BASIC PLANNING OF A NEWLY BUILT EXCLUSIVE SHIP FOR SPENT FUEL TRANSPORT

I.Obara (1) ,T.Sasao(2).H.Akiyama(3),and T.Kubota (4)

(1) Nuclear Fuel Shipping Co., Ltd. 1-1-3 , Shiba, Daimon, Minato-ku, Tokyo 105 , Japan
(2) Nuclear Fuel Transport Co., Ltd.. 1-1-3 , Shiba, Daimon, Minato-ku, Tokyo 105 , Japan
(3) Mitsui Engineering and Shipbuilding Co., Ltd. 6-4 , Tsukiji 5 Chome , Chuo-ku , Tokyo 104 , Japan
(4) Mitsui Engineering and Shipbuilding Co., Ltd. Tamano Works 1-1,3-Chome , Tama , Tamano City , Okayama , 706 , Japan

SUMMARY

A commercial reprocessing plant is under construction at the Fuel Cycle Facilities in Rokkasho-mura, Aomori Prefecture. To prepare for the transport of spent nuclear fuels (SF) from all Japanese nuclear power stations to this reprocessing plant, the need for an exclusive transport ship was recognized. Nuclear Fuel Transport Co.,Ltd. (NFT), in cooperation with electric power utilities planned the construction of a such a ship over a period of several years.

During this period NFT developed new types of cask to transport high burn-up spent fuels to the reprocessing plant. Six kinds of casks were developed and 40 units are now under fabrication. The ship was designed to carry a maximum of 20 units.

Based on the Irradiated Nuclear Fuel (INF) Code adopted by the International Maritime Organization (IMO), the Japanese Ministry of Transport (MoT) issued new domestic regulations in September,1995 which covered design criteria for ships carrying Irradiated Nuclear Fuels. The new SF transport ship is the first one to which this new regulation was applied. Although the ship will only ply the coastal routes of Japan, she has been designed to conform with all the international requirements for the Class-3 of the INF Code.

In May 1995, Nuclear Fuel Shipping Co.,Ltd (NFS), a wholly-owned subsidiary of NFT, concluded a contract with Mitsui Engineering and Shipbuilding Co.,Ltd. for the construction of the exclusive transport ship. The keel was laid in November 1995. The ship was launched in April 1996 and named "Rokuei-Maru". At the end of September, she was completed and delivered to the ship owner, NFS.

INTRODUCTION

The national policy of Japan is to reprocess spent nuclear fuel (SF) and to reuse plutonium and uranium as new fuel in order to effectively utilize uranium resources. This is the background to the construction

of the Nuclear Fuel Cycle Facilities at Rokkasho-mura. The safe and effective transport of nuclear fuel and radioactive materials between relevant facilities is crucial to the operation of the Nuclear Fuel Cycle. Sea transport plays a particularly important role in Japan, because all nuclear power plants are located along the sea coast and road traffic conditions are not ideal.

There is an existing reprocessing plant run by the Power Reactor and Nuclear Fuel Development Corp.(PNC) located in Tokai-mura, Ibaraki Prefecture. In addition to this Japan Nuclear Fuel Ltd.(JNFL) is constructing a commercial reprocessing plant at Rokkasho-mura. Most of the spent fuel from Japanese nuclear power stations has so far been transported to Europe for reprocessing with only a small portion going to PNC. After the completion of the new plant, most SF will be transported to Rokkasho-mura.

OUTLINE OF SF TRANSPORT PROCESS

Transport casks containing spent fuel are carried from the nuclear power station to the nearest port and loaded on board the exclusive-use ship. The ship carries the casks to Mutsu-Ogawara (MO-port) in Rokkasho-mura. After arriving at the MO-port, the casks are unloaded and stowed on special vehicles. The vehicles carry the casks to the reprocessing facility on a private JNFL road. Part of this road is public.

MO-port is located on the Pacific coast of Aomori-pref.(Fig 1) This port is public and managed by local government. The "Rokuei-Maru" class ships come alongside Takahoko Quay at the MO-port. The length of the quay is about 260m and the depth of water is 7.5m. The front sea surface is wide enough for 100m-long ship's maneuvering. Fig 2 shows SF unloading at Takahoko Quay.

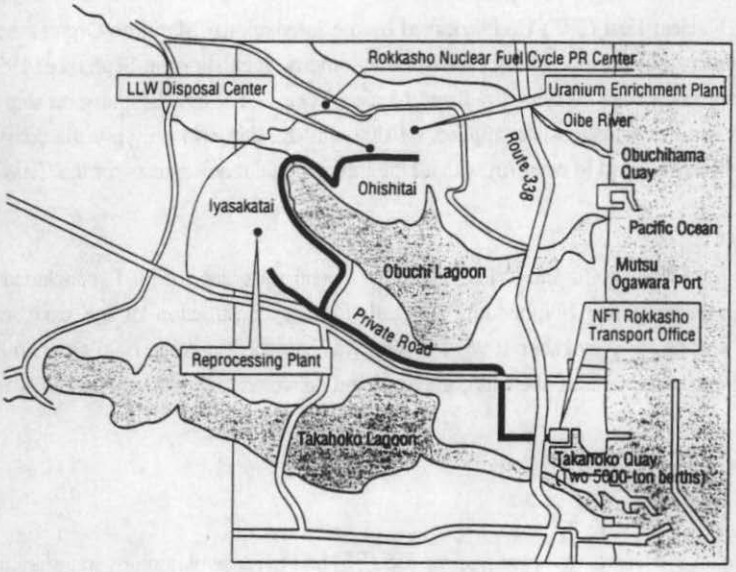

Fig 1. JNFL Facilities and MO - Port

Most Japanese nuclear power stations have their own ports. Depending on the port location, there are various restrictions on the type of ship which may call at the port. Factors include size and facilities of the port, weather and sea conditions, social requirements from local authorities and so on. In particular, front sea surface and water depth at the port limit the size of ships entering directly. This is the reason why "Rokuei-Maru" and LLW transport vessel "Seiei-Maru" have the same length: approximately 100m with a maximum draft 5.6m.

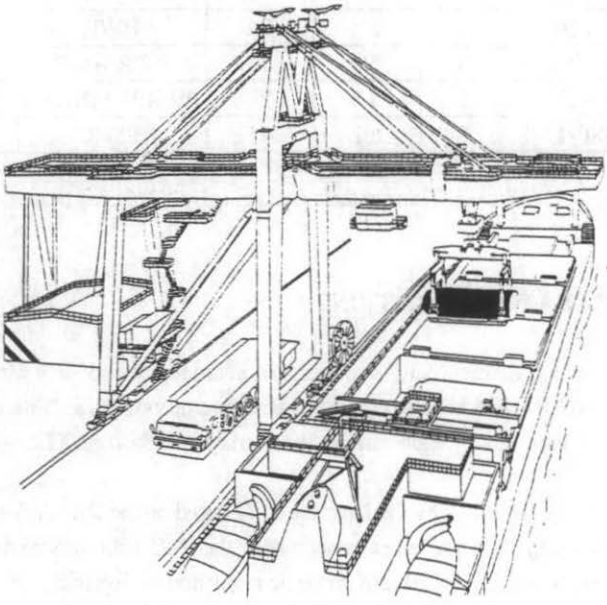

Fig 2. Image of SF unloading at MO - Port

TRANSPORT CASKS ONBOARD

Preparing for the new SF transport, NFT has developed new types of cask to transport high burn-up SF effectively. In developing the cask, the greatest efforts were exerted to maximize cask payload in order to minimize transport frequency. Six kinds of casks were developed corresponding to the six ranges of crane capacity available at the power station sites throughout the country (Ref.). The design of all types of NFT casks was approved in 1994 and 40 units are under fabrication at Japanese and foreign manufacturers.

The new exclusive-use ship "Rokuei-Maru" will transports mainly these newly developed NFT casks, however the ship was designed to transport HZ-75T, MSF-1 and NH-25 casks as well. HZ-75T casks have so far been used to transport SF to PNC's reprocessing facility, while MSF-1 and NH-25 casks have been employed in transport to the SF testing laboratory. Table-1 shows the kinds of casks which "Rokuei-Maru" can transport..

Type of cask	Diameter (m)	Length (m)	Loaded Weight(t	Type of Fuel	NO. of Fuel
NFT-14P	2.6	6.3	115	PWR	14
-10P	2.6	6.2	84	PWR	10
-38B	2.4	6.4	119	BWR	38
-32B	2.6	6.4	106	BWR	32
-22B	2.6	6.3	98	BWR	22
-12B	2.3	6.4	74	BWR	12
HZ-75T	2.3	5.9	80	PWR/BWR	7 / 17
NH-25	1.5	5.8	29	PWR/BWR/ATR	1 / 2
MSF-1	1.8	6.2	45	PWR	1

Table 1. Transportable packaging by " Rokuei – Maru "

APPLIED RULES AND REGULATIONS

As a SF transport ship, "Rokuei-Maru" was designed in accordance not only with the ordinary rules and regulations applicable to ships but also other special requirements, such as "Special Criteria for Irradiated Nuclear Transport Ships" and "Regulations for the Carriage and Storage of Dangerous Goods".

The former is a regulation issued by the Japanese MoT based on the INF Code which was adopted as a resolution A.748(18) by the 18th general assembly of the IMO held in November 1993 (Ref.). The new design criteria was promulgated as a domestic regulation in September 1995. Before then, three regulations had covered ships carrying Spent Fuel, Plutonium and High Level Radioactive wastes respectively. The new regulation covers the transport of all three kinds of material and consequently on the day of the new announcement, the old regulations were abolished.

The new design criteria basically accords with the INF Code, but provisions for an "anti-collision structure" have been additionally included. These provisions were listed in the previous regulation and applied to the first Japanese SF transport ship "Hinoura-Maru" and PNTL ships which enter the ports of Japan.

Typical requirements based on this criteria are as follows.

- Sufficient residual stability in a damaged condition should be provided by an appropriate tank arrangement.
- Double hull and double bottom constructions should be adopted to ensure the safety of the cargo in the event of collision or stranding. The collision energy would be absorbed by the "Anti-collision structure" of side wall.
- A refrigeration system which removes decay heat of the SF casks should be installed in the cargo holds.
- A strong tie-down device should prevent SF casks from moving and toppling down under severe ship force.

- In addition to conventional fire extinguishers, flooding systems should be provided.
- Stand-by generators should be independently located. Major equipment and systems should be duplicated.
- Automatic Radar Plotting Aids system, echo sounder, and other navigation and communication equipment should be provided for the safe navigation.

The latter regulation is applied to the ships which carries dangerous goods including radioactive materials and prescribes necessary procedures and requirements. According to the regulation, the SF transport ship is required to have radiation shielding which keeps the maximum dose equivalent rate lower than 1.8 μ Sv/h at accommodation spaces, 2mSv/h at the surface of ship and 100 μ Sv/h at 2m from the surface.

Design specifications, calculations and other explanatory notes for the new ship were submitted to MoT. After design approval, various inspections on the ship structure, machinery and equipment were carried out by ship inspectors of MoT and Ship's Classification Society NIPPON KAIJI KYOKAI (NK). At the beginning of September 1996 the ship's performance was finally confirmed at sea trial. Ships safety certificate and other documents were issued by MoT and NK.

At the same time, MoT issued NFS with a "Document of Compliance" which certifies that the construction and equipment of "Rokuei-Maru" complies with the INF Code applicable to ships whose class is INF 3.

SHIP'S BASIC PLANNING

There are various restrictions and requirements for the design of ships. However, once the cargoes are decided, ship's designs are basically flexible. At the early stage of the study concerning the new SF ship, a combined ship for SF and LLW transport was discussed. It was eventually concluded that a separate SF and LLW ship should be constructed, considering the increase of SF and LLW shipments.

Under the following fundamental conditions, the planning of the new SF transport ship was carried out.

- The ship carries SF from all of the nuclear power stations in Japan to the newly built reprocessing plant in Rokkasho-mura, as well as to PNC's plant. JNFL has planned to receive 400MTU/year of SF tentatively and 800MTU/year in the near future.
- Highest priority must be put on transport safety. Considering the importance of understanding and cooperation from general public, the ship should possess safety equipment which exceeds the legal requirements.

In consideration of the special nature of the cargo, the following was taken into account in planning the ship. NFT planned in corporation with maritime consultants, shipping companies, etc.

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