

OCEAN DUMPING OF LOW-LEVEL WASTES IN JAPAN: PAST AND FUTURE

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INTRODUCTION

Japan began the development and utilization of nuclear energy only for peaceful purposes in 1955. In the earlier stages only imported radioisotopes (RI) were used for academic research and medical application. At present more than 4,400 chiefly small institutions, are using RI for various purposes, about 40% of these being employed in the medical field. In 1957 the first research reactor, 50 kWth Water Boiler-type, became critical at Tokai Research Establishment, Japan Atomic Energy Research Institute (JAERI). In 1966 the first commercial power reactor, 166 MWe Calder Hall-type, was commissioned in Tokai Station, Japan Atomic Power Company (JAPCO) and in 1970 the first PWR of 340 MWe and the first BWR of 357 MWe were commissioned, then followed by PWRs and BWRs. At present 23 power reactors are producing 15.676 GW electricity, corresponding to about 15% of Japan's total electricity output.

Very little uranium reserves have been found in Japan, and therefore most of the necessary uranium has been imported after being enriched in the USA. Four fuel fabrication factories are at present supplying uranium fuels. Irradiated fuels are reprocessed in Tokai Reprocessing Plant, Power Reactor and Nuclear Fuel Development Corporation (PNC) which has a capacity of only 210 t/yr. Most of the spent fuels discharged from nuclear power stations are transported to France and the UK to be reprocessed according to the commercial contract effective from 1980 to 1990. The contract requests the return of reprocessing wastes to Japan. After 1990 a large scale reprocessing plant of 1200 t/yr capacity will be operated by a newly-established reprocessing company.

Recovered plutonium should be utilized in FBR and by the time enough FBRs are in operation, plutonium will be burned in ATR (Japanese-developed advanced thermal reactor) or in conventional LWRs. Most uranium is and will continue to be imported and Japan must utilize the precious energy resources by developing a uranium-plutonium fuel cycle. Only PNC is capable of handling, processing and fabricating plutonium-bearing oxide fuel and it has produced more than 50 tons of Mixed Oxide fuels mostly for its FBR "JOYO" and ATR "FUGEN".

In these nuclear activities various kinds of radioactive wastes have been produced. Most of them are low-level wastes from power generation. Japan has no uranium mill tailing problem. Tokai Reprocessing Plant is producing high-level waste and has about 100 m³ stored in underground tanks. PNC and JAERI are developing a safe vitrification process and final disposal method, and they have ample time to perfect them. At this stage all plutonium is handled only inside PNC organization and plutonium-contaminated wastes are stored

at the site. Other institutions have no transuranic (TRU) waste problems.

RI users are producing low-level wastes around the country and it is difficult to expect them to be able to process and dispose of them safely. Therefore, the government (Science and Technology Agency, STA) has revised the relevant regulation to permit them to request other competent fully-staffed and equipped bodies to receive and manage the wastes. In addition it has asked to Japan Radioisotope Association (JRIA), practically the sole RI importer and distributor, to collect and temporarily store the wastes on request. JRIA has constructed 4 local storage facilities and when they become full, the waste will be transported to the JAERI Tokai radwaste treatment plant to be processed. This national network system has been operating effectively since its establishment in 1960 and the resultant concentrates have been solidified with cement in drums and stored in Tokai semi-underground pits.

Nuclear power stations are producing large quantities of low-level waste, potentially contaminated with short-lived activated products and some with little fission products. Every year about 13,000 m³ of low-level waste are being produced and stored on each site, and have accumulated to 67,000 m³ in total.

PAST OCEAN DUMPING

The small and densely populated islands of Japan are enclosed to the east and south by the Pacific Ocean, to the north by the Okhotsk Sea and the Sea of Japan, and to the west by the East China Sea. For thousands of years the Japanese have lived around the sea, taking various marine products for food and resources and have disposed of natural wastes and some industrial wastes into the sea. They have done so in the knowledge that small amounts of hazardous materials could be disposed of without harmful effect to themselves or to other neighbouring nations. The Brynielsson panel of the IAEA has concluded that wastes of low and intermediate activity may safely be disposed of into the sea under controlled and specified conditions, and the USA and some European countries have been dumping low-level waste in the Pacific and the Atlantic Oceans in accordance with the IAEA conditions. Packaged waste with a specific gravity above 1.2 may be dumped into the ocean at depths above 2,000 m.

As the Japan Radioisotope Association has no storage space at its Tokyo head office site they asked the competent national authorities, STA, to conduct sea dumping of the packaged wastes discharged after the RI redistribution. The main contaminant was cobalt-60. Just outside the mouth of Tokyo Bay there are ocean depths of more than 2,000 m. The Association chartered commercial cargo-boats of 30 to 880 tonnage, loaded the packaged wastes onboard and dumped them at the determined site with the cooperation of the Maritime Safety Agency. Every operation was performed under the guidance of an STA Escorting Officer who checked the waste handling, dumping operation and radiation monitoring. In 1955 to 1969 fifteen such operations were conducted and 1661 drums with 453 Ci were dumped. Cobalt-60 was the major nuclide of 374 Ci,

mixed with radium-226 of 0.48 mCi and others. Gross average activity per drum was 273 mCi and the average weight was 400 kg/drum. Dump sites were located at 34°40'N, 139°55'E (2400 - 2800 m deep) for 12 operations, and 34°35'N, 139°55'E (2400 - 2800 m deep), 34°55'N, 139°25'E (1400 - 1500 m deep) and 34°34'N, 138°32'E for one operation each. As an exception the last site was in Suruga Bay (2000 - 2500 m deep) just of the southern sea-slope of Mt. Fuji.

These areas have been monitored for radioactivity in routine nuclear test fallout effect surveys, and no significant contamination has been discovered.

As mentioned already, the Association began the national waste collection and storage service network in 1960 and it became possible to transfer the waste to local storage sites. STA began the technical study on radioactive solid waste management in 1969, and suggested suspension of the dumping operation pending the study's conclusion. Dumping operations were ceased in 1970, the year which the USA stopped its sea dumping mainly for economical reason.

Thereafter Japan disposed of no radioactive waste either on land or at sea. At present RI-originated low-level wastes are been stored in temporary storage houses, in Sendai, Tokai-mura, Sakai and Fukuoka. At present, about 2,000 m³ is awaiting final disposal.

PREPARATION FOR OCEAN DUMPING

Nuclear power stations in Japan are located on the coasts and have their own harbors for personal use, except for one station which uses a nearby business harbor. Sea transportation is very convenient and safe, and it is quite natural for them to study sea disposal first and then ground disposal.

STA's technical study committee defined the necessary conditions for sea dumping of low-level wastes considering OECD-NEA's conditions for the Atlantic dumping operation. Dumping should be restricted to those areas of the oceans between latitudes 50°N and 50°S, and the area should have an average water depth greater than 4,000 m. Sites should be located clear of continental margins, namely in ocean basins. Volcanic and seismic zones and sea trenches should be avoided. Major fishing areas and areas with potential marine resources should also be excluded. In 1972 the committee selected four candidate sites for sea disposal. These sites are all located in the North-West Pacific Basin, surrounded by the Kamchatka Peninsula, the Kurile Islands, the Japanese Archipelago, Izu and Ogasawara Islands, the Mid-Pacific Mountains, Hawaiian Islands, and the undersea Emperor Seamount Chain. Except for one site, they are in the sea about 6,000 m below sealevel and are outside the 200-nautical mile Economic Resources Zones.

In 1972 - 1974, oceanic surveys were conducted at these sites and their vicinities by the Fisheries Agency, the Meteorology Agency, the Meteorological Research Institute and the Maritime Safety Agency, and since 1977 further surveys have been underway by these and other

institutions. Considering the results it was concluded B site, 30°N and 147°E, with a depth of 6,300 m was most favorable for dumping. It is located about 900 km southeast of the mouth of Tokyo Bay and the nearest islands are the Japanese Ogasawara or Bonin Islands, about 550 km away. The nearest foreign land is the Northern Mariana Islands located about 1,200 km away and Saipan Islands, the largest island and the capital is located about 2,000 km southward.

It is required under international regulation that waste packages descend to the seabed safely and that the container and contents remain intact during descent. Since the B site is deeper than the Atlantic site by about 2,000 m, the strength of waste packages must be verified to withstand the greater hydrostatic pressure, approximately 600 atmospheres, and to be sure that any release of radioactivity is minimal, to the attainable degree. For this purpose high water-pressure test facilities were manufactured by JAERI and the Central Research Institute of Electrical Power Industries (CRIEPI) up to the world's highest levels of water pressure of 500 and 700 atmospheres, with which tests have been carried out. Impact tests and long-term water corrosion tests of containers have also been conducted. In addition, simulated solidified packages were actually dumped with cables attached and lifted again, which proved their soundness for disposal at the site.

The Japan Marine Science and Technology Center developed the technology to verify the soundness of waste containers, using a deep-sea camera system attached to the package to take photos while the container was descending, on arrival on the sea bed, and while lodged there. The system operated right through to the recovery of the container. The Center has used this technology successfully for tests at the candidate B site. Technology is also being developed for remote viewing of the packages to observe their condition on the seabed, using a movable supersonic survey system on the seabed.

In 1975 - 1976 the STA conducted an environmental safety assessment on the experimental or trial disposal of a limited amount of solidified packages, with 500 Ci in 5,000 - 10,000 drums, and full-scale disposal (annual 100,000 Ci disposal is the basis of calculation, but it is far less in reality) is to be undertaken only after the safety of trial disposal has been confirmed. The results of this assessment were checked again in 1979 by the Nuclear Safety Commission and the conclusion was confirmed. The assessment used the diffusion coefficients, biological concentration factors, etc., obtained from the oceanic surveys of the candidate site. Since packages have been confirmed to be sufficiently sound under actual disposal conditions, the assessment took into consideration the worst conditions, on the hypothesis that all radioactivity is released into the sea water and diffused there immediately on the package reaching the seabed. Calculated concentration of radioactivity in the trial disposal is only about 1/10 millionth of the natural radioactive potassium in sea water. And the concentration of radioactivity in marine organisms and its eventual consumption by human beings resulting from trial disposal is 0.00001 m rem/yr. Full-scale disposal will result in an exposure dose of 0.02 m rem/yr, about 1/5000 of the natural radiation exposure dose. Moreover, the radioactivity in a package is retained within a container for years, during which time it decays to lower levels. Even

if the container corrodes, and the contents are exposed to sea water, the radioactivity is released at a very slow rate, and most of it will be adsorbed by the seabed sediment. Anyhow sea water naturally contains a large amount of radioactivity, to which people have been exposed already for a long time.

The Radioactive Waste Management Center (RWMC), a public utility corporation, was established in 1976 by the electric utilities, the nuclear fuel industries, JAERI, PNC, JRIA and others. The Center was established to carry out the waste disposal, for which private sector is responsible, in response to the Japanese AEC policy adopted in 1976. Activities on sea disposal so far carried out by the Center are: designing and preparation of sea disposal vessels, mock-up production and tests of remote-handling and dumping cranes, verification of inspection technology of waste packages, etc. The Center is under contract to conduct trial disposals for the nuclear plant operators, and it is expected that the Center will soon begin full-scale disposal as Japan's sole waste disposal operator.

The relevant laws and regulations were revised in 1978 - 1980 and improved to conform to international regulations and revisions made in line with the findings of tests and studies. The law on Compensation for Nuclear Damage was also revised, and the new law provides for compensation of up to 200 M yen to be paid for nuclear-related damage due to sea disposal of nuclear fuel wastes.

FUTURE DUMPING IN THE PACIFIC ODEAN

Japan is planning to dispose of its ever-increasing radioactive waste at sea or in the ground, depending on the type of treatment it is subjected to. Wastes of low radioactivity are to be solidified and disposed of on the deep sea bed, but other low-level wastes, not suited for such disposal or those required to be kept in a retrievable condition, are to be stored at the site of each plant or disposed of in the ground. It is expected that about 60 - 70% of low-level wastes will be disposed of in the ocean and the remaining 30 - 40% in the ground. The Japanese AEC adopted a fundamental policy on radioactive waste management in 1976, and stressed that with respect to the sea disposal operation, efforts to obtain international understanding is imperative and operations should be carried out in a spirit of international harmony. In this spirit, it participated in the London Dumping Convention in November 1980 and in the Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Wastes established within the OECD-NEA in July 1981. At present they are making every effort to obtain the understanding of the parties concerned in Japan and Oceanian areas, explaining the content and safety of the ocean dumping program.

The candidate site for Japanese dumping was chosen in such a way as to avoid areas that have potential seabed and fishery resources which may be exploited. To the Japanese domestic fishing industries concerned, the Fisheries Agency and STA have been explaining the program since 1976, and their talks appear to have reached the final

stage. To the Oceanian and Southeast Asian countries and areas under UN trusteeship, which have expressed concern about the effects of sea dumping, technical briefing missions of STA have been sent several times in 1980 - 1982. In addition, taking advantage of the fact that officials and influential persons from the areas concerned visit Japan, STA and the nuclear industrial and electrical utilities organizations intend to show them the nuclear power stations and waste management operations to provide them with an understanding of the issues. This is a tedious and time-consuming way to deal with the situation, but Japan believes this is the only way to achieve harmony with the so-called Pacific way.

Ocean dumping of low-level wastes, which has been much studied and under preparation since 1961, may begin from 1984 if everything goes smoothly. First there will be the trial dumping of a small amount of wastes, and a government-affiliated organization will monitor the sea, and an assessment will be made by the Nuclear Safety Commission for the endorsement of safety. It is expected that this whole process will take about two years, and only when the safety of trial dumping has been verified can the full-scale dumping begin, which will likely be in 1987 or later, assuming smooth progress of the programs. It is expected to take several more years before routine disposal operations begin. Until that time all waste-producing organizations must keep their wastes on their site awaiting routine disposal operations. They are making every effort to diminish the volume of waste and to store it on-site economically and safely.