OPERATION OF THE SWEDISH SEA TRANSPORTATION SYSTEM FOR SPENT FUEL

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Abstract

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At PATRAM 83, the Swedish Nuclear Fuel and Waste Management Co. (SKB) presented a paper on "The realization of a sea transport system for radioactive material". Some information was also given on the very first experience of the transport of some 35 t of uranium between Sweden and France. Since 1 March 1985, M/S Sigyn has been sailing under the Swedish flag and operated by the Swedish shipping line, Rederiaktiebolaget Gotland. The Swedish AFR facility CLAB was put into active operation in July 1985, with a receiving capacity of 300 t of uranium per year and a storage capacity of 3000 t of uranium at present. During the first year of operation CLAB received 250 t of spent fuel. The paper describes experience based on 16 sea voyages and the reception in CLAB of about 80 casks with spent fuel from Swedish nuclear power plants. The CLAB facility is equipped with a cask maintenance workshop, where preventive maintenance, re-inspection and repairs are carried out.

GENERAL

The Swedish Nuclear Fuel and Waste Management Co. (SKB), which is owned by the four nuclear power utilities in Sweden, is in charge of the back-end of the nuclear fuel cycle. The company's responsibilities include research, planning, construction, operation and ownership of facilities and the transport system.

A central interim storage facility for spent nuclear fuel (CLAB) (Fig. 1) next to the Oskarshamn nuclear power plant, has been in operation since 1985. A final storage facility for low and intermediate level waste (SFR) is being constructed next to the Forsmark nuclear power plant and will be put into operation in 1988.

A complete transport system has been built up by SKB for carrying spent nuclear fuel and radioactive waste from Swedish nuclear power plants. As all these plants have their own harbour facilities, the spent nuclear fuel and radioactive waste can be transported by sea. The M/S Sigyn handles all sea transport duties from the stations to CLAB at Oskarshamn. As of 1988, it will also be used for transporting waste to the SFR at Forsmark. The ship will then be making about 30 trips a year between the power plants, CLAB and the SFR.

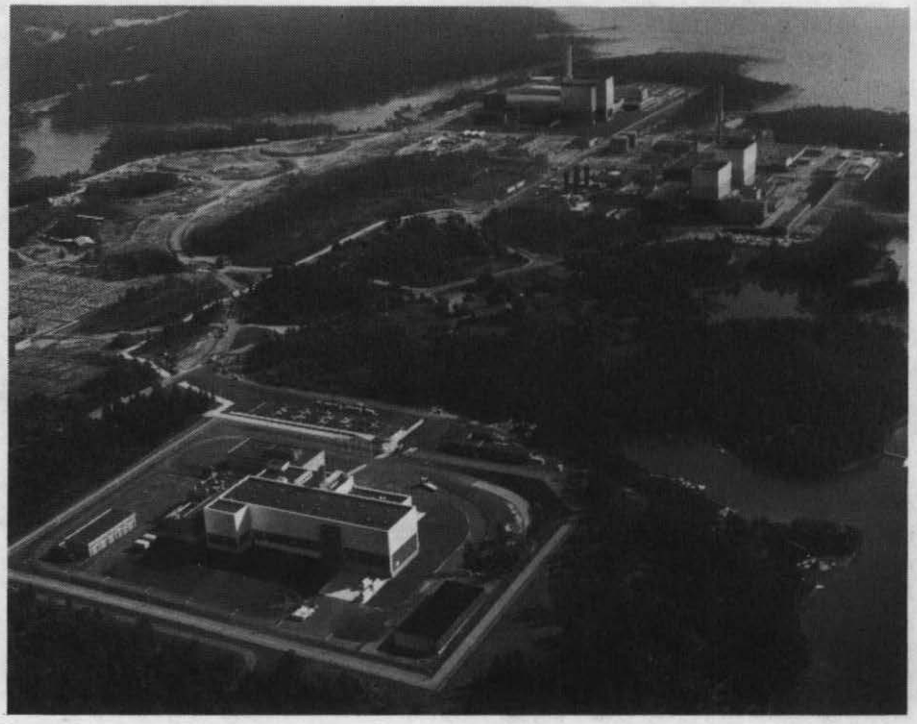

FIG. 1. Aerial view of the CLAB facility.

CLAB was commissioned in July 1985. Spent fuel and core components will be stored there for a period of about 40 years prior to disposal in a final repository somewhere in the Swedish crystalline bedrock. During interim storage in CLAB, the radioactivity and heat generation of the spent fuel decline considerably, facilitating handling prior to final disposal.

During transport, the fuel assemblies are stored in forged steel shielding casks, each weighing about 80 t and with a capacity of 3 t of fuel (uranium).

TRANSPORTATION SYSTEM

At present, the sea transportation system consists of ten transport casks for spent fuel, two casks for core components, three terminal vehicles for local road transport at the sites, and a specially designed ship, the M/S Sigyn (Fig. 2).

The system was put into operation in January 1983. Six transports (57 t) of spent fuel from Swedish reactors to La Hague (Cherbourg) were made during 1983, the central storage facility, CLAB, then still being under construction.

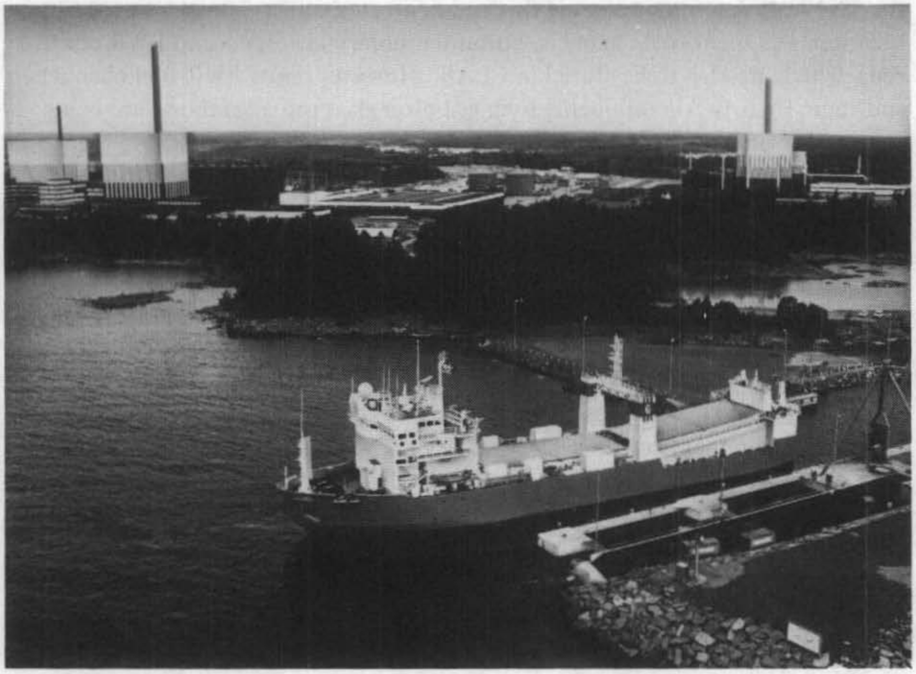

FIG. 2. M/S Sigyn in the harbour at Simpevarp (Oskarshamn).

During its first years the ship sailed under the French flag, and was operated by a French shipping line, Chargeurs Réunis. Since 1 March 1985, it has been sailing under the Swedish flag and is operated by the Swedish shipping line Rederiaktiebolaget Gotland. M/S Sigyn is wholly owned by SKB.

Since the storage facility was put into operation in the middle of 1985, the transport system has been operated continuously. About 250 t of spent fuel has been transferred to CLAB, corresponding to over 1200 fuel elements, most of them from BWR plants. About 20% of the casks have been transported from the nearby Oskarshamn plant, and about 80% by sea from the other plants.

The transport cask used is the TN17/Mk2, which can hold 17 BWR assemblies or 7 PWR assemblies. It is positioned on a transport frame during transport. In the cargo hold of the ship there are lashing fittings and corner pieces in ten fixed positions for the transport frames. On land, the transport is handled by a terminal vehicle, which drives in under the transport frame and lifts the entire cargo unit hydraulically.

There are at present ten TN17/Mk2 casks in the system, which, according to the experience gained so far, provide sufficient transport capacity. There are also two special casks for core components (TN17/CC, a simplified version of the TN17/Mk2, without cooling fins and neutron shield). These are used for such items as spent fuel channels, boron temporary absorbers and BWR control rods, which are also to be stored in CLAB. However, most BWR fuel channels, and some PWR fuel components such as boron glass rod assemblies, are being transported and stored together with the fuel assemblies.

RECEIVING CAPACITY FOR SPENT FUEL

The nominal yearly receiving capacity of CLAB is 300 t. The working schedule of CLAB is 2 shifts, 5 days a week. To fulfil the capacity requirements with some margin, about 5 casks must be emptied and prepared in 2 weeks (10 working days). After less than one year of operation, it is obvious that the capacity requirements of the CLAB facility are well satisfied.

There are 12 reactors in Sweden, 8 of which have delivered spent fuel to CLAB. (The last 4 have not been in operation long enough.) The immediate need is thereby taken care of, i.e. there is now enough space in the plants' own pools to guarantee next year's refuelling. When all 12 plants produce spent fuel, about 250 t will be discharged every year. With the reception of 300 t in CLAB, there will still be capacity for a further reduction in the accumulated amounts of fuel at the plants.

TRANSPORT LOGISTICS AND TIME SCHEDULE

Normally, about 5 casks at a time are delivered to a power plant. These are filled with fuel in 8–12 days and returned to CLAB with the ship. In the meantime the other 4 or 5 casks are emptied in the CLAB facility and prepared for transport. Thus, directly after unloading of the filled casks at the Simpevarp harbour (CLAB site), the empty casks can be loaded on board, and the ship is ready to sail. One terminal vehicle at the power plant and at least one vehicle at CLAB must be available (Fig. 3).

The transport time schedule is prepared on an annual basis. During the first few months of CLAB operation some spare weeks were included, but today a schedule with one transport every 2 weeks is applied, with the exception of holidays, etc. This means a cycle time for each individual cask of maximum 4–5 weeks and each cask is used about 10 times a year.

Since the actual time at sea is about 24 hours in each direction, it is small compared to the total cask handling time.

In total, 20 of the 21 scheduled transports had been made by the end of May 1986, comprising 82 casks (Fig. 4). During the same period of time, 13 casks with used core components (compressed BWR channels) were received. Thus there are 70 PWR (about 32 t) and 1200 BWR (about 220 t) assemblies, and

FIG. 3. Terminal vehicles with transport casks.

13 component canisters stored in the underground storage pools of CLAB at the time of writing (May 1986).

In 1988 the final repository for low and intermediate level waste, SFR, will be in operation. The shielding waste containers will be transported with M/S Sigyn to Forsmark from the other power plants. There are (at least) three different kinds of waste containers, for waste of different sizes and radiation levels. The time schedule will be co-ordinated with the fuel transports to CLAB.

CASK HANDLING

Nuclear Transport Limited, NTL, was contracted by SKB to provide services and advice regarding cask handling and loading operations, and NTL has been present at the power plants during cask loading, thus helping the plant staff to build up their own experience. During the first months of operation in CLAB, NTL was also present during unloading.

There is a maintenance workshop for transport casks in CLAB where regular inspection and maintenance operations in accordance with the 'Green Book' are performed. So far 5 casks have passed their first '10-cycle-service'.

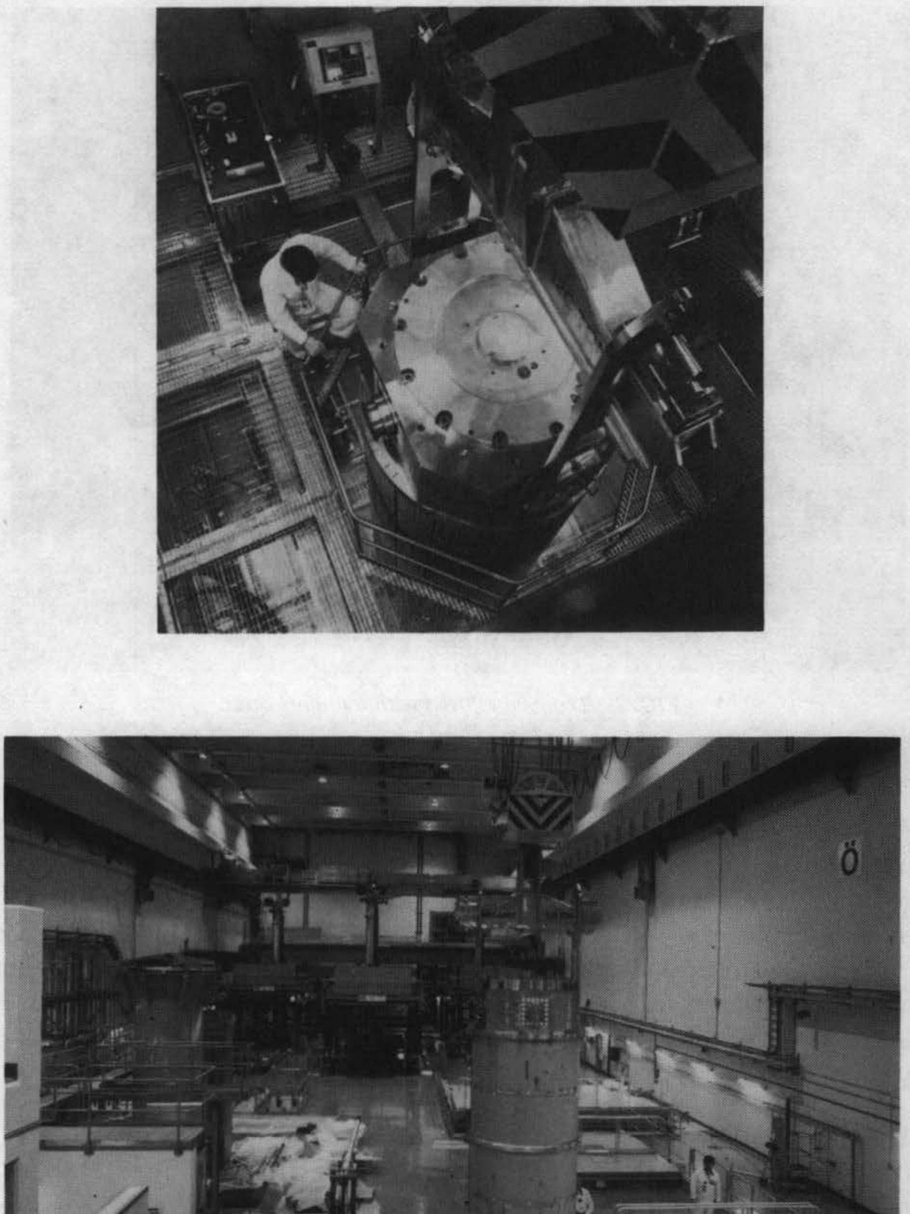

FIG. 4. Cask handling in the CLAB reception building.

OPERATIONAL EXPERIENCES

The routines for the cask handling, i.e. the chain of operations from CLAB to ship to harbour to power plant and vice versa, have worked adequately. Each transport is governed by a transport message and there are people responsible for the casks and their documents during each step.

The radiation shielding and protective measures have also proved adequate. The radiation doses to the ship's crew, which are evaluated once a month, have been below the registration limit without exception (July 1985–April 1986). However, the fuel transported in the casks has been, on average, of relatively low burnup/long cooling characteristics, thus giving surface dose rates and especially cask temperatures far below design values for the TN17/Mk2 – typically, 2–14 kW heat generation (compared to a design value of 43.5 kW) and 0.03–0.15 mSv/h (compared to 2 mSv/h). Sometimes contaminated spots (i.e. spots with more than 40 kBq/m^2) are found on smear tests after arrival. Typical surface temperatures during transport have been around 30°C.

The total time taken for transportation with the ship is far below the capacity of the ship. When waste transports to the SFR start in 1988, the utilization of the ship will increase, but the capacity will still be sufficient.

There have been no delays caused by equipment problems on the ship, and only minor delays caused by severe ice or wind conditions.

ADMINISTRATIVE ISSUES