The Current Status of Nuclear Fuel Transport in Japan

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1. Introduction

More than thirty years have passed since the development and utilization of nuclear power began on a full scale in Japan. During that time, the nuclear power generation of Japan marked a rapid growth. As a result, the transportation of nuclear fuel materials in Japan has increased significantly in frequency as well as in quantity.

The development of the nuclear fuel cycle facilities of Japan is well under way. A commercial uranium enrichment facility has been operating for some time in Rokkasho-mura, Aomori Prefecture. A low-level waste burial facility is scheduled to start operation in the end of this year. A high-level waste management facility is under construction, and a steady progress has been made in the preparation for a reprocessing facility. The development of such facilities is expected to advance the diversification of transportation modes of the nuclear fuel materials.

The basic principle for the assurance of safety relating to nuclear fuel materials transportation in Japan is to keep the exposure of the transport workers and the general public as low as reasonably achievable according to the Regulations for the Safe Transport of Radioactive Material of the International Atomic Energy Agency (IAEA). The designs of packages and the transport methods are regulated according to this principle.

2. Present State of Safety Regulations for Nuclear Fuel Transport

2.1 Nuclear Power Generation and Nuclear Fuel Transport in Japan

As of the end of May 1992, there are 41 operating nuclear power plants, with the total output of about 33,240 MW, accounting for about 30 % of the total power generated in Japan. When the plants under construction and those under active consideration were included, the total number of nuclear power plants would be 53, with the output of about 45,910 MW.

The actual records of the nuclear fuel transportation for these plants in the period from 1987 to 1991 are shown in Table 1.

Table 1 Records of Confirmation of Packages of Nuclear Fuel Materials for Power Generation (Unit: ton-U)

		1987	1988	1989	1990	1991
		T Q	T Q	T Q	T Q	T Q
Fresh fuel	UF_6	35 558	36 555	41 760	43 705	48 781
	UO_2	76 629	79 652	91 703	80 655	102 802
	Assembly	55 861	54 854	50 854	56 941	61 915
Spent fuel		51 527	38 484	33 515	45 489	46 494

Note) Only packages of nuclear fuel materials for power generation that require confirmation of competent authority.
T: times
Q: total quantity

2.2 Present State of Safety Regulations of Nuclear Fuel Transport in Japan

The regulations concerning nuclear fuel transport in Japan are governed by the Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, the Ships Safety Law, and the Civil Aeronautics Law. The technical standards concerning the transportation are stipulated in ministerial ordinances and notifications based on these laws. The Japanese technical standards for transportation of radioactive materials have been based on the IAEA Transport Regulations. The 1985 Edition of the IAEA Transport Regulations was examined by the Special Committee on Safe Transport of Radioactive Materials (Chairman: S. Aoki), the Nuclear Safety Commission, and has been incorporated into the domestic laws and regulations. The new regulations was enforced on and after January 1, 1991.

As for the application of the regulations, when a fissile material package or a BM or BU type package is to be transported, the law requires confirmation of the safety. The confirmation is made in three stages: the approval of the design of the nuclear fuel package; the approval (registration) of the packaging; and the confirmation of transport (confirmation of the package and the transport method).

When a large quantity of nuclear fuel is to be shipped by sea, a dedicated carrier is used. The carrier has features of double hull construction, anticollision construction, and greater stability, all stipulated by the Ships Safety Law.

3. Transport of New Nuclear Fuel Materials Resulting from the Advancement of the Nuclear Fuel Cycle

The construction of nuclear fuel cycle facilities is well under way in Rokkasho-mura, Aomori Prefecture to establish a nuclear fuel cycle in Japan. The commercial uranium enrichment facility has been operating for some time. The low-level waste burial facility will start operation in the end of this year. The high-level waste management facility is under construction, and the preparation for the reprocessing plant is making a steady

progress. This development will be accompanied with the further diversification of transport modes of nuclear fuel materials.

3.1 Transport Relating to the Low-Level Waste Burial Facility

There are 41 commercial nuclear power plants in operation as of the end of May 1992. The total capacity of these plants amounts to about 33,240 MW. The plants are located at 16 sites. The low-level wastes generated from these power plants are incorporated into cement or bitumen and solidified in drum cans. The drums are presently stored in storage houses provided at the respective sites. The accumulated quantity of the low-level waste drums stored in power plants in Japan is about 780,000 drums as of the end of March 1992. The power plants have been managing these drums by expanding storage houses. To put the accumulated drums to land disposal altogether, the construction of the low-level waste burial facility is under way at Rokkasho-mura, Aomori Prefecture. The maximum burial capacity of the facility will be, at first, about 40,000 m^3 (equivalent to 200,000 200-liter drums). The capacity will be expanded stepwise to the final capacity of about 600,000 m^3 (equivalent to 3 million 200-liter drums).

The transportation relating to the facility will be as follows: The low-level waste drums will be shipped from the dedicated port of each power plant site or the port closest to the site. The drums will be transported by a dedicated ship "Seiei Maru" to the port closest to the low-level waste burial facility. Then the drums will be carried by truck to the facility. The actual transportation will be started around the coming December. The initial scale of transport will be about 30,000 drums per year. Then it will be increased to the normal level of about 50,000 drums per year.

3.2 Transport Relating to the Commercial Uranium Enrichment Facility

With regard to the balance between uranium enrichment demand and supply of Japan, enrichment service of about 3,000 ton SWU per year is currently provided by the United States of America in accordance with the Japan-U.S. Atomic Energy Cooperation Agreement. The contract assures a supply of about 6,000 ton SWU/year around the year 2000. Japan also has a contract with Eurodif for receiving enrichment service of a total of about 18,000 ton SWU in a period of 25 years starting in 1980. Thus Japan has the assured supply of enriched uranium for nuclear power generation up to around the year 2000.

From the viewpoint of establishing an autonomous nuclear fuel cycle, Japan has been constructing a commercial uranium enrichment facility in Rokkasho-mura, Aomori Prefecture. The facility has an enrichment capacity of 1,500 ton SWU/year (the final capacity), and the facility has been partially operating since last March.

As for the transport relating to the enrichment facility, natural UF_6 is imported from the overseas, and transferred to the enrichment facility by truck. The product of the enrichment facility is planned to be transferred to domestic conversion plants for conversion into UO_2. The UO_2 product will be transferred to fabrication plants.

3.3 Transport Relating to the Private Reprocessing Plant

The reprocessing of spent fuel is done by the reprocessing plant of the Power Reactor and Nuclear Fuel Development Corporation (PNC) and by the British Nuclear Fuel Ltd. (BNFL) and Compagnie Générale des Matiéres Nucleaires (COGEMA) under reprocessing commissioning contracts. As of March 1992, about 3,150 tons of spent fuel are safely stored in storage pools of the respective nuclear power stations and the Tokai Reprocessing Plant. The Tokai Reprocessing Plant has a reprocessing capacity of 0.7 ton/day. The plant started the full scale operation in January 1981. The plant has processed a total of about 630 tons of spent fuel in the period from September 1977 to June 1992, including the period of test operation.

On the other hand, the private reprocessing plant is planned to be constructed in Rokkasho-mura, Aomori Prefecture. The plant will have a reprocessing capacity of 800 ton U/year, and is scheduled to start operation in 1999.

As for the transportation relating to the reprocessing plants, the spent fuel is transported by sea, in the same manner as the low-level wastes, from the dedicated port of each power station or the port closest to the station to the port closest to a reprocessing plant. Then the spent fuel is transferred on land to the reprocessing plant.

3.4 Transportation Relating to the High-level Waste Management Facility

Vitrified high-level wastes resulting from the commissioned overseas reprocessing of the spent fuel are to be returned from Europe to Japan. Hence the construction of the high-level waste management facility is under way in Rokkasho-mura, Aomori Prefecture. The planned management capacity of the facility is 1,440 canisters (the final capacity is three thousand and several hundred canisters).

As for the transportation relating to the management facility will be as follows: The high-level waste packages will be transported by a dedicated carrier from the overseas reprocessing plants to the port closest to the management facility. Then the packages will be transferred from the port to the management facility by truck. The actual transport will be started in 1995.

3.5 Transportation Relating to the Utilization of Plutonium

The basic approach of plutonium utilization in Japan is to use it in fast breeder reactors. At present, the construction of a prototype fast breeder reactor "Monju" is well under way. The reactor is scheduled to become critical in the coming spring. The first transportation of the uranium and plutonium mixed oxide fuel for the initial loading of the reactor was made by truck in the beginning of last July.

Maritime transportation of some plutonium from Europe to Japan will be made in this autumn. The plutonium will be used as the material for producing the refueling fuel of "Monju." A dedicated carrier, that meets the requirements prescribed by the Ministry of Transport, will be used in the transportation.

It is the policy to accomplish, as early as possible, the utilization of plutonium in light water reactors and advanced thermal reactors. This is intended to establish, before the practical utilization of fast breeder reactors, the extensive range of technical systems for plutonium utilization in the age of fast breeder reactor. It is also intended to improve the overall long-term economy of the nuclear fuel cycle. The transportation for such purposes will be made as well.

4. Research on Transport Safety

To assure the safety of transportation of nuclear fuel materials, strict regulations are essential. It is also necessary to promote safety research in a systematic manner, on the basis of the technical progress and the accumulated findings. To this end, the following research programs are under way, as shown in Table 2, at various national research institutes.

It is necessary for the Japanese Government to positively participate in the IAEA's reviews of the safe transport rules for radioactive materials, since nuclear fuel materials are transported between nations as well as in Japan. A Safety Standards Subcommittee has been established under the Special Committee on Safe Transport of Radioactive Materials, the Nuclear Safety Commission to look after the international responses.

Table 2 Safety Research Programs of the Annual Safety Research Plan for Nuclear Facilities, etc.

Research field	Research topics (example)	Institute
(1) Research on structure and material	Research on safety of threaded joints of transport packaging against shocks.	Mechanical Engineering Laboratory
(2) Research on heat resistance and fire resistance	Research on thermal characteristics of UF_6.	Power Reactor and Nuclear Fuel Development Corporation
(3) Research on sealing	Research on sealing performance of seals when deformed.	Mechanical Engineering Laboratory
(4) Research on shielding and criticality	Research on neutron shielding evaluation for high burn-up spent fuel transport.	Ship Research Institute
(5) Research on safety analysis codes	Development of transport packaging thermal structural safety analysis codes.	Japan Atomic Energy Research Institute