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232- Transport of residues with TN®81 cask: Past, present, and future

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ABSTRACT

France, like other countries including Japan, the UK, Russia and China, has chosen the closed fuel cycle, where 96% of the content of used fuel is recycled. This treatment, performed at AREVA's La Hague plant allows recovering uranium 95% and plutonium 1% for recycling, the remaining 4% being considered as ultimate waste.

Most of the ultimate waste can be sorted into two categories:

- High level activity waste (HLW) composed of fission products and minor actinides which account for the largest share of radioactivity; this type of waste is vitrified.
- Long-lived intermediate level waste (ILW) composed of structural elements of used nuclear fuel (hulls and end pieces); this type of waste is compacted.

Whether vitrified or compacted, the waste is conditioned in the same universal and multipurpose container, the Universal Canister (UC). The resulting residue is named CSD-V (or UC-V) for vitrified waste and CSD-C (or UC-C) for compacted waste; they both remain property of the utilities and must be returned to the countries of origin.

In order to transport Universal Canisters under the best technical and economical conditions, TN International designed two cask solutions for its customers: either for transport only or for dual purpose, storage and transport, depending on the facility receiving the canisters.

The purpose of this paper is to outline the past, the present and the future of the TN®81 dual purpose cask.

In the mid nineties, TN International started to design a cask for transport and storage of vitrified high level waste conditioned at the AREVA La Hague recycling facility: TN®81 cask.

The TN®81 cask is currently licensed in France, Switzerland and the UK and will very soon be licensed in Australia. The first TN®81 cask was loaded in June 2004.

The TN®81 cask is the best solution for the return and storage of all kinds of recycling waste packed in a universal metallic canister. It will be proposed in the near future to other European customers who have chosen the recycling of used fuel.

INTRODUCTION

In collaboration with its customers, AREVA NC has implemented a policy of waste volume reduction and conditioning. First, the glass canister was designed for fission products and minor actinides. The shape and the characteristics of the canisters were designed to enable easy handling operations either by a crane or by loading/unloading equipment.

Moreover, the vitrified residue waste form has been licensed by the French Authorities and Safety Authorities from Belgium, Japan, Germany, Switzerland, the United Kingdom and the Netherlands, making the glass canister a universal standard.

For the hulls and end pieces, AREVA NC uses compacting technology, and in an effort to standardize the differing types of waste, AREVA NC has developed the stainless steel multi-purpose container, the "Universal Canister" (UC) for both vitrified and compacted waste.

The Universal Canisters are used as containers for:

- fission products immobilized in a glass matrix produced at the R7/T7 facilities at AREVA's La Hague plant; the resulting canister is named CSD-V (or UC-V)
- the hulls and end pieces produced at the ACC (Atelier de Compactage des Coques) facility at AREVA's La Hague plant; the resulting canister is named CSD-C (or UC-C)

Figure 1: universal canister

VITRIFIED WASTE

As mentioned above, high level activity waste (HLW) is composed of fission products and minor actinides resulting from the reprocessing of used fuel. The waste is conditioned in vitrified waste canisters named CSD-V. HLW has a very high concentration of radio-nuclides and thermal power, an average of 1,900 watts per canister at the time of vitrification.

In order to deliver canisters under the best technical and economical conditions, TN International has designed two solutions for AREVA and its customers depending on the facility which will receive the waste:

- In Belgium, the Netherlands and Japan, vault facilities are ready to house the canisters. Therefore, the transport solution developed is a fleet of routine transport casks (TN™28VT).
- Switzerland has already chosen a uniform handling of waste and of vitrified residues with the proposed solution of the TN®81 dual purpose transport/storage cask to transport and store the canisters.
- The "German version" of the TN®81, the TN®85, is used by German utilities.

THE TN®81 CASK

The TN®81 cask is a dual purpose cask that can be used for transport and storage of compacted waste (UC-C) and vitrified residues (UC-V) conditioned in recycling plants such as La Hague.

Technical description

The TN®81 cask is mainly composed of a thick forged cylindrical steel vessel, a welded bottom end made of forged steel and two lids (primary and secondary) made of forged steel. The external part of the cask is made of hollow aluminum profiles screwed on the vessel then filled with lead and neutron shielding.

The cask can be provided with two transport configurations T1 and T2 which are described hereafter and in Figure 2.

In the T2 configuration, the secondary lid is set over the primary lid. It is bolted onto the forged cask body. The secondary lid is not put in place at the recycling plant as it is only required for storage purposes. Thus, the cask has been designed for transport in the T1 configuration, where an aluminum flange is put in place in addition to the secondary lid as a spacer and to protect the secondary lid gasket seat.

The T1 configuration is primarily used to transport the cask after the loading from the recycling plant to the storage sites. The T2 configuration is used to transport the cask after its storage time. The secondary lid is put in place during storage and need not be removed before transport.

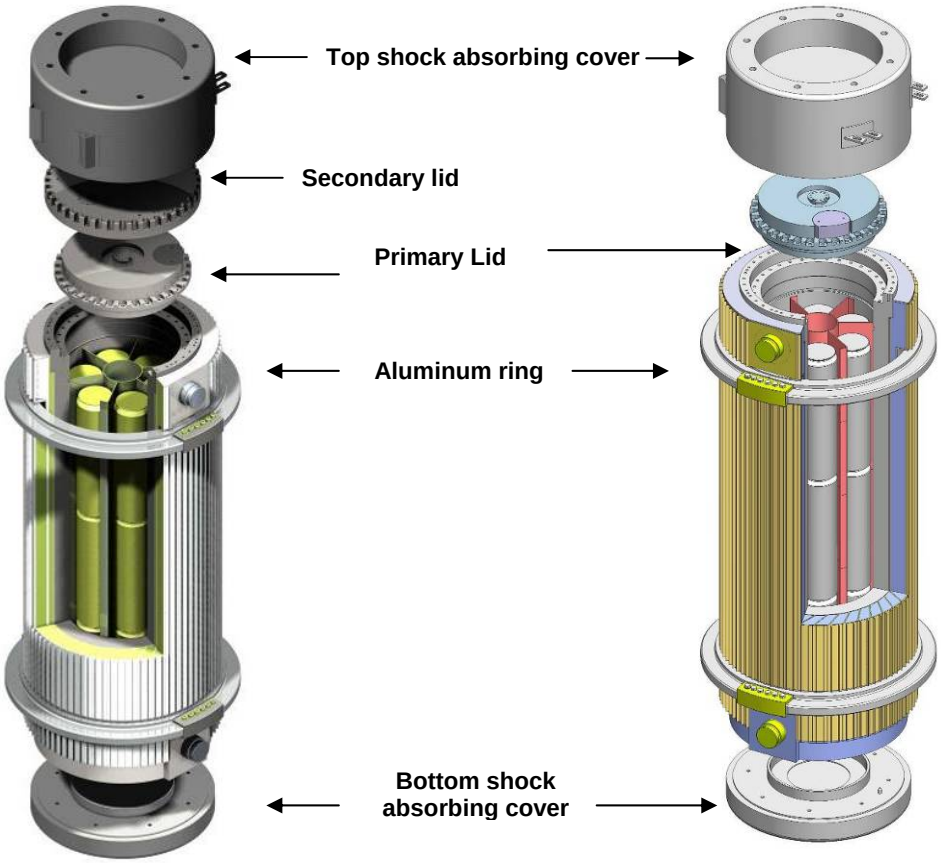

Figure 2: T1 and T2 transport configurations

The forged vessel and the lead provide the main gamma shielding.

The neutron shielding is ensured by a patented high density resin compound. At the bottom end of the cask, a steel casing is also filled with resin. The primary lid also carries a steel casing filled by the resin compound. The shock absorbing covers also provide additional neutron shielding with the wood and resin they contain.

The aluminum profiles are produced directly with outer fins that enhance the thermal dissipation of the heat load of the vitrified residues into the ambient atmosphere.

Two pairs of trunnions on the forged vessel are used to handle, tilt and block the cask during transport.

During transport, the shock absorbing function is performed laterally by two aluminium rings, and axially, at the top and bottom, by shock absorbing covers. The main characteristics of the TN®81 cask in transport configuration are presented in Table 1.

Table 1: Main Characteristics of the TN®81 cask in transport configuration

	T1 transport configuration	**T2 transport configuration**	**Storage configuration**
Max weight (empty cask)	100,000 kg	102,000 kg	104,000 kg
Max weight (loaded cask)	114,000 kg	116,000 kg	118,000 kg
Max length	7,215 mm		6,454 mm
Max diameter	2,750 mm		2,780 mm

In storage configuration, the TN®81 cask is equipped with an anti-aircraft crash cover placed over the two bolted lids. The storage configuration is presented in Figure 3.

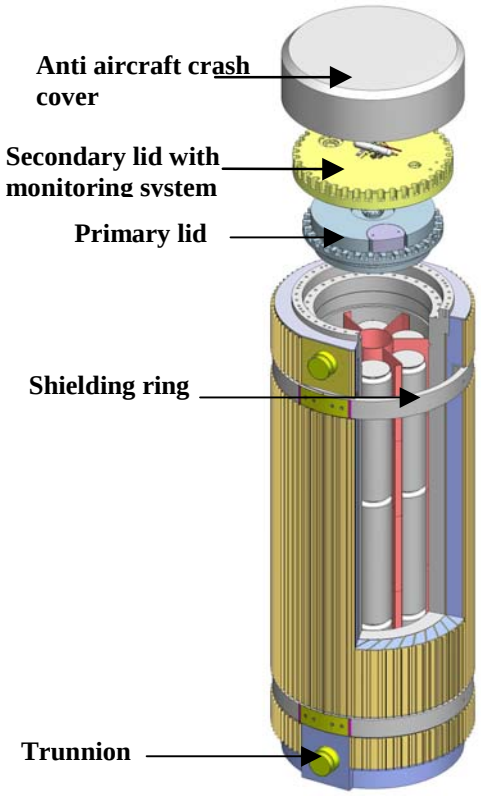

Figure 3: storage configuration

The main dimensions of the cask in storage configuration are presented in Table 1.

Admissible content

The TN®81 cask was originally designed to safely transport and store highly radioactive waste packed in a canister. This highly radioactive waste (especially fission products) generated in the nuclear reactor are segregated and recovered during the treatment operation. The waste is then incorporated into a glass matrix and finally poured into a stainless steel canister where it cools and solidifies. These canisters named Universal Canisters for vitrified residues (UC-V) are conditioned at the AREVA La Hague recycling plant in France.

The TN®81 cask is used for the transportation and the interim storage of 28 vitrified residue canisters (UC-V) for a maximal thermal output of 56 kW.

Since 2009, a second content has been authorized for loading into the TN®81 cask: 20 compacted waste canisters, Universal Canisters for Compacted waste (UC-C). The UC-Cs are stainless steel canisters which have the same dimensions as the UC-V but are filled with hulls and ends of the fuel elements processed at the AREVA La Hague recycling plant which are compressed together under high pressure.

The TN®81 cask is a very **flexible solution**; the cask is already licensed for any type of partial loading, so for instance it can be loaded with a number of UC-V from 1 to 28 with a maximum number of 3 dummy canisters for the whole cask. In the same manner the partial loading of UC-C from 1 to 20 is already included the current license.

TN®81 for high level waste from La Hague (FR)

Swiss and German Utilities

The TN®81 cask is currently licensed in France and in Switzerland: the transport approval reference in France is F/366/B(U)F-96 and the validation reference is CH/5071/B(U)F-96 in Switzerland.

The TN®81 cask has been adapted to the German market under the brand TN®85. The TN®85 cask is currently licensed in France and in Germany: the transport approval reference in France is F/392/B(U)F-96 and the validation reference is D/4334/B(U)F-96 in Germany.

The first TN®81 cask was loaded in June 2004, and TN®81 casks loaded with vitrified residues are currently stored at the ZWILAG storage facility in Switzerland. Eleven TN®85 casks are currently loaded with vitrified waste produced in France and stored at the Gorleben interim storage facility in Germany.

Australian Utility

Ansto has already chosen the TN®81 cask for the return of vitrified waste. A validation of the transport license in Australia will be implemented before the end of 2015. TN International will also prepare the safety analysis report concerning the on-site storage.

Future returns

Utilities in countries such as Spain or Italy, which will have to implement the return of high level waste from La Hague in the future, have the option of choosing the flexible TN®81 cask solution for both transport and storage of UC-V or UC-C. It is an easy way to implement interim storage of a reduced volume of final waste while waiting for the opening of the final repository.

TN®81 for high level waste from Sellafield (UK)

Swiss utilities

In order to fulfil their obligation to retrieve the waste issued from the treatment of used fuel, KKG requested TN International to provide TN®81 casks for the transportation and the interim storage of its high level vitrified waste produced at the Sellafield site in the United Kingdom.

Based on Sellafield Ltd data, TN International modified the design of the TN®81 cask in order to comply with requirements imposed by the new content and the new interfaces on the site. For example, the primary lid orifice is equipped with a new shielding plug compliant with the site constraint.

The vitrified residue canisters comply to the Sellafield Ltd specifications, HLWP SD 02459 Issue 1, “SL VR Characteristics for TN® 81 Licensing” (July 2009).

The TN®81 cask is licensed in France with a validation in the UK for this new content.

Furthermore, the Safety Analysis Report for interim storage will be updated in order to include the new content within the framework of the storage licensing of the TN®81 cask for the ZWILAG

interim storage facility. For each TN®81 cask, an optimized cask loading pattern is defined taking into account the list of canisters produced at the Sellafield site.

Future returns

Utilities which must implement the return of high level waste from Sellafield (UK) in the future have the option of the flexible TN®81 cask solution for both transport and storage of UC-V.

CONCLUSION

TN International activities in designing casks and transporting nuclear materials is an integral part of the AREVA waste management policy which aims at reducing waste volume while maintaining the highest level of nuclear and occupational safety and of environmental protection during transportation.

Since 1995, TN International has been transporting vitrified waste to Belgium, the Netherlands, Switzerland, Germany and Japan. TN International has thus accumulated extensive knowledge in cask design, cask licensing and transport management. This experience and the lessons learned have been used to improve current solutions for waste transport.

Utilities which have opted for the closed fuel cycle with a significant volume reduction of final waste will have to implement the return of their high level waste from La Hague or other recycling plants in the future.

The TN®81 flexible cask solution for both transport and storage of UC-V or UC-C is the best choice: it is an easy way to implement the interim storage of a reduced volume of final waste while waiting for the opening of the final repository.