Use of Type-B Packages for Transporting LSA Waste

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INTRODUCTION

Paragraph 422 of IAEA Regulations for the Safe Transport of Radioactive Material (Safety series n°6, 1985 Edition As amended 1990) Specifies that "the quantity of LSA material or SCO in a single industrial package... shall be so restricted that the external radiation level at 3 m from the unshielded material... does not exceed 10 mSv/h (1 rem/h)."

This requirement introduced in the last edition of IAEA regulations, results in the impossibility to transport the most irradiating LSA waste in an IP container, except if the quantity of such irradiated waste is reduced with a view to meet the above-mentioned criterion.

This is a concern for companies like EDF or SKB, the Swedish nuclear waste management organisation.

Both of them therefore asked Transnucléaire to suggest a solution, able to avoid the limitation of transported material, compatible with the dose rate criteria, with the natural wish to keep the use of the primary container (for which the compliance with storage requirements had been strictly demonstrated) and matching as much as possible with the operational parts of the corresponding nuclear and storage sites and transport system, against a reasonable cost.

The purpose of this paper is to present the solutions which have been proposed and are under implementation; and to explain how the compliance with the regulations is obtained.

MEDIUM LEVEL WASTES IN FRANCE

Background

For a long time, medium level waste generated by EDF reactors have been immobilized within a solid matrix, packed in concrete cylinders and then sent to ANDRA low/medium level waste storage site through the rail and road network, as Industrial Packages.

Since 1985, and due to their dose rates at 3 meters from the unshielded content, some of these standard EDF cylinders, licensed by ANDRA can no longer be classified as IP but have to be transported as type B packages.

Concrete Cylinders

The most irradiating EDF medium level wastes consist in either ion-exchange resin or primary loop filters. The first ones are mixed with a polyester resin, and the second ones are bound with cement.

They are then placed into C1 or C4 concrete cylinders (resp. ϕ 1,400 mm, H 1,300 mm and ϕ 1,100 mm, H 1,300 mm).

The cylinders are made mainly of a reinforced long life concrete, an internal additional shielding (steel or lead), a cement plug, which is poured on EDF sites after introduction of the wastes into the cavity.

The total mass of the filled cylinders ranges from 2,500 kg (min. C4) to more than 6,000 kg (max. C1).

Developed Solution

The development of Transnucléaire's solution has been based upon the fact that the concrete cylinders with their contents had been tested in accordance with the very severe storage criteria specified by ANDRA and 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 studied:

- 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 strengthen the cylinders in such a way that after drop and puncture tests, the concrete cylinder is still in a good enough condition that its insulation capacity is maintained for 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 radionucleide-containing materials, for different waste temperatures. Results give the proportion of each radionucleide 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.

Overpack Design and Regulatory Test Program

Transnucléaire designed its two-part overpacks based on the previous conclusion. They are equipped with a secured and quick-locking device facilitating their industrial use on EDF sites.

One full-scale prototype has been manufactured for each type of concrete cylinders (C1 and C4), provided by EDF and loaded with real inactive wastes (polyester resin in the C1 cylinder, and a primary loop filter in the C4 cylinder).

Both packages (cylinder + overpack) have been submitted to a 5-drop test program (one puncture test on the locking device, and four 9-m drops in different configurations) and are now under preparation for the regulatory fire test, during which temperatures shall be controlled in order to :

- demonstrate that the waste temperature remains within the acceptable range considering the release mechanisms, and

- provide a real case for the establishment of a model which will allow the calculation of waste temperature for other geometrical configurations of the internal part of the cylinders (different thickness of internal shielding for example).

Results

Although the fire tests have not been performed yet, the mechanical behaviours of the packages during drop tests let us expect such a temperature of the waste that, considering the maximum transported activity, the regulatory criteria for type B packages will be respected.

MEDIUM LEVEL WASTE IN SWEDEN

Background

The wastes generated by Swedish utilities are immobilized within a solid matrix and packed in concrete or steel cubic boxes or steel drums. These boxes or drums are transported in containers, such as ATB-12 K, and then sent to SFR low/medium level waste underground storage site.

It appeared that the implementation of IAEA 1985 created in Sweden similar problems to those described for France:

- The use of industrial packages, as ATB-12K with its contents is classified at this time, is no longer possible, due to excessive dose rates around the unshielded content;

- The primary contents (box or drums) have been licensed according to storage regulations;

- The containers have been studied to be fully compatible with the organization implemented in Sweden for the transport from nuclear plants to SFR facility;

- These equipments amount to a fairly high investment.

Therefore, SKB's idea was to ask Transnucléaire to adapt the whole system to the new regulatory requirements.

Waste Conditioning and Containers

The wastes generated by 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.

Twelve cubical boxes or 48 drums can be loaded in one ATB-12 K container.

The ATB-12K is made of 130-mm thick metallic welded walls and a locked metallic cover 130 mm thick, also.

A frame is welded to the container and allows its easy transfer and stowage. It is a standard equipment regarding the SKB transport system.

The maximum total weight is 120 tonnes.

Principles of Solution for a Type B Container

As for the French cases, the chosen principles were to take advantage of the characteristics and properties of the radioactive waste when it is mixed or bound with cement or bitumen. This allowed discovery of a solution compatible with the existing transport system and meeting the cost target.

Basically, the aim is to demonstrate that after drop, puncture, and fire tests the content of the container is still undamaged, in order to avoid the dispersal of radioactive contents, and to made sure that the requested thermal protection made of the container is still in place.

Implemented Solution

Transnucléaire studied for SKB the modifications of the ATB-12K with the same philosophy as for the design of French overpacks :

- Prevention of activity release results from the content itself;

- The steel container must remain in place around the content after drop and puncture tests 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.

Then, preliminary tests on a scale model have shown that, for existing containers, reinforcement of wall connections and of cover locks could enable reaching this goal. On the other hand, calculations have shown that in that case, the content temperature during the fire test remains in such a range that no unacceptable release is observed.

At that time, the studied and tested reinforcements are implemented on a new design: the ATB - 8 K, the same type of container as ATB - 12K, but with thicker walls and therefore a lower useful load, which will be used for the transport of more active wastes without significant modification of the SKB medium level waste transport system.

CONCLUSION

Facing a new type of request, due a new regulatory requirement, Transnucléaire proposes an original approach, with the constant idea of meeting the cost and industrial targets of the customers.