ADVANCED SOLUTION FOR USED FUEL MANAGEMENT

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When choosing the interim storage solution, two ways of dealing with used fuel elements are available:

- wet interim storage inside pools
- dry interim storage inside casks

Both solutions have a lifetime of 50 to 100 years, after which the used fuel elements will certainly have to be transported to a final storage site, to a recycling plant or to another interim storage site. Performing these shipments involves dealing with new laws, new regulations, new safety requirements and a new public acceptance environment, more importantly it also means having access to new technologies. Thus, the solutions needed today by the utilities to manage their used fuel must be innovative and flexible.

This article will describe the various solutions for managing used fuels proposed to the utilities bearing in mind the future problem of transferring these materials.

Introduction

Each and every year around 10,000 tons of heavy metal are stocked into interim storage solutions throughout the world. Interim storage solutions are multiple, but whatever the chosen solution fuel elements will have to be transported after five to ten decades. What will be the main particular and common issues of this future transport and will it be possible to reduce the risk?
By focusing on the four main solutions proposed by the Logistics BU of AREVA for interim storage, this paper will analyse the strength and weakness of each solutions and also the main concerns of transport of used fuel.

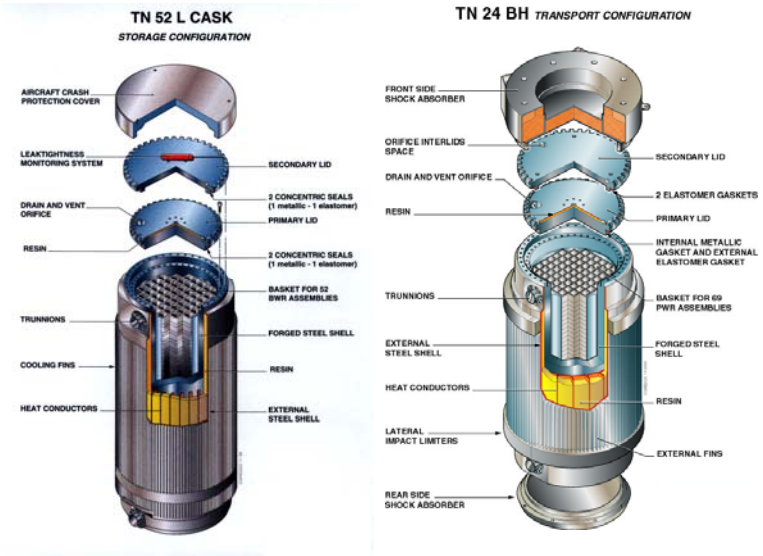
I Interim storage solutions

Around 200,000 tons of heavy metal are in interim storage throughout the world. Interim storage duration is limited due to the lack of current knowledge concerning the long term behaviour (around 50 to 60 years) of used fuel. Even if this duration may be prolonged thanks ever increasing knowledge, used fuel will have to be

transported in a few decades, either to be recycled or directly to be placed in a final repository.
What are the main solutions for interim storage?

A Dry Interim Storage
Concrete module and canister: the NUHOMS® system
This system is used mainly in the United States. The concrete modules are built near the nuclear power plant within the protected zone. A transfer cask is used to transfer the used fuel from the pool to the concrete storage module. The OS197 transfer cask is used by most of the NUHOMS® Systems currently in operation for standard-diameter canister designs. The exterior shell has a highly polished surface to facilitate decontamination. The transfer cask cavity is designed to be used for all BWR canisters and several PWR canisters (24P, 24PT2, 32PT and 24PTH). A cask spacer at the bottom is used to accommodate shorter-length PWR DSC designs.
The transfer cask is constructed of two concentric cylindrical steel shells with a bolted top cover plate and a welded bottom end assembly. The annulus formed by these two shells is filled with cast lead to provide gamma shielding. The transfer cask also includes an outer stainless steel jacket which is filled with water for neutron shielding. The top and bottom end assemblies incorporate a solid neutron shield material. The transfer cask is designed to provide sufficient shielding to ensure that dose rates conform to ALARA standards.
The cask has a ram access port at the bottom to push or pull the DSC from the HSM in a horizontal position. Two top-lifting trunnions are provided for handling with a lifting yoke and an overhead crane. Lower support trunnions are provided for pivoting from / to the vertical and horizontal positions on the support skid / transfer trailer. The canister is pushed inside the module by means of a hydraulic jack. Once the canister is inside the module, a metallic door closes the module. The transfer cask may be adapted to be transported on public roads. A certificate of approval will then be needed. In that case, shock absorbers will be added.
At mid 2010, 471 modules were loaded, corresponding to 14,987 used fuel elements stored on 27 different nuclear sites in the US.

Dual purpose Metallic casks: TN® 24 family

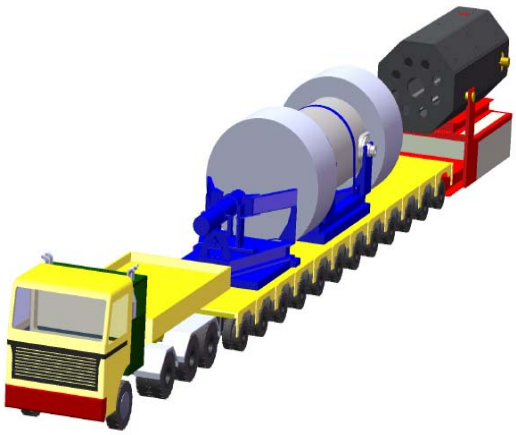


The metallic casks of the TN® 24 family have two functions: they transport as well as they store used fuel elements. In Europe, they are stocked in dedicated building in Switzerland, in Japan, in Germany or in Belgium. In the US, casks are stored outside. They are all built following the same model:

- a basket made of boronated aluminium and stainless steel
- a forged steel vessel and lead when necessary, depending on the need of gamma shielding
- neutron shielding made of a specific resin
- thermal copper fins
- two bolted lids

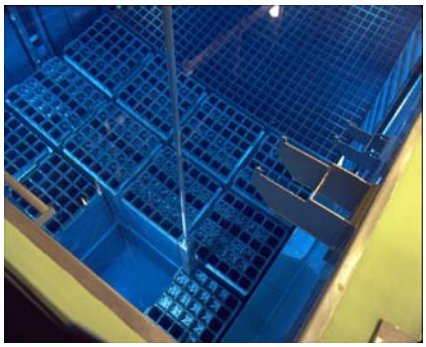
TN® 24 casks are used in Europe (Belgium, Switzerland, Germany, Italy), in the US and in Japan. In the US more than 6,000 used fuel elements are stored inside TN® 24 casks. In Switzerland around 1,900 fuel elements are currently stored in TN™ 24 casks in ZWILAG, the dedicated Swiss storage building. In Belgium more than 2000 used fuel elements are stored in Doel, corresponding to 66 casks. The same type of casks is also used to transport and store vitrified and compacted waste.

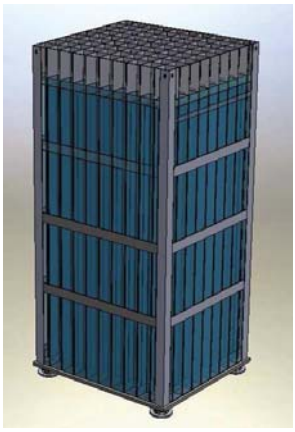
The TN™ NOVA: a new storage system



The TN NOVA™ is a combination of the NUHOMS® and the TN® 24 solutions. It uses a transport shuttle to transfer the used fuel elements from the nuclear power plant to the interim storage site. This shuttle is loaded with a welded metallic canister, just like the NUHOMS® system.
The shuttle is equipped with a hydraulic jack which pushes the canister inside a metallic storage module. The metallic module is then tilted and moved inside the storage building like the TN®24 casks. This new system will be used in Switzerland to store used fuel from the Leibstadt NPP.

B Wet interim storage





Two thirds of the used fuel elements in the world are stored in wet conditions either in the pools located in the reactor building or in pools near the reactor. Racks have been developed using borated structures (aluminium or stainless steel) to optimise space for the storage of used fuel assemblies. The Logistics BU has developed state-of-the art racks of fuel management by significantly improving the weight, the density of storage and the price. The L-BU pool racks are compliant with the new generation of reactors such as the EPR™, but also with existing PWR and BWR reactors throughout the world. This new type of racks has been developed using all the knowledge acquired with manufacturing the NUHOMS® and TN®24 baskets. Different types of interim storage solutions necessitate different types of transport solutions for used fuel elements.

II Transport solutions

A Shuttle solutions

For the NUHOMS®, TN NOVA™ and wet storage solutions a transport shuttle is used to transfer used fuel elements to a recycling plant or to a final repository site. In some cases transport is very easy: if the shuttle used to load the concrete modules or the metallic modules has a valid Transport Certificate of Approval it can also be used to unload the modules and to transfer them to another site. If it is not the case either, the shuttle had not been used for along time and its certificate is no longer valid, or the shuttle is no longer usable at all or, in the case of wet storage, never existed. In either of these situations, a new solution for transport must be found. Solutions are easier to find if the transport activity of the company has been continuous during the storage period. A company which performs long term nuclear transport is likely to develop a solution which will comply with Competent Authorities' current requirements and customer needs.

Dual purpose casks

In the case of a dual purpose cask, the same cask is used both for transport and storage. The transport license has to be maintained during the entire storage period in many cases, for example in Germany. But sometimes it is only needed at the beginning of the storage period and can be abandoned during the storage period, for example in Switzerland. In that case, the competent authorities' requirements are vigilantly monitored. Every five years, a technical report is written to list the technical studies which would be needed to get a new certificate of approval.

The leaktightness of all the casks stored is constantly surveyed by monitoring the inter-lid pressure. This pressure is normally below the atmospheric pressure (around

0.3 bars). If a leak occurs during the storage period, as the level of leaktightness given by the metallic seals is very high, it will take a very long time to get a pressure equal to the atmospheric pressure in the inter-lid space. Enough time will be allowed to plan a solution.

Licensing

Maintaining a transport cask fleet is a tough job. The lifetime of a transport cask is around thirty to forty years whereas the lifetime of a certificate of approval is generally five years. Moreover the certificate of approval must be revised for each new type of content, and of course, to be validated by each country crossed by the shipment. Using a transport cask fleet means having constant links with Competent Authorities and knowing exactly their requirements. Thus, even though the interim storage period is long, if the company which designed the shuttle has performed nuclear shipments during the storage period, it will know exactly what to do to obtain a new license or to design a new cask and the time it will take to do so. Having long term experience in the nuclear transport field is essential to facilitate the renewal of an existing certificate of approval or for the creation of a new cask.

In most countries, the transport certificate of approval is valid during the whole storage period. That means, as for transport casks, getting a new transport license each five to ten years. As all the TN®24 casks where not delivered at the same time, the process of getting new transport licenses is spread out. For the casks sold in Europe the certificates of approval were delivered by the French Competent Authorities. Thus, it is easier to survey the changes in the requirements by having multiple safety files under the validation process. Even if the casks are stored for several decades, the transport phase is never forgotten. Maintaining certificates of approval validity is more and more difficult as it is not possible to change the existing designs to fulfil the competent Authorities requirements once the casks are stored. This issue is well identified by all the involved parties. In November 2010, TN International will participate to a “Working Group on the Evaluation of the Safety Case for the Dual Use Cask for Spent Nuclear Fuel” at the IAEA Headquarters in Vienna.

Maintaining a dual purpose cask with a valid transport certificate of approval is perhaps a little bit harder than for a shuttle but the changes in the requirements are not very strict and are introduced little by little. A cask like the TN®12 was designed in the 70’ still has a valid certificate of approval and will only be replaced in five to eight years by a new generation of transport cask which is currently under design. Each and every year, several designs of TNI transport casks and dual purpose casks are under licensing or validation process at the same time in different countries. Furthermore, Transnuclear Inc. in the US and Transnuclear Ltd. in Japan are also involved in licensing process with their national Competent Authorities. The international experience gained by the Logistics BU during the last 45 years is thus very important.

Use

The main difference between the shuttle and the dual purpose solutions will be speed of used fuel element evacuation. Using one single shuttle means one loading operation, one shipment, one unloading operation and one return shipment back to the storage site. For dual purpose casks, operations are less complicated, the anti-impact or protective cover has to be removed, the monitoring system is removed, the shock absorbers are put in place and the cask is transported. Upon arrival, the shock absorbers are removed and sent back to the storage site (if there is only one set of shock absorbers which is not always the case). The evacuation of the used fuel is quicker using TN®24 casks.
The utilities are not always free to choose the solution to be used. For example, in Germany the only acceptable solution to the German Competent Authorities for interim storage are metallic casks like TN®24 casks or CASTOR casks.

Conclusion

To fulfil all the needs of the utilities for their used fuel interim storage, the solutions proposed must be varied and flexible so as to adapt to specific requirements of the national Competent Authorities, customers or from technical interfaces. The provider of interim storage solutions must be in constant relations with the Competent Authorities during the whole storage period, in order to anticipate the changes. To have several customers in several countries and to provide transport solutions is also a plus to maintain the transportability of the used fuel throughout the whole storage period.