



## **TN<sup>®</sup>PNS, A NEW SINGULAR PACKAGE**

**Nicolas Guibert**  
AREVA Logistics Business Unit  
Transnuclear, Inc., Columbia, US

**Catherine Grandhomme**  
AREVA Logistics Business Unit  
TN International, France

### **INTRODUCTION**

TN International has developed a new package called TN<sup>®</sup>PNS dedicated to the transport of Primary Neutron Source rods (PNS) containing Californium-252 neutron sources. PNS are necessary to start the new nuclear cores and to calibrate the control devices.

In the framework of the nuclear renaissance, new nuclear power plants will have to be started, including the EPR<sup>™</sup> reactors. Transports are done from France where the PNS rods are manufactured by AREVA CERCA to any nuclear site all over the world, by road, sea, rail and air transport mode.

This package is a cylindrical shape cask. A specific shielding located near the sources allows a biological protection for the high level of radiation emitted by the rods. High performance radiation shielding is provided during the transport and loading/unloading operations.

The package is equipped with a transport frame which purpose is to handle, to secure in transport and to tilt the cask. A transportable vertical stand is dedicated to stabilization once the package is in vertical position.

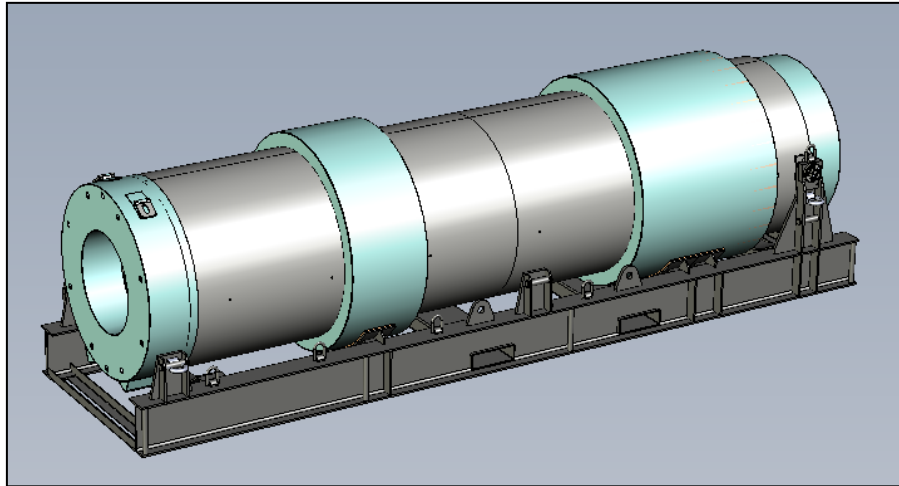
One of the main characteristic of the TN<sup>®</sup>PNS is that it is fully integrated to the PNS rods manufacturing line for better safety and operability performances. Contrarily to most of packages, trunnions are not located on package but on the frame. Lodgements in the packages are ensuring tie-down and tilting functions without any relief on the cask body. Geometry of the holes is designed so that tie-down is resistant to accelerations for air transport. All the tilting and tie-down system can be set up very easily by hand.

### **GENERAL STATEMENTS**

#### **Packaging Description:**

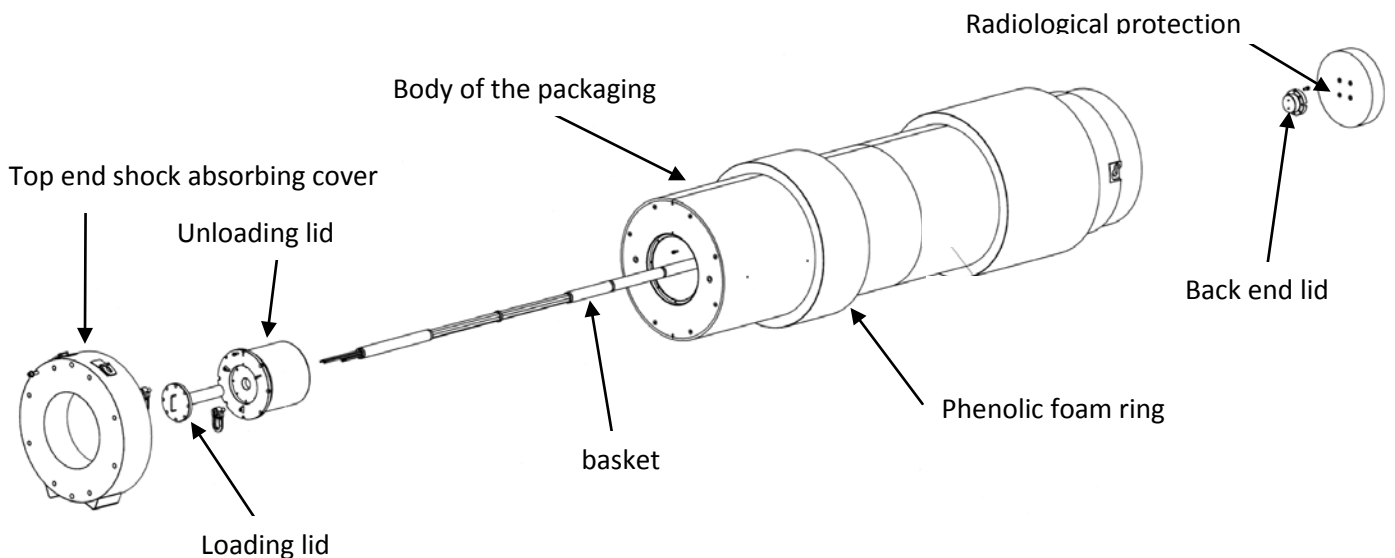
The TN<sup>®</sup>PNS package is a Type A package capable of containing up to 6 Californium PNS rods with a total maximum activity of 1 A1 (equivalent to 0.1 TBq for a source composed of 100 % of <sup>252</sup>Cf according to <1>), with all transport modes.

The mass of the package and its transport frame does not exceed 6,000 kg. The main dimensions of the transport / tilting frame with the packaging are a length of 5 m, a width of 1.3 m and a height of 1.435 m. Figure 1 shows the packaging lying on its transport frame in transport configuration.



**Figure 1. Packaging lying on its transport frame**

As shown in figure 2, the body of the packaging is cylinder-shaped with an external diameter of Ø1.12 m and a length of 4.3 m. It is composed of concentric shells in stainless steel fitted together by welding with radial gussets also made of stainless steel.



**Figure 2. Main components of packaging**

The body has 2 lodgements on the back end in order to receive the transport / tilting frame axes allowing its stowing in transport conditions or its tilting during its loading/unloading operations.

The body can be decomposed in 2 parts:

- a part ensures the shielding: this zone located on the back end includes all the components (PEHD, stainless steel, lead) ensuring the radiological shielding of the neutronic sources located in its centre.
- the drum: this zone located on the front side is a waterproof containment which may be filled with water in order to bring a supplementary radial shielding if required for operational reasons. This containment is always empty in transport and handling condition. This volume can only be filled or drained in horizontal position, so it will not be possible to perform an unloading in vertical position with water.

One lid is bolted on the body at each end side of the cask. The top end lid is composed of two concentric caps. The central one is dedicated to the loading operations while the “large” one to the unloading operations. The bottom end lid (near the source) allows the access to the cask cavity in horizontal position. These lids ensure a positive fastening of the cask.

The cavity of the packaging is obtained by a central tube. The basket is made with tubes. These tubes are covered with soft material which purpose is to improve the sliding of the rods into the tubes and to protect the rods in transport.

The lid is equipped with 6 lodgements which are in line with the lodgements of the basket allowing increasing their length. The length of the cavity of the lodgements is depending on the length of modular spacers which are placed in the lodgements of the loading lid. The length is adapted to the type of rods as shown in figure 3.

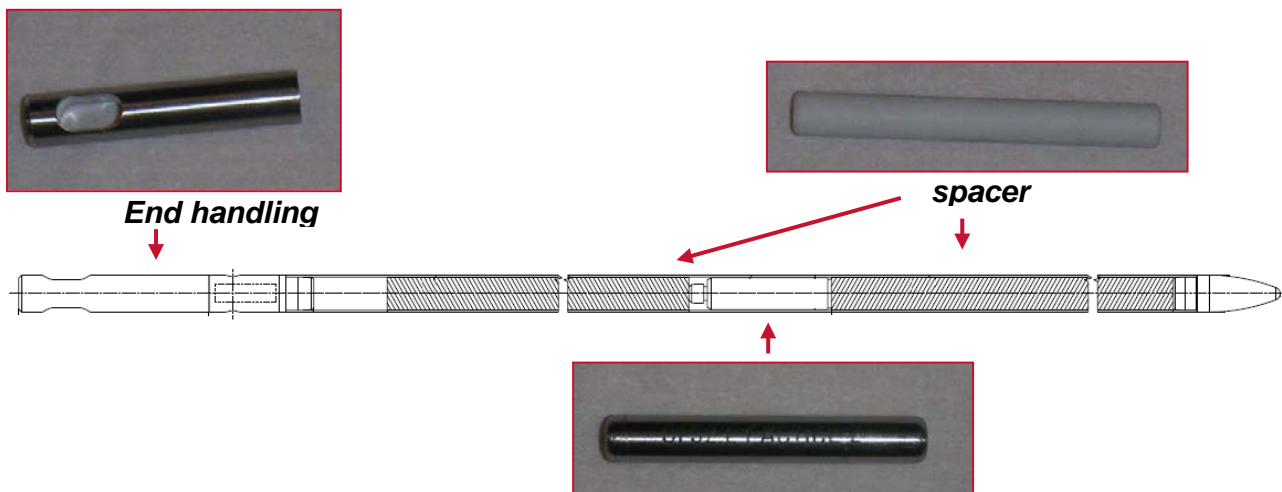


**Figure 3. Spacer for the cavity**

The packaging is also equipped with 2 shock absorbing covers at its both ends and 2 rings in phenolic foam in a stainless steel cladding.

### Special Form Radioactive Material

The Primary Neutron Source is a sealed source of californium included in a single rod, located at its bottom. The rod is constituted with a tube closed on their both sides thanks to top and back end plugs, as shown in figure 4. In this tube are piled spacers serving for positioning the source.



**Figure 4. Source of californium**

This sealed source is defined by its own *special form radioactive material* Certificate of Approval. *Special form radioactive material* means either:

- An indispensible solid radioactive material; or
- A sealed capsule containing radioactive material that shall be so manufactured that it can be opened only by destroying the capsule.

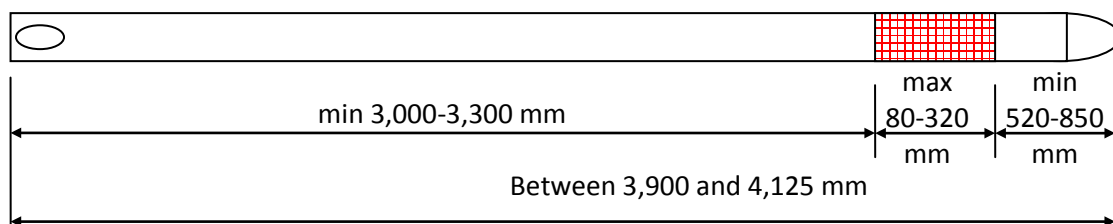
Shielding specifications :

The maximum dose rates allowed in the sense of IAEA <1> in transportation (non exclusive use) are:

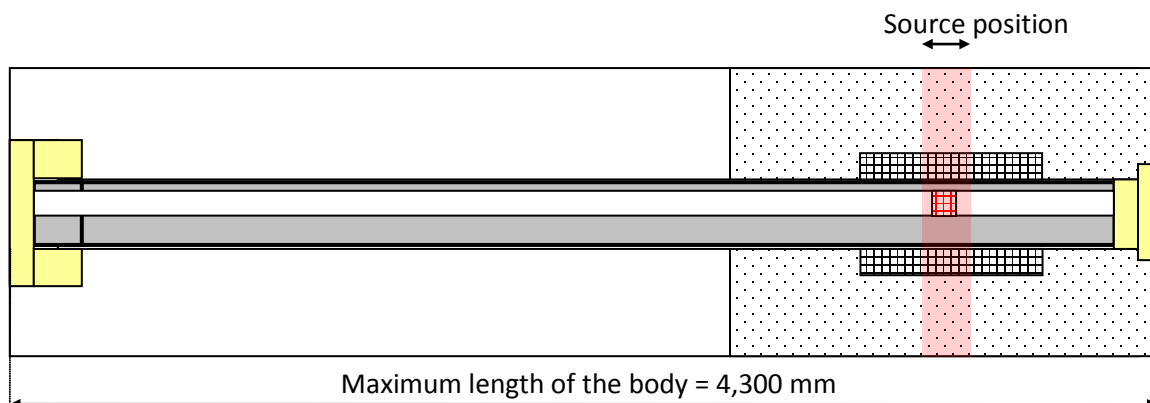
- 2 mSv/h at any point of the external surface of the package
- 0.1 mSv/h at 2 m from the external surface of the package, freight container

These conditions are considered as the base shielding specifications for the design. Nevertheless, the dimensioning specifications are assumed to be lower than the authorized limits for the transportation following the ALARA principle.

The shielding is ensured by the container materials to meet the requirement described in the previous paragraph considering the variable position of the PNS source as described in Figure 5. The location of the shielding is given in Figure 6.



**Figure 5. Position of the californium source in the rods**



**Figure 6. Position of the source in the container**

### Containment of the package

The containment of the radioactive material and its integrity are ensured by the special form agreement.

The package must retain the radioactive material if it is subjected to tests for demonstrating ability to withstand normal conditions of transport according to <1>.

### Thermal specifications

The thermal power inside the package comes from the californium isotopes activities. The thermal power corresponding to the maximal activity to transport is lower than 1 W.

### Mechanical specifications

TN International has demonstrated the ability of the package to withstand routine and normal conditions of transport according to requirements of <1>.

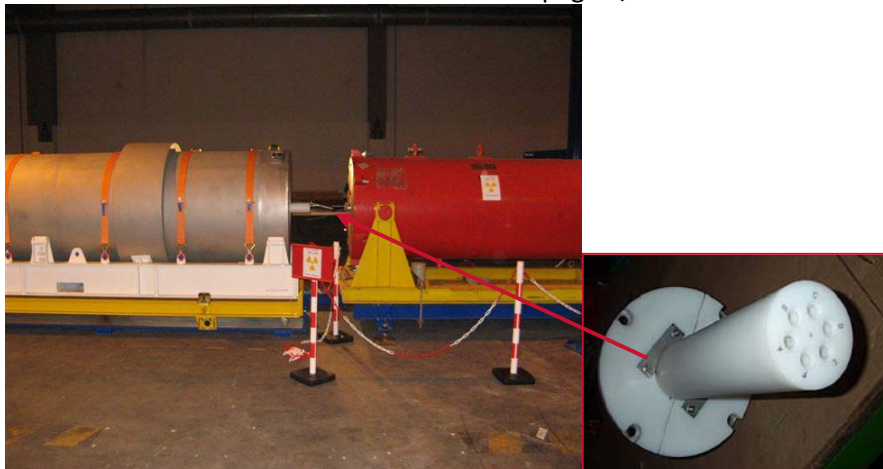
The maximum acceleration to the routine conditions accelerations that may apply to the rods in the worst case is 11 g in any direction (cumulated acceleration in all directions in air transport <1>). If there is no transport by air, this acceleration is restricted to 6 g in any direction.

The package is also designed so that the maximum allowable deflection of the PNS rods allowed is less than 1.8 mm between 2 supports (300 mm).

### Interface specifications

The package meets all the requirements implied by its use in various facilities:

- Horizontal loading of PNS rods in the cask at manufacturing facilities: the transport cask and the manufacturing cask are aligned so that the rods could be translated from a container to the other as shown in Figure 7.

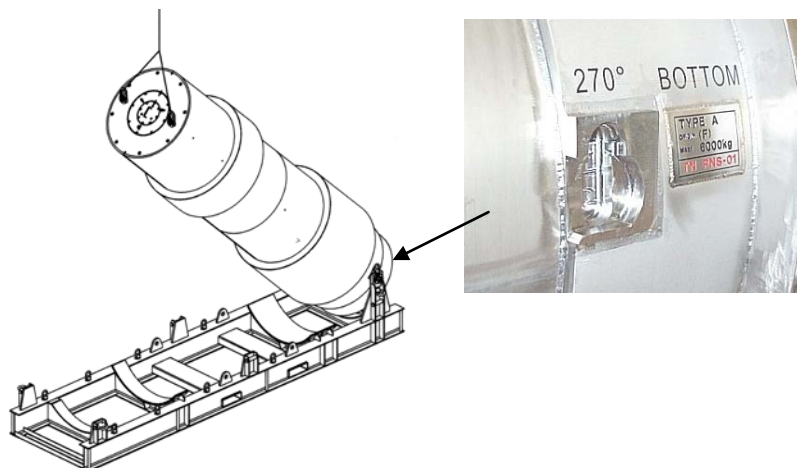


**Figure 7. Translation of rods from manufacturing cask to transport cask**

The remaining distance between the extremity of the transport cask and the manufacturing cask (about 30 cm) is filled by a PEHD interface piece.

The package is also able to be handled with its transport frame with a fork lift.

- Vertical unloading of PNS rods in the power reactors in dry transfer conditions. Before unloading the cask is tilted on its transport frame. The tilting operations are performed, after removing the bottom shock absorber, thanks to rings located on the bottom of the package and to the transport frame as shown in figure 8.



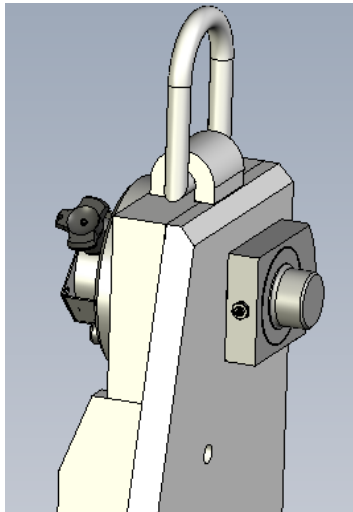
**Figure 8. Tilting of packaging**

Attention must be focused on the position of the tilting axes which are dedicated to the safety of the tilting operations and to the stowage during transport.

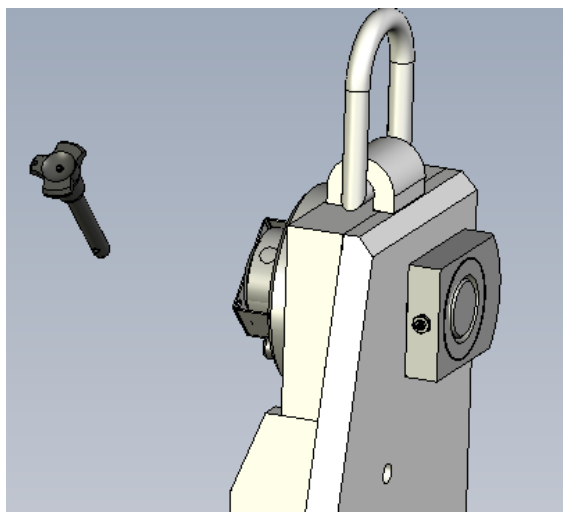
During transport and tilting (until removal of package), tilting axes are in locked position with safety pin in place (see figure 9a)

To remove package tilting axes are in unlocked position with safety pin removed (see figure 9b)

The passage from locked to unlocked position of tilting axes consists just in unscrewing the tilting axes in order to remove them from their lodgement in the packaging.

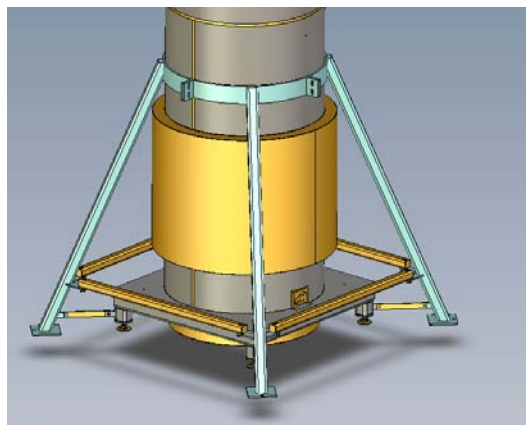


**Figure 9a: Locked position**



**Figure 9b: Unlocked position with safety pin removed**

Once the package stood up at final position and removed from the transport frame, it is translated onto a vertical stand which serves to stabilization of package. Once in place, the vertical stand is fastened to the package as shown in figure 10.



**Figure 10: Position of packaging in the vertical stand**





## CONCLUSIONS

The design of the TN<sup>®</sup>PNS has been driven by the latest applicable regulations, by strong operational specifications and by the use of standard parts or materials. Design, licensing and fabrication have been carried out in a very tight schedule. The first PNS delivery was done in January 2009 to start the core of a Japanese power reactor. Design, licensing, and manufacturing have been achieved in a little more than 1 year. Now this singular package is ready to deliver new EPR<sup>™</sup> or other PNS rods all over the world.

The TN<sup>®</sup>PNS can transport up to 6 PNS rods for the EPR<sup>™</sup> reactor or other PWR reactors with a maximum activity 100 GBq in Cf-252. Rods are introduced into a removable basket which may be changed allowing future rod design or bring additional shielding. That gives the TN<sup>®</sup>PNS a lot of modularity.

## REFERENCES

- <1> Regulations for the Safe Transportation of Radioactive Material, 2005 Edition, IAEA Safety Requirements, No. TS-R-1.