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KEEPING USED FUEL CASK FLEET CURRENT

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Abstract

More than 40 years ago, the Business Unit Logistics (BU-L) of AREVA began designing casks for the transport of nuclear material and subsequently for the intermediate storage of fuel elements. The BU-L became involved in the history of the civil nuclear industry at a very early stage and TN casks have accompanied the evolution of the nuclear industry and the requirements of the Competent Authorities.

First designed under the 1973 Edition of the IAEA, the Mark II casks family everyday safely transports all the fuel elements to be reprocessed at the AREVA La Hague plant. They have been regularly upgraded over the last 30 years by mainly improving the design of the baskets, the use of burn-up credit to accommodate higher enrichment and the maintenance programme. Since the '80s, the BU-L has also designed the TN^{TM}24 dual purpose casks family to securely transport and store the fuel elements for intermediate storage.

To stay competitive, the BU-L has to upgrade and enlarge regularly its product portfolio. Thus, the BU-L will soon start designing new types of cask for transport as well as for intermediate storage of spent fuel. These new casks, will take into consideration the new fuel elements data of many nuclear power plants including the 3rd generation reactor EPR, as well as the latest demands of the Competent Authorities. During the last 40 years, the BU-L has never stopped creating or evolving its designs to fit exactly the needs of the nuclear industry and the requirements of the Competent Authorities. Therefore, even though the creation of a new range of casks always appears a challenge, thanks to its experienced staff, its know how and its forty years of feedback from operations, the BU-L is confident of making it a success.

INTRODUCTION

Under the pretence of a quiet and peaceful flow of the transportation of used fuel elements, there is a hive of experienced workers who everyday face the challenge to satisfy both the customers and the Competent Authorities. A cask designed to transport or store used fuel is not simply a piece of steel; it is a highly technical product whose design takes several years.

To be cost effective, the casks are designed to last for several decades, but during this long lifetime many evolutions can occur.
First of all, the regulations are updated periodically (3 main revisions of the IAEA regulations since 1973). In addition, the customers' needs also change as the technical data on the fuel elements, enrichment and burn-up increase. The technologies and suppliers are also in a state of constant evolution. It has therefore been a heavy commitment to keep the cask fleet up-to-date over the decades, to face the demands for adaptation and, when necessary to create new types of casks which will be able to meet evolutions during the coming decades.

A BIT OF HISTORY

Forty years ago, a small company called Transnucléaire was already involved in the design of casks for the transportation of the used fuels elements such as Pégase, TN1 or TN2. In 1977, the first TN12 cask was commissioned for Japanese and European transportation needs. In 1985, the first TN24 for the transport and storage of fuel elements was designed for the US nuclear industry, then in 1994 for the European market, and for that in Japan in 1995. In 1997, Transnuclear Inc. purchased the NUHOMS® technology system.

As a result, the Logistics Business Unit (BU-L) of AREVA, composed of TN International (formerly Transnucléaire), Transnuclear Inc. and Transnuclear Ltd. has been heavily involved, since the very beginning, in the market for the casks for used fuel elements. Each type of cask designed has been a great opportunity to learn how to deal with the Competent Authorities of different countries, the customer needs and interfaces and also the profitability of our products.

To manage a cask fleet can be slightly different when talking about transport or storage/transport dual purpose casks.

TRANSPORT CASK FLEET

Since 1967, TN international has developed a cask fleet able to transport not only the fuel elements of almost any P or BW nuclear plant but also for research reactors fuel elements. The TN12 was the first of a large family based on the same type of design (see Fig. 1) created in 1977 under the IAEA 73 regulations.
Used to transport the fuel elements from the different NPPs to the AREVA La Hague reprocessing plant, these casks are able to safely transport fuel elements with only 8 months cooling time. Since 1967, more than 30 000 tHM (tons of Heavy Metal) have been safely transported in TN casks from France, Japan, Germany, Belgium, Switzerland, Australia, the Netherlands…In 2006, more than 200 transportations were performed with a fleet of around 30 of those casks corresponding to more than 1 200 tHM transported. To obtain such a result, TN International has had to continuously upgrade the casks design over the decades.

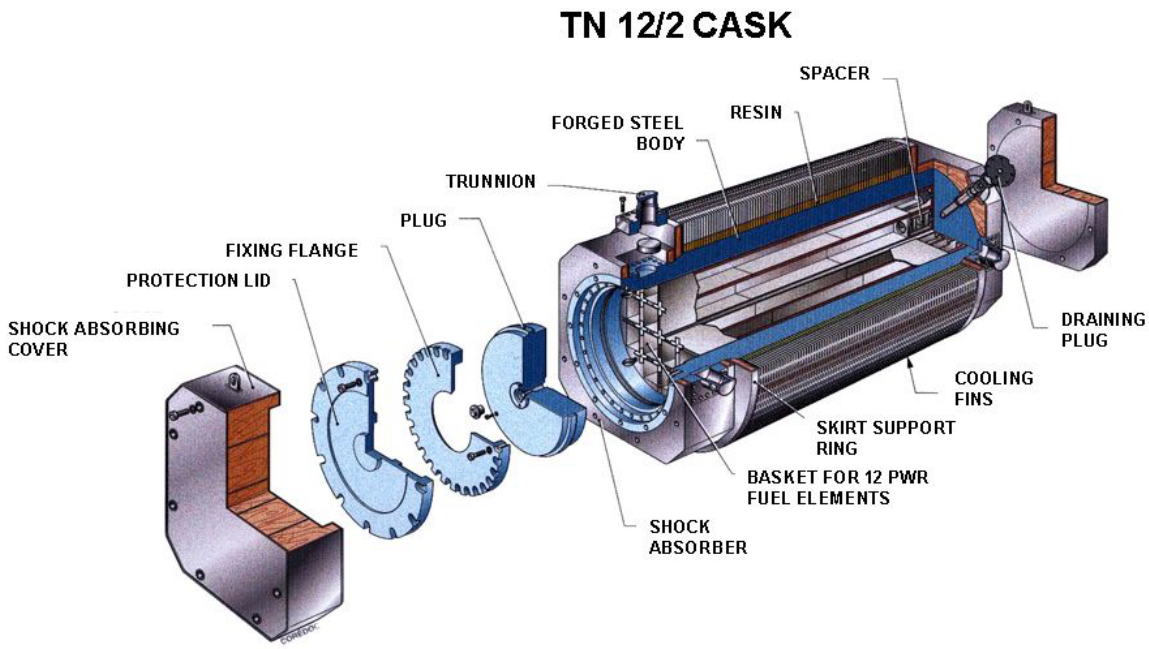

Figure 1: TN 12 design

The entry data of a design are multiple (see fig. 2).

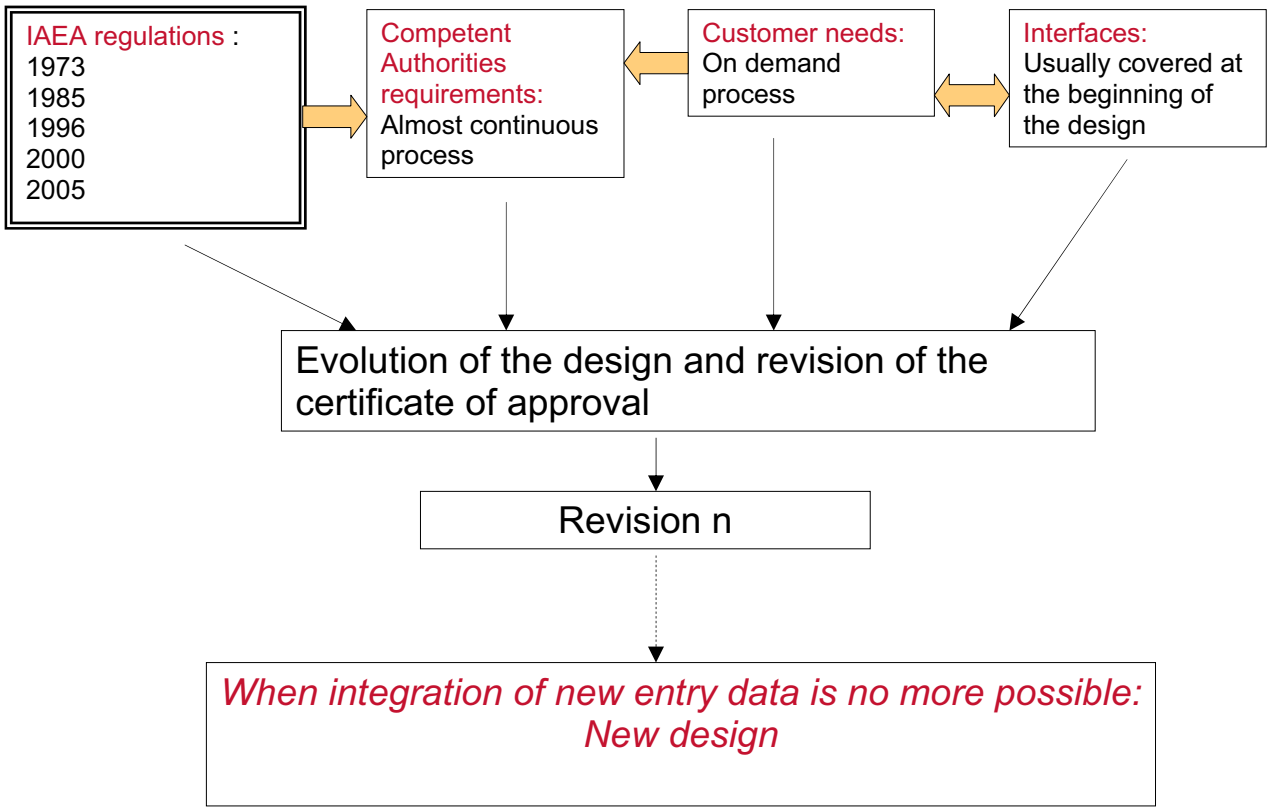

Figure 2: Diagram of a design evolution

Over the last thirty years, the first design has been upgraded and transformed into a whole family of cask and baskets:
List of casks:

- TN12/1
- TN12/2 (version A and B)
- TN13/1
- Tn13/2 (version A and B)
- TN17/2 (version A and B)

For example:

- the /2 version corresponds to the addition of a second lid in accordance with the T0 workshop interfaces of AREVA La Hague plant. The A and B versions correspond to the adaptation of the customer needs as regards the burn-up of the fuel elements to be transported; the B version of the cask is over-shielded.

- Considering the different types of basket for example in the TN12/2:
    - type 901, 902, 922, 927, TN M932 and TN M931

- Or in the TN 13/2:
    - - Type 924, 925, 928 and 929

All these types of baskets enable the casks to accommodate almost any type of P or BWR fuel elements with or without quiver, with a burn-up of up to 60 000 MWd/tU and enrichment of up to 4.75% with a short cooling time. But they are also able to transport fresh MOX fuel and failed fuel elements. Thus, a single design created thirty years ago is today able to transport almost any type of fuel elements.

Each design change involves a revision of the Safety Analysis report and a new revision of the certificate of Approval for transport. As a result two phenomena occur:

- Extension of the Certificate of Approval when there is a new content to be taken into account.
- Renewal of the Certificate of Approval every five years

Therefore, during the lifetime of a transport cask design its Certificate of Approval may very often be revised. As an example, the TN12/2 certificate of Approval has been revised 13 times between its two last renewals. The BU-L has a dedicated team of engineers to perform this demanding job of continuously updating the mechanical, thermal, shielding, containment and criticality data of the safety analysis report. Even though the TN12 casks were designed following IAEA 73 safety regulations it has been possible to certify them following the IAEA 85 regulations. Since the end of 2006, it is no longer possible to manufacture an IAEA 85 cask but it will be possible to use them for a few more years. The BU-L now has to design the new generation of transport cask. But, as the former cask type has been regularly upgraded and improved, the engineering staff has never stopped learning and working with the Competent Authorities. To keep a used fuel transport cask fleet current requires the long term involvement of the cask designer, the confidence of the Safety Authorities and of course a flexible and adaptable design.
The International Safety regulations are determining entry data for the transport cask design, as their periodic revisions have a huge influence on the lifetime of the casks.

TRANSPORT AND STORAGE CASKS

Some countries have chosen to store their used fuels inside pools or inside casks. Since the 80's, the BU-L has developed a whole set of casks able to safely transport and store the used fuel elements: the TN 24 casks family (see figure 3) and the NUHOMS® system family (see figure 4). Each cask corresponds to a customer need, in terms of national regulations for storage, capacity, type of fuel elements, adequacy with the NPP and storage sites interfaces. But each type of cask also corresponds to one Certificate of approval and one Safety Analysis Report and each new design is an opportunity to improve and to learn.

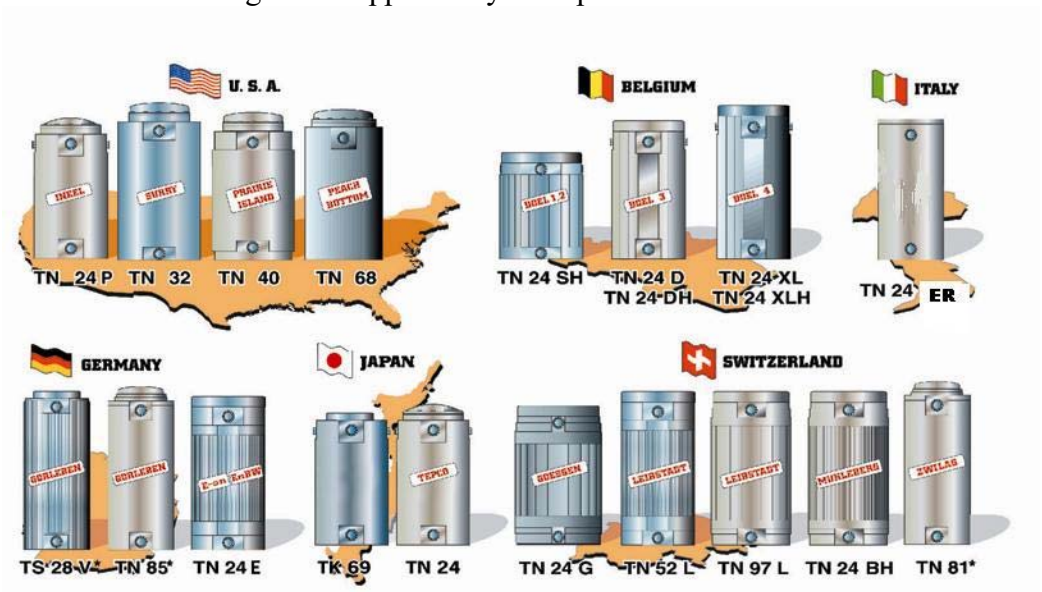

Figure 3: TN 24 family

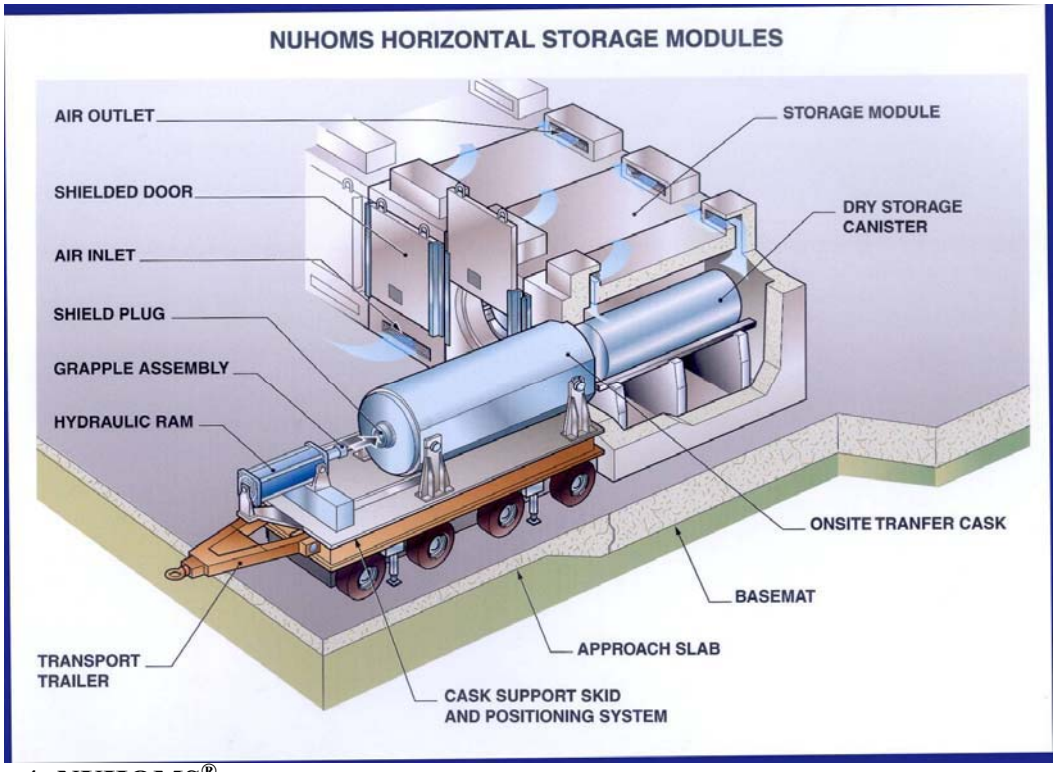

Figure 4: NUHOMS® system

Since 1984, around 40 types of casks have been developed depending on customer needs. What these casks are able to store is summarized in table 1.

Type of casks	TN 24	NUHOMS®
Fuel elements	21 PWR to 97 BWR	24 PWR to 61 BWR
Max average BU	from 33 000 to 65 000 MWd/tU	From 23 550 to 62 000 MWd/tU
Cooling time	from 2.5 to 10 years	From 3 to 10 years
Enrichment	from 3.2 to 5%	From 2.4 to 5 %

Table 1: performances of the storage and transport casks

Considering the burn-up and enrichment increase, our casks have had to be more and more efficient and our R&D program has had to face many challenges to keep the level of performances in line with the revsions of the regulations and of the fuel elements themselves.

As an example, we may consider the case of two casks which have been developed to store used fuel elements of Doel NPP in Belgium, the TN24 XL and TN 24 XLH. The TN 24 XL was approved following the IAEA 1985 regulations in October 1997 and is able to safely transport and store 24 PWR fuel elements with maximum burn-up of 55 000 MWd/tU, an U_{235} enrichment of up to 3.4 % and a global thermal power of 23 kW. Two years later, the TN24XLH approved under IAEA 1996 increased its capacity to 4.25 % for enrichment and 33 kW for thermal power. During this short period of time, our engineers were able to increase the thermal efficiency of the basket by more than 30%. Looking at our latest design, the TN 24 E, which will be approved by the German authorities in a few months, we are now in the position to propose a cask able to store and transport PWR fuel elements with an enrichment of 4.65% and 65 000 MWd/tU burn-up.

All these improvements in the design capacity have led to an increase in the competitiveness of our products. And all the design and R&D advantages gained can be used for any new type of casks to be designed. The international, national or local safety regulations applied for the transportation and storage cask design only have an influence at the design time and do not determine the lifetime of the cask.

For a transport cask, the principle criteria for design are the safety regulations and the customer needs, for the transport and storage casks the main criteria are the customer needs and the competitiveness of the product as it is a one-shot investment compared to a long term one.

All the work performed to upgrade our designs is used both for transport and dual purpose casks and requires the long term involvement of the cask designer. As a long term anticipation is needed when important evolutions of design have to be faced, the designer also has to have a very comprehensive knowledge of the Safety Authorities and market. Through its geographical distribution which creates a world wide network (US, Japan, Europe), its 3 subsidiaries having the same scope of activities, the BU-L has acquired a comprehensive knowledge of the market, together with the possibility to adapt our design to the different Competent Authorities regulations.

CONCLUSION

For the next generation of transport cask, the main challenges will be to have two containment barriers leak-tight in accident conditions, as well as being able to transport fuel elements with up to 5% in U_{235} enrichment and 70.000 MWd/tU in terms of burn-up. For the dual purpose casks another challenge will also have to be faced: the huge increase in the price of raw materials and manufacturing (for example: steel and forged pieces) has implications for our casks design. New designs less sensitive to these increases are under construction (consideration?).

For the two types of casks, the lifetime is counted in decades. The fact that the BU-L is part of big company such as AREVA leads to confidence in the necessary stability to maintain the technological know-how, together with long standing relations with the competent authorities and the customers during the casks lifetime and for the future.

Thanks to both its long term experience and involvement in the field of the transportation and storage of fuel elements and its global network, the BU-L is confident of meeting all these challenges in the next few years and of creating casks as flexible and as innovative as the current ones.