GE Nuclear Energy

General Electric Company
Vallecitos Nuclear Center
P.O. Box 460, Vallecitos Road
Pleasanton, CA 94566

November 19, 1992

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

Reference: Certificate of Compliance No. 5939, Docket 71-5939.

Dear Mr. MacDonald:

GE hereby requests that Certificate of Compliance No. 5939 for the Model 1500 shipping container be renewed. Enclosed in support of this request is an updated version of our consolidated application for the previous renewal. Any changes from the previous version are noted with vertical lines in the right-hand margin.

Maintenance procedures for most GE shielded shipping containers are generic in nature and have been submitted previously and approved by your staff under Docket 71-5926. A set of the procedures including the loading/unloading procedures for the Model 1500 is included as Exhibit E to this application. No quality assurance procedures for the manufacture or receipt of new containers are included as GE currently does not plan to obtain new containers.

Current certification drawings are enclosed as Exhibit F.

Sincerely,

G. E. Cunningham
Senior Licensing Engineer
(510) 862-4330

/ca

Enclosures

240071

MODEL 1500 SHIELDED CONTAINER

1.0 Package Description - Packaging

(a) **General**

All dimensions referenced in the description section are nominal dimensions. Actual dimensional tolerances are contained in the certificate drawings. This container is detailed in GE Drawings 129D4748, Rev. 7; 129D4749, Rev. 5; and 129D7450, Rev. 9. (See Exhibit F to this application.)

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

Size: The shielded cask is 30-1/4 inches in diameter by 48-1/2 inches high. The protective jacket is 60-7/8 inches high by 49-1/2 inches across the box section. The base is 59-1/2 inches square by 8-5/8 inches high.

Construction: The cask is a lead-filled stainless steel weldment. The closure seal is made on the lid flange with provisions made for a second seal on the lid step. The protective jacket is a double-walled structure of 3/8-inch carbon steel plate and surrounds the cask during transport. The square base is 1/2-inch carbon steel with four I-beams attached.

Weight: The cask weighs approximately 12,000 pounds. The protective jacket and base weighs approximately 3,600 pounds.

1.0 Package Description - Packaging (Continued)

(b) Cask Body

Outer Shell:	3/8-inch-thick plate, 47-3/4 inches high by 30-1/4 inches in diameter with a 1/2-inch bottom plate and a one-inch top flange.
Cavity:	1/4-inch wall and bottom plate, 7 inches in diameter by 25 inches deep.
Shielding Thickness:	11 inches of lead on the sides, 11 inches of lead beneath cavity, and 10 inches of lead above cavity.
Penetration:	One 1/2-inch outer diameter by 0.065-inch wall tube gravity drain line from the center of the cavity bottom to the side of the outer shell near the cask bottom. Closed with a fusible lead-cored 1/2-NPT hex head brass pipe plug or a solid stainless steel plug or an equivalent plug. General Electric may, at its discretion, permanently close and seal the drain line for this container 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.
Primary Coolant:	Air.

1.0 Package Description - Packaging (Continued)

(c) **Cask Lid**

Shape:	Two right cylinders of decreasing diameter attached to flat plates.
Size:	Top plate is 17-1/2 inches in diameter by 3/4-inch thick. Bottom plate is 9-9/16 inches in diameter by 1/4-inch thick. The top right cylinder is 6-1/2 inches high and is tapered such that the diameter at the top is 12-1/4 inches and the diameter at the bottom is 12-1/8 inches. The bottom right cylinder is 3.75 inches high and is tapered such that the top diameter is 9-5/8 inches and the bottom diameter is 9-7/16 inches.
Construction:	Lead-filled cylinders welded to circular plates.
Closure:	Six 1-inch, 8-UNC-2A steel bolts equally spaced 60° apart on a 14-7/8-inch-diameter bolt circle.
Closure Seal:	Molded silicone rubber seal bonded to an aluminum back-up plate. Also, a flat silicone rubber gasket may be used on the upper flange as an alternate.
Penetrations:	One 1/2-inch outer diameter by .065-inch wall tube test line from the top plate of the lid to the side of the top right cylinder. Closed with a fusible lead-cored 1/2-NPT hex head brass pipe plug or a solid stainless steel plug or an equivalent plug.
Shield Expansion Void:	None.
Lifting Device:	Single loop, 3/4-inch-diameter rod located in center of lid top. Covered by protective jacket during transport.

(d) **Liners** — None anticipated. If used, they will be made of lead, tungsten or uranium encased in stainless steel.

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:	60-7/8 inches high by 50 inches wide across the box section. Outer cylindrical diameter is 36-1/2 inches. Inner diameter is 33 inches. A 5-1/2-inch-wide by 3/8-inch-thick steel flange is welded to the outer wall of the open bottom.
Construction:	Carbon steel throughout. Double-walled construction. The walls are 3/8-inch thick. 1-3/8-inch air gap between cask shell and inner jacket wall and 1 inch between inner and outer jacket walls, throughout. Eight 12-inch-high by 3/8-inch-thick gussets are welded to the outer cylindrical wall and flange.
Attachment:	Six 2-inch bolts connect the protective jacket body through the flange to the protective jacket base.
Lifting Devices:	Two rectangular 7/8-inch-thick steel loops located on top of the box section at the corners. The steel is 9 inches long by 3 inches high by 5-1/2 inches wide. A stiffening plate 4 inches wide by 9 inches high by 1/4-inch thick is attached to each side plate.
Tiedown Devices:	Two diametrically opposed 7-inch by 4-1/4-inch by 2-1/2-inch steel ears welded to sides of box section; each ear has a 1-1/2-inch hole to accept clevis or cable.
Penetrations:	Slots along periphery of the protective jacket at the bottom; slots in box section under lifting loops. Allows natural air circulation for cooling.

1.0 Package Description - Packaging (Continued)

(f) **Protective Jacket Base**

Shape:	Hollow cylindrical weldment with square bottom plate. Four I-beams are welded to square bottom of plate.
Size:	Bottom plate is 59-1/2 inches square and 1/2-inch thick. The cylindrical collar is 31-3/4 inches in diameter by 3 inches high. The I-beams are 3 inches high by 59-1/2 inches long.
Construction:	The cylindrical collar houses two sets of 1-1/4-inch by 1-1/4-inch by 1/4-inch steel energy-absorbing angles separated by a 3/8-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.
Attachment:	Six 2-inch 4.5-UNC stainless steel nuts welded to underside with two diametrically opposed guide blocks, all equally spaced 45° apart.

2.0 Package Description - Contents

(a) General

Radioactive material as the metal or metal oxide (but specifically not loose powders) or other nondecomposable (at 650°F) solid materials.

(b) Form

(i) Byproduct material and special nuclear material meeting the requirements of special form radioactive material and antimony pins encased in stainless steel;
(ii) (Deleted)
(iii) Solid nonfissile irradiated metal hardware and reactor control rods (blades); or
(iv) Stainless steel encapsulated solid metal Co-60 sources (200,000 Ci).

(c) Fissile Content

Plutonium in excess of 20 curies per package must be in the form of metal, metal alloy or reactor fuel elements, and 500 grams U-235 equivalent mass. (U-235 equivalent mass equals U-235 mass plus 1.66 times Pu mass.)

The cask would be shipped as Fissile Class III. The criticality analysis is contained in Exhibit C of this application.

(d) Radioactivity

That quantity of any radioactive material which does not generate spontaneously more than 3,120 thermal watts by radioactive decay and which meets the requirements of 49CFR173.467.

(e) Heat

Total maximum internally generated heat load not to exceed 3,120 thermal watts. Equilibrium thermocouple temperature recordings for this package loaded to 3,028 watts thermal were as follows:

Cavity Wall	307°F
Maximum lead temperature	307°F
Inner surface of protective jacket	139°F
Outer surface of protective jacket	99°F
Ambient	80°F

2.0 Package Description - Contents

(e) Heat (Continued)

The temperature change resulting from the difference between the requested watt loading and the test condition is small. Reference is made to the GE Model 100 Application, 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; no coolant is used during transport. 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 are affixed to the cask closure. If that portion of the protective jacket which is used in the tiedown system or that portion which constitutes the principal lifting device failed in such 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 a 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 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, 5.1, Exhibit C, for a method of determining static loads.

3.0 Package Evaluation

(a) General (Continued)

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. Atomic Energy 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, another 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 were demonstrated with the General Electric Shielded Container, Model 100 (Ref.: Section 3.0 of the Model 100 Application). The protective jacket design for the General Electric Shielded Container, Model 1500 was scaled from the design of the Model 100 in accordance with the cask weight and dimensions, 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.

A tiedown analysis is included as Exhibit A to this application.

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*TID-7651, SE-RR-65-98

3.0 Package Evaluation (Continued)

(b) Normal Transport Conditions

Thermal:	Packaging components, i.e., steel shells and lead, uranium and/or tungsten shielding, 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.
Vibration:	Inspection of the Model 1500 casks used since 1966 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 13-pound by 1-1/4-inch-diameter bar from four feet onto the most vulnerable exposed surface of the packaging.
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 1500 during transport, and there is no reduction in effectiveness of the package.

3.0 Package Evaluation (Continued)

(c) **Hypothetical Accident Conditions**

General: The effectiveness of the strain rate calculations and engineering intuitiveness in the design and construction of protective jackets were demonstrated with the GE Shielded Container, Model 100 (Ref.: Section 3.0 of the Model 100 Application). Extrapolations of the Model 100 data were used in the design and construction of the GE Model 1500 protective jacket. The increased weight and dimensions of the Model 1500 container over the Model 100 container necessitated a protective jacket wall of 3/8-inch steel compared to a 1/4-inch wall for the Model 100.

Drop Test: The design and construction of the GE Model 1500 protective jacket were 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 that would withstand the test conditions of 49CFR173.467 and 10CFR71.73 without breaching the integrity of the Model 1500 cask. The intent of the design for the GE Model 1500 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 3.0 of

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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; October 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; October 14-18, 1968; pp. 373-398.

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

3.0 Package Evaluation

(c) **Hypothetical Accident Conditions**

Drop Test: (Continued)

the Model 100 application). It is expected that damage not exceeding that suffered by the GE Model 100 will result if the GE Model 1500 is subject to the 30-foot deep drop test. A bolt analysis is attached as Exhibit B.

Puncture Test:

The intent of the design for the GE Model 1500 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 not greater than that sustained by the GE Model 100 will be received by the GE Model 1500 in the event that the package is subjected to the puncture test.

Thermal Test:

Since it is expected that the GE Model 1500 cask will sustain negligible damage and only minor damage will occur to the protective jacket in the drop and puncture tests, it is reasonable to consider the resultant package, for purposes of thermal resistance, as essentially undamaged. Accordingly, the package was assessed using the General Electric Transient Heat Transfer Computer Program, Version D (THTD), which allows the analysis of the general transient problems involving conduction, convection, and radiation. The program allows the thermal properties of the materials to be entered as a function of temperature and the boundary conditions to be entered as a function of time.

The significant assumptions, approximations, and boundary conditions used for the analysis are listed below:

1.	Fire temperature	1,472°F
2.	Effective fire emissivity	0.9
3.	Fire shield surface emissivity and constant with temperature	0.8

3.0 Package Evaluation

(c) Hypothetical Accident Conditions

Thermal Test: (Continued)

4. Emissivity of other surfaces and constant with temperature 0.8

5. There is intimate contact between the lead shielding and the stainless steel shell of the cask.

6. There is negligible heat transfer by conduction through the pipes used as spacers between the cask and the first shield and between the two shields of the protective jacket.

7. There is negligible heat transfer by convection between the two shields of the protective jacket and between the cask and first shield of the protective jacket.

8. There is an internal heat load of 3,120 watts with a temperature profile as outlined in Section 2.0 of this application.

The computer program calculations were run for a 30-minute fire. The calculations indicate a maximum temperature rise of less than 390°F for the lead after 30 minutes and no lead melting could be expected. Although a coast-up analysis was not performed on this container, the resulting maximum lead temperature, after equilibrating for 40 minutes, is expected not to exceed 470°F. Exhibit A to the Model 100 Application further describes the computer code THTD.

Water Immersion:

Since optimum moderation of product material is assumed in evaluations of criticality safety under accident conditions, the water immersion test was not necessary.

3.0 Package Evaluation

(c) **Hypothetical Accident Conditions**

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 1500 is adequate as packaging for the contents specified in 2.0 of this section.

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 VNC in the normal conduct of its business.

Each package is 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

<u>EXHIBIT A</u>

TIEDOWN ANALYSIS

February 20, 1969

Mr. B P. Brown
Irradiated Fuels Branch
Division of Materials Licensing
U.S Atomic Energy Commission
Washington, D.C. 20545

Dear Blake:

Enclosed are pencil changed drawings on the remaining containers designating jacket tie-down bolts. Please note that one drawing (No. 106D3981) represents three different containers. The official modifications to the applications are in the mail to Mr. Chitwood, excluding the modified drawings. These will be forwarded when they become available.

As requested, an analysis was performed according to the data sheets attached. Both the Models 1500 and 700 containers were evaluated as being 'most severe' cases. As the analyses show, the resulting forces acting on the jacket and pallet structures are less than the yield strength of the materials used in these members.

Sincerely,

Walter H. King
Administrator-Licensing
Vallecitos Nuclear Center

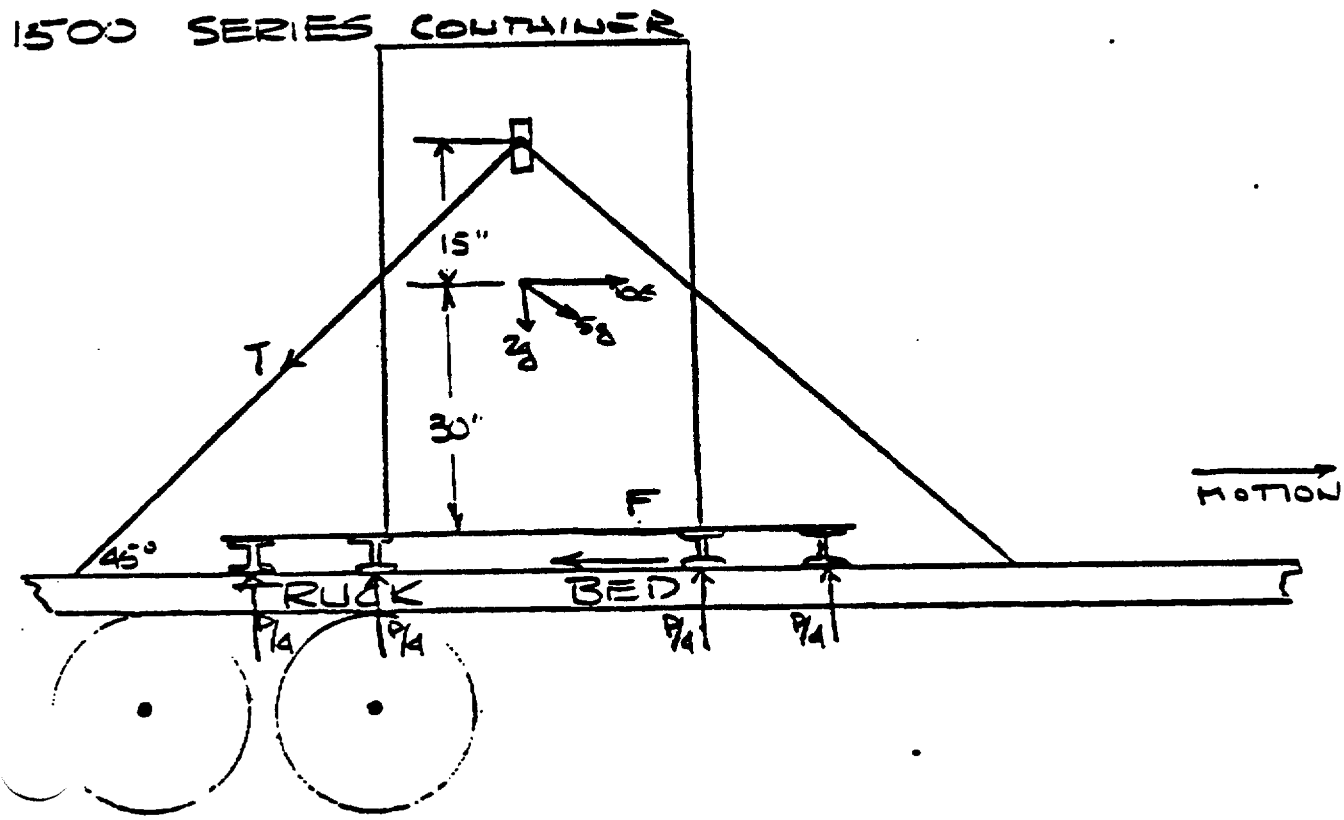
WHK:msg
Enclosures

8004020137 / p.

FOR A [illegible] RESTING ON A TRUCK BED WITH STATIC LOADS OF 10G, 5G, AND 2G AS SHOWN, NO PART OF THE CASK CAN YIELD UNLESS THE WHOLE VERTICAL FORCE IS CONCENTRATED ON ONE EDGE OF THE PALLET, IN WHICH CASE THE PALLET WOULD YIELD. THIS CAN ONLY OCCUR IF THE CABLES BREAK AND ALLOW THE CASK TO ROTATE. THE CABLES WILL NOT BREAK, AND THE PALLET WILL NOT YIELD UNDER THESE LOADINGS.

BRUCE ROGERS
4512

1500 SERIES CONTAINER



WHEN C.G. IS LOADED AS SHOWN FIND IF P/4 WILL BEND PALLET

ME HANDBOOK 3-34

IF F IS FRICTION FORCE FOR $\mu = 0.74$
AND T IS TENSION IN CABLE

$$F = \mu (2g + T \sin 45°)$$

$$T = (10g - F)/\cos 45°$$

$$F = \mu (2g + (10g - F) \tan 45°)$$

$$F = \mu (2g + (10g - F))$$

$$F = \mu (2g + 10g - F)$$

1500 SERIES CONTAINER

$(1+\mu)F = 12\mu g$

FOR $g = 15{,}000$ lbs

$F = 76{,}500$ lbs

$$T = \frac{(10g - F)}{0.707}$$

$T = (150.000 - 76{,}500)/0.707$

$T = 104{,}000$ lbs

$T_{FOR\ 1\ CABLE} = 52{,}000$ lbs

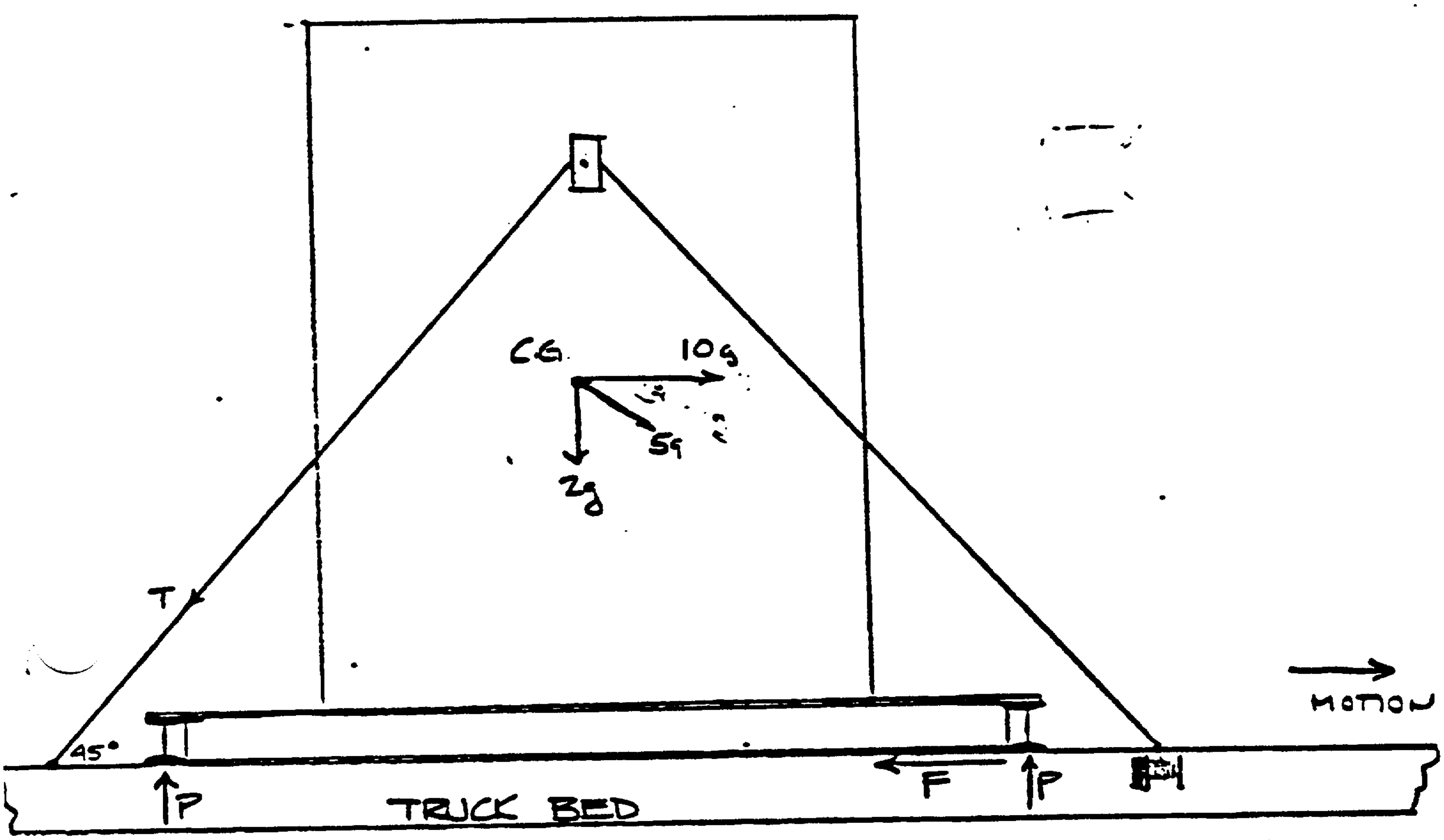
CABLE WON'T BREAK SO ASSEMBLY CAN'T ROLL OR ROTATE. SO VERTICAL FORCE WILL GO INTO UNIFORM COMPRESSING OF I BEAMS

P = VERT. FORCE

$P = 2g + T\sin 45^\circ$

$P = 30{,}000 + 73{,}500 = 103{,}500$ lbs COMPRESSION

700 SERIES CONTAINER



1. "P" is THE VERTICAL REACTION FORCE WHICH IS UNIFORMLY DISTRIBUTED OVER THE AREA OF THE BASE OF THE PALLET.
2. THE CASK WT = g
3. μ is FOUND IN MARKS M.E. HANDBOOK PAGE 3-34 FOR STATIC CONDITIONS
4. "F" is FRICTION FORCE BETWEEN PALLET AND TRUCK BED.

700 SERIES CONTAINER

$F = \mu(2g + T \sin 45°)$

$T = (10g - F)/\cos 45°$

$F = \mu(2g + 10g - F)$

$(1+\mu)F = 12\mu g$

$\mu = 0.74$

$G = 24{,}000$ lbs.

$1.74F = 12(.74)(24{,}000)$

$$F = \frac{12(0.74)(24{,}000)}{1.74} = 122{,}400 \text{ lbs}$$

$$T = \frac{10g - F}{0.707}$$

$$T = \frac{240{,}000 - 122{,}400}{0.707} = 166{,}300$$

FOR 1 CABLE $T = 83{,}300$ lbs SAFE LOAD

CABLE WON'T BREAK SO ASSEMBLY CAN'T ROLL OR ROTATE.

VERTICAL FORCE WILL GO INTO COMPRESSING BEAMS.

$P_{VERT} = 48{,}000 + 117{,}600 = 165{,}600$ lbs COMPRESSION

EXHIBIT B

BOLT ANALYSIS

GENERAL ELECTRIC SHIELDED CONTAINER
MODEL 1500

Container Drop Test Analysis - The analytical method presented in the following pages was used in determining the size and number of carbon steel bolts required to hold the protective jacket to the rest of the packaging for each of the GE container applications now being evaluated by the AEC.

Given: 1. Container Weight . . . . 15,000 lbs.

2. Drop Height . . . . 30 ft.

3. Bolt Properties:

Carbon Stl. Grade 5 or equivalent

Yield Strength . . . . 74,000 lbs./in^2

Shear Yield Strength . . . . 55,500 lbs./in^2

4. Loading at Impact . . . . ≈ 130 G's

Problem: Determine the size and number of carbon steel bolts required to hold the package together under conditions generated by a 30 foot drop test striking the test surface at the worst possible position.

Model:

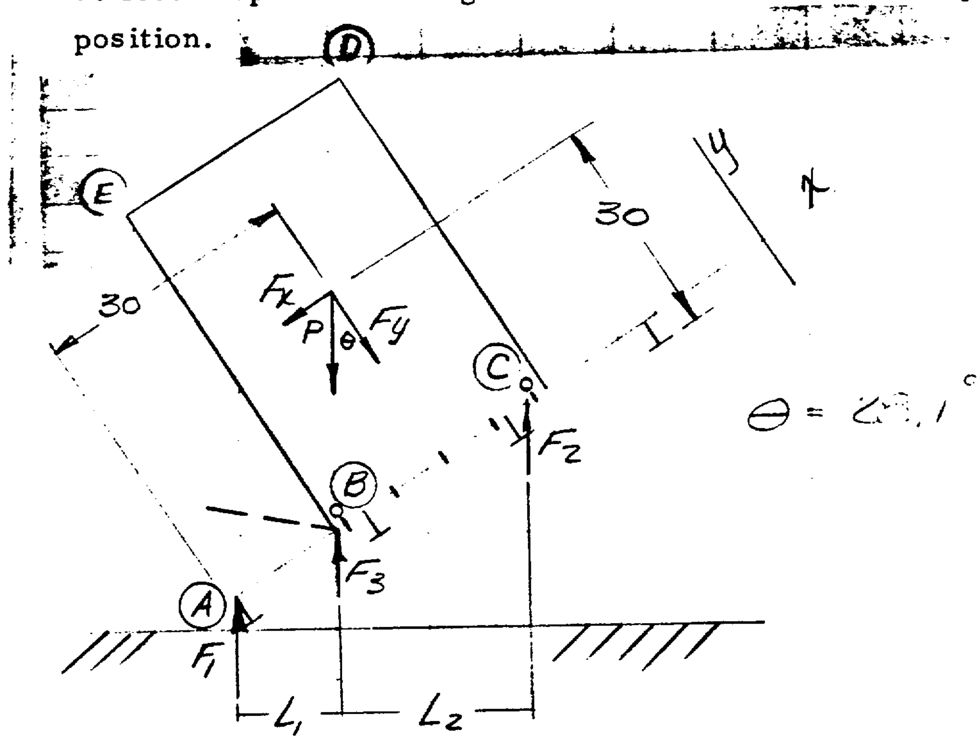


FIGURE 1

Solution: The worst case drop test occurs when the container is dropped in the position shown in Figure 1*. After initially striking the pallet edge and deforming it upwards, the container will strike the test surface with the center of gravity directly above a point on the bolt circle of the jacket flange.

The maximum force that can be exerted on the edge of the pallet is that force necessary to yield the pallet. Refer to Figure 1 and Figure 2.

W = Pallet Width

FIGURE 2

$$\Sigma M_b = 0$$

$$F_2L_2 = F_1L_1 = \left(\frac{t}{4}\right)\left(\sigma_{yp}\ W\ \frac{t}{2}\right) \quad (2) \qquad (1)$$

where:

t = Pallet thickness, ½ in.

σ_{yp} = 59,000 lb/in.^{2}

W = 60 in.

$$F_1 = \frac{\sigma_{yp}\ Wt^2}{4\ L_1}$$

$$F_1 = \frac{59,000\ (60)\ (\frac{1}{2})^2}{4\ (10)}$$

$$F_1 = 22,150\ \text{lb.}$$

$$F_2 = \frac{\sigma_{yp}\ W\ t^2}{4\ L_2}$$

$$F_2 = \frac{59,000\ (60)\ (\frac{1}{2})^2}{4\ (40)}$$

$$F_2 = 5,530\ \text{lb.}$$

* See, also, Appendix 1.

(1) Flugge, W., Handbook of Engineering Mechanics, McGraw-Hill, New York, N.Y. (1962), p. 49 -

The maximum force required to yield the pallet about the edge of the jacket is 22,150 lb. Notice that the horizontal bolt at C (Figure 1) is loaded only with 5,530 lbs. Any loading on the vertical hold-down bolts is insignificant at this stage.

The container moves downward making impact at point B. In the process, energy is expended in (1) crushing the energy absorption angles, (2) in tending to shear the tie-block and collar welds and the horizontal bolts, and (3) in loading the vertical bolts holding the jacket to the pallet.

Since the center of gravity is directly over the point of impact, no rotational momentum will occur.

The impact force will exert a shearing stress on the collar and tie-block welds. In order for the cask to exert a shearing force on the vertical hold-down bolts, it must first fail the collar and tie-block welds allowing the cask to contact the jacket. However, we will neglect any force on the welds, and consider the shearing force acting only on the vertical bolts.

The F_y force will impart only a small tensile load on the vertical bolts at impact. After impact, the container is free to rotate either onto its pallet or onto its side. These minor tensile stresses were neglected in the analysis.

The shearing force, F_x, (see Figure 1) is equal to 920,000 lbs.

$$F_x = \text{(No. of G's) (Weight) Sin } \theta$$

$$F_x = 130\ (15{,}000)\ (\text{Sin } 28.1°)$$

$$F_x = 920{,}000 \text{ lbs.}$$

The required bolt area to resist the shearing force is:

$$A = \frac{F}{S_s} = \frac{F}{0.75\ Y.S.} = \frac{920,000}{0.75\ (74,000)}$$

$$A = 16.67\ in.^2$$

A 1-1/2 diameter bolt has a shaft area of 1.765 $in.^2$
Ten 1-1/2 diameter bolts are sufficient.

$$S_s = \frac{920,000}{17.65}$$

$$S_s = 52,000\ lb/in.^2$$

For the 1500 series cask assembly hold-down system, use 10 - 1-1/2 - 6 UNC x 2A x 2 in. long, Grade 5, carbon steel bolts.

Note: After impact at Point B, the assembly will fall onto its pallet or its side. In either case, the forces generated on the bolts will be negligible.

APPENDIX 1

DISCUSSION:

The container system was analyzed in three different drop test positions. The three positions were:

Position 1. Assembly striking the surface with the center of gravity directly above A horizontal hold down bolt (i.e., with the pallet hitting 28 degrees above horizontal.

Position 2. Assembly striking with the pallet in the horizontal position.

Position 3. Assembly striking with the pallet in the vertical position.

In order to provide for a conservative analysis, many energy absorbing aspects of the container system were neglected. The following effects were neglected:

1. Deflection and shearing of the pallet collar and tie-block welds.
2. Friction force between the pallet plate and jacket flange caused by preloading the vertical bolts, which would help resist shearing forces through the bolts.
3. Energy absorption in bending the pallet was not considered in the worst case.
4. The strengthen effects of the eight gussets (four per side) were ignored in this analysis.

Position 1. This is the worst case condition and the maximum stresses were generated in the vertical bolts.

Position 2. The container system was analyzed in this position and the stresses generated in the vertical bolts were less than 5,000 lb/in.^{2}

Position 3. The container system was analysed with the pallet in the vertical position and the maximum shearing stresses generated in the vertical bolts were less than 9,000 lb/in.^{2}

CONCLUSION:

Ten - 1-1/2 inch diameter - 6 UNC - 2A x 2 inch long bolts will hold the jacket and pallet assembly together through a 30 foot drop test.

EXHIBIT C

CRITICALITY ANALYSIS

GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION

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

May 3, 1976

Mr. C. B. MacDonald, Chief
Transportation Branch
Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Ref. 1) License SNM-960, Docket 70-754
2) NRC Certificate of Compliance #USA/5939/B( ).

Dear Mr. MacDonald:

The General Electric Company, Vallecitos Nuclear Center (VNC), has for several years transported the Model 1500 Series shipping container under Amendment 71-50 to License SNM-960 and Certificate of Compliance #USA/5939/B( ). The fissile content of shipments in this container has been limited to 15 grams or less.

VNC now requests that the fissile limits be changed to 300 gms Pu or 500 gms U-235 or a prorated ratio of the two such that:

$$\frac{\text{Grams U-235}}{500} + \frac{\text{Grams Pu}}{300} \leq 1.0.$$

The cask would be shipped as Fissile Class III.

The Density Analogue Method as described in Section 5.4.4 of the SNM License Application for VNC, Docket 70-754, April 10, 1966 was used to calculate the number of containers critical. 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 two casks together would remain subcritical. Of course, a single cask containing the 300/500 gram limit would be subcritical under all circumstances.

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The material was assumed in the calculation to be either pure Pu-239 or U-235. The fissile material was homogenized with water to fill the volume of the cask cavity (7" in diameter by 25" in length). This was done to permit wet loading, if necessary. Criticality parameters were taken from TID-7028, June, 1964.

The calculations indicate the following safe numbers of containers:

Material	Quantity	Safe Number
Pu-239	0.3 Kg	22
U-235	0.5 Kg	115

This calculation and approach is consistent with that used for the approved G.E. Models 100 (Cert. #USA/5926/B( )F), 200 (Cert. #USA/5971/B( )F), and 1600 (Cert. #USA/9044/B( )F) containers.

Because of operating considerations, VNC requests the NRC to forward the necessary revised Certification prior to July 1, 1976.. If your staff has any questions concerning this application, please contact this office at any time. Thank you.

Sincerely,

G. E. Cunningham
Sr. Licensing Engineer

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<u>EXHIBIT D</u>

LEAK TEST DATA

Model 1500 Qualification Test

The new 1500 seal (G.E. Drawing Number 129D4690) was tested to determine its ability to seal at 15 psig to a sensitivity of 10^{-3} atm cm^3/sec.

The seal was installed on the 1504 cask and the lid bolts tightened to 60 ± 20 feet pounds of torque. The cask was then lowered into the RHO pool (<2" of water covering the lid). The cask was pressurized to 15 psig and held for 15 minutes. The seal area was then inspected for bubbling. None was detected.

It can therefore be concluded that the model 1500 seal is capable of sealing at 15 psig per ANSI 14.5-1977[1] to a sensitivity of 10^{-3} atm cm^3/sec.

R. G. Sears
Equipment Engineering

vcc

[1] American National Standard for leakage tests on packages for shipment of radioactive materials.

EXHIBIT E

GENERIC OPERATING PROCEDURES