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EVALUATION OF L-3 SHIPPING PACKAGE
FOR SHIPMENT OF URANIUM 233 NITRATE
(²³³UNH) SOLUTION

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The three-liter, type L-3, shipping package (also known as the Model BP-1 by the General Electric Company, and the Bettis Atomic Power Laboratory) is approved for the transport of Uranium 235 and plutonium 239 as both nitrate solutions and oxides by the Department of Transportation (DOT).

This document provides information to support a request for the addition of ²³³UNH solution to the authorized commodities listed in DOT Special Permit No. 5330, for the Type L-3 shipping package.

This evaluation shows that:

- . The ²³³UNH solution is compatible with the materials of construction of the L-3 package.
- . Up to 100 L-3 packages can be transported together on the same vehicle as a Fissile Class II shipment.
- . As a Fissile Class II shipment of ²³³UNH each L-3 package would carry a Transport Index of 0.5.
- . Up to 270 L-3 packages can be transported together on the same vehicle as a Fissile Class III shipment.
- . All other conditions of DOT-SP-5330 remain unchanged.

In making this evaluation it was noted that ^{233}UNH has been safely shipped previously in these containers, under a Bureau of Explosives approval. The DOT has currently authorized shipment of ^{233}UNH under SP-5795, in the Oak Ridge "Foamglas Container." This container has the same overall outside dimensions and inner (Spec. 2R) container as the L-3 package; it differs in that it is insulated with foamed glass instead of vermiculite.

The addition of ^{233}UNH as an authorized commodity for the L-3 package requires determination of compliance with AEC Appendix 0529, Sections II.A.1, II.I, and II.J. Compliance with all other regulations remains as stated in DOT-SP-5330.

The materials of construction of the L-3 package have been demonstrated to be compatible with both uranium and plutonium nitrate solutions. These containers have been used in this service for at least five years with no evidence of deterioration from attack by the lading.

Since the $^{233}\text{uranium}$ isotope is a fissile material, it is necessary that the number of L-3 packages which constitute a 3-dimensional critical reflected array be calculated. From this array the number of packages permitted to be transported as Fissile Class II and Class III shipments is determined.

The calculation of the number of L-3 packages which constitute a critical reflected array was made using the KENO code and the Hansen-Roach 16 group cross sections. The calculation assumed that:

- . The array was reflected by twelve inches of Portland concrete.

. Each package contained 1.58 kilograms of ^{233}U .

(Approximately 3.5 liters of ^{233}UNH having 450 grams of ^{233}U per liter of solution.)

The critical reflected array is calculated to be 600 L-3 packages. [1]

In determining the number of packages which could be transported as a Fissile Class III shipment, the calculated critical reflected array (600 L-3 packages) is reduced by ten percent. This is done to assure compliance with AEC Appendix 0529. The allowable number of containers, quantity of material, etc., for Fissile Class II and Class III shipments is shown in the following table. The limits shown are more conservative than required by the regulation because concrete was assumed to be the reflector.

TABLE I

<u>Type of Contents</u>	<u>Quantity Per Package</u>	<u>Fissile Class II Transport Index</u>	<u>Fissile Class III Maximum Packages Per Vehicle</u>
Uranium ^{233}U Nitrate	1.58 Kg*	.5**	270

* 15.01 Curies ^{233}U .

** 100 L-3 packages per Class II shipment.

Compliance with specific items of AEC Appendix 0529 is stated below.

II. PACKAGE STANDARDS

A. General Standards for All Packaging

1. Packages shall be of such materials and construction - - - contents.

There is no reaction between the ^{233}UNH and the package materials.

I. Specific Standards for a Fissile Class II Package

1. A fissile Class II package shall be - - - - so limited that:

a. Five times that number of such undamaged packages would be subcritical in any arrangement if closely reflected by water.

An array of 600 L-3 packages is a critical array when reflected by 12 inches of Portland concrete, but it is less than a critical array when reflected by water. The allowable number of L-3 packages for a Fissile Class II shipment is calculated as follows:

$$\frac{5 \times 50}{600} = 0.417 \text{ rounded up to nearest tenth} = 0.5$$

$$50 \div 0.5 = \frac{100}{\text{shipment}} \text{ L-3 packages per Fissile Class II shipment}$$

$$100 \times 5 = 500 < 600 \therefore \text{The array is subcritical.}^{[1]}$$

b. Twice that number of packages would be subcritical if - - - - as described in "G" above.

$$100 \times 2 = 200 \text{ L-3 packages}$$

$$200 < 600 \therefore \text{the array is subcritical}$$

This condition is less reactive for the L-3 package than that described in "a" above.^[2,3]

2. The transport index for each Fissile Class II package is calculated by dividing the number 50 by the number of such Fissile Class II packages which may be transported together as determined under the

limitations of "1" above: The calculated number shall be rounded to the first decimal place.

$$\frac{50}{100 \text{ L-3 packages}} = 0.5 \text{ Transport Index}$$

J. Specific Standards for Fissile Class III Shipment

A package for Fissile Class III shipment shall be so designed and its contents so limited that:

1. The undamaged shipment would be subcritical with an identical shipment in contact with it and with the two shipments closely reflected on all sides by water.

270 L-3 packages (Table I) are authorized for a Class III Shipment.

$$270 \times 2 = 540$$

540 < 600, therefore it would be subcritical.

2. The shipment would be subcritical if each package were - - - - shipment.

270 is much less than 600, therefore the shipment is predicted to be subcritical under the condition described. [2,3]

Since the critical array calculations were made assuming that the reflector was twelve inches of Portland concrete, the number of containers which comprise a critical array is considerably smaller than would be calculated for a water reflected array. This conservatism is considered acceptable.

REFERENCES

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of Interspersed Moderation on Array
Criticality."
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W. T. Mee, and R. H. Pletz, "Evaluation of a
Shipping Container for Enriched Uranium
Solution."