Inservice Inspection and Maintenance of Transport Casks at the CLAB Facility in Sweden

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INTRODUCTION

In Sweden 12 nuclear reactors are now in operation. They are located at four different sites: Oskarshamn, Barsebäck, Ringhals and Forsmark, all situated at the coast in the southern half of the country.

The first reactor, Oskarshamn 1, was taken into operation in 1972 and the last, Oskarshamn 3, in 1985.

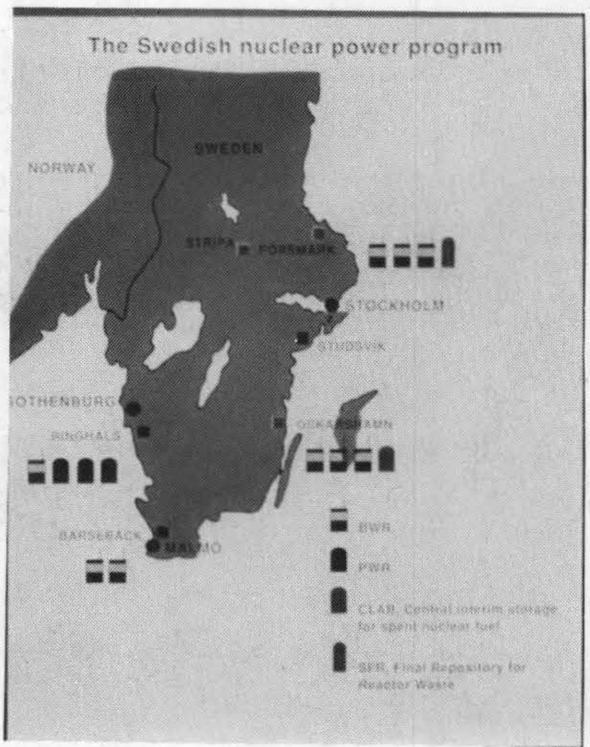

Figure 1 Location of Swedish nuclear power plants, CLAB and SFR

The total electrical power generated by the reactors are 9820 MW. They produce around 65 TWh a year, which amounts to 50% of the electricity consumption in Sweden.

The reactors produce around 250 tons of spent fuel and 2000 m^3 of reactor waste every year.

For the management and disposal of the radioactive waste the Swedish nuclear utilities have assigned to SKB, Swedish Nuclear Fuel and Waste Management Co, to develop, build and operate facilities and systems for this purpose.

Today SKB is operating the Central Intermediate Storage for Spent Fuel, CLAB, at Oskarshamn and the final storage for reactor waste, SFR, at Forsmark. For the transportation of the fuel and waste from the reactor plants to CLAB and SFR, SKB has designed and built an integrated sea transportation system (ISTS) consisting of the special ship M/S Sigyn, terminal vehicles, transport frames and transport casks. The system and the ship is presented in another paper at this conference, see references 1 and 2 to this paper.

Transport casks

During an average year about 85 casks with spent fuel and 10 casks with irradiated core components are transported from the reactors to CLAB.

SKB owns and operates 10 transport casks for spent fuel and 2 casks for spent core components.

<u>TN 17/2</u>

The spent fuel transport cask, TN 17 Mark 2, was designed by the french company Transnucléaire. It is licensed as a type B(U) cask both in France and in Sweden.

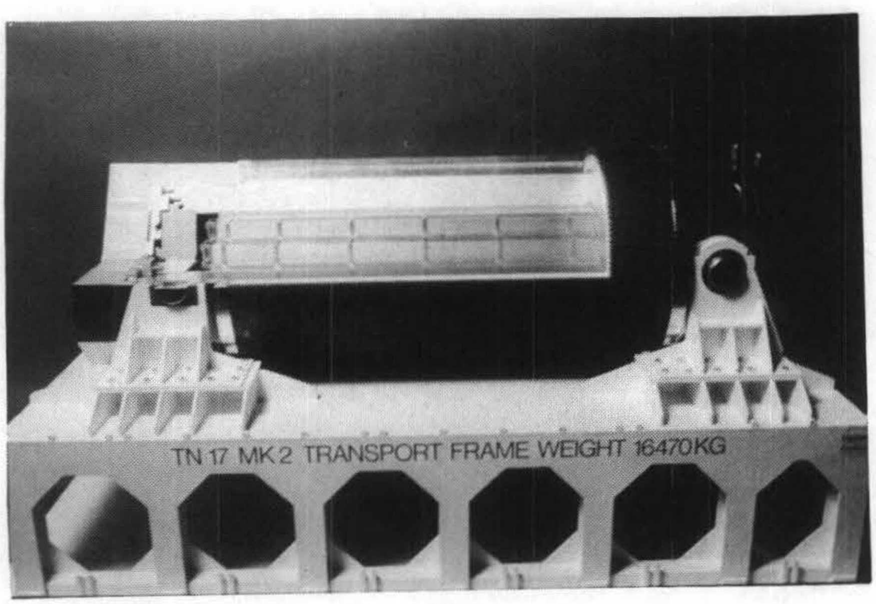

Figure 2 Model of TN17/2 on transport frame

The cask has the following main data:

Dimensions:

overall length	6150 mm
overall diameter	1950 mm
inside diameter	920 mm
length of cavity	4630 mm
Shipping weight	76 tonnes

Depending on the type of fuel to be transported in the cask, it can be equipped with two kinds of baskets.

The BWR basket contains 17 lodgements and the PWR basket 7 lodgements. The cask is equipped with three orifices for water in- and outlet. All penetrations have a double lid design with possibilities to test the space between the lids for leakage. Furthermore the cask has three pairs of trunnions. The surface of the cask is covered by about 40 000 cooling fins which are surrounded by a layer of resin for radiation shielding.

TN 17-CC

The design of the core component cask TN 17-CC is similar to TN17/2. As there is no need for cooling, the cask surface has no fins and the surface is painted. The core components, i.e. control rods, detectors, fuel channels etc. are loaded into special canisters at the power station. After transportation in the TN 17-CC cask to CLAB, the canister is unloaded and stored together with the fuel canisters in the storage pools at CLAB.

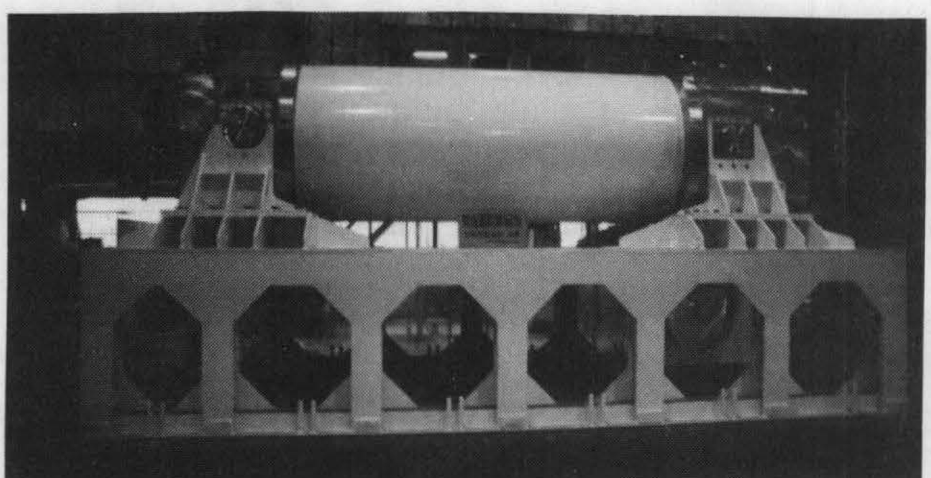

Figure 3 TN 17-CC. Transport cask for core components

Turnround inspection, maintenance and periodic testing

During the complete transport cycle from the CLAB facility to the power plant and back to CLAB, it is important that the casks are handled in a safe way and that damages or other abnormalities are discovered and taken care of. Each cask has its own transport document where all steps during the transport and the handling at the power plant are recorded and special observations are written down. Small repairs and changing of minor components such as O-ring gaskets etc., are made by the operators at the power plant if necessary. Major repairs or replacements are performed at the CLAB facility.

Besides this turnround inspection the regular inspection, maintenance and periodic testings are carried out at intervals after 8-10 cycles. A supplementary maintenance is performed after 30-40 cycles

Maintenance at CLAB

Except for visual inspections and minor maintenance measures, all maintenance and periodic testing of the casks are performed at the CLAB facility where a special workshop for this purpose is located. Around 100 casks per year are received in CLAB. This means that one cask per month as an average is going through an 8-10 cycle maintenance in the workshop.

The CLAB facility is operated by OKG AB. OKG is one of SKB's shareholders and is owner and operator of the three power plants at the Oskarshamn site, where CLAB is located.

The workshop

The cask workshop is located inside the reception building at CLAB. After unloading of the fuel elements the cask is transported to the workshop by a 130 tonnes overhead crane and lifted down into the workshop through hatches.

The cask can be placed either in a vertical or in a horizontal position. The workshop has a floor area of 265 m^2 and the highest part is 14.5 m high. The workshop is equipped with a small overhead crane with a lifting capacity of 15 tonnes. When the cask is placed in the vertical position, which is the normal maintenance position, the cask is surrounded by a mobile platform from which any position of the cask can be reached. The workshop is also equipped with a special turnable table, which facilitates the maintenance work on the cask lid.

Other important equipment is

- hydraulic equipment for test loading of trunnions
- special tools for inserts and penetration plugs.
- equipment for leak tight testing
- go- and no-go-gauges for all threads on the cask.
- vacuum leak testing equipment

Maintenance procedures

The inspection and maintenance work at CLAB is based on the manual and procedures in the so called "Green Book". The Green Book describes the common policy of Cogema, BNFL, PNTL and NTL for inspection, maintenance and periodic testing of spent fuel transport casks. Through an agreement with this group in 1984, SKB got access to these procedures and has adopted them to suit the handling facilities at CLAB. The procedures have been approved by the Swedish competent authorities and have been in use since CLAB started operation in 1985. So far regular inspections have been carried out at each 8-10 cycle and a more extensive inspection at each 30-40 cycle. At present SKB is seeking approval from the Swedish Nuclear Inspectorate to carry out the periodic maintenance at intervals of 15 and 60 cycles according to the last revision of the Green Book (ref. 3).

8-10 cycle inspection and maintenance

During a 8-10 cycle inspection and maintenance normally two persons are engaged in the work. At the most time consuming works, such as removal of silicon layers around bolts and trunnions, 1 or 2 extra persons are engaged.

The total time for a 8-10 cycle maintenance is 3 weeks or 15 working days. During this work all defects and damages which have not already been taken care of after the turnround inspection, are repaired. Furthermore the work includes a thorough check and replacement of all items which have been weared out or damaged. The inspection and maintenance work follows a detailed manual where all steps are recorded and signed after completed work by the responsible engineer.

The time spent at different phases during the 8-10 cycle maintenance is shown in figure 4.

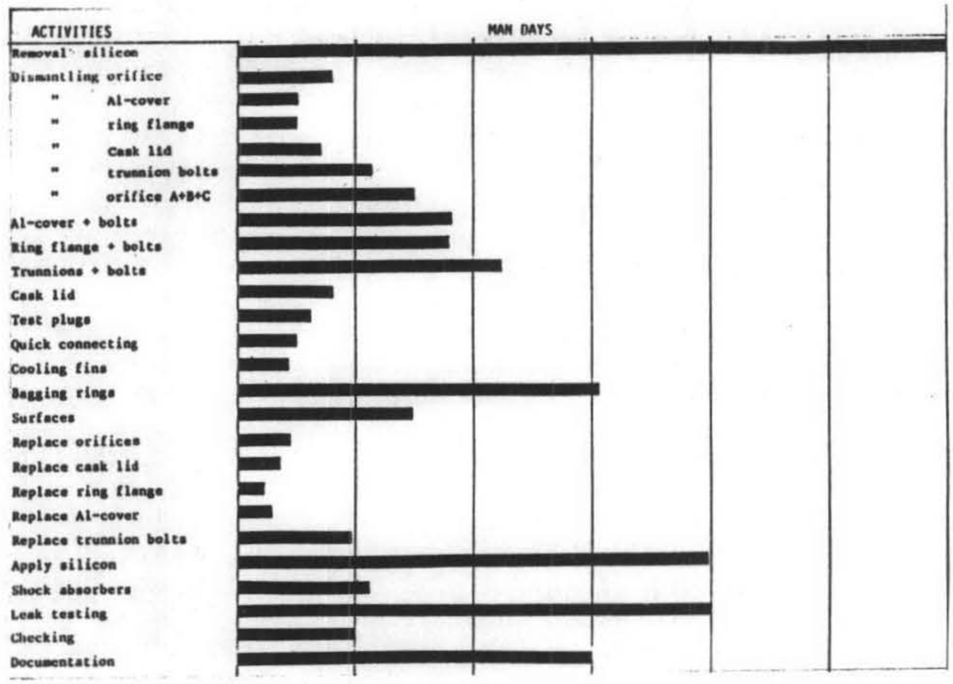

Figure 4

The most time consuming work is removal and application of silicon around trunnion bolts. Grinding and polishing of scraps and damages on the bagging rings is also a quite extensive work as well as leak testing. As could be seen in the figure the quality control and the documentation of the performed work is a fairly big part of the inspection.

Special efforts have been made to facilitate the boring work with silicon. To minimize the amount of silicon to be applied, plastic plugs and small aluminum lids were placed to cover the bolt heads before application of the silicon. This measure together with improved tools and gained experience will shorten this work in the future.

Figure 5 shows a tabulation of faults and damages which have occurred on the different casks during four years of operation, 1986-1989. As could be expected most of the damages have been found on trunnion surfaces and bagging rings. Also damages on the orifice plugs are quite frequent.

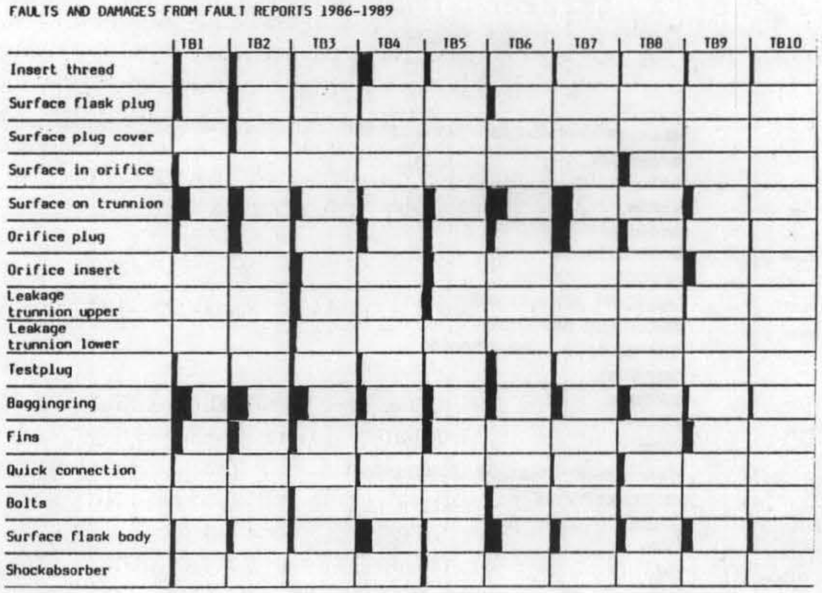

Figure 5 Fault and damages from fault reports 1986-1989

30-40 cycle inspection and maintenance

During this more extensive maintenance program supplementary inspections and tests are made on cask shielding, heat transfer characteristics, basket lodgements, tightness of drums and shock absorbers, trunnions and fusible plugs.

The shielding measurements are performed on a full loaded cask which is placed in a horizontal position. The measurements are made along three different generatices with the central generatrix going through the trunnion line. Gamma- and neutron measurements are made at contact and at a distance of 1 meter from the cask.

Heat transfer measurements are made with the cask in the same position and using the same fixture for the measuring equipment as during the shielding measurements.

None of the baskets have yet passed 30-40 cycles. Therefore no specific control has yet been made of the boron content in the basket walls. Normally this inspection is done by using a neutron source and a detector, which are placed on different levels of the basket walls.

In order to find alternatives to this method, tests have been performed at CLAB using TV monitoring. By using a TV camera all basket walls are inspected to find any damages or cracks which could influence the presence of boron. The difficulty with this method is to set criteria for size and depth of damages that may be detrimental to the neutron absorbtion characteristics of the basket material. This study will continue in cooperation with the designer of the baskets, Transnucléaire.

Experience from the inspection, maintenance and periodic testing at CLAB

From the start of operation of CLAB in mid 1985 up to today, about 1000 tonnes of spent fuel have been received in CLAB. This corresponds to about 300 cask transport cycles. During this period only one notable incident has occurred, when a faulty handling with a lifting yoke at a power station slightly damaged a trunnion. The cask was transported empty back to CLAB for inspection and repair.

30 casks have passed the 8-10 cycle maintenance and 3 casks have passed the 30-40 cycle maintenance.

The experience has shown that most of the damages have occurred on the sealing surface on the cask lids and the aluminum cover. Defects on bagging rings and trunnions are also quite frequent.

The most time consuming work is removal and application of silicon layers around bolts.

As a result of close cooperation and information exchange between the operators at CLAB and at the power stations, the handling of the casks has been improved and the number of damages on the casks are decreasing.

In view of these results and the good operational records of the casks, SKB has found that the prolonged inspection intervals introduced in the new revision of the Green Book will be appropriate also for the Swedish casks serving the CLAB facility.

References

1. Development, Implementation and Experience of the Swedish Spent Fuel and Waste Sea Transportation System. PATRAM 89, B. Gustafsson, SKB

2. Navigation Systems Adopted for Marine Transport of Radioactive Material, PATRAM 89 J. Josefsson, Rederi AB Gotland

3. Inspections, Maintenance and Periodic Testing of Flasks Utilised for Irradiated Nuclear Fuel Transport, GREEN BOOK,rev 5.

4. Experience From Transport Casks Management in the Swedish AFR-Facility CLAB, IAEA, april 1989 P. Dybeck, SKB, P. Grahn OKG AB