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Transport of Core Components and Large Contaminated Objects in Sweden

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Abstract

Since 1985 SKB has operated a national sea transport system for transport of spent fuel and radioactive waste to the intermediate storage facility for spent fuel, Clab and the final repository for low- and intermediate level waste, SFR in Sweden.
During the last few years this system has also been used for transport of large contaminated objects such as steam generators and reactor vessel lids.
The transports have been performed from the Swedish nuclear power plants to Studsvik, an industrial installation specialized in decontamination, cutting, melting and conditioning of large radioactive components. Studsvik as well as all nuclear plants and storage facilities are located at the Swedish coast with their own harbours. This is why sea transport performed by the SKB sea transport system is preferred.
Transports of core components are today performed with the sea transport system from the nuclear power plants to the Clab facility. Storage of core components at Clab is quite costly as it is primarily foreseen for storage of spent fuel.

SKB, in co-operation with the Swedish nuclear power plants, is now developing a new concept for dry storage of core components at an existing underground storage facility, BFA, at the Oskarshamn Nuclear Power Plant. The paper will describe this new concept including design of a new type B cask for transport of the core components from the nuclear plants to this intermediate dry underground storage in Oskarshamn.

1. Introduction

SKB, the Swedish Nuclear Fuel and Waste Management Co, is owned by the operators of the Swedish Nuclear Power Plants (NPP) and has the responsibility for handling and storage of all radioactive waste in Sweden. SKB operates a facility for intermediate storage of spent fuel, Clab, a final storage for low- and intermediate level waste, SFR, and a sea transport system. The system and facilities have been in operation since the middle of the 1980´s.

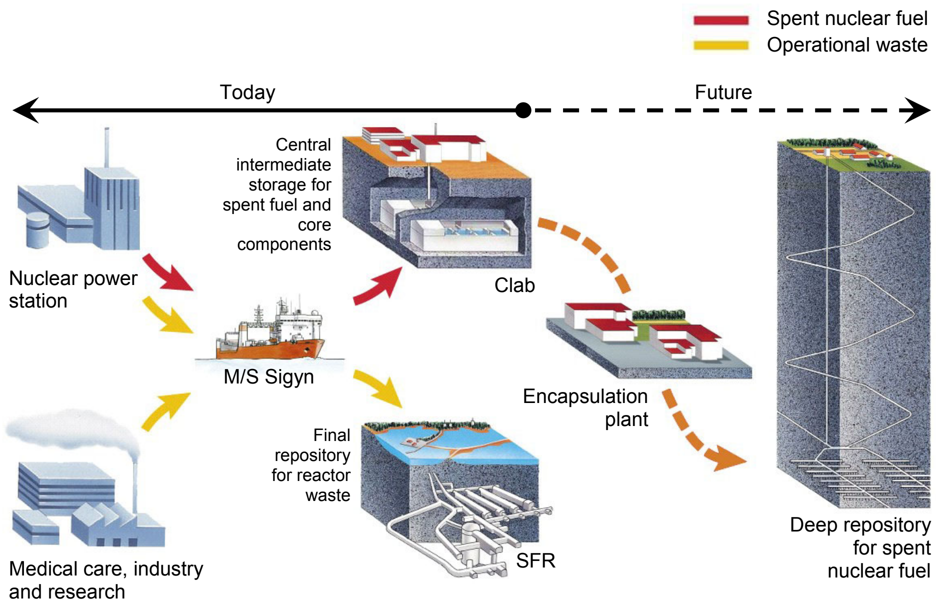


Fig 1. The Swedish System

SKB is presently planning a final repository for spent fuel including a plant for encapsulation of the spent fuel into copper canisters.
In the near future, 2009, an application for siting of these facilities will be submitted to the Swedish authorities.
This is also resulting in renewal of the whole transport system including design and purchase of a new ship, new transport casks for spent fuel and new casks for encapsulated fuel in the coming years.

2. The Transport System and Facilities

The transport system consists of the ship M/S Sigyn, 12 type B casks for spent fuel and used core components, 27 IP-2 containers, ATB, specially designed for transport of low- and intermediate level waste and five terminal vehicles.
The system has been in operation since 1985. A new type B cask for transport of intermediate waste is ready for operation. This cask, ATB 8K, has been designed by TNI in cooperation with SKB and will be used for waste packages with a surface dose rate up to 500 mSv/h.

Until August 2007, 1 600 transport casks with spent fuel and 139 casks with core components have been transported from the twelve (ten) Swedish nuclear power plants to Clab.
The total amount of fuel presently stored at Clab is 4 700 tonnes of Uranium or 21 700 fuel assemblies.

Clab is the central intermediate storage facility for spent fuel in Sweden situated at the southeast coast of Sweden close to Oskarshamn Nuclear Power Plant. At Clab, the spent fuel assemblies will be stored for 30–40 years before encapsulation in copper canisters and transport to the final repository.

During almost the same period 1988–2007, 31 000 m^3 of low- and intermediate level waste have been transported to SFR, the final repository for reactor waste. SFR is situated at the east coast 150 km north of Stockholm close to the Forsmark Nuclear Power Plant. This amount of waste corresponds to about 1 500 ATB containers.
In the future, radioactive waste from the decommissioning of the Swedish reactors will also be stored at SFR.

The final storage for long lived intermediate level waste, SFL, is scheduled for operation in 2045 or later.

3. Transports of Core Components to Clab

Core components are defined as components which are, during operation of the reactor, within 1 meter of the reactor core and therefore containing high levels of induced activity. Such components are control rods, core grids, fuel boxes, detectors, moderator tanks and lids etc... Each type of core component is transported in its special designed canister and the core components have to be cut into small pieces. This is costly and time consuming. The complete core component canister is unloaded from the cask and intermediate stored at Clab in the same kind of storage racks as for the spent fuel. On the other hand the spent fuel elements are unloaded individually to canisters for storage which are placed directly in the storage racks in Clab.

Since 1985, the start of operation of the Clab facility, all types of used core components from the Swedish reactors have been transported to Clab. The transports have been performed using a special designed type B (U) cask, TN 17-CC. The cask can hold one canister filled with core components with a weight up to 5 tonnes.

Fig 2. TN 17-CC

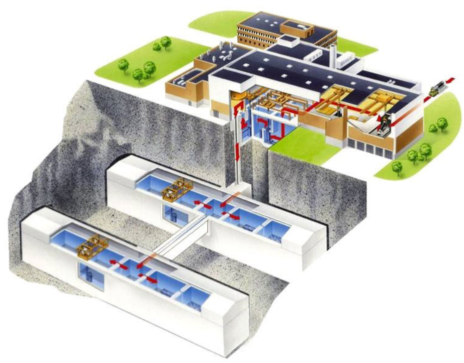


Fig 3. Clab

The transports are quite similar to the transports of spent fuel to Clab and follow the same procedures in licensing, transport permits and documentation. All transports are pre-announced to the Swedish authorities.

During an average year around 5–6 transports are performed, often in connection with spent fuel transport campaigns from the power plants. This way of transporting and storing of the core components has worked well during the past 20 years.
The storage capacity at Clab has now reached the level where an enlargement of the storage capacity is necessary. The new storage pools are ready for operation in the beginning of 2008 resulting in an increased storage capacity at Clab to 8 000 tonnes of spent fuel.

During the last ten years SKB together with the power plants have investigated alternative ways for intermediate storage of core components to provide a more cost efficient way than today. Even though the transport and storage of the components has been successful the cost for every storage position at Clab is very high, about 4 MSEK. Another reason for a more efficient storage method is the fact that the foreseen operation time of the Swedish reactors will increase from originally 25 years up to 40 and perhaps 60 years in the future. This development will require more storage positions for spent fuel at Clab and put more pressure on the importance of efficient storage for the core components.

4. Transports of Core Components to the Intermediate Dry Storage Facility, BFA

Close to the Clab facility, on the peninsula of Simpevarp, the OKG Company, who owns and operates the three nuclear power plants in Simpevarp, operates an intermediate dry underground storage for different kind of radioactive waste. BFA is today used for storage of different kinds of waste including tanks from OKG. The storage facility consists of seven rock caverns with a storage capacity of 13 500 m^3 on a storage surface of 5 000 m^2. The different caverns are separated by 10–12 meters of solid rock.

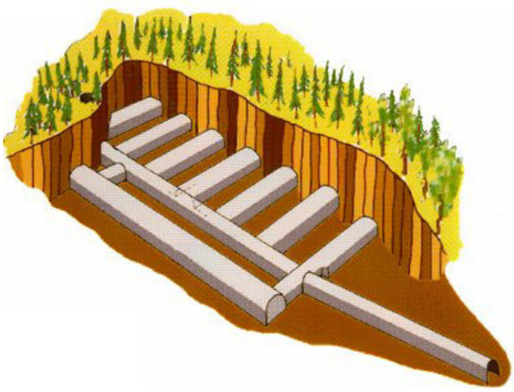


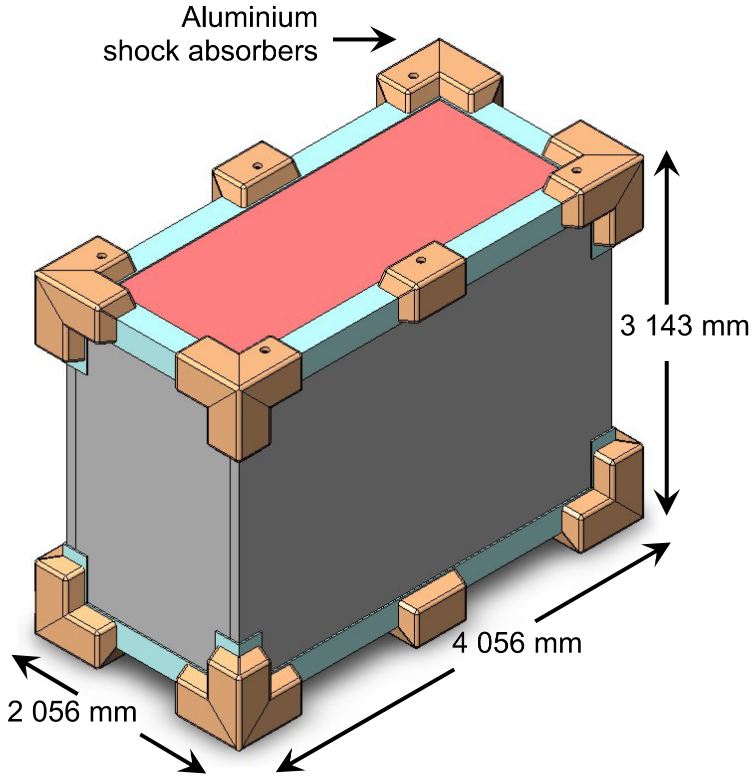
Fig 5. BFA

In May 2007, OKG has applied for permission from the Swedish authorities for intermediate storage of core components in BFA from all the Swedish reactors. SKB, in agreement with OKG, will take over the responsibility for storage of the core components.

Before transport the core components are cut and placed in special steel tanks, BFA-tanks, with the dimensions 3.3 x 1.3 x 2.3 metres and a wall thickness from 50 to 200 mm of steel. The total requirement for intermediate storage capacity for BFA tanks is 110 tanks for an operation time of 40 years and 246 tanks for 60 years of operation of the Swedish reactors. As BFA is only an intermediate storage facility the core components have to be transported to a final repository for long lived waste in the future (2045).

5. ATB 1T

Transport of the BFA tanks from the power plants to BFA requires a new transport cask
The new cask should fit in to the present SKB sea transport system and should meet the IAEA regulations for type B containers. The container will be designed for a maximum dose rate of 200 mSv/h on the BFA tank surfaces.
The total weight of the container including the transport frame will be 120 tonnes. Preliminary, the dimensions are 4.1 x 2.1 x 3.1 m and a steel thickness of 190 mm. The weight of the lid, which is bolted to the container body, is approximately 8 tonnes.



Fifg 6. ATB 1T

The ATB1T cask is bolted to a transport frame which fits into the SKB transport system. During loading at the power plants the cask lid slides away from the container and the BFA tank which is covered by a shielded protection frame, is lifted from the reactor hall down to the ATB 1T cask and placed into the cask.

The design of the container is ordered from TNI in France and the detailed design has just started. SKB will apply for a license from the Swedish authorities in 2009 and plan to take the cask into operation in 2012.

6. Transports of Large Contaminated Objects

Transport of spent fuel and radioactive waste from the power plants to Clab and SFR only utilise 1/3 of the available time for the ship M/S Sigyn. Therefore, when the transport schedule permits, the ship is used for other kinds of transport especially large and heavy components, both contaminated and clean objects. These transports are made on a commercial basis. As the ship is purpose built for transport of radioactive material and classified as INF III according to the IMO regulations, transport of contaminated objects for SKBs owners, the Swedish Power Plants have priority.
Examples of clean goods transported with M/S Sigyn are, large transformers, generators, lifting cranes, wind mills, gas turbines etc.

Fig 7. M/S Sigyn

Contaminated objects such as reactor vessel lids, used turbines from the power plants and steam generators have been transported from the power plants to Studsvik for decommissioning, melting and final preparation for storage.

Studsvik is situated on the east coast of Sweden. Studsvik has its own harbour for roll on /roll off handling. Studsvik Co is operating facilities for incineration and melting of low-level waste (LLW)-material, which has been generated in Sweden or in foreign countries. Studsvik also has a facility for conditioning of Swedish ILW. The facilities have been in operation in Studsvik since 1976 and 1987 respectively. Studsvik also operates a facility for the conditioning of intermediate level waste (ILW) for the final repository in Sweden, but only for waste generated in Sweden.

The melter has a licence for 5 000 tons per year including lead, aluminium, copper, brass and steel and iron. Ashes, slag and filter dust from the treatment – which contains the activity – is always returned to the owner of origin within 2 years from delivery.

The use of this facility means that a large proportion of material can be decontaminated and reclaimed. This arrangement also includes the mandatory return of the secondary waste to the customer. This is very advantageous for foreign nuclear power plants and decommissioning agencies as it provides a technical and cost effective route for dealing with such wastes and materials.

The facility can also deal with large and complex components where the possibility for pre-treatment at the original NAP is limited. Examples of such larger components are MEBs (Multi element bottles from the UK), turbine parts from Forsmark NPP and the steam generator from Ringhals-3 NPP, presently treated at Studsvik for free-release. After treatment at Studsvik about 85% of the material may be free released.
These large objects are normally transported by sea using M/S Sigyn.

Transport of a steam generator (SG) from Ringhals to Studsvik

In May, 2007, one steam generator from Ringhals was transported with M/S Sigyn to Studsvik. The total weight of the SG is 310 tonnes, length 19 meter and a diameter of 4.5 meters.
The activity, based on measurements, was calculated to 1 TBq mainly Ni-63. From a radiation point of view the most important nuclide is Co-60 which is about 0.68 TBq. The surface contamination level is < 40 kBq/m^2 (gamma, beta) and< 4 kBq/m^2 (alpha) on accessible surfaces.

Fig 8. Steam generator

The transport were performed in accordance the IAEA regulations for transport under *special arrangement* and therefore needed an approval from the Swedish authorities.

The main non conformities to the regulations were.

- A_2-value 0.4 TBq for Co-60 was exceeded
- The dose rate at 2 m distance was calculated to exceed 0.1 mSv/h
- The package consisted of the outer wall of the SG itself

To meet the safety requirements during the transport several measures were put in place: i.e.

- The SG was covered with plastic sheets around the outer surfaces and then covered by tarpaulins
- Special trailer for land transport, speed limit 10 km/h
- Lashing arrangements on-board M/S Sigyn
- Security and radiation protection personal available during the transport
- Transport performed under "exclusive use".

The application for approval for transport in accordance with this special arrangement was done by the Consignor, Ringhals AB in March 20th, 2007 and the approval from the competent authority, the Swedish Radiation Protection Institute, SSI, was issued in May 21st, 2007. The work behind this approval from SSI will be presented in the next presentation of this session.

The approval from the authorities stated that Ringhals should present a report to SSI presenting the collective dose to the people involved during the complete transport.
The dose budget for the complete transport including preparation before transport, loading and unloading and land transport to the final position at Studsvik was calculated to 8 mmanSv.

After the transport the following result was presented to the authority, SSI.

Ringhals	
Preparations for the transport	0.97 mmanSv – 8 persons undertake the operation
Transport, loading on ship, lashing and securing	1.57 mmanSv – 17 persons undertake the operation
Studsvik	
Unloading, land transport	0.31 mmanSv – 12 persons undertake the operation
Total collective dose	**2.85 mmanSv – 29 persons involved in the complete operation**

The next SG from Ringhals will be transported to Studsvik at the end of October, 2007.

7. Summary

- The Swedish sea transport system will be enhanced with a new ship and new transport casks (for spent fuel, core components and copper canisters) in the near future.
- The new alternative method for transport and intermediate storage of core components in BFA will reduce the costs for storage and make available more storage positions for spent fuel at Clab.
- The transport system enables safe and efficient transport of large contaminated objects for complete waste conditioning at Studsvik.
- The use of M/S Sigyn for the transport of items not typically included in the ordinary transport programme is both of economic benefit for SKB and its owners.