OCEAN DISPOSAL OF NUCLEAR WASTES

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Introduction

With the continued growth of the nuclear industry, particularly in Europe and East Asia, developed nations have been obliged to look for new locations for the wastes generated by their nuclear power plants. The seemingly vast expanses of the oceans appear as a logical dump site to many decisionmakers, particularly those located in crowded or geologically unstable countries with active population groups that resist land dumping.

The Japanese have had a proposal to dump low-level wastes on an abyssal plain halfway between Tokyo and the Northern Marianas, which they have been discussing since the mid-1970s. The implementation of this proposal has been postponed repeatedly because of the protests of Pacific islanders, and in early 1985, Prime Minister Nakasone told Pacific islanders that this proposal was no longer under active consideration. Nonetheless, if Japan's nuclear industry continues to grow, internal pressure from within Japan will undoubtedly lead to a reexamination of the ocean option sooner or later (see below).

Four European countries--led in volume by the United Kingdom--dumped low-level wastes annually at a site in the

Northeast Atlantic until February 1983 when a moratorium call by the members of the 1972 London Dumping Convention and the resistance of the British transport union brought a halt to these operations. The members of the London Dumping Convention then established a panel of scientific experts which issued a report on the current scientific knowledge about ocean disposal of nuclear wastes in June 1985 (see below). At their Ninth Consultative Meeting in September 1985, the member-nations of the London Dumping Convention voted to extend the moratorium pending further scientific and social science studies.

The United States, which has not dumped low-level wastes since 1970, was considering scuttling its nuclear submarines in the waters near its coasts, but has rejected that project--at least for the time being--because of opposition from its coastal residents. The British continue to release considerable amounts of radionuclides into the Irish Sea from their nuclear reprocessing plant at Sellafield (see below). A proposal to emplace high-level wastes in the clay floor of the North Pacific and selected sites in the Atlantic is also under active consideration by nuclear nations, but implementation of this project would be at least a decade off even if it is found to be technologically feasible.

Recent Scientific Studies and Controversies

Because of the opposition to the use of the ocean as a depository for nuclear wastes, coupled with a continuing need to find some acceptable site for these unwanted materials, scientists have been regularly asked to examine and evaluate the actual risks created by ocean disposal. Four studies have been published in recent years and a major controversy is underway in the United Kingdom over the releases at the Sellafield reprocessing plant and the country's whole nuclear waste program:

1. The South Pacific Regional Environment Programme's Review of "Radioactivity in the South Pacific." This report was prepared by a five-member group chaired by Dr. Michael Bacon of the Woods Hole Oceanographic Institution. It presents a lengthy discussion of radioactivity, concluding with two chapters on the Pacific Ocean. The analysis of Japan's proposal criticizes the methods used by the Japanese scientists in evaluating their disposal operation, particularly in failing to compare this option to other alternatives, but nonetheless concludes that the Japanese proposal does not present "significant" environmental safety issues. The report reviews the existing literature without presenting any new data and does not present a collective dose assessment of the harm that may be caused by a dumping operation at the scale proposed by

Japan. The authors conclude by saying that scientific questions are not alone dispositive, that alternatives should continue to be evaluated, and that in the end judgments on nuclear waste disposal must be made on the basis of "good judgment and common sense."

2. The British "Report of the Independent Review of Disposal of Radioactive Waste in the Northeast Atlantic." After the moratorium call by the February 1983 meeting of the London Dumping Convention and the subsequent refusal of the British National Union of Seamen to participate in dumping activity, a four-member committee was established to reevaluate this subject, chaired by Professor Fred Holliday of the University of Durham. This group reviewed the literature and computed the maximum individual dose from past nuclear waste dumping to be 0.8 microsievert, about 0.04 percent of the annual average dose to individuals in the United Kingdom from natural background radiation. No collective doses were computed and the report states that "the total health detriment is uncertain." The report also noted that "it may be that the people at risk are members of a distant community deriving no direct benefit from Britain's nuclear programme," and recommended that the British refrain from further dumping until the current scientific reviews are completed. It also recommended that land-based

alternatives be evaluated "as a matter of urgency" for comparison purposes and that "a suitable marine monitoring programme should be designed and undertaken."

2. The OECD/NEA "Review of the Continued Suitability of the Dumping Site for Radioactive Waste in the North-East Atlantic." The Nuclear Energy Agency of the Organization for Economic Cooperation and Development has established a process for monitoring the dump site used by the European nations and every five years reviews the suitability of that site. The latest report was issued in 1985. This report is substantially more complete and detailed than the version that was published in 1980, and it has been used as the basis for many of the conclusions of the London Dumping Convention's Panel of Experts, discussed next, including the "collective dose."

4. The London Dumping Convention's Panel of Experts Expanded Report on "The Disposal of Low-Level Radioactive Wastes at Sea." This report was prepared in draft form in early 1985, and then discussed and reviewed in London by scientific representatives of the members of the London Dumping Convention in June 1985 (International Maritime Organization 1985). It reviews the literature once again and again provides a long analysis of the scientific determinations involved in

these evaluations. It also, however, provides important data for the debates among policy-makers by calculating the "collective dose" of radiation generated by the past and proposed dumping operations and the health consequences of this dose. The scientific conclusion is that 1,000 additional cases of death or severe harm over the next 10,000 years can be attributed to the past dumping that has already taken place in the Northeast Atlantic and that an additional 100 cases of death or severe harm will occur for every additional year of dumping at the average rate that occurred between 1978 and 1982. The report states that these numbers are small in relation to the cases of cancer that will be caused by natural background radiation (2 billion cases of death or severe harm over the next 10,000 years) and are also below the levels of cancers attributable to fallout from past testing. Nonetheless, we now have actual figures based on existing scientific data that do indicate levels of harm that will be caused by ocean disposal of low-level nuclear wastes. These figures can be compared to the dangers and risks attributable to land-based disposal methods and other energy sources. These figures also help in the evaluation of the ethical and equitable issues that arise from the fact that most of those who experience the deaths or severe harm will

receive no direct benefit from the energy created by the process that generated the wastes.

All of the scientific groups agree that more monitoring is necessary, that more baseline studies should be undertaken, that interaction between the radionuclides and the sediments requires more research, and that some pathways that might bring radioactive materials back to our environment are unstudied and might cause problems in the future. The scientists themselves have not been asked to evaluate the acceptability of the risks, which is ultimately a political judgment that must be made by all concerned parties in light of the benefits and risks and in comparison to other energy options and waste disposal possibilities.

5. Controversies and Investigations Concerning the Sellafield (United Kingdom) Reprocessing Plant. The United Kingdom has reprocessed spent nuclear fuel at Sellafield (formerly called Windscale) on its Cumbrian Coast facing the Irish Sea since 1952. Reprocessing is a complicated and hazardous process designed to extract from used fuel uranium and plutonium which can then be reused for energy or weapons. Liquid waste effluents are released from the Sellafield plant directly into the Irish Sea. Regulations in effect as of 1984 permitted discharges of up to 300,000 curies (11.12×10^{15}

becquerels) of beta emitters and up to 6,000 curies (666 x 10^{12} becquerels) of the longer-lived alpha emitters. (Black 1984:46). Although actual discharges have been below these maximums in recent years (ibid.: 42, 47-50) the discharges have nonetheless been recently characterized as "significantly in excess of those from similar plants in other countries" (ibid.: 94).

In November 1983, an accident caused by lax procedures and human error resulted in a large slick of radioactive crud (containing ruthenium-106) being released into the coastal waters (ibid.: 8) This crud washed up on the nearby beaches and caused officials to urge residents to avoid 20-miles of shoreline for the following six months. In July 1985, the operator of the Sellafield plant, British Nuclear Fuels Limited, was fined 10,000 pounds ($14,500 U.S.) and ordered to pay up to 60,000 pounds ($87,000 U.S.) for the costs of prosecution. The jury concluded that although the radioactive discharge did not exceed authorized limits, the operator should be punished because it was "not as low as reasonably achievable" (The Times (London) 1985).

Also in November 1983, the British network ITV showed a film report entitled "Windscale--the Nuclear Laundry" charging that young people living near

Sellafield contracted cancers and leukemias in rates that dramatically exceeded those of other British communities (Black 1984: 7). The Minister of Health appointed an Independent Advisory Group to examine the data, and this group confirmed that some of the small communities adjacent to the plant did exhibit rates of leukemia among its children (particularly males) that significantly exceeded national averages (ibid.: 29, 91). The Advisory Group also noted, however, that the absolute numbers of cases were small, making firm conclusions difficult, and recommended further studies to test whether any direct correlation could be established between the malignancies and the radioactive discharges from the plant (ibid.: 34-35, 93-94). The Group also recommended that attention be given to reports of increased numbers of Down's Syndrome births in adjacent coastal communities (ibid.: 36).

These recurring concerns have led the British House of Commons to conduct a full investigation of nuclear waste through its Select Committee on the Environment. Hearings were held throughout 1985 and volumes of testimony have been published, examining all aspects of these issues. The nation that has been most active in disposing of its nuclear wastes in the ocean is thus in the midst of a thorough review of its current policies.

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Groups opposed to the use of the oceans for dumping have pursued their cause through the treaty mechanisms established by the 1972 London Dumping Convention, through the activities of the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organization of Economic Cooperation and Development (NEA/OECD), and by efforts to create regional treaties to limit or exclude the disposal of nuclear wastes within defined geographical boundaries. Pacific island nations have played a significant role at the consultative meetings of the London Dumping Convention that have produced the present moratorium and have set the stage for further studies (Boehmer-Christiansen 1986). As of this writing, however, Kiribati, Nauru, Papua New Guinea, the Solomon Islands, New Zealand, and Australia are the only Pacific island nations that have joined the Convention. Others have stayed out of this body because of a view that the Convention is not strong enough and that it has permitted dumping of low-level wastes in the past. Although this position is not entirely without merit, it ignores the value of this body as a mechanism to control global wastes and the significant standards that have been established.

In addition to the moratorium and scientific studies mentioned above, another important requirement has been to insist that sound environmental impact studies be prepared prior to any dumping operation. The Japanese prepared an Environmental Safety Assessment in the late 1970s which was widely criticized by

scientists--even those that generally supported ocean dumping. The failure of the Japanese to prepare a convincing document certainly was a contributing factor in their decision to shelve this project. Their environmental assessment is reviewed in some detail here to illustrate the value of this type of exercise.

The Japanese Proposal

In the mid-1970s, Japanese policy-makers began planning seriously for ocean disposal of its low-level nuclear wastes, and in 1980 Japan became a party to the London Dumping Convention, apparently in order to legitimize its plans to dispose low-level wastes at sea. Takehiko Ishihara, the Director of Japan's Radioactive Waste Management Center, explained Japan's decision by analogizing Japan's situation directly to that of the Western European dumping nations:

> Japan has very small land space, and its structure is geologically unstable, making ground disposal extremely difficult. It is quite natural therefore for Japan to have opted for sea disposal, as with the U.K. and the Netherlands, where, in some respects conditions are similar.

The Science and Technology Agency of Japan, an arm of the Prime Minister's Office, proposed to dump low-level radioactive wastes into the Pacific Ocean at a depth of 6,000 meters. (Nuclear Safety Bureau (Japan) 1980a). The suggested location was at 30° N. 147° E., about 560 miles southeast of Tokyo and 620 miles

north of Maug Island in the Northern Marianas, at a location beyond the exclusive economic zone of either the United States or Japan. The plan had four phases: a pre-operational safety assessment to be conducted in the ocean and in the laboratory, an experimental dumping of between five and ten thousand cement-filled fifty-five gallon drums containing about 500 curies of radioactivity, a second series of oceanographic experiments designed to monitor the effects of the experimental dumping operation, and finally a full-scale dumping of approximately one to two million drums containing about 100,000 curies per year (ibid.). This proposed operation would have been roughly comparable in magnitude to that of the Europeans between 1978 and 1982, but it may have presented different risks because of the different mix of radionuclides proposed to be dumped (compare OECD/NEA Site Review 1980:31 with Nuclear Safety Bureau (Japan) 1980b:10)

The Japanese "Environmental Safety Assessment"

Japan does not require environmental assessments for projects within its borders, and so its agencies are not experienced in preparing the comprehensive, multi-disciplinary assessments that have become commonplace within the United States prior to any major development. The recommendations of the International Atomic Energy Agency state, however, that members of the London Dumping Convention "shall not grant a special

permit for dumping of radioactive waste unless a detailed environmental and ecological assessment gives a reasonable assurance that such dumping can be accomplished in accordance with the objectives and provisions of the Convention and the Recommendations set out in this Document" (IAEA 1978: para. B.1.1; emphasis added). Because of this obligation, the Japanese Nuclear Safety Bureau and Nuclear Safety Commission combined to produce a document entitled Environmental Safety Assessment on Sea-Dumping of Low-Level Radioactive Wastes (ESA). This document did not, however, address all the topics required by the London Dumping Convention and the IAEA Recommendations and lacked the "adequate scientific basis" required by Annex III.B.9 of the Convention.

The site identified by Japan is about 6000 m deep and most of the surrounding area is at least 5000 m deep. (Taira, Imawaki, and Teramoto 1980:71; Imawaki and Takano 1980:81). An 8000 m deep submarine trench--the Izu-Ogasawara Trench--lies about 300 mi. to the west. Immediately to the west of the trench is the Izu-Ogasawara Rise, which comes within 2000 m of the surface. Fishing takes place at near-surface levels above and around the proposed dump site; the major species are skipjack tuna, mackerel, and codfish. Polymetallic nodules are found on the sea floor, but they are apparently not of commercially harvestable quality.

The Japanese Environmental Safety Assessment used an ocean diffusion model to forecast the ultimate human exposure to radiation resulting from the proposed dumping. An idealized model of the North Pacific Ocean was hypothesized, 12,000 km from east to west, 6,000 km from south to north, rectangular in shape, and uniformly 5 km deep. It was assumed that radioactivity would be released from a fixed point on the ocean bottom. The spread of the radioactive particles was then estimated, using several parameters for horizontal and vertical diffusion, and for upwellings. As the radionuclides spread out over time they also decay--reducing their total radioactivity. The assessment then calculated the concentrations of radionuclides in the sea water, using values generated by the assumed dispersion resulting from diffusion and currents (Nuclear Safety Bureau (Japan), 1980b: 15-26, 32-33).

Human exposure to this diluted radiation can occur directly from exposure to contaminated sea water, salt spray, or other sources, but the most important exposure would be likely to come through the consumption of fish and other marine organisms. The ESA estimated the radioactivity to be found in marine organisms using the derived concentrations of radionuclides in sea water. It then estimated the radionuclides that would reach humans through the consumption of sea food (ibid.: 82-92).

The major question the ESA was intended to answer is whether the dumping poses a risk to human health. The purpose of the ESA and its ocean model was to arrive at an estimate of human exposure that did not understate the exposure that will actually occur. To accomplish this goal, the ESA systematically incorporated assumptions that should lead to overestimates of the final radiation exposure. The first of these assumptions is that all of the radionuclides contained in the drums would be released as soon as the drums hit the ocean bottom (ibid.: 5). This is an extreme assumption, made to introduce a substantial safety margin. It has been demonstrated that properly designed and filled drums will retain their integrity during the descent to the bottom (Seki, Ito, Wadachi, and Amano 1981). It is difficult to know, however, just how much of a safety factor is introduced by this assumption because the corrosion rate of the drums and the rate at which radionuclides leach out of the concrete filler are difficult to determine.

After assuming the total, immediate release of the radionuclides, the ESA assumed that all of them enter the water, and that none become bound to the sediments or the drums themselves. (Nuclear Safety Bureau (Japan) 1980b:28) This assumption is unrealistic. Research indicates that the radionuclides tend to become bound to the sediments in the immediate vicinity of the drums (Bowen and Hollister 1981: 242, 265). The assumption was defended on the ground that it tends to

over-estimate the final exposure to humans--if some radionuclides are bound in the sediments, the concentration in the water becomes lower, and radionuclides bound to the sediment 6000 m down are not going to hurt anyone (Nuclear Safety Bureau (Japan) 1980b:28). Whether the radionuclides will remain in the sediments is a controversial issue, which should have been treated more fully in the ESA.

Once the radionuclides are in the water, their fate depends primarily on diffusion, currents, and upwellings. The values of these parameters are difficult to establish accurately (ibid.: 23). The ESA used a very low value for horizontal diffusion, because if the radionuclides diffuse slowly their concentrations in the water will be higher. On the other hand, the ESA used a very high value for vertical diffusion, because rapid vertical diffusion will result in the radionuclides reaching surface water more quickly, where they can enter the human food chain (ibid.: 21). Oceanographers believe that in most areas, bottom water mixes very slowly with the upper layers, so that radionuclides should remain near the bottom for a long time (Pritchard, Reid, Okubo, and Carter 1971:121).

The model's treatment of currents is quite interesting. Japanese scientists have done considerable research on deep currents in the general area of the dump site. They found an "intense" southward-flowing current near the bottom about 100 mi. west of the proposed dump site. (Taira, Imawaki, and Teramoto

1980:70) At the dump site itself, however, currents were weaker (Imawaki and Takano 1980). The ESA concluded:

> In view of the fact that the presently available knowledge about velocity distributions within the model space is extremely fragmented and that the actual currents are extremely complex in structure, it is nearly impossible to model the currents so that they may be applicable to such simple semi-infinite model space as used here (page 20).

Because of this uncertainty, the ESA ignored the effects of these currents, except that it adjusted upward the diffusion coefficients to account somewhat for them. In one sense, this approach is justifiable, because currents, which disperse radionuclides, again lower the ultimate concentration. On the other hand, currents impart direction to the flow of the nuclides. The residents of Guam and the Marianas, to the south of the dump site, would undoubtedly want to know if these currents are likely to bring the radionuclides in their general direction.

The model also projected the effects of hypothetical upwellings, which might bring the radionuclides into shallower, more biologically active waters more quickly. When combined with even slower horizontal diffusion, concentrations could reach 10,000 times those calculated under the even-diffusion hypothesis--but the upwelling and slow diffusion would have to continue for several years (Nuclear Safety Bureau (Japan) 1980b:44). The ESA did not follow through with any estimates of human exposure resulting from these higher concentrations,

probably because all of the parameters were considered unlikely.

The ESA next turned to the concentration of radioactivity in marine organisms, using concentration factors determined from other studies to estimate how much radioactivity will accumulate in marine organisms, based upon the projected concentrations in the water (ibid.: 64-69). This part of the assessment does not appear to have been handled in a very sophisticated fashion, with generalized groupings of species used and some recent data ignored.

The final step in the Japanese analysis was the projection of the human exposure that would result from the dumping. The calculated exposures are extremely small: about 0.01 millirem (0.0001 millisievert) per year of dumping per person for the general public, and about twice as much for fishers (ibid.: 77). The collective dose (the individual doses multiplied by the relevant population) is calculated to be 400 man-rem per year of dumping (4 man sieverts) for Japan and 1000 man-rem (10 man sieverts) per year for other countries (ibid.: 87). The figures are dramatically below the collective dose estimates found in the recent report of the London Dumping Convention's Panel of Experts. These scientists found that the collective dose from the past European dumping is 40,000 man-sieverts and that an additional 4,000 man-sieverts would be added to the burdens of the world's population for each additional year of dumping at 1978-82 rates (International Maritime Organization 1985).

Although some diference would be expected because Japan expects to dump different radionuclides than those dumped by the European nations, a difference of this magnitude alone would be enough to call for a thorough review of the Japanese Assessment.

The Japanese Environmental Safety Assessment was thus seriously deficient in several important respects when compared to the IAEA's requirements for a "detailed environmental and ecological assessment." Some of the gaps are quite specific and could be filled using existing data. A more fundamental criticism is, however, that the Japanese document was based on faulty models. It was not a comprehensive description of the likely effects of the dumping, and instead was a hypothetical analysis of a scenario that bears little resemblance to the likely fate of the wastes. The ESA did not refer to studies or radioactive waste dumping at other sites and it did not consider realistic effects of the dumping. Its use of the existing scientific data was inadequate. The Japanese Environmental Safety Assessment failed to present the whole picture and failed to give decision-makers enough information to enable them to make an informed judgment.

The Shortcomings of the Assessment

a. The Availability of Land-Based Alternatives

The London Dumping Convention requires that before issuing a permit for ocean dumping, a nation must consider "[t]he practical

availability of land based methods of treatment, disposal or elimination, or of treatment to render the matter less harmful for dumping at sea (Annex III(c)(4)). The Japanese are in fact now looking seriously at land-based storage, but their ESA did not compare these alternatives to ocean dumping.

b. Net Benefit to Society

The 1978 IAEA Recommendations require that "[t]he operations should be justified by assessing their net benefits, taking into consideration the radiation consequences and the possibilities of alternative procedures ..." (Para. B(1)(1)). This provision may mean that the net benefit of the entire nuclear energy process, including the dumping, should be evaluated because it is difficult to see how a dumping operation, by itself, could ever produce a net benefit. In that case, the net benefits could be established by comparing the eventual human exposure with the output of energy and other benefits from nuclear power and scientific research. Alternatively, this provision may require the dumping nation to compare ocean dumping to land dumping once again to evaluate which alternative would produce the "net benefit" in terms of shielding humans most from the harmful radioisotopes. In any event, the Japanese ESA does not explicitly address this requirement.

c. Production of "Taints"

The London Dumping Convention says that a national permit-granting authority must consider the "[p]robability of

production of taints or other chances reducing marketability of resources (fish, shellfish, etc.)" (Annex III)(A)(8)). Fish buyers in Japan and elsewhere would undoubtedly become aware of the location of Japan's radioactive waste dump, and it is entirely possible that the marketability of fish taken from the area would be reduced or eliminated entirely. This result could occur despite official assurances that the fish were safe; many food products have become "tainted" and unmarketable because of hysteria about radioactive or other toxic waste (Van Dyke, Smith, and Siwatibau 1984: 736). This provision of the London Dumping Convention clearly does not require proof of actual health hazards; health hazards are covered in other sections of the Convention (see e.g. Annex III(A)(4)).

d. "Scientific Basis" and the Likely Effects of Dumping

The Japanese ESA ignores important sources in the recent scientific literature regarding ocean dumping of low-level nuclear wastes and fails to acknowledge how little is known about the actual effects of ocean dumping. The dumping nation has the burden of proof of showing that its operation will not create hazards to the marine environment and human health. A strong argument can therefore be made that the Japanese proposal for ocean dumping of radioactive wastes lacks the "adequate scientific basis" required by Annex III(B)(9) of the London Dumping Convention.

The Japanese Environmental Safety Assessment makes no

mention of the ecosystem that will inevitably build up around the hundreds of thousands of drums that are introduced into the otherwise relatively featureless deep-sea plain. The canisters at the ocean floor will also increase the roughness of the otherwise smooth surface, which can change patterns of the ocean current and greatly increase vertical mixing in the zone immediately above the bottom (Bowen and Hollister 1981). The ESA did not mention the effect on marine life from these nonradiological aspects of dumping, although it did recognize that, because of the lack of knowledge about benthic organisms, it is undesirable to have a great deal of biological activity around the dump site (Nuclear Safety Bureau (Japan) 1980b:17).

The ESA assumed that all the radionuclides that leaked from the canisters would enter into the water and that none would be absorbed into the sediments (ibid.: 15). It did not, therefore, examine the processes by which the radioisotopes might travel from the sediments into the food chain. Although information about sediments and biological activity was available to the authors of the ESA, they did not utilize it partially because of the vast uncertainties involved (ibid.: 28). The ESA also ignored the effect of the organic materials in the drums leaching into the surrounding area and promoting the development of a new ecosystem in the area (ibid.: 27). The susceptibility of the benthic organisms to radioactivity was assumed to be the same as creatures living close to the surface, although it has been

recognized that significant differences may exist. (Nishiwaki 1981).

e. Further Research and Monitoring

The obvious solution to the scientific uncertainties involved in the deep ocean dumping of radioactive waste is more scientific research; very extensive and difficult observations will be necessary before an adequate scientific basis can be presented to justify a future dumping operation. Adverse effects may take many years to appear. For example, sea anemones in the Northeast Atlantic dump site, sampled in 1979, had strontium-90 and cesium-137 concentrations at least ten times higher than those found in samples taken in 1966, even though the use of the site had been discontinued in the meantime (Feldt, Kanish, and Lauer 1981: 477-79). The samples at the old site were also ten times higher than those in the present Northeast Atlantic dump site and a control site (ibid.). Contamination is not likely to be noticed until old drums start to leak, which might not occur for ten or twenty years.

The studies done at the Northeast Atlantic sites and at the shallower dump sites have been far too sketchy to give definitive answers to many of the questions raised. Because sediments show such a wide variation in the presence of artificial radionuclides from fallout and other artificial sources of radioactivity, it is extremely difficult to determine the effects of past dumping. Studies of past dumping are inconclusive because it is usually

not certain exactly what was dumped. Although major contamination has been noticed, the studies have not answered the question: what has happened to the waste? Bowen and Holister comment:

> ... it will always be possible by taking too small samples, or the wrong ones, or by using sufficiently insensitive analytic methods, to detect nothing, even from an enormous perturbation (1981: 266).

Even though damage to marine ecosystems has not yet been noticed, because of our limited knowledge about such communities, disturbances are not likely to be noticed unless they are "enormous" (Osterberg 1976:1000).

f. Summary

The Japanese Environmental Safety Assessment suffered from serious procedural and informational deficiencies. Land-based alternatives were not explored, risks to the marine ecosystem were ignored, the role of bacteria and meiofauna was neglected, biological food webs were inadequately discussed, and no mention was made of future options that might be foreclosed by the dumping. The document was based solely on scientific data--mostly from physical oceanographers--with no input from other relevant disciplines. Finally, the public had no opportunity to comment on the assessment, a process that would have permitted a wider variety of viewpoints to be expressed and that would probably have produced a document that more accurately

reflected the range of views that exist on this important subject. The Environmental Safety Assessment did not meet the burden of demonstrating an "adequate scientific basis" for a dumping operation of the magnitude proposed by the Japanese.

Pacific Regional Agreements

The Pacific island nations have worked conscientiously under the auspices of the South Pacific Regional Environment Programme (SPREP) to prepare a Convention for the Protection and Development of the Natural Resources and Environment of the South Pacific Region, and the delegates to the meetings looking at the draft proposal have discussed the question of nuclear waste dumping in detail (SPREP Report 1986). All participating nations have agreed that all nuclear waste dumping should be excluded within the area to be covered by the Convention, and at the November 1985 meeting in Noumea, New Caledonia, the negotiators (including the United States) agreed that this area should include the 200-mile zones of the Pacific island entities and also the waters that are beyond the 200-mile zones but "enclosed from all sides" by the 200-mile zones of Pacific island communities (Article 2(a)(ii)). This latter agreement is quite significant because the waters beyond 200 miles are part of the "high seas" which are not subject to any nation's direct control. It is also significant that the ban on "dumping" explicitly includes the emplacement "into the seabed and subsoil

of the Convention area of radioactive wastes or other radioactive matter" (Article 10(1)). The delegates to the negotiations have thus agreed to ban the disposal of both low and high-level nuclear wastes from a vast area of the Pacific Ocean, extending from the Northern Marianas in the Northwest Pacific and including most of the South Pacific Ocean.

Judicial Challenges

In addition to the efforts to limit ocean dumping through the mechanisms of the London Dumping Convention and regional treaties, consideration has been given to bringing a judicial challenge against the next nation that dumps nuclear waste into the ocean. Such a challenge might take many forms, including, for instance, a challenge by, say, Spain against the United Kingdom brought in the International Court of Justice if the United Kingdom began dumping again. Or, if the Japanese proposal were ever implemented, a Pacific island nation might try to bring an action against Japan in the International Court or a group of fishers in Guam might file an action against Japan in the U.S. District Court in Guam or the Northern Marianas, or possibly in a Japanese court. Each of these challenges would raise procedural difficulties that might make a court reluctant to reach the substantive issues, including sovereign immunity, the act of state doctrine, acceptance of the court's jurisdiction, and so on--depending on which court is chosen.

The substantive issues would also be complex and somewhat difficult to predict. A court would have to examine the governing international law by looking at the treaties and then grappling with "customary international law," which establishes norms protecting the marine environment and imposing a duty of "reasonable regard" to the interests of other nations. Emerging trends also appear to establish a duty to consult and may also impose a duty to monitor in this situation. The overarching duty is to avoid injuring the territory of other nations, but this responsibility will be hard to evaluate because radioactive materials in the amounts being dumped will cause latent injuries that will not manifest themselves for many years. If nuclear materials were released as a result of a transportation accident, the impact might be more immediate and the harm more easily determined.

In order to evaluate the long-term effects of a slow release of radioactive materials in the marine environment, a court might look to the emerging law being developed in the products liability field, where judges are forced to face related issues. Courts have tended to apply a standard of strict or absolute liability to harm caused by the use of ultrahazardous activities, and this standard would almost certainly be applied to injury from nuclear materials, thus eliminating the requirement of proving that the dumping nation acted negligently or recklessly in its operation. The party bringing suit would still, however,

have to prove some causal relationship between the dumped nuclear materials and the harm that has occurred or is anticipated. One U.S. court that recently evaluated the effects of nuclear fallout on residents living near the atmospheric tests of the 1950s required the plaintiffs to prove that their injuries were more-likely-than-not substantially caused by the increased radioactivity introduced into the environment by the nuclear tests (Allen v. United States 1984).

Because actual physical injuries may be difficult to prove, a challenger may wish to pursue a claim based on the emotional distress created by the introduction of radioactive materials into the nearby environment and the increased fear of contracting cancer. These harms have been recognized by a number of courts and could be a basis for suit, at least in some jurisdictions.

Another promising recent development has been the recognition that courts should authorize the creation of a medical monitoring fund in cases where the evidence reveals that the defendant has introduced a toxic substance into the environment and where the health of the public can be protected by regular monitoring of their conditions and research into the effects of the introduced substances. A court in New Jersey said in 1983, for instance, that a party seeking a medical fund does not have to prove that its members will probably suffer cancer in the future, but only that they have been exposed to such an extent that they would benefit from "annual medical testing in

order to properly diagnose the warning signs of the development of the disease" (Ayers v. Jackson Township 1983). Similarly, a Pennsylvania court said in 1985 that an organization seeking a medical trust fund to provide them with moneys "to monitor and detect all future medical problems" associated with chemical toxins in a land dump site near their homes needed only to "show the potential for severe and latent injuries and the need for early detection and treatment" (Habitants Against Landfill Toxicants v. City of New York 1985).

The U.S. Court of Appeals for the District of Columbia recognized these same principles in a 1984 decision ordering the Lockheed Aircraft Corporation "to create a $450,000 fund from which reasonable expenses of diagnostic examinations would be paid" to monitor the health effects of Vietnamese orphans who suffered a neurological development disorder as a result of a 1975 plane crash (Friends for All Children, Inc. v. Lockheed Aircraft Corp. 1984). The court's analysis indicates that when a defendant puts a population group "at risk" of future medical problems, the defendant should be required to cover the costs of diagnostic examinations that are medically advisable because of the risks created by defendant's actions. Also, in 1985 and 1986, the Circuit Court in Honolulu, Hawaii, approved a settlement establishing a $4,000,000 medical monitoring fund to examine the long-term health effects of a pesticide contamination in Hawaii's milk supply on the children of that community (Ahn v.

Foremost 1985; Ahn v. Meadow Gold 1986).

Applying these recent decisions to a nuclear waste dumping situation leads to the conclusion that a dumping nation should be required to create a fund that would be used to monitor the dump site to determine the movements of the radionuclides over time and also to monitor the health effects on affected persons and on marine plant and animal life. Such a fund would encourage the dumping nation to weigh the true costs of dumping when evaluating this option against land-based alternatives (and other energy sources) and would encourage the nation to use the highest possible standards of care if ocean dumping were still chosen after these additional costs are factored in the equation.

Because we now have been told by the scientific community that 100 cases of death or severe harm over the next 10,000 years will be caused by each year of nuclear dumping at the 1978-82 rate of European dumping at the Northeast Atlantic site, we can quantify the risks created by nuclear dumping and require the dumping nation to pay for these health problems as one of the costs of their nuclear operation. Although it is conceivable that some nations may still decide that ocean disposal is their best option after these costs are included, no nation should be permitted to dump without creating a fund that would assist present and future generations affected by their dumping.

Summary and Conclusion

The ocean environment is still relatively unexplored in many respects, particularly with regard to the marine life in the deep ocean. A strong case can be made, therefore, in favor of continuing the present moratorium on ocean dumping while additional scientific research is undertaken.

The recognition by the London Dumping Convention's panel of scientific experts that 1,000 cases of death or severe harm over the next 10,000 years can be attributed to dumping that has already taken place in the Northeast Atlantic and that 100 additional cases will result from each year of renewed dumping at the 1978-82 rates has the effect of recasting the debate and allowing policymakers to weigh this option more directly against other alternatives. It also directly raises the equitable issues that follow from the fact that the risks of nuclear dumping are felt over a wide range of coastal communities all over the ocean basin while the benefits serve only those nations with a nuclear industry generating the wastes.

Although the Japanese dumping proposal could not be directly compared to the European dumping--because different radionuclides were to be involved--Japan's Environmental Safety Assessment was deficient in a number of serious respects and did not permit proper analysis of their proposal. Environmental assessments of this sort allow others to scrutinize dumping proposals in detail and illustrate again the value of the global standards being

developed through the consultative meetings of the parties to the London Dumping Convention. Regional approaches to ocean disposal issues are also important, and the Pacific island communities have moved boldly to prohibit the disposal of both low- and high-level wastes in its ocean areas in the current draft of the Convention for the Protection and Development of the Natural Resources and Environment of the South Pacific Region.

If a nuclear nation does proceed with a dumping operation, then serious consideration would have to be given to a judicial challenge in which the international law governing the marine environment and the standards of care owed to coastal residents could be enforced. Judicial decisions in the United States and elsewhere have responded creatively to the threats caused by the introduction of toxic materials into the environment, and it can be argued forcefully that a nation that does go forward with a dumping operation should establish a fund to monitor the effects of the dumping and to compensate victims in present and future generations.

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