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

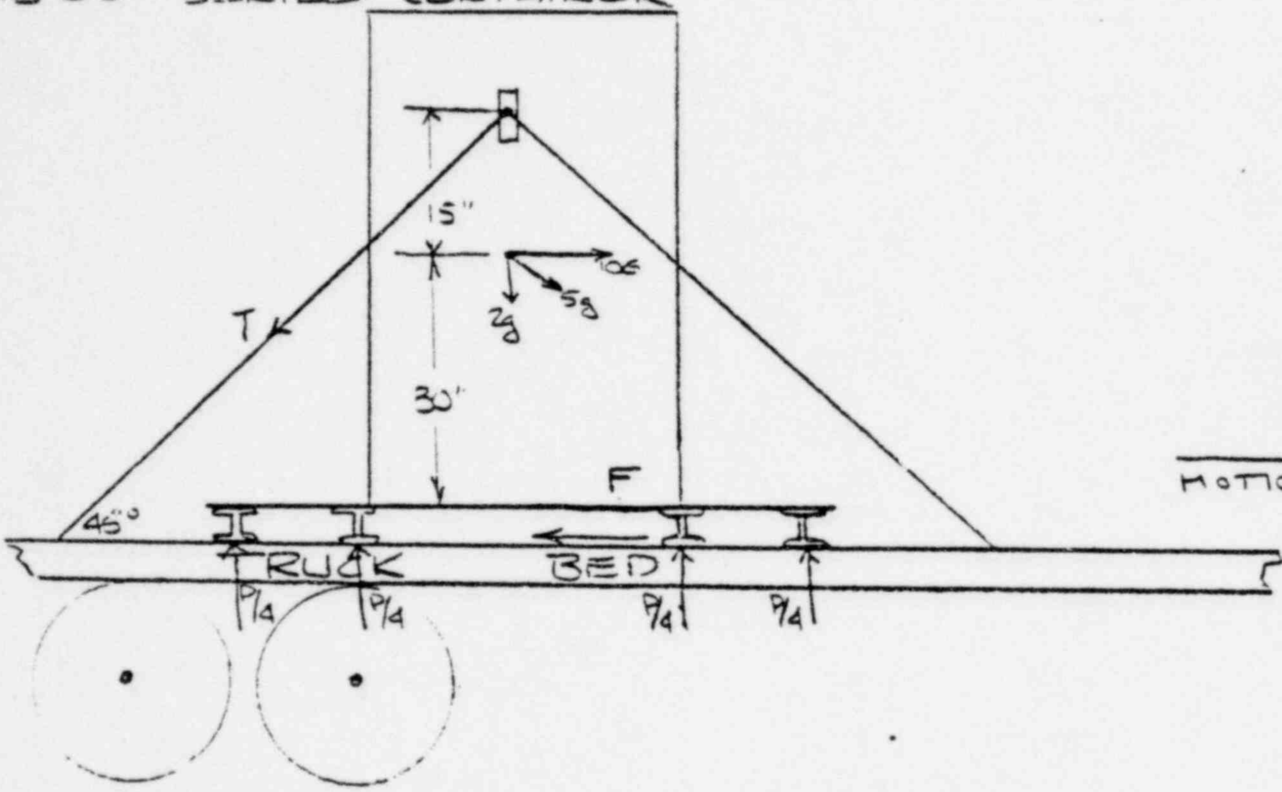
WHK:msg
Enclosures

8004020137

FOR A CONTAINER 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

IF F IS FRICTION FORCE FOR $\mu = 0.74$ ME HANDBOOK 3-34
AND T IS TENSION IN CABLE

$$F = \mu\,(2g + T \sin 45^\circ)$$

$$T = (10g - F)/\cos 45^\circ$$

$$F = \mu\left(2g + (10g - F)\tan 45^\circ\right)$$

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

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

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

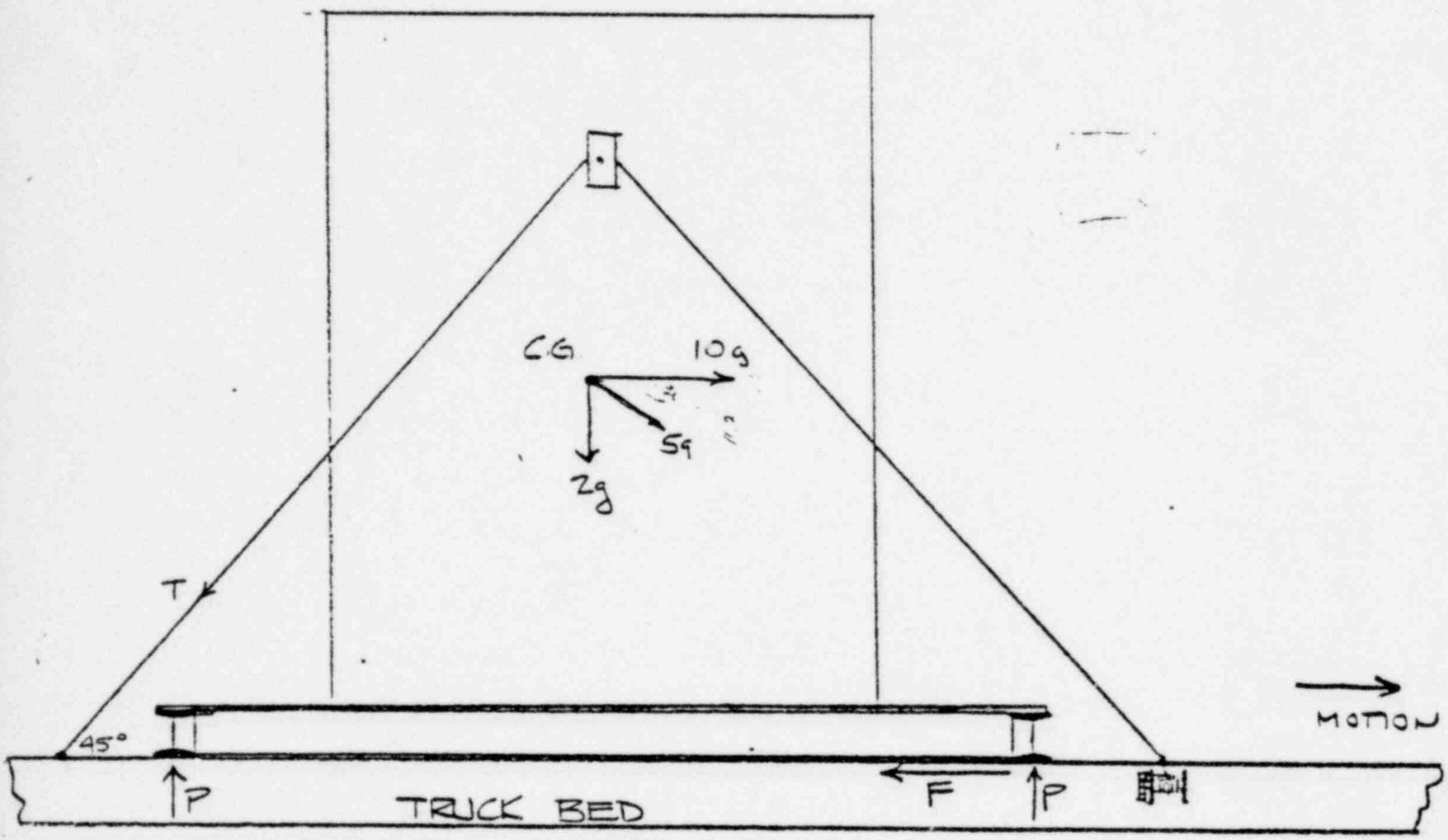
CABLE WON'T BREAK SO ASSEMBLY CAN'T ROLL OR ROTATE. SO VERTICAL FORCE WILL GO INTO UNIFORM COMPRESSING OF I BEAMS

P • VERT. FORCE

$P = 2g + T \sin 45°$

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

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

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

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

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

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

$$\Sigma M_b = 0$$

$$F_2 L_2 = F_1 L_1 = \left(\frac{t}{4}\right)\left(\sigma_{yp}\ W \frac{t}{2}\right) \quad (2) \qquad (1)$$

where:

t = Pallet thickness, $\frac{1}{2}$ in.

σ_{yp} = 59,000 lb/in.^{2}

W = 60 in.

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

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

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

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

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

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

---

* 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 gene ;ed 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 5. The container system was analyzed 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.

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

gb

EXHIBIT D

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.

15639