SAFE TRANSPORTATION SYSTEM FOR LLW/MLW WITH HIGH RADIATION LEVEL ATB-8K

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Introduction

The ATB-8K packaging has been designed in the 90's to complete the fleet of radioactive waste transportation containers in Sweden. Its technology can be useful to any waste transportation issues.

This packaging is able to ship a wide range of waste in full compliance with IAEA Regulations and in optimized operating conditions: ion exchange resins solidified in concrete or in bitumen, in steel or concrete moulds and steel drums.

The ATB-8K container is basically a 3-meters cube in which a maximum weight of waste of 34 tons can be packaged. The waste can be very simply loaded inside its cavity, using a crane. The waste is loaded in the container cavity or within a basket. During its design, a special attention was paid to give its users the most convenient operating conditions.

The ATB-8K package design meets the regulatory requirements for type B (U) package design and was approved by the Swedish Competent Authority in November 2000.

One ATB-8K will be manufactured during 2001 and taken into operation in a near future to transport waste from the different Swedish Nuclear Power Plants to the final storage, SFR located in Forsmark. It will be transported using the same sea transportation system developed by SKB and in use since 1985 to transport spent fuel and reactor waste in Sweden.

This paper will describe the ATB-8K package design, the waste it can contain, the transportation system and thus, the improvements it can bring to operators in the management of higher activity technological waste transportation.

Background

All nuclear facilities produce radioactive waste consisting mainly of contaminated items such as gloves, filters, ion exchange resins, scrap metals etc. Most of the time the waste is solidified in bitumen or concrete and classified as Low Specific Activity Materials according to the IAEA transport regulations.

If the activity is low enough, the waste can be transported in Industrial Packages (IP) or type A packages. But if the activity is such that the radiation level at 3 m from the unshielded material or object or collection of objects exceeds 10 mSv/h, then a type B package is required by the IAEA regulations. This restriction, introduced in the 1985 edition of the regulation, has obliged the operators to rethink their transportation systems.

In this context, TRANSNUCLEAIRE started the design of the ATB-8 K type B package in the early 90's for the Swedish Nuclear Fuel and Waste Management Co, SKB.

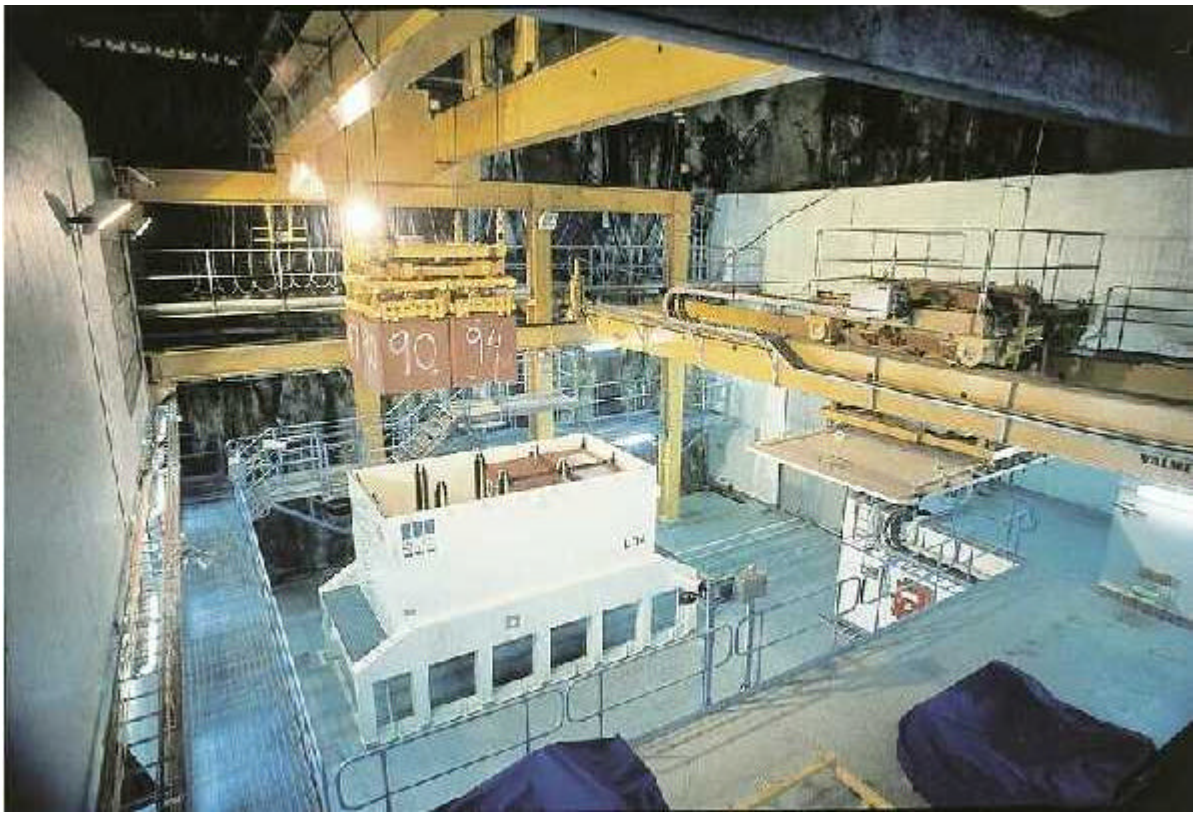
The purpose of this paper is to describe the solution that was found, the way it was implemented and licensed in Sweden and the perspectives of operations.

Specification for the design

When the transport regulation became more restrictive it appeared that many primary containers (box or drums) which were in the past easy to transport (within type A or industrial packages) and licensed for storage were still appropriate for storage but now required type B package for transport. For this reason it was important to seek for solutions that do not impact the capability for storage and do not increase its cost. In other words it was not appropriate to modify the primary containers but rather to adapt the transport system.

For SKB, the solution was, starting from the existing ATB design, to develop a new type B container, the ATB-8 K.

The new challenge was to justify that in accident conditions of transport (i.e mainly the 9 meter drop test, the punch test and the fire test) the package was till able to contain the Low Specific Activity materials, to justify a low enough release of activity and a low enough dose rate around the package.



Waste description

The wastes generated by the Swedish facilities and concerned by the limitation of dose rate around the unshielded content are:

- medium level ion exchange resins or metal scraps mixed with cement and cast in cubical concrete boxes 100 or 250 mm thick and 1.2 m wide ;

- Low level ion exchange resins mixed with cement or bitumen, or metal scraps mixed with cement, cast in cubical steel boxes 5 mm thick and 1.2 m wide or in 200 l. metallic drums.

Developed solution

The development of Transnucléaire's solution was based on the fact that the primary containers with their contents had been tested in accordance with very severe storage criteria related to leaching. Therefore it appeared that the waste, due to its clearly demonstrated ability to retain activity, could participate to the fulfillment of type B requirements with a packaging design, which does not imply the use of seals.

Then, two important points had to be evaluated:

- the first one was the evaluation of activity release mechanisms, which have been described thanks to a strong bibliographic study of what had been done in laboratories on this subject,
- the second one was the definition of a metallic overpack, able to protect the primary containers in such a way that after drop and punch tests, the primary containers are still in a good enough condition that their insulation capacity are maintained for the fire test.

Release Mechanism

Experimental studies have been performed in different laboratories in order to predict the behavior of certain LSA wastes under accident conditions involving fire during transport. Data have been collected on the generation of solid particulate and volatile radio-nuclide-containing materials, for different waste temperatures. Results give the proportion of each radio-nuclide released for each type of matrix.

The main conclusion of these studies is that, for a given temperature, the release mechanism is connected to the amount of water contained in the waste and in the matrix.

In order to estimate an upper value of activity release under normal transport conditions, dry air is supposed to penetrate through all the gaps existing between the different parts of the packaging and to reach the waste form matrix. It is then assumed that air saturated with the water contained in the matrix pores escapes. Regarding the accident transport conditions, the evaluation of activity release is based on the global results of heat tests performed in a laboratory on similar types of wastes.

The ATB-8K design

The ATB-8K design is based on the design of the ATB-12K, an Industrial Packaging. The philosophy of the design is:

- Prevention of activity release results from the content itself ;
- The steel container must remain in place around the content after drop and puncture test in order to provide the needed thermal insulation during the fire test. In that case, and based on tests performed in Sweden, it is demonstrated that if the temperature of the matrix remains low enough, no unacceptable activity release occurs from it.

The ATB-8K is roughly a cubic package (nearly 3-meter long in each direction) with a top lid. The walls and the lid are made of carbon steel with sufficient ductility to prevent from any risk of brittle fracture within the limits given by the IAEA regulation (ambient temperature ranging from – 40° C up to 38° C). The walls as well as the lid are approximately 200 mm thick, allowing transport of waste with surface dose rates up to 500 mSv/h. The lid is equipped with Elastomer seals and fire insulation.

A particular attention was paid on the design of the closure system since it was to be easy to operate as well as robust enough to withstand a 9-meter drop test. It is basically made of two sliding bars, each equipped with four pins that fit into four staples welded on the body of the package.

The weight of the empty package is about 74 tons. The gross mass of the packaging when equipped with its transport frame is 120 tons.

The ATB-8K packaging contents an internal arrangement (basket) designed to receive the conditioned waste. It is a frame made of stainless steel. The basket divides the internal volume of the ATB-8K into four square compartments, each of one receiving either two cubic moulds or eight 200-l drums.

Regulatory tests

The test specification was discussed and approved by the Swedish Competent Authority. A scale model (scale ratio 0.4) was fabricated and the minor differences between the model and the package were duly justified.

Thus, one punch test and four nine meter drop tests were performed in the COGEMA facility at Moronvilliers located near Reims (France). The different orientations tested were chosen in order that the specimen suffers the maximum damage.

After all the tests performed on the same model, the package was still confining the content. The closure system has suffered minor damages and the model proved the capability of the package to withstand the regulatory fire test after the drop test. For this purpose numeric simulation was performed, using qualified calculation codes and taking into account the exact geometry of the package after drop tests. Due to the heavy mass of the package and its content on one side and to the very low heat power of the content on the other hand, very low temperatures were found.

The maximum temperature (roughly 120° C) was found very locally with very conservative assumptions: it was assumed that only a very small amount of waste was transported and that this very small amount was in a corner of the package.

Licensing

Following these tests, a complete Safety Analysis Report was submitted to Swedish Competent Authority. After several series of questions and answers the license was finally granted in year 2000. It was the first type B license issued by the Swedish Competent Authority (In the past only validation of foreign certificate had been issued).

Transport System

SKB is now in a position to start fabrication and then operations. The major asset of the ATB-8K is that with its transport frame it fully fits into the transport system that was designed years ago by SKB and for which significant investments had been made.

The ship M/S Sigyn is specially designed for shipments of spent nuclear fuel and radioactive waste. It is a combined roll-on/ roll-off and lift-on/lift-off vessel with a double bottom and a double hull, built for unrestricted ocean service. The performance of the ship has been excellent. It is large enough for the transport volume required. The handling and lashing operations of the waste containers and transport casks on board the ship are fast and efficient which reduce the dose rates to the crew to a minimum. Since 1985, M/S Sigyn has sailed in total around 400 000 N.M. with an average of some 25000 N.M. a year. The radiation measurements have shown no larger doses to the crew than those obtained from the background radiation. The permissible maximum annual dose rate per individual is 5 mSv. In the beginning of 2001 Sigyn was certified as an INF Class III ship in accordance with the IMO regulations.

Transport containers

The design and strength of the different types of transport containers and casks guarantee the overall safety of the transportation system. The SKB transportation system comprises containers for high-level, intermediate-level and low-level waste.

For transporting intermediate-level waste, ILW, SKB has designed and developed large IP-2 steel containers, ATB, which fit into the transportation system. The containers are of different types depending on shielding requirements and size of the waste units. The weight of a loaded ATB is almost 120 tons. From the start of SFR in 1988, more than 1100 ATB and containers have been transported from the power plants to SFR.

In terms of operations, the ATB-8K is not significantly different from the ATB, an Industrial Package. This was a real challenge since most of the time, operations for type B packages are much more complicated than for Industrial Packages.

The ATB-8K will be transported from the Swedish Nuclear Power Plants by road on the specific trailer shown below to the plant harbor where it will be loaded on the M/S Sigyn. Then it will be transported by sea to the Swedish final storage facility, SFR, located in Forsmark where it will be unloaded.

Conclusion

The ATB8-K is a type B package that can be operated as easily as an Industrial Package. It is now licensed in Sweden and since it is not fissile package, it can be used in other countries without validation process. It enables to transport large quantities of Low Specific Activity materials with higher radiation levels.