Proceedings of the 17th International Symposium on the
Packaging and Transportation of Radioactive Materials
PATRAM 2013
August 18-23, 2013, San Francisco, CA, USA

COMMON CASK FLEET MANAGEMENT

Authors:

Delphine LABROCHE-MORETTI TN International (AREVA group) 1 rue des hérons F-78180 Montigny-le-Bretonneux Tel : +33 (0)1 34 96 50 00 delphine.labroche-moretti@areva.com,	**Sébastien CLAVERIE-FORGUES** CEA Cadarache DSN/STMR, Bâtiment 220 13108 Saint-Paul-lez-Durance, France Tel : +33 (0)4 42 25 26 24 sebastien.claverie-forgues@cea.fr,
Thierry DELON CEA Cadarache DSN/STMR, Bâtiment 220 13108 Saint-Paul-lez-Durance, France Tel : +33 (0)4 42 25 26 24 thierry.delon@cea.fr	**Claude LEROY** CEA Cadarache DSN/STMR, Bâtiment 220 13108 Saint-Paul-lez-Durance, France Tel : +33 (0)4 42 25 26 24 claude.leroy@cea.fr

ABSTRACT

The French nuclear research center CEA and AREVA TN International jointly own a fleet of diversified packages to transport nuclear products for research, as well as products including radioactive liquids and wastes coming from nuclear facilities.

The CEA and TN International share significant experience in design, licensing, manufacturing and maintenance of diversified packages used in the nuclear industry in France and abroad. Moreover, TN International has been involved in the transportation of radioactive materials at all stages of the nuclear cycle for more than 50 years.

In 2008, the CEA and TN International created a partnership to optimize the control and the management of its package fleet based on two main activities:

- Maintenance: Maintenance of all packages is executed by a specialized team. Methods of work have been optimized and standardized for the entire fleet and for corrective maintenance for allowable reactivity. The strengths of our organization is :
  - Expert knowledge of packages
  - Standardization of maintenance method
  - Return of experience on maintenance for routine utilization which increases the skills on packages, prevents failure and optimizes the number of maintenance operations

  All this ensures the required high quality level with respect to the safety requirements and reinforces the Safety Authorities' trust in our ability to guarantee conformity to the transport license.
- Licensing and Design :

- Exchange and discussions between the CEA and TN International technical experts on difficult subjects such as radiolysis, thermolysis or release fraction of fission gases, provides opportunities to define the best methodology for safety justifications in response to the ever-increasing requirements of the Regulations.
- The same procedure is used to adapt or to develop the package fleet design in response to new needs attributable to new products to be transported or in response to the Authorities' new requirements. One example is the development of a new frame for packages jointly-owned by the CEA and TN International, the objective of which is to provide an appropriate solution for the features added to the package.

INTRODUCTION

TN International and the Logistics Business Unit

The Logistics Business Unit (BUL) of the AREVA group sets global standards in the packaging and transportation of radioactive materials thanks to its internationally-recognized known-how. For nearly 50 years, the BUL has provided high performance, reliable and innovative solutions to its customers. The BUL has established a well-structured international network with unique capabilities to supervise transportation and manage risk with an unfailing commitment to safety and security.
TN International is the main entity of the BUL. It designs and manufactures packaging systems and organizes and carries out international shipments of radioactive materials. TN International also ensures tracking through its related services.

The CEA

The CEA is the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives). It is a public body established in October 1945 by General Charles de Gaulle. A leader in research, development and innovation, the CEA is active in four main areas: low-carbon energies, defense and security, information technologies and health technologies. In each of these fields, the CEA maintains a cross-disciplinary culture of engineers and researchers, building on the synergies between fundamental and technological research.
Civil nuclear research is focused on two main fields: nuclear systems for the future and nuclear waste management.
The research studies are supported by demonstration resources and equipment using nuclear materials, which are spread over the ten CEA research centers in France, each specialized in specific fields. Consequently, the transport of nuclear materials between its own nuclear facilities and the waste produced by its activities, including the dismantling of obsolete facilities, is a key issue for the successful conclusion of CEA programs and projects. The CEA has therefore designed, licensed and manufactured a wide range of nuclear transport packages to cover its own varied needs over the last 65 years.

The CEA/TNI Partnership

The partnership between TN International and the CEA is based on the pooling of the two individual fleets. In this way, the CEA and TN International have a shared portfolio of over 1,000 packages (covering around 40 different concepts) at their disposal to be used at each step of the nuclear fuel cycle. They can be used for transport as well as for storage, and contents vary from fresh or irradiated material to waste in liquid or solid form.

The partnership was built on common interests: the sharing of maintenance and utilization as well as the fulfillment of specific needs that are imposed by the particular requirements of nuclear facilities (research reactors, laboratories…). It is based on the respective experience of the two partners in the design, manufacturing and licensing of packages as well as the organization of shipments. The objectives of this association are specifically:

- The guarantee of an effective fleet management
- Shared feedback on maintenance operations for subsequent optimization
- The development of a shared position for safety demonstrations as well as for R&D studies

ADVANTAGES OF A PARTNERSHIP FOR PACKAGE MAINTENANCE

The CEA and TN International have decided to share two aspects of package management consisting of technical know-how and execution of maintenance operations.
To accomplish this, the partners have put in place a unique organization to pilot, execute and control the quality of maintenance operations, thus guaranteeing the conformity of the packages to the regulations.
A further objective, behind this organization, is the optimization of maintenance operations by taking into account the feedback and other information harvested from the package users. The aim is to do the good maintenance operation at the right time. This information is centralized through our organization and subsequently used, particularly during licensing renewals, to demonstrate the robustness of the implemented maintenance and to propose modifications (frequency of maintenance, integration of controls, adaptation of controls …) to the Authorities.

A specialized organization

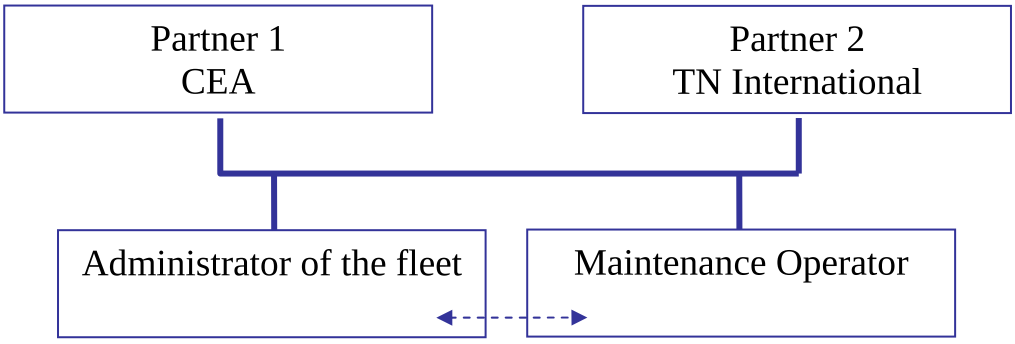

Figure 1: Partnership organization for Maintenance

The main actor in the partnership is the fleet administrator. This actor, designated by the two partners, is responsible for the scheduling of the exploitation and maintenance of the packages. His role is to guarantee compliance of the packages with regulatory controls and their availability in agreement with the transport schedule including all client requirements (for example: if the execution of a shipment is authorized according to special arrangements, the administrator ensures that the package conforms to these requirements).

Maintenance is also piloted by the administrator. The administrator owns the necessary technical skills in order to write up all the technical specifications and to manage all operations linked with the maintenance (scheduling of maintenance, supply and availability of replacement parts, management of tool boxes...).
A maintenance operation is divided into 4 steps:

1. Preparation: checking of technical specifications to be sure that documents are updated, purchasing of replacement pieces and scheduling the physical operation
2. Execution: This task is subsequently assigned to a single sub-contractor which is regularly audited and controlled by the fleet administrator. This second actor is the maintenance operator.
3. Control: Checks are performed by the administrator's team during step 2. They consist of following the progress of the operation, resolving any technical difficulties, checking the conformity to the specifications, and verifying the follow-up of documentation…
4. Validation: The fleet administrator reviews the execution of each maintenance operation and verifies, via a check list, that all the steps have been correctly followed and conform to the criteria of the maintenance specifications.

Contribution of the fleet administrator

A single fleet administrator is in charge of writing technical maintenance specifications for TNI's and the CEA's packages. These documents are in compliance with the regulatory requirements. Because of the significant knowledge gained from more than 5 years of experience, and through the work executed (explained below), his mastery of safety concerns can now be demonstrated.

The administrator has accomplished fundamental work through the analysis of initial TNI and CEA maintenance documentation resulting in an accumulation of Best Practices. Subsequent to this work, he has been able to propose a standardization of maintenance operations. This was particularly important for the packages jointly owned by TNI and the CEA such as the TN®106 and the TN®MTR.

Maintenance specifications are ever-changing and are fed through different sources:

- Regulatory evolutions: he must take into account the appearance of new requirements
- Maintenance REX: the administrator capitalizes the information concerning the execution of a maintenance operation with the maintenance operator
- Follow-up sheet for casks: These Follow-up sheet are similar to a ship's log for each package. All significant information concerning a package's maintenance history (date, operations executed, difficulties encountered…) are noted here as well as any events observed by the operators judged to be important (any valve difficulty, seal replacement…)
- FMECA (*Failure Modes, Effects and Criticality Analysis*): This is a tool to ensure good functioning and manage quality. The objective is to identify any potential failure

of components on each package, their causes and effects, and to prevent any failure by implementing controls and maintenance operations.

Solicited upstream by the Applicant the administrator has real added value.
Through the REX for maintenance and operations, the Cask Follow-up sheet, and the FMECA, he can propose important evolutions for maintenance (frequency of part replacements based on observations, implementation of additional controls…).

Because of his experience, methodologies, and test materials at his disposal, he can also intervene reactively for any necessary corrective maintenance, identify the root cause and propose adapted solutions (i.e.: the new LR144 concept, see below).
Furthermore, he can provide technical advice to the Applicant such as the feasibility of certain tests required by the Authorities proposing the best method. It is possible to illustrate these benefits by citing the example of maintenance on the CEA SORG package for Type B liquid waste transport.

<u>Examples of implemented improvements</u>

Corrective maintenance operations on the LR144 package for the transport of Type B liquid waste

During the loading of radiological materials, an abnormally weak debit value (40 l/h instead of 250 l/h) was observed. The presence in the tank of liquid material with high activity during the detection of the problem led to an additional difficulty in treating this dysfunction. An analysis was thus conducted by the fleet administrator to identify the two most probable causes:

1. a mechanical block between the bottom of the tank and the “staubli” connection of the dip tube circuit
2. a chemical blockage (from particles).

Figure 2: LR144 tank

A succession of interventions was conducted to free each component of the dip tub circuit and to precisely identify the cause. The observations (visual, endoscopic, disassembly of certain components…) let the administrator of the fleet conclude to the necessity to cut the dip tube, the extremity of which was too close to the bottom of the tank and which was obstructed by particles, even though no blockage had been identified.

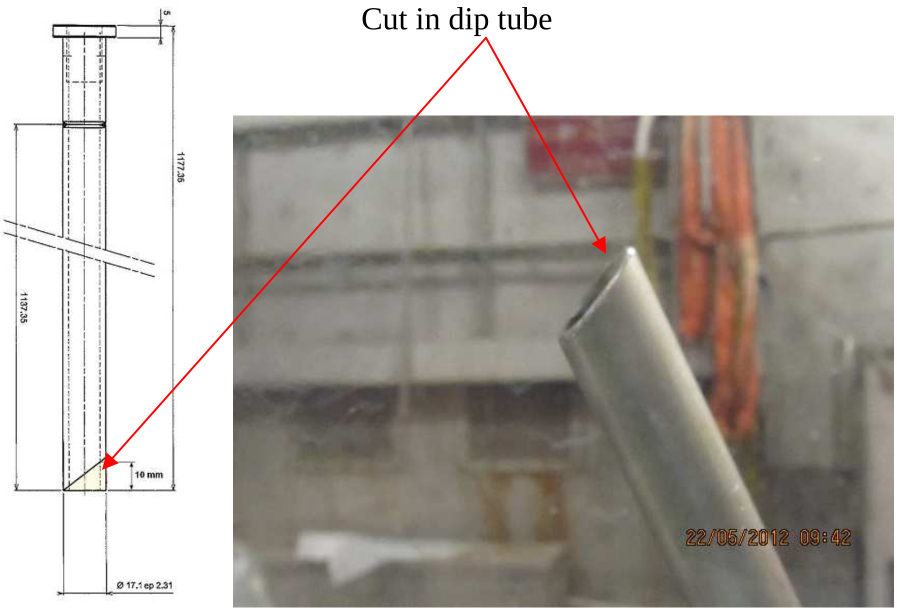

Figure 3: Cut in the dip tube

Besides that, preventative measures, such as upstream agitation and filtration, led to the consolidation of the modification to the operations system, enhancing safety.
Since this intervention, no problems during loading have been signaled. The operation has had two significant impacts: the integration of this evolution for the smooth functioning of the package (manufacturing plan); the addition of a verification of the dip tube in the maintenance specifications.

Evolution a maintenance requirement for SORG packages

During the maintenance preparation of a SORG package, the fleet manager noticed that the presence of a liquid at the bottom of the cavity prevented the execution of the leaktightness test on the weldings of the containment barrier which was required by special arrangement F/873/X in the CEA Safety File: the prescribed method required the injection of helium into the double barrier of the container to detect the appearance of Helium in the cavity. It was impossible to attain the necessary pressure for the proper functioning of the helium detector (high-vacuum) because of the presence of liquid in the cavity.
It was also impossible to empty and dry the cavity because of the residual volume, the elevated dosage, and the safety code of the installation. The fleet administrator thus proposed to the CEA an alternative method for testing the confinement barrier weldings: the injection of helium in the cavity to detect leakage of helium into the double barrier.
The CEA validated the principle of the method and the fleet administrator established a new procedure to conduct the leaktightness test. Meanwhile, this significant modification had to be approved by the relevant French Safety Authorities (ASN) prior to its implementation. It was thus decided with the CEA to finalize all the other maintenance operations on the SORG package and to wait for ASN approval to execute the leaktightness test.

The ASN ultimately pronounced a new special arrangement F/879/X integrating the new procedure so that the maintenance of the SORG package could be completed and the package made available to the customer.

Figure 4: SORG tank

LICENSING – COMMON POSITION

The CEA and TNI are both Applicant and work to obtain, renew or extend a license for the transport of a package on the public transport system. The partnership encourages regular meetings enabling the design teams to keep abreast of new issues that come up during the assessment of safety documents (volume of released gases, delayed impact, explosion, justification that features added to the package at the time of transport (i.e. transport frame) not reduce the package safety…). These work meetings allow the teams to debate the technical orientations foreseen by each other and to determine the common strategies of demonstration on certain subjects. For example:

- volume of gases released,
- common stowing frame.

<u>Rate of fission gases released</u>

To meet the Safety File requirements for packages used to transport type B irradiated fuel (IR100, IR200, TN®106), it is necessary to evaluate the quantities of fission gases susceptible to being released into the cavity of the package at the time of a rupture of the fuel rod. To do this, it is necessary to know the fraction of fission gases released from the fuel pellets and present in the free volumes of the leaktight rods during their transport after irradiation; to estimate an envelope value when possible; and to determine the additional release which can occur during shipment.

Recently, the relevant Safety Authorities requested the CEA and TNI to take into account the double irradiation phenomena. A long rod initially irradiated in a power reactor is cut to create a short rod with a length lower than 500 mm. This short rod in then re-irradiated in a type research experimental reactor, such as OSIRIS.

In the absence of irradiation condition especially for experimental condition, the relevant Safety Authorities have requested the CEA and TNI to apply a percentage of fission gases released excessively disadvantageous and extremely restrictive for transportation, equal to 100%. The requirement to apply a rate of 100% must also be applied to high burn-up fuel.

The release of fission gases (xenon and krypton) mechanism from the fuel pellets was studied based on :

- the release of fission gases experiment of TNI due the expertise on numerous type of fuel assemblies and leaned to AREVA experiment on the used fuel knowledge
- the release of fission gases experiment of CEA due to the its specific research reactors and characterization of fission gases for fuel type and irradiation

Two preponderant parameters were isolated for further study (temperature and combustion rate).

Indeed, experimental irradiations were conducted in experimental reactors such as SILOE, OSIRIS or HALDEN, often with conditions upper the standard power reactor conditions:, in particular with linear powers clearly higher which can lead to greatly superior release values.

Moreover, numerous long rods from power reactors (PWR) have been subjected to puncture test to measure the quantity of gases released and to deduce the release rate or released fractions (quantities released / quantities created); they were either experimental rods (for example for the qualification of new products such as new materials for cladding rod), or rods coming from surveillance programs during the implementation of a new way to drive the reactor.

It appears that the value required by the Safety authority is excessive compared to the real value in particular due to the specific way of irradiation and fuel assembly for CEA reactor.

Work is actually underway with the CEA's Department of Fuel Studies (Département d'Etude du Combustible) to provide documentation to the Safety Authorities so as to define more realistic percentages that are more exploitable in the gases release studies for the Safety Files for transport packages.

A best knowledge of the irradiation conditions, shared between the reactor facility and the Applicant on such difficult subjects, thanks to collaboration allow to reduce the taken margin with the final aim to maintain the transport capacities, in agreement with facility needs.

Impact of transport frame on the package safety

The development of a specific frame originates from the relevant French Safety Authorities 2010 requirements linked to the justification of frame impact on the cask during regulatory drop tests for type B packages.

The frame of the IR200/TN®106 casks is considered as an adjunction to the package by the French Safety Authorities. A 2010 study demonstrated that it is not foreseeable to justify the absence of any "safety" impact of the frame of the current IR200/TN®106 casks.

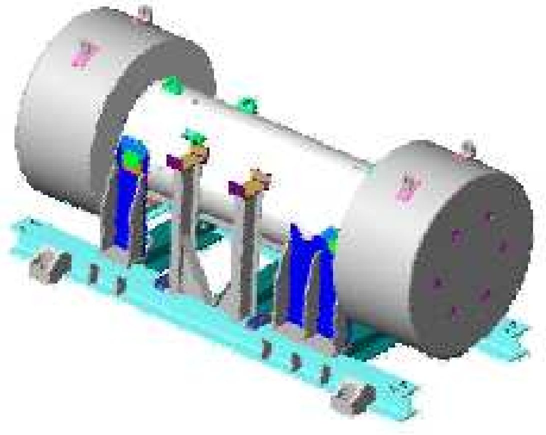

Figure 5: Current frame of IR200

The new frame design must integrate a non-aggressive geometry, in particular at the interfaces with the cask and facilitate the de-solidarization between the frame and the package in case of brutal shock (notion of mechanical fuse liaison: straps, sheared pieces, shearing pins).

The frame is dimensioned to guarantee an efficient liaison while it is submitted to transport accelerations (INF acceleration), including fatigue behavior. The maintainability of the different parts of the frame is equally integrated into the design process. Different drop configurations are studied to validate the absence of any impact on the package (or of any aggressive elements), if necessary by means of static or dynamic digital calculations of the LS DYNA type to validate the behavior during the break of the mechanical fuses.

A preliminary project was transmitted for information to the French Safety Authorities at the end of 2011. A review of the design organized for the beginning of June 2013 permitted us to lock the design details. The justification of frame impact absence on the cask during regulatory drop tests for type B packages should be submitted for French Safety Authorities validation during the second half of 2013. The fabrication and rollout are programmed for the first half of 2014.

CONCLUSION

The partnership is advantageous for both the CEA and for TNI.
With such a structured organization in place and with a limited number of intervening parties, the partnership guarantees not only an effective management of the regulatory and associated files for the fleet but also the delivery of packages for the execution of shipments as planned.

The exchange of skills and knowledge helps the partners to reinforce the safety demonstration for licensing and design. Exchanges and discussions between the CEA and TN International technical experts on difficult subjects such as radiolysis, thermolysis or release fraction of fission gases, provide opportunities to define the best methodology for safety justifications in response to the ever-increasing requirements of the Regulations.
The same procedure is used to adapt or to develop the package fleet design in response to new needs attributable to new products to be transported or in response to the Authorities' latest requirements.