High Capacity Cask (TN28V) and International Transport System for the Return Shipment of Vitrified High Activity Wastes

G. Sert[1], B. Savornin[1], Y. Rouquette[2]

[1]*Transnucléaire, Paris*
[2]*Cogema, Vélizy, France*

INTRODUCTION

The reprocessing of spent fuel generates different kinds of wastes. Among them fission products and non fissile actinides represent 98 percent of the radioactivity ; these wastes are separated, concentrated, mixed with molten glass and poured into stainless steel containers.

For political reasons, it is necessary to return these vitrified high activity wastes to the foreign countries which have decided to have their spent fuel reprocessed in France. So the transport of vitrified waste is vital for both the reprocessor and the utilities that have trusted the reprocessor and this operation has to be securely performed to give satisfaction to all concerned parties.
For that reason Cogéma will control the whole transport activity from La Hague plants to the receiving facilities of the customers.
Therefore Cogéma will be responsible of the transport whatever the cask type (transport or storage) and will subcontract the transport operation to experienced companies such as Transnucléaire, PNTL or NTL, who will act on behalf of Cogéma.

Cogéma will be the owner of the transport casks while the storage casks will normally be owned by the customers. Both cask types will of course have to comply with the requirements of La Hague, as published by Cogéma.

DESCRIPTION OF THE HIGH CAPACITY CASK TN28V

Using the characteristics of the vitrified waste specified by Cogéma, Transnucléaire have designed and developed on their own funds a high capacity cask named TN28V.

This casks exists in several versions which have in common the body and differ by the basket or by the closure system.

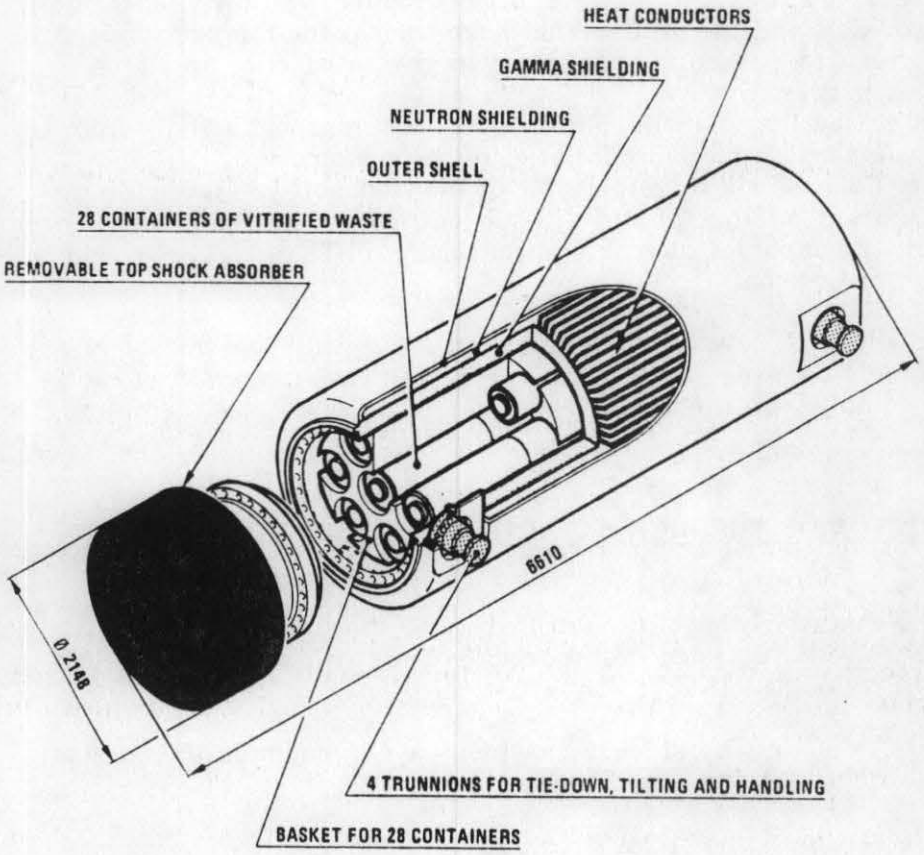
The basic version is the TN28VT cask, suitable for repetitive transports. It is closed by a single lid, the primary lid.

In the storage version (TS28V), the primary lid is covered by one or more lids to allow the monitoring of leaktightness of two independent barriers for 40 years, even when one of these lids becomes defective.

In both transport and storage casks, different baskets may be installed so that they may be loaded with either 28 or 20 containers of vitrified wastes according to their respectively nominal or guaranteed characteristics, as specified by Cogéma.

The procedures for licensing have started in different countries with the assistance of Nukem in Germany and Transnuclear Ltd in Japan.

TN 28V PACKAGING



Cask body

The main containment vessel is made up of a thick forged steel shell, with a bottom connected by full penetration weld. The shell constitutes the primary gamma shielding. Its material has been selected to provide at the same time high resilience at low temperature and good conductivity. It consists of forged steel manufactured according to A350 grade LF1 modified with 1.5 % nickel.

A special qualification program has been implemented with close cooperation with steelmakers to investigate the toughness properties of this material at temperatures of - 40°C and below.

More details about the results of this program will be presented to this symposium in the paper of *Y. Brachet from Transnucléaire, Justification of Forged Steel against Brittle Fracture.*
The results were excellent and even better in the welding heat affected zone. They confirm that there is a large safety margin even when the stress intensity reaches the yield strength.

The external envelope that ensures the shielding of secondary gamma rays is made of steel plate material. As it is covered with a paint with an emissivity coefficient better than 0.9, it may dissipate up to 45 kW in ambient air at 38°C.

Forty copper heat conductors are welded longitudinally on both inner and outer shells to convey residual heat from the containment vessel to the atmosphere.

Bars of neutron absorbing resin fill in the compartments created between the inner shell, the heat conductors and the outer shell. The total thickness of resin has been oversized on purpose to include allowance for extra requirements that have or will have to be applied. For instance the International Commission of Radiation Protection (ICRP - Paris protocol - 1985) has recommended to increase the neutron conversion factors, and from year 2000, more and more high burnup wastes or MOX wastes, with higher neutron sources will have to be transported.

Basket

The basket is formed by aluminium elements assembled together by stainless steel mechanical components : tie-rods, centering pins, lower and top plates, etc..

The basket that corresponds to glass containers of nominal characteristics, has 7 cylindrical holes. Each hole accommodates 4 stacked glass containers, resulting in a payload of 28 containers.
For glass containers with activity and heat power above nominal characteristics, the basket has 5 holes only, resulting in a total capacity of 20 glass containers. In this basket, additional shielding is provided at the periphery.

Closure system:

It is based on a primary lid which is common to all versions and is installed at the loading facility.

The gamma shielding is provided by a steel plate and by a lower casing filled with lead, the neutron shielding by an upper compartment incorporating resin plates.

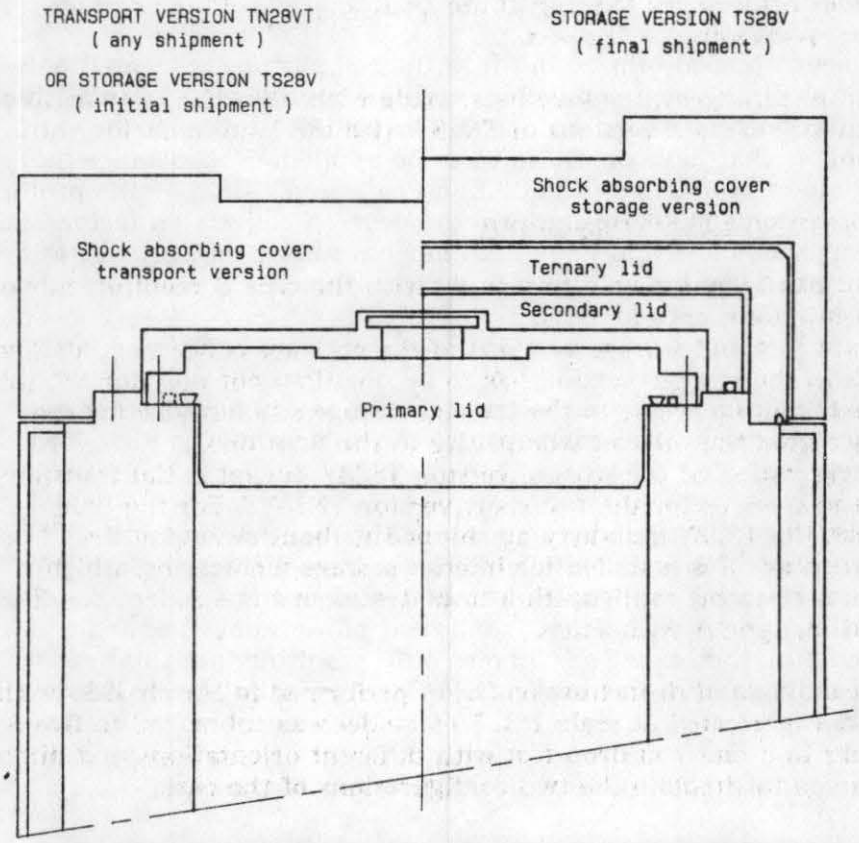
The leaktightness under the accident conditions corresponding to type B(U) qualification is provided by an elastomer O-ring. For the storage version, an additional metallic gasket is fitted to the primary lid to fulfill the requirements for the subsequent long term storage.

Upon arrival of the storage cask, at the intermediate storage facility, the closure system is complemented by additional lids serving a double purpose during storage :

. create two independent containment barriers equipped with devices allowing to continuously monitor the leaktightness of the two barriers, even if the misfunction of one lid is detected,

. provide a complementary protection against missile impact or airplane crash and eventually provide a weather protection in case of outdoor storage,

and allowing later on to transport the cask to the final repository.



CLOSURE SYSTEMS OF THE DIFFERENT TN28V VERSIONS

Shock absorbers

The top shock absorbers are removable ; they are fabricated in stainless steel plates filled with wood. They also protect the lids and their seals against accidental fire.
Their contour is adapted to the geometry of the closure system which is specific of each version.

The bottom shock absorbers are either built in the cask body or removable, according to the versions. In any case they can support the cask weight, thus allowing to keep it installed for loading or unloading the cask, which reduces the radiation dose integrated by the operators.

CASK PERFORMANCES

The design of the cask has to meet all the requirements related to the various operating conditions.

Compliance with acceptance criteria for loading at La Hague and Sellafield

Both transport version (TN28VT) and storage version (TS28V) when equipped with the primary lid only are fully in compliance with the *acceptance criteria for loading at the La Hague Plant the residues transport packagings - Cogéma.*

In addition arrangements have been made with BNFL for allowing the full compatibility of both versions of TN28V with the loading facility of Sellafield.

Compliance with IAEA regulations

The cask has been designed to comply with the type B requirements of IAEA regulations, edition 1985.
Both transport and storage versions of the cask are concerned, furthermore the cask in the storage version has to be qualified not only for the initial transport from La Hague to the interim storage site but also for the transport from the interim storage site to the final one.
The configuration of the storage version TS28V during initial transport is nearly the same as for the transport version TN28VT. For the final transport, the TS28V cask may be shipped without removing the complementary lids installed for interim storage monitoring, which represents a second configuration to be tested in the accident conditions required for type B packagings.

A first campaign of drop tests has been performed in March 1989 with a test model fabricated at scale 1/3. This model was submitted to five 9 m drop tests and one 1 m drop test with different orientations and different components to simulate the two configurations of the cask.

The performance of the shock absorbing components turned out to be quite close to the preliminary evaluations based on either calculations or rough tests at small scale. Leaktightness tests of the elastomer O-ring of the primary lid have been generally successful. Only minor modifications are necessary to fully justify the transport version TN28VT which will be provided with only elastomer O-rings.

The drop test model in the storage configuration was also equipped with metallic gaskets to evaluate the influence of impacts on their seating conditions and sealing efficiency. We have taken advantage of these observations to finalize the design of the closure system of the storage version of the cask.

From those results, we are now revising the design with a view to accordingly modify the test model and submit it to a second series of drop tests for full type B(U) qualification.

Compliance with storage criteria

The customers who have chosen to store the vitrified wastes in metallic casks have given lists of complementary requirements. Among them we may note :

. dose rates at contact of surface should not exceed 100 µSv/h for n and 100 µSv/h for gamma rays,
. materials should withstand a storage time of 40 years
. leakage rate of each of the two barriers should not exceed 10^{-7} atm.cm^3/s of helium in standard conditions .
. the primary lid cannot be opened and thus is not repairable on the intermediate storage site.

Allowable contents

According to the preceding requirements and to the limitations of the cask materials, the maximum activity and heat power of glass containers have been computed and the corresponding minimum cooling times for the contents are indicated in table 2.

Cask version	Capacity (number of glass containers)	Type of source (1)	Cooling time of waste (years after reactor unloading)
Transport TN28VT	28	nominal	7
	20	guaranteed	7 (2)
Storage TS28V	28	nominal	8
	20	guaranteed	7 (2)

(1) as specified by Cogéma
(2) provided that the heat power per glass container does not exceed 2 kW as specified by Cogéma

Such performances are compatible with the anticipated schedule for the return shipments of wastes vitrified in UP2 or UP3 Cogéma plants.

TRANSPORT SYSTEM

The transport of the vitrified waste will be very similar to the transport of spent fuel which has now become routine.
Some specific features make it even easier to operate : absence of criticality risk and low level of external and internal contaminations thanks to systematic operations of containers and casks in dry condition.

However the quality of the glass containers has to be faultless when delivered to the customer facilities ; therefore a Quality Control and a Quality Assurance systems will be implemented for the conditioning and the transport of the vitrified wastes.

Inspection of glass containers

In addition to the Quality measures taken for the production, handling and storage of glass containers in La Hague plants, the properties of the wastes will be guaranteed through different inspections as measurements of weights, dose rates and surface contamination.

Inspection of the casks

The implemented Q.A. system will also concern the procurement, the operation and the maintenance of the casks, and will be similar to the one already applied to the spent fuel transport.

More particularly it will concern before and after loading :

- checking of approval certificates and validation of packagings
- preparation of the loading diagram
- general inspection of the vehicles
- inspection of empty cask including its basket
- closing of the loaded cask, tightening torques
- filling the cavity with helium
- leaktightness tests
- radiation and temperature survey all around the cask
- contamination check of cask and vehicle
- periodical maintenance

A transportation file will be prepared for each shipment and will include the check list and the main results of these inspections.

The same procedure will be implemented by the customer representative during the unloading operations.

Economical considerations

The reprocessing cost should not be significantly increased by the cost of the transport of vitrified wastes.

Therefore existing equipments will be used as often as possible.

The existing spent fuel casks could not be used but their vehicles are well adapted to the transport of vitrified waste casks : semi-trailors with 8 lines of wheels, railwaggons with 8 axles, special PNTL sea-going carriers.

CONCLUSION

Up to now, only for LWR spent fuel, about 8,000 tons of uranium have been transported to La Hague plant after approximately 2,400 shipments.

Despite this large number of shipments (by road, rail and sea), no accident has happened in which people have been injured or property damaged as a result of the radioactive nature of spent fuel. The reason lies in the very high level of safety of these transports.

As the transport system for vitrified waste will be similar to the one used for spent fuel, and as the number of casks to be transported (up to 70 in a year) will be lower than the one of spent fuel casks, we can assert that vitrified waste transport will be a very safe activity and more especially as the radioactive contents is conditioned in a more stable form.

REFERENCES :

- Specifications of Vitrified Residues Produced at UP2 or UP3 La Hague Plants - Cogéma - 300 - AQ - 016 - 2nd series - July 1986.
- A. Verdier and G. Sert, Criteria for the Transport of Reprocessing Wastes Proceedings of PATRAM'86 - IAEA-SM-286/197-(1987)
- *Y. Brachet and al, Justification of Forged Steel against Brittle Fracture, PATRAM'89*
- *Acceptance Criteria for Loading at the La Hague Plant the Residues Transport Packagings - Cogéma/ A9810.SP.001, rév. 1 - June 87.*