DOCKET NO. 70-58

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MARTIN COMPANY

NUCLEAR
DIVISION
Baltimore,
Maryland
21203

Mail No. 845
Refer to: ACC-324
26 August 1964

Division of Material Licensing
U. S. Atomic Energy Commission
Washington, D. C.

Attention: Mr. Kenneth Lauterbach

Subject: Drop Test of Shipping Container -
Proposed Amendment No. 21 to SNM-53

Gentlemen:

As a result of our discussion in Bethesda on August 20, 1964 we have conducted a drop test for the container designated A in support of our request for shipment approval for loaded tubular elements containing approximately 5% enriched UO_2 pellets. We selected Container A since it represents the container having the lesser structural strength of the two containers proposed for this shipment. All calculations have been based on the drop test results for Container A. A steel rod weighing approximately 75 pounds and filling the inner 40 schedule pipe was used to simulate the loading of the container with fuel. The first drop was made to provide a side impact on the shipping container from a height of 30 feet measured to the bottom of the drum. The diameter of the drum prior to the drop was 22.75 inches and a deformation of 3.25 inches was determined after the drop. Since the container remained intact another drop on the top was performed in the same manner with the same container. Except for an approximate 2½ inch protrusion from the bottom of the drum no significant deformation was produced.

Our nuclear safety calculation, considering a cubic array of the deformed containers, was performed using the dimensions resulting from the drop test. Since this calculation has shown that the most reactive array of the deformed containers will not produce criticality, we request that your approval of this shipment be made without a requirement for shoring as described in our August 14, 1964 submission. Fuel is ready for shipment at Nuclear Fuel Services and we request immediate approval for shipment of the tubular elements.

1cy to CB 8/26/64
2cy to Compliance 8/28/64
1cy to PDR

B/30
ACKNOWLEDGED

We appreciate very much the excellent cooperation of all AEC personnel who have reviewed our submissions. Their comments have been very helpful.

Very truly yours,

C. W. Keller

C. W. Keller
Nuclear Accountability &
Licensing Representative

CWK/mc

DOCKET NO. 71-57

Nuclear Safety Evaluation

Discussion

Nuclear safety calculations have been completed for the MH-1A shipping container using the dimensions obtained from the 30-foot drop test. The container consists of a 4-inch inside diameter pipe centered in a 55 gallon drum. The maximum deformation of the diameter was 3.25 inches.

The calculations were based on a 19.5 inch center-to-center drum spacing for the most reactive array assuming that the shipping containers were stacked two high as shown in the solid angle calculations.

The calculations assumed that:

(1) each container contained a maximum of 27 fuel tubes which limited the U-235 content to 1.11 kilograms

(2) the active fuel region was a 4 inch cylinder 40 inches in length*, and

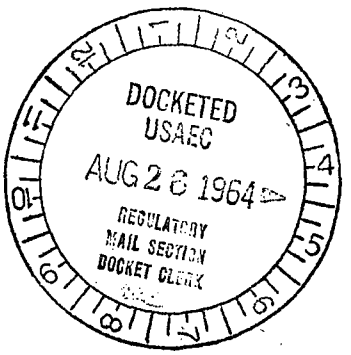
(3) the container was flooded with water

The effective multiplication factor for the most reactive unit in the array was 0.35. A unit consisted of shipping containers stacked two high.

Conclusions

The total allowable solid angle is equal to 9-10 k_{eff} or 5.5 steradians. The total calculated solid angle was 4.7 steradians for the previously described array. Therefore, the use of the shipping containers described in this letter presents no potential hazards from the nuclear safety standpoint.

*The 4-inch diameter center pipe is actually 42 inches long. However, the active fuel is actually 36 inches long with a 2 inch end-cap welded onto each fuel tube.



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EFFECTIVE NEUTRON MULTIPLICATION CALCULATIONS

MATERIAL	VOLUME (cm³)	VOL. FRACTION	Σ_a	Σ_a [illegible]
H_2O	10,330.333	.63010	.0221	.01393
347 SS	1,072.822	.06512	.231	.01445
U-238	2,447.728	.14872	.128	.01903
U-235	113.783	.00692	32.79	.22625
OXYGEN AND IMPURITIES	2,455.989	.14914	~0	~0

THERMAL UTILIZATION

$$f = \frac{\Sigma_a^{fuel}}{\Sigma_a^{fuel} + \Sigma_a^{H_2O} + \Sigma_a^{SS}} = \frac{.24528}{.27666} = .887$$

FAST FISSION FACTOR

$$\epsilon = 1 + \frac{.0125}{1 + .286\left(\frac{V_m}{V_f}\right) + .200\left(\frac{V_s}{V_f}\right)} = 1 + \frac{.0125}{1 + (\text{[illegible]})(\text{[illegible]}) + (\text{[illegible]})(\text{[illegible]})} = 1.012$$

RESONANCE ESCAPE

$$p(E) = \exp\left(-\frac{f_r}{1 - f_r}\right)$$

$$\frac{V_f}{V} = .1237$$

[illegible]

$$E_2 = 1 + \frac{(K_0 h_0)^2}{2}\left[\text{[illegible]}\right]$$

$$E_2 = 1 + .194[2.099 \cdot 1.5 + \text{[illegible]}(.077) - .55] = 1.005$$

WHERE: $K_0 = .51\ cm^{-1}$, $h_0 = .510\ cm$

WHERE: [illegible]

$$\frac{1}{f_n} = 1 + \frac{V_f}{V_n}\frac{\Sigma_{af}}{\Sigma_{an}}E_f + (E_n - 1) = 1 + [illegible]$$

$$\frac{1}{f_n} = 12.550$$

$$f_n = .0738$$

$$p(E) = \exp\left(-\frac{.0728}{.7762}\right) = .923$$

NEUTRONS LIBERATED PER THERMAL NEUTRON ABSORBED IN FUEL

$$\eta = 1.923$$

INFINITE MULTIPLICATION FACTOR

$$k_\infty = \varepsilon \eta f p = (1.044)(1.923)(.887)(.923) = 1.645$$

BUCKLING

$$B^2 = \left(\frac{2.405}{R}\right)^2 + \left(\frac{\pi}{H}\right)^2 = .077?? + .000?? = .07770$$

WHERE: [illegible]

EFFECTIVE MULTIPLICATION FACTOR

$$k_{eff} = \frac{k_\infty}{(1+L_f^2B^2)^2(1+L_s^2B^2)(1+L_t^2B^2)} = \frac{1.645}{4.755} = .346$$

WHERE:

$$L_f^2 = 2.625$$

$$L_s^2 = 26.537$$

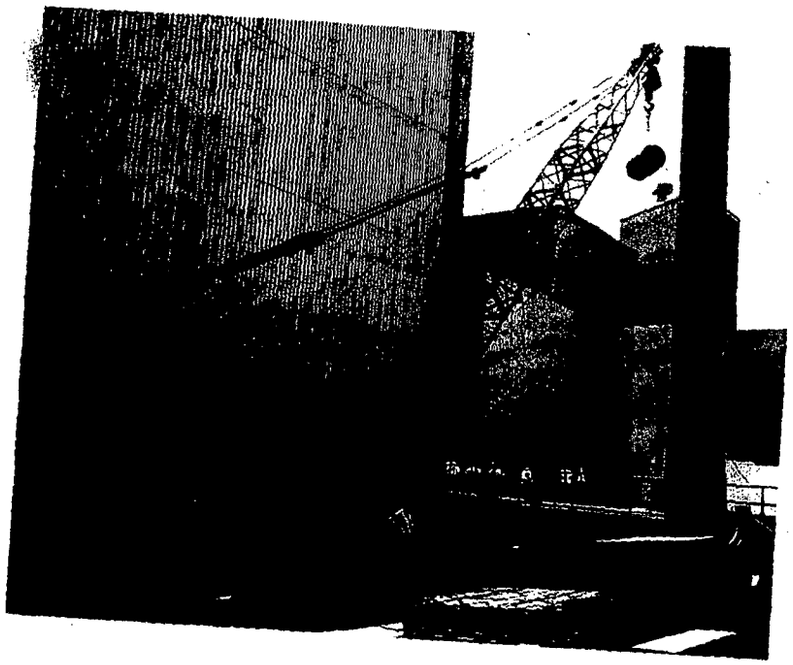
$$L_t^2 = L_{tm}^2(1-f) = 8.1225(1-.887) = .918$$

$$(1+L_f^2B^2)^2 = (1+2.625 \times .07770)^2 = 1.4495$$

$$(1+L_s^2B^2) = (1+26.537 \times .07770) = 3.0621$$

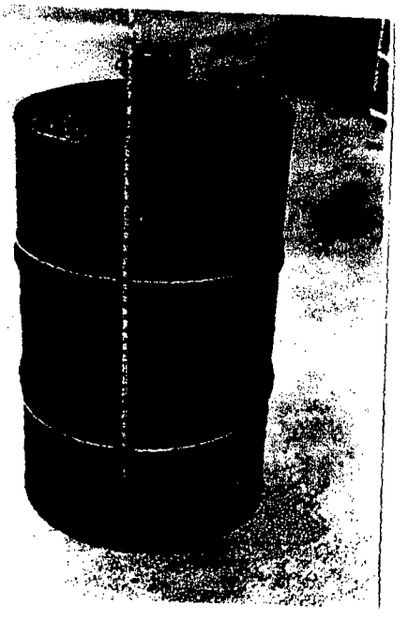
Pages 6 through 7 redacted for the following reasons:

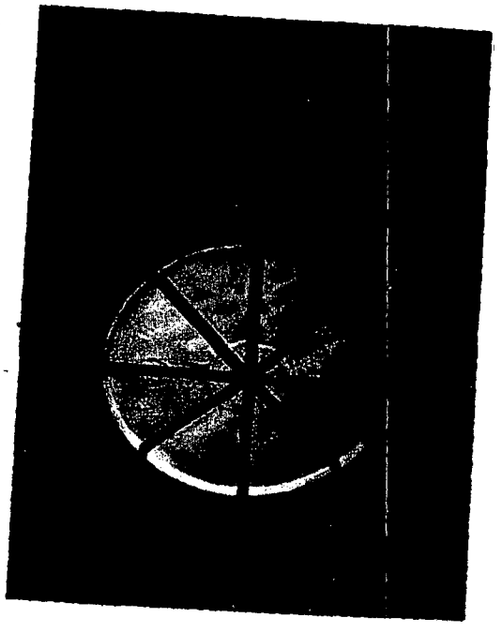
(b)(4)

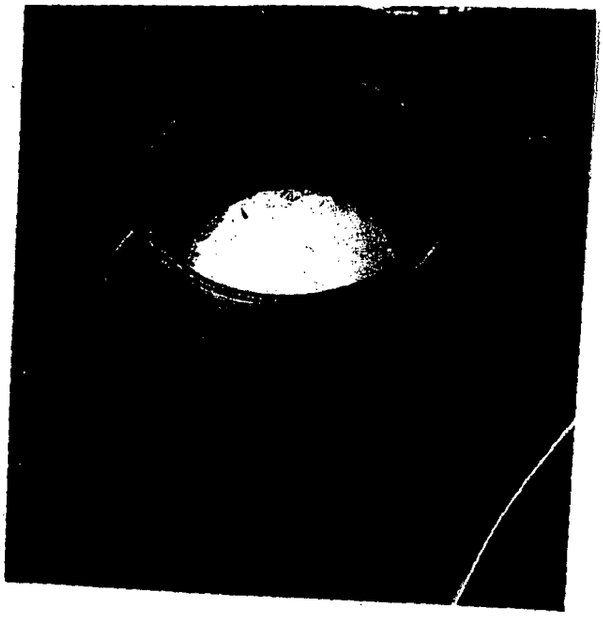


Shipping Container 30 Foot
Above Ground Level

Top View of Shipping Container
After 30 Foot Drop Test
(Max. Deformation 3½ Inches)

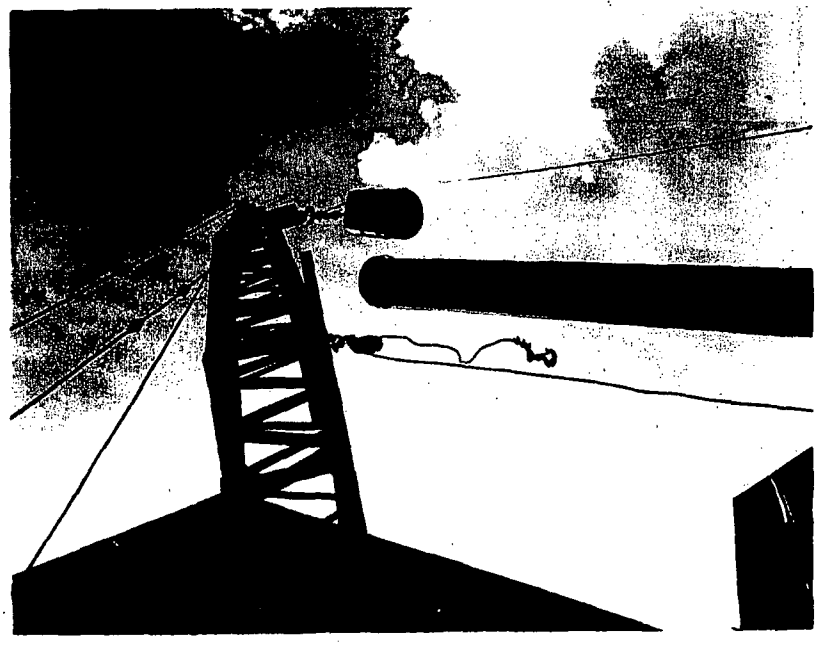






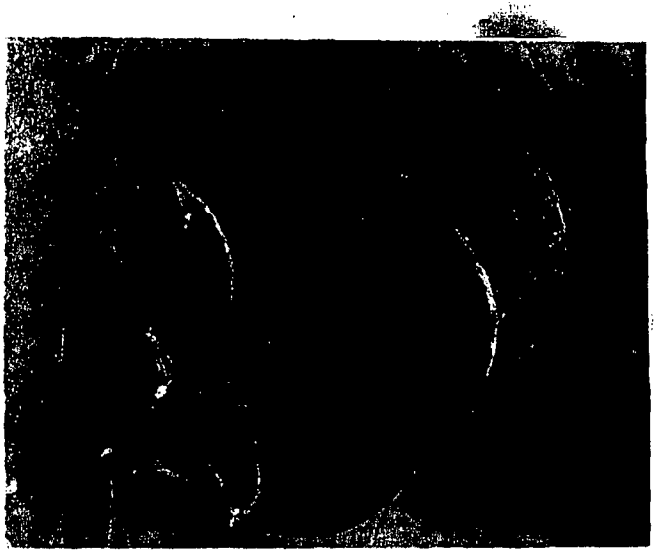
Top View of Shipping Container and 3 Inch Diameter Steel Pipe

3 Inch Diameter Steel Pipe
35 Inches in Length
Weighing 20 pounds



Shipping Container Prior to Second 30 Foot Drop Test

(Container dropped from vertical position with top facing downward)



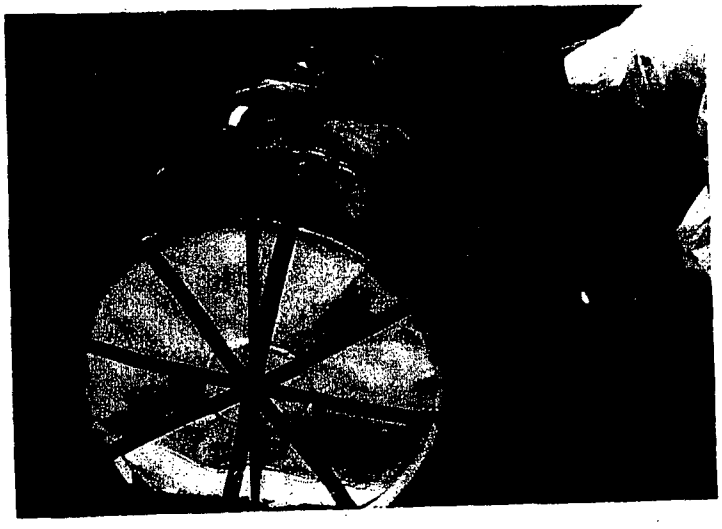
Top View After Second 30 Foot Drop Test

Top View Prior to Second 30 Foot Drop Test

Side View After Second 30 Foot Drop Test

(Side View Prior to Second Drop Test)

Side View of Shipping Container
After 30 Foot Drop Test



End View of Shipping Container
After 30 Foot Drop Test