

R75 TYPE B(U) PACKAGE: A ROBATEL'S NEW DESIGN FOR THE CLUSTER GUIDES TRANSPORTATION FROM EDF'S NPPS

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ABSTRACT

As part of the maintenance of its French NPPs (Nuclear Power Plants), EDF/UTO (Operational Technical Unit of Electricité De France) commissioned ROBATEL Industries to design and manufacture a new Type B(U) transport package in order to remove cluster guides to be renewed. These are stainless steel assemblies which are contaminated and activated under neutron flux. They have various geometries depending on the different NPPs where they come from (about 300 kg and 4.5 m long). This package of 24 tons called R75 will transport by road under exclusive use up to 5 items between the various NPPs and the Hot Operational Base of Tricastin in Vaucluse, France.

With its old nuclear history of more than 50 years and its strong experience in the design of radioactive material transport package (with about 80 approved type casks designed over the past 20 years), ROBATEL Industries has put its technical knowledge to serve a cask's design that integrates not only the regulatory requirements and the specific needs of EDF but also the technical innovations able to meet the latest expectations of the Safety Authorities.

This paper therefore aims to present, through the example of the R75 packaging, how ROBATEL Industries develops innovative solutions both regarding the designs that the safety studies to continually improve its concepts and their relevance to the safety imperatives.

That is specifically the case for such topics as the effects of an internal impact on the closure system (due to potential movements of the contents during an accident), the contaminated dusts containment (depending of the knowledge degrees and of the operational control capabilities regarding their activity level) or compliance and representativeness of the conditions of the realized drop tests (with those required by the regulations for the real package). For each of these points mentioned as examples, the safety justifications have constantly to fit to take account on one hand of the ever-increasing expectations of the Nuclear Safety Authorities and on the other hand of the progress of the scientific knowledge.

INTRODUCTION: OVERVIEW OF THE INDUSTRIAL CONTEXT

Cluster guides that equip reactors of EDF's (Electricité de France) nuclear power plants may need to be replaced. This is especially true with the extension of the life of plants. The lower part of a cluster guide is very close to the fuel and thus is strongly activated. To be transported, it requires a significant radiation shielding. It can also be contaminated by the primary fluid. Their activity generally exceeds the activity threshold for transport in type A or industrial packages.

ROBATEL is a French company founded in 1830 whose activity is for 60 years focused exclusively to the nuclear field. It has a specialty in the field of packages for the transport of radioactive materials. ROBATEL manage the whole process: from the customer technical specification it designs the cask and the operating tools, builds the safety studies, obtains the approval certificate for type B packages, manufactures the casks and tools, performs the qualification tests ... The main tasks of this process (design, calculations, drop tests, safety files, cask assembling and testing) are done in-house with ensure a real efficiency and reactivity.

ROBATEL has designed the last 30 years almost 80 type B packages and produced over 1000 specimens of packagings (all types and for all kinds of contents: sources, fuel rods, radioactive liquids, activated metal pieces or waste...).

EDF, anticipating the possibility of replacing the cluster guides in large numbers contracted with ROBATEL Industries to design and manufacture a Type B package for transporting up to 5 cluster guides and 9 packages for interim storage on-site of up to 33 cluster guides each and all the tools for operating them.

DESCRIPTION OF A CLUSTER GUIDE

The cluster guide parts are stainless steel and are mainly composed of two parts:

- The lower part is a square tube of 186 mm side. It is provided with a perforated flange whose the diameter of the outer casing is 258 mm.
- The upper part is a round tube 229 mm in diameter and 11 mm thickness.

These two parts are assembled by means of a square flange 254 mm side and a carrying strap. The lengths of the cluster guides for 1 300 MWe and 1 450 MWe reactors are about 4 370 mm, those of cluster guides for 900 MWe reactor are about 4 100 mm (see figure 1 hereinafter).

The masses of the cluster guides are:

- Type 900 MWe:..... 283 kg
- Type 1 300 MWe:..... 312 kg
- Type 1 450 MWe:..... 328 kg

The gamma activity is concentrated to 90% in the guide foot because of its proximity to the fuel. It can reach about 2 TBq of Co⁶⁰. The rest of the activity is distributed over the entire guide and comes mainly from contamination of the fluid of the primary circuit. The total activity is estimated between 1 and 8 A2 per guide depending on the level of contamination.

The replacement of a guide tube is made during a unit outage. It is handled with a host of transfer to ensure radiation protection. There is no way to store in the reactor building cluster guides in large numbers, hence the need to evacuate them as and when their withdrawal.

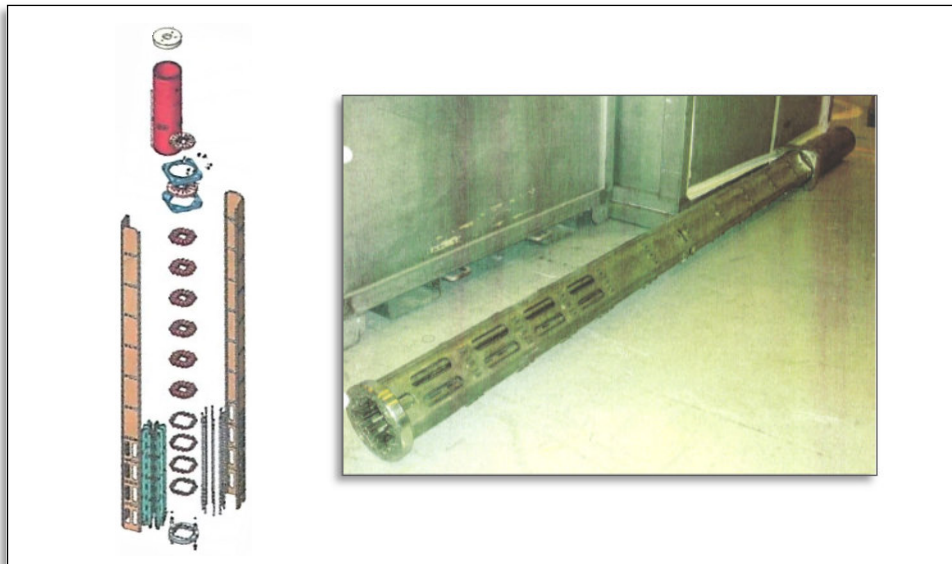


Figure 1: Overview of a cluster guide
(on the left: schematic representation / on the right: photo of a cluster guide)

PRESENTATION OF THE NEW TYPE B PACKAGE R75

The R75 cask is a Type B cask designed to the transport by road of 5 cluster guides from a nuclear power plant where it is loaded toward a storage or repair facility.

It consists principally of a cylindrical body and a shock absorber at each end (see figures 2 and 3 hereinafter). The body is made of an inner and outer stainless steel casing with a thickness of 20 to 30 mm, enclosing a biological lead protection of variable thickness (up to 95 mm) on the length of the cask and also a thermal protection PNT7™ (the PNT7™ is a compound developed by ROBATEL and used in many cask design as a neutronic and thermal protection).

The body is closed by a lid fixed by 24 screws.

Clusters guides are inserted into a modular basket depending on the type of charged guide (different by plant type 900 MWe, 1 300 MWe or 1 450 MWe). A restraint system prevents then content from exercising a significant effort on the lid during transport or in case of a shock or a drop on lid side.

Shock absorbers are made of wood of different species within a stainless steel shell.

The total mass of the package is 24 tons, for a maximum load including the basket of 2.2 tons. This mass allows it to stay within the weight limits of conventional transport. The main dimensions of the R75 cask are as following:

- Length overall:..... 5 559 mm
- Overall diameter: 2 100 mm
- Body length with lid: 4 755 mm
- Diameter outer body:..... 1 240 mm
- Diameter internal cavity:..... 880 mm
- Internal cavity length:..... 4 540 mm
- Internal cavity volume:..... ≈ 3 000 L

Status of the project:

- Order:.....July 2010
- Drops test: December 2012
- Request for approval:May 2013
- Manufacture:..... Ongoing, objective: December 2013

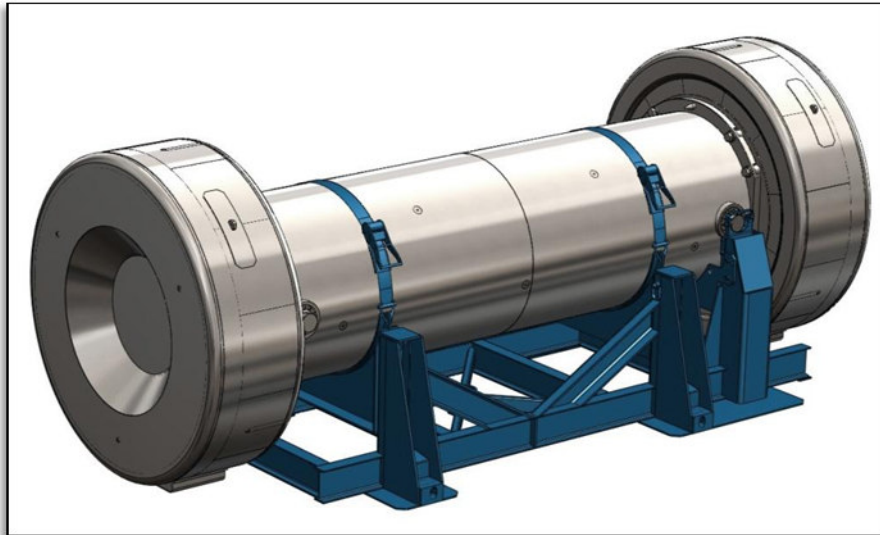


Figure 2: Overview of the R75 cask (on its transportation frame)

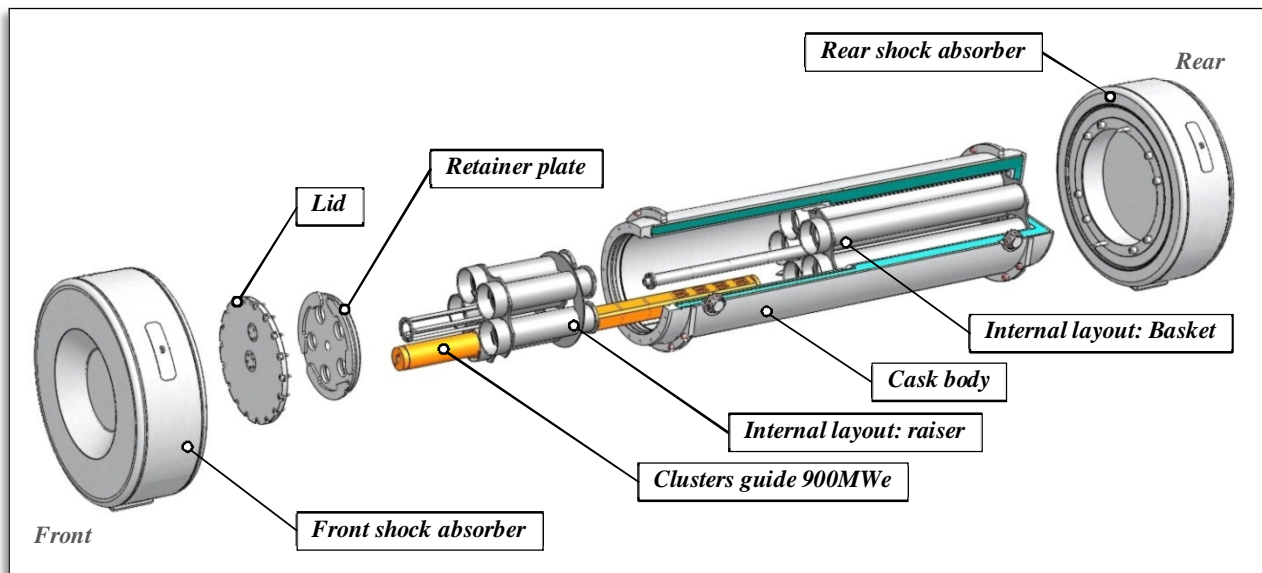


Figure 3: Schematic details of the components of the R75 package

PRESENTATION OF THE RTG32S AND RTG33S PACKAGES

RTG32S and RTG33S casks are designed to provide on-site storage of reformed cluster guides. They meet the internal transport rules of EDF and allow the loading of 32 or 33 cluster guides in the reactor building.

These casks, of cylindrical shape, are made with stainless steel envelope enclosing the biological protection of concrete and lead of variable thicknesses along the length of the package (see figure 4 below). The body is closed by a lid fixed by 24 screws.

Guides clusters are inserted into a flexible basket depending on the type of charged guide (different by level 900 MWe, 1 300 MWe or 1 450 MWe). The casks are equipped with a drainage system which enables the loading of guides, the cask being filled with water.

The main dimensions of the package RTG32S are as below.

- Length overall:..... 5 025 mm
- Diameter outer body:..... 2 480 mm
- Overall diameter 2 710 mm
- Diameter lower internal cavity: 1 940 mm
- Diameter inner upper cavity..... 1 990 mm
- Internal cavity length:..... 4 505 mm
- volume void internal cavity: 13.7 m³

The total mass of the package is 56.3 tons, for a maximum load including the basket of 11.8 tons. This mass is consistent with the means of handling of NPP of EDF.



Figure 4: Overview of two of the RTG32S packagings

Status of the project:

- Order:.....July 2011
- Drops test: February 2012
- Manufacture:9th cask achieved by August 2013

OVERVIEW OF THE SPECIFIC TECHNICAL AND INDUSTRIAL ISSUES

A new application of the French Nuclear Safety Authority is to consider the phenomenon of delayed impact of content during regulatory drop tests. For practical reasons, it is necessary to leave

a space between the cluster guides and the closure system (around 17 mm). This space is compensated by a spring system that prevents cluster guides from moving during transport. However, this system cannot withstand the deceleration of the content induced by the impact when a fall of 9 m height. There is therefore a risk of impact of content on the closure system time-shifted with respect to the impact of packaging on the ground.

This phenomenon of delayed impact of content, which can lead to a very important amplification of the stresses on the lid and fixing screws, was taken into account in the design of the R75 cask. A restraint system of content, independent of the lid has been imagined. This system has been integrated to the scale model with which the regulatory tests have been performed and has withstood two successive drop tests of 9.3 m without repair (see figure 5 below).

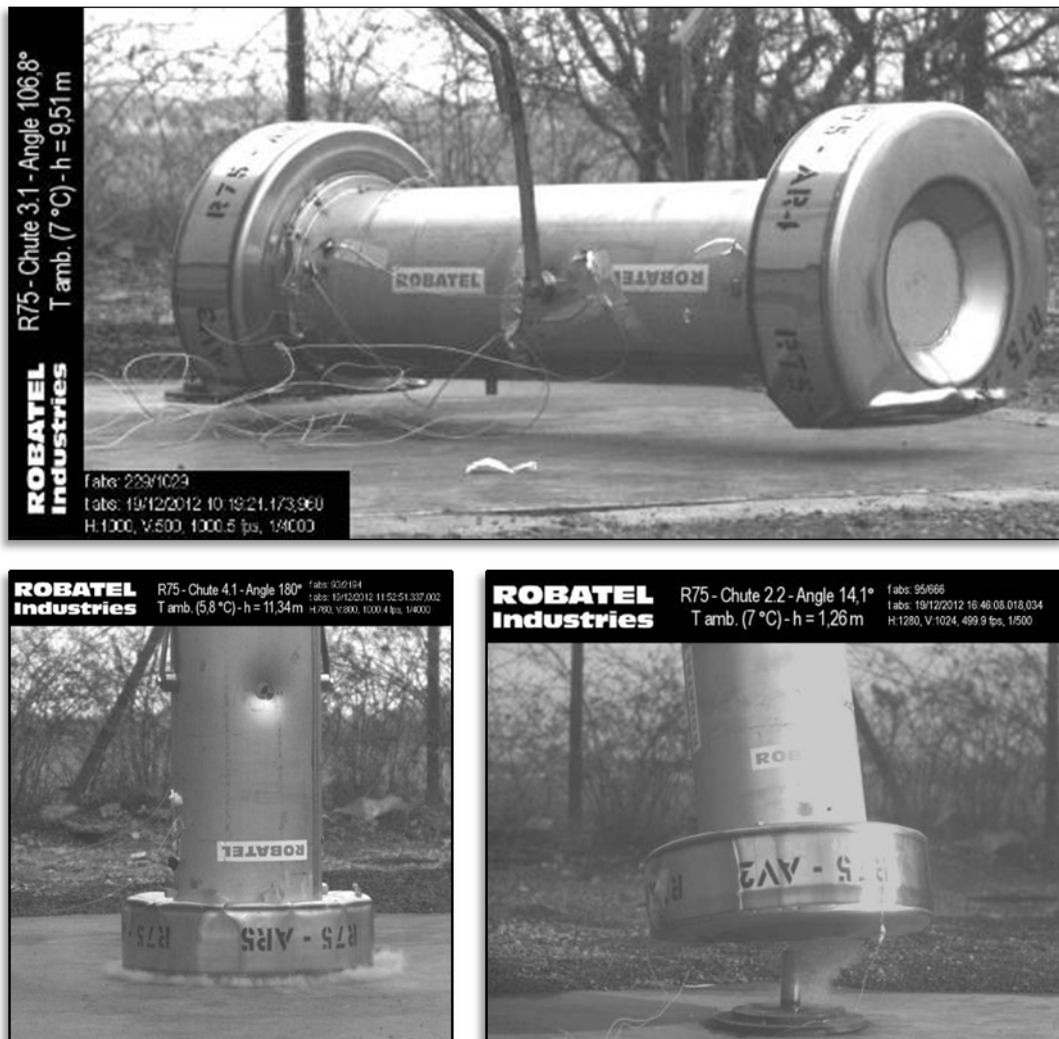


Figure 5: Drop tests performed on a scale model of the R75 package
(images from movies made using high speed cameras)

R75, RTG32S and RTG33S casks are loaded into the reactor building or the fuel building. To do so they come with all the necessary equipments to interfacing at site. Among these tools can be listed in particular a tipping frame, lifting beams, additional radiation shielding, a scaffold, and a module-filling-drain-drying.

The problem of drying is important. Indeed, because of the loading into the reactor building it is crucial to limit at maximum the drying time. The drying module was thus dimensioned to allow a complete drying of the cavity (12 m³) in less than 4 hours.

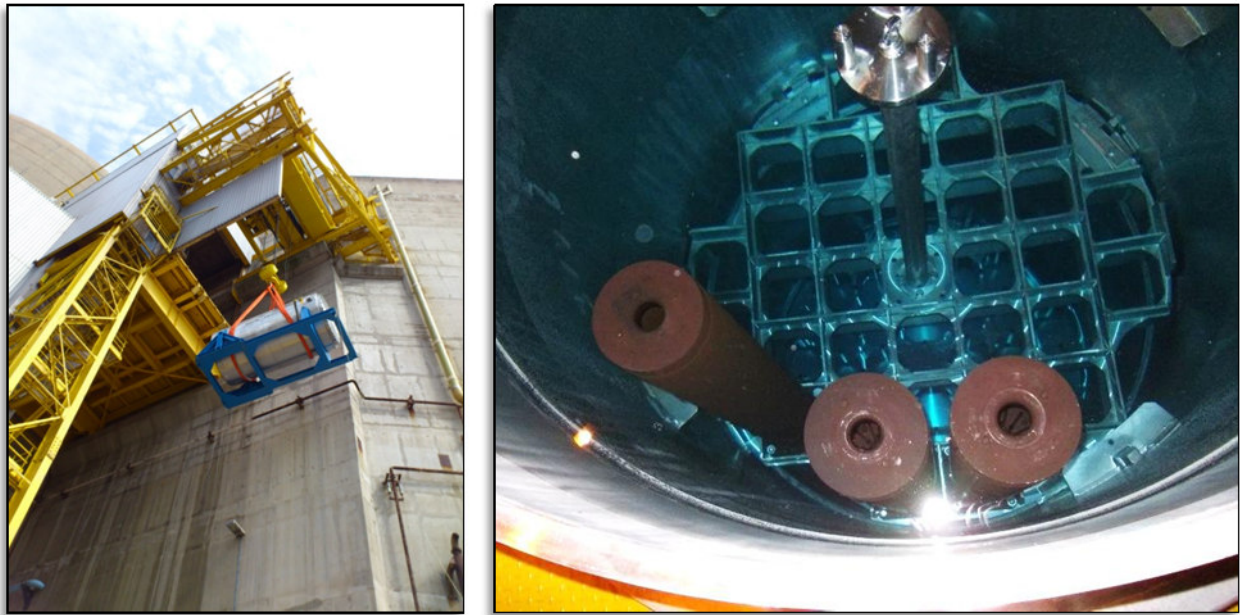


Figure 6: Loading/unloading dummy tests performed on-site with the RTG32S

CONCLUSION

The perspective of replacing cluster guides in large numbers on its fleet of nuclear reactors has led EDF to study the evacuation solutions of these activated and contaminated parts. As the dismantling outfalls are not completely defined, it has been necessary to provide the temporary storage of cluster guides on plant sites themselves. ROBATEL accompanied EDF in finding the best possible solutions for transportation and interim storage. In particular, ROBATEL has presented to EDF optimized solutions in terms of content and cost that lead ROBATEL to win contracts of designing and manufacturing a type B cask and 9 on-site storage casks, as well as all associates production tools in about 3 years only.