Transport of Spent Nuclear Fuels, High and Intermediate Level Wastes: A Continuous Challenge - 9216

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ABSTRACT

For more than 45 years TN International has been involved in the radioactive materials transportation field. Since the beginning the used nuclear fuel transportation has been its core business. During all these years TN International, now part of AREVA, has been able to anticipate and fulfil the needs for new transport or storage casks design to fit the nuclear industry evolutions. A whole fleet of casks able to transport all the materials of the nuclear fuel cycle has been developed. In this presentation we will focus on the casks for the spent fuel, high level waste and intermediate level waste transportation.

Answering to the constant evolution of the nuclear industry transport needs is a challenge that TN International faces routinely. Concerning the spent nuclear fuel transportation, TN International has developed in the early 80s' a fleet of TN12 type casks fitted with several types of baskets able to safely transport all the spent fuel from the nuclear power plant or the research laboratories to AREVA La Hague plant. The current challenge is the design of a new transport cask generation taking into account the needs of the industry for the next 30 years. The replacement of the TN12 cask generation is to be scheduled as the regulations have changed and the fuel characteristics have evolved. The new generation of casks will take into account all the technical evolutions made during the TN12 thirty years of use.

MOX spent fuel has now its dedicated cask: the TN112 which certificate of approval has been obtained in July 2008. This cask is able to transport 12 MOX spent fuel elements with a short cooling time. The first loading of the cask has been performed in 2008 in the EDF nuclear power plant of Saint-Laurent-des-Eaux.

Concerning the high level waste such as the La Hague vitrified residues a whole fleet of casks has been developed such as the TN 28 VT dedicated to transport, the TN81 and TN85 dedicated to transport and storage. These casks have permitted the safe return of the vitrified residues to Japan, Belgium, the Netherlands, Switzerland and Germany where the vitrified residues are to be stored either in a dedicated building or in the cask.

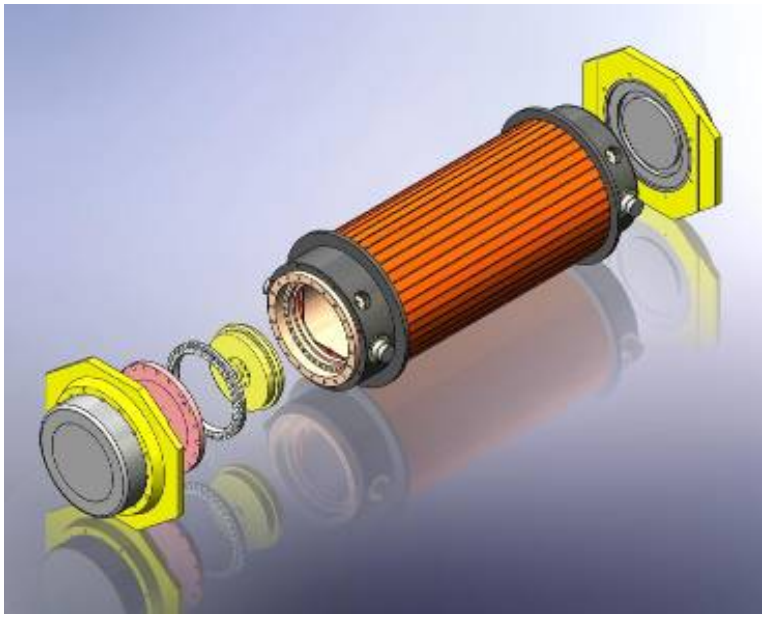
Concerning the transport and the storage of Intermediate Level Waste such as the compacted waste several solutions are under development:

- using the same cask as for the HLW
- using a TN24 cask type with a dedicated basket
- developing a dedicated transport and storage cask
- developing a dedicated transport cask

The first transport of compacted waste is scheduled in 2009.

By its continuous involvement in the nuclear transportation field, TN International has been able to face the many challenges linked to the radioactive materials transportation especially talking of spent nuclear

fuel, high level waste and intermediate level waste. TN International will also have to face the increasing demand linked to the nuclear renaissance.



INTRODUCTION

To proceed to the recycling of the used fuel elements, the used fuel elements are to be transported to the recycling plant and of course, all the waste are to be transported back to their countries of origin and the recycled U and Pu to the fuels elements manufacturing plant. TN International, which has been involved in this process since the very beginning, is in charge of all these transports and also of the design of the casks used to transport the radioactive material to and out of AREVA NC La Hague reprocessing plant.

1. Before recycling

For more than thirty years, TN International has developed a dedicated fleet of casks which has transported more than 44 000 tHm (tons of heavy metal) to AREVA La Hague plant.
Those casks from the TN12 family, first put on the road in 1977 have been able to transport used fuel elements with higher and higher enrichment and burn-up. By creating new types of baskets and by adapting the family of casks with casks such as TN13 and TN17 (low weight) TN International has been able to face the growing needs of our different customers.

TN International is fully able to transport PWR and BWR used fuel elements to La Hague plant.
Each and every year, TN transports around 200 TN12 type casks to La Hague corresponding to approximately 1200 t of heavy metal.

TN International is now at a cornerstone. As the TN12 cask fleet is IAEA85 certified it can no more be manufactured. Furthermore it can no more be adapted to fuel elements with up to 5% enrichment and 70000 MWd/tU of burn-up. Anticipating the future needs, TN International has thus launched the design of a new generation of cask: the TNG3 which will be able to transport the current and the future used fuel elements. The main challenge is to design a cask able to face thirty years of potential evolution like its predecessor the TN12.

Figure 1 : TNG3

The TNG3 should be available around 2015. Like its predecessor this new type of cask will be adapted to the power plant interfaces, including the EPR™ ones and of course to the AREVA La Hague plant interfaces. TN has put in place a dedicated team to have the most cost effective design and to be sure that the TNG3 will fulfil the nuclear industry needs as long as possible like the TN12 did.

2. After recycling

After having waited a few months in La Hague pools, the fuel elements are recycled that means:

- the fuel elements are cut into pieces
- the pellets are solved in nitric acid
- the U, Pu and fission products are separated
- reprocessed uranium in transported with the LR65 tank to the fuel elements manufacturing plant in Pierrelatte and revised in fuel elements manufacturing
- Plutonium is transported in FS47 casks in secured dedicated vehicles to MELOX Plant in Marcoule in the south of France.
- Fission products and minor actinides are melted inside a glass matrix and poured in Universal canisters.
  Each canister contains around 400 kg of glass matrix including the fission products and minor actinides.
- The **non uranium part of the fuel elements** that means:
  - the cladding
  - the grid, top and bottom part of the fuel elements are compacted in disk form and put inside Universal canisters

TN International is in charge of the transport of all these different types of products, from the cask design to the transport itself.

2.1 The recycled products: REPU (REProcessed Uranium) and Plutonium

Concerning the REPU (REProcessed Uranium) it is transported under nitrate uranyl form in LR65 tank.
The LR65 tanks are mainly transported by rail to Pierrelatte Plant. Like all the radioactive material transports performed for AREVA business, these transports are under continuous survey in our

tracking centre. Since 2007, TN International has put in place a dedicated organization which is in charge of all the AREVA transports oversight.
The REPU is used to manufacture new UOX fuel elements.

La Hague plant is also producing plutonium which is transported in FS47 casks to MELOX plant in the south of France. These transports are made within secured vehicles and under a strict security. The Pu powder is used to manufacture MOX fuel elements.

To transport the fresh MOX fuel elements, TN International has developed a dedicated fleet of casks which enable to reduce the amount of transports, as each cask is able to transport 6 to 8 PWR (MX6 and MX8) fuel elements or 16 BWR fuel elements instead of 2 fuel elements/package in the previous FS65 cask. The MX6 has been designed to transport the MOX fuel to Germany and Switzerland. It will also be used to transport MOX fuel to Japan in a near future. By performing more than 150 transports (54 MX6 and 102 MX8) from 2004 to today, these casks have demonstrated their safety level and their ability to fulfil the utilities needs.

Figure 2: MX6 cask

The MX8 has been developed for the transport the fresh MOX full Power plant. It can be dry or wet unloaded.

To loop the International loop, TN has recently obtained the AIEA 2005 certificate of approval for the TN112 cask. This brand new cask is able to safety transport 12 used MOX fuel elements from the EDF Nuclear Power Plant to La Hague plant. Used MOX fuel is not recycled yet on an industrial scale today because there is not demand from the power companies. Experiments on the recycling of several tons have nonetheless been carried out at the La Hague plant to demonstrate its feasibility without significantly changing the current process. It is expected that Generation IV fast reactors will be designed to recycle plutonium from used MOX fuel.

Before having the TN112, the used MOX fuel was transported inside TN12 with a proportion of 8 UOX + 4 MOX and with a cooling time of more than 10 years for the MOX. The TN112, which

first loading has occurred in September 2008 should perform around 6 transports per year. This is the first AIEA 2005 certificate of approval obtained by TN International.

The cooling time of the MOX fuel elements is reduced to 2.5 years. The maximal Thermal power to be transported is 50 kW, the loading may be homogenous or heterogeneous.

Figure 3: TN112 cask

2.2 The vitrified and compacted wastes

As explained before the fission products and minor actinides are calcined and mixed with glass frit in a melter heated to 1700°C (3,092°F). The mixture is poured into a canister that is stored to cool for 24 hours before being checked for the absence of surface contamination. The canister is then placed in a storage facility at the treatment plant site if the customer is a French power company, or shipped abroad if the customer is a foreign utility. For the shipment of the foreign customer vitrified waste, TN International has developed two main types of casks:

- The TN28 design to transport the vitrified waste when the storage of the waste is made in a dedicated building.
- The TN81 or TN85 casks design to transport and store the vitrified waste.

TN International is in charge of the design, the licensing, the manufacturing and the transport of these casks. The TN81 and TN85 are able to transport up to 28 vitrified waste canisters corresponding to a thermal power of 56 kW. It is the only cask currently on the market able to transport such a heat power. The first transport of 11 TN85 casks to Germany has been performed in November 2008. The eleven casks have been loaded in La Hague plant, the whole loading process per cask is taking two weeks from the cask preparation to the dose rate checking, the loading of the 28 canisters themselves is automatically performed and take around one day.

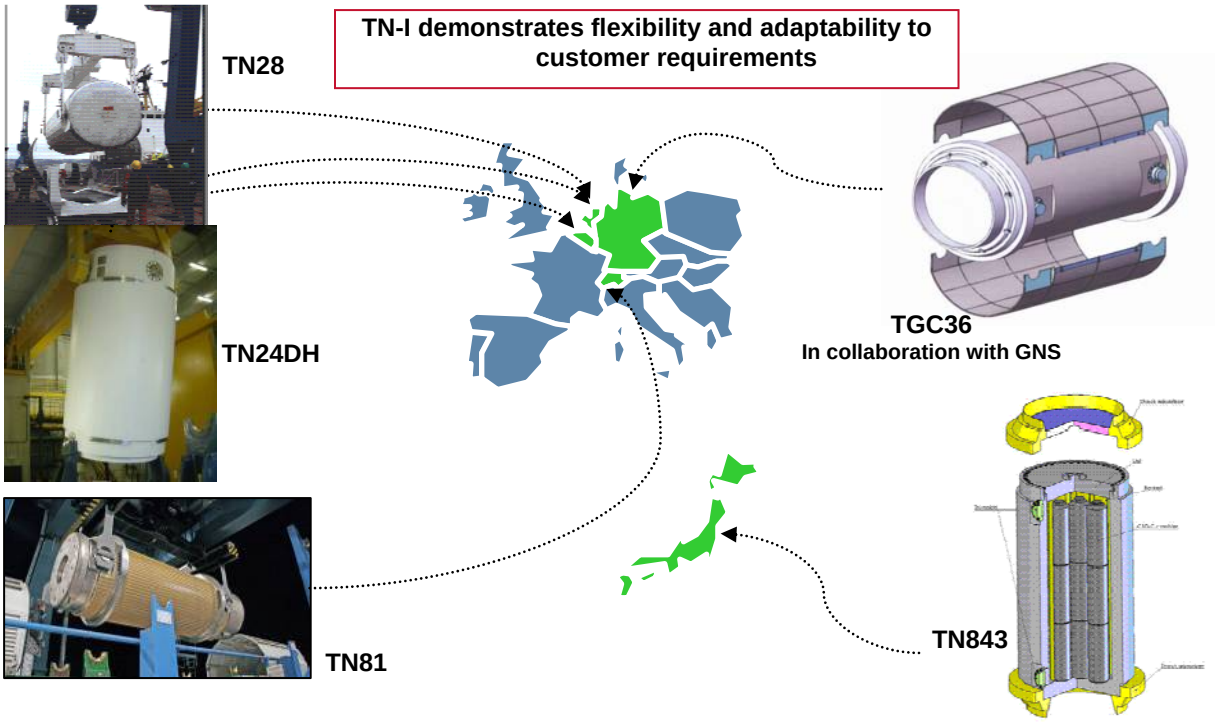
Accounting the TN81, 14 casks have already been loaded in La Hague corresponding to the return of 352 vitrified canisters to Switzerland and Germany.

The TN28 used for Belgium, the Netherlands and Japan has already return more than 1700 canisters without any incidents.

During the recycling process the fuel elements are unbundled and cut into process or “hulls” approximately 35 mm (1.38in) long and routed to a dissolver filled with nitric acid. The dissolver is a wheel fitted with buckets that turns continuously. Approximately every two hours, the hulls and sheared nozzles contained in each bucket are dropped through a funnel onto a ramp where they are rinsed with nitric acid and package in drums pending compaction. The disks obtained after compaction are put inside universal canisters having the same shape than the vitrified waste canisters. Thus the means used to handle and transport the compacted waste may be the same than for the vitrified ones. In that

Figure 4: compacted wastes different solutions

case, as the compacted wastes are far less radioactive than the vitrified ones the casks used are over



shielded, but as the compacted waste canisters are heavier some mechanical calculations have to be performed. The return of the compacted has not begun for the moment.

Several solutions are under study:

- In Belgium, an adapted TN24DH originally designed for the intermediate storage of used fuel elements will be used to transports 24 canisters of compacted waste.
- In Switzerland the TN81 will be used to transport the compacted waste and after to transport and store the vitrified waste.
- In the Netherlands, the TN28VT will be used. The first transport of compacted waste is scheduled in 2009. It will use the TN28VT to transport compacted waste canisters to the Netherlands, where they will be stored in the HABOG intermediate storage building.

- In Germany, a consortium with GNS has been signed to develop a dedicated design , the TGC36, able to safely transport and store 36 compacted waste canisters
- And finally to transport the compacted waste to Japan, a dedicated transport cask is under design: the TN 843 also able to transport 36 compacted waste canisters.

These solutions are the reflection of TN international adaptability to answer to its customers needs.

CONCLUSION

For more than 45 years, TN International has developed and is developing a complete fleet of casks and tanks able to transport all the radioactive materials going to and coming out AREVA La Hague plant. This fleet is fully in accordance with the customers' and the users' requirements, concerning the capacity of the casks, the interfaces to be taken into account and the transport means to be used. TN has thus developed a wide knowledge in cask design, cask licensing and transport management. To design a new cask is always a challenge, but as TN has always worked for many different customers all over the world it has continuously learned and improved its products. All the lessons learned have been implemented in the design of our well known transport and storage casks and also in activities performed for the front-end business.