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9 February 1959

AIR MAIL

Mr. Lyall Johnson
Licensing Branch
Div. of Licensing & Regulation
U. S. Atomic Energy Commission
Washington 25, D.C.

SUBJECT: Special Nuclear Material License SNM-33 - Shipping Containers for Fuel Elements

Dear Mr. Johnson:

Mallinckrodt Nuclear Corporation is preparing to manufacture for Allis-Chalmers several thousand fuel pins containing UO_2 pellets of nearly theoretical density. These pins are approximately 18" long and 7/16" diameter. Each pin will contain 255 grams of UO_2 at 1.8% enrichment. We propose to package 170 pins in a water-tight drum which has been thoroughly tested by the military services of the United States. The pins will be supported in this drum by polystyrene foam dunnage. Each drum will, therefore, contain

$$255 \times .8815 \times 170 = 32{,}216 \text{ grams U}$$

$$32{,}216 \times .018 = 687.89 \text{ grams } U^{235}$$

NOTE: Limited safe quantity of 1.8% assay uranium is 135 kg U per table XVII, K-1019 Part 4, Deleted.

The mechanical details of the package are shown on Drawing No. 3369-4 which is attached. The central drum holding the fuel tubes has the Military designation AN-8025-20 and is equipped with a heavy bolt ring closure to make it water tight. The outer drum will be a standard 55 gallon drum of commerce. Mechanically, this structure is very similar to one which has been given standard I.C.C. 4 Ft. drop tests by Mallinckrodt and it is anticipated that prior to Bureau of Explosives permission to use this container similar drop tests will be performed on this structure. The 55 gallon drum will be equipped with a quick-lock closure and a gasket to insure water tightness.

The calculations below are a comparison of the solid angle subtended by a central drum in a close packed hexagonal array with the solid angle subtended by the standard 20" birdcage used by the Atomic Energy Commission and its contractors for the past 15 years. This 20" birdcage is used for shipment of a maximum of 1000 kg of U^{235} per car and a limit of 11.5 kg of U^{235} per cage.

E-139

This particular birdcage is 20" on the edge exterior and the center pot has internal dimensions of 9-3/4" diameter and 5" deep. The pot is centered in the cage.

Solid Angle Subtended by Proposed Shipping Container (Using Method E-1, Page 11 of TID-7016)

$H = 18.75"$
$D = 10.5"$
$L = 18.5"$

$$\theta = \arctan \frac{\sqrt{(5.25)^2 + (9.25)^2}}{18.75} = .56747$$

$\theta = 29°34'$

$\sin \theta = 0.49344$

$$\Omega = \frac{2D}{H} \sin \theta = \frac{2(10.5)}{18.75} \times 0.49344$$

$\sum \Omega = 6\Omega = 3.3159$ steradians

$3.3159 = 26.388\%$ of 4π steradians.

For the 20" birdcage of the Commission and its contractors, using the same method, we must consider a nine cage array in a single layer square.

Ω_1 is for adjacent containers - Ω_2 is for the corner containers.

For Ω_1

$$\theta = \arctan \frac{\sqrt{(4.875)^2 + (2.5)^2}}{15.125} = 0.3623$$

$\theta = 19°55'$

$\sin \theta = 0.34065$

$$\Omega_1 = \frac{2D}{H} \sin \theta = \frac{2 \times 9.75}{15.125} \times .34065$$

$\Omega_1 = 0.4391$

For Ω_2

$$\theta_2 = \arctan \frac{\sqrt{(4.875)^2 + (2.5)^2}}{23.425} = 0.2239$$

$$\theta_2 = 13°10''$$

$$\sin \theta_2 = 0.22778$$

$$\Omega_2 = \frac{2 \times 9.75}{23.425} \times 0.22778 = 0.1896$$

$$\Sigma \Omega = 4\Omega_1 + 4\Omega_2 = 2.5148 \text{ steradians}$$

$$2.5148 = 20.5\% \, 4\pi$$

NOTE: These calculations are made for a single layer array; however, the drawing of this birdcage distinctly shows stacking lugs on the top side of the cage. It must, therefore, be assumed that these birdcages are in fact stacked when used by AEC contractors for shipments of large quantities. The solid angle calculated above would be very conservative under these circumstances.

The following table compares the proposed shipping container with the standard 20" AEC birdcage on a series of points:

	AEC 20" Birdcage	Proposed Shipping Container
Water tightness	One gasket	Double drum, both gasketed
U^{235}	11.5 kg	0.688 kg
Carload quantities	1000 kg U^{235}	47.16 kg U^{235}
Edge to edge spacing	10.5"	13.5"
Solid angle subtended	20.5% of 4π	26.4% of 4π
Material to be shipped	Solid uranium metal or compounds - any enrichment	UO_2 pellets in sealed aluminum tubes

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Shipping [illegible]

Based on the fact that the proposed shipping container offers a considerably greater margin of safety than the 20" ANC birdcage from the standpoint of (1) quantity to be shipped, (2) edge to edge spacing, (3) protection from damage, and (4) water in-leakage, we request approval for shipment of single layer loads by any common carrier method.

Very truly yours,

MALLINCKRODT NUCLEAR CORPORATION

W. M. Leaders

W. M. Leaders
Technical Director

WML:dj