Dry Storage of Irradiated Fuel at ENEA'S EUREX and ITREC Plants: Two Solutions

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Introduction

ENEA has in storage at its pilot reprocessing plants more than one hundred spent fuel elements arising from ENEL's (the Italian Electricity Board) power station of Trino Vercellese and from the Elk River reactor.

This fuel has been in the pools of the EUREX and ITREC plants respectively since 1976 and 1968 and is now to be removed.

Among the different solutions considered those envisaging the dry storage in casks at the plant sites will be described.

Two different storage casks have been conceived, both deriving to a more or less large extent from Transnucléaire's TN 24 storage and transport cask. This choice was determined by the intention of giving the Italian industry the opportunity of manufacturing these casks, knowing that it would not be economical to develop them indipendently due to the small domestic market; moreover, the casks would not differ too much in technology from the AGN-1 transport cask, which has been built by Nuovo Pignone for ENEL and used to transport 4OO or more fuel elements.

However, to adapt the existing TN 24 to the fuel and installations mentioned above it has been necessary to modify the design in some parts and to resort to original solutions; for instance, the internals of both casks are completely different from those of TN 24. These modifications and the handling system devised for the EUREX plant have been designed by NUCLECO under a contract from ENEA.
Furthermore, both casks may be modified, mainly by changing their internals, for the transport and storage of other types of fuel elements and of other nuclear material.

1. Storage at the EUREX Plant

1.1 Present Situation

At present, the pool of the EUREX plant stores 52 cross-shaped PWR fuel elements from the Trino reactor. These fuel elements are shown in Fig.1 and their characteristics are given in Tab.1.
The fuel elements are placed in baskets, six per basket; and each basket has been positioned horizontally on the bottom of the pool by means of a tilting device.
On account of the insufficient depth of the pool, in order to move the fuel elements into a cask, a lead shielding bell must be employed when the fuel element is vertical and is to be lifted into the cask.
Moreover, the capacity of the pool's crane (50 tU) is not sufficient to lift the TN 24 cask.

1.2 Envisaged solution

The system envisaged for the transport and storage of the Trino fuel elements consists of the following main components (see Fig.1):

- a) body and lid of the TN 24 cask
- b) sealed basket, shielded at the top and bottom ends
- c) additional gamma shield and bottom plate, to be used only when transferring basket (b) into cask (a) but not during transport of the cask
- d) spacer, positioned on the bottom of cask (a).

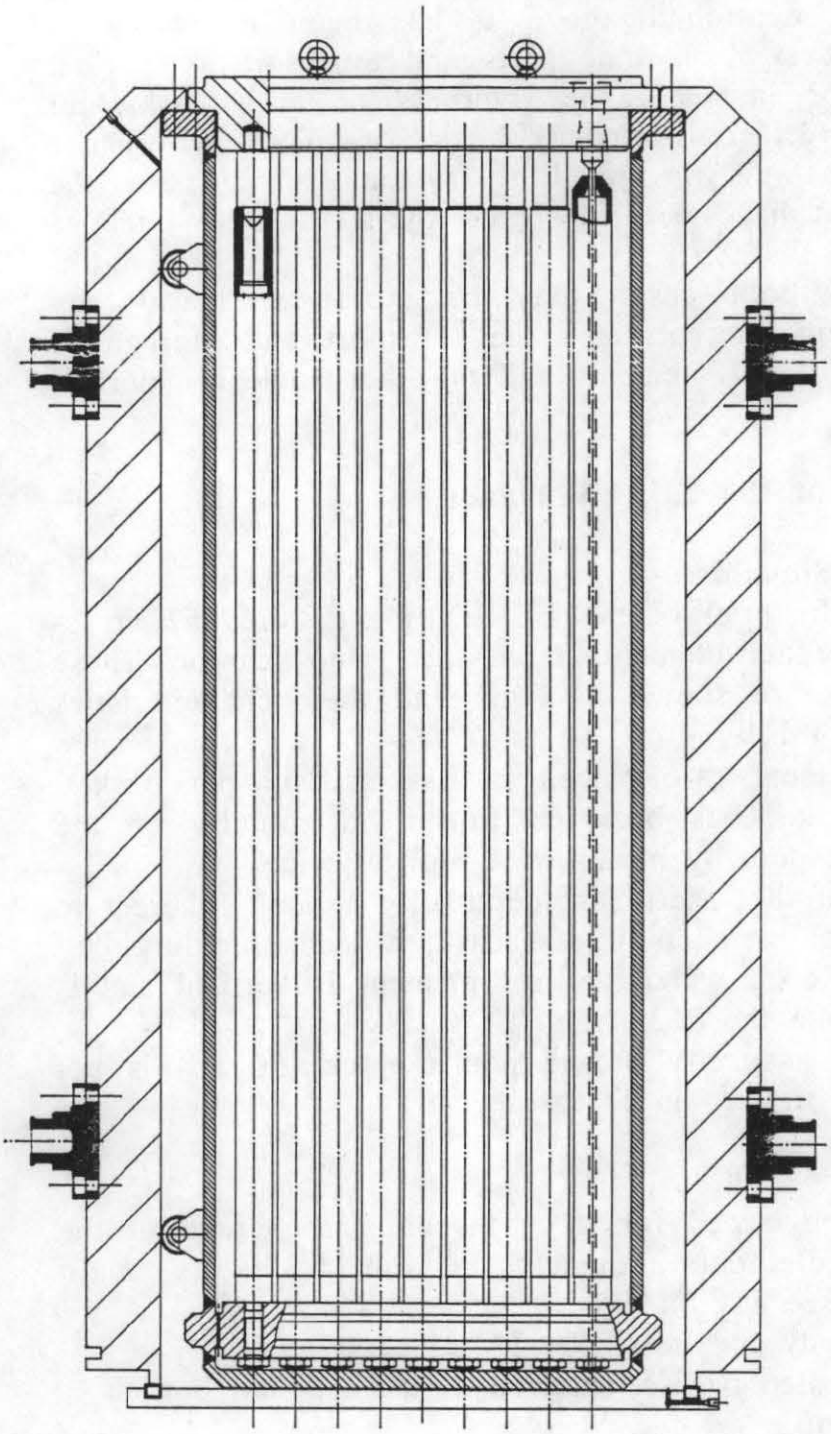

FIGURE 1. "TRINO - C" SHIELDED BASKET

TABLE 1. Characteristics of the Trino Fuel Cask

Contents	
Fuel element type	PWR
Number of fuel elements	52
Burn-up (MWd/tU)	25.000-35.000
Cooling time (y)	15
Initial enrichement (% U235)	2.7
Dimensions of sealed basket (mm)	
Cavity diameter	1.106
Cavity lenght	3.032
External diameter (with shield)	1.800
External lenght	3.512
Weights (Kg)	
Sealed basket	11.000
Removable shield	25.000
Fuel	3.800
Spacer	1.000
Total weight inside TN 24 cask	16.000
Total weight at the crane hook (without water)	42.000

TABLE 2. Characteristics of the Elk River fuel cask

Contents	
Fuel element type	UO2-ThO2
Number of fuel elements	84 (64+20)
Mean burn up (MWd/tU)	9.500
Max. burn up (MWd/tU)	13.000
Initial enrichement (% U235)	4.5
Dimensions (mm)	
Cavity diameter	1.710
Cavity lenght	2.417
Basket channel section	117x117
External diameter	2.120
Overall storage lenght	3.100
Weight (Kg)	
Total weight at the crane hook (without water)	44.000

The TN 24 cask (a) is very well known and will not be described here.
The basket (b) is a sealed cylindrical vessel with a flange on its upper side, welded next to the bottom to a thick plate; spacer tubes are connected to this plate to hold the fuel elements in position. The basket is provided with a welded bottom plate and at the top with a lid, acting also as a shield, bolted to the upper flange.
On the side of the vessel four wheels assist the introduction and extraction of the basket into and out of the cask, should these operations take place horizontally.
The filling and draining of the basket are carried out by means of a multifunction orifice similar to that of TN 24.
The additional shield (c) is used during the transfer of the basket from the bottom of the pool to the cask. It consists of a thick cylindrical shell in forged steel; its top is flanged to the basket and is provided with trunnions for handling. The shell is closed by a flanged bottom plate provided with an inflatable gasket to seal off the interspace between the basket and the shield; when the fuel is being loaded into the basket and shield system on the bottom of the pool, the interspace is pressurized in order not to contaminate the side of the basket (alternatively clean water may be circulated through the interspace).
To transfer the vessel inside the cask, the bottom plate of the shield is removed and the shield is connected to the cask's top flange by means of a locking device; then, after removing the bolts connecting the basket to the shield, the basket is lowered into the cask and placed on the spacer (d).
The cask is closed and its lid bolted; the cask is then tilted from vertical to horizontal by means of a hydraulic device and moved to an area outside the pool building for storage at the site or for transport to a reprocessing or an indipendent storage facility.

2. Storage at the ITREC Plant

2.1 Present Situation

In the pool at present there are 64 spent Elk River fuel elements, shown in Fig.2 and described in Table 2; they are

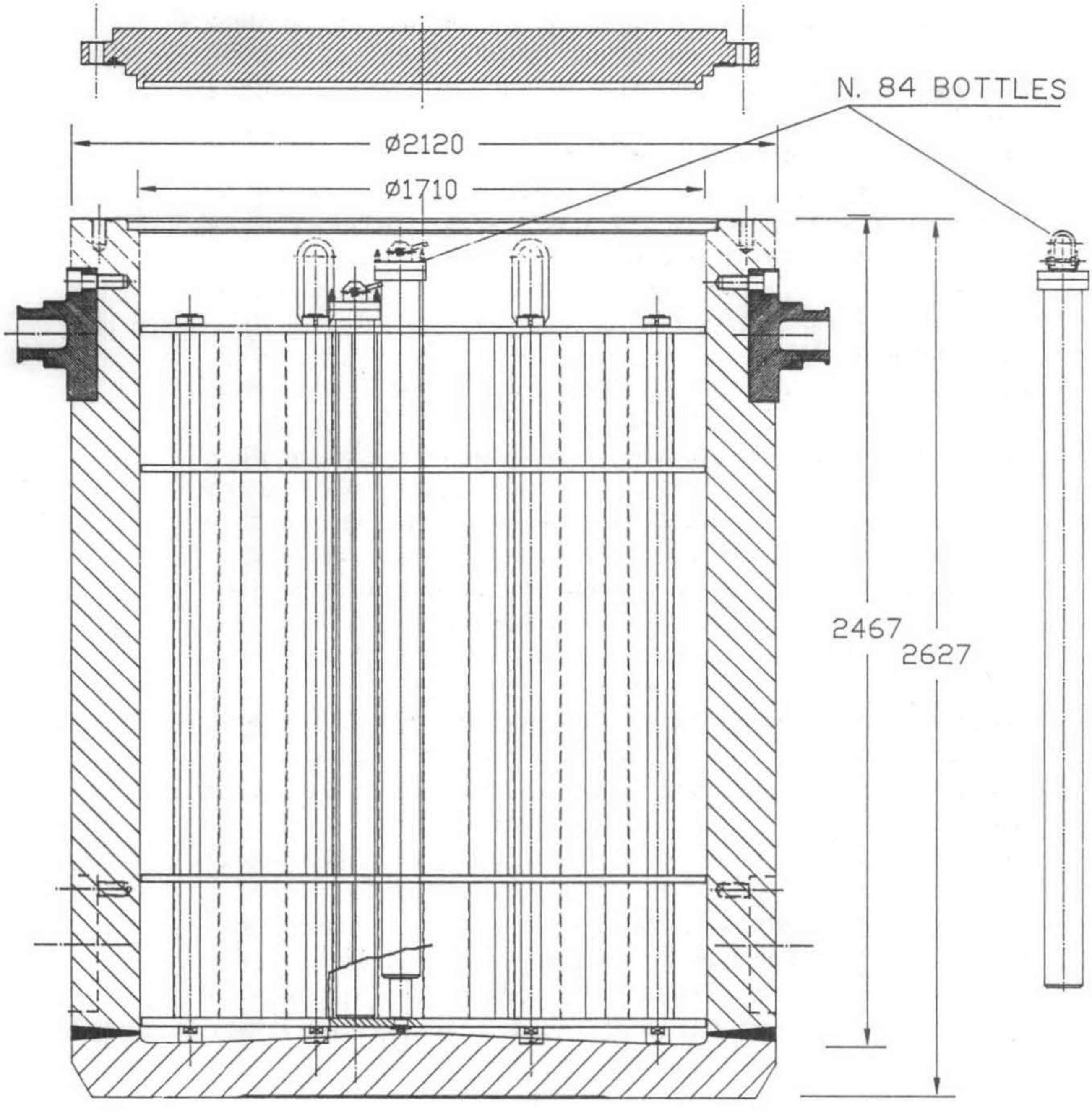

FIGURE 2. "ELK RIVER" STORAGE CASK

not going to be reprocessed but will be containerised in bottles and stored in the pool. Furthermore, the U-Th liquid solution, obtained from the reprocessing of 2O elements carried out at the plant, is to be turned into powder via the sol-gel process: the oxides produced will be put into 20 bottles, like those for the fuel.
It will be necessary in the near future to empty the pool of all the fuel stored there; different solutions have been considered, among these is the dry storage in a steel cask of the 64 bottled fuel elements and the 2O bottles with U-Th oxides. The cask taken as reference is Transnucléaire's TN 24.

2.2 Envisaged Solution
The body of the storage cask for the Elk River fuel (see Fig.2) consists of a thick cylindrical shell of forged carbon steel, butt welded to a forged carbon steel bottom.
The lid is made of a thick stainless steel plate, bolted to the body; sealing is ensured by a double O-ring metallic gasket, with a test orifice for the control of the leakage between the two gaskets. The gasket seals on the lid and the body have a stainless steel overlay.
The lid carries a multiple function orifice for filling, draining, drying and venting the cask and controlling its atmosphere.
During storage the main lid is protected by a cover that provides an additional barrier against leakage and preserves the metal gaskets and the flange bolts from corrosion.
The body and the lid of the cask ensure the containement of the fuel elements and the gamma shielding. On account of the small thermal load of the fuel there are no problems as regards heat removal: the cask's body is smooth and no fins are needed.
The body is equipped with two trunnions at the lid end for the handling of the cask; only two are necessary because the cask will be only moved vertically and no trunnions for tilting are provided, unless otherwise desired.
Inside the cavity a draining tube is installed and also the device for the alignement of the basket.
Protection against corrosion is provided by a metal coating deposited on all surfaces of carbon steel, while the outside

surfaces are painted as well, to protect them from atmospheric agents and to allow an easier decontamination.
The basket consists of square channels made of bended stainless steel sheets separated by boron steel plates for criticality control. The channels and the plates are held together by an upper and a bottom disk and by two intermediate disks appropriately formed and spaced. The upper disk, in particular, is machined to enable the accurate spacing of the bottles containing the fuel elements. The bottom disk is provided with supports which hold the bottles alternatively at two different heights thereby keeping the covers from interfering and reducing the diameter of the cask.
The principle characteristics of the cask are given in Tab.2.

3. Conclusions

Notwithstanding the peculiar characteristics of the fuel and the limitations existing at the plants (limited space and small handling capacity), two solutions have been found which allow the storage at the sites of all the fuel in two casks of large capacity.
Special arrangements have been designed in order to place all the fuel of the same type inside a single cask, thereby reducing the capital outlay.
In the case of the EUREX cask, in particular, resorting to a standard TN 24 cask on the one hand minimizes the licensing costs and on the other allows Italian industry to set up and qualify the fabrication processes necessary to build other casks of the same type (with different internals) such as may be required for the Italian nuclear activities.
Moreover, the manufacture and operation of the casks will allow Italy to obtain considerable experience concerning the dry storage of fuel in different operating conditions, and also regarding the licensing aspects of a dry storage facility.