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EXTRA

**MALLINCKRODT  
NUCLEAR  
CORPORATION**

SAINT LOUIS 7, MISSOURI • U.S.A. • CENTRAL 1-8980

July 8, 1960.

Mr. J. C. Delansy  
Division of Licensing and Regulation  
U. S. Atomic Energy Commission  
Washington 25, D. C.

**SUBJECT:** Extension of SMR-33 to include a birdcage  
for the shipment of  $UF_6$  in 8" diameter cylinders

Gentlemen:

We have recently been informed that  $UF_6$  enriched between 3.75% and 12.5% will be supplied in 8 inch diameter cylinders. The birdcage required for the shipment of this cylinder must be supplied by Mallinckrodt.

Enclosed is a copy of a report titled, "Birdcage For Eight Inch Diameter  $UF_6$  Cylinders". This report describes the proposed method of shipment and the nuclear safety of such a shipment. As pointed out in the report all shipments will be made via exclusive use of the truck with a maximum of 24 cylinders per truck.

We are respectfully requesting extension of our SMR-33 license to include the shipments of  $UF_6$  as described in the enclosed report.

Please let us know if you require additional information in order to approve this extension.

Respectfully yours,

MALLINCKRODT NUCLEAR CORPORATION

L. J. Swallow  
Hematite Plant

LJS/lb

B-64



THE WORLD'S FIRST AND LEADING PRODUCER OF NUCLEAR FUELS

MALLINCKRODT NUCLEAR CORPORATION  
St. Louis 5, Missouri

BIRDCAGE FOR EIGHT INCH DIAMETER UF<sub>6</sub> CYLINDERS

Future shipments of UF<sub>6</sub> enriched between 3.75% and 12.5% will be made in an eight inch diameter UF<sub>6</sub> cylinder. This is depicted in Figure A (6) on Page 32 of the TID 7019, "Guide to the Shipment of U<sup>235</sup> Enriched Uranium Materials". Data pertinent to this cylinder follows:

Dimensions: 8" I.D. x 48" High  
Capacity: UF<sub>6</sub> = 250 pounds (114 kilograms)  
U<sup>235</sup> = 21.2 pounds (9.6 kilograms) at 12.5% enrichment  
= 6.34 pounds (2.88 kilograms) at 3.75% enrichment

Since this cylinder is owned by Union Carbide Nuclear Company (as agents for the Atomic Energy Commission) it is assumed that this cylinder has already been licensed and no further comment on this cylinder is required.

It is planned to ship the UF<sub>6</sub> cylinders, described above, by exclusive use of the truck. To provide the necessary space between cylinders, it is planned to package the cylinder in the birdcage shown on Mallinckrodt Drawing No. 3226-3. This is the same birdcage already licensed for the shipment of UF<sub>6</sub> in standard MD cylinders.

It is generally known that UF<sub>6</sub> will react with water forming UO<sub>2</sub>F<sub>2</sub>; consequently, extreme care is exercised to keep water away from the UF<sub>6</sub> resulting in a water content very much less than 1% by weight. If a 1% water content is assumed the H/U<sup>235</sup> ratio at a 12.5% enrichment is 3.1; similarly, at an enrichment of 3.75% the H/U<sup>235</sup> ratio is 10.3. The limited safe mass, as listed in Table III of TID 7019, corresponding to the above moderation is 14 kilograms of U<sup>235</sup> and 4.5 kilograms of U<sup>238</sup>, respectively. Comparison of these quantities to the actual capacity listed above shows that each cylinder will contain less than a limited safe quantity determined for extreme conditions. Therefore, the cylinders may be considered under conditions of mass and moderation control. Thus, a multiplication factor, K, of .65 may be assumed, and the maximum permissible solid angle is 2.5 steradians as per paragraph 2a on Page 22 and Figure 5 of TID 7019.

Appendix

As shown on the referenced drawing, the overall dimensions of the birdcage are 3'-1-1/4" x 3'-1-1/4" x 4'-10" high. The inside dimensions of a standard trailer are 7'-11" high x 7'-8" wide x 39'-7" long. Comparing the birdcage dimensions to the trailer dimensions it can be seen that only two rows of birdcages in a single layer can be loaded. Under these conditions, no more than 24 birdcages can be loaded in a trailer.

The interaction solid angle was calculated in accordance with Figure B1 in Appendix 4 of TID 7019. For the single shipment of 24 cylinders the solid angle subtended by the most central unit is 1.39 steradians. In the event a twin shipment of 24 cylinders is placed along side, the maximum solid angle is 2.37 steradians.

MALLINCKRODT NUCLEAR CORPORATION  
St. Louis 5, Missouri

Birdcage for eight inch diameter  $UF_6$  Cylinder  
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On the basis of the above discussion, the safety of a 24 cylinder shipment can be summarized as follows:

1. Each cylinder contains less than the limited safe mass of  $U_{235}$ .
2. The dimensions of the birdcage makes double stacking on the truck impossible.
3. The spacing provided by the birdcage is more than enough to make the shipment safe in the event a second truck with an identical shipment is placed along side.
4. The safety factors inherent in TID 7019 have in no way been reduced.