TRANSPORTATION OF VITRIFIED HIGH LEVEL WASTE FROM SELLAFIELD TO SWITZERLAND

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ABSTRACT

In the mid nineties, TN International started to design casks for transport and storage of vitrified high level waste conditioned at AREVA La Hague recycling facility: TN®81 and TN®85 casks.

The TN®81 cask is currently licensed in France and in Switzerland and the TN®85 cask is currently licensed in France and in Germany. The first TN®81 cask was loaded in June 2004. Up to now, 15 casks have been stored in Switzerland or Germany.

In order to face up to their obligations to get back the waste issued from the treatment of their used fuel, the Swiss Utilities asked TN International to propose a solution for the transportation of their high level waste produced at the Sellafield site in the United Kingdom. TN International performed in conjunction with International Nuclear Services (INS) and Sellafield Limited (SL) some investigations and analysis in order to check the conformance of the TN®81 cask with the new requirements. In particular TN International performed the following studies:

- Assessment of the compatibility of the content with the TN®81 specification,
- Assessment of the compatibility of the TN®81 cask with the interfaces at Sellafield plant,
- Identification of the main interfaces modifications and design of specific tools required to receive the TN®81 at the Sellafield site and at the associated port of Barrow,
- Radiological assessment,
- Assessment of the proposed route from Sellafield plant to Zwilag, the central Würenlingen interim storage facility in Switzerland and of the logistical organization of the transport.

The purpose of this paper is for TN International and INS to present this experience, and furthermore to underline their know-how and ability to manage the shipment to European Customers of vitrified high level waste produced in the United Kingdom in a safe and efficient manner.

INTRODUCTION

Until 2006, the Swiss utilities have sent their used fuel for treatment to France (AREVA) and to the United Kingdom (Sellafield Ltd). The waste arising from used fuel treatment must be returned to Switzerland and stored at ZWILAG facility (Zwischenlager AG Würenlingen), the Central Interim Storage Facility which started operation in 2001.

Up to now transport and storage casks containing canisters with high level waste had been taken back only from France. For the return of radioactive waste from the United Kingdom to Switzerland, the Swiss utility KKG (Kernkraftwerk Gösgen-Däniken AG) ordered TN®81 dual purpose casks.

TN International performed some analysis in order to check that the TN®81 cask was suitable for this transport of the high level waste produced at Sellafield site.

THE TN®81 CASK

The TN®81 cask is a dual purpose cask that can be used for transport and storage of high level waste. It is dedicated to transport and store 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 steel forged cylindrical vessel, a welded bottom end made of forged steel and two lids (primary and secondary) made of forged steel. The external part of the flask is made of hollow aluminium profiles screwed on the vessel then filled with lead and neutron shielding.

The flask can be provided with two transport configurations T1 and T2 which are described hereafter and in the figure 1.

In the T2 configuration, the secondary lid is set over the primary lid. It is bolted on the flask forged body. The secondary lid is not put in place at the recycling plant, because it is required for storage purpose only and not for initial transport purpose. So the cask has been designed to be transported in a T1 configuration, where an aluminium flange is put in place of the secondary lid as spacer and to protect the secondary lid gasket seat.

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

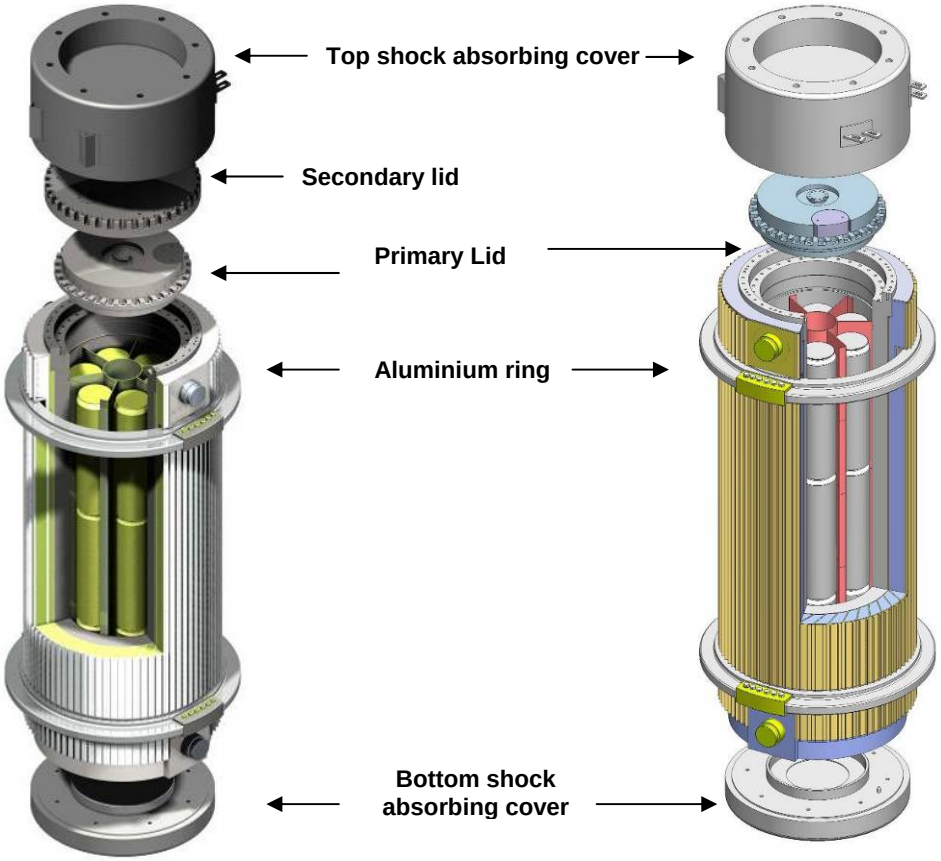

Figure 1: T1 and T2 transport configurations

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

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

The aluminium profiles are produced directly with outer fins that enhance the thermal dissipation of the vitrified residues heat load at the external surface covered by fins to the ambient atmosphere.
Two pairs of trunnions on the forged vessel are used to handle, tilt and block the flask 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 the 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 aircraft crash cover placed over the two bolted lids. The storage configuration is presented in the figure 2.

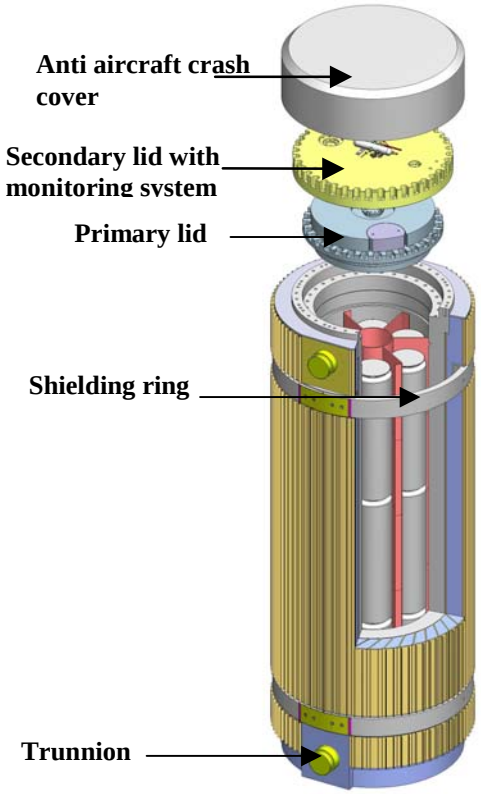

Figure 2: storage configuration

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

Admissible content

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

accordance with the AREVA specification 300 AQ 016 "Specifications of vitrified residues produced from treatment at UP2 or UP3-A La Hague Plants" (Second series, July 1986).
The TN®81 cask allows the transportation and the interim storage of 28 vitrified residues canisters (UC-V) for a maximal thermal output of 56 kW.

Since 2009, the TN®81 cask allows a second admissible content: 20 compacted waste canisters, Universal Canisters for Compacted waste (UC-C). The UC-C are stainless steel canisters which have the same dimensions as the UC-V but filled with hulls and ends of the fuel elements processed at the AREVA La Hague recycling plant which are pressed together under high pressure.
It can be noted that the first shipment of compacted metallic waste resulting from the treatment of used nuclear fuel that had been sent by rail from France back to Switzerland took place at the end of 2009. The shipments of compacted waste have been performed using the TN®81 casks and represent the transport of five TN®81 casks.

The main characteristics of the admissible contents are presented in the table 2.

Table 2. Admissible contents of the TN®81 cask.

	Vitrified waste	**Compacted waste**
Number of canisters	28 UC-V	20 UC-C
Max weight of canister	550 kg	850 kg
Max Length of canister	1335 mm	
Max diameter of canister	435 mm	

Package approval

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 German market under the brand TN®85 cask. 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 three TN®81 casks are currently stored at the storage facility of ZWILAG in Switzerland with vitrified residues. Eleven TN®85 casks are currently loaded with vitrified waste produced in France and stored at the German interim storage facility of Gorleben.

ADAPTATION OF THE TN®81 CASK TO THE HIGH LEVEL WASTE PRODUCED IN UNITED KINGDOM

In order to face up to their obligations to get back the waste issued from the treatment of used fuel, KKG requested TN International to provide a solution for the transportation and the interim storage of its high level vitrified waste produced at the Sellafield site in the United Kingdom.
TN International proposed the TN®81 cask. As previously indicated the TN®81 cask has been originally designed to accommodate the vitrified waste canisters produced by the AREVA La

Hague recycling plant. So TN International in conjunction with INS and Sellafield Limited performed some analysis in order to check the conformance of the TN®81 cask with the new requirements imposed by the new content and the new interfaces at Sellafield site.

Package approval for the vitrified canister produced at Sellafield site

Based on Sellafield Ltd data, TN International designed the modification of the TN®81 cask in order to comply with the specific site requirement. So TN International designed an absorbing stool for the loading operations which is based on an adaptation of the current bottom shock absorbing cover. Moreover, the primary lid orifice will be equipped with a new shielding plug compliant with the site constraint.

With regard to the new content, TN International took into account the new specification issued by Sellafield Ltd and performed in particular the following safety analysis which will be the support of the transport application of the package approval:

- mechanical evaluation of the cask with the new content and the new shielding plug,
- shielding calculation around the cask taking into account the vitrified residues typical source,
- thermal evaluation of the cask taking into account the vitrified residues thermal characteristics and geometry,
- criticality evaluation of the cask content taking into account the vitrified residues glass characteristics and geometry.

The vitrified residues canisters are in accordance with the Sellafield Ltd specification HLWP SD 02459 Issue 1, « SL VR Characteristics for TN® 81 Licensing » (July 2009). The main characteristics of the new content are presented in the table 3.

Table 3. New content of the TN®81 cask.

	Vitrified waste
Number of canisters	28 UC-V*
Max weight of canister	550 kg
Max Length of canister	1338 mm
Max diameter of canister	430 mm

* This canister has a different content from the UC-V conditioned at AREVA La Hague

TN International is in process for the application of the package approval extension in France, its validation in Switzerland and in the United Kingdom. The package approval is expected to be granted in 2010 for the first return of vitrified waste canisters from United Kingdom.

The Topical Safety Analysis Report will be updated in order to include the new content within the framework of the storage licensing of the TN®81 cask within the ZWILAG interim storage facility.

Additional studies for the vitrified canisters produced at Sellafield site

For each TN®81 cask, an optimized cask loading pattern will be defined taking into account the list of canisters produced at Sellafield site. Furthermore before each loading, TN International will check that the technical characteristics of the canisters meet the requirements defined in the transport license and meet all the storage relevant criteria defined at the storage facility.

As TN®81 casks from the United Kingdom to Switzerland will be transported on a ship via either Pacific Nuclear Transport Ltd (PNTL – a wholly owned subsidiary of International Nuclear Services) or an NDA vessel, a specific thermal study related to maritime transport of Sellafield vitrified residues canisters loaded into 3 TN®81 casks must be performed based on assumptions given by INS and Sellafield Ltd. The analysis will confirm that the heat removal inside the holds is compatible with the thermal performance of the cask in term of temperature criteria for the main components of the casks and the content.

Transportation from the United Kingdom to Switzerland

International Nuclear Services, on behalf of TN International performed preliminary assessment of the proposed route from Sellafield site to ZWILAG storage facility in Switzerland and of the logistical organization of the transportation. These assessments have been required by KKG utility in order to validate the possibility to use the TN®81 casks for the return of the vitrified residue canisters produced in the United Kingdom to Switzerland.

It is planned to transport 3 TN®81 casks together. The organisation of the transport will be carried out by INS for the maritime transport from Barrow Port (near Sellafield site) to Cherbourg Port in France and by TN International for the land transport part. At Cherbourg port, the TN®81 casks will be handled from the ship onto railway wagons and then transported by rail to the Swiss Würenlingen station; there, the TN®81 casks will be transferred onto a trailer truck for a road transport between the Würenlingen station and the ZWILAG facility.

CONCLUSION

TN International working with International Nuclear Services (INS) and Sellafield Ltd proposed to its customer KKG a global service for the return of vitrified residue from the United Kingdom to Switzerland including the supply of dual purpose casks and the associated engineering and logistical services. This combined experience underlines the know-how and ability of TN International and INS to manage the safe and secure shipment of vitrified high level waste produced in United Kingdom to European Customers.

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