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PDR 71-9022

POWER SYSTEMS

January 11, 1980

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Charles E. MacDonald, Chief
Transportation Branch
Division of Fuel Cycle & Material Safety

Gentlemen:

It is requested that Certificate of Compliance No. 9022 (Model CE-250-2) be renewed for a 5 year period. Enclosed are ten copies of our renewal application which is a consolidation of our original application dated July 12, 1974 and all supplements to date.

The CE-250-2 container is presently approved for shipment of dry UO_2 enriched to a maximum of 4.0% U^{235} and for UO_2 of unspecified moisture content enriched to a maximum of 3.5% U^{235}. It is requested that this container be approved for shipment of uranium oxide with a moisture content of 5 wt. % or less and enriched to a maximum of 4.1% U^{235}. A complete criticality safety analysis has been performed, the calculations and results of which are incorporated into this renewal application.

If you have any questions regarding the content of this application, please contact Mr. G. J. Bakevich of my staff on extension 3150.

Very truly yours,

H. V. Lichtenberger
Vice President-Nuclear Fuel
Nuclear Power Systems-Manufacturing

HVL/GJB/ssb
Enclosure

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1.0 GENERAL INFORMATION

1.1 Introduction

This renewal application is submitted for approval for delivery to a carrier for transport of Combustion Engineering's CE-250-2 shipping container. The CE-250-2 shipping container is used for the transport of uranium oxide with a measured moisture content of less than 5 wt % and enriched to a maximum of 4.1% U^{235}. This shipping container meets the criteria of 10 CFR Part 71.39 for shipping as Fissile Class II, with a maximum of 90 packages per shipment and a transport index of 0.56.

1.2 Package Description

1.2.1 Packaging

The CE-250-2 package consists of a 16 gauge steel inner container 11-5/8" inner diameter by 57-1/4" long with a bolted and gasketed top flange closure and steel welded bottom plate. The inner container is centered within a 22-1/2" I.D. by 68-3/8" long 16 gauge outer steel drum. The inner container is supported by twelve 1/4" diameter steel springs welded to the inner container at the top flange and the bottom of the container. The void space between the inner and outer container is filled with vermiculite.

The CE-250-2 package design incorporates two containment boundaries excluding the inner stainless steel can containing the uranium oxide. The secondary containment consists of the bolted and gasketed inner container. The primary containment consists of the surrounding 16 gauge steel drum.

Closure of the inner container is maintained by a rubber gasket and (6) 1/2" hex head bolts and nuts. These bolts and nuts secure the 1/2" steel inner lid to the package. The outer container is then sealed with a standard 17H 12 gauge nut and bolt ring over the gasketed 16 gauge outer lid.

The weight of the package is approximately 575 lbs. when loaded and is constructed in accordance with Combustion Engineering's Drawing No. NFM-E-Z2175 Rev. 0 dated 6/13/79 (Appendix 1.3).

It should be noted that the CE-250-2 package does not contain any valves, sampling ports or protrusions.

1.2.2 Operational Features

Not Applicable - The CE-250-2 package is a simple design with no operational features.

1.2.3 Contents of Packaging

Each package will be limited to four cans of uranium oxide in either powder or pellet form enriched to a maximum of 4.1 w/o U^{235} and having a measured moisture content of 5 wt % or less. A spacer will be used to make up the remaining volume within the inner package. Each can contains a maximum of 30 Kg uranium oxide for a total of 120 Kg uranium oxide per CE-250-2 package. At a maximum of 4.1 w/o in the isotope U^{235}, the package would contain a maximum of 4.5 Kg U^{235}. The weight of the total contents will not exceed 300 lbs. The maximum radioactivity for each container is 0.21 curies with 90 packages per shipment yielding 18.9 curies of radioactivity per Fissile Class II shipment.

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1.3 Appendix

Dimensional details of the CE-250-2 shipping container are described in CE Drawing NFM-E-Z2175 Rev. 00 dated 6/13/79.

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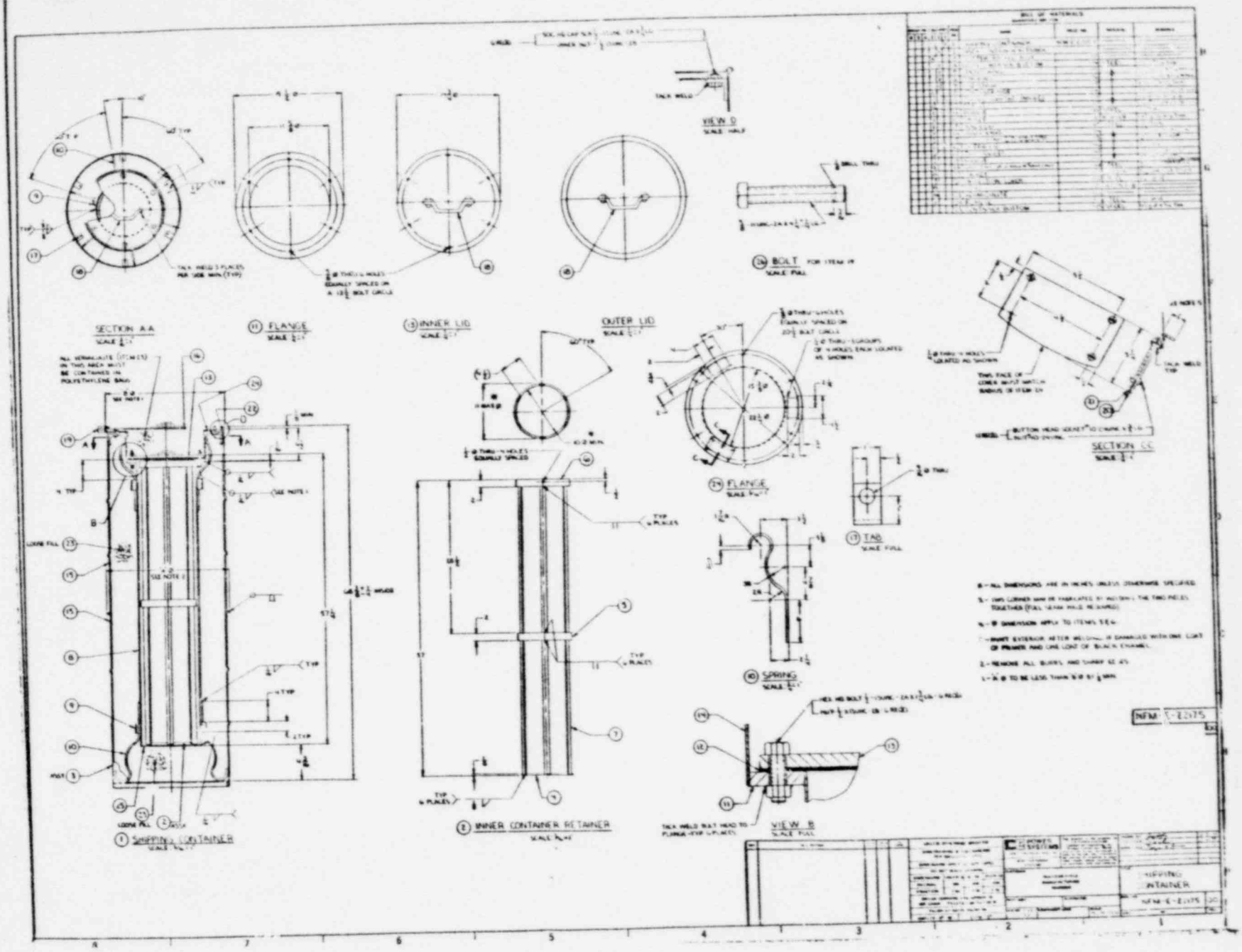
SECTION A-A
SCALE 1/2
11 FLANGE
SCALE 1/2
3 INNER LID
SCALE 1/2
OUTER LID
SCALE 1/2
24 FLANGE
SCALE FULL
SECTION C-C
SCALE 1/2
17 TAB
SCALE FULL
10 SPRING
SCALE 1/2
24 BOLT
SCALE FULL
VIEW D
SCALE HALF
VIEW B
SCALE FULL
1 SHIPPING CONTAINER
SCALE 1/4
2 INNER CONTAINER RETAINER
SCALE 1/4
BILL OF MATERIALS
NFM E-2575
SHIPPING CONTAINER
NFM E-2575

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2.0 STRUCTURAL EVALUATION

2.1 Structural Design

2.1.1 Discussion

The secondary containment of the package is the 11-1/2" I.D. x 57-1/4" long 16 gauge steel inner container. The inner container closure is achieved by securing a 1/2" steel lid to the inner flange with (6) 1/2" Hex Head Bolts and Nuts tack welded to the flange.

The primary containment vessel consists of two 55-gallon drums which have been welded together to the following dimensions: 22-1/2" I.D. x 68-3/8" long. The closure of the outer container is assured by a standard 17H 12 gauge ring with 5/8" bolt and nut. See View B on Drawing NFM-E-Z2175 dated 6/13/79 Rev. 00 in Appendix 1.3.

2.1.2 Design Criteria

The test results described in Appendix 2.10 support the structural requirements specified in 10 CFR Part 71.35 and 71.36.

2.2 Weights and Centers of Gravity

The CE-250-2 container weighs approximately 575 lbs. when loaded. The 4 cans of uranium oxide (30 Kg each) weigh ~300 lbs. with the CE-250-2 container weighing ~275 lbs. The container is approximately symmetrical; the center of gravity is at the center of the container. When the cans are loaded inside the inner container, the center of gravity shifts vertically to a slightly lower point because of the spacer used to make up the remaining volume within the inner package.

2.3 Mechanical Properties of Materials

Materials of all structural components used in the manufacture of the container have physical and mechanical properties equivalent to or better than 16 gauge steel.

2.4 General Standards for All Packaging

2.4.1 Chemical and Galvanic Reactions

There are no significant chemical, galvanic or other reactions among the packaging components and the package contents. The CE-250-2 shipping container is fabricated of carbon steel. The contents are: vermiculite for insulation between the outer and inner containers, stainless steel cans containing uranium oxide in either the powder or pellet form and having a moisture content of 5 w/o or less.

2.4.2 Positive Closure

Positive closure of the CE-250-2 containers is assured by: 1) The inner container being gasketed and sealed with 6 Hex Head Bolts and Nuts and 2) the outer container being sealed by a standard 17H 12 gauge ring with a 5/8" bolt and nut. Both of these closure systems insure that the container cannot be inadvertently opened.

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2.4.3 Lifting Devices

Both the inner and outer container lids have handles attached. These handles are present for the sole purpose of aiding the operator in positioning of the lids during the closing or opening of the container. They are not for the purpose of lifting the container. No lifting devices are incorporated as a structural part of this container.

2.4.4 Tiedown Devices

No tiedown devices are incorporated as a structural part of this container.

2.5 Standards for Type B and Large Quantity Packaging

N/A (Type A quantity per package).

2.6 Normal Conditions of Transport

The CE Model 250-2 package is identical to the Westinghouse BB250-2 package except that the overall length is 68-3/8" and the inner container length is 57-1/4" (compared to 74" and 63-1/2" respectively). These packages both utilize design concepts which are similar to those used in the design of the NUMEC LA-36 and Pu 10-1 packages. These packages were tested in accordance with the requirements specified in 10 CFR Part 71 Appendix A for normal conditions to assure compliance with the standards outlined in section 71.35. (See Appendix 2.10 for tests performed on the NUMEC Pu 10-1 and LA-36 containers).

2.7 Hypothetical Accident Conditions

This section describes the hypothetical accident conditions as specified in Appendix B to 10 CFR Part 71 and meets the standards in 71.36. The inner container of the CE-250-2 when fully loaded weighs approximately 340 lbs. over a base area of 121 in^2 resulting in a vertical loading of 2.8 lbs/in^2. The inner container of the NUMEC Pu 10-1 package, when fully loaded, including the neutron moderator weighs 279 lbs. over a base area of 78.54 in^2 resulting in a vertical loading of 3.55 lbs/in^2. Thus, the tests performed on the latter container are valid for the CE-250-2 package.

As a result it is concluded that:

1) The integrity of the package is not affected by the tests. Because the lid is bolted in a minimum of six places around the top of the drum, separation of the lid from the drum does not occur. In this connection, test experience with the BB250-1 shows that as a result of a top corner drop, the lid and the body are folded together into a tighter closure.

2) The incorporation of five inches of vermiculite is equal to that provided in the NUMEC package, and is sufficient to assure that after the drop and thermal tests, the temperature of the inner container of the CE-250-2 package would not exceed the observed maximum of 500°F. Since the gasket is service rated to 800°F, the closure of the inner container is not compromised.

3) The test series does not result in the addition of moderation to the contained fissile material.

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4) The dimensions of a damaged package are conservatively taken to be 20" O.D. x 64-3/8" Lg. This assumes a reduction of 2-1/2" in diameter as the result of a drop test with the package in a horizontal posit' ', plus a reduction of 4" in height as the result of a drop test with the package in a vertical position. No deformations in excess of these values were experienced during the testing of the Pu 10-1 package.

(See Appendix 2.10 for BB-250-2 & Pu 10-1 test results).

2.8 Special Form

N/A (All radioactove material in the packages is in normal form).

2.9 Fuel Rods

N/A (The CE-250-2 package is not used for the shipment of fuel rods).

2.10 Appendix

(1) BB-250-2 Test Results - Westinghouse SNM-338

(2) NUMEC Pu 10-1 Test Results

(3) NUMEC LA-36 Test Results

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APPENDIX 2.10

WESTINGHOUSE LICENSE SNM-338

BB-250-2 TEST RESULTS

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16.4 Limits and Controls

The Fissile Class II limit, Fissile Class III limit, and the Procedural Controls presented in Sections 4.4, 4.5, and 4.6, respectively, will apply directly to this package, if "Equipment Specification E-676498" is substituted for "Equipment Specification E-676200".

17. NUMEC LA-36 Shipping Package

The construction, limits on contents, and loading procedures will be in strict compliance with those given in Amendment 71-1 of License SNM-145, Docket 70-135.

18. BB 250-2 Shipping Package

18.1 Packaging Description

Designation - BB 250-2

Gross Weight - 575 pounds, maximum

Fabrication - The design and fabrication details for this container are given in Westinghouse sketch #SKA-252 which is attached as Appendix L to this application.

Coolants - Not applicable

18.2 Contents Description

Radioactivity - Not applicable

Identification and enrichment of SNM - The SNM will be unirradiated uranium enriched to a maximum of 4 w/o in the isotope U-235.

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18.2 (continued - BB 250-2)

Form of SNM - The SNM will be in the form of bulk uranium oxide (UO_2 or U_3O_8) with a density $\leq$ 2 grams/cubic centimeter. The moisture content of the SNM will not exceed 0.5 w/o and the total H/U ratio, including all packaging materials, will not exceed 1.13.

Neutron Absorbers, etc. - None

Maximum Weight of Fissile Content - 4.0 kilograms U-235

Maximum Net Weight of Contents - 250 pounds of oxides enriched $\leq$ 4 w/o contained in 9.5 inch diameter Fiberpak drums or other containers having equivalent strength. These are contained in an 11.5 inch diameter (maximum) cylindrical inner container.

Maximum Decay Heat - Not applicable

18.3 Compliance with Subpart C of 10 CFR 71

General Standards - The materials which have been specified for this package will not result in significant chemical or galvanic reactions. There will be no specific lifting or tie down devices.

General Criticality Standards - Tests demonstrate that immersion in water, alone, is not sufficient to affect the structural integrity of the 9.5 inch diameter Fiberpak drums. Calculations using LEOPARD procedures show that a fully reflected, 11.5 inch diameter, infinitely long cylinder is nuclearly safe for homogeneous uranium enriched $\leq$ 4 w/o in U-235 under any conditions of moderation.

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18.3 (continued - BB 250-2)

Normal and Accident Conditions Evaluation - This package utilizes design concepts which are similar to those used in the design of the NUMEC LA-36 and Pu-10-1 packages, described in SNM-145 and SNM-414, respectively. The outer shell consists of two 16 ga, 22.5" diameter (nominal) steel drums welded end-to-end to form a package approximately 74" long. The inner container is an 11.5" diameter (maximum), 16 gauge (nominal) steel cylinder with a flanged closure consisting of a 1/2 inch thick (minimum) bolted flange and flange cover. A minimum of six 1/2"-13 NC bolts are used to seat a 1/8 inch thick Anchor Packing Company "Target" or "425" gasket which is provided to assure a leak-tight closure. Six tightly closed Fiberpak drums contain the uranium oxide. These drums have a nominal 9.5 inch diameter. Vermiculite is used to provide thermal and mechanical insulation for the gasketed inner container which is positioned with a minimum of 12 steel spring spacers, as shown in the sketch #SKA-252. The top insulation plug may be fabricated of unibestos. At least 5 inches of vermiculite insulates the inner container from the drum, except at the bottom where its thickness may be 4 inches.

The effects of the hypothetical accident conditions specified in Appendix C of 10 CFR 71 are considered on the basis of the results described by NUMEC.

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18.3 (continued - BB 250-2)

Normal Conditions of Transport - All conditions described in the referenced licenses apply to this package. Because the package array is based on the consideration that each vertical projection of packages is replaced by a continuous cylinder having an identical length, the loss of spacing incurred in a vertical four foot drop test is not of concern. It is considered that the low horizontal loading will result in minimal displacement of the inner container in a horizontal drop test.

Accident Test Conditions - The inner container of the BB 250-2, when fully loaded, weighs 329.4# resulting in a vertical loading of 3.17 lbs/in^2 over a base area of 103.87 in^2. The inner container of the NUMEC Pu-10-1 container, when fully loaded, and including the neutron moderator weighs 279#, resulting in a vertical loading of 3.55 lbs/in^2 over a base area of 78.54 in^2. When placed in a horizontal position, the loadings are 0.456 lb/in^2 for the BB 250-2, and 0.442 lb/in^2 for the NUMEC Pu-10-1 container. Thus the tests performed on the latter container are valid for the BB 250-2 package. As a result, it is concluded that:

1. The integrity of the package is not affected by the tests. Because the lid is bolted in a minimum of six places around the top of the drum body, separation of the lid from the drum body does not occur. In this connec-

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18.3 (continued - BB 250-2)

tion, test experience with the BB 250-1 shows that as a result of a top corner drop the lid and the body are folded together into a tighter closure.

2. The incorporation of five inches of vermiculite is equal to that provided in the NUMEC package, and is sufficient to assure that after the drop and fire tests the temperature of the inner container would not exceed the observed maximum of 500°F. Since the gasket is service rated to 800°F, the closure of the inner container is not compromised.

3. The test series does not result in the addition of moderation to the contained fissile material.

4. The dimensions of a damaged package are conservatively taken to be 20" O.D. X 70" Lg. This assumes a reduction of 2 1/2" in diameter as the result of a drop test with the package in a horizontal position, plus a reduction of 4" in height as the result of a drop test with the package in a vertical position. No deformations in excess of these values were experienced during the testing of the Pu-10-1 package. 1939 214

Single Package Evaluation - The safety considerations which pertain to a single package will assure nuclear safety even assuming that the failure of the inner

23. Pellet Shipping Package

23.1 Packaging Description

The packaging will be the BB 250-2 packaging as described in Part 18.

23.2 Contents Description

Radioactivity - Not applicable

Identification and enrichment of SNM -

The SNM will be unirradiated uranium enriched to a maximum of 5 w/o in the isotope ^{235}U.

Form of SNM -

The SNM will be solid uranium compounds that will not react chemically or decompose at temperatures below 750° F. The material will be enclosed within a container constructed of steel having a 24-gage specified minimum thickness. The container will have a maximum ID of 8.5" and a nominal height of 15.375", and will utilize a gasketed lid with bolted locking ring. The container will be constructed in accordance with US Military Standard MS 24347. As an inner container within the BB-250-2 packaging's inner cylinder, it is considered completely adequate to retain the SNM under the hypothetical accident conditions. A comparison between the structural features of this container and a DOT Spec. 17-H container is shown in Table 23.2.1. A maximum of four of these containers will be inserted in each package. The maximum allowable H/U ratio, considering all sources of hydrogenous material within the inner cylinder of the packaging will not exceed 1.5. A typical arrangement for shipping material in the form of pellets is shown in Westinghouse Drawing C7108D10, which is enclosed as part of Appendix R. Military Standard MS 24347 also is enclosed as part of Appendix R.

Neutron Absorbers, etc. -

None

Maximum Weight of Fissile Content -

5.0 kilograms contained ^{235}U

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23.2 Contents Description (continued)

Maximum Net Weight of Contents -

250 pounds of uranium compounds.

Maximum Decay Heat - Not applicable

Table 23.2.1

Structural Feature	MS24347 Container	Spec. 17-H Container
Capacity (gal.)	3.5	5
Type	Straight Side	Straight Side
Diameter (in.)	8.5	11.25
Height (in.)	15.375	12.75
Metal Gauge		
Body	24	24
Cover	24	20
Bottom	24	24
Closure	Bolted Locking Ring	Multiple Lugs
Construction	Welded Seam	Welded Seam

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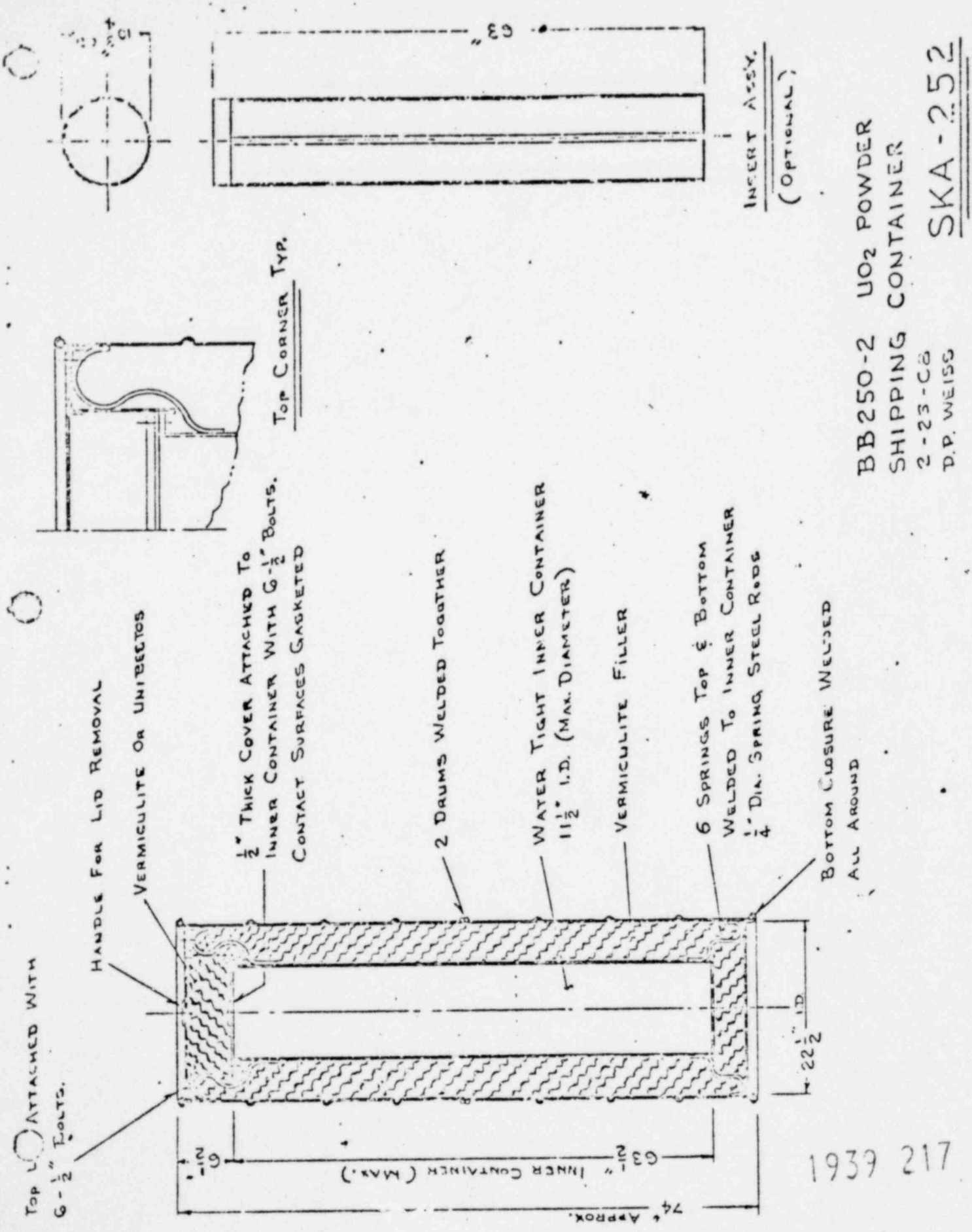
APPENDIX L



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APPENDIX 2.10

NUMEC LICENSE SNM-414

Pu 10-1 TEST RESULTS

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VI.1 NUMEC Pu-10-I Container

VI.1.1 Container Description

a. Gross Weight - 400 lbs. (max.)

b. Model Number - Pu-10-I

c. Materials of construction, weights, dimensions, and methods of fabrication.

Outside drum: 19" or 24" diameter
Pressure vessel: Solid stainless steel, with flanged, gasketed, bolted closure
Pressure vessel gasket: 1/8" target or blue asbestos compressed asbestos sheet
Moderator: Polyethylene granules with polyester resin filling interstices
Primary container: 11 liter polyethylene bottle contained in two sealed polyvinyl bags

More detailed design information is provided in the enclosed drawings, and in the following sections.

d. Identification and maximum radioactivity of radioactive constituents

1. Pu-239 - 154 Curies (Transport Group I)
2. U-233 - 1.71 Curies (Transport Group II)
3. U-235 - 5.24×10^{-3} (Transport Group III)

e. Classification of material to be shipped:

Large source and fissile material

f. Identification, chemical and physical form, and maximum quantities of fissile constituents:

1. Uranyl nitrate solutions having a concentration of U-235 not to exceed 350 grams per liter, provided that (a) the combined U-233 and plutonium content is not more than 1% of the U-235 content, and (b) the minimum free acid is 2 molar.

2. Uranyl nitrate solutions having a concentration of U-233 and U-235 not to exceed 250 grams per liter, provided that (a) the U-233 content is not greater than 10% of the combined U-233 and U-235 content, and (b) the plutonium content is not more than 1% of the combined U-233 and U-235 content, and (c) the minimum free acid is 2 molar.

3. Plutonium nitrate solutions having a concentration not to exceed 250 grams Pu-239 per liter, provided that (a) the Pu-240 content is at least 3% of the total plutonium, and (b) the minimum free acid is 2 molar.

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4. Maximum quantity of material per package: Ten (10) liters of solution, containing not more than 2.5 kilograms of fissile isotope.

g. Extent of reflection, amount and identity of non-fissile neutron absorbers in the fissile constituents, and the atomic ratio of moderation to fissile constituents.

The fissile material is contained in a polyethylene bottle (0.16" wall thickness) which is contained in a cadmium wrapped 3/16" thick stainless steel pressure vessel. A 2 inch thick polyethylene-polyester resin composite surrounds the cadmium wrapped pressure vessel. Items f1, 2, 3, and 4 above specifies the atomic ratios of moderation to fissile constituents.

h. Maximum weight of contents: 42 pounds including the polyethylene bottle.

DRAFT - i. Maximum amount of decay heat: For plutonium containing less than 1 w/o Pu-238, we estimate a 30°F temperature differential between the solution and the outside of the container, yielding an internal temperature of 160°F under condition 1 of Appendix A, 10 CFR 71.

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VI.1.2 Container Evaluation

VI.1.2.1 General Standards

a. Internal Reactions

All fissile material is contained within a polyethylene bottle (0.16" wall thickness) which is double bagged in 0.012 inch PVC, and contained in a pressure vessel fabricated from stainless steel, precluding the possibility of internal chemical reactions with the packaging material.

b. Closure

Closure of drums consists of a 12 gauge bolted ring with drop forged lugs, one of which is threaded, using a 5/8" bolt.

c. Lifting Devices

No lifting devices are incorporated as a structural part of the container or its lid.

d. Tie-down Devices

No tie-down devices are incorporated as a structural part of this container.

e. Structural Standards for Large Quantity Packaging

Because the package may contain in excess of 20 curies of transport Group I materials, as defined in 10 CFR 71.4(ʃ), it is evaluated as a large quantity package as well as a fissile material package.

1. Load Resistance

Calculations demonstrate that the yield strength of the packaging material is not exceeded under the conditions set forth in 10 CFR 71.32(a).

2. External Pressure

The containment vessel is equivalent to an ICC 2R container, and is therefore capable of withstanding an external pressure of 25 psig.

VI.1.2.2 Criticality Hazards for Fissile Material Packages

DELETE REFERENCE TO Pu

a. Optimum Water Moderation is a Normal Condition of Shipment.

Under this condition, 2.5 kg U-235 is subcritical in a 5.625" I.D. cylinder with full water reflection (Figure K-1.2(a), Y-1272), and up to 250 gm Pu/liter is subcritical in an infinite 5.625" I.D. water reflected infinite cylinder (Figure J-2.7, Y-1272).

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b. All fissile material is contained within a polyethylene bottle which is provided with a vented cap which has been tested to open at 6 ounces to 16 ounces internal pressure. The bottle is enclosed in two 12-mil polyvinal seamless bags, each of which has been sealed to prevent leakage of liquid. The enclosed bottle is placed within the containment vessel which is provided with a gasketed flanged closure.

DELETE VENTED CAP.

Because this system provides double containment of the fissile material in a subcritical geometry, and precludes the leakage of liquids into an unsafe geometry in spite of any single packaging error, the fissile content of any single packaging exceeds the minimum critical mass under conditions of optimum configuration (sphere) and reflection.

Administrative procedures detailed in VI.1.2.5 below are used to verify the leak tightness of each containment vessel.

VI.1.2.3 Evaluation of a Single Package

a. Normal Conditions of Transport

1. Exposure to direct sunlight at an ambient temperature of 130°F in still air.

The external container is a steel drum inside of which is a vermiculite insulated steel structure containing a moderator, a stainless steel pressure vessel, and the product solution. All are exposed with t damage to more severe thermal conditions during the required thermal test with no damage. As previously indicated, the solution may achieve a temperature of 160°F, which is within the allowable limits for the ultra-ethylux bottle.

2. Exposure to an ambi nt temperature of -40°F.

Loss of properties of the steel and insulating material at that temperature will not occur, and possible crystallization of the moderator will not change its moderating properties. The polyethylene bottle is composed of "ultra-ethylux-28" as produced by Westlake Plastics Company, or equal, and does not embrittle until the temperature is reduced to -55°F. To allow for expansion of the solution on thawing, at least 10% free space is provided in the bottle.

3. Exposure to atmospheric pressure of 0.5 times standard atmospheric pressure.

The drum lids have no gaskets, allowing the equilization of pressure.

4. Vibration

Each package is vibrated for 5 minutes as a part of the fabrication procedure in order to promote settling of the vermiculite insulation.

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5. Water Spray

Experience with packages using similar drum designs (LA-36, HA-10, Ref: SNM-145) demonstrate that exposure to heavy rain for extended periods of time does not result in water inleakage.

6. Free Drop

This test was not performed because the Pu-10-I container does not depend on spacing for nuclear safety.

7. Corner Drop

Because the package is fabricated from steel, this test does not apply.

8. Penetration

The drums are fabricated from 16 Ga. steel, and are similar to those used for the NUMEC LA-36 containers. Therefore, the test results reported in Section X of SNM-145 apply.

9. Compression

A 2,000 pound load was placed on top of a sample package for a period of 24 hours with no measurable deflection of the drum.

Based on the above, we conclude that requirements set forth in 10 CFR 71.35(a) (1), (2), (3), (b) (1) and (4) III are satisfied. 10 CFR 71.35(a) (4) and (5) do not apply as there are no coolants in this package. 10 CFR 71.35(b) 1 and 3 are discussed in VI.1.2.2 above, and 10 CFR 71.35(b) (4), (1) and (II) does not apply as the spacing provided by the package does not effect nuclear safety.

With regard to 10 CFR 71.35(c), the vent valve is closed prior to all shipments.

b. Accident Test Conditions

Five sample containers identified in Drawings ASK-1058-D-1, 2, and 3 were subjected to the accident test conditions required by 10 CFR 71. These drawings show direction of impact for each container, and indicate maximum internal temperatures recorded.

Drop tests were conducted in a manner to assure that the lowest point of the container was at least 30 feet above the point of impact on an unyielding surface at the time of release. Thermal tests were performed in a furnace which provided the required conditions. However, containers numbered 1 and 2 were exposed to high temperatures for 36 minutes to compensate for a temperature

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drop in the furnace observed immediately subsequent to the insertion of the containers. The other containers were exposed for the required period. Here, the temperature drop was minimized by additional pre heating of the furnace to 1600°F. An 11 liter polyethylene bottle containing sand for ballast was placed within each container.

Container number 5 suffered impact on the top corner causing the drum lid to spring open and release some vermiculite. Resulting from this failure, further testing was held in abeyance pending evaluation of the damage, and the determination of corrective measures. As finally determined, these measures consisted of the use of drum lids with a sufficient lip to completely enclose the upper half of the rolled lip on the drum body, and the omission of the lid gasket to assure better seating.

That these measures were sufficient to assure closure under accident conditions was demonstrated by container number 3 which was also corner dropped. The lid remained properly seated on the drum, and no vermiculite was lost.

Container number 4 was impacted on both its top and bottom surface. The impact onto its top surface caused a seam in the upper drum body to separate slightly, yielding an opening measuring about 1/8" x 1". No measurable amount of vermiculite was lost through this opening, and subsequent to the above tests, the drum was impacted from a height of 40 inches onto a 6 inch diameter by 8 inch long bar, as specified by 10 CFR 71. Impact occurred on the welded seam joining the drums. Although a 1-1/2" to 2" deep depression resulted, the integrity of the drum and weld was not violated.

As previously indicated, other tests were performed as illustrated in Figures 1, 2 and 3 of this application.

Examination of the containers subsequent to their removal from 24 hours of immersion under three feet of water revealed three principal facts; (1) no water leaked into the containment vessel, (2) no moderator was lost, and (3) the maximum temperature experienced within the containment vessel was in excess of 100°F, but less than 150°F. Additionally, the cadmium wrapping of the containment vessel was in no way effected by the test sequence. From these findings, we conclude that:

1. No radioactive material will be released from the package under the stated accident conditions.

2. The package will remain subcritical as the material remains confined to a subcritical geometry, and the geometric form of the contained material is not altered (10 CFR 71.35 (b)(2).

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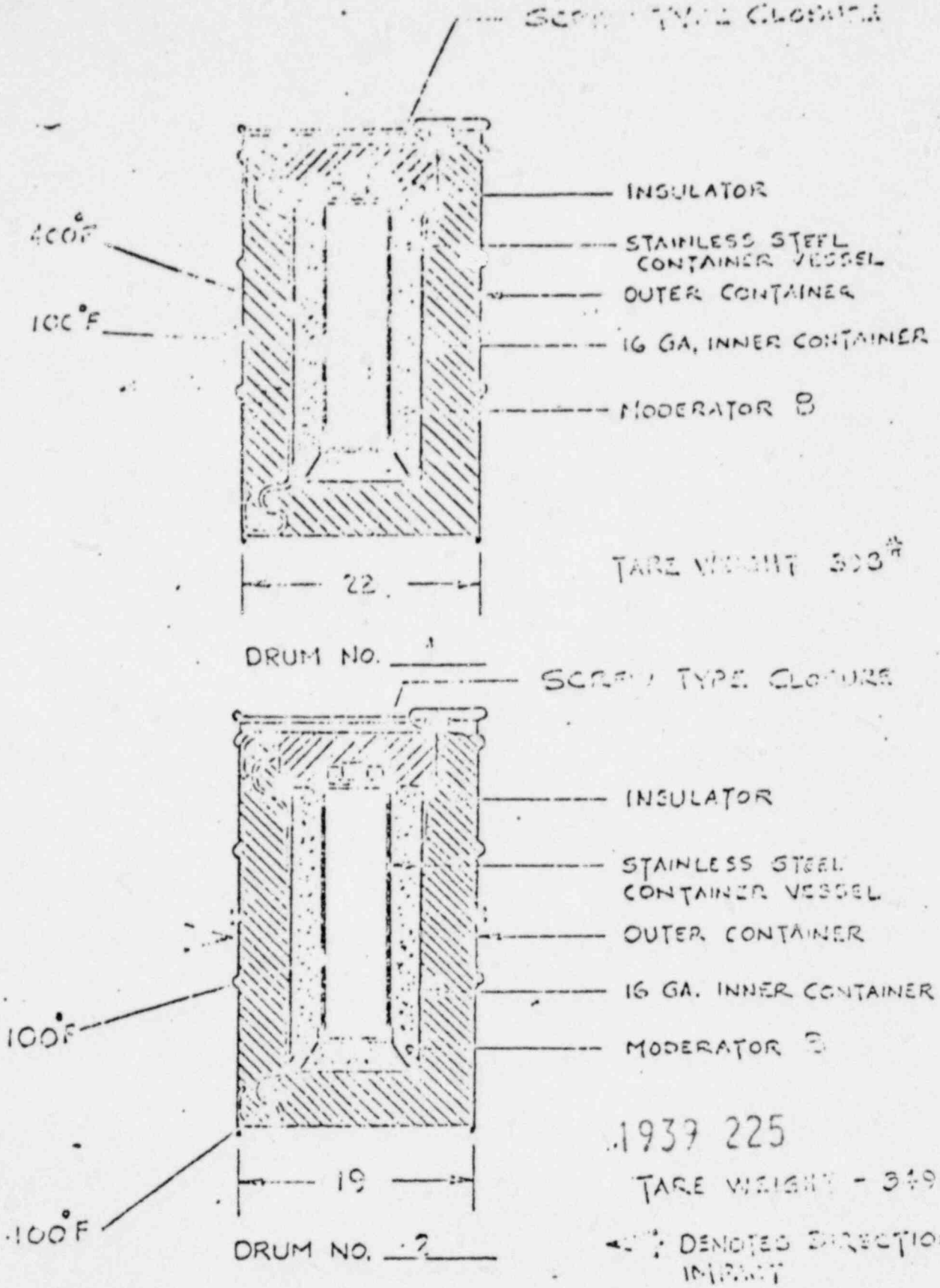

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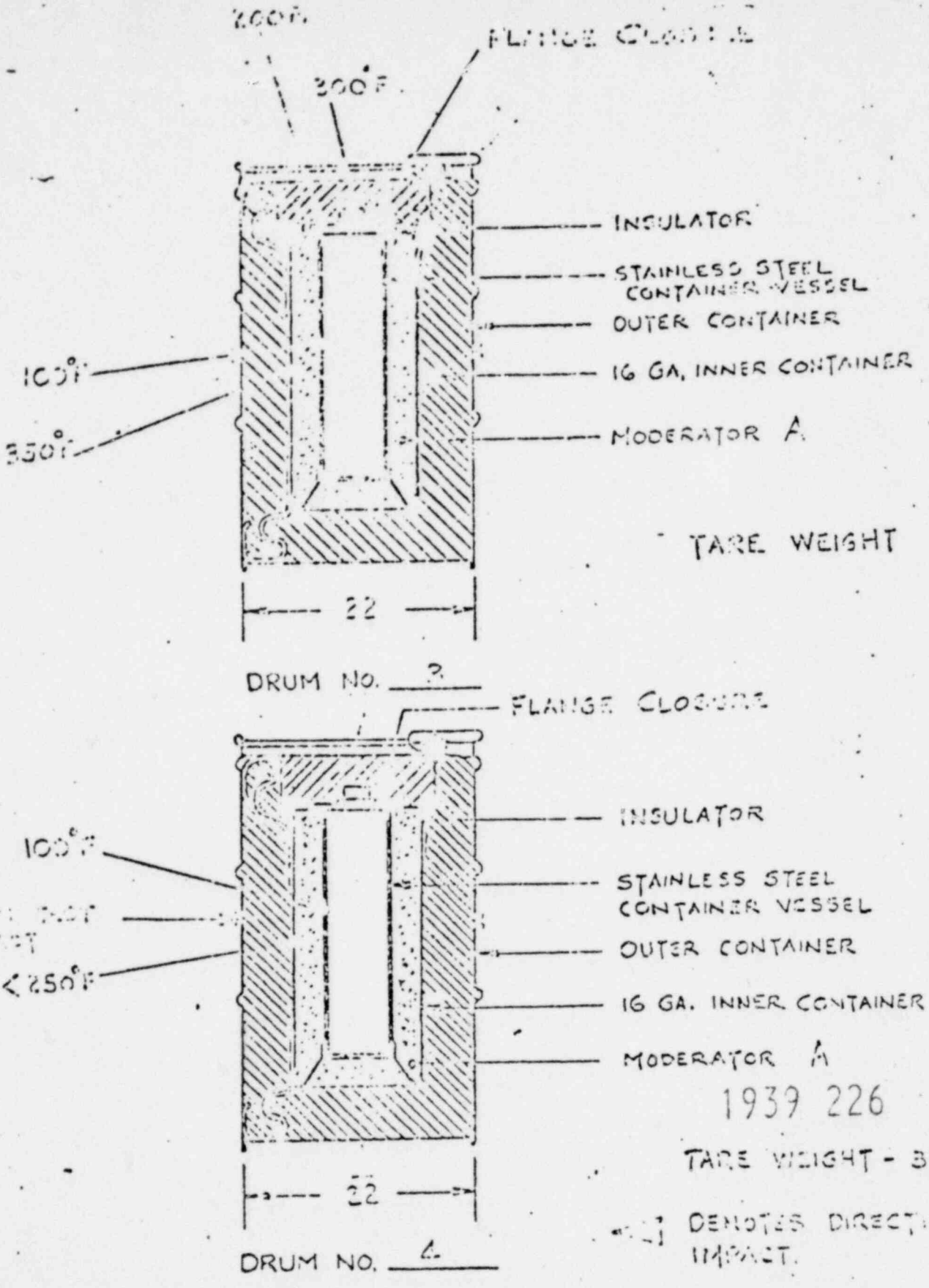
FIG # 1

NUMEC PU-10-I
SHIPPING CONTAINER
ASK-1058-D-1
1-21-65 C. SMITH



TARE WEIGHT 3[illegible]

1939 226

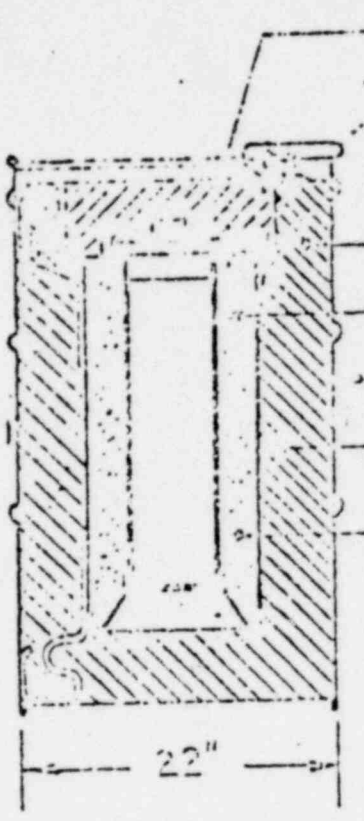
TARE WEIGHT - 370

DENOTES DIRECTION IMPACT.

FIG 2

NUMEC PU-10-I
SHIPPING CONTAINER

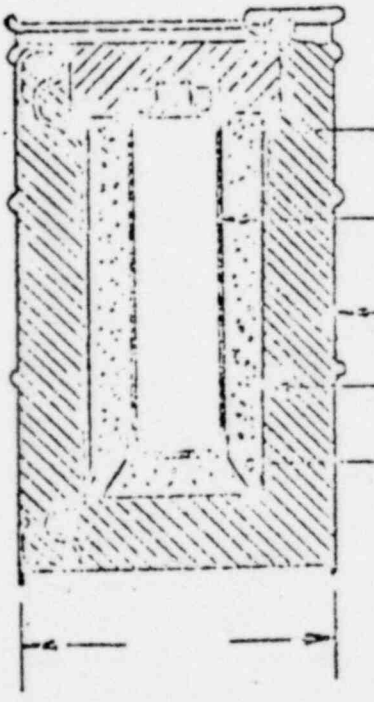
ASK-1058-D-2
1-21-65 C. SMITH



TARE WEIGHT 375#

NOTE:
LID BUCKLED OPEN ON IMPACT.

DRUM NO. 5



1939 227

→| INDICATES DIRECTION OF IMPACT

DRUM NO. _____

FIG. #3

NUMEC PU-10-I
SHIPPING CONTAINER
ASK-1058-D-3
1-21-65 C. SMITH

3. Double containment is maintained in that the internal temperatures noted during the tests are insufficient to compromise the integrity of

   a. the polyethylene bottle
   b. the PVC bagging
   c. the pressure vessel

   It is recognized, however, the pressure buildup within the polyethylene bottle may displace gram quantities of solution from the bottle. However, such material remains doubly contained within the double PVC bag and the pressure vessel.

4. No damage was suffered by any of the components or materials of construction due to exposure to the thermal test.

VI.1.2.4 Evaluation of an array of Pu-10-I containers

In view of the fact that the test conditions did not effect the containment or moderation of the material within the container, we evaluate an array of Pu-10-I containers in both the damaged and undamaged condition on the basis of the following conditions:

Solution Diameter	-	5.56"
H/X Ratio	-	44
Cadmium Thickness	-	0.016"
Moderator Thickness	-	2.0"
Equivalent Water Thickness	-	1.91"

Two methods are considered herein to demonstrate that the cadmium wrapped 5.625" diameter cylinders are isolated when surrounded by the equivalent of 1.9 inches of water.

We consider first an analysis based on neutron penetration data, and correlated to interacting subcrits, as reported in K-1478.

By this method, a just critical array is described when

$$K = 1.0 - \frac{kc}{1-V}$$

where

kc = reactivity of subcrit
$V = \Omega F\,(1 - UF)(ab)\,p$
ΩF = fractional solid angle

$(1-UF)$ = fast leakage probability
$(ab)p$ = neutron penetration. The weighting factor p is set equal to 1.0.

To obtain values of geometric buckling Bg^2, an appropriate value of δ is required. Using the critical height of a cadmium wrapped water

1939 228

APPENDIX 2.10

NUMEC LA-36 TEST RESULTS

1939 229

DOT 5442

1 NUMEC LA-36 Container

1.1 Package Description

a. Gross Weight: 250#

b. Model Number: LA-36

c. Details of Construction:

This information is provided in the enclosed drawings (10-D-1167, 10-D-1168, 10-A-214 and 10-A-215).

d. Identification and maximum radioactivity of radioactive constituents:

U-234 + U-235 - 11.1×10^{2} curies
U-238 - 1.3×10^{-2} curies

e. Classification of material to be shipped:

Fissile material only.

f. Identification, chemical and physical form, and maximum quantities of fissile constituents:

1. Dry non-decomposable forms of uranium having a maximum U-235 assay of 5.0%:

Maximum Loading: 36 kg of material containing no more than 1.58 kg U-235.
Maximum Uranium Density: Any
Maximum Water Content: 0.5 w/o

2. 36 kg of hydrous decomposable compounds containing a maximum of 1.0 kg U-235. The maximum weight of the uranium bearing material shall be 36 kg.

g. Extent of reflection, amount and identity of non-fissile neutron absorbers in the fissile constituents, and the atomic ratio of moderation to fissile constituents:

The fissile bearing material is contained in two sealed 5 gallon ICC-17H pails. The above mass limits assure that no single package contains a critical mass under any credible conditions of moderation and reflection. Non-fissile neutron absorbers, if present, are neglected for the purpose of evaluation. Actual moderation ratios are as follows:

1. Non-decomposable forms of uranium:

($\leq$0.5 w/o H_2O)

U-235 Assay	H/X
1-2	14.8
2-3	7.41
3-4	4.95
4-5	3.7

1939 230

2. Decomposable forms of uranium:

Optimum hydrogen moderation is assumed.

h. Maximum weight of contents: 36 kg

i. Maximum amount of decay heat: Negligible

1.2 Container Evaluation

1.2.1 General Standards

a. Internal Reactions

1. Non-decomposable forms of uranium:

No internal chemical reactions are considered credible.

2. Decomposable forms of uranium:

All decomposable forms of uranium are packaged within an inert material, such as polyethylene in the form of sheet or a bottle in order to preclude chemical reactions between the material, and the 5 gallon pails which provide primary containment.

b. Closure

Closure of the drums consists of a 12 gauge bolted ring with drop forged lugs, one of which is threaded, using a 5/8" bolt.

c. Lifting Devices

No lifting devices are incorporated as a structural part of the package or its lid.

d. Tie Down Devices

No tie down devices are incorporated as a structural part of the package.

e. Structural Standards for Large Quantity Packaging

Not applicable

1939 231

1.2.2 Criticality Standards for Fissile Material Packages

a. Each container is limited to assure that its contents would remain subcritical under any condition of water moderation and reflection.

b. Each container is further limited to assure that its contents would remain subcritical in an optimum configuration, with optimum water moderation and reflection.

1 NUMEC LA-36 Container

1.1 Package Description

a. Gross Weight: 250#

b. Model Number: LA-36

c. Details of Construction:

This information is provided in the enclosed drawings (10-D-1167, 10-D-1168, 10-A-214 and 10-A-215).

d. Identification and maximum radioactivity of radioactive constituents:

U-234 + U-235 - 11.1×10^{-2} curies
U-238 - 1.3×10^{-2} curies

e. Classification of material to be shipped:

Fissile material only.

f. Identification, chemical and physical form, and maximum quantities of fissile constituents:

1. Dry non-decomposable forms of uranium having a maximum U-235 assay of 5.0%:

Maximum Loading: 36 kg of material containing no more than 1.58 kg U-235.
Maximum Uranium Density: Any
Maximum Water Content: 0.5 w/o

2. 36 kg of hydrous decomposable compounds containing a maximum of 1.0 kg U-235. The maximum weight of the uranium bearing material shall be 36 kg.

g. Extent of reflection, amount and identity of non-fissile neutron absorbers in the fissile constituents, and the atomic ratio of moderation to fissile constituents:

The fissile bearing material is contained in two sealed 5 gallon ICC-17H pails. The above mass limits assure that no single package contains a critical mass under any credible conditions of moderation and reflection. Non-fissile neutron absorbers, if present, are neglected for the purpose of evaluation. Actual moderation ratios are as follows:

1. Non-decomposable forms of uranium:

($\leq$0.5 w/o H_2O)

U-235 Assay	H/X
1-2	14.8
2-3	7.41
3-4	4.95
4-5	3.7

2. Decomposable forms of uranium:

Optimum hydrogen moderation is assumed.

h. Maximum weight of contents: 36 kg

i. Maximum amount of decay heat: Negligible

1.2 Container Evaluation

1.2.1 General Standards

a. Internal Reactions

1. Non-decomposable forms of uranium:

No internal chemical reactions are considered credible.

2. Decomposable forms of uranium:

All decomposable forms of uranium are packaged within an inert material, such as polyethylene in the form of sheet or a bottle in order to preclude chemical reactions between the material, and the 5 gallon pails which provide primary containment.

b. Closure

Closure of the drums consists of a 12 gauge bolted ring with drop forged lugs, one of which is threaded, using a 5/8" bolt.

c. Lifting Devices

No lifting devices are incorporated as a structural part of the package or its lid.

d. Tie Down Devices

No tie down devices are incorporated as a structural part of the package.

e. Structural Standards for Large Quantity Packaging

Not applicable

1.2.2 Criticality Standards for Fissile Material Packages

a. Each container is limited to assure that its contents would remain subcritical under any condition of water moderation and reflection.

b. Each container is further limited to assure that its contents would remain subcritical in an optimum configuration, with optimum water moderation and reflection.

1939 233

1.2.3 Evaluation of a Single Package

a. Normal Condition of Transport

1. Exposure to direct sunlight at an ambient temperature of 130°F in still air.

The external container is a steel drum inside of which is a vermiculite insulated steel sleeve which contains two ICC-17H pails. All are exposed without damage to more severe thermal conditions during the required thermal test.

2. Exposure to an ambient temperature of -40°F

Exposure to -40°F will not affect the structural materials, which are steel, or the insulating material, which is vermiculite.

3. Exposure to atmospheric pressure of 0.5 times standard atmospheric pressure.

The drum lids have no gasket, allowing equilization of pressure.

4. Vibration

Each package is vibrated for 5 minutes as a part of the fabrication procedure in order to promote settling of the vermiculite insulation.

5. Water Spray

A number of containers have been exposed to heavy rain storms for extended periods of time, with no water inleakage. Such exposure exceeds the requirements of the water spray test.

6. Free Drop

Two sample packages were dropped from a height of 4 feet onto an unyielding surface. One package was dropped botton end down, and experienced a less than 5% loss of spacing and reduction of volume. The other was dropped in a horizontal position, and also experienced a less than 5% loss of spacing and reduction of volume.

7. Penetration

Both sample packages were subjected to a penetration test as specified in Appendix A of 10 CFR 71. The resulting dents did not exceed a depth of 3/16 inch.

8. Compression

A 1275 pound load was placed on top of a sample package for a period of 24 hours with no measurable deflection of the drum.

Based on the above, we conclude that the requirements set forth in 10 CFR 71.35 are satisfied to the extent that they are pertinent.

1939 234

b. Accident Test Conditions

Two sample packages, each containing at least 36 kg of dry brick mortar, and designated as Drums #1 and #2, were subjected to the accident test conditions, as set forth in Appendix A, 10 CFR 71.

1. Impact

Drum number 1 was dropped at a 45° angle from a height of 30 feet on its cover. The drum caved inward several inches at the point of impact. The ring and cover were not dislodged. Drum number 2 was dropped from a height of 30 feet so as to strike flat on its side. Impact occurred approximately half way between the spacer rods. This drum was then dropped 30 feet in a vertical position, suffering impact on its bottom surface.

2. Puncture

Drum number 1 was dropped through a distance of 40 inches onto a 6 inch diameter cylindrical target. A dent approximately 1-1/8 inches deep resulted.

3. Thermal

Both drums were placed within a furnace heated in excess of 1500°F prior to insertion of the drums, and maintained at 1475°F for 1/2 hour subsequent to the insertion of the drums.

4. Immersion

Both drums were immersed under three feet of water for a period of 24 hours.

5. Container Dismantling and Inspection

The two sample drums were dismantled, inspected and measured to determine the loss of spacing suffered during the impact tests, and the extent of water inleakage into the 5 gallon pails.

5.1 Weight Checks

All pails were weighed before the tests commenced, and again, on the same scale, on completion of the tests. These weights are tabulated below, and demonstrate that no measurable inleakage of water into the pails had occurred.

1939 235

WEIGHTS OF PAILS

	NUMEC (before tests)	ORGDP (before tests)	ORGDP (after tests)
Number 1			
Top Pail	22,470	22,470	22,470
Bottom Pail	20,470	20,440	20,440
Number 2			
Top Pail	20,510	20,490	20,490
Bottom Pail	20,450	20,440	20,440

5.2 Inspection Checks

5.2.1 Drum number 1 experienced a maximum temperature of 500°F on the cover plate. Removal of the cover and the pails revealed that water had entered, but only half filled the inner container. The inner container had shifted approximately 1/4 inch as a result of the impact.

Both pails experienced maximum temperatures of from 200 to 300°F, and appeared to have suffered little damage. When opened, dryness of the contents was confirmed.

5.2.2 Drum number 2 also experienced a maximum temperature of 500°F on the cover plate. As with drum number 1, water had entered, but only half filled the inner container. The inner container had shifted approximately 7/8 inch as a result of the impact. In addition, the drum had caved in at the point of impact, yielding a total loss of 2-1/2 inches spacing between the center of the inner container, and the nearest point on the outer container.

The upper pail experienced a maximum temperature of 325°F. Pieces of the gasket pulled loose when the lid was removed as a result of the adherence to the side of the pail.

The bottom pail experienced deformation on its rolling hoop, suffering a loss of 1 to 1-1/2 inches in overall height. However, the gasket had not deteriorated appreciably, and maintained its seal. A strip of seemingly caked powder 3/8 inches wide by 3/4 inches long by 1/64 inch thick was found near the top of the pail. No other indications of caked material was noted. Attempts to brush this material from the pail with light pressure were unsuccessful, but similar attempts with finger nail pressure indicated that it may not have been completely reacted. No other attempt had been made to identify the nature of this caking. However, in view of the general tendency of hygroscopic powdered material to form localized adhesions on many apparently dry surfaces, the nature of the milligram quantities of caked powder observed cannot be ascertained with any degree of certainty. It is, therefore, on the basis of recorded weight measurements that moderation control is claimed.

1939 236

A series of additional tests has been carried out wherein pairs of pails have been dropped together without benefit of the surrounding drum structure, exposed to temperatures typical of those recorded above, and immersed under three feet of water for 24 hours. The results confirm those reported above. Included in these tests were pails which were equipped with lids identical to the standard 17-H lids, except that the closure device is a lever-lock ring formed of .032 steel sheet, in place of the standard lid closure lugs. The lids are identical in all other respects.

Based on the above tests, we conclude that:

1. The individual package remains subcritical under all conditions by virtue of the mass limit.

2. The ability to exclude water from the material being shipped provides the basis for evaluating an array of packages on the basis of dryness of the material.

1.2.4 Evaluation of an Array of LA-36 Containers

1.2.4.1 Dry Compounds

In view of the proven ability to exclude water moderation, we consider that all material being shipped contains a maximum of 0.5 w/o water.

a. Undamaged

Because this material is essentially unmoderated ($H/U \leq 0.5$), criticality cannot be achieved with any finite mass. Accordingly, an infinite number of containers is safe.

b. Damaged

The minimum volume occupied by the LA-36 container in a close packed hexagonal array is $3.46\ R^2H = 3.46\ (.835)^2\ (3.16) = 7.6\ ft^3$.

Mcb = Critical mass of an unreflected sphere of UO_2 (93% U-235)

Because the moderation ratio may be as high as 14.8 for 1.0% enriched uranium, we determine the value of Mcb from Figure 10 of LA-3366. While the value of Mcb thus obtained represents a carbon-water-uranium system, it yields slightly conservative results, as seen in Figure 9 of LA-3366. Thus,

McB = 25 kg U-235. The density ρ_0 = 1.7 gm/cc.

The average uranium density ρ for the system is

$$\rho = \frac{1.58 \text{ kg U-235}}{215 \text{ liter}} = .007\tfrac{1}{4} \text{ gm/cc}$$

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3.0 THERMAL EVALUATION

Materials of all structural components used in the manufacture of the container have physical and mechanical properties equivalent to or better than mild steel throughout a temperature range of -40°F to 1500°F.

(See Appendix 2.10 page (VI-7) of NUMEC Pu 10-1 tests "No damage was suffered by any of the components or materials of construction due to exposure to the thermal test".)

1939 238

4.0 CONTAINMENT

4.1 Containment Boundary

The primary containment of the CE-250-2 package is the outer 16 gauge 55-gallon drums which have been welded together (22-1/2" I.D. x 68-3/8" long). The secondary containment boundary is the 16 gauge steel inner container, 11-5/8" inner diameter x 57-1/4" long. As a result of the tests performed on the Westinghouse BB 250-2 and the NUMEC Pu 10-1 containers, it was determined that the integrity of the CE-250-2 package would not be affected by the test conditions.

4.1.1 Containment Vessel

The outer shell of the CE-250-2 package is composed of two 55-gallon drums made of 16 gauge steel welded together.

4.1.2 Containment Penetrations

There are no penetrations into the primary containment.

4.1.3 Seals and Welds

All seals and welds are specified in Drawing NFM-E-Z2175 Rev. 0 dated 6/13/79.

4.1.4 Closure

Closure of the outer container is achieved by using a standard 55-gallon 12 gauge Nut and Bolt ring securing the gasketed 16 gauge outer lid. The closure of the inner container is maintained by a gasket and 6 Hex Head Bolts (1/2" 13 UNC-2A x 1-3/4" Lg and nuts (1/2" 13 UNC-2B). These two closure devices provide positive sealing of the container.

4.2 Requirements for Normal Conditions of Transport

It is concluded that under normal conditions of transport (as specified in 10 CFR Part 71, Appendix A) the tests results described in Section 2.6 of this application indicate the following:

1) There will be no release of radioactive material from the containment vessel.

2) The effectiveness of the packaging will not be reduced. 1939 239

3) There will be no mixture of gases or vapors in the container which could, through any credible increase of pressure or an explosion, significantly reduce the effectiveness of the package.

4) The package is so designed and constructed, and its contents so limited, that under the normal conditions of transport specified in Appendix A of 10 CFR Part 71:

   (a) The package will be subcritical. Criticality safety calculations are presented in Section 6 of this application.

(b) The geometric form of the package contents will not be substantially altered.

(c) There will be no substantial reduction in the effectiveness of the packaging, including:

(i) Reduction by more than 5 per cent in the total effective volume of the packaging on which nuclear safety is assessed;

(ii) Reduction by more than 5 per cent in the effective spacing on which nuclear safety is assessed, between the center of the containment vessel and the outer surface of the packaging, or;

(iii) Occurrence of any aperture in the outer surface of the packaging large enough to permit the entry of a 4" cube.

1939 240

4.3 Containment Requirements for the Hypothetical Accident Conditions

The effect on the loaded CE-250-2 container of conditions hypothesized to occur in an accident was assessed during the testing of a loaded NUMEC Pu 10-1 container. Two 30-foot free drop tests and puncture tests as specified in Appendix B of 10 CFR Part 71 were conducted.

These tests demonstrated that no radioactive material would be released.

The thermal tests performed on the NUMEC Pu 10-1 container demonstrated that no damage was suffered by any of the components or materials of construction during the thermal test.

Examination of the containers subsequent to their removal from 24 hours of immersion under three feet of water revealed that no water leaked into the containment vessel.

It was evident from the above tests that the package would remain subcritical because the material remains confined to a subcritical geometry and the geometric form of the contained material is not altered.

1939 241

5.0 SHIELDING EVALUATION

N/A (The packages are used for the shipment of uranium oxide in pellet or powder form in stainless steel cans which are then placed in the container. External dose rates are less than 1 mR/hr β-γ at the surface of the CE-250-2 package.)

1939 242

6.0 CRITICALITY SAFETY EVALUATION

6.1 Discussion and Results

The CE 250-2 shipping drum design incorporates a steel inner cylinder which can hold up to 4 fuel-bearing stainless steel cans. The void between the outer drum and the inner steel cylinder is filled with vermiculite. It has been shown that the hypothetical accident conditions do not compromise the leak-tight feature of the container. The inner cylinder design thus provides an added margin of criticality safety by maintaining a greater separation distance between fuel-bearing containers and by excluding moderator from this region. A summary of the criticality evaluation (as Fissile Class II) is presented as follows:

NORMAL CONDITIONS	
Number of undamaged packages calculated to be subcritical (closely reflected by water)	448
Package size, cm^3	444,333.03
ACCIDENT CONDITIONS	
Number of damaged packages calculated to be subcritical with optimum interspersed hydrogeneous moderation and full water reflection	180
Package size, cm^3	330,485.36
Transport Index	0.56

6.2 Package Fuel Loading

All material to be shipped in the CE-250-2 package will meet one of the following two restrictions:

1) The material to be shipped will be homogeneous and sampled to verify that the moisture content is less than 5 wt %.

or 2) The material to be shipped will be heated to at least 600°C in a moist atmosphere for at least one hour to assure dryness.

In addition, a maximum of 30 kg of uranium oxide per can will be allowed. (Four cans maximum per package).

6.3 Model Specification

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6.3.1 Description of Calculational Model

The calculational model (Figure 6.1) is nearly identical to the actual package dimensions. The following conservative assumptions were incorporated in the model:

1) Each stainless steel can was assumed to be packed full with UO_2 at a bulk density of 3.5 gm UO_2/cc. This translates to over 46 kg UO_2 per container. A maximum of 30 kg uranium oxide is allowed.

2) The fuel was assumed to contain 7 wt % H_2O. The limit is 5 wt % verified by analysis.

3) The package was assumed to contain the maximum number of cans (4) all at the maximum allowable enrichment of 4.1% U^{235}.

4) A 1 foot thick external water reflector was assumed for each case.

5) For the array cases, the actual triangular pitch was converted to a square pitch, resulting in tighter packing of the drums than is physically possible.

6) For the accident case, it was assumed that the drums were reduced 2-1/2" in diameter and 4" in height. These reductions were obtained from the previously referenced test results.

7) Optimum interspersed hydrogeneous moderation was assumed for the accident case.

6.3.2 Package Regional Densities

Fuel Composition

U^{235} - .00032418 x 10^{24} atoms/barn - cm

U^{238} - .00748708 x 10^{24} "

Hydrogen - .01763005 x 10^{24} "

Oxygen - .02443744 x 10^{24} "

6.4 Criticality Calculations

The KENO-IV Code with 16 group Hansen-Roach cross section sets was used to determine the reactivity of the CE-250-2 drums under normal conditions of transport and under hypothetical accident conditions. The following results were obtained:

Normal Conditions of Transport

Description	K_{eff}
Isolated package 1 ft. H_2O reflector 7% H_2O in fuel	0.4409 ± 0.0046
Same as above with 15% H_2O in fuel	0.7392 ± 0.0046
8x8x7 array, 1 ft. thick external H_2O reflector, 7% H_2O in fuel	0.8421 ± 0.0048

Hypothetical Accident Conditions

Description	K_{eff}
Isolated package 1 ft. H_2O reflector 7% H_2O in fuel	0.4555 ± 0.0056
Same as above with 15% H_2O in fuel	0.7545 ± 0.0073
6x6x5 array, 1 ft. thick external H_2O reflector, 7% H_2O in fuel	0.8676 ± 0.0048

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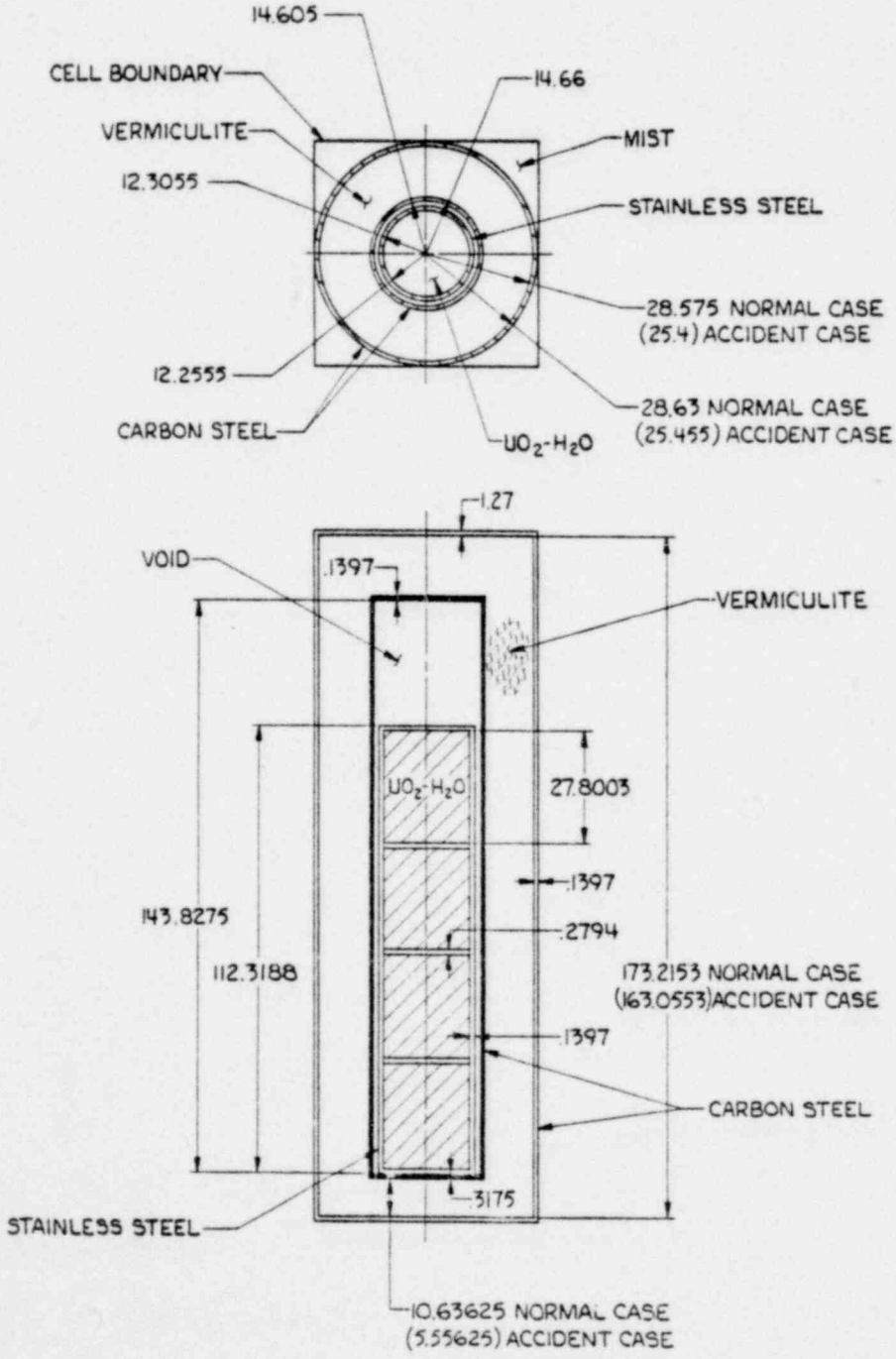
The last case was the highest reactivity calculated in a parametric study of an array of damaged packages under various external mist densities. Results of this study are shown in Figure 6.2.

6.5 Code Validation

The KENO Code with 16 group Hansen-Roach cross sections was validated in an Oak Ridge report entitled "Validation of the "KENO" Code for Nuclear Criticality Safety Calculations of Moderated, Low-Enriched Uranium Systems" by G. R. Handley and C. M. Hopper, Y-1948, issued June 13, 1974. In the study, the Monte Carlo computer code, KENO, was employed to calculate 40 critical experiments with uranium enrichments in the U^{235} isotope of 5% or less. A variety of geometries and materials were considered. The code input parameters and the 16 energy-group-cross sections were included. It was concluded that the code and cross sections are adequate and that reliable criticality safety calculations may be made for systems of general interest.

1939 245

FIGURE 6.1
CE-250-2 SHIPPING CONTAINER
KENO-IV MODEL

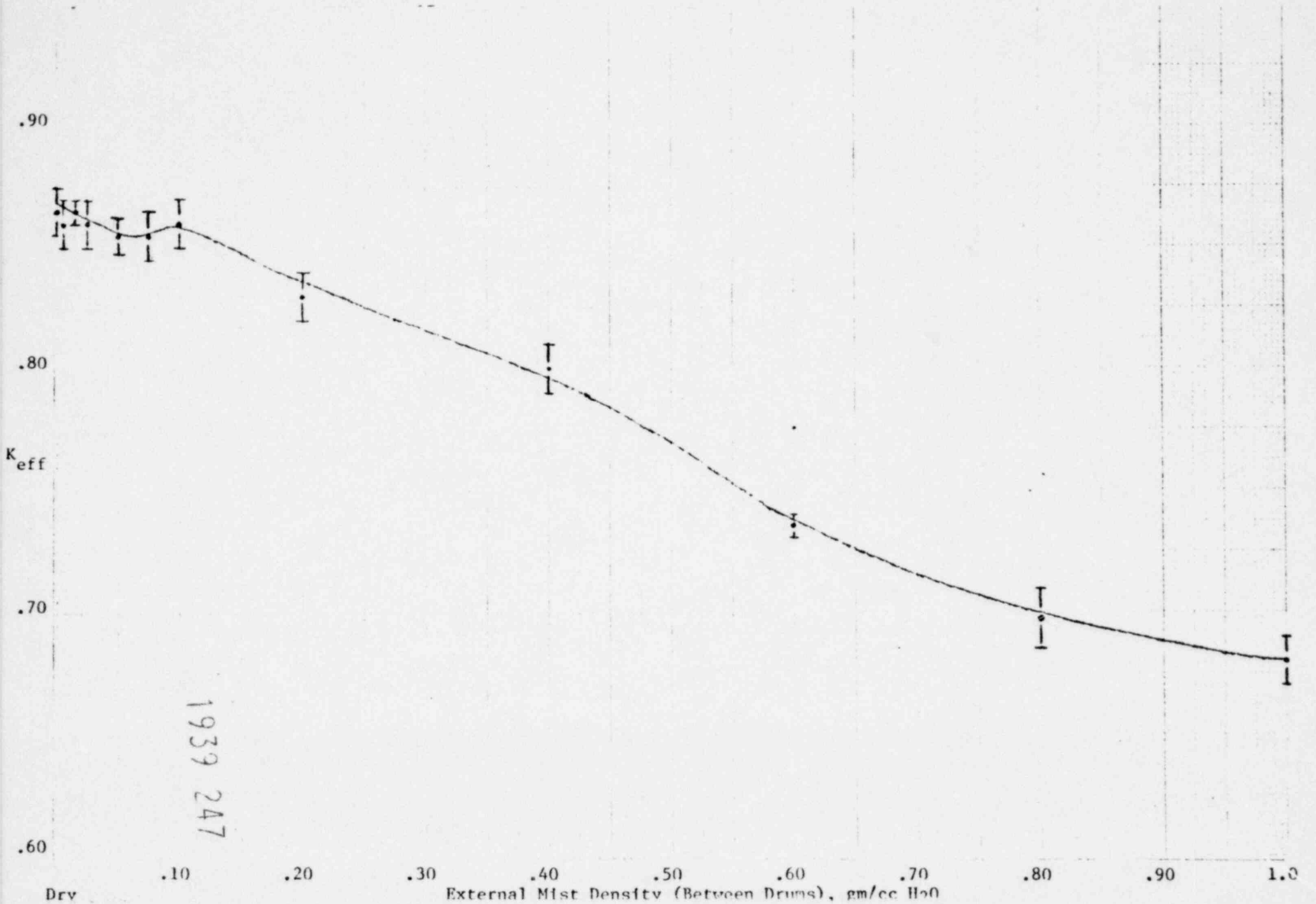


NOTE: ALL DIMENSIONS ARE NOMINAL AND ARE IN CENTIMETERS

1937 246

FIGURE 6.2

CE-250-2 SHIPPING DRUMS, HYPOTHETICAL ACCIDENT (HA)
REACTIVITY OF 6x6x5 ARRAY



1939 247

7.0 OPERATING PROCEDURES

7.1 Procedures for Loading the Package

A member of the Nuclear Licensing, Safety, and Accountability staff must be present to witness loading of the CE-250-2 packages. A packaging check list is then filled out after inspection of the following:

1) Each package must be in serviceable condition with no damage which could compromise its integrity.

2) Condition and placing of gasket

3) Proper seating of gasket to assure leak tightness

4) Proper closure of flange bolts

5) Inclusion of spacer can

6) Proper placement and tightening of ring seal or cover bolts

7.2 Procedures for Unloading the Package

Manufacturing has a specific operating procedure for unloading the CE-250-2 shipping containers. This procedure outlines the proper order and methods for unloading the package with instructions to notify Health Physics of any problems encountered.

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8.0 MAINTENANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

All containers to be fabricated will be constructed in accordance with CE Drawing NFM-E-Z2175 Rev. 0 dated 6/13/79 and shall be source inspected prior to leaving the vendor's facility. Changes to the design of the container which fall outside of the safety envelope specified in this application will be submitted to NRC for approval. This may include retesting of the container if analytical results are not capable of demonstrating that the test sequence previously performed would be applicable to the changes made.

8.2 Maintenance Program

Health Physics personnel determine during the loading inspections when any repair or replacement of material is required.

1939 249

15225