GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION

GENERAL ELECTRIC COMPANY . . . . VALLECITOS NUCLEAR CENTER
VALLECITOS ROAD, PLEASANTON, CALIFORNIA 94566, Phone (415) 862-2211

IRRADIATION PROCESSING OPERATION

July 3, 1973

Mr. C. E. MacDonald, Chief
Transportation Branch
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Ref: 1) License SNM-960
Docket 70-754
2) Amendment 71-32 to SNM-960, 4/18/69
3) Amendment 71-50 to SNM-960, 4/5/71

Dear Mr. MacDonald:

General Electric has shipped large quantities of byproduct materials and limited quantities of fissile materials in the Model 1600 Shipping Cask under Amendments 71-32 (4/18/69) and 71-50 (4/5/71) to License SNM-960 without incident for several years. General Electric now petitions the Atomic Energy Commission for an amendment to SNM-960 which will increase the allowable loading of fissile material.

Specifically, General Electric requests that the fissile loading of the Model 1600 Shipping Cask be increased to 1200 grams provided: (1) the fissile material is contained in standard waste liners constructed of 5-inch schedule 40 pipe with a maximum inside length of 39-5/16 inches, (2) no more than four such liners are shipped at one time, (3) each liner contains no more than 300 grams fissile, and (4) the cask is provided with a positioning lattice such that the geometry shown in Figure 1 is maintained. The purpose of the positioning lattice is to improve the criticality characteristics of the cask. However, as noted in the criticality analysis, the liner is not necessary to maintain the cask in a subcritical condition (i.e., the close proximity cases).

The waste liners are closed with either a bronze or brass screw top with a ¼-inch "O" ring gasket. The gasket material may be either buna-N rubber or neoprene.

The cask will be shipped as Fissile Class III.

The criticality analysis was performed using the computer code ANISN[1], a discrete ordinates, one-dimensional transport theory code. The problem was solved in two parts using geometries as shown on Figure 1. The dimensions and material regions for this figure are given in Tables 1 and 2. The normal transport configuration is shown on Figure 1 as solid lines. The dotted lines represent one of the accident cases considered.

From this analysis we conclude that the 1600 series cask is critically safe for the shipment of four standard waste liners each containing 300 gm fissile (Pu^{239}, U^{233}, or U^{235}) for a total cask limit of 1200 grams fissile. This limit is safe with no restriction as to fissile type or composition.

Four cases were considered in this analysis, the design shipping geometry, the design geometry flooded, and the cases when the four liners are in close proximity. These geometries are shown in Figure 1. The results of the criticality calculations are as follows:

1. Design Geometry $k_{eff} = 0.720$
2. Design Geometry - Flooded $k_{eff} = 0.713$
3. Close Proximity Geometry $k_{eff} = 0.959$
4. Close Proximity - Flooded $k_{eff} = 0.976$

The case of two casks adjacent to each other was considered by calculating the infinite multiplication (k_∞) and migration area (M^2) from properties determined by the ANISN calculation for the cask. The effective multiplication of the two cask system was then determined from the buckling relationship. This value was found as:

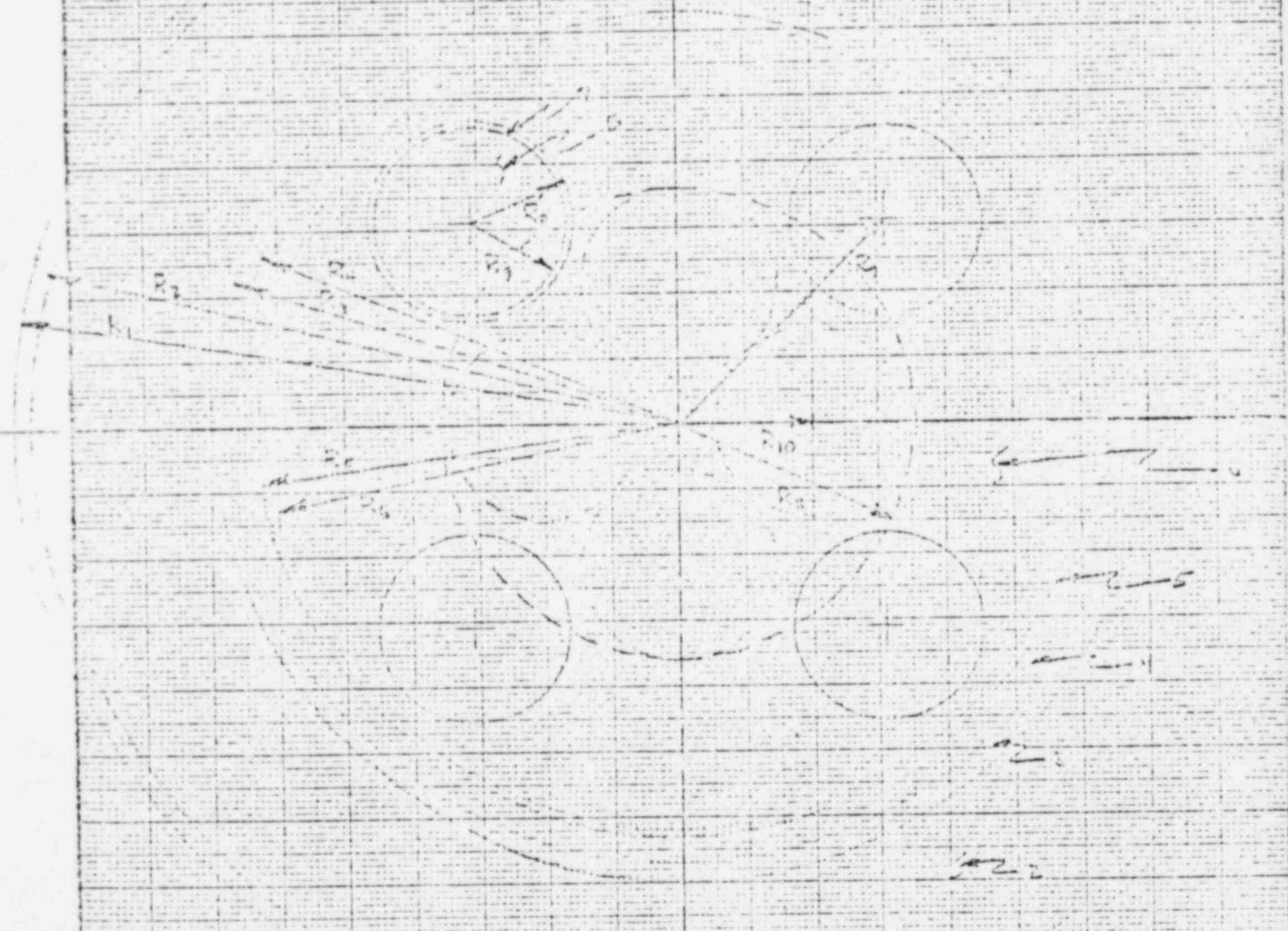
$$k_{eff} = 0.773$$

Table 1. 1600 Series Cask Dimensions

Radius	R-cm
R1	48.895
R2	47.625
R3	34.925
R4	33.655
R5	31.4325
R6	31.115
R7	Dimension determined by liner cell calculation*
R8	7.7203
R9	7.065
R10	Dimension determined by liner cell calculation*
R11	17.96

$*R = 1.414 \sqrt{R_c^2}$, where R_c = liner cell radius volume

1600 Series Cask



K+E 10 X 10 TO THE CENTIMETER 46 1510
KEUFFEL & ESSER CO.

POOR ORIGINAL

Table 2. Material Regions

Region	Material	Identification
1	Stainless	Outer Liner
2	Lead	Shield
3	Stainless	Inner Liner
4	Void	Void
5	Stainless	Liner Bucket
6	Fuel Cell	Homogenized Fuel, Liner, Void
7	Aluminum	Liner
8	Fissile Material	Fuel Material

The first part of the problem consisted of an infinite cylinder cell calculation for the individual fuel liners. This calculation was performed to obtain cell-weighted cross-sections to be used in subsequent calculations. Each cell consisted of the fissile material/moderator combination contained within the waste liner, the waste liner itself, and the void surrounding each liner. The waste liner dimensions are as shown in Table 1. Each liner was assumed to contain 300 grams of plutonium-239, the VNC limit for each liner, with the remainder of the liner filled with water. For the actual waste liner volume, the resulting Pu density was $0.023 \frac{\text{gm Pu}}{\text{cm}^2}$.

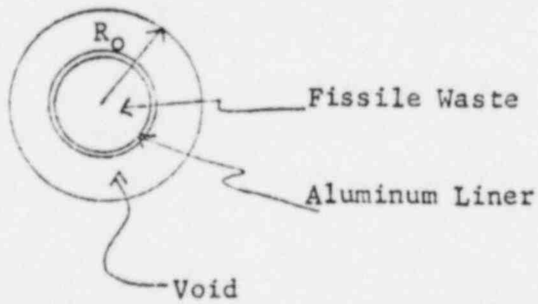
The volume fraction for the water was determined by assuming a theoretical plutonium density of 11.46 gm/cm^3 (the most likely density of fissile waste material to be shipped). The atom densities used in the cell calculation are shown in Table 3:

Table 3. Atom Densities

Calculation	Material	Isotopes	Atom Densities (Atom/b-cm)
Liner Cell	Liner	Aluminum	6.023×10^{-2}
	Fissile	Plutonium-239	5.796×10^{-5}
		Hydrogen	6.673×10^{-2}
		Oxygen	3.337×10^{-2}
Cask	Stainless	Iron	6.01×10^{-2}
		Chromium	1.72×10^{-2}
		Nickel	8.81×10^{-3}
	Shield	Lead	3.31×10^{-2}

For the normal shipping configuration, the cell size was determined by dividing the total volume of the cask cavity into four equal volumes and calculating an equivalent cell radius. This radius represented the outer dimension of the ANISN problem with void between this and the actual outer diameter of the liner. For normal shipping configuration, this dimension was: R_o = 15.55 cm. For the case where the liners were assumed in close proximity, as shown by the dotted circles in Figure 1, this dimension was taken as: R_o = 8.98 cm. The geometry used in the liner cell calculation is shown in Figure 2.

Figure 2. Liner Cell Geometry



The problem was set up for ANISN using Los Alamos 16-group cross-section sets(2, 3, 4) with P_1 scattering. The problem was calculated for an infinite cylinder with a "white" boundary condition on the outer diameter. The output from the calculation included flux and cell volume weighted 16-group macroscopic cross-sections.

The second part of the problem consisted of evaluating the criticality safety of the entire cask. This was also done using ANISN where the neutron cross-sections obtained from the liner cell calculation were used for the material region that included the liners. For the normal transport configuration, this region included the entire volume within the stainless liner bucket. The dimensions for the "close proximity" case, the dotted areas in Figure 1, were determined by considering the total volume for four liner cells and calculating an equivalent radius for that volume. The region between this volume and the stainless liner bucket was assumed to be void. One additional off-normal case was considered, the normal transport geometry-flooded. This was done by substituting water for void in the cell calculation to obtain cross-sections for the cask calculation.

General Electric believes that the above analysis clearly demonstrates the safety of the proposed fissile load for the Model 1600 Shipping Cask.

Attachment A to this subm'ttal contains the revised pages to our basic application for the Model 1600 (Appendix D to License SNM-960).

General Electric also requests that the provisions of this submittal and the provisions of Amendments 71-32 and 71-50 be consolidated into a single amendment to SNM-960 and that the new composite amendment be approved under the General License provisions of 10CFR71.12(b) (new designation).

Thank you for your timely consideration of this application.

Sincerely,

G. E. Cunningham
Administrator - Licensing

gw

Att.

References

1. Engle, W. W., "A User's Manual for ANISN", K-1693, Union Carbide, Oak Ridge, Tenn., March 30, 1967.

2. Hansen, G. E. and Roach, W. H., "Six and Sixteen Group Cross-Sections for Fast and Intermediate Critical Assemblies", LAMS-2543, Los Alamos Scientific Lab, Los Alamos, New Mexico, November, 1961.

3. Connolly, L. D., et al., "Los Alamos Group Averaged Cross-Sections," LAMS-2941, Los Alamos Scientific Lab., Los Alamos, New Mexico, July, 1963.

4. Personal Communication, Smith, D. R. to Walker, E. E., Los Alamos Scientific Lab, Los Alamos, New Mexico, February 26, 1971.

ATTACHMENT A

Amended Pages to Appendix D, SNM-960

Size: Bottom plate is 68 inches square and ½-inch thick. The cylindrical collar is 39 inches in diameter by 3 inches high. The I-beams are 3 inches high by 68 inches long.

Construction: The cylindrical collar houses two sets of 1-½ inch by 1-½ inch by ¼-inch steel energy absorbing angles separated by a ½-inch thick carbon steel mid-plate. The cask rests on this assembly. The collar is welded to the ½-inch thick carbon steel base plate. Four I-beams are welded in parallel to the base plate.

Attachment: Two diametrically opposed tie blocks to accept jacket attachment bolts.

5.12.2 Package Description - Contents

(a) General: Radioactive material as the metal or metal oxide, but specifically not loose powders. Two ABC neutron sources ($\leq 1 \times 10^9$ n/sec/source).

(b) Form: Clad, encapsulated or contained in a metal encasement of such material as to withstand the combined effects of the internal heat load and the 1475°F fire with the closure pre-tested for leak tightness.

(c) Fissile Content: Not to exceed 500 grams of U-235, 300 grams U-233, 300 grams Pu, or a pro-rated quantity of each such that the sum of the ratios does not exceed unity,* or not to exceed 1200 grams fissile provided: (1) the fissile material is contained in standard waste liners constructed of 5-inch schedule 40 pipe with a maximum inside length of 39-5/16 inches,

(2) no more than four such liners are shipped at one time, (3) each liner contains no more than 300 grams fissile, and (4) the cask is provided with a positioning lattice to maintain separation between the liners.*

(d) Radioactivity

That quantity of any radioactive material which does not generate spontaneously more than 600 thermal watts by radioactive decay (50 thermal watts for the wet shipment) and which meets the requirements of 49CFR173.393.