International Transport of Radioactive Materials Between Japan and Europe

K. Ikeda

Chubu Electric Power Company Inc.
1, Toshin-cho
Higashi-ku, Nagoya City, Aichi Prefecture, Japan

NUCLEAR POWER DEVELOPMENT IN JAPAN

Importance of Nuclear Power Generation and Nuclear Fuel Cycle

It is indispensable for nations like Japan, which do not have plentiful domestic energy resources, to secure energy supplies in the long-term in order to ensure sustainable social and economic development. Nuclear power is an effective option to secure energy supplies, and from the point of view of environmental conservation, it is superior to fossil fuels because it emits no carbon dioxide. In Japan, we therefore consider nuclear power to be an important energy resource both at present and for the future, and we are striving to promote it positively.

Just as fossil fuels are finite, so is uranium. Some people predict that uranium reserves will be exhausted by about the middle of next century. Therefore, in order to secure its energy supplies in the future, Japan has adopted a nuclear policy to establish its own nuclear fuel cycle: we thus utilise plutonium and uranium recovered from spent fuel reprocessing. Furthermore, we believe that it is worthwhile establishing a nuclear fuel cycle because it enables us to appropriately manage and dispose of the radioactive waste.

Current Status of the Nuclear Fuel Cycle in Japan

In accordance with the basic nuclear policy in Japan, we have commercialised uranium enrichment,

fuel fabrication, disposal of low-level radioactive waste (LLW), and interim storage of high-level radioactive waste (HLW).

Thus far, Japanese utilities have entrusted spent fuel reprocessing to European companies. In parallel with this, Power Reactor and Nuclear Fuel Development Corp.,(PNC) has been developing reprocessing technology at Tokai reprocessing plant in Japan. Also Japan Nuclear Fuel Ltd., started construction of its reprocessing plant at Rokkasho-mura in Aomori prefecture in 1993. This plant is expected to come into commercial operation in 2003 with an annual reprocessing capacity of 800 ton-U.

While research and development into fast breeder reactor (FBR) has been conducted in Japan aiming the use of plutonium recovered from reprocessing, we also plan to use plutonium in light water reactors (LWR) for the time being in order to use resources effectively and to develop our technology of using plutonium.

Our basic policy regarding the disposal of HLW arising from reprocessing is to stabilise it in solid form and store it for 30-50 years so that it can be cooled before being disposed into deep underground.

TRANSPORT OF RADIOACTIVE MATERIALS

As the spent fuel derived from Japanese nuclear power plants has been reprocessed mainly in Europe, spent fuel and HLW have been transported between Japan and Europe. Moreover, mixed-oxide (MOX) fuel, recovered uranium and LLW, will in future be transported from Europe to Japan.

In addition, almost all of the uranium used for nuclear fuel is imported.

Transport of Spent Fuel

The Japanese utilities entrust COGEMA and BNFL with reprocessing and its contractual quantity is 7,100 ton-U of spent fuel. We started transporting gas-cooled reactor spent fuel in 1969, and LWR spent fuel in 1973. As of March 1997, around 150 total shipments of spent fuel have been conducted to Europe and the total amount of fuel transported is about 6,800 ton-U.

Spent fuel is contained in EXCELLOX type or TN type packages, etc. and is transported in the dedicated vessels.

Transport of MOX Fuel and Recovered Uranium

The Japanese utilities have about 15 tons of plutonium recovered from spent fuel in Europe. We plan to fabricate it into MOX fuel in Europe and use it to load into LWRs in Japan. This MOX fuel is planned to be transported to Japan by sea.

We also plan the re-enrichment of recovered uranium at overseas plants and transport it to Japan.

Transport of Radioactive Waste to Japan

Two kinds of radioactive waste arise from reprocessing: HLW and LLW, which are returned to Japan by contract. HLW includes fission products and LLW is composed of low radioactive effluent solidified by asphalt and compacted hull-ends.

The HLW is vitrified into a stable form in stainless steel canisters, put into packages (TN28VT), and transported to Japan by dedicated vessels for spent fuel. In 1995, 28 canisters were transported, and 40 and 60 canisters in 1997 and 1998 respectively. Over the next 10 years, a total of 3,000 and several hundred canisters will be returned in one or two shipments per year. The LLW equivalent to several thousands of drums will also be transported by sea.

Transport of Natural UF_6, Enriched UF_6 and Enriched UO_2

Because there are no uranium mines on a commercial scale in Japan, more than 1,000 tons of uranium are imported every year in the form of natural UF_6, enriched UF_6 and enriched UO_2. Container ships or dedicated vessels with double-bottom are employed to bring these to Japan. When large amount of natural UF_6 is transported directly to the Rokkasho Enrichment Plant, a double-bottom vessel is used to provide additional safety taking into consideration of the INF code of the IMO. We have developed a custom-made transport container with a fire-resistant protection cover to hold natural UF_6 cylinders. This new transport device improves handling efficiency and

satisfies fire-resistance requirement in 1996 IAEA regulations.

SAFE TRANSPORT

Transport of radioactive materials between Japan and Europe entails a long trip, much of it by sea. To ensure safe international transport, safety measures for the transport vessels and packages have been very carefully considered. We observe and implement the regulations of both the IMO and the IAEA.

Safety of Transport Vessels

The INF code of the IMO stipulates strict regulations for vessels used to transport spent fuel. In Japan, technical criteria for such a vessel with a double-hull and collision-resistant structure etc. were already formulated in 1974. This fully complies with the INF code enacted in 1993 and has been applied to PNTL vessels, which have been used to transport spent fuel between Japan and Europe, and to the *Hinoura-Maru* used for the transport of spent fuel to the PNC Tokai Reprocessing Plant. Also when the INF code was enacted, it was adopted into domestic technical criteria for application on HLW, plutonium and MOX fuel transport vessels. The *Rokuei-Maru,* a 3,000 DWT vessel, was completed in 1996 to transport spent fuel to the Rokkasho reprocessing plant in Japan. This is the first spent fuel transport vessel built in the world after the INF code was stipulated.

Safety of Packages

In Japan research and study for spent fuel packages started in the latter half of the 1960s. Technology for analysis and manufacturing was introduced from the United States to develop the first domestic package (called the HZ type package) for the transport of spent fuel to the Tokai Reprocessing Plant. This package was completed in 1978. Test packages, both 50 and 100 tons, have been manufactured combining the features of HZ packages and packages used for spent fuel transport between Japan and Europe, and conducted safety verification tests such as drop, fire and

immersion tests. Through these process, we proved reliability of design, manufacturing and analysis and its safety, and established technology for the domestic production of transport packages around 1985.

In the next step, we started development of new transport packages capable of containing high burn-up spent fuel as well as more fuel assemblies in order to meet transport of 800 ton-U a year for the Rokkasho reprocessing plant. By studying European packages and using domestic technology, the development of NFT packages was completed in 1997. NFT packages are large sized containing 38 BWR fuel assemblies or 14 PWR fuel assemblies and can transport high burn-up fuel assemblies. We performed drop, fire and immersion tests on the package, confirmed the adequacy of the analysis method, and proved compliance with various criteria of IAEA regulations. In order to transport even higher burn-up fuel, we are presently trying to improve safety evaluation technology for packages by studying rational evaluation methods adopting original Japanese technology.

HLW transport package was developed by COGEMA, but we also verified the safety of this package by safety verification tests such as drop tests, fire test, and immersion tests on the full-scale model manufactured in Japan prior to the HLW transport from Europe to Japan.

PA Activities

The transport route between Europe and Japan is a long one. It is therefore vital to obtain the understanding of those countries along the route. The Japanese government and utilities have worked together positively to provide a convincing explanation of the safety of transport.

For example, taking the opportunities provided by the transport of HLW and meetings of the South Pacific Forum (SPF), representatives of the three governments of Japan, France and UK, together with the three firms, the Japanese utilities, COGEMA and BNFL, have explained transport safety measures for HLW and spent fuel to the government officials along the route and the coastal media.

To enable smooth transport we ,Japanese Utilities, co-operating with COGEMA and BNFL, will strengthen our PA activities by following measures.

a. Closer co-operation with the Japanese government and support for the government's PA activities. (Participation in government PA missions, support for government public information campaigns on nuclear power to countries along the route etc.)
b. Communicating with media of the countries on route.
c. Strengthening ties with scholars, experts, and research agencies who are sympathetic to nuclear power in these countries.
d. Expanding activities within international organizations such as the IMO and the IAEA.

In such ways, we will continue to promote our PA activities. In addition, we expect greater support by France and UK because COGEMA and BNFL, in cooperation with the Japanese utilities, are heavily engaged in the reprocessing project.

CONCLUSION

To date there has been no incident of radioactive leakage during the transport of radioactive material between Japan and Europe. This alone proves the safety of such transport. We have conducted many original research and development on the radioactive material transport enthusiastically in Japan. We believe that these result and experience may be applicable in Europe. The relationship between Japan and Europe is extremely close, and we hope to maintain cooperation on every aspect of the transport of radioactive materials.

Finally, we strongly believe that the experience of transport of radioactive material between Japan and Europe will be useful in the wider international transport field. This is especially so for Asian countries, where the development of nuclear power is expected to make rapid progress.

SESSION 2.1

Regulations