First transport of type B(U) packaging for hotlabs

Amir Arsalan Hushyar Yazdian, Robby Vandendries, Wim Boeckx

Transnubel, Dessel, Belgium

Abstract

Research labs worldwide investigate radioactive materials that come from and go to nuclear power plants or research reactors. This can be nuclear fuel, irradiated material samples, instrumentation … all materials with different composition, dimension, weight, residual heat, fissile material. The transport of these radioactive materials often requires the use of a type B transport packaging according to the IAEA SSR-6 recommendations. To be able to fulfil this specific transport services, Transnubel has, amongst others, a new package design at its disposal: TNB 170.

During the first transport of irradiated fuel samples, the loading of the TNB 170 was executed horizontally against a hotcell and the unloading was performed by placing the packaging vertically inside a hotcell. Specific tools and liners were designed and fabricated for executing the loading/unloading and transport operations in a safe way.

There have been a number of challenges that had to be solved regarding the design of the liner, interfaces between loading/unloading facilities, tools, transport frames … to guarantee a safe transport cycle. Meeting these challenges, especially in the environment of hotlabs with limited access and tools, is important for all future transports with the TNB 170.

Introduction

TNB 170 is a package design of type B(U) for the transportation of radioactive material in various physical and chemical forms. It is suitable for the transport of highly activated materials, allowing shipment by road, rail and sea. This packaging is designed for solid or powder materials. TNB 170 is an B(U) type package in accordance with the IAEA SSR-6 2012 edition.

Since the beginning of 2018, the new-build packaging TNB 170 has been in operation. This packaging was developed based on the experience gained during over 40 years of nuclear transports. TNB 170, a type B(U) packaging, is designed for the transport of fresh or irradiated UOX/MOX fuel, sealed or unsealed radioactive sources and neutron sources of type Xx-Be. The loading and unloading can be done vertically in or horizontally against a hotcell.

Despite the reduced dimensions, the packagings used for the transport of fuel rod segments are subjected to the same issues as those for the transport of irradiated fuel rods. The packaging can be selected depending on the properties of the segments.

The purpose of this paper is to share the information regarding the first transport of irradiated UOX/MOX fuel. There have been a number of challenges that had to be solved regarding the design of the liner, interfaces between loading/unloading facilities, tools, transport frames … to guarantee a safe transport cycle. Meeting these challenges, especially in the environment of hotlabs with limited access and tools, is important for all future transports with the TNB 170.

For the loading/unloading operations of segments of fuel rods, specific requirements are needed depending on the packaging and the installation. For instance, the docking against the hot cell, the specific basket needed in the packaging or the need to encapsulate the segments which may be required by the safety analysis report of the packaging.

Specification of the TNB 170

Description of the packaging

The TNB 170 packaging (see figure 1) is made up of the following main components:

- The primary packaging made up of a body and a lid.
    - The body is made up of an inside layer of stainless steel, a layer of lead, a layer of thermal insulation and an outside layer of stainless steel. The inside layer forms a useful cavity with a diameter of 48 mm and a height of 201 mm. The upper part of the body is fitted with 8 lifting ears.
    - The plug is made up of an inside layer of stainless steel and contains a layer of lead and a layer of thermal insulation of plaster. The plug is fitted with two gaskets. The lid is fixed to the body with 4 bolts. The upper part of the plug is fitted with a hole with thread for fixing a lifting ear and with a test point with access to the space between the gaskets. The bottom part of the plug is fitted with a hole with thread for the possible attachment of the capsule.
- A protective casing made up of 2 shock absorbers.
    - Each shock absorber is made up of an inside layer and an outside layer, both in stainless steel, between which wooden blocks are placed. The reinforcing ridges in the central part of the protective casing are fitted with holes for handling the package. A flat gasket is applied between the shock absorbers. The shock absorbers are fixed to each other by 8 bolts.

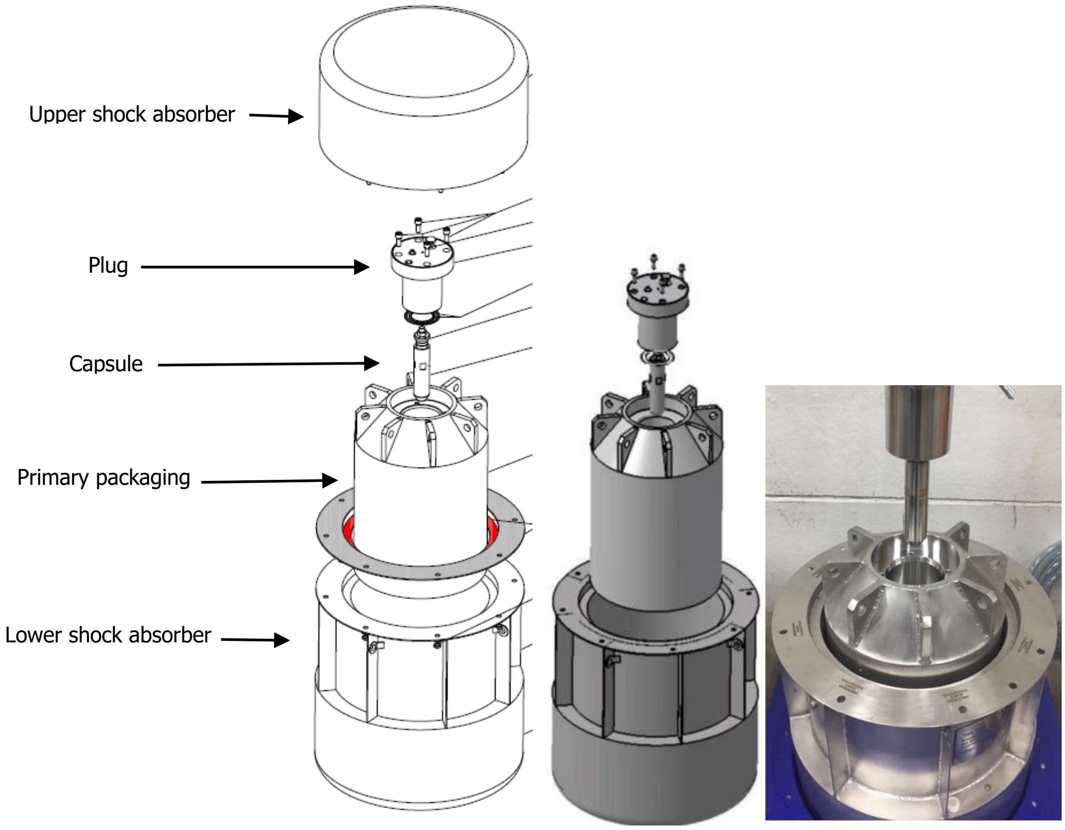

Figure 1. Exploded view of TNB 170 package

Dimensions masses

The dimensions and masses of the packaging TNB 170 can be found in Table 1. The inner dimensions of the packaging can be used for loading a capsule. The capsule of the packaging can be changed and specifically designed depending on the size and quantities of fresh or irradiated UOX/MOX fuel, sealed or unsealed radioactive sources or neutron sources of type Xx-Be.

The weight of the packaging is 600 kg and the maximal weight that can be loaded inside the cavity is 2,5 kg, including the weight of the capsule (Table 2).

Dimensions	**Outer dimensions (mm)**	**Inner Dimensions (mm)**
Diameter	600	48
Length	921	201

Table 1. Dimensions of TNB 170

Loaded weight (kg)	**Maximum load (kg)**
600	2,5

Table 2. Weight of empty and loaded TNB 170

Allowed content

In table 3, the allowed oxide mass and source type can be found. Depending on the minimum cooling down time the maximum allowed oxide masse changes. In this table the maximum allowed activity and specific activity is also given for Am-241/Be and Pu-293/Be.

Minimum mass ratio U-235/U (%)	3,5		4,0	
Maximum mass ratio U-235/U (%)	4,0		5,0	
Maximum burn-up (GWd/tHM)	60		80	
Minimum cool down time (years)	1,0	3,0	1,0	3,0
Maximum allowed oxide masse (g)	**76**	**87**	**76**	**87**

Minimum mass ratio (Pu+Am)/(U+Pu+Am) (%)	9,0		11,0	
Maximum mass ratio (Pu+Am)/(U+Pu+Am) (%)	11,0		15,0	
Maximum burn-up (GWd/tHM)	60		80	
Minimum cool down time (years)	1,0	3,0	1,0	3,0
Maximum allowed oxide masse (g)	**60**	**76**	**60**	**76**

Type of source	**Am-241/Be**	**Pu-239/Be**
Maximum activity (GBq)	100	104
Maximum specific activity (GBq/g)	31,9	-

Table 3. Allowed oxide masse and type of source

Operational

For the loading/unloading operations of segments of fuel rods, specific requirements are needed depending on the packaging and the installation. A tilting device (see Figure 2) is foreseen to bring the packaging from the vertical to the horizontal position. The docking equipment (see Figure 4) will allow a smooth gliding of the plug when pulled into the hot cell. In order to have an easy access from inside the hot cell, an extension tool (see Figure 3) is mounted on the plug.

Figure 2 – Tilting device

Figure 3 – Extension tool

Figure 4 - Docking part

Return of experience, first transport of irradiated fuel rod segments

There have been a number of challenges that had to be solved regarding the design of the liner, interfaces be-tween loading/unloading facilities, tools, transport frames … to guarantee a safe transport cycle.

The first challenge arose during the selection of the means of transport. The TNB 170 is small enough and can be transported with a van. However the lashing capabilities of the van were not equipped to take into account the forces for lashing a type B packaging. Therefore the use of a truck with halfen rails as a lashing possibility was required for transporting the TNB 170. In Figure 5, the halfen rail system is shown.

Figure 5 – Halfen rails

A second challenge came up during the selection of the hotlab for loading and unloading the packaging horizontally, while being docked to a hotlab. The TNB 170 used an extension tool to pull out the content out of the packaging. Forces are exerted on the telemanipulator during this operation. It is important that the telemanipulator can handle the weight of the extension tool and content. Otherwise, tools can be used like a table that is height-adjustable or a hoist to assist the telemanipulator. Due to the unavailability of this during unloading, a change of on-site hotlab was necessary, where unloading could be done vertically.

A particular attention must be paid to the contamination of the liner and the internal cavity of the TNB 170. Indeed, when the liner is filled into the hot cell, the external surfaces of the liner could be contaminated and in this way this contamination could be transferred to the cavity even if the TNB 170 is docked. The physical and chemical composition of the source and the contamination of the hotlab are going to influence the probability of the contamination and should be analysed during the prior risk analysis.

The leak test should be done once the TNB 170 is loaded and before the transport by creating a vacuum in-between the seals and the surveillance of the pressure build-up. All persons in charge of the leak tightness test should be trained to be able to use the device correctly.

In addition to the leak tightness equipment other tools/devices are necessary for the transport and the utilisation of the TNB 170 as for example : the transport frame, the hoisting equipment or the connecting tools to hot cell.

Another critical point is the potential interference between the operating procedures of the TNB 170 and the eventual operating procedures of the site where the packaging should be loaded or/and unloaded. The TNB 170 operating procedures are usually sent to the customers and are analysed by the two sides for eventual adaptations.

Finally the liner was connected by means of screw to the lid of the TNB 170. Because of vibration during transport the capsule came loose and as a consequence the telemanipulator could not easily take out the fuel out of the small space. In future special attention must be given during the design of the liner. The design needs to fill the entire space of the cavity to prevent this issue.

Results

A solution has been provided to transport unirradiated/irradiated MOX pellets or neutron sources with the TNB 170, a compact packaging that is easy to handle within nuclear facilities. The first transport has proven the feasibility of the compact design on-site. With the return of experience of the first transport, we will be able to improve further transports of the TNB 170 in the future.