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**Technical and Administrative Preparations
Required for Shipment of Research Reactor
Spent Fuel to Its Country of Origin**

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**Swedish Experience with
Shipment of MTR Spent Fuel**

Erik B. Jonsson
Studsvik Nuclear AB
Sweden

International Atomic Energy Agency
Vienna, Austria

Argonne National Laboratory
Illinois, USA

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Erik B Jonsson, Studsvik Nuclear AB

Summary

The 50 MW R2 research and test reactor at Studsvik produces some 50 spent fuel assemblies per year. Over 30 return shipments to US of spent HEU fuel have been performed since the start of the reactor operation in 1960. The US take back policy was interrupted in 1988 for renewed environmental impact investigations and meanwhile the stock pile of spent HEU fuel overfilled our reactor pools and in 1994 we requested emergency return shipment due to insufficient self protection of the oldest fuel.

The experience from the 1994 emergency shipment and the first shipment under the final EIS in August 1996 will be described. Both shipments were performed together with spent fuel from other research reactors in Europe, which complicated the formal procedures for a nuclear transport. The tight time schedule also put a lot of stress on the authorities, transporter and on the reactor operator.

The TN 7-2 cask, which holds 64 fuel assemblies, was used in both transports and the Edlow International Co was the co-ordinating transporter in both cases.

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1 Introduction

The 50 MW R2 research and test reactor at Studsvik produces some 50 spent fuel assemblies per year. Over 30 return shipments to US of spent HEU fuel have been performed since the start of the reactor operation in 1960. The US take back policy was interrupted in 1988 for renewed environmental impact investigations (1,2,3) and meanwhile the stock pile of spent HEU fuel overfilled our reactor pools and in 1994 we requested emergency return shipment (2) due to insufficient self protection of the oldest fuel.

The experience from the 1994 emergency shipment and the first shipment under the final EIS in August 1996 will be described. Both shipments were performed together with spent fuel from other research reactors in Europe, which complicated the formal procedures for a nuclear transport. The tight time schedule also put a lot of stress on the authorities, transporter and on the reactor operator. Both transport were, however, successfully finished.

The TN 7-2 cask (4), which takes 64 fuel assemblies, was used in both transports and the Edlow International Co was the co-ordinating transporter in both cases.

2 Storage facility, crane capacity

The R2 reactor is operated within a concrete structure, which is divided into three pools by movable doors. Two of these pools are used for storing partly and fully burnt fuel assemblies. The storage capacity is approx. 200 assemblies, which covers about four years of operation. The discontinued return of the spent fuel to US in 1988 created a need for additional storage space. Studsvik had, however, a special storage facility on the site where one pool was converted for R2 fuel use. It was refurbished with new epoxy lining, new racks and a submersible pump/ion exchanger system for water control (5). The initial storage capacity was 144 cut MTR assemblies. The storage capacity has since been extended.

Fuel assemblies for the two last shipments have been taken from this storage facility where we have our oldest and thus most urgent fuel for shipment. The building is well suited for its task, it has easy access for the cask through a large entrance door. The container with the cask can be taken through the large door directly into the loading area on the truck. It is also equipped with a multihist crane that can take loads up to 30 metric tons, which means that the largest MTR fuel transport casks can be handled.

3 Transport preparations

The ideal preparation for a spent fuel transport includes

- plenty of time for paper work, alert the authorities about the plans
- request of offers on the cask rental and the transport work
- evaluation of offers to minimise cost
- co-ordination with participating RR, authorities and transport companies
- check availability of casks, certificate valid in all involved countries
- planning of the internal work: write procedures for handling the cask, loading of fuel baskets, safeguard,
- calculations of fuel isotopic composition, decay heat and radioactivity and issue of the DOE Appendix A (3)
- arrange supplemental insurance, issue of certificate of financial security (nuclear liability)
- planning of outside work, trucks, cargo handling including loading onto ship, arrange physical protection
- final issue of the general transport plan to the Swedish authorities

The real world has been quite different at least for the two last shipments, where much of the planning was made in a hurry with very little freedom to modify the parameters.

The emergency transport in 1994 was decided with a rather short preparation time for arranging the transport. Due to the process of the EA the cask and transport co-ordinator was already decided. The major obstacle we encountered was to persuade the transport firms to use the new regulations for sea transport, the INF code, which just had been issued but not ratified in the participating countries. That meant that the transporter in a very late state of the preparation had to find a ship that fulfilled the INF code. As that was new regulations not used for this kind of transport there was no ship available and two ships had to be retrofitted with equipment to meet, in our case, the INF-2 code.

4 Cask, arrival and loading of fuel

We are using the TN 7-2 cask (4), which holds 64 cut fuel assemblies in four baskets. The cask, surrounded by a weather shield, is fixed onto an open 20 foot freight container. The cask and container are rented from Nuclear Cargo & Services in Germany. They provide the instructions and procedures for handling the cask. Normally we go through the procedures with all the personnel and some of the critical steps in the handling are translated to Swedish.

The cask handling group consists of a supervisor, a crane operator, a radiation protection technician and a technician. The safeguard (i. e. material accounting) procedures are normally handled by a group from IAEA/EURATOM and the SKI (Swedish Nuclear Inspectorate) together with our own safeguard officer.

When the cask arrives, hopefully in good time before shipment, it is directly taken inside the storage facility by the truck. In one occasion the truck with the container was too high for the entrance port, but the truck was equipped with air supported suspension and by reducing the pressure the container was lowered some 10 cm to allow passage. Compare Figure 2. Inside the building the weather shield is removed and the baskets and toolbox are unloaded, Figure 3 and 4. The cask is then lifted off the container (Figure 5) and the empty container with the weather cover is moved outside, as the space is limited (Figure 6).

The shock absorbers on both sides are removed from the cask and it is raised in vertical position and the lid is loosened. The baskets are made ready for loading.

The loading of the cask is scheduled to take two days. The first day the cask is lowered into the fuel pool. This is a tricky procedure where the cask has to be lowered very slowly to avoid turbulence in the water and some strings has to be attached to the hoist ropes to facilitate their removal under water. This will take up to two hours.

The first basket is then lowered into the pool and the fuel assemblies are moved from the storage racks to the basket. The assemblies are cut so a special tool has been constructed to securely grip and hold the assembly during transfer. Each assembly is identified, in our case we use an under water TV-camera, so before putting the assembly into the correct basket position the assembly is moved in front of the camera. Loading of each basket takes less than two hours and the whole loading can be completed in 8 to 10 hours.

The cask with the lid on is lifted from the pool and drained. The proof that the fuel assemblies in the cask are unfailed is performed by filling the cask with fresh demineralized water and measure the activity increase of water samples over four hours. The procedure is described in Appendix B of the DOE contract.

The cask is also cleaned outside as it has been in the pool water and after that a radiation and contamination survey is performed according to the special scheme provided by NC&S. During the night the cask is also vacuum pumped to assure that no water is left inside. The next day the cask is placed into the freight container together with the toolbox and the weather shield is mounted.

The container is then ready for shipment after marking and labelling according to applicable transport regulations is performed.

5 Transport

The transport outside the Studsvik site must follow a general transport plan approved by the authorities, it contains, among others, all necessary information on the fuel content, choice of route, means of transport, vehicle/vessel and physical protection measures taken. The transport plan is an official document, according to Swedish legislation and as such it is open to the public. The physical protection part of the transport is, however, not official and therefore the exact time, route, ship, etc. is not revealed in the general transport plan.

The transport is planned to start from Studsvik in due time to arrive at the harbour with minimum waiting time. The container is loaded on a truck and all paper for the export and transport are forwarded to the truck driver, cargo handling agent, master of the ship, etc. A transport safety specialist from Studsvik is present during cargo handling within the harbour area.

Due to special circumstances Studsvik has arranged the loading of the container onto the ship by a rented mobile crane. However, it is preferable to use normal container handling cranes within a sea terminal. The loadings 1994 and 1996 are displayed in Figures 7 and 8.

The required equipment on the ship is well regulated by the INF code. DOE has additionally requested special satellite communication and reporting from the ship in the last shipments.

6 Safeguard

The safeguard documentation (material accounting) of the transfer of the fuel assemblies is drawn up by the responsible safeguard manager of Studsvik. The last loading in August 1996 was supervised and checked by the IAEA/EURATOM safeguard team. Their seal was also applied to the cask and the serial number revealed to the Savannah River Operations Office upon arrival there.

7 Conclusions

In 1994 and 1996 similar transports of spent MTR fuel from the R2 reactor were arranged and they arrived safely to the Savannah River site. The success of these transports was not self-evident, as both transports were threatened by legal actions in the US. The firm determination of the US-DOE staff and the Edlow International Co concurred together with the research reactor operators all

obstacles and the fuel reached its destination. We are very grateful to the dedicated people that spent much time and effort to finish the EIS and made the return of MTR fuel to US possible.

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