Transportation of Vitrified Residues With the TN 28 VT Cask

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INTRODUCTION

At the La Hague reprocessing plant, the high activity fission products and long lived actinides separated from Pu and U as re-usable materials are conditioned in a glass matrix. These conditioned wastes, called vitrified residues, are internationally recognized as the optimal conditioning for final disposal by COGEMA customers and their respective Authorities.

The reprocessing contracts stipulate that COGEMA's foreign customers have the responsibility for storage and disposal of such residues. On this basis, vitrified residues have to be transported from the La Hague plant to a storage facility specially designed by the customers. Up to now, the first transport of vitrified residues to Japan was carried out last February, while transports to Germany and Belgium are under preparation.

THE VITRIFIED RESIDUES

Vitrified residues are contained in cylindrical stainless steel canisters, each holding 150 liters of glass. The volume reduction resulting from reprocessing is such that a single canister contains the fission products of about three PWR assemblies.

Vitrified residues' main characteristics can be described as follows :

- canister height (with lid) 1,340 mm
- outside diameter 430 mm
- weight of filled canister 400 kg
- maximum $\beta\gamma$ activity 4.5×10^{16} Bq (1.2×10^{6} Ci)
- maximum α activity 3.5×10^{14} Bq (9.5×10^{5} Ci)
- maximum heat output 2 kW

The heat output as well as the activity will decrease with time. At transportation time, the canister heat load is required to be less than 2 kW.

Vitrified residues specifications, which identified an optimum glass composition for HLW along with an operating range of process parameters and defined key process parameters to ensure glass quality (so-called guaranteed parameters), have been approved by the French Safety Authorities. Japan, Belgium, Germany, the Netherlands and Switzerland governmental Authorities have confirmed these specifications.
In addition, Bureau Veritas has been entrusted by COGEMA's foreign customers to check and certify that the canister is in accordance with the specifications, and therefore ready for transportation. The Quality Assurance and Quality Control programs comply with the International standard ISO 9002.

THE TN 28 VT CASK

For the purpose of the transport of vitrified residues TRANSNUCLEAIRE, a French company part of the COGEMA group, has designed the TN 28 VT cask.

The cask has been designed in order to meet the criteria set out by international as well as domestic regulations.

- The TN 28 VT transport cask has almost the same length, outer diameter and weight as the existing transport cask used for spent fuel transport.

	Vitrified residues transport cask **TN 28 VT**	Spent fuel transport cask **TN 12**
Total length (m)	6.6	6.2
Outer diameter (m)	2.4	2.5
Total weight with payload (t)	112	102
Payload	28 canisters (≃ 14 ton)	12 PWR assemblies (≃ 8 ton)
Maximum thermal output (kW/cask)	41	58.6
Activity (Bq/cask) (Ci/cask)	1.27×10^{18} 3.43×10^{7}	5.24×10^{17} 1.42×10^{7}

Its concept relies on the use of a thick forget steel wall, a typical feature of a large number of spent fuel transport casks designed by TRANSNUCLEAIRE, which are currently in operation throughout Europe and between Japan and Europe (TN 12, TN 17, ...).

- The body of the transport cask is made of carbon steel and resin acting as major shielding materials against gamma and neutron. The body is sealed by a stainless steel lid and double gaskets. The bottom is integrated by a full penetrating welding. A stainless weld overlay will provide additional protection against corrosion. The carbon steel has been selected because it combines several advantages : a good mechanical behavior at low temperatures, appropriate heat transfer characteristics, well known and well mastered manufacturing and inspection techniques. A shock absorbing cover is put on the top side, and a base shock absorber is set on the bottom side of the body. Transport cask is handled using two pairs of trunions which are set at the upper and lower part of cask body respectively.

- A basket made of aluminum alloy is contained inside the cask in order to accommodate vitrified residues at fixed positions. The basket technology offers a compact configuration for the canisters. The basket also provides mechanical resistance and a good thermal conductivity.
  Canisters are contained in 7 cylindrical lodgments, where canisters are stacked by columns of 4 units. The transport cask is designed to accommodate 28 canisters. The maximum activity level and thermal output per cask is similar to the cask for spent fuel, i.e. in the range of 1×10^{18} Bq (2.7×10^{7} Ci) and 41 kW respectively.

- The TN 28 VT package meets the IAEA type B requirements as well as French and foreign regulations.
  Technical criteria set out in laws and regulations for this category of package are applicable. Those criteria are established in order to cover normal operations as well as accidental cases. Maximum levels of contamination and dose rate are defined, and subcriticality must be ensured at all time. A list of prescribed tests has been established to check the resistance and safety of the package. These tests are very stringent, and are often more stringent than real life potential accidents.

TN 28 VT LOADING OPERATIONS

The TN 28 VT cask is optimized for loading and unloading operations, since it will be used several times for transportation. The cask is loaded under dry conditions.

Canisters to be transported are removed from their storage pits and transferred to the cask loading facility where several controls will take place before the shipment (heat load by calculation, canister visual inspection, identification of each canister, non-fixed surface contamination, $\beta\gamma$ and neutron dose rate measurement). This is to ensure that the canisters meet the guaranteed parameters at the time of cask loading and can be safely transported in compliance with international regulations.

Bureau Veritas checks all documents pertaining to the control of the glass canister at the time of loading into the transportation cask. On this basis, Bureau Veritas will certify that the canister meets the whole specifications and can be shipped.

The transport cask will be loaded inside the so-called DRV facility. The main steps of the operations are the following :

- reception of a shuttle containing 7 glass canisters. The shuttle is transferred to the unloading station located beneath a destorage cell,
- unloading of the glass canisters from the shuttle into the destorage cell. The glass canisters are picked up outside the shuttle, controlled and stored in the destorage cell. The shuttle is removed after non-contamination and dose rate checking,
- transportation of the TN 28 VT, removal of the plug and cask connection to the destorage cell,
- loading of the transportation cask,
- preparation of the transportation cask for shipment. The cask is disconnected from the destorage cell, the plug is put back, a leak test is performed, and the internal cavity is put in depression.

THE TN 28 VT TRANSPORTATION SYSTEM

Basically the transportation system is similar to the transport system implemented for spent fuel transport from the utilities to the La Hague reprocessing plant - similar design of the casks (overall dimensions and weight, main features and materials, ...), same modes of transport (rail or sea for the longest part of the route, road for the departure and the arrival routes to the sites), similar means of transport (vehicles, wagons, ship), same management of operations.

All the experience achieved in the LWR spent fuel transportation over more than twenty years, which is now a routine activity, is fully benefiting the vitrified residues transportation. It is true to say that, from the point of view of transportation, vitrified residues shipment is nothing new.

On April 25, 1995, the Pacific Pintail ship landed at the Mutsu-Ogawara port in Japan, completing a 62 days voyage from the port of Cherbourg, France, across the Atlantic, Cape Horn, and East Pacific Ocean. The cargo was a 112 ton cask containing 28 canisters, resulting from the reprocessing of Japanese spent fuel at the COGEMA La Hague reprocessing facility.

QUANTITIES OF VITRIFIED RESIDUES TO BE TRANSPORTED

While this transport was the 125th sea shipment of nuclear materials between Japan and Europe performed routinely for more than 20 years, it had a particular symbolic importance in the history of the nuclear power industrial development, as being the first shipment of vitrified residues returned to their country of origin.

The successful completion of this operation is based on a long and detailed preparation work. Through the issue of this operation, Japanese utilities, JNFL and COGEMA have shown their capacity to fulfill their contractual obligations to return the ultimate residues back to Japan.

This first shipment of vitrified residues will be followed by a number of other residues and products of reprocessing in the next years between France and COGEMA's foreign customers. It is worth underlining that, if the total weight of the PWR spent fuel cask and the vitrified casks are the same, the payload of one vitrified residue cask (containing 28 canisters) corresponds to the reprocessing of the payload of 7 PWR spent fuel casks. It means that the number of vitrified residues transports is seven times less than the number of the corresponding spent fuel transports.

Through the first shipment, it has been demonstrated that a close cooperation in the preparation and the execution of such a voyage is a key to success. Administrative and regulatory paper work, reports to Governments and political arenas, information of the media and the general public, form a so-called Global Acceptance program which must be carefully planned and undertaken in the respect of the safety and security measures.

For the future transports, the same philosophy regarding safety, protection of the environment and public information will be pursued and improved through permanent technical progress and return of experience.