
The Transport of Reprocessed Uranium

Y. Kotani, T. Ohtake, M. Kubo, T. Kitamura, T. Mochiji, T. Shigeto

Power Reactor and Nuclear Fuel Development Corporation, Tokyo, Japan

The Power Reactor and Nuclear Fuel Development Corporation (PNC) transports reprocessed uranium from the reprocessing plant to the refinement and conversion facility as a part of a reconversion testing program in an overall program of fuel cycle development. This report describes the methods employed in the transport of reprocessed uranium. The IAEA is now discussing internationally the definition of "Uranium", that is to say, including several different isotopes (U-232 and U-236 etc.) which are not present in natural uranium, and the categorization of the package. The reprocessed uranium is now often transported in different types of chemical forms as UO_3 , UF_6 and UO_2 . And it is found that the categories of the package become complex due to the respective different enrichment of the reprocessed uranium.

This paper shows the samples of the categorization of the package containing the reprocessed uranium. The reprocessed uranium is in the form of UO_3 in this paper, and its enrichment is considered to be less than 1.3%. The weight of the reprocessed uranium is assumed to be 295kg- UO_3 in a packaging. This reprocessed uranium can be categorized as LSA-II (Low Specific Activity) material, from the standpoint of IAEA Regulations on the Safe Transport of Radioactive Material (1985 Edition) as shown as follows :

A calculation to determine the value of A_2 for a shipment of the reprocessed uranium trioxide with 295kg- UO_3 is performed using the formula shown below:

$$A_2 \text{ value of the mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

Where:

$f(i)$: the fraction of activity of nuclide in the mixture

$A_2(i)$: A_2 value of each nuclide.

The calculation is summarized in the Table 1.

Table 1 $A_2(i)$ Value of the Mixture

Isotope	Radioactivity of Nuclide	$A_2(i)$ Value	$f(i)$	$f(i)/A_2(i)$ (1/Ci)
U-232	7.9×10^{-3}	8×10^{-3}	1.2×10^{-2}	1.5×10^0
U-234	2.8×10^{-1}	2×10^{-2}	4.4×10^{-1}	2.2×10^1
U-235	5.5×10^{-3}	————	8.6×10^{-3}	————
U-236	5.7×10^{-2}	2×10^{-2}	8.9×10^{-2}	4.5×10^0
U-238	8.1×10^{-2}	————	1.3×10^{-1}	————
Uranium daughter nuclide	1.6×10^{-1}	————	2.5×10^{-1}	1.3×10^{-2}
Transuranium nuclide	1.6×10^{-2}	————	2.4×10^{-2}	5.8×10^{-1}
Fission product	2.7×10^{-2}	————	4.2×10^{-2}	1.0×10^{-3}
Total	6.4×10^{-1}	————	= 1.0	28.59

This table shows that the A_2 value of the reprocessed uranium mixture is :

$$A_2 \text{ value of the mixutre} = \frac{1}{28.59} = 0.0350 \text{ Ci}$$

Therefore, under the criterion of LSA-II, $10^{-4}A_2/g$ is determined to be:

$$0.0350 \text{ Ci} \times 10^{-4}/g = 3.5 \times 10^{-6} \text{ Ci/g}$$

Secondarily, the specific activity (S.A.) of the 295kg- UO_3 is determined to be :

$$\begin{aligned} \text{S.A.} &= \frac{\text{The sum of activity of each nuclide}}{\text{The total amount of } UO_3} \\ &= \frac{6.4 \times 10^{-1} (\text{Ci})}{2.95 \times 10^5 (\text{g})} = 2.2 \times 10^{-6} \text{ Ci/g} \end{aligned}$$

Consequently, it has been shown that its specific activity is smaller than the IAEA limit value in terms of $10^{-4}A_2/g$ as LSA-II material. That is $2.2 \times 10^{-6} \text{ Ci/g (S.A.)} < 3.5 \times 10^{-6} \text{ Ci/g (} 10^{-4}A_2/g)$, then the UO_3 (the reprocessed uranium) is categorized as a LSA-II material. The above mentioned evaluation shows that this reprocessed uranium can be LSA-II material, and it applies to the type IP-2 package with fissile material.

The package for transporting this reprocessed uranium is named "UOX/A Package". Fig.1 and Table 1 show a general view of the package for the Reprocessed Uranium. The transportation of the reprocessed uranium is forecasted to increase in the future. And it is uncertain whether the reprocessed uranium with the different burnup rates and the re-enriched reprocessed uranium can be necessarily categorized as LSA-II material.

It is, therefore, very important to immediately discuss and harmonize the categorization of the package containing the reprocessed uranium on the international base in the near future.

FIG. 1 GENERAL VIEW OF THE PACKAGE FOR THE REPROCESSED URANIUM TRIOXIDE

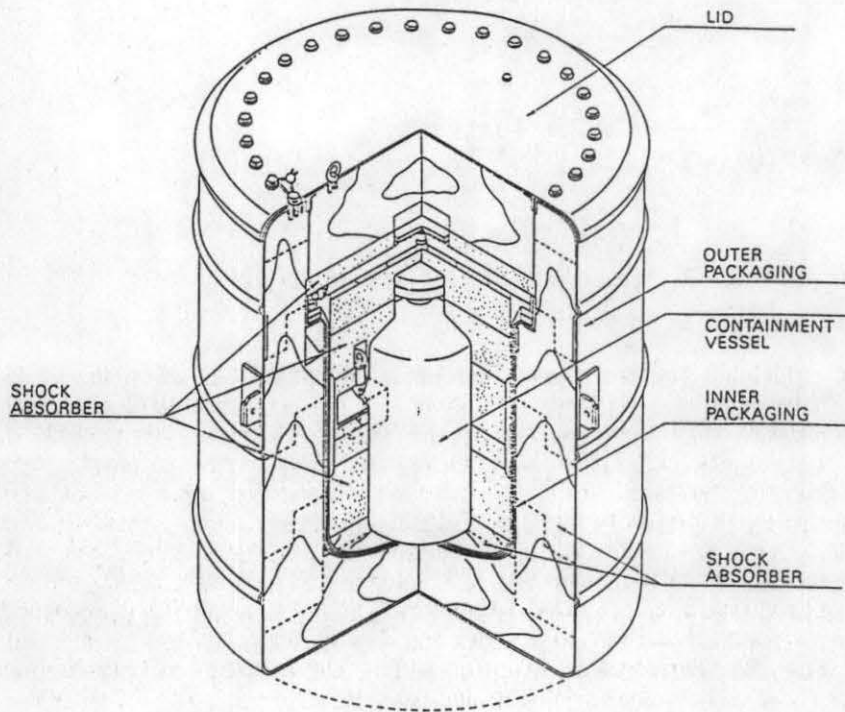


Table 2 Specifications of the UOX/A package

Items	Specifications
Weight of Package	1.6 MT
Size of Package · Outer Diameter · Height Diameter	Approx. 1.3m Approx. 1.6m
Main Materials · Structure · Shock Absorber	Carbon Steel Balsa Wood
Quantity of Radioactive Material · U-Metal · U-235	Max. 260kg Max. 4.16kg