It had previously been assumed that spent fuel would be reprocessed for recovery of fissionable material and the residue conditioned for treatment as a waste. See, e.g., Bebbington, *supra* note 38. Only the leachate resulting from the first cycle of the chemical extraction of U/Pu or equivalent chemical products, has customarily been considered "high-level waste." See, e.g., 10 C.F.R. Pt. 50 App. F (1980).

47. See *ibid*.

48. See text at notes 94, 133-141, *infra*.
49. See text at notes 29-30, *supra*.
50. See, e.g., Royal Commission on Environmental Pollution [U.K.]. Sixth Report, *Nuclear Power and the Environment* (Cmnd. 6618, 1976), Her Majesty's Stationery Office, London, 205 pp., at 149.
51. See *ibid.*; NEA study, *supra* note 33, at 55-56.
52. See text at note 31, *supra*.
53. See Royal Commission Report, *supra* note 50, at 153.
54. A more extensive analysis of the legal status of these methodologies may be found in D. P. Finn, "Ocean Disposal of Radioactive Wastes: The Obligation of International Cooperation to Protect the Marine Environment," 21 *Va. J. Int. L.* 621-690, at 645-683 (1981).
55. United Nations Third Conference on the Law of the Sea (UNCLOS III). Draft Convention on the Law of the Sea (Informal Text) (hereinafter "Draft LOS Convention"), U.N. Doc. A/CONF. 62/WP.10/Rev. 3 (27 Aug. 1980). Art. 1(4). This definition is derived from the work of the U.N. interagency Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). See GESAMP, Comprehensive Outline of the Scope of the Long-Term and Expanded Program of Oceanic Exploration and Research, U.N. Doc. A/7750, Part I, at 3 (Nov. 10, 1969).
56. See generally L. Springer, "Towards a Meaningful Concept of Pollution in International Law," *Int. & Comp. L. Q.* 26: 531-557, at 537-551 (1977).
57. M. Hardy, "International Control of Marine Pollution," *Nat. Res. J.* 11: 296-348 (1971), at 299-300; Springer, *supra*.
58. Bilder, "International Law and Natural Resources Policies," *Nat. Res. J.* 20: 451-486, at 452-465 (1980).
59. See text at notes 64-73, *infra*.
60. In the case of shared resources such as international watercourses there may be both substantive and procedural constraints on action by a state or its authorities. See United Nations Environment Program (UNEP), Governing Council, Draft Principles of Conduct in the Field of the Environment for the Guidance of States in the Conservation and Harmonious Utilization of Natural Resources Shared by Two or More States. Decision 6/14 (May 19, 1978), G.A.O.R., 33rd Sess., Supp. No. 25, U.N. Doc. A/33/25, at 154-155, recommended for the guidance of states by the U.N. General Assembly in Res. 34/186 (Dec. 18, 1979). See C. O. Adede, "United Nations Efforts Toward the Development of an Environmental Code of Conduct for States Concerning Harmonious

Utilization of Shared Natural Resources," *Albany L. Rev.* 43: 488-520 (1979). See generally Stephen T. Schwebel, "Second Report on the Law of the Non-Navigational Uses of International Watercourses," U.N. Doc. A/CN.4/332 (Apr. 24, 1980), plus addenda.

61. See Draft LOS Convention, *supra* note 55, Arts. 122-123.

62. See text at notes 74-96, *infra*.

63. See text at notes 104-111, *infra*.

64. United Nations Conference on the Human Environment (Stockholm, 1972). Report of the United Nations Conference on the Human Environment, U.N. Doc. A/CONF. 48/14/Rev. 1 (1973).

65. See, e.g., United Nations General Assembly, Charter of the Economic Rights and Duties of States, Res. 3281 (XXIX) (Dec. 12, 1974), Art. 2.

66. See Draft LOS Convention, *supra* note 55, Arts. 55-75.

67. Baron S. von Welck, "The Third United Nations Conference on the Law of the Sea and the Use of Nuclear Energy," *Nucl. L. Bull.* 15: 63-72, at 69 (1975).

68. J. Schneider, "Something Old, Something New: Some Thoughts on Grotius and the Marine Environment," *Va. J. Int. L.* 18: 147-164, at 151 (1977).

69. H. Kautsky, "The North Sea Region Taken as an Example for the Behavior of Artificial Radioisotopes in Nearshore Sea Areas," in NEA Tokyo Seminar, *supra* note 10, pp. 283-289.

70. A. Preston and N. T. Mitchell, "Evaluation of Public Radiation Exposure from the Controlled Marine Disposal of Radioactive Waste (with Special Reference to the United Kingdom)," in IAEA, *Radioactive Contamination of the Marine Environment* (Proc. Symp. Seattle) (Vienna, 1972), at 575.

71. See *ibid.*, at 589.

72. These are promulgated by the International Commission on Radiological Protection (ICRP), a nongovernmental scientific organization of professional radiologists meeting in conference. See *Recommendations of the International Commission of Radiological Protection* (rev. 1977) in *Annals of the ICRP* 1(3) (1977), ICRP Pub. No. 26, Pergamon Press, Oxford, 53 pp. In addition to dose limitations, the ICRP has recommended that exposures be "kept as low as reasonably achievable, economic and social factors being taken into account," and that exposures should be optimized—i.e., no practice leading to increased exposure being adopted unless it produces a net social benefit. *Ibid.*, par. 12-13.

73. See text at notes 56-63, *supra*.

74. See, e.g., M. P. McDougal and W. T. Burke, *The Public Order of the Oceans* (1962) Yale University Press, New Haven, 1226 pp., 757-763.

75. See *ibid.*

76. Convention on the High Seas (1958), 13 U.S.T. 2312, TIAS No. 5200, 450 U.N.T.S. 82, *entered into force* Sept. 30, 1962.

77. See notes 120-132, *infra*.

78. Compare McDougal and Burke, *supra* note 75, at 867 (Article 25 admonitory only) with P. Reyners, "La pratique des évacuations en mer des déchets radioactifs et nécessité d'une réglementation internationale," in *Droit nucléaire et droit océanique* (Colloque) (Recherches Panthéon-Sorbonne, Univ. de Paris I, 1975), pp. 95-115 (Article 25 imposes an obligation on states to engage in technical consultations to resolve outstanding scientific concerns on reasonableness of proposed operations).

79. See text at notes 120-132, *infra*.

80. See text at notes 10-14, *supra*.

81. See Statement of Roger Mattson, *supra* note 2, at 13.

82. See text at notes 146-153, *infra*.

83. See IAEA Definition and Recommendations, *supra* note 4.

84. (1972), 26 U.S.T. 2403, TIAS No. 8165, *entered into force* Aug. 30, 1975. Japan acceded to this treaty effective October 15, 1980 (information supplied by Office of the Treaty Advisor, U.S. Department of State).

85. Decision of the OECD Council of 22nd July 1977 Establishing a Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Waste. OECD Doc. C(77)115 (final) (hereinafter "OECD mechanism").

86. See text at note 11.

87. Japan S & T Agency, *supra* note 10, at 6.

88. See text at notes 12-13, *supra*.

89. See, e.g., J. Davis, "Present Status of Oceanic Radioactive Waste Dumpsites" (abstract), attached to IMCO Doc. LDC. VI/7/3, *supra* note 23, as Annex 4.

90. See, e.g., Government of Japan, "Safety of the Japanese Sea Dumping Program," IMCO Doc. LDC VI/INF.2 (5 Oct. 1981); see also document of same title informally distributed at the London Convention Sixth Consultative Meeting.

91. See text at notes 133-141, 155-158, *infra*.

92. See NEA, "Review of the continued suitability of the dumping site for radioactive waste in the North-East Atlantic," 100 pp. (Paris,

Apr. 1980). See also OECD, NEA, *Eighth Activity Report 1979* (Paris, 1980), 114 pp., at 35-36.

93. See note 10, *supra*.

94. The proposed annual radioactive input — 10^5 Ci — exceeds the totals currently dumped by European nations into the North Atlantic, which ran to 8.45×10^4 Ci in 1979. See R. S. Dyer, "Sea Disposal of Nuclear Waste: A Brief History" in T. C. Jackson, ed., *Radioactive Waste: The Ocean Alternative* (Proc. Conf. Washington, 1980) Pergamon Press, New York, 1981, pp. 9-16. Total European dumping 1967-1979 was just over 5×10^5 Ci. *Ibid.* The latter totals have caused concern among U.S. officials about their potential transmission from the well-established Northeast Atlantic Dump Site. See note 92, *supra*.

95. See text at notes 72-76, *supra*.

96. Recommended limitations on radioactive doses are not distinguished as to source; all doses must be summarized in controlling the health effects of nuclear activities. See ICRP, "Implications of Commission Recommendations that doses be kept as low as Readily Achievable," ICRP Pub. No. 22 (rev. 1980), par. 17. Pergamon Press, Oxford, 17 pp.

97. See generally Finn, *supra* note 54.

98. See text at notes 29-30, *supra*.

99. See text at note 28, *supra*.

100. Rochlin, *supra* note 37, at 257-293.

101. See text at notes 177-198, *infra*.

102. See text at notes 64-68, *supra*.

103. See text at notes 74-76, *supra*.

104. See generally T. G. Kronmiller, *The Lawfulness of Deep Seabed Mining* (1980), Vol. 1, at 19-52. National Technical Information Service, Bethesda, Maryland, 2 vols., 560 pp.

105. *Supra* note 55, Art. 136.

106. *Ibid.*, Art. 137(1).

107. See generally DOE Generic EIS, *supra* note 29, at 3.22-3.24.

108. See *ibid.*, at 3.23.

109. The potential toxicity of the radionuclides found in spent nuclear fuel is generally discussed in B. Cohen, "The Disposal of Radioactive Wastes from Fission Reactors," *Sci. Amer.* 236(6): 21-31 (1977).

110. See generally Rochlin, *supra* note 37, at 213-256.

111. See text at note 36, *supra*.

112. *Supra* note 84.

113. *Ibid.*, Annex I(6).

114. *Ibid.*, Art. IV(1)(a).

115. *Ibid.*, Annex II(D).
116. *Ibid.*, Art. IV(1)(b).
117. States are directed to exercise citizenship, territorial, and limited port state jurisdiction over vessels and aircraft conducting dumping operations. See *ibid.*, Art. VIII.
118. *Ibid.*, Annex I(6).
119. *Ibid.*, Annex II(D).
120. IAEA, *Radioactive Waste Disposal into the Sea*, Safety Series No. 5 (1961). International Atomic Energy Agency, Vienna, 174 pp.
121. 450 U.N.T.S. 58 (Apr. 27, 1958).
122. See text at notes 75-80, *supra*.
123. See generally IAEA Definition and Recommendations, *supra* note 4, par. A.1.1 and n.1.
124. See *ibid.*, at par. 2.3.1.
125. *Ibid.*, par. B. 1.2.
126. *Ibid.*, sec. B.
127. *Ibid.*, par. C.2.1(2).
128. *Ibid.*, par. B.1.3.
129. *Ibid.*, par. B.1.1.
130. London Convention, *supra* note 85, Art. VI(4).
131. *Supra* note 4; see generally text at notes 122-129, *supra*.
132. See IAEA Definition and Recommendations, *supra* note 4, par. B.1.1.
133. See OECD/NEA, *Radioactive Waste Disposal Operation Into the Atlantic—1967* (Paris, 1968), 74 pp.
134. See OECD/NEA, "Guidelines for Sea Dumping Packages of Radioactive Waste" (Paris, rev. Apr. 1979), 32 pp.
135. See OECD/NEA, "Recommended Operational Procedures for Sea Dumping of Radioactive Waste" (Paris, Apr. 1979), 15 pp.
136. See text at note 92, *supra*.
137. *Supra*, note 86; see generally P. Strohl, "Establishment of a Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Waste," in International Nuclear Law Association, *Nuclear Inter Jura '77* (Proc. Conf. Florence) (1977), at 554.
138. OECD mechanism, *supra* note 85, Art. 3(b).
139. *Ibid.*
140. *Ibid.*, Art. 4(c).
141. *Ibid.*, Art. 6.
142. See 10 *Nucl. L. Bull.* 25 (1972).
143. See Japan S & T Agency, *supra* note 11, at 7.

144. For a current list of members of the OECD, see OECD, *Technical Change and Economic Policy* (Paris, 1980), at 2.

145. *Supra* note 85 (preamble).

146. See note 84, *supra*.

147. *Supra* note 4; see generally text at notes 123-132, *supra*.

148. See Japan S & T Agency, *supra* note 10, at 10. The remoteness of the proposed dump site from fishing areas has been questioned *inter alia* by the Philippine government. See IMCO Doc. LDC VI/INF.3 (6 Oct. 1981).

149. See 1980 Hearings, *supra* note 2, at 1 (statement of Leslie H. Brown).

150. See Intergovernmental Maritime Consultative Organization (IMCO), "Report of the Secretary-General on the Status of the London Dumping Convention," IMCO Doc. LDC V/2 (Sept. 4, 1980); see also IMCO Doc. LDC VI/7/3, *supra* note 23.

151. See *ibid*.

152. London Convention, *supra* note 85, Art. XI (amended) & app. A. The text of the dispute resolution amendment may be found in IMCO Doc. LDC/LG/4, at Annex III.

153. *Supra* note 84, Art. VIII.

154. See Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft ("Oslo Convention") *entered into force, reprinted in 11 Int'l Legal Materials 262 (1972)* (North Sea and parts of the Northeast Atlantic and Arctic Oceans); Convention for the Protection of the Mediterranean Against Pollution and Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft, *entered into force, reprinted in 15 Int'l Legal Materials 290, 300 (1976)*.

155. See text at note 141, *supra*.

156. Commentators appear to have generally assumed that it would be. See, e.g., Reyners, *supra* note 78, at 114.

157. Art. VIII of the London Convention, *supra* note 84, reads:

"In order to further the objectives of this Convention, the Contracting Parties with common interests to protect in the marine environment in a given geographical area shall endeavour, taking into account characteristic regional features, to enter into regional agreements consistent with this Convention for the prevention of pollution, especially by dumping. The Contracting Parties to the present Convention shall endeavour to act consistently with the objectives and provisions of such regional agree-

ments, which shall be notified to them by the Organization [IMCO]. Contracting Parties shall seek to co-operate with the parties to regional agreements in order to develop harmonized procedures to be followed by Contracting Parties to the different conventions concerned. Special attention shall be given to co-operation in the field of monitoring and scientific research."

The Convention also specifically allows required notifications to be submitted through secretariats established under such regional agreements. *Ibid.*, Art. VI(4).

158. The government of the Philippines has explicitly made this point:

"The Philippines will find it difficult to agree with Japan's plans for disposal of low level radioactive waste into the Pacific Ocean into the absence of an international body to supervise or monitor dumping in the Pacific area even though Japanese operational plans for nuclear waste dumping is [*sic*] quite advanced and in accordance with the [London] Convention.

Under the . . . Convention, IAEA is not vested with any supervising or control functions regarding nuclear dumping operations made by States Parties.

The problem with the Japanese proposed dumping is the absence of a nuclear international organization to supervise dumping operations."

Statement on the disposal of radioactive wastes in the Pacific Ocean, IMCO Doc. LDC VI/INF.3 (6 Oct. 1981).

159. The United States government, which has ratified the London Convention and is a participating state under the OECD mechanism, and an active member of the NEA with respect to matters concerning radioactive waste dumping in the North Atlantic, has already come under fire from its Pacific basin states and affiliates for not taking a stronger stand against the proposed dumping by Japan. See note 12, *supra*. It would appear difficult for the United States to take a substantively stronger position while retaining the procedural integrity of the international machinery in which it participates. In addition, the United States itself may soon allow radioactive waste dumping to recommence. See Statement of Roger Mattson, *supra* note 2, at 2-4.

160. See text at notes 29-30, *supra*.

161. See IAEA, *supra* note 120.

162. London Convention, *supra* note 84, Art. IV(1)(a) & Annex I(6).

163. See generally Finn, *supra* note 54, at 673-683.

164. See generally D. A. Deese, *Nuclear Power and Radioactive*

Waste: A Seabed Disposal Option? (1978), at 81-87. Lexington Books, Lexington, Massachusetts, 206 pp.

165. See U.S. Environmental Protection Agency, Memorandum from M. B. Corash, General Counsel, to Dr. D. Oakley, Acting Director, Office of International Activities, and E. C. Beck, Ass't Administrator for Water and Waste Management, "Deep Seabed Emplacement of High Level Radioactive Wastes and the Ocean Dumping Convention," Feb. 25, 1980.

166. See generally Rochlin, *supra* note 37, at 302-305.

167. See *ibid.*

168. See *ibid.*

169. See text at notes 196-198, *infra*.

170. See text at notes 142-159, *supra*.

171. See text at note 28, *supra*.

172. See text at notes 29-30, *supra*.

173. See text at note 3, *supra*.

174. See text at note 2, *supra*.

175. See, e.g., note 9, *supra*.

176. The most notorious episode is the case of the *Fukuryu Maru* (*Lucky Dragon*), a Japanese fishing boat whose crew was exposed to fallout from a weapons test. The United States government actually paid compensation to these victims but refused to acknowledge legal liability to do so. Less well known, perhaps, is the exposure of the inhabitants of Rongelap and other islands to the fallout from a groundburst explosion on Bikini atoll, due to an unexpected wind shift during testing.

177. See text at notes 38-53, *supra*, for a brief summary of major back-end functions and associated problems.

178. See Rochlin, *supra* note 37, at 205.

179. See *ibid.*, at 205, 217.

180. See *ibid.*

181. See *ibid.*

182. See text at note 31, *supra*.

183. See text at notes 29-30, *supra*.

184. See generally Rochlin, *supra* note 37, at 302-305.

185. See *ibid.*, at 202.

186. See *ibid.*

187. See generally G. Broinowski, chapter on "Asia and the Middle East," in J. Williams and D. A. Deese, eds., *Nuclear Proliferation: The Spent Fuel Problem* (1979), at 99, 115. (Pacific island spent fuel storage facility concept).

188. See generally Rochlin, *supra* note 37, at 302-305 (political evaluation of extraterritorial disposal options, including seabed emplacement).

189. See generally IAEA, *Regional Nuclear Fuel Cycle Centres*, 2 vols. (Vienna, 1977), IAEA Doc. RFCC/1-2; Rochlin, *supra* note 38, at 260-262.

190. Rochlin, *supra* note 37, at 222 (safety of maritime operations), 247-248 (security of maritime operations).

191. See, e.g., DOE Generic EIS, *supra* note 29, at 6.61 (safeguarding of island waste repository), 6.81 (safeguarding of seabed waste repository).

192. See, e.g., *ibid.*, at 6.59, Royal Commission Report, *supra* note 50, at 154 (delectability of radioactive releases from mined geological repository on an island).

193. See, e.g., DOE Generic EIS, *supra* note 29, at 5.5-5.6 (effect of subsurface hydrology on selection and design of mined continental repository for high level waste).

194. See 1980 Hearings, *supra* note 2, at 454 (statement of James P. Walsh), 469 (statement of Clifton Curtis) (less popular reaction to deep seabed than continental repository operations).

195. See, e.g., note 192, *supra*.

196. See generally Rochlin, *supra* note 37, at 192-205.

197. See Rochlin, *supra* note 37, at 302-305, 329; 9 *INFCE*, *supra* note 41, at 235.

198. On the international equity considerations regarding use of marine areas for nuclear fuel cycle activities, in relation to both world ocean and nuclear politics, see generally Finn, *supra* note 54, at 686-690.

199. See note 158, *supra*.

200. See *ibid.*