A TRANSPORT / STORAGE CASK TAILORED TO JAPANESE NEED: THE TK 69 CASK

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Introduction

Within the back end management, dry interim storage especially directly on the Nuclear Power Plant site is one solution. Therefore, it is a good opportunity for two companies to bring their complementary know-how and feed back on more than 200 interim storage casks sold, in order to provide to the Japanese Utilities a new design with high capacity with the best safety conditions.

When a Japanese utility reveal its request for proposal, Kobe Steel Ltd. and Transnucléaire decided to start a joint work so as to profit by the experience of both companies. The fruitful common work between the two companies lead to the design of the TK 69 that permit the loading of 69 BWR fuels assemblies. This high capacity was achieved by careful optimization of the design whilst paying strict attention to the safety requirements for both transport and interim storage.

A joint work

As early as 1984, Transnucléaire and Kobe Steel Ltd. have been working together on dry dual purpose casks. This resulted, among other things into nine TN 24 BWR storage casks for Japanese Nuclear Power Plant. All of which were licensed for storage purpose, manufactured, loaded and stored with satisfaction.

By the time, each company has improved its experience:

- Kobe Steel Ltd. with the delivery of several transport casks and development of specific materials such as neutron shielding rubber, borated aluminium…
- Transnucléaire with many successful developments and licensing of transport/storage casks mainly for Belgium, Swiss, Italian and American utilities. Many of them belong to the TN 24 cask family.

It was clearly defined that the best way was to make full use of the flexibility of the TN 24 dual purpose cask family. It would lead to the development of a new type of cask optimized to suit the Japanese utilities needs. Of course, the present project has required close collaboration with project teams of both companies. The goal was to take the best advantage of each company competence.

Analysis of Japanese needs

The request at the origin of the TK 69 cask was clearly the need of storage casks in order to evacuate spent fuels from the pools and to store them on the Nuclear Power Plant site.

At an early stage, a preliminary commercial and technical choice has been made. Our target was not only to satisfy Japanese utility expressed needs to store on storage site but also to propose them the possibility to be compatible with reprocessing technology. It means not only to focus on the Japanese storage requirements but to fit with specific requirement for transportation. This possibility could be a commercial opportunity in term of flexibility for the utilities because it keep open all back up solution after interim storage. Indeed, it

allows transport of spent fuels from interim storage sites to either a long-term repository or to reprocessing facilities.
As a consequence, engineering teams have to closely examine the physical limits in terms of size and weight for the new cask so as to:

- Be able to load spent fuel in casks and to store them at the NPP,
- To be able to transport the cask from the NPP to an interim storage facility
- But also to get the casks suitable for transport to a reprocessing site, should the need arise.

Then the preliminary design studies identified several key parameters, among them:

- Characteristic of fuels assemblies to be loaded,
- Weight limitation in the pool loading conditions: 125 t,
- Cask external features such as trunnions in order to be compatible with existing facilities such as handling equipment, storage frame,
- A limitation of size concerning the maximal outer diameter of the packaging. It concerns the compatibility with the rail transport limitation especially in Europe.

But first of all, the safety requirements that the cask must comply with should be noticed. Indeed, the cask safety should be studied in order to comply with the Japanese regulations relevant for storage and transport. Additional safety requirements of transport international regulations should also be analyzed and taken into account should the use of an European transportation needed. It means that the cask must conform to:

- Japanese storage requirements with approval by Japanese competent authority
- IAEA type B(M)F requirements with approval by Japanese competent authority,
- IAEA type B(U)F or B(M)F requirements with approval by competent authority from an other country than Japan, should transportation to other country be needed.

Main fuel characteristics for the cask
The definition of the spent fuel assemblies was the following.

Fuel assembly	
Type	BWR
Array	8 x 8
Burn-up (MWj/tU)	
Average	33 000
Maximal	40 000
Average Enrichment (%)	3
Cooling time (years)	10
Thermal power (W/assembly)	270
Length (mm)	
Active	3710
Maximal	4470

Design process of the TK 69 cask

Based on the above data and basic requirements, engineering team of both companies worked so as to optimize the capacity of a TN 24 family type of cask.

The TN 24 family of casks is characterized by the use of the following principles in the design:

- The body of the cask is a cylindrical vessel mainly formed by a thick cylindrical shell in forged carbon steel, a bottom in forged carbon steel welded to the shell. The shell could presents internal or external machining so as to optimize the weight or the interfaces with the internal arrangement. The steel of the forged shell insures most of the gamma shielding.

- On the main part of its length, the shell is surrounded by a neutron shielding made of resin compound. This one is protected by an outer structure which is a steel shell constituted of painted carbon steel.

- The neutron shielding is crossed by heat conductors constituted by long "L" copper plates in close contact with the body thick shell in one side, while the other flange is fixed on the inner face of the outer structure. They allow evacuation of heat power by conduction from inside to outside of the packaging.

- In transport configuration and at each extremity, the cask is equipped with one shock absorbing cover. It is constituted of a steel casing filled with wood. Both shock absorbing covers are fixed on the body by screws.

- At last, a technology of internal arrangement, mainly the basket, based on aluminum with boron.

The design optimization was an iterative process to examine the potential weight savings of each component in order to make full effective use of the shielding materials and to optimize the payload.

The result of the analysis consist in the definition of the TK 69 design with a capacity of 69 BWR 8 x 8 fuel assemblies. The hereunder figure shows the main shape of the design. An indicative value for the maximal mass of this package when loaded is 130 000 kg.

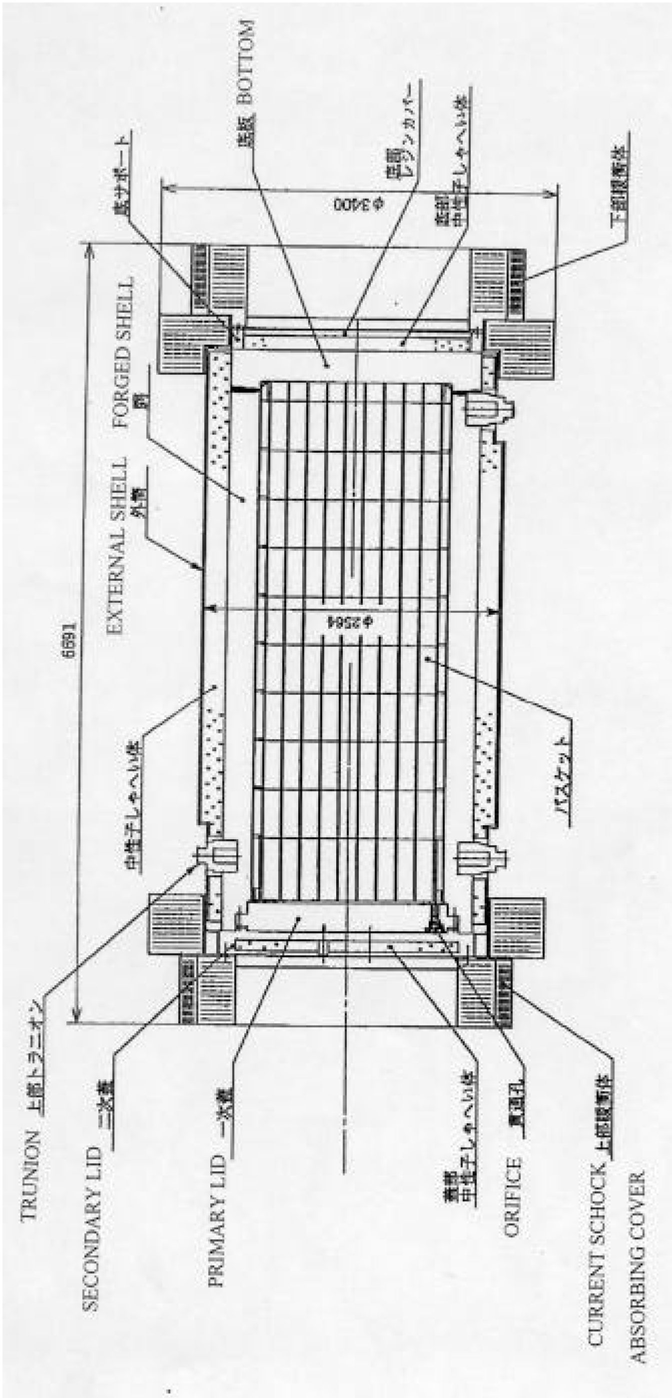

Figure 1: TK 69 cask

This result could have been achieved due to specific choice. Indeed, several solutions were available. But arbitration has been made so as to settle high capacity with manufacturing cost and time saving. Among other things, the following items can be noticed:

- The use of a resin shielding made of an ethylene-propylene rubber that allows the compliance with Japanese criterion of maximum dose rate at 1 m of the outer surface. This criteria is more restrictive than the international transport regulation (IAEA safety requirements): indeed, the applicable limits is total dose rate at 1 meter of the cask must be lower than 100 µSv/h whilst IAEA requirements is total dose rate at 2 meter of the cask must be lower than 100 µSv/h. This choice was also done so as to facilitate the manufacturing.

- The adaptation of the basket already in service in other TN 24 cask. The basket must maintain the arrangement of the fuel in a sub critical condition under the range of accidental conditions defined by the regulations whilst safely dissipating the decay from the fuel assemblies to the cask body. A simple interlocking plate structure was chosen using boronated aluminium. It allows optimization of the spent fuel array in the cask but also to achieve a low temperature of the fuel assemblies loaded. The internal surface of the forged shell is provided with machining to tight the basket within the cavity so as to insure better mechanical resistance of the basket during transport accident conditions.

- The development of shock absorbing cover based on results of previous drop tests performed with a scale model of a TN 24 type of cask (see figure 2).

This methodology consist in designing the shock absorbing of the TK 69 packaging imposing a similarity with the scale model used as a reference. It has lead to the definition and safety justification of two sets of shock absorbing covers with two different outer diameters. Both designs comply with safety criteria defined by Japanese or other country competent authorities. In fact, the second design with a smaller outer diameter is an optimize solution that allows at the present moment a routine transportation with the existing rail wagons actually in service in Europe.

Picture 1

Licensing status

As already explained, the TK 69 must comply with both transport and storage regulations. The demonstration is achieved trough typical safety analysis reports.

The first application has been performed in Japan. The Japanese STA Design Approval has already been delivered by Japanese Competent Authorities for the TK 69 as B(M)F packaging.

Furthermore, a safety analysis report demonstrating conformance with IAEA requirements for type B(U) package design for fissile material will be prepare so as to be submitted to an other authority than Japanese one, should the need arise of a transportation in an other country.

Conclusion

The development of the TK 69 package is an example of a fruitful common work between the two companies. These works permits a proposal to Japanese utilities of an optimized cask. The optimization should be understood in term of capacity safely possible but also in term of flexibility after storage offered without significant extra-cost.