DEVELOPMENT OF A B(U) CASK FOR HOTLAB: THE FLYING PIG PROJECT

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ABSTRACT

The purpose of this presentation is to share the work accomplished since 2009 by TN International and some hot laboratories to develop a new type B(U) cask. This project called “Flying Pig” will help to increase and facilitate international exchange of small quantities of irradiated material between those hot labs.
This paper also highlights the main technical choices that were made in order to guarantee the best possible efficiency and operability of the cask.

1 INTRODUCTION

1.1 AREVA and TN International

AREVA supplies solutions for carbon free power generation. Its expertise and know-how in this field are setting the standard, and its responsible development is anchored in a process of continuous improvement. As the global nuclear industry leader, AREVA’s unique integrated offer covers every stage of the fuel cycle, nuclear reactor design and construction, as well as related services.

Within AREVA, the Logistic Business Unit (LBU) designs and manufactures packaging systems and organizes and carries out domestic and international shipments of radioactive materials and also ensures tracking through its related services. For nearly 50 years, the LBU has provided high-performance, reliable and innovative solutions for the packaging and transportation of radioactive materials to its customers.

The LBU has established a well-structured international network with unique capabilities to supervise transportation and manage risk, as well as an unfailing commitment to safety and security. LBU sets global standards thanks to its internationally-recognized know-how.

The LBU is mainly composed of three companies: TN International in France, TN Inc in the United States, and TN Tokyo in Japan.

1.2 Initiation of the Flying Pig Project

Over the past years, the demand for a **cost-effective** and **flexible solution** to transport small quantities of irradiated material for research purposes has been continuously increasing. However, there was no small and low cost transport cask available on the market to carry out this task.

Hence the Flying Pig project was initiated by some of the HOTLAB members: CEA (France), IFE (Norway), INL (USA), ITU (Germany), NNL (UK), NRG (the Netherlands), PSI (Switzerland), RIAR (Russia), SCK-CEN (Belgium), and Studsvik (Sweden).

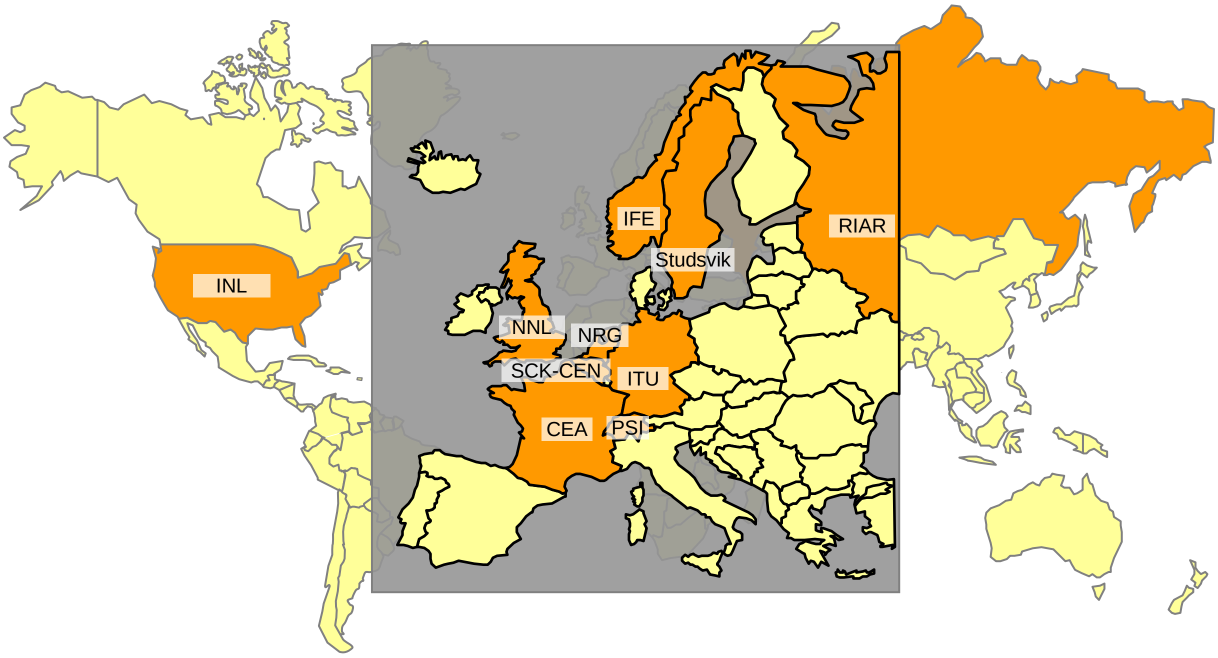


Figure 1: Initiators of the Flying Pig Project

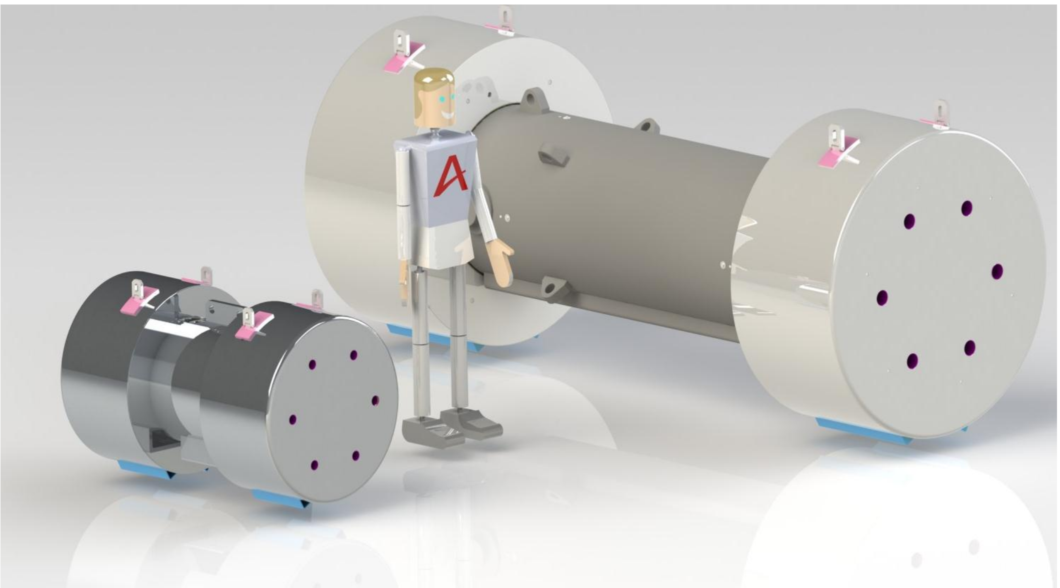
In this context, a specific Working Group was created in 2009 to investigate the transport issues and to develop specifications for a new transport cask. Taking into account prior experiences and feedback of existing casks on the market, the Working Group was able to define the main principles of a new cask optimized for hot lab needs and to consequently issue a call for proposal for a cask following these principles.

2 OBJECTIVES AND MAJOR MILESTONES OF THE FLYING PIG PROJECT

The most important specifications for this B(U) cask were the transportability by air, a weight preferably below 4 tons, and the adherence to a fissile content limit of 15g. Concerning the handling, a horizontal or vertical dry loading and unloading with the connection to the hot cell was chosen.

Consequently, a task force of experts was formed to conduct a benchmark analysis of existing casks on the market in late 2009. As no suitable cask could be identified, TN International was contacted at the beginning of 2011 for a first analysis. Taking into consideration the different kinds of contents, the thickness of shielding, and the release rate of fission gas, the mass of transportable irradiated material inside the cavity was determined for this new B(U) package. The goal was to reach a compromise between the package main dimensions and the transportable material masses (taking into account the results of shielding analysis and the loss of radioactive content analysis).

After the HOTLAB's call for proposal, TN International was selected at the beginning of 2012 to design and license the new B(U) cask. TN International's proposed solution has the aim of maximizing the transportable content and taking advantage of an existing cask design, the TN®106. The objective is to keep the content definition as open and simple as possible in order to allow the greatest possible flexibility for clients.



TN®106

Figure 2: TN®106 and the Flying Pig in Comparison

3 MAIN DESIGN PRINCIPLES OF THE CASK

As defined in the laboratories' request, the cask will be a "small cask" capable to transport irradiated material by all modes of transport, including air. This allows users to reduce the duration of transportation.

The new B(U)[a] cask will have a French certificate with a US DOT validation, allowing transportation in countries that have signed the ADR regulation and international transportation to or from the United States.

The main characteristics of the cask are:

- a weight around 2.5 metric tons,
- a cavity (cylinder) of:
  - ~ 300 mm in length,
  - ~ Φ150 mm in diameter,
- a gamma shielding equivalent to around 220 mm of steel.

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[a] A type B(U) package is a package which can transport various kinds of material with high activity. This kind of package can withstand a free drop of 9 meters and a fire of 30 minutes with limited impact on the environment.

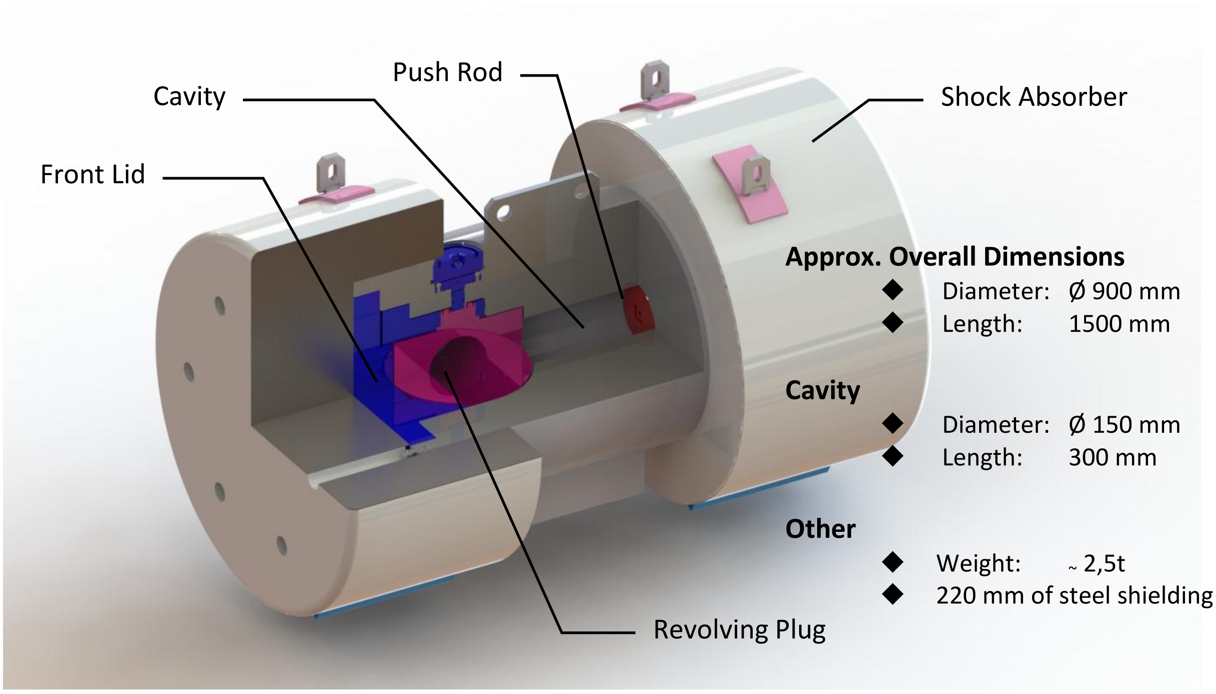

Figure 3: Flying Pig Design

In order to facilitate the modality of transportation, the cask will be a non-fissile cask (type B(U)). The quantity of fissile material will be less than 15 g, in order to fall below the limit defined in the regulation.

4 DESCRIPTION AND PHILOSOPHY OF CONTENT DEFINITION

In order to meet the main objectives (flexibility and cost efficiency), TN International chose to change the way of defining the content of the package in the certificate of compliance. The content will be defined with a **"table of isotopes"** instead of a definition with **"physical parameters".**

The former definition (physical parameters) would have defined content for an irradiated pellet with:

- Isotopic composition before irradiation
- Type of irradiation
- Burn-up fraction
- Cooling time
- …

This kind of definition is in some way rigid. If the burn-up is higher than the maximum burn-up allowed by the certificate of compliance, a modification of the certificate is needed which reduces flexibility and increases costs. This is particularly detrimental for hot lab users whose needs are to transport very particular contents.

The definition with **table of isotopes** on the other hand will detail each isotope present in the pellet and give the limits of all safety fields (release of activity, thermal evaluation…) for each isotope as shown in the list below.[b]

Isotope[c]	Maximal Activity (Bq)[2]	Thermal limit (g)[2]	... Other safety fields ...		
^{3}H	$3,5.10^{16}$	150	…	…	…
^{10}Be	8.10^{10}	560	…	…	…
I I I I	I I I I	I I I I	I I I I	I I I I	I I I I
^{246}Cm	$1,1.10^{12}$	5000	…	…	…
^{247}Cm	$3,5.10^{10}$	7800	…	…	…
^{248}Cm	$1,5.10^{10}$	6500	…	…	…

Figure 4: Example of Criteria for the Table of Isotopes

This way to define content optimizes the capacity of the package and reduces the need to modify the certificate of compliance. The safety studies take regulatory limits as a basis in order to optimize the capacity of the package. For example, the package cannot transport more tritium than the limits that are explicitly identified in the table.
For users, this means that they can transport an optimized amount of material allowed under the regulation, and permits them to quickly see which isotopes can be transported in which quantities.

5 OPERABILITY OF THE CASK

The cask will be loaded and unloaded vertically as well as horizontally in connection to a hot cell (dry (un)loading) thanks to the revolving plug and the push rod which are necessary to protect users.

The operability of the cask, broadly speaking, will resemble the TN®106, as the design of the cask is based on this existing TNI cask. The use of the established design of the TN®106 allows a good operability and reliability.

In fact, the TN®106 has an established track record of successful international shipments, having already completed more than 200 shipments since it has been put into service in 2001. In addition, hot laboratories already have been able to gain experiences with this cask. It has among others a French FCA certificate, a DOT validation in the US, a BfS validation in Germany, as well as validations in Sweden and other countries.

[b] Calculations done by Andreas Lagotzki, Paul Scherrer Institute, Switzerland
[c] The values and the list of isotopes are just examples.

6 FUTURE MILESTONES

After receiving the Letters of Intent (LoI) from all participating laboratories, specification and interface studies will have to be completed by the technical correspondent (the CEA) in order to allow TN International to finalize the feasibility study.

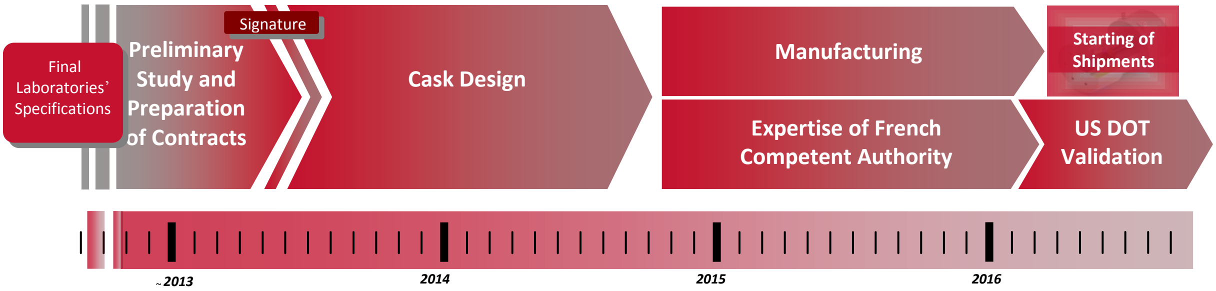

Figure 5: Future Milestones of the Flying Pig Project

The design process is currently planned to be completed in 2014, the manufacturing of the cask one year later in parallel with the French Competent Authority approval by the end 2015. Afterwards, we can let the "Pig" fly in countries that signed the ADR regulation! For the US, the DOT validation will be issued around six months later.