3.4 Radioactive Waste Management (RWM) Status in Japan

3.4.1. National Policy for Radioactive Waste Management

Atomic Energy Commission revised the Long Term Program in 2000 and placed importance on the backend measures. The program states that the present generation, which enjoys the benefits of nuclear power, has the obligation to do its utmost for the safe disposal of radioactive waste resulting from the research, development and utilization of this energy source. It also mentions that continued efforts will be exerted to achieve steady progress in the proper disposal of such waste. The program expresses the basic policies for treatment/conditioning and disposal of radioactive wastes as follows:

- Radioactive waste is generated primarily at nuclear power plants and nuclear fuel cycle facilities (including waste returned waste from abroad after spent fuel reprocessing under contract), but some does come from universities, research institutes, medical institutions and other facilities.
  Such waste should be safely treated/conditioned and disposed of by the generators. The government should provide guidance to or regulate the generators to ensure that the treatment/conditioning and disposal are carried out properly and safely.
- Since radioactive waste varies greatly in its level of radioactivity and in the type of radioactive material contained, arrangements should be made to classify the waste by method of disposal, regardless of the facility from which it comes, and take specific measures for its treatment/conditioning and disposal.
- In order to win people's trust in the business of radioactive waste final disposal, efforts are also needed to provide full information on the disposal project and to secure its transparency at all stages.
- Steps should be taken to reduce the amount of waste generated and to recycle/reuse it. Research and development to those ends should be actively pushed forward. Interested parties and the competent authorities should jointly conducted an extensive study on the uses of such waste and the development of systems for that purpose, including satisfactory safety checks.

Waste with a radioactivity concentration below the "clearance level" need not be dealt with as radioactive material, and may not be handled in the same way as conventional waste in respect of safety. In principle, it is important to recycle waste to the fullest extent practical and reasonable.

3.4.2. Practice of Radioactive Waste Management

3.4.2.1. Legal System Related to the Radioactive Waste Management

The treatment, storage and disposal of radioactive wastes generated during operation of nuclear facilities is regulated by either the Law for Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactor (hereinafter referred to as "Reactor Regulation Law") or the Law for the Prevention of Radiation Hazard due to Radioisotopes, etc. (hereinafter referred to as "Radiation Hazard Prevention Law") according to the kind of facilities which generate the wastes. These two laws: Regulation Law and Prevention Law are in conformity with the Atomic Energy

Basic Law, which establish the basic policy of nuclear activity as Peaceful uses, Safety Assurance, Democratic management, Autonomy and Publication of results.

Since Reactor Regulation Law enacted in 1957, the treatment, storage and discharge of gaseous or liquid radioactive wastes generated at nuclear facilities (the refining facilities, fabricating facilities, reactor facilities, reprocessing facilities, or other utilization facilities of nuclear source material or nuclear fuel material for research or industrial use, etc.) as well as the management and treatment of solid radioactive wastes have been regulated by Reactor Regulation Law on the basis of management at individual plant site.

In 1986, Reactor Regulation Law was amended to allow for a shallow land disposal of low-level radioactive waste. The Reactor Regulation Law prescribed the provision of the following two types of disposal businesses for radioactive waste:

- To carry out the burial disposal of radioactive waste, and
- To carry out the storage of radioactive waste (storage and treatment prior to the final disposal)

Regarding the standard of the final disposal of the radioactive waste, only a part of low-level radioactive waste from nuclear reactor is prescribed in Japan now.

Concerning the high-level radioactive waste, the fundamental policy is that the high-level radioactive waste remaining after the recovery of plutonium, uranium and other useful materials from spent fuel by reprocessing should be solidified in a stable form and, after being stored for 30 to 50 years for cooling, buried under the ground by the geological disposal method.

The Nuclear Safety Commission has concluded in March 1989 the "Principles for Safety Evaluation of Radioactive Waste Management Facilities" from its consideration to licensing review on high-level radioactive waste. Along with these principles, the Science and Technology Agency and the Nuclear Safety Commission conducted a double check on a license application for a high-level radioactive waste management facility at for 30-50 years in vitrified solid form. Vitrified high-level radioactive waste is already stored at a repository.

According to the "Final Disposal of Designated Radioactive Waste" Program, which was issued on October 2, 2000, under the Law on Final Disposal of Designated Radioactive Waste, final disposal will start sometime in the latter half of the 2030's.

The geological disposal is to be performed in four stages:

- Selection of acceptable geological formations (1st stage)
- Selection of the candidate disposal sites (2nd stage)
- Demonstration of disposal technology at the candidate disposal site (3rd stage)
- Construction, operation and closure of the disposal facilities (4th stage)

On the other hand, Radiation Hazard Prevention Law prescribes that radioactive wastes generated during utilization of radioisotopes have been required to be treated, stored and discharged at individual facility, as well as the legal system of Reactor Regulation Law since l957. However, Radiation Hazard Prevention Law does not prescribe for the land disposal system.

The sea disposal was prohibited in 1994 in accordance with the Convention on the Marine Pollution (London Convention).

3.4.2.2. Organization and Responsibilities for the Waste Management

Regarding the responsibility for treatment and disposal of the waste, it basically lies with the waste generators. The generators who are responsible for disposal shall be required to meet their obligations in that respect in an appropriate and sure manner on the basis of specific working plans and at their own expense.

The national government is responsible for adopting appropriate measures to ultimately ensure that those responsible generators meet their responsibilities concerning the safety. That includes comprehensive formulation of disposal methods, confirmation of the safety of disposal and devising legal and other measures that are necessary for long-term guarantee of meeting of the responsibilities for disposal.

The Ministry of Economy, Trade and Industry (METI) is a competent authority of nuclear administrative functions for energy use. The Agency of Nuclear and Industrial Safety in METI regulates the safety of nuclear power generation facilities, commercial nuclear fuel cycle facilities and radioactive waste facilities.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) is a competent authority of nuclear administrative functions for research and development. The Nuclear Safety Division in MEXT regulates the safety of research reactor and radiation protection.

The Atomic Energy Commission (AEC) and Nuclear Safety Commission (NSC) are in cabinet office independently and properly give directions (if necessary) to the competent authority from higher standpoint. The Nuclear Safety Commission has the authority to plan, deliberate and make decisions on matters concerning the regulation for ensuring safety of atomic energy, of matters concerning the research, development and utilization of atomic energy. Government organizations related to radioactive management are shown in Fig. 3.4-1.

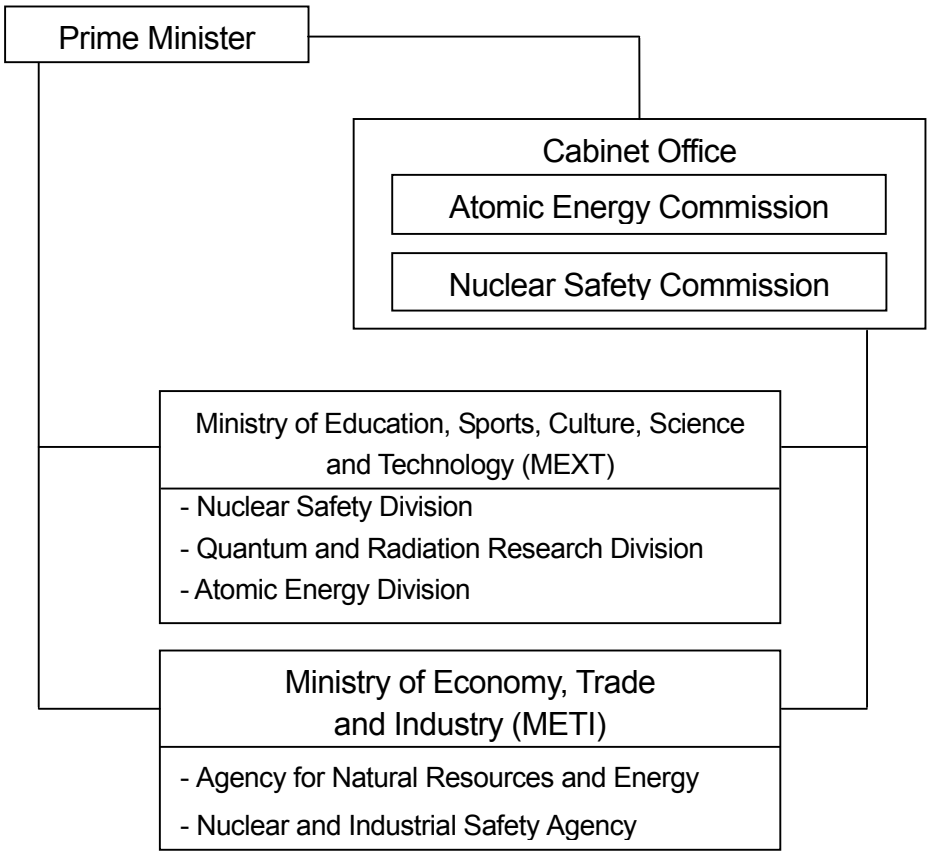

Figure 3.4-1 Government Organizations Related to Radioactive Management in Japan

3.4.2.3 Regulations on Radioactive Waste Management

- Regulations on Radioactive Waste Management within the Plant Site:

When the reactor licenses, fabricating businesses, and other nuclear businesses manage radioactive wastes generated as a result of their business within the plant site, the regulations are applied as a part of the regulations concerning each facility. The regulations call for the following measures in common:

- Gaseous radioactive wastes:
  - must be released through exhaust equipment.
  - must be stored in exhaust gas tanks which have radiation hazard prevention functions, etc.
- Liquid radioactive wastes:
  - must be released through drainage equipment
  - must be stored in liquid waste tanks which have radiation hazard prevention functions
  - must be enclosed in containers or solidified in containers and put into storage/disposal facilities which have radiation hazard prevention functions, etc.
- Solid radioactive wastes:
  - must be incinerated by incinerators which have radiation hazard prevention functions.
  - must be enclosed in containers, or solidified in containers and put into storage/disposal

facilities, which have radiation hazard prevention functions, etc.

When gaseous or liquid radioactive wastes are released, they are continually monitored to ensure that they do not exceed the concentration levels of radioactive materials in the air or water prescribed by law. In practice, each individual facility, based on the "ALARA" (As Low As Reasonably Achievable) concept.

- Regulations on Radioactive Waste Management Outside the Plant Site:

When nuclear businesses manage (including transportation outside the plant site for management) of radioactive wastes outside the plant site, the following measures must be taken:

- The wastes must be placed in facilities with radiation hazard prevention functions.
- The record of the wastes must be delivered.
- The imposed wastes
  - must be solidified in containers for radiation prevention.
  - must be wastes which can be managed in the management facility (about size, weight, strength, radioactivity, etc.)
- The radioactive material must not be scattered and leaked easily with no heavy damage, etc.

Out side the plant site management of imported waste cannot be carried out without prior confirmation that the operations comply with the above measures by the government.

- Regulations on Radioactive Waste Management on Disposal Facility
  - Basic concept of safety regulations

    The Nuclear Safety Commission had discussed basic concept of the safety regulation of the burial/disposal of low-level radioactive wastes and made a report entitled "Basic Concept of Safety Regulations Concerning Land Disposal of Low-level Radioactive Solid Wastes" in 1985.

    Based on this concept, the Radiation Council has issued a recommendation. The recommendation says that it is quite appropriate to adopt the individual radiation dose of 10 micro-Sv per year as a criterion for the release of disposal site from regulatory control. Safety Regulation for Burial Disposal Business of Radioactive wastes is carried out on this criterion. The concept of safety regulations that apply to burial disposal business can be reduced stepwise with time.

    The concept of safety regulations at each stage is summarized as follows:
    - First stage: (10-15 years, until the placement of the cover soils), maintaining the integrity of the engineered barrier.
    - Second stage: (30 years, until the cover soils become stable), securing the performance of barriers
    - Third stage: (300 years, from the end of the first stage), prohibition or restriction of specified act
    - Post closure: (After 300 years), people may enter the area

- Regulation Process

The inauguration of waste disposal is preceded by an application for permission to a Minister of the Ministry of Economy, Trade and Industry (METI), based on the "Reactor Regulation Law."

The Nuclear Safety Commission and the Atomic Energy Commission examine the safety examination report and prove its correctness. Then, the minister of METI grants approval. Whenever any modification is made during any of the phases, an application is made to the government for approval to modify the technical specification, at which time the safety considerations are checked again. When the construction is completed and/or facility is closed, the government checks the completion measures. After the construction of the disposal facility, the METI confirms the facility's compliance with the technical standards and approve the start of operation.

All waste to be disposed of needs approval from the competent authorities. To ensure that the waste to be disposed of is within the specified limits, before the transport of the waste to the facility, the documentation is checked and the activity concentrations of the waste are measured by the authorities. The waste can be placed in the facility, after the check of the surface of container, weight, identification number and label.

Regulation process on disposal of radioactive wastes is shown in Figure 3.4-2.

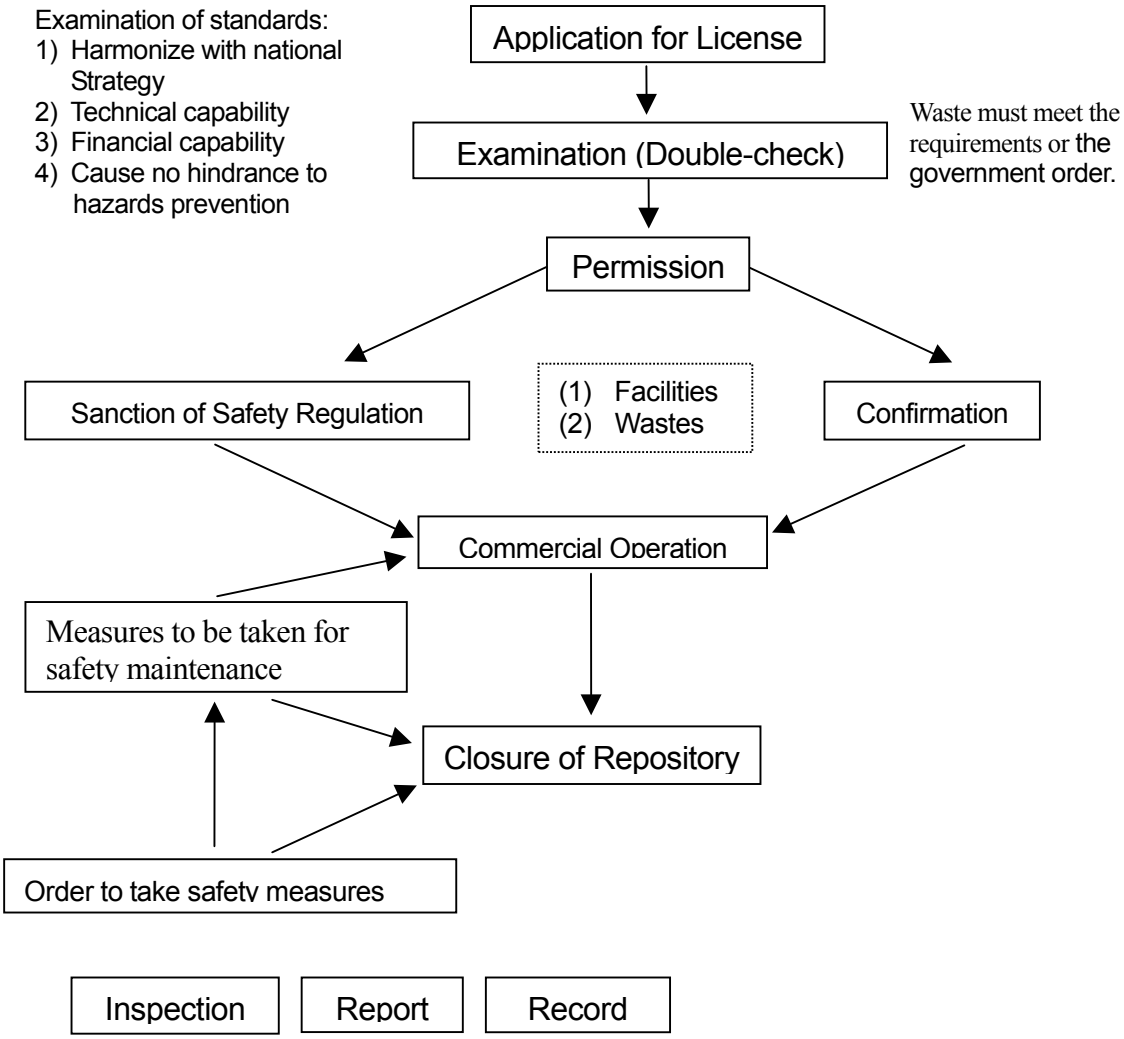

Figure 3.4-2 Regulation Process on Disposal of Radioactive Wastes

3.4.3 Criteria Used to Define and Categorize Radioactive Waste

Radioactive wastes are categorized into two types: high-level radioactive wastes (HLW) and low-level radioactive wastes (LLW). HLW is the high-level liquid waste separated in the reprocessing of spent fuels and its vitrified waste. All wastes other than HLW are LLW.

LLW are further categorized into several types based on the origin of the wastes: power reactor wastes, TRU contaminated wastes, uranium wastes and RI・laboratory wastes. Power reactor wastes are generated from the operation and decommissioning of nuclear power plants. TRU contaminated wastes are generated at overseas/domestic reprocessing plants and MOX fuel fabrication plants. Uranium wastes that are exclusively contaminated with uranium are generated at front-end facilities such as refining plants, conversion plants, enrichment plants and UO2 fuel fabrication plants. RI・laboratory wastes are generated at the facilities which use radioisotopes, and at research reactors and research laboratories which use nuclear and other radioactive materials.

These LLW from different origins are further grouped into several types based on the

composition and level of radioactivity for the purposes of rational waste management and safety of final disposal:

- Power reactor wastes
  - Relatively higher LLW with relatively significant amount of β and γ nuclides, such as core internals
  - Relatively lower LLW, such as liquid concentrate
  - Very low-level wastes, such as concrete block
- TRU contaminated wastes
  - Ag-adsorbent with high concentration of I-129
  - Hulls and end-pieces with high concentration of C-14
  - Solidified packages of concentrated waste with high nitrate
  - Others

Uranium wastes and RI・laboratory wastes are also grouped into several types based on their characteristics. It should be noted that in RI・laboratory wastes, there exist the wastes which could be categorized into other types.

3.4.4 Radioactive Waste Management Facilities

3.4.4.1 Outline of Radioactive Waste Treatment and Disposal Facilities

The only operational disposal facility for radioactive waste in Japan is Japan Nuclear Fuel Ltd.'s Low-Level Radioactive Waste Disposal Center in the Village of Rokkasho, Aomori Prefecture. It went into service in December 1992, to dispose of low-level waste from nuclear power plants. The center's Disposal Facility 1 has a storage capacity of 200,000 storage drums' worth of homogeneous solidified waste, and has so far received about 130,000. In October 2000, Disposal Facility 2, able to store 200,000 drums' worth of compacted solid waste, commenced operation. The current capacity of Facility 2 is 400,000 200-liter-drums' worth, and will be increased eventually to 3,000,000 drums' worth.

Low-level radioactive waste is also stored temporarily at commercial nuclear power plants. Solid waste is first incinerated and compacted, and liquid waste is concentrated, solidified, and treated.

High-level radioactive waste is now being stored and managed at two locations. Japan Nuclear Fuel Ltd.'s Rokkasho Storage Facility in Rokkasho, Aomori Prefecture, stores and manages high-level waste generated during reprocessing overseas. At that facility, every step in the handling and inspection process is remotely controlled, and cooling is via natural ventilation. The current capacity of the facility is 1,440 vitrified packages, which will be doubled in the future. As of January 2001, 272 packages were stored.

The Vitrification Facility at the Japan Fuel Cycle Development Institute's Tokai Reprocessing Center in the Village of Tokai, Ibaraki Prefecture, stores vitrified packages of high-level radioactive waste from the center's Tokai Reprocessing Plant; those packages were created in the development of vitrification technology. The current capacity of the facility is 420 vitrified packages. As of September 2000, 72 packages were stored.

About 180 research institutes and over 5,000 facilities using radioisotopes (RI) also

generate radioactive waste. The Japan Atomic Energy Research Institute's Radioactive Waste Treatment Facility, at the institute's Tokai Research Establishment, is one facility dealing with waste from research institutes, incinerating and compacting solid waste, and evaporating and concentrating liquid waste. RI waste is collected by the Japan Radioisotope Association, which is responsible for its treatment/disposal, and treated and stored at the association's Kaya Memorial Takizawa Research Institute in the Village of Takizawa, Iwate Prefecture. Solid waste is incinerated and compacted, and liquid waste is evaporated, concentrated and stir-dried.

Waste is also stored at facilities operated by the Japan Fuel Cycle Development Institute, which is engaged in R&D on new-type power reactors and nuclear fuel cycle technology. As necessary, solid waste is incinerated, compressed and fused, and liquid waste is evaporated, concentrated, solidified and treated.

Table 3.4-1 Major Radioactive Waste Treatment and Disposal Facilities

Name	Location	Purpose	Characteristics
Rokkasho LLW Disposal Center	Rokkasho-mura, Aomori Prefecture	Burial-disposal of low-level radioactive waste	・Concrete pit installed on seismically stable base rock ・Easy drainage through porous concrete layer inside the pit ・Reduced volume of infiltrating water by compacted bentonite ・Current capacity is 400,000 drums
Rokkasho Storage Facility	Rokkasho-mura, Aomori Prefecture	Storage and management of high-level radioactive waste generated in reprocessing overseas, until final disposal	・Handling and inspection by remote operation ・Vitrified packages cooled by natural ventilation ・Current capacity is 1,440 packages, to be increased to 2,880 packages
JNC Tokai Vitrification Facility (TVF)	Tokai-mura, Ibaraki Prefecture	Development of vitrification technology, and storage of vitrified packages	・Handling by remote operation ・Forced cooling of vitrified packages ・Storage capacity is 420 packages
Radioactive Waste Treatment Facility of JAERI Tokai Research Establishment	Tokai-mura, Ibaraki Prefecture	Treatment and storage of waste from JAERI Tokai and other institutes	・Incineration, melting and compaction of solid waste ・Evaporation and concentration of liquid waste; cementation or bituminization of concentrated liquid waste ・Storage capacity is 139,000 drum 200-liter equivalent
Japan Radioisotope Association's Kaya Memorial Takizawa Laboratory	Village of Takizawa, Iwate Prefecture	Centralized treatment and storage of RI waste	・Incineration and compaction of solid waste ・Evaporation, concentration and stir-drying of liquid waste
Waste storage facilities at nuclear power plants	Each nuclear power plant site	Treatment and temporary storage of waste from its own plant	・Incinerating and compacting solid waste Evaporating, concentrating, and solidifying liquid waste ・Temporary storage of post-treatment waste

3.4.5 Inventory of Radioactive Wastes (RW)

3.4.5.1 Inventory of RW in Storage

- Low-level Radioactive Waste

Gaseous radioactive wastes and extremely low-level liquid radioactive wastes generated at nuclear facilities are processed so that their radioactivity is reduced to a level below the standards prescribed by law. They are then released into the atmosphere or sea. Other liquid wastes are concentrated solidified and solid wastes are put into containers (following a volume reduction and solidified. These are then safely stored at the facilities temporary. Table 3.4-2 shows the amount of low-level radioactive wastes.

- High-level Radioactive Waste

Vitrified high-level radioactive waste separated from spent fuel at reprocessing facilities.

- Vitrified waste returned from abroad: 272 containers (as of the end of February 2000)
- Vitrified waste treated in the country: 62 containers (as of the end of March 1998)

3.4.5.2 Inventory of RW in Disposal

Low-level radioactive waste from nuclear power plants, about 130,000* drums were disposed (as of the end of December 1999, measured in 200 liter drum-can equivalents).

*Disposal facility: Disposal in concrete pit, shallow land disposal facility for low-level radioactive wastes. Licensee is The Japan Nuclear Fuel Co.

Very low-level radioactive waste generated from Japan Atomic Energy Research Institute Tokai Research Establishment, 1,670* tons were disposed.

*Disposal facility: Disposal in trench, shallow land disposal facility for very low-level radioactive wastes. Licensee is Japan Atomic Energy Research Institute.

Table 3.4-3 Amount of Low-Level Radioactive Wastes Managed in Nuclear Facilities

Category	Facility	Major Materials	Total Volume[1]
Waste managed in nuclear power plant	Generated by operation and decommissioning of nuclear power reactor	<Generated by operation> Concentrated waste, miscellaneous solid waste, control rod, ion exchange resin, etc. <Generated by decommissioning> Concrete, metal of reactor structure, etc.	About 490,000 (as of the end of March 1999)
Waste containing TRU nuclides	Generated by reprocessing and MOX fuel fabrication	Concentrated waste, miscellaneous solid waste, covering material, ion exchange resin, filter, etc.	About 87,000[2] (as of the end of March 1998)
Uranium waste	Generated by uranium conversion and fabrication and uranium enrichment	Ash, miscellaneous solid waste, filter, etc.	About 81,000 (as of the end of March 1998)
RI waste, research institute and other waste	Generated from facilities using radioisotopes and research institutes and similar entities using nuclear materials	<RI Waste> Paper, plastic, concrete, metal, filter, radiation sources, etc. <Research Institute & Other Waste> Solidified liquid, miscellaneous solid waste, metal, concrete, etc.	<RI Waste> About 109,000 <Research Institute and Other Waste> About 283,000[3] (as of the end of March 1998)

[1]Measured in 200-liter drum-can equivalents
[2]Other waste containing TRU nuclides that from abroad reprocessing are planed to return future
[3]Include some of the waste containing TRU nuclides and Uranium waste

3.4.6 Nuclear Facilities in the Process of Being Decommissioned and the Status of Decommissioning Activities at those Facilities

Commercial nuclear power reactors are considered to be dismantled and removed as soon as possible after their operation are completed. Based on this philosophy, the Japan Power Demonstration Reactor (JPDR) decommissioning program was conducted by the Japan Atomic Energy Research Institute (JAERI) from 1981 to 1996, and demonstrated the usefulness of the decommissioning technologies for future use in dismantling commercial power plants. The extremely low-level radioactive wastes arising from demolishing the JPDR biological shield was disposed of into the near surface burial site in JAERI as a safety demonstration test.

The Tokai Power Station, the oldest commercial gas-cooled nuclear power plant of the Japan Atomic Power Company (JAPCO), completed its commercial use in March 1998. The decommissioning plan is being prepared, and the regulatory procedure is planned to start within a few years. This will be the first case of decommissioning of commercial nuclear power plant in Japan.

The Fugen Nuclear Power Station of the Japan Nuclear Cycle Development Institute (JNC), which is a prototype of advanced thermal reactor, will be shut down in 2002. Preparatory study on the decommissioning of Fugen was started in 1999 by JNC.

As for the research reactors, the Japan Research Reactor No. 2 (JRR-2) of JAERI was shut

down in December 1996 and its decommissioning program was then started to remove core part in one piece. The decommissioning program will complete by 2007. Other five reactors used for nuclear criticality experiments and training and one developmental reactor are under decommissioning in March 2000.

The JAERI Reprocessing Test Facility (JRTF) decommissioning program started in December 1996 to demonstrate the dismantling of fuel cycle facilities. The activities are in progress to be completed in 2004.

The Research Association for Nuclear Facility Decommissioning (RANDEC) was set up in December 1988 (reorganized in 2000 as The Radioactive Waste Management and Nuclear Facility Decommissioning Technology Center), to be responsible for the research and development on decommissioning of nuclear facilities, related technical information service, training of the specialists, and others.