EUROPEAN EXPERIENCE IN THE FIRST SHIPMENTS OF UNIVERSAL CANISTERS CONTAINING COMPACTED METALLIC WASTE COMING FROM TREATMENT

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ABSTRACT

TN International's experience in designing packages and transporting nuclear materials is part of the AREVA waste management policy. The aim is to reduce waste volume, while maintaining a high level of nuclear and occupational safety and of environmental protection during transportation.

Since 1995, TN International has been performing vitrified waste return shipments to Belgium, the Netherlands, Switzerland, Germany and Japan. TN International has thus developed wide knowledge in cask design, cask licensing and transport management. This experience and the lessons learnt have been used to improve current designs and to develop innovative solutions for compacted waste transport. The first implementation of these solutions was successfully performed in June 2009 for the first return of compacted residues to the Netherlands. Such returns are now planned on a regular basis over the next years.

INTRODUCTION

France, like other countries including Japan, the UK, Russia and China, has chosen the closed fuel cycle. This treatment, performed at AREVA's La Hague plant recovers 95% of uranium and 1% of plutonium for recycling purposes. The ultimate wastes created by the treatment process are from two types:

- High level activity waste (HLW) composed of fission products and minor actinides (corresponding to the 4%), 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, i.e. Universal Canisters (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 electric utilities and must be returned to the countries of origin.

Since the mid-1990s, TN International has transported CSD-V residues to Belgium, the Netherlands, Switzerland, Germany and Japan. As most of these CSD-V return programs are nearing completion, TN International is now in charge of the CSD-C return program, which began in 2009 for The Netherlands. Taking the 2010 transport program into account, a total of three shipments to the Netherlands, two to Switzerland and one to Belgium encompass TN International's European experience in the transportation of such waste.

Experience of preparation and execution of these shipments is now significant and is worthy of sharing. For example, different types of existing casks were used. Their selection was tailored to the specific situation of each customer in order to provide the best economic solution without cutting down on the service quality. As far as cask licensing procedures are concerned, various issues were solved to obtain all package approval certificates for the CSD-C content. When necessary, transport equipment was adapted to the different cask designs taking all interface constraints into account. Indeed, lessons were drawn from the cask operations themselves: loadings at La Hague plant; road and rail transport; multi-modal trans-shipments; unloadings at the delivery sites.

ALREADY HISTORY – VITRIFIED WASTE CASKS AND THEIR TRANSPORTATION

In order to deliver CSD-V under the best technical and economical conditions, TN International has conceived two solutions for AREVA and its customers depending on the facility which receives the waste:

- Belgium, the Netherlands and Japan: interim vault facilities house the canisters. Therefore the transport solution developed is a fleet of routine transport casks (TN®28VT).
- Germany and Switzerland: interim storage facilities for which dual purpose transport/storage casks such as TS 28, TN®81 and TN®85 casks are used.

The TN®28VT transport cask

For the transport of vitrified residues, an IAEA Type B packaging is required. The TN®28VT (fig.1) is the transport cask proposed by TN International for this type of waste.

Figure 1. TN®28VT cask

The TN®28VT design has been licensed for several years and casks have been in operation since 1995 for the transport of vitrified residues from the La Hague reprocessing plant to the interim vault facilities in Japan, Belgium and the Netherlands.

Dual purpose solutions for CSD-V: TN®81 and TN®85 casks

In the mid nineties, TN International and other cask manufacturers started to design dual purpose transport and storage casks. Due to the evolution of burn-up from fuel being reprocessed, HLW canister characteristics will soon approach the specified production limits. In this context, the first generation of HLW casks imposed a stringent selection process for loaded canisters. In order to reduce the constraints on the selection of loaded canisters, new casks were designed with a specification of 56 kW thermal output and increased radioactive limits: the TN®81 and TN®85 casks (Fig. 2) (see PATRAM 2007 article “ European experience in transport / storage cask for vitrified residues ”).

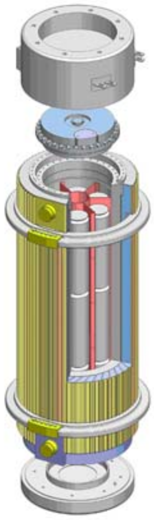

Figure 2. TN®81/TN®85 cask

CSD-V transport program

Since 1995 (date of the first return), more than 4,400 CSD-V canisters, representing about 83% of the total amount to be returned and about 158 loaded casks, have been successfully returned to the countries of origin:

- 12 returns to Japan in TN®28VT (100% completed)
- 10 returns to Germany in TS 28 V or in CastorHAW20/28CG or in TN®85
- 14 returns to Belgium in TN®28VT (100% completed)
- 8 returns to Switzerland in CastorHAW20/28CG or TN®81
- 5 returns to the Netherlands in TN®28VT

DESCRIPTION OF CSD-C CANISTERS

In the AREVA NC La Hague reprocessing plant, structural elements of used nuclear fuel are processed in head-end facilities and in a compaction facility (ACC). The purpose of the head-end facility is to separate the nuclear material from the fuel assembly structural elements, so that the nuclear material can be dissolved in nitric acid and then undergo the PUREX process. Two different types of waste are treated in the compaction facility (ACC):

- Spent fuel structural elements released from the two La Hague head-end facilities; they mainly consist of hulls and end-pieces.
- Technological waste resulting from operations and maintenance in the La Hague reprocessing plants.

This waste is put into drums which are compacted with a high performance press. Compaction at high pressure allows volume reduction optimization. CSD-C canisters are filled with about 7 or 8 compacted disks depending upon their thickness. Afterwards, an outer lid is welded onto this canister.

The compacted waste is classified as long-lived intermediate level activity (LL-ILW) waste. Compared to CSD-V canisters, CSD-C canisters have a similar external geometry, but a higher mass: about 40% more. Also, the thermal output of a CSD-C is much lower than that of a CSD-V.

Compacted waste, as well as vitrified waste, is produced according to production specifications reviewed by French competent nuclear authorities. These specifications are also reviewed by the competent nuclear authorities of Belgium, Switzerland, the Netherlands, Japan and Germany.

TRANSPORT SOLUTIONS FOR CSD-C CANISTERS

Parallel to the operations of the ACC workshop and the manufacturing of the CSD-C canisters, TN International started working with AREVA NC and its customers on the organization of the return of the CSD-C with the objective to perform the first return to the European countries in 2009.

For the transport of the compacted residue, an IAEA Type B packaging is necessary. As for the CSD-V returns, transport only or transport and interim storage concepts of casks were then studied depending on the interim storage solution implemented by each country. In addition, the cask transport solutions have been tailored to the situation of each AREVA NC customer. On the basis of interface and transport constraints together with the number of CSD-Cs to be returned, the best technical and economic option has been implemented.

In some cases, already existing casks developed for CSD-V transport have been adapted to be used for CSD-C transport; in other cases, new casks are being designed specifically for CSD-C transport in order to increase the capacity of the casks and thus reduce the number of shipments.

<u>Adaptation of existing transport cask: TN®28VT</u>

The TN®28VT is used to transport compacted waste canisters to the Netherlands, where they are stored in the HABOG interim storage building. No specific adaptation was required for this cask. The safety analysis has been revised to take into account CSD-C content; thus, new thermal, mechanical and radiological calculations were performed. An extension of the approval of the TN®28VT package for CSD-C content has been obtained. Due to the CSD-C's higher mass, the capacity of the TN®28VT cask is limited to 20 CSD-C, with a maximum payload of 14 tons.

<u>Adaptation of existing transport cask: TN®81</u>

The TN®81 cask was initially designed as a dual-purpose cask (with limited transport). Some improvements have therefore been necessary in order to use it as a routine transport cask:

- A stainless steel cladding has been added on the primary and secondary lid seal-bearing surfaces in order to protect against corrosion.
- Helicoils in the threaded holes for fixing the shock absorbing covers and the primary lid onto the cask body have been added.
- A plate protecting the secondary lid seal-bearing surface against mechanical damage during transport is screwed on the cask body in the cask configuration with only the primary lid.
- The primary lid orifice has been modified in order to adjust the cavity internal pressure or provide for gas sampling through a quick coupling connector.

According to the safety demonstrations, the TN®81 cask can be loaded with up to 20 CSD-C with a maximum payload of 14 tons and a maximum weight per canister of 850 kg. Empty basket lodgments are allowed, as well as the use of spacers (dummy canisters) to complete the loading, in order to offer the highest flexibility to the customers.

<u>Adaptation of existing transport cask: TN®24DH</u>

The TN®24DH cask was also initially designed as a dual-purpose cask and is already used for the intermediate storage of used fuel elements. This design has been adapted in order to be used as a routine transport cask for compacted waste shipments:

- The original basket was specifically designed for fuel elements. Therefore a new basket has been redesigned in order to be able to load up to 24 canisters of compacted waste.
- The primary lid has been modified in order to be equipped with a lid handling system, compatible with the customers' handling devices.
- The primary lid orifices have been changed to the TN®28VT orifice design, to be compatible with the existing tools already in use in the customers' facilities.
- Helicoils in the threaded holes for fixing the top shock absorbing cover and the secondary lid were already present in the used fuel configuration. New helicoils have been added onto the rear part of the cask body for fixing the bottom shock absorbing covers.

Figure 3. TN®24DH cask

According to the safety demonstrations, the TN®24DH (fig. 3) can be loaded with up to 24 CSD-Cs with a maximum payload of 18 tons and a maximum weight per canister of 850 kg. As with the TN®81, empty basket lodgments are allowed in order to offer the highest flexibility to the customer.

<u>Dual purpose solution for CSD-C canisters</u>

The German nuclear utilities have opted for storage of compacted waste in casks at their Ahaus storage site. A dual-purpose cask called TGC36 to safely transport and store CSD-C canisters is being developed in partnership with GNS. Licensing will be applied in Germany.

Cask	Countries	Adaptation	Number of CSD-C
TN®28VT	The Netherlands	Not necessary	20
TN®81	Switzerland	Mainly the primary lid	20
TN®24DH	Belgium & The Netherlands	Mainly the primary lid and the basket	24
TGC36	Germany	New design	36

Table 1. Summary of European CSD-C transport solutions

Issues solved during the package approval procedures

For already existing casks, the safety analysis reports were mainly based on the safety analysis reports already valid for the CSD-V or spent fuel contents. Therefore, the CSD-C content was an extension to the package approval certificates contents. So the mechanical studies remained valid, as the CSD-C total weight would not exceed the previous maximal weight of the contents.

However, a new content implies new studies for gaseous release, the dose rates or the criticality. The CSD-C content was described in AREVA NC standard specifications. Some discussion points requiring the provision of additional information appeared during the expertise by the authorities:

- Gaseous release and especially hydrogen release: As it was not easy to clearly determine the maximal gaseous release by calculations, due to the current state of the art, tests needed to be performed by AREVA NC. These tests showed that the calculations were conservative. However, the authorities required additional measurements to be taken once the casks are loaded, to check the assumptions made.
- CSD-C crushing during the mandatory drop tests: The CSD-Cs are designed for the safe storage in plants so they need to fully comply with storage requirements from the authorities. In accidental conditions of transport, some deformation of the CSD-C head may occur. To quantify this phenomenon and assess its influence on cask safety, compaction tests were performed by TN International on representative pieces.
- Criticality safety: Storage conditions are different from transport conditions, especially for the assessment of criticality safety. The storage models that were used to determine the criticality safety were not applicable for the computations in a transport cask. This implied the definition of new models, which have to be compatible with the fissile material mass as used in storage conditions. The approach to define valid hypotheses on geometry and material identification appeared to be different from one national authority to the other. In some cases, this led to more restrictive criteria. Still, such criteria have always been compatible with the CSD-C to be transported.

CSD-C RETURN PROGRAM

A total of about 7,000 CSD-Cs have been contracted to be transported to their countries of origin. Below is the current transport program of CSD-Cs from AREVA NC La Hague:

Utilities	Composition of a convoy	Average number of convoys per year	Beginning date	Already performed convoys	End date
Belgium	2 TN®24DH	3	2010	1	2013
The Netherlands	1 TN®28VT or 2 TN®24DH	2	2009	3	2012
Switzerland	Up to 3 TN®81	2	2009	2	2016
Germany	To be defined	To be defined	2015	-	2024

Table 2. European CSD-C transport programs

FEEDBACK FROM THE ORGANISATION OF SHIPMENTS

Adaptation of the transport equipment

The TN®28VT and TN®81 flasks had already been used for the safe transportation of CSD-V, so no adaptations were required on the transport equipment.

The TN®24DH flasks chosen for the Belgian and Dutch transportation of CSD-C had never been used before in AREVA NC La Hague or on the unloading sites in Belgium and the Netherlands. Various changes were therefore made in order to guarantee safe loading, transport and unloading of these packages. Some of these adaptations are listed as follows:

- The TN®24DH is equipped with shock absorbers and shock absorbing aluminium rings. Dealing with these rings was a new topic for the facilities. Studies were performed to check whether it was necessary to remove these rings during the loading or unloading processes. These studies showed that La Hague and the Dutch facility were not required to remove the rings, so procedures were adapted in order to keep them. In the Belgian facility, various operational tests were performed. It was noticed that the bottom aluminium was able to stay, but the top one had to be removed. Procedures were reviewed to enable this operation.
- Table 3 below presents some of the equipment adaptation performed specifically for the TN®24DH flask.

Place	Equipment	Adaptation
AREVA NC La Hague	Lorries	New supports
	Loading facility	Specific rotating seat for the flask during loading operations
	Procedures	Dismounting of the secondary lid while the flask is in horizontal position
Wagons	Canopies	New canopy design in order not to exceed the maximal width for non-exceptional railway transportation
Belgium	Transport frames	The transport equipments primarily used for the CSD-V could not be adapted for the TN®24DH flasks: manufacturing of new frames, tarpaulins and handling device.
	Handling device	

Table 3. Equipment adaptations

Feedback from loading procedures

Various blank tests were performed in the facilities, notably to check the correct adaptations of the equipment as described above. These blank tests appeared to be very useful to finalize these adaptations. Some examples from La Hague facility include:

Some adjustments were performed on the primary lid handling device, so that the lid would not stick and to ensure a correct repositioning after the loading,.

- The handling of some parts required the use of articulated lifting lugs in order not to stress these parts during the tightening of the slings.

New procedures were also set in order to perform gas sampling in the cavities a few days after loading allowing the determination of the quantity of dihydrogen in the cavity before the performance of the transport, as required by the regulatory authorities.

Feedback from transport operations

The transport is compliant with national and international transport regulations for radioactive materials. For physical protection requirements, the transport conditions corresponding to the international nuclear material “Category II irradiated fuel” classification are applicable for both vitrified and compacted waste. Based on TN International’s excellent record under the current conditions for the vitrified waste shipments, authorities agreed to apply the same conditions to compacted waste.

Blank tests performed before the transport of the loaded packages enabled the finalization of the procedures and adaptations of the equipment. As an example, the first trans-shipment of a TN®24DH flask in the Belgian railway terminal required an adjustment of the weight distribution on the handling device in order to keep the flask absolutely horizontal.

Feedback from unloading procedures

Upon arrival at the interim storage facility, the package is inspected and then enters in the facility unloading process: shock-absorber removal, tilting, lid opening, specific operations. The CSD-Cs are then unloaded from the basket. These CSD-Cs are checked according to internal procedures before being dispatched for interim storage. Once the unloading is completed, operations for the return transport of the casks are performed. Packages are not all returned under the same UN number, so specific requirements change from one cask to another: internal non-contamination checks, leak-tightness tests, etc.

Once again, the performance of blank tests before receiving the loaded packages enabled the finalization of the procedures and adaptations of the equipment and led to successful operations.

Up to now, the application of these procedures has ensured that all CSD-C transport has been successful. Most of the operations were even performed quicker than initially planned.

CONCLUSIONS

TN International’s experience in designing casks and transporting nuclear materials is part of the AREVA waste management policy which aims to reduce waste volume while maintaining a high level of nuclear and occupational safety and of environmental protection during transportation.

Since 1995, TN International has been performing vitrified waste return shipments to Belgium, the Netherlands, Switzerland, Germany and Japan. TN International has thus developed extensive knowledge in cask design, cask licensing and transport management. This experience and the lessons learnt have been used to improve current systems and to develop innovative solutions for compacted waste transport. The first implementation of these solutions was successfully performed in June 2009 for the first return of compacted residues to the Netherlands, followed in October 2009 by the first return to Switzerland and the first return to Belgium in June 2010. Some minor events that occurred in the framework of these shipments have been presented to share experience. All of them were without any consequence on the transport programs. Hence the returns are now planned on a regular basis over the next years. This experience will also be applied for the return of CSD-C to Germany and to Japan.