Ocean disposal of radioactive waste: Status report

A number of studies are being done to more fully assess the impact of sea disposal

by Dominique P. Calmet

National and international programmes have improved knowledge about the potential impact of deep sea disposal of radioactive waste. Shown here, about to be submerged, is a new type of "sediment corer" to sample the 30 upper metres of seabed sediment. (Credit: CEA/DPT)

For hundreds of years, the seas have been used as a place to dispose of wastes resulting from human activities. Although no high-level radioactive waste (HLW) has been disposed of into the sea, variable amounts of packaged low-level radioactive waste (LLW) have been dumped at more than 50 sites in the northern part of the Atlantic and Pacific Oceans.* In 1946, the first sea dumping operation took place at a site in the North East Pacific Ocean, about 80 kilometres off the coast of California. The last known dumping operation was in 1982, at a site about 550 kilometres off the European continental shelf in the Atlantic Ocean. *(See map.)*

Between these two dates, an estimated 63 PBq (1.7 MCi) of radioactive waste coming from research, medicine, and nuclear industry activities have been packaged, usually in metal drums lined with a concrete and bitumen matrix, and disposed of at sea.** This inventory includes some unpackaged waste and liquid waste which were disposed of from 1950 to 1960. Beta-gamma emitters represented more than 99% of the total radioactivity of the waste. They were fission and activation products such as strontium-90m, caesium-137, iron-55, cobalt-58, cobalt-60, iodine-125, carbon-14, and tritium. These represent one-third of the total radioactivity dumped in the North East Atlantic sites. The wastes disposed of also contained low quantities of alpha-emitting nuclides with plutonium and americium representing 96% of the alpha emitters present.

The dumping operations were performed under the control of national authorities, or of the "Multilateral Consultation and Surveillance Mechanism" of the member countries of the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA/OECD). The NEA also set up a Co-ordinated Research and Environmental Surveillance Programme (CRESP) in 1977 for the NEA dumping site. Since then, the North East Atlantic site has been surveyed on a yearly basis. A radiological survey of the Pacific and North West Atlantic Ocean sites is carried out from time to time. So far, samples of sea water, sediments, and deep sea organisms collected on the various sites have not shown any excess in the levels of radionuclides above those due to nuclear weapons fallout, except on certain occasions where caesium and plutonium were detected at higher levels in samples taken close to packages at the dumping site.

These observations are consistent with the main objective of radioactive waste disposal in the deep sea. This objective is to isolate radioactive waste from man's surrounding environment for a period of time long enough so that any subsequent release of radionuclides from the dumping site will not result in unacceptable radiological risks, even in the long-term. However, the potential dispersion of radionuclides in the world's oceans, which was originally seen as offering a large dilution sink ensuring low concentration rates in the marine environment, has raised questions concerning

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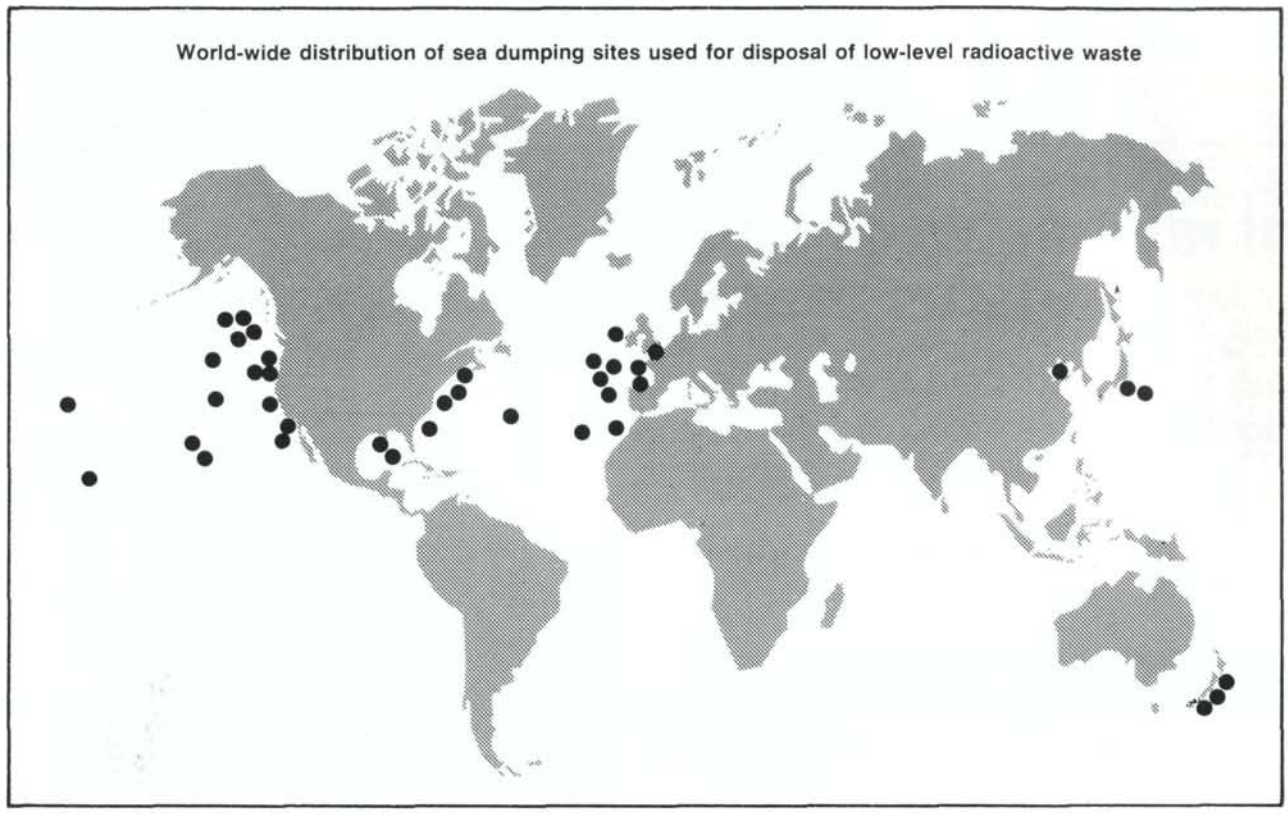
* Low-level waste is defined as waste which, because of its low radionuclide content, does not require shielding during normal handling and transportation.

** PBq = 10^{15} becquerels. MCi = 10^{6} curies.



the possible damage to the marine resources. These concerns have been expressed mainly by countries which do not share the benefits of nuclear energy. They were expressed in 1958 in Article 48 of the Law of the Sea which recommended "that every State shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standard and regulation which may be formulated by the competent international organizations".

As a result, since 1957, the date of its first meeting to design methodologies to assess the safety of "radioactive waste disposal into the sea", the IAEA has provided guidance and recommendations for ensuring that disposal of radioactive wastes into the sea will not result in unacceptable hazards to human health and marine organisms, damage to amenities or interference with other legitimate uses of the sea.

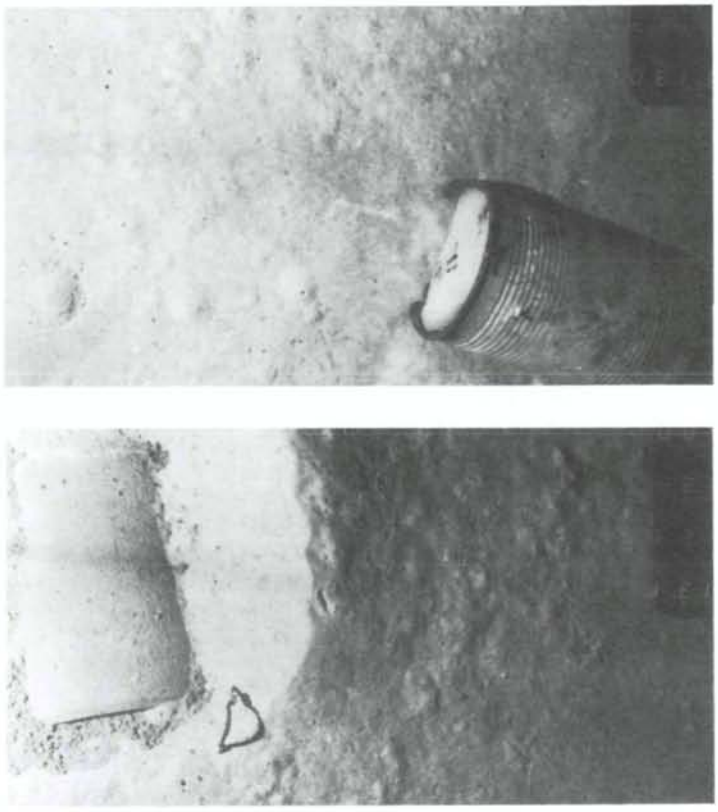
IAEA recommendations to protect man and marine environment

Although sea dumping is essentially a strategy of dispersion/dilution rather than one of containment, IAEA has recommended that the waste packages be designed to ensure containment of the waste during its descent to and impact on the sea floor and to minimize, to the extent reasonably achievable, subsequent releases of radionuclides to the sea. Scenarios for the releases of radionuclides from the waste matrix and container, their dispersion in the marine ecosystems and their transfer to the surrounding human environment were identified. Due to the low concentration of radionuclides expected in the various marine components, the radionuclide transfer back to man from the deep sea could not be ascertained by a monitoring approach and was evaluated using mathematical models, as is still the case today. The subsequent development of new mathematical models, the acquisition of improved data concerning the oceanographic, geochemical, and biological processes involved in radionuclide behaviour in the marine environment have made it possible to continuously refine the impact assessment of sea dumping of radioactive wastes on human populations and on the marine environment.

The London Dumping Convention

Since the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (referred to as the London Dumping Convention, or LDC) came into force in 1975, the dumping of waste has been regulated on a global scale. The LDC prohibits, *inter alia*, the dumping of HLW and requires that LLW be dumped only after a special permit has been issued.

At the seventh consultative meeting (1983) of the contracting parties to the LDC, an amendment to these annexes was proposed to prohibit the dumping of all radioactive waste at sea. A resolution was adopted calling for suspension of all dumping pending a review of the scientific basis for sea dumping of radioactive wastes. In 1984, an independent panel of experts reviewed the scientific and technical considerations rele-



Metal and concrete drums were used to dispose of low-level radioactive waste at a Northeast Atlantic Ocean site at a depth of 4700 metres. The high density of the concrete drum (below) caused it to be half embedded in the sediment. Traces of biological activity can be seen near the drum.

vant to the proposed amendment. Their conclusion, presented at the LDC eighth consultative meeting (1985), stated that "no scientific or technical grounds could be found to treat the option of sea dumping differently from other available options when applying internationally accepted principles of radiation protection to radioactive waste disposal".

In 1986, as a result of the continuous improvement of the impact assessment methodology, the IAEA presented its third version of the definition of HLW unsuitable for dumping at sea and its recommendations for the control of low-level packaged waste dumping operations.* Despite this new information, the LDC tenth consultative meeting (1986) agreed to establish an intergovernmental panel of experts to consider the wider political, legal, economic, and social aspects of sea dumping of LLW. The moratorium was extended pending the results of these new studies. At the same time, the IAEA was requested to advise contracting parties specifically with respect to outstanding scientific and technical issues. Two of the studies requested from the IAEA in this context are described below.

Comparative risk studies

Many chemicals, some of which have been identified as carcinogens for man, are present in the marine environment as a result of the disposal of wastes from various industrial activities. In contrast to the extensive knowledge of man's exposure to ionizing radiation from all type of marine sources, the impact on human populations of non-radioactive chemicals in the oceans is not well known. In order to fill this gap a group of experts have been convened under IAEA auspices to compare the risks estimated to result from the dumping at sea of radioactive wastes with those from other uses, applications, disposals, and disseminations of potentially hazardous substances.

In 1986, the IAEA offered guidance on an approach for comparison of land-based disposal options with sea dumping and the costs and risks associated with these options. Optimizing a waste management system, involves the review of a series of parameters specific to the waste characteristics, the site environment, and available resources combined with national, social, and political factors. Currently, on behalf of the LDC, the IAEA is undertaking a review of the published studies dealing with comparative environmental and safety assessments of various disposal options for different types of solid LLW.

Toward an inventory of radioactive waste dumped and released into the sea

On several occasions, the LDC has requested the Agency to develop an inventory of radioactive wastes entering the marine environment from all sources. To date a provisional computerized database with information on the date, location, depth, quantity, weight, and

* *Definition and Recommendations for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter*. IAEA Safety Series No. 78 (1986 edition).

IAEA responsibilities in the context of the London Dumping Convention

The ocean, a source of many resources, is international territory whose water movements know no national boundaries. These facts imply that international collaboration is of the essence to prevent and combat global marine pollution. In 1958, the United Nations Conference on the Law of the Sea recommended specifically that "the IAEA should pursue whatever studies and take whatever action is necessary to assist States in controlling the discharge or release of radioactive materials to the sea, in promulgating standards, and in drawing up internationally acceptable regulations to prevent pollution of the Sea by radioactive materials in amounts which would adversely effect man and his marine resources".

Following the United Nations Conference on the Human Environment in Stockholm (1972), the concept of pollution prevention took effect when, in 1975, the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Dumping Convention) entered into force. The London Dumping Convention entrusts the IAEA with specific responsibilities for the definition of high-level radioactive wastes unsuitable for dumping at sea, and for making recommendations to national authorities for issuing special permits for ocean dumping of low-level radioactive wastes. IAEA was mandated to keep the definitions and recommendations under review to limit the impact of the dumping operation.

type of containers, as well as the quantities of dumped radionuclides, has been established. Consideration is being given to including information on controlled authorized liquid releases from nuclear facilities into the coastal waters in the inventory.

The rationale for the inventory is to establish an information base which can provide more accurate data for assessing the impact of radioactive waste dumping operations in the sea. Such an inventory will also serve as a deterrent against disposal of more waste coming from various countries than recommended in a single oceanic basin.

Seabed disposal

The deep sea floor is one of the most stable and predictable geologic formations on earth and has therefore been considered as a potential alternative solution to deep geological disposal of HLW on land. If a seabed disposal option was selected, packaged HLW could be embedded in the sediment using penetrators or drilling techniques. The packages would contain the wastes for 500 to 1000 years after emplacement. Long-term containment, for tens of thousands of years, would be provided by the barrier properties of the sediment.

In 1984, the contracting parties agreed that the LDC consultative meeting was the appropriate forum to address the scientific and legal issues of the HLW seabed disposal. It was also agreed that no HLW disposal into the seabed should take place until it is proved to be technically and environmentally acceptable, including a determination that such wastes can be effectively isolated from man and the marine environment.

In 1988, the NEA/OECD Seabed Working Group concluded that sub-seabed burial of HLW was technically feasible, but added that its long-term safety assessment required further research to reduce the uncertainties before the option is used.

The future

Following the voluntary moratorium, no dumping operations have been carried out since 1982. This disposal option, however, still remains open pending a final decision by the contracting parties to the LDC and is a concept which can, in principle, be considered as an alternative to disposal on land.

Through the NEA/OECD Seabed Working Group and Co-ordinated Research and Environmental Surveillance Programme, scientific data on geochemistry, physical oceanography, and deep-sea marine biology continue to be accumulated on the processes controlling radionuclide transport and dispersion in the North East Atlantic and North West Pacific Oceans. These data, in addition to research activities in the field of mathematical modelling of radionuclide transport processes to marine organisms and man, have improved the capability to assess the impact of radionuclides dumped into the sea. Next year, the NEA Committee of Radiation Protection and Public Health will conduct a review of the suitability of the North East Atlantic Ocean NEA dumping site for the disposal of packaged LLW.* The purpose is to ensure that new scientific data do not contradict the conclusions of past assessments of the site.

In 1988, an IAEA/NEA Experts Group reached a consensus on the criteria for determining which types of radiation sources and practices may be exempted from regulatory control on the grounds that they present a trivial radiation risk. These criteria must now be explicitely applied to waste disposal in the marine environment to establish rules and guidelines for determining which types of LLW may be treated as being non-radioactive for the purpose of sea disposal.

Current studies to examine the risks of sea dumping and to compare them with those of land disposal and with those from sea disposal of other types of hazardous waste may give a more balanced appreciation of the real impact of sea dumping.

* As required by the OECD 1977 Multilateral Consultation and Surveillance Mechanism, such a review is to be performed every 5 years.