A NEW MEDIUM SIZE PACKAGING FOR LWR FUEL: THE TN 9/4

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Introduction

For its long term needs of spent fuel transports, BKW-FMB Energy Ltd. (BKW), the operator of the Swiss nuclear plant of Mühleberg has concluded an arrangement with Transnucléaire which includes the development of a new medium size packaging for high burnup LWR fuel: the TN 9/4.

Mainly devoted to transports between Mühleberg NPP and the centralized Zwilag interim storage facility, the TN 9/4 packaging is however compatible with the reprocessing plants of Sellafield and La Hague.

Transnucléaire, has developed this new TN 9/4 concept which is compatible with IAEA standard TS-R-1.

The paper will present this new cask, the design approach in accordance with the IAEA requirements and the test program performed.

BKW needs

BKW is a Swiss electricity company, operating the nuclear power plant of Mühleberg. The NPP which is a Boiling Water Reactor was introduced into service in 1972. The electric power is 372 Mwe gross.

As a result from a fuel back end management mainly oriented towards reprocessing, BKW has performed more than 150 transports with the NTL 9 packaging which was also designed by Transnucléaire in the seventies.

The BKW need was clearly identified. The transport cask with a B(U)F package type approval, shall be mainly devoted to transports to the storage site Zwilag, where storage will be realized in high capacity dual purpose casks, but shall also be compatible with the reprocessing plants of La Hague and Sellafield.

Furthermore, the key parameters of Mühleberg power plant shall be taken into account and among them:

- The fuel characteristics.
- The weights and dimensions limits.

General context

Within the back end fuel management, the dry interim storage is an alternate option being pursued by the Swiss Nuclear Utilities in parallel with reprocessing. BKW, as Mühleberg NPP operator, is concerned by this policy and involved in purchasing dual-purpose casks for storage of spent fuels.

Strongly interested by high capacity interim storage casks and limited by the power plant lifting capacity, BKW decided to use medium sized transport cask compatible with the NPP handling

equipment and to use the Zwilag hot cell in order to transfer the spent fuels from the transport cask to the storage cask with higher capacity.

As the existing NTL 9 could not reach this scope, the TN 9/4, as new medium size packaging, is the best solution corresponding to BKW long-term transport needs. Fully in accordance with IAEA standard TS-R-1, the TN 9/4 limited at 40 tons allows BKW to transport spent fuels to Zwilag storage plant for in high capacity storage casks.

Transnucléaire, is developing the TN 9/4 design which is a dry transport packaging, for 7 BWR high burnup spent fuel assemblies.

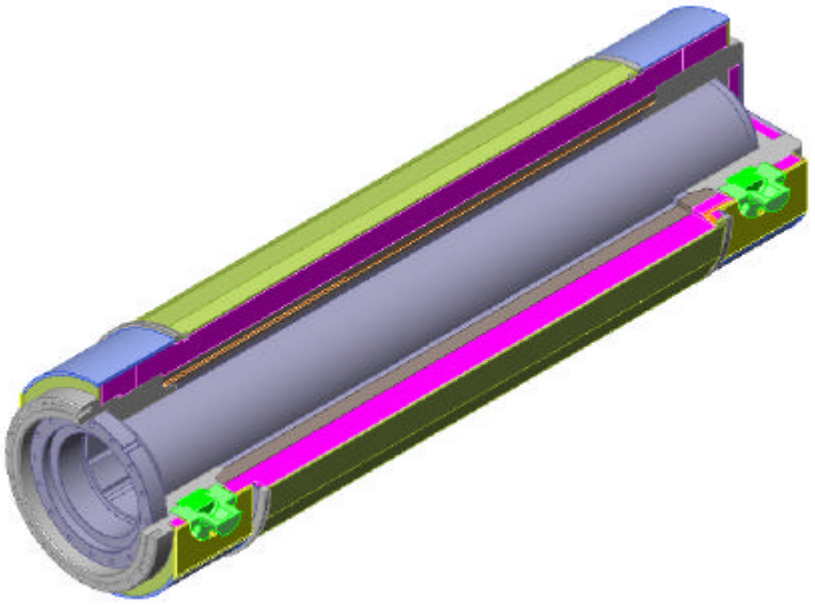
TN 9/4 concept

The design of the TN 9/4 is a state-of-the-art concept, fully compatible with the IAEA regulation ST-R-1. In particular, it features two independent containment barriers that allow this cask to be considered as dry (no introduction of water in the containment barriers) under all regulatory accident conditions.

The TN 9/4 transport cask is mainly constituted by the 7 position basket, the canister (first containment barrier), the cask body (second containment barrier) and the shock absorbing covers.

The basket, essentially an alloy of aluminium plates, is placed in the canister. It mechanically supports fuel assemblies and maintains subcriticality during transport conditions and during fuel loading and unloading operations. It transfers the fuel decay heat to the cask body. The design of the basket fulfils these functions in accident conditions as well. One position is designed to allow the transport of one failed fuel in a bottle.

The canister is removable. It can be inserted and withdrawn in dry conditions for maintenance. All operations are performed through the primary lid single orifice which is based on the design of dual transport/storage casks developed by Transnucléaire: the TN 24 family. The canister contributes to the shielding.



The cask body based on the design of the multi-layer type casks contributes as well as the canisters, to the shielding and to the transfer of the decay heat. With its lids, it constitutes the second containment barrier. In accident conditions, the safety is mainly insured by the cask body equipped with its shock absorbing covers.

The sketch hereafter shows the main characteristics of the TN 9/4 design: double containment barriers.

Design process of the TN 9/4 cask.
Both regulations and technical requirements led Transnucléaire to develop a new design with 2 containment barriers based on the TN 24 family type cask.

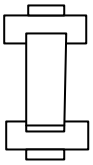
The design optimization was an iterative process between the thermal, shielding, criticality and mechanical calculations on one hand and the weight calculations on the other hand.

The result of this iterative process led to the TN 9/4 design as described on the previous paragraph with the following main characteristics:

Item	**Technical characteristics**
Capacity	7 BWR fuels
Fuel type	GE8b / GE11 / GE14
Thermal power	6,16 kWh
Weight	40 tons
Length with shock absorbing covers	6 680 mm
Length without shock absorbing covers	5 100 mm
External diameter with shock absorbing covers	2 100 mm
External diameter without shock absorbing covers	1 330 mm

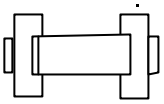
The validation of this new design was performed through a drop test program detailed hereafter with a representative 1/3 scale model. The drop test program was performed in January 2001 successfully.

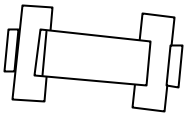
DROP 2
9m axial drop



DROP 5
9m drop with slap down
1st impact on the bottom

DROP 4
9m horizontal drop

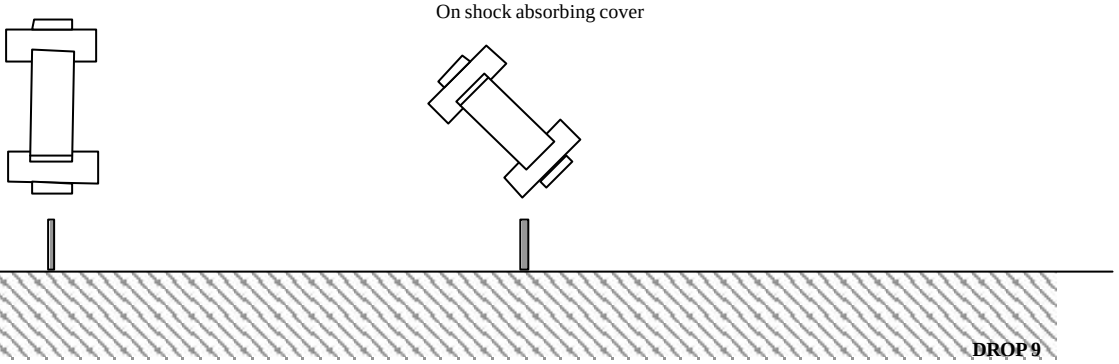




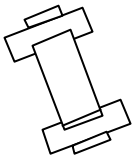
DROP 1

1 m puch test
Center of the secondary lid

DROP 3
1 m punch test
On shock absorbing cover



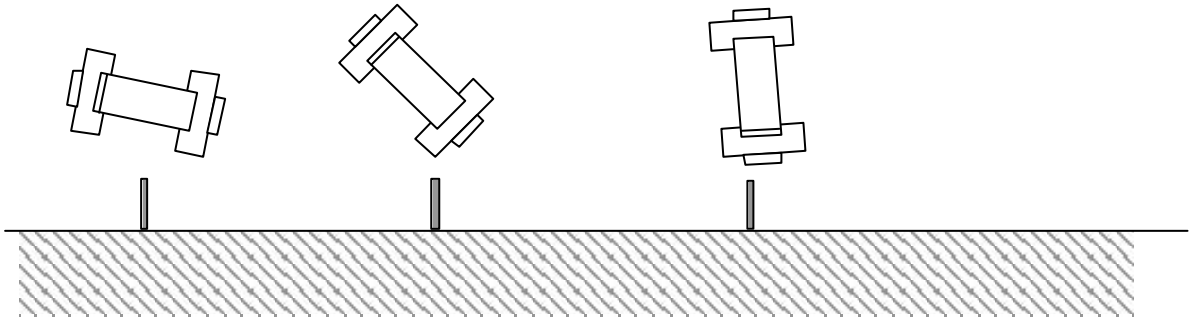
DROP 9
9m vertical drop
On the corner of shock absorbing cover



DROP 6
1 m punch test
On the shell

DROP 7
1m punch test
On the bottom orifice

DROP 8
1m punch test
On the secondary lid orifice plate



The regulatory drop tests had shown through five punch tests and four 9m drop tests, the efficiency of the double containment barriers. Both the canister and the body withstood the drop test program. The mechanical behavior proved to be satisfactory and all leak tightness criteria were reached.

Because lead behavior is altered by high temperature and in order to be as representative as possible, two 9m drop tests were performed with a scale model with temperature raised to simulate the normal transport conditions.

On this basis, a Safety Analysis Report demonstrating conformance with IAEA requirements for type B(U)F package had been issued.

Conclusion

The TN 9/4 packaging is a design developed by Transnucléaire to respond to BKW long term needs. This new medium-size packaging is a transport cask for high burnup BWR fuels.

It has been designed fully in accordance with the IAEA standard TS-R-1, and, in particular, it is the newest full double containment cask for the transport of BWR fuels in dry condition.

Presently, two TN 9/4 casks are under manufacture and the first transports with TN 9/4 are scheduled in 2002.