THE FS80, A NEW HIGH CAPACITY PACKAGING FOR THE TRANSPORT OF PLUTONIUM OXIDE POWDER

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SUMMARY

The reprocessing of the spent fuel issued from the nuclear power plants allows to reuse most of the nuclear material for the manufacture of new fresh fuel assemblies. It is the case for the MOX fuels whose pellets are made of uranium and plutonium oxides.

Therefore, plutonium oxide must be transported from the reprocessing plant to the MOX manufacturing facility. For the time being the most elaborate transports of such material are those carried out between La Hague and Dessel or Cadarache or Melox. The plutonium oxide is put in different inner equipments which are finally loaded in a type B(U)F packaging, called FS 47. The transports are performed by road by means of a specific container which can carry 10 FS 47 flasks. Due to the sensitivity of this material, all these transport equipments are specially designed to guarantee a high level of safety and physical protection.

Nowadays, more and more nuclear power plants use fresh Mox fuels in their reactors. Therefore, the capacity of the MOX manufacturing facilities will increase in the future in order to supply all the MOX reactors and consequently the quantity of plutonium oxide transported will also increase. This evolution offered a good opportunity to design a new packaging with a high level of safety and physical protection similar to the existing transport system, but with a larger capacity for plutonium oxides. The present objective is to increase the capacity by a factor 3, and therefore to reduce the number of transports by 3.

The present paper outlines the main characteristics required by COGEMA to use this new transport system between its facilities. It also describes the resulting FS80 transport system, and more particularly the packaging designed by Transnucléaire.

BASIC DATA

Apart from the initial goal, in terms of quantity of transported oxide powder, the following data have been determined to set-up the new transport system:

- In order to keep the existing inner equipments and transport facilities of the reprocessing plant, the packaging technique of the powder has been maintained. This one is contained in stainless steel cans, crimped after filling. The cans are then stacked, by groups of five in stainless steel canisters, the lid of which is welded. The canister is finally introduced in a specific cylindrical container (AA 227), with a screwed lid. The new packaging had therefore to be designed for the transport of AA 227 containers.

- The total payload of the transport system should not exceed 40 metric tons. This type of transport, which, for physical protection purposes is carried out using specific semi-trailers, implies that the mass of the empty packaging has to be optimised.

- The semi-trailers (tractor + trailer) already used for the transport of plutonium oxide powder with FS 47 packagings must, as far as possible, remain in operation. Moreover, the trailers must not be dedicated only to this type of transport with a view to preserving the flexibility of the rolling stock.

- Envelope data have been considered in order to take into account the evolution of the isotopic composition of MOX fuels and particularly the characteristics of the $PuO2$ according to the initial enrichment, burnup and cooling time of the fuel assemblies.

REGULATORY FRAMEWORK

The safety related justifications are based on the IAEA 1996 recommendations, for a type B(U)F packaging.

As far as radiological protection is concerned, the neutron sources contribute primarily to the dose rate, and the ICRP 60 recommendations are observed, more particularly the new definition of the Neutron Quality Factor.

PRELIMINARY PROJECT

A rough pre-project has been carried out in order to check the feasibility and assess the main difficulties relevant to the concept of such transport system. This preliminary stage has mainly involved the physical protection and safety aspects.

Physical protection aspects

The global concept of the transport system has been revised with a view to taking into account the constraints regarding physical protection. The space surrounding the container in the truck has been reconfigured, since the current equipment is not compatible with the features of the new packaging. It has to be emphasized that the physical protection aspect is fully taken into consideration in the packaging design.

Safety aspects

The preliminary studies have rapidly outlined, as for all the other types of packagings designed for this kind of content, that the control of the sub-criticality is particularly dimensioning.

Numerous simulations have been led on different configurations of loaded AA 227 container arrays. These simulations have been associated to very conservative assumptions with regards to the different possible scenarios for the moderation of the transported powder. An optimal configuration has been then retained, thus enabling to obtain, in the most restricted volume, the sub-criticality of the package type in normal and accident conditions.

The sub-criticality control of this array is ensured by means of a specific material, developed under Transnucléaire's control, combining a moderator component (hydrogenated material) with another component showing a large cross section for thermal neutrons.

The radiological protection which has to be implemented also constitutes a predominant issue for this type of packaging, the main difficulty lying in the dimensioning of the shieldings while mastering at the same time the different thermal exchanges to limit the temperature of the various packaging components. These two issues are overcome by means of an efficient shielding resin, combined with design features favouring good thermal exchanges. The packaging sketched out at this stage required a containment vessel providing a high level of containment, under the normal and accident regulatory transport conditions. This containment is ensured by means of stainless steel shells, and by an efficient closure system.

Specific energy absorption devices allow to limit the accelerations transmitted to the packaging containment during the various regulatory drop tests.

The preliminary project has thus shown that the pre-set targets in terms of quantity of transported powder was achievable: fifteen AA 227 containers can be loaded in one FS80 packaging and two flasks can be tied down on one trailer.

Nevertheless, this design requires highly efficient components, mainly for the sub-criticality screens, as well as for the radiological protection. Moreover, the optimisation needed in terms of mass to reach the assigned capacity goal introduces another difficulty to the concept of the system.

ACHIEVEMENT OF THE TRANSPORT SYSTEM

Further to the evaluations performed during the preliminary project the use of two identical high-capacity packagings tied down side by side on the transport system has been chosen. Each packaging, with a capacity of fifteen AA 227 canisters for an overall weight of approximately 10 tons, is secured on an individual frame. This frame is designed to integrate all the interfaces which are part of the existing FS 47 transport system, which allows to keep using the corresponding trailers as well as the handling equipment of the Hague facility truck lock. Furthermore, additional measures are implemented to guarantee transport security.

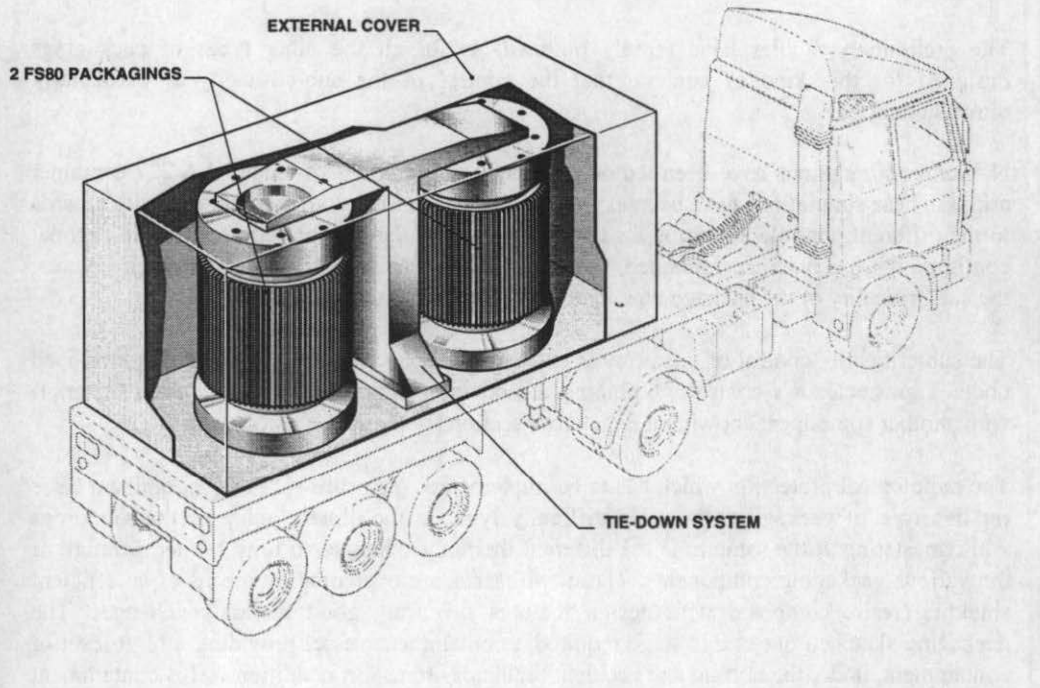

Figure 1: FS65 transport system

PACKAGING DESCRIPTION

See figure 2

The packaging is designed around a massive forged steel circular plate in which are located 15 orifices giving access to cells in which the AA 227 canisters are stacked. A main shell is located underneath the circular plate to contain the sub-criticality control material.

The radiological protection is ensured by:

- the sub-criticality control material, therefore performing two functions,
- a layer of neutron- absorbing resin poured around the inner shell, allowing an acceptable thermal exchange,
- a resin layer located at the bottom and on the lid, to ensure the axial shielding.

The thermal dissipation system located on the side is optimised to reduce at best the surface temperature of the loaded package. A massive lid is located at the upper part, with ancillary devices allowing to check the packaging leaktightness. Finally, shock-absorbers protect the top and bottom of the packaging in order to maintain its containment during the regulatory drop tests.

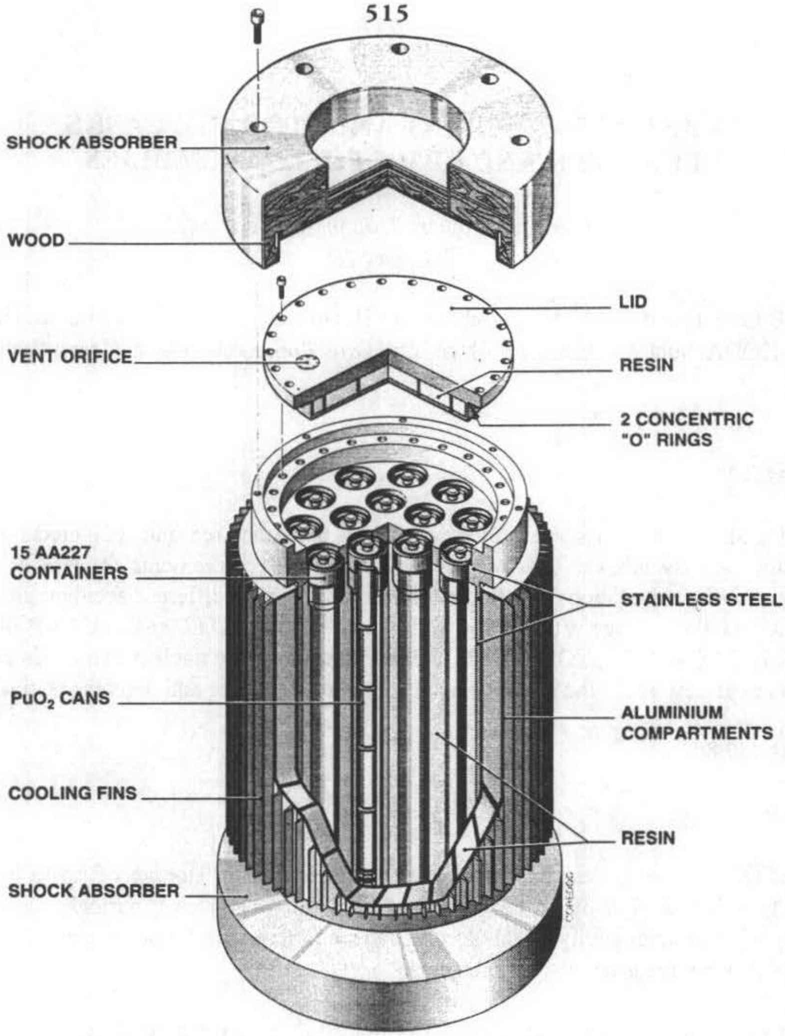

Figure 2: general view of the FS80 packaging

CONCLUSION

Nowadays, an increasing number of power plants use MOX fuel assemblies in their reactors. This situation gives rise to increased transport requirements, not only for the complete assemblies, but also for the plutonium oxide powder to be incorporated in this particular type of fuel. In that respect, and in order not to increase the number of transports, Transnucléaire is presently studying on behalf of COGEMA a new system, offering a higher capacity and allowing to ensure the transports under optimal safety conditions. The system project study is presently under progress, with the goal to put it in operation in the years 2001/2002.