PDR 71-5980

GENERAL ELECTRIC

NUCLEAR ENERGY

ENGINEERING

DIVISION

GENERAL ELECTRIC COMPANY, P.O. BOX 460, PLEASANTON, CALIFORNIA 94566

October 10, 1979

Mr. Charles E. MacDonald, Chief
Transportation Branch
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Ref: Certificate of Compliance No. 5980

Dear Mr. MacDonald:

The General Electric Co., Vallecitos Nuclear Center (VNC), requests that Certificate of Compliance No. 5980 for the G.E. Model 600 shipping container be renewed.

In support of this request we are enclosing a consolidation of our original application with subsequent applications for amendment into a single package. This consolidation includes the changes contained in our application of October 8, 1979. The submittal of May 21, 1974, a criticality analysis demonstrating the safety of the approved 1200 gram fissile loading is enclosed as Attachment A.

As the certificate expires on October 31, 1979, and as the container is in frequent use, VNC requests that a temporary extension be granted to permit the use of the container while the application for renewal is evaluated.

Enclosed is a check for $150.00 for the renewal fee as required by 10CFR170.31.

If your staff has any questions concerning this application for renewal, please contact me at 415-862-2211, Ex. 4330.

Sincerely,

G. E. Cunningham
Sr. Licensing Engineer

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cc: R. R. Rawl
U.S. Dept. of Transportation
Office of Hazardous Materials Operations
Washington, D.C. 20590

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GENERAL ELECTRIC SHIELDED CONTAINER - MODEL 600

1.0 Package Description - Packaging

(a) General: All containers of this model, for purposes of constructing additional containers of this model, will have dimensions of plus or minus 5% of the container dimensions specified in this application, and all lifting and/or tiedown devices for additional containers of this model if different from the lifting and/or tiedown devices described in this application will satisfy the requirements of 10CFR71.31(c)(d).

This container is detailed in G.E. drawings 161F470, 693C293, 144F650, 212E247, 106D3892, 129D4684, 129D4685, 195F162, and 106D3898 attached.

Shape: An upright circular cylinder shielded cask and an upright circular cylinder protective jacket with attached square base.

Size: Shielded cask is 34 inches in diameter by 59-7/8 inches high. The protective jacket is 72-7/8 inches high by 63-1/2 inches across the box section. The base is 63-1/2 inches square.

Construction: The cask is a lead-filled carbon and stainless steel weldment. The protective jacket is a double walled structure of 1/2 inch carbon steel plate and surrounds the cask during transport. The square base is 1/2 inch carbon steel with four I-beams attached.

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1.0 Package Description - Packaging (continued)

(a) (continued)

Weight:	The cask weighs 15,000 pounds. The protective jacket and base weigh 3,000 pounds. The weight of the additional plastic shielding for neutron sources is approximately 750 pounds. The lead liners weigh 500 pounds and 4810 pounds respectively for a maximum total weight of approximately 23,300 pounds.

(b) Cask Body

Outer Shell:	3/8 inch thick steel plate, 59-7/8 inches high by 34 inches diameter with a 3/8 inch bottom plate and a 3/8 inch top flange.
Cavity:	3/8 inch stainless steel wall and bottom plate, 20-1/2 inches inner diameter by 46 inches deep.
Shielding Thickness:	6 inches of leak on sides, 6 inches of lead beneath cavity. In the wet shipment case the cavity will be filled with water with a 5 inch air space.
Penetration:	One 1/2 inch outer diameter by 0.063 wall stainless steel tube gravity drain line from the center of the cavity bottom to the side of the outer shell near the cask bottom with a 1/2 - 14 NPT pipe plug. General Electric may, at its discretion, permanently close and seal the drain line for this container model with no interference to other structural properties of the cask.
Filters:	None.
Lifting Devices:	Two diametrically opposed ears welded to sides of cask, covered by protective jacket during transport. Two additional ear mounting hole patterns are provided for redundant ears which are shipped separately.

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1.0 Package Description - Packaging (continued

(b) Cask Body (continued)

Primary Coolant:	Air

(c) Cask Lid

Shape:	A right conical cylinder attached to flat plate
Size:	Top plate is 34 inches diameter by 3/4 inch thick. Bottom plate is 24 inches diameter by 3/8 inch thick. The conical cylinder is 26-1/4 inches diameter at top by 6-3/8 inches high by 24 inches diameter at bottom.
Construction:	Lead-filled steel clad cylinder welded to circular steel plates.
Closure:	Six - 1 inch - 8-UNC-2A steel bolts equally spaced 60° apart on a 30 inch diameter bolt circle.
Closure Seal:	A minimum 3/16 inch thick flat silicone rubber or equivalent gasket between body and lid.
Penetrations:	None.
Shield Expansion Void:	None.
Weight:	1450 pounds.
Lifting Device:	Single steel loop, 1 inch diameter steel rod located in center of lid top. Covered by protective jacket during transport.

1.0 Package Description - Packaging (continued)

(d) Liner - Inner Liner:

Shape:	Basically a right circular cylinder with a hollow center.
Size:	7-1/2 inch outer diameter by 3-3/8 inch inner diameter by 36 inches high.
Construction:	1/8 inch thick top and bottom circular plates welded to 1/8 inch thick lead-filled stainless steel clad cylinders.
Weight:	500 pounds
Attachments:	3/8 inch diameter stainless steel curved rod 7 inches long is attached to the top plate.

Liner - Outer Liner (Body)

Shape:	Basically a right circular cylinder with a hollow center.
Size:	20 inch outer diameter by 7-7/8 inch inner diameter by 43 inches high.
Construction:	3/8 inch thick top and bottom circular plates welded to 3/8 inch thick lead filled stainless steel clad cylinders.
Weight:	4530 pounds (without lid).
Attachments:	Two - 3/4 - 10UNC-2B x 2 inch deep holes 180° apart in top plate to accept a 3/4 - 10UNC-2A eyebolt.

Liner - Outer Liner (Lid)

Shape:	Two right circular cylinders of different diameters attached to flat plates.

1.0 Package Description - Packaging (continued)

(d) Liner - Inner Liner (continued)

Liner - Outer Liner (Lid): (continued)

Size:	All plate is 3/8 inch thick. Top plate is 17 inches diameter while the bottom plate is 14 inches diameter. Both cylinders are 2 inches high.
Construction:	Lead filled steel clad cylinders welded to circular steel plates.
Weight:	280 pounds.

Liner - Polyethylene:

Shape:	A right circular cylinder with a hollow center cavity.
Size:	20-inch outer diameter by 38-3/4 inches high; the inner cavity is 2-1/4 inches in diameter by 22-1/4 inches deep; the liner is equipped with an 8-inch diameter by 8-1/2 inch stepped plug.
Construction:	The liner is of 6061 aluminum with welded construction. The cylinder walls are 1/8-inch thick. The top and bottom plates on the lid and the bottom of the cylinder are 1/4-inch thick. The top plate of the cylinder is 1/2 inch thick. Shielding is provided by 2% borated polyethylene filler.
Weight:	Approximately 750 pounds.
Attachments:	Two 3-inch by 3-inch by 1/2-inch ears with 1-1/2 inch diameter connection holes for lifting device attachments.

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1.0 Package Description - Packaging (continued)

(e) Protective Jacket Body

Shape:	Basically a right circular cylinder with open bottom and with a protruding box section diametrically across top and vertically down sides.
Size:	72-7/8 inches high by 63-1/2 inches wide across the box section. Outer cylindrical diameter is 40-1/2 inches. Inner diameter is 36 inches. A 5-1/2 inch wide by 1/2 inch thick steel flange is welded to the outer wall of the open bottom.
Construction:	Carbon steel throughout. Double walled construction. The walls are 1/2 inch thick. One and a quarter inch air gap between cask shell and inner jacket wall and a one and a half inch gap between inner and outer jacket walls, throughout. Six 12 inch high by 1/2 inch thick gussets are welded to the outer cylindrical wall and flange. Including the two box sections, the gussets are spaced 45° apart.
Attachment:	Eight - 2-inch bolts connect the protective jacket body, through the flange to the pallet.
Jacket Lifting Device:	Two rectangular 1 inch thick steel double loops located on top of the box section at the corners. The loops are respectively 7 inches long by 3 inches high by 6 inches wide and 9 inches long by 3 inches by 6 inches. These loops are used only for lifting the jacket, not the complete assembly.

1.0 Package Description - Packaging (continued)

(e) Protective Jacket Body (continued)

Assembly Lifting and Tiedown Devices: Two diametrically opposed 3 inch thick steel ears welded to sides of box section, each ear has a 1-1/2 inch hole to accept cable clevis or cable; or an optional rectangular tie-down yolk fabricated 3/16-inch wall rectangular milled steel tubing. This yolk also has 3-inch thick shackle ears and surrounds the protruding box section on top of the cylindrical jacket.

Penetrations: Slots along periphery of the protective jacket at the bottom, slots in box section under lifting loops. Allows natural air circulation for cooling.

(f) Protective Jacket Base

Shape: Hollow cylindrical weldment with square bottom plate. Eight I-beams are welded to the bottom plate.

Size: Bottom plate is 63-1/2 inches square and 1/2 inch thick. The cylindrical collar is 36 inches in outer diameter by 3 inches high. The I-beams are 3 and 4 inches high by 63-1/2 and 62-3/8 inches long.

Construction: The cylindrical collar houses two sets of 1-1/2 inch by 1-1/2 inch by 1/8 inch steel energy absorbing angles separated by a 1/2 inch thick carbon steel mid-plate. The cask rests on this assembly. The collar is welded to the 1/2 inch thick carbon steel base plate. Four I-beams are welded in parallel to the base plate.

1313 096

Attachment: Eight 2-inch diameter nuts are welded to the bottom of the base for jacket attachment.

2.0 Package Description - Contents

(a) General — Radioactive material as the metal or metal oxide, but specifically not loose powders. Neutron sources and other radioactive materials in special form.

(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 generically 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 prorated 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 and which meets the requirements of 49CFR173.393. Shipments of neutron sources will be limited to 50 thermal watts.

(e) Heat — Total maximum internally generated heat load not to exceed 600 thermal watts. (50 thermal watts for neutron sources).

2.0 Package Description - Contents

(e) Heat (continued)

Although equilibrium temperature recordings were not taken for this package loaded to 600 watts thermal, General Electric will analyze by test or other assessment each container heat loading with and without liners, as the specific case dictates, prior to shipment to verify that the requirements of 10CFR71.35 will be satisfied. Reference is made to the GE - Model 100 Application, Section 5.1, Exhibit B, for a method of internal heat load analysis and heat dissipation.

3.0 Package Evaluation

(a) General

There are no components of the packaging or its contents which are subject to chemical or galvanic reaction; there is no coolant except for air. The protective jacket is bolted closed during transport. A lock wire and seal of a type that must be broken if the package is opened is affixed to the cask closure. If that portion of the protective jacket which is used in the tie-down system or that portion which constitutes the principal lifting device failed in a manner to allow the protective jacket to separate from the tiedown and/or lifting devices, the basic protective features of the protective jacket and the enclosed cask would be retained. The package (contents, cask, and protective jacket) regarded as a simple beam supported at its ends along its major axis, is capable of withstanding static load, normal to and distributed along its entire length equal to five times its fully loaded weight, without generating stress in any material of the packaging

1313 098

3.0 Package Evaluation (continued)

(a) <u>General</u> (continued)

in excess of its yield strength. The packaging is adequate to retain all contents when subjected to an external pressure of 25 pounds per square inch gauge. Reference is made to the GE-Model 100 Application, Section 5.1, Exhibit C, for a method of determining static loads.

The calculative methods employed in the design of the protective jacket are based on strain rate studies and calculations and on a literature search of the effects on materials under impact conditions. The intent was to design a protective jacket that would not only satisfy the requirements of the U.S. Nuclear Regulatory Commission and the Department of Transportation prescribing the procedures and standards of packaging and shipping and the requirements governing such packaging and shipping but would protect the shielded cask from significant deformation in the event of an accident. In the event that the package was involved in an accident, a new protective jacket could be readily supplied and the shipment continued with minimal time delay.

The effectiveness of the strain rate calculations and engineering intuitiveness in the design and construction of protective jackets was demonstrated with the General Electric Shielded Container - Model 100 (Ref.: Section 5.1.3 of the Model 100 Application). The protective jacket design for the General Electric Shielded Container - Model 600 will be scaled from the design of the Model 100 in accordance with the cask weight and dimensions,

3.0 Package Evaluation (continued)

(a) General (continued)

maintaining static load safety factors greater than or equal to unity, and in accordance with the intent to protect the shielded cask from any deformation in the event of an accident.

(b) Normal Transport Conditions

Thermal: Packaging components, i.e., steel shells and lead are unaffected by temperature extremes of -40°F and 130°F. Package contents, at least singly-encapsulated or contained in specification 2R containers, but not limited to special form, will not be affected by these temperature extremes.

Pressure: The package will withstand an external pressure of 0.5 times standard atmospheric pressure. The cask was pressure tested under water to 11 PSIG with no detectable leakage.

Vibration: Inspection of the Model 600 casks used since 1961 reveals no evidence of damage of significance to transport safety.

Water Spray and Free Drop: Since the container is constructed of metal, there is no damage to containment resulting from dropping the container through the standard drop heights after being subjected to water spray.

Penetration: There is no effect on containment or overall spacing from dropping a thirteen pound by 1-1/4 inch diameter bar from four feet onto the most vulnerable exposed surface of the packaging.

3.0 Package Evaluation (continued)

(b) Normal Transport Conditions (continued)

Compression: The loaded container is capable of withstanding a compressive load equal to five times its weight with no change in spacing.

Summary and Conclusions: The tests or assessments set forth above provide assurance that the product contents are contained in the Shielded Container - Model 600 during transport and there is no reduction in effectiveness of the package.

(c) Hypothetical Accident Conditions

General: The effectiveness of the strain rate calculations and engineering intuitiveness in the design and construction of protective jackets was demonstrated with the GE Shielded Container - Model 100 (Ref.: Section 5.1.3 of the Model 100 Application). Extrapolations of the Model 100 data were used in the design and construction of the GE Model 600 protective jacket. The increased weight and dimensions of the Model 600 container over the Model 100 container necessitated a protective jacket wall of 1/2 inch steel compared to a 1/4 inch wall for the Model 100.

Drop Test: The design and construction of the GE Model 600 protective jacket was based on an extrapolation of the proven data generated during the design and construction of the GE Model 100 and on the results of cask drop experiments by C.B. Clifford(1)(2) and H. G. Clarke, Jr.(3). The laws of similitude were used in an analytical evaluation(3)(4) to determine the protective jacket wall thickness

3.0 Package Evaluation (continued)

(c) Hypothetical Accident Conditions (continued)

Drop Test: (continued) that would withstand the test conditions of 49CFR173.398(c) and 10CFR71.36 without breaching the integrity of the Model 600 cask. The evaluation, described in GE - Model 1000 Application, Section 5.9, Exhibit A, indicated a protective jacket wall thickness of 1/2 inch.

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(1) C.B. Clifford, The Design, Fabrication and Testing of a Quarter Scale of the Demonstration Uranium Fuel Element Shipping Cask, KY-546 (June 10, 1968).

(2) C.B. Clifford, Demonstration Fuel Element Shipping Cask from Laminated Uranium Metal-Testing Program, Proceedings of the Second International Symposium on Packaging and Transportation of Radioactive Materials, Oct. 14-18, 1968, pp. 521-556.

(3) H.G. Clarke, Jr., Some Studies of Structural Response of Casks to Impact, Proceedings of the Second International Symposium of Packaging and Transportation of Radioactive Materials, Oct. 14-18, 1968, pp. 373-398.

(4) J.K. Vennard, Elementary Fluid Mechanics, Wiley and Sons, New York, 1962, pp. 256-259.

Drop Test: (continued) The intent of the design for the GE Model 600 is, during accident conditions, to sustain damage to the packaging not greater than the damage sustained by the GE Model 100 during its accident condition tests (ref.: Section 5.1.3(c) of the Model 100 Application). It is expected that damage not exceeding that suffered by the GE Model 100 will result if the GE Model 600 is subjected to the 30 foot drop test.

Puncture Test: The intent of the design for the GE Model 600 is to sustain less or equal damage to the packaging during accident conditions than the deformation suffered by the GE Model 100. It is expected that deformation

3.0 Package Evaluation (continued)

(c) Hypothetical Accident Conditions (continued)

Puncture Test (cont.) not greater than that sustained by the GE Model 100 will be received by the GE Model 600 in the event that the package is subjected to the puncture test.

Thermal Test: Because of the various combinations of lead liners and thermal loads available with this container, the THTD fire transient was not run. However, reference is made to the shielded container Models 100, 700, and 1500 which demonstrate the effectiveness of the double walled steel jacket as a fire as well as a crash shield.

General Electric will analyze by test or other assessment each container heat load with and without liners as the individual case dictates, to verify that the loaded container will withstand the 30 minute 1475°F fire without significant lead melting in the cask.

Water Immersion: Since optimum moderation of product material is assumed in evaluations of criticality safety under accident condition the water immersion test was not necessary. The cask was pressure tested under water to 11 PSIG with no detectable leakage.

Summary and Conclusions: The accident tests or assessments described above demonstrated that the package is adequate to retain the product contents and that there is no change in spacing. Therefore, it is concluded that the General Electric Shielded Container - Model 600 is adequate as packaging for the contents specified in 2.0 of this application.

4.0 Procedural Controls

Vallecitos Site Safety Standards have been established and implemented to assure that shipments leaving the Vallecitos Nuclear Center (VNC) comply with the certificates issued for the various shipping container models utilized by the VNC in the normal conduct of its business. Routine audits are performed to assure compliance with these licenses and permits.

Each cask is inspected, leaktested, and radiographed prior to first use to ascertain that there are no cracks, pinholes, uncontrolled voids or other defects which could significantly reduce the effectiveness of the packaging.

After appropriate U.S. Nuclear Regulatory Commission approval, each package will be identified with a welded on steel plate in accordance with the labeling requirements of 10CFR71 and any other information as required by the Department of Transportation.

5.0 Fissile Class - Class III

An analysis has indicated that not greater than the following amount of fissile material may be shipped in any single container:

$$\frac{\text{Grams U-235}}{500} + \frac{\text{Grams U-233}}{300} + \frac{\text{Grams Pu(Fissile)}}{300} \leq 1.0$$

The container shall be provided with a rigid metal liner so that the fissile material is confined to a cylindrical geometry with an inner diameter not exceeding 7.0 inches (nominal).

The Density Analog Method as described in SNM License Application for VNC, Docket 70-754, Section 5.4.4, dated April 18, 1966, was used for calculations. Although this method is normally used to calculate the number of units for transport under Class II, it was used in this case to demonstrate that one shipment of two casks would be subcritical.

No credit was taken in the calculations for Pu-240 or other poisons present. The cask cavity was filled with water, and the fuel was homogenized with the water in the volume of the 7.0 inch liner. This water filling was done to represent the accident case and to allow for wet loading of the casks. The full results of the calculations are shown in the table below:

5.0 Fissile Class - Class III (continued)

Fissile Material	Quantity	Safe Number
Pu-239	0.3 Kg	33
U-233	0.3 Kg	51
U-235	0.5 Kg	210

In all cases, regardless of fissile mixtures involved, the loadings will be assumed to be exclusively Pu. The contents will be shipped dry.

6.0 Modes of Transportation

All modes with the exception of passenger aircraft are requested.

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ATTACHMENT A

CRITICALITY ANALYSIS

1313 106

APPENDIX I

GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION

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

May 21, 1974

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

Ref: 1) License SNM-960
Docket 70-754
2) Amendment 71-31 to SNM 960, 4/18/69
3) Amendment 71-57 to SNM 960, 11/19/73

Dear Mr. MacDonald:

General Electric has shipped large quantities of byproduct materials and limited quantities of fissile materials in the Model 600 Shipping Cask under Amendment 71-31 (4/18/69) 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 600 Shipping Cask be increased to 1200 grams provided: (1) the fissile material is contained in standard waste liners constructed of five-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.

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. These waste liners are exactly the same as those used in the Model 1600 container.

The cask will be shipped as Fissile Class III.

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General Electric requests that a very timely review be made of this application in order to expedite shipment of irradiated AEC-owned fissile material to the AEC for disposal. We believe that this request is reasonable in the light of your review of our submittal for the same fissile loading for the Model 1600 container (Ref. 3). The two containers are extremely similar with, from the viewpoint of criticality safety, the significant difference being the smaller cavity of the Model 600. Drawings of the two casks are enclosed as Attachment B to this submittal.

The analysis was performed using the computer codes ANISN[(1)], a discrete ordinates one-dimensional transport code, and KENO[(2)], a Monte Carlo code. ANISN was used to analyze the normal shipping design geometry while KENO was used for the accident case.

From this analysis we conclude that the 600 series cask is critically safe for the shipment of four standard waste liners each containing 300 gm fissile (Pu^{239} 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. It is not intended to ship U^{233} in this container in excess of the presently permitted limits.

The results of the criticality calculations are as follows:

1. Design Geometry $k_{eff} = 0.869$
2. Accident (Close Proximity - Flooded) = $k_{eff} = 0.945 \pm .029$

The error associated with the accident case result was computed at 3σ. The infinite multiplication of this cask (i.e., an infinite array of such casks) was calculated for the design geometry to be

$$k_\infty = 0.974$$

The design geometry was analyzed using the same method as was used to analyze the 1600 series cask. This geometry is shown on Figure 1. The dimensions and material regions for this figure are given in Tables 1 and 2. The problem was solved in two parts using the ANISN code and Los Alamos 16-group cross-section sets[(3, 4, 5)] with P_1 scattering. The first part consisted of defining an infinite cylinder cell with a "white" boundary condition on the outer diameter for the individual fuel liner. This calculation resulted in a 16-group cell weighted macroscopic cross-section set to be used in subsequent calculations. The outer dimension for the cell calculation was determined so as to preserve the atom densities of the materials within the cavity normalized to the cavity volume. Each cell consisted of the fissile material/moderator combination contained within each liner, the waste liner itself, and the void surrounding each liner. Each liner shall be limited to 300 gms of fissile material which will result in a fissile density of

$$\rho_f = 0.023 \text{ gm/cm}^3$$

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FIG 1 : 600 SERIES CASK • DESIGN GEOMETRY

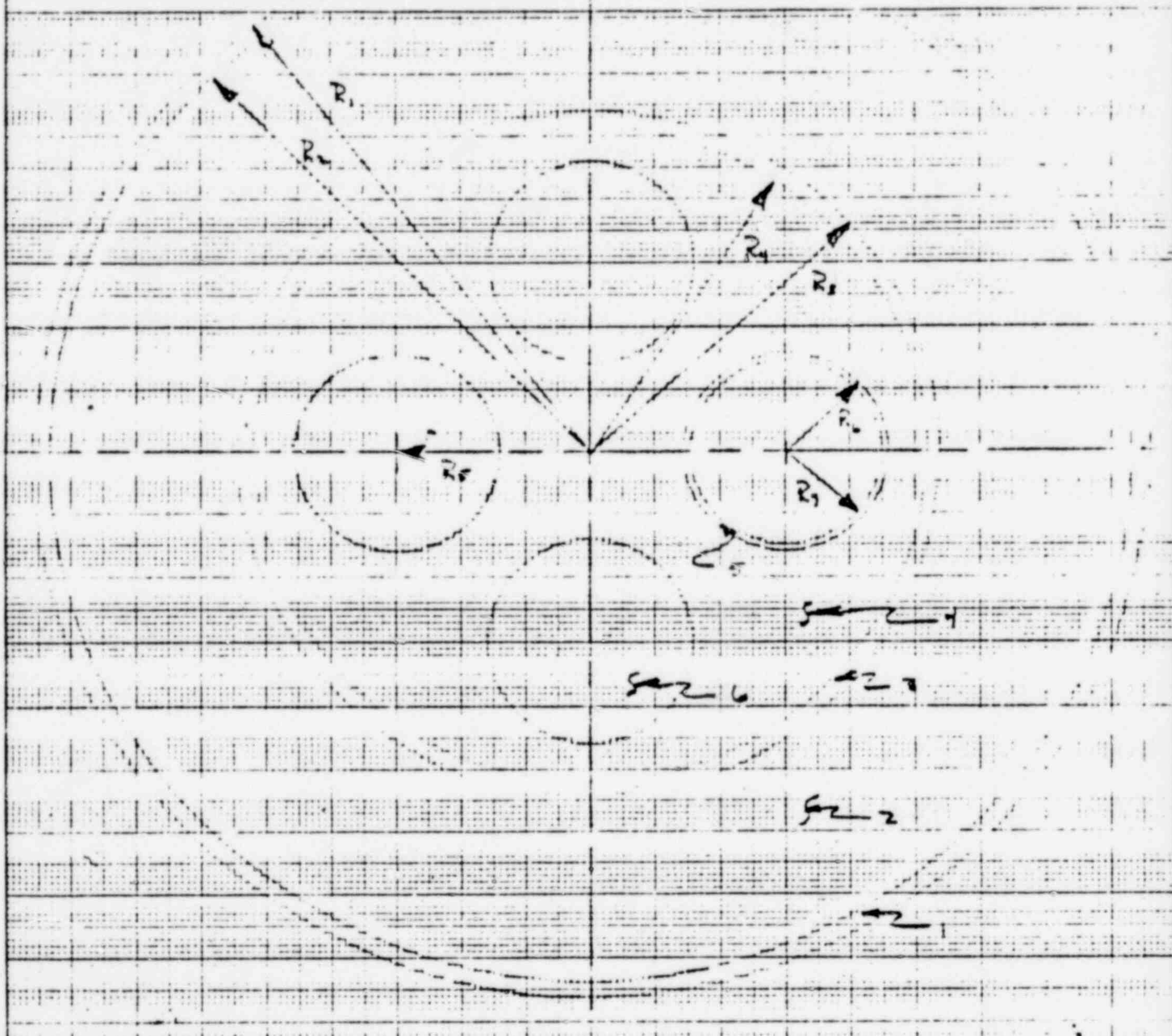

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Table 1: 600 Series Cask Dimensions

Radius	R-cm
R_1	43.18
R_2	42.2275
R_3	26.9875
R_4	26.035
R_5	15.00
R_6	7.7203

Table 2: Material Regions

Region	Material	Identification
1	Stainless	Outer Liner
2	Lead	Shield
3	Stainless	Inner Liner
4	Void	Void
5	Aluminum	Waste Liner
6	Pu & H_2O	Fissile Waste

This density was used to determine the atom density in the liner for the infinite cylinder. 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 the fissile waste material to be shipped). The atom densities for this problem are shown in Table 3.

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Table 3: Atom Densities

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

With the homogenized cell-weighted set of cross-sections obtained for the liner in the first calculation, the entire cask was analyzed with ANISN. The cell-weighted cross-sections were used to describe the cask cavity and the remainder of the cask was described discretely by material region. It might be noted here that the resultant k_{eff} for this configuration is higher than the corresponding results obtained for the 1600 series cask -

600 Series Cask: $k_{eff} = 0.869$

1600 Series Cask: $k_{eff} = 0.720$

This is the result of the smaller cavity in the 600 cask causing the liners to be closer together than in the 1600 cask.

The accident case where the liners are assumed to be somehow arranged together in the center of the cavity and flooded, was first analyzed in a manner similar to the approach used for the design geometry. The results of this calculation were:

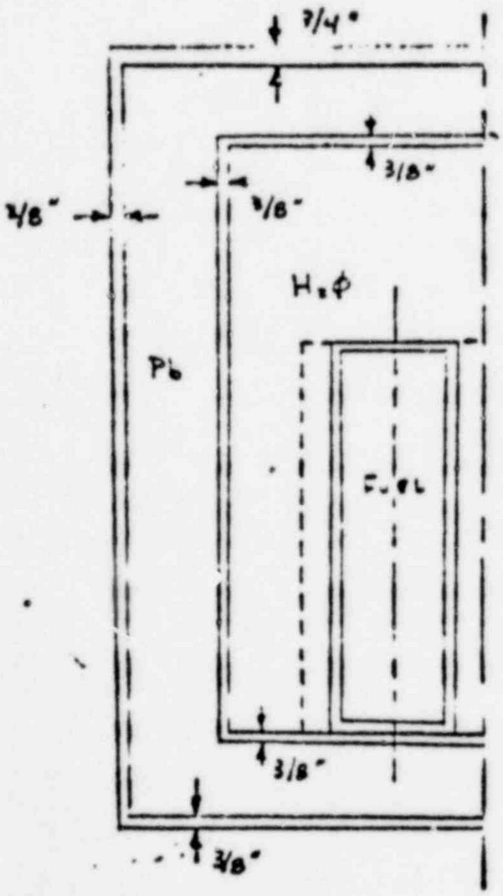
$k_{eff} = 0.981$

Although this number is less than 1.00, the confidence of subcriticality of the system is reduced because of the necessity in making assumptions deviating from the true description of the system to facilitate analysis. The assumption that could have the most effect on this number is the assumption of an infinite cylinder along the Z-axis. In order to account for axial leakage, it is necessary to go to a two- or three-dimensional code. For this problem, KENO, a Monte Carlo code, was selected. This code permits three-dimensional description of systems for analysis. The cask was described in KENO as shown in Figure 2.

The liners were described as box types in the setup with the "core" region then described as a 2 x 2 array of such boxes. The cask itself was then input as reflector regions. The ANISN problem previously described was re-run to obtain adjoint fluxes with which neutron weighting factors for the reflector regions were determined. The number densities used for this problem are given in Table 3. The calculations were then performed using a Knight-modified[6] Hansen and Roach[3] set of cross-sections obtained from Oak Ridge National Laboratory.

The results of this calculation are given on Figure 3. After 4320 histories the average was 0.945 with the maximum of 0.974 and the minimum of 0.915 at the 99% confidence level.

Fig. 2: 600 Series Cask - Three-Dimensional Representation



Liner: R_i = 7.065 cm

R_o = 7.7203 cm

H_i = 99.854

H_o = 106.998

Cask	R-in	R-cm	H-in	H-cm
Cavity	10.25	26.035	46	116.84
Liner	10.625	26.9875	46.75	118.745
Lead	16.625	42.2275	58.75	149.225
Liner	17.0	43.18	59.875	152.083

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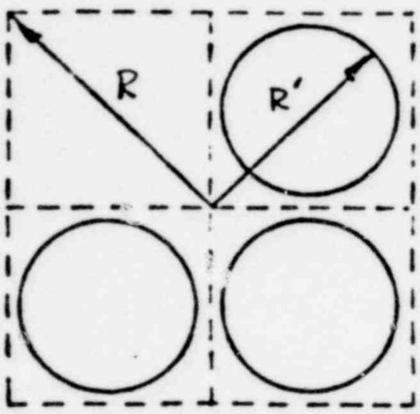
Fissile Box Geometry



R = 21.84 cm

R' = 18.6403

General Electric believes that the above analysis clearly demonstrates the safety of the proposed fissile load for the Model 600 Shipping Cask.

Attachmen A to this submittal contains the revised pages to our basic application for the Model 600 (Appendix D to License SNM-960).

Thank you for your timely consideration of this application.

Sincerely,

G. E. Cunningham
Administrator - Licensing

gw

Att.

POOR ORIGINAL

1313 113

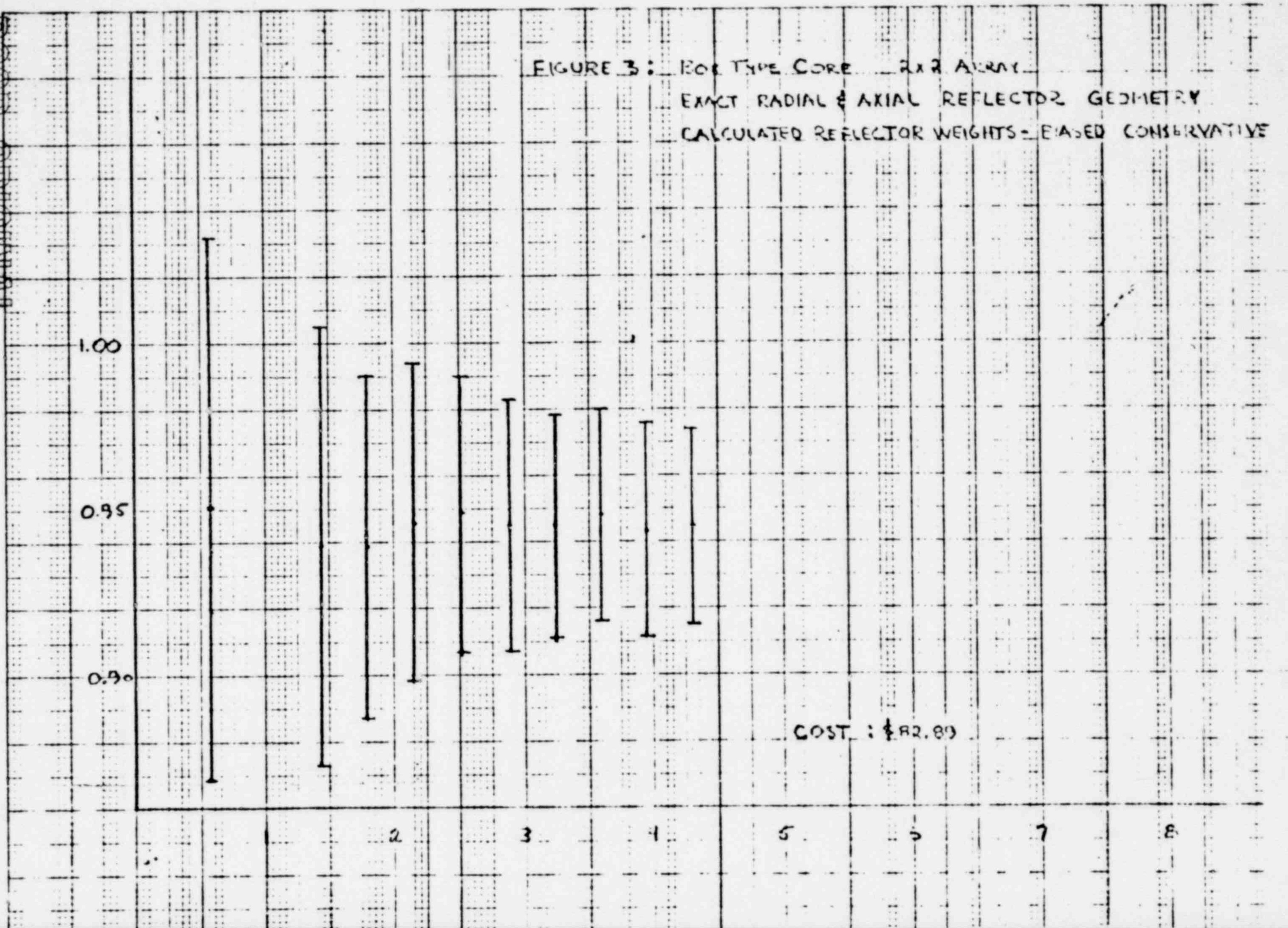


FIGURE 3: BOX TYPE CORE 2x2 ARRAY
EXACT RADIAL & AXIAL REFLECTOR GEOMETRY
CALCULATED REFLECTOR WEIGHTS - BIASED CONSERVATIVE
1.00
0.95
0.90
COST : $82.89
2
3
4
5
6
7
8

References

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