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# LWR Damaged Spent Fuel Transport

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## 1- INTRODUCTION

In the weeks following a reactor shut down, spent fuel is checked to control fuel integrity and to identify leaker fuel assemblies.

For transport, sound fuel is loaded directly in the cask and defect one in special bottle designed by COGEMA and placed into the cask.

We will review the main technical aspects of LWR damaged spent fuel transport and COGEMA's experience in this type of transport.

## 2- MAIN TECHNICAL ASPECTS

### 2.1. Qualification of the fuel at the reactor site

When, after their discharge from the reactor core and their cooling in the reactor pond, the fuel elements are made available for transport, their quality needs to be assessed so that risks are not taken by the transporter and later on by the reprocessor when cask unloading takes place.

This requirement is well accepted by the customers. Indeed, the consequences brought by a leaker fuel loaded directly in a cask would bring a lot of difficulties for the following customers due to the delay necessary to come back at a normal situation.

COGEMA has defined various procedures depending on the power plants (PWR, BWR) and their equipment (in-core sipping, out-of-core sipping ...), the implementation of which is audited by COGEMA. These procedures make it possible to estimate the degree of soundness of the cladding and/or the existence of possible leaks.

The damages acceptable for the transport of fuel in bottles are as follows :

- . The deformations of the damaged fuel acceptable to COGEMA are such that it is possible to place without effort (insertion and removal) the damaged fuel assembly in a prismatic volume having :
  - a cross section equal to the internal cross section of the bottle for that fuel type less 2 mm on both sides,
  - a total length equal to the useful length of the said bottle minus 10 to 20 mm.
- . The integrity of the cladding may be deteriorated beyond the limits of the acceptance criteria for non damaged fuel (1) for which COGEMA has also defined precise and detailed criteria provided that no fuel pellets or fragments can escape from the cladding during transport and subsequent operations.
- . The integrity of the fuel structure is such that it will be possible to remove all of the fuel assembly from the bottle using the normal gripping tool corresponding to the fuel type.

## 2.2. Use of special bottle

Damaged fuel assemblies release a big amount of fission products through their cracks which could bring an important contamination of the cask, unloading facilities, pond storage and various equipments used. Contamination and irradiation risks of the operators could lead to the interruption of the work until the normal conditions return (with a very important decontamination work).

- (1) The acceptance criteria for non damaged fuel describes all techniques qualified by COGEMA and presently used in the reactors to demonstrate the fuel soundness.

To prevent these risks, COGEMA has designed a special bottle used for transportation and storage before reprocessing of the damaged fuel.

This bottle, has to meet the following requirements :

- Good confinement of fission products and particles.
- Handling with a fuel assembly inside.
- Easy gas release.
- Easy water filling, emptying and drying.
- No corrosion for a long period storage.
- Opening of the bottle even after a long storage period.

These bottles are made of three main parts (see fig. 1)

- the bottle body
- the bottom closing system
- the lid

. The body is a square tube with a bottom plate.

. The bottom closing system mainly consists of a valve mounted on a spring plate and equipped with a filter. This valve shuts when the bottle rests on its bottom (for example while stored in a pond).

. The lid allows :

- the closing with a castle-nut,
- the handling of the bottle with a square top part so called mushroom,
- the gas release (if any) through 2 head valves coupled in parallel and equipped with filters (which catch the particles so that the activity is kept inside the bottle).

The dimensions of the bottle depends on the size of the assembly to be transported.

Practically, the fuel assemblies are sorted in different dimensional families for each of which one specific bottle is designed with specified dimensions.

On a general basis, with :

- an overall length of the fuel assembly : L mm
- an overall cross section of the fuel assembly : X mm

The main dimensions of the bottle are :

- overall cross section :
  - . on the body : (X + 12) mm
  - . on the head part : (X + 26) mm
  - with a minimum value of 179 mm
- overall length :  $L (1 + 0,5 \%) + 165$  mm

To stay in the same dimensional family with shorter fuel assemblies, the use of an internal stool will bring the fuel assembly top part at around 20 mm below the lower face of the bottle lid and allows the utilization of standard casks.

The bottles are manufactured in accordance with technical specifications and quality assurance system of COGEMA.

To perform a transport of damaged fuel assemblies, a checking of the various package equipments including the bottles is done before departure of the empty cask from La Hague in order to be sure of its conformity with the cask approvals.

The operations at the reactor site are as follows :

- installing the cask in vertical position in the preparation area, then filling of the flask cavity with water,
- dipping of the cask in the reactor pond,
- opening of the cask lid (this operation can be done before cask dipping),
- opening and removing of the bottle lid using special tools,
- loading of the damaged fuel assembly into the bottle,

- setting and screwing of the bottle lid with the tools mentioned above,
- after completion of the various manipulations :
  - . lifting the cask out of the pond,
  - . draining of the cask cavity (the bottles will drain at the same time),
  - . cask drying in the same way as a normal shipment,

Samples are taken to determine Cs134 - Cs137 - Co60 elements in :

- the pond water close to the cask before and after fuel assemblies loading,
- the cask inner cavity water as soon as out of the pond (at the beginning of the draining).

### 3- Use of standard casks

Damaged fuel assemblies are transported in the same casks used normally for the transport of sound fuel.

The casks capacities are summarized as follows :

	PWR	BWR
TN 12	Up to 4 bottled assemblies (together with sound assemblies)	Up to 4 bottled assemblies (together with sound assemblies)
TN 17	Up to 2 bottled assemblies (together with sound assemblies) Only the design of this basket exists	7 bottled assemblies
TN 13	Up to 2 bottled assemblies (together with sound assemblies)	
NTL 8/3	3 bottled assemblies	
NTL 9		3 bottled assemblies

The use of special baskets with mixed loading (ie bottled fuel with non damaged fuel) allows to keep the same total capacity as normal basket.

The maximum heat release for one bottled assembly is 3 KW for PWR and 2 KW for BWR.

The cost of the transport of a damaged fuel assembly is the same as a sound element. However, the cost of the bottle with associated expenses increase the total price. In order to reduce this cost, the recovery of the bottles after decontamination has to be considered.

#### 4- COGEMA's experience

COGEMA began the transport of LWR damaged spent fuel in 1976.

Two types of bottles were used up to now.

The mark 1 type allowed the transport of 44 PWR fuel assemblies.

With the mark 2 type, developed by COGEMA eight years ago, whose the main differences are located in the lid conception with improvements in the screwing, handling and exhaust systems, 64 (27 PWR and 37 BWR) fuels assemblies were shipped into 18 flasks.

With both types, no problems occurred.

The first 44 fuel assemblies were reprocessed without any difficulties.

#### 5- CONCLUSION

The total of transports performed with damaged fuel has given to COGEMA a significant experience.

Bottle handling, cask drying time so that the transport are normal.

The good confinement efficiency of the bottle bring no activity increasing in the storage ponds.

This mastership allows COGEMA to increase the range of services offered to its customers.