PDR 71-5768

Babcock & Wilcox

Nuclear Materials Division
609 North Warren Avenue, Apollo, Pa. 15613
Telephone: (412) 842-0111

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September 26, 1980

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Charles E. MacDonald, Chief
Transportation Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. MacDonald:

Babcock and Wilcox, Nuclear Materials & Manufacturing Division, Pennsylvania Operations (PA Ops) is submitting this consolidated application for renewal of Certificate of Compliance No. 5768 to request authorization to use the BB-250-2 shipping container.

In addition to PA Ops, the following also request authorization to use this container in accordance with the certificate of compliance:

The Babcock & Wilcox Company
Attn: Mr. D. W. Zeff
P.O. Box 800
Lynchburg, VA 24505

EXXON Nuclear Company, Inc.
Attn: Mr. L. Hansen
2955 George Washington Way
Richland, WA 99352

General Electric Company
Attn: Mr. Arthur L. Kaplan
P.O. Box 780
Wilmington, NC 28401

Nuclear Fuel Services, Inc.
Attn: Mr. C. J. Michel
P.O. Box 218
Erwin, TN 37650

Westinghouse Electric Corporation
Attn: Mr. Ronald P. DiPiazza
P.O. Box 355
Pittsburgh, PA 15230

Under separate cover, PA Ops is forwarding a check in the amount of $150.00 to cover the fee of this application.

If you have any questions regarding this application, please contact either myself or Mr. Peter J. Defilippi.

Sincerely,

MAustin

Michael A. Austin
Manager, Technical Control

MAA/mhb

Enc. (10)

8010240369

Babcock & Wilcox

Nuclear Materials Division

609 North Warren Avenue, Apollo, Pa. 15613

Telephone: (412) 842-0111

September 30, 1980

Mr. Douglas Weiss
Licensee Fee Management Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket No. 71-5768

Dear Mr. Weiss:

Reference is made to our letter of September 26, 1980 to Mr. C. E. MacDonald associated with an application for renewal of Certificate of Compliance #5768 for the Model BB-250-2 shipping container.

Enclosed is a check for $150.00 as an administrative amendment fee for the above referenced letter.

If you have any questions or comments, please contact me.

Sincerely,

MAAustin

Michael A. Austin
Manager, Technical Control

PJD/MAA/mhb

Enc.

BABCOCK & WILCOX, NM&MD, PENNSYLVANIA OPERATIONS

CONSOLIDATED APPLICATION

FOR

RENEWAL OF CERTIFICATE OF COMPLIANCE #5768

FOR

BB-250-2 SHIPPING CONTAINER

SEPTEMBER 26, 1980

TABLE OF CONTENTS

CHAPTER 1.0

GENERAL INFORMATION

CHAPTER 1.0

GENERAL INFORMATION

1.1 Introduction:

This document represents a consolidated application for renewal of Certificate of Compliance 5768, for the Model BB-250-2 shipping container, used for the shipment of fissile material.

1.2 Package Descripcion:

1.2.1 Packaging

1.2.1.1 Model Number: BB-250-2

1.2.1.2 Description:

Inner container is 11-1/2" ID, 16-gauge steel cylinder, 63-1/2" long, with bolted and gasketed top flange closure and seal welded bottom plate. Inner container is centered and supported in a 22-1/2" ID by minimum 74" long 16-gauge steel drum by 1/4" diameter spring steel rods and vermiculite. Maximum weight of packaging and contents is approximately 575 pounds.

1.2.1.3 Drawings:

The BB-250-2 packaging is constructed in accordance with Babcock & Wilcox Drawing 10-F-771 (included as Appendix A to this application). The outer cover is secure by either a 12-gauge closure ring or six (6) 1/2" diameter bolts. Westinghouse Electric Corporation Drawing C7108D10 is included as Appendix B and U.S. Military Standard MS24347 is included as Appendix C to this application.

1.2.2 Contents of Packaging:

Application is made for the following categories of contents:

1.2.2.1 Bulk uranium oxide (UO_2 or U_3O_8) powder with a maximum density of 2 g U/cc and enriched to a maximum 4 w/o in the U-235 isotope. The maximum H/U atomic ratio, considering all sources of hydrogenous material within the inner container shall not exceed 1.13. The inner container has dimensions of 9-3/4" diameter x 12".

Total contents not to exceed 250 pounds, with the U-235 content not to exceed four (4) kilgorams.

1.2.2.2 Uranium compounds which will not decompose at temperatures up to 750°F. Uranium may be enriched to a maximum 5 w/o in the U-235 isotope. The maximum H/U atomic ratio, considering all sources of hydrogenous material within the inner container shall not exceed 1.5.

Total contents not to exceed 250 pounds, with the U-235 content not to exceed five (5) kilograms. Four (4) steel drums containing not more than 1.3 kilograms U-235 each shall be packaged in the shipping insert within the inner container as shown in Westinghouse Electric Corporation Sketch SKA-252-1 (Appendix F to this application) and Drawing C7108D10. The steel drums shall be constructed in accordance with U.S. Military Standard MS 24347 with a maximum ID of 8-1/2" and a nominal height of 15.4".

1.2.2.3 Uranium oxide pellets, enriched to a maximum of 4.0 w/o in the U-235 isotope. The maximum H/U atomic ratio, considering all sources of hydrogenous material within the inner container, shall not exceed 3.0. The contents described herein shall be contained in either:

a. Metal inner containers having 9-3/4" diameter, or

b. The inner container shown on NUMEC Drawing 10-F-676 (Appendix D to this application).

Total contents not to exceed 250 pounds, with the U-235 content not to exceed 4.0 kilograms.

The inner container shown in Babcock & Wilcox Drawing 10-F-771 shall be secured with twelve (12), 1/2" diameter bolts only when utilizing method b. above.

CHAPTER 2.0

STRUCTURAL EVALUATION

REFERENCE

Much of the information presented in Chapter 2.0 herein was extracted from several pertinent reference documents. These documents had previously received approval from the Nuclear Regulatory Commission.

Where statements or information extracted from reference documents appear in this presentation, the text will be numerically footnoted to reference the applicable document.

Numerical notation will be as follows:

(1) Westinghouse Electric Corporation letter dated July 13, 1973.

(2) NUMEC Evaluation of November 1966 for the LA-36 Shipping Container.

(3) NUMEC Evaluation of November 1966 for the Pu-10-1 Shipping Container.

(4) Babcock & Wilcox Letter dated February 16, 1977.

CHAPTER 2.0

STRUCTURAL EVALUATION

2.1 Structural Design

This section provides the structural design and evaluation for the contents described in Sections 1.2.2.1, 1.2.2.2, and 1.2.2.3a of this application.

2.1.1 Discussion

This package utilizes design concepts which are similar to those used in the design of the NUMEC LA-36 and Pu-10-1 packages. The outer shell consists of two 16 gauge 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 ".125" 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. 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.[1] The maximum weight of the packaging and contents is approximately 575 pounds.

2.2 General Standards[2]

2.2.1 Positive Closure

The outer cover is secured by either a 12-gauge bolted closure ring or six (6) 1/2" diameter bolts.

2.2.2 Lifting Devices

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

2.2.3 Tie Down Devices

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

2.2.4 Structural Standards for Large Quantity Packaging

Not applicable.

2.3 Normal Conditions of Transport

As stated previously, the BB-250-2 package utilizes design concepts which are similar to those of the LA-36 and Pu-10-1 packages. The below presentation is extracted from previous evaluations of the two latter packages.

2.3.1 Heat(3)

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 without 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.

2.3.2 Cold(3)

Exposure to an ambient 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.

2.3.3 Pressure(3)

Exposure to atmospheric pressure of 0.5 times standard atmospheric pressure.

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

2.3.4 Vibration(3)

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

2.3.5 Water Spray(2)

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.

2.3.6 Free Drop[3]

This test was not performed because the Pu-10-1 container does not depend on spacing for nuclear safety.

2.3.7 Corner Drop[3]

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

2.3.8 Penetration

The drums are fabricated from 16 gauge steel, and are similar to those used for the NUMEC LA-36 containers.[3]

Two 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.[2]

2.3.9 Compression[3]

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) 111 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.

2.4 Hypothetical Accident 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.[1]

Secondly, as previously stated, the BB-250-2 package utilizes design concepts which are similar to those of the LA-36 and Pu-10-1 packages.

The below presentation reiterates the accident test conditions for both the LA-36 and Pu-10-1 containers. The tests performed for these containers are valid for the BB-250-2 package.

2.4.1 Pu-10-1 Accident Test Conditions[3]

Five sample containers identified in Drawings ASK-1058-D-1, 2, and 3 (Figures #1, #2, and #3 of this application) 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 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 container material is not altered (10 CFR 71.35(b)(2).

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.

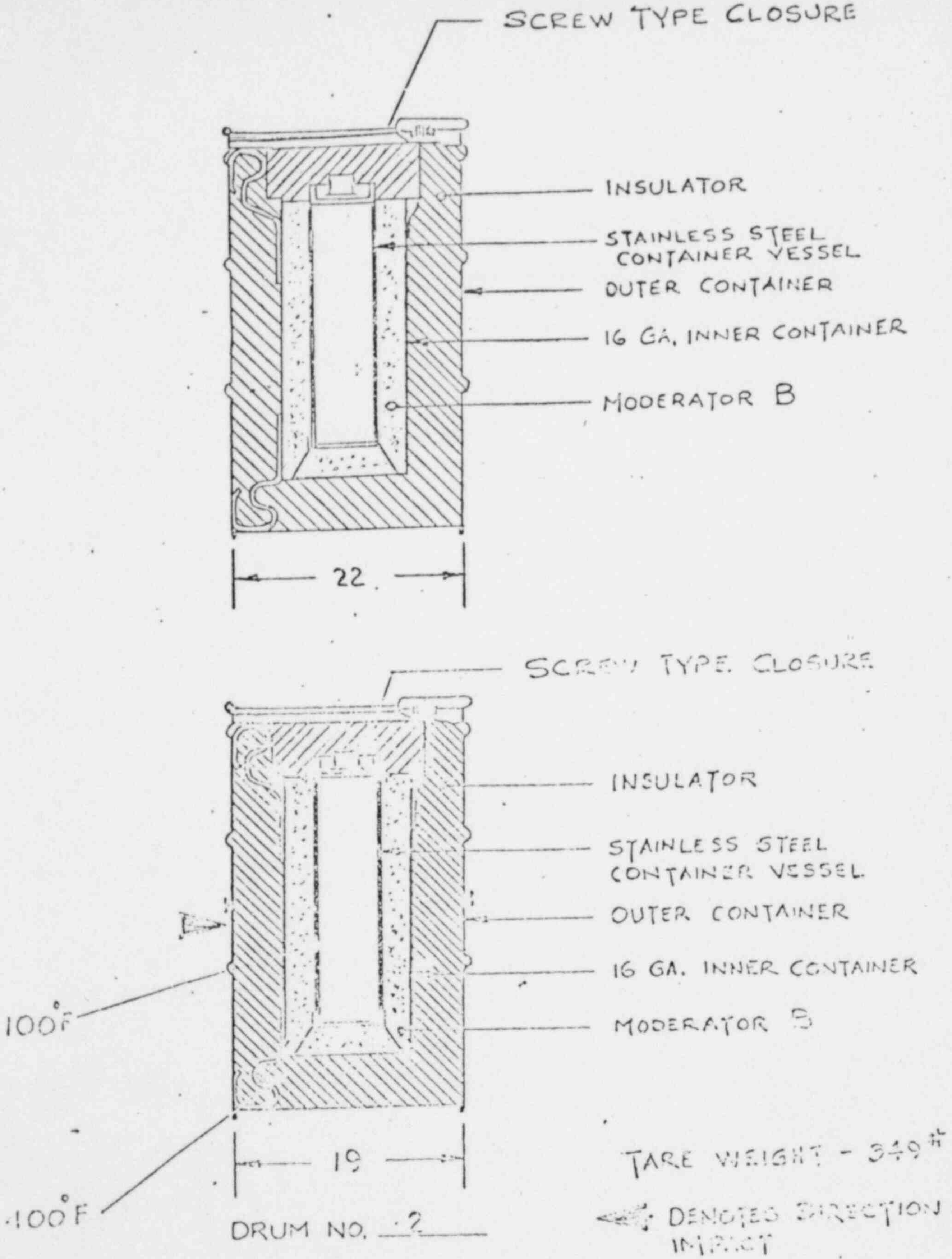

FIG # 1

NUMEC PU-10-I
SHIPPING CONTAINER

ASK-1058-D-1

1-21-65 C. SMITH

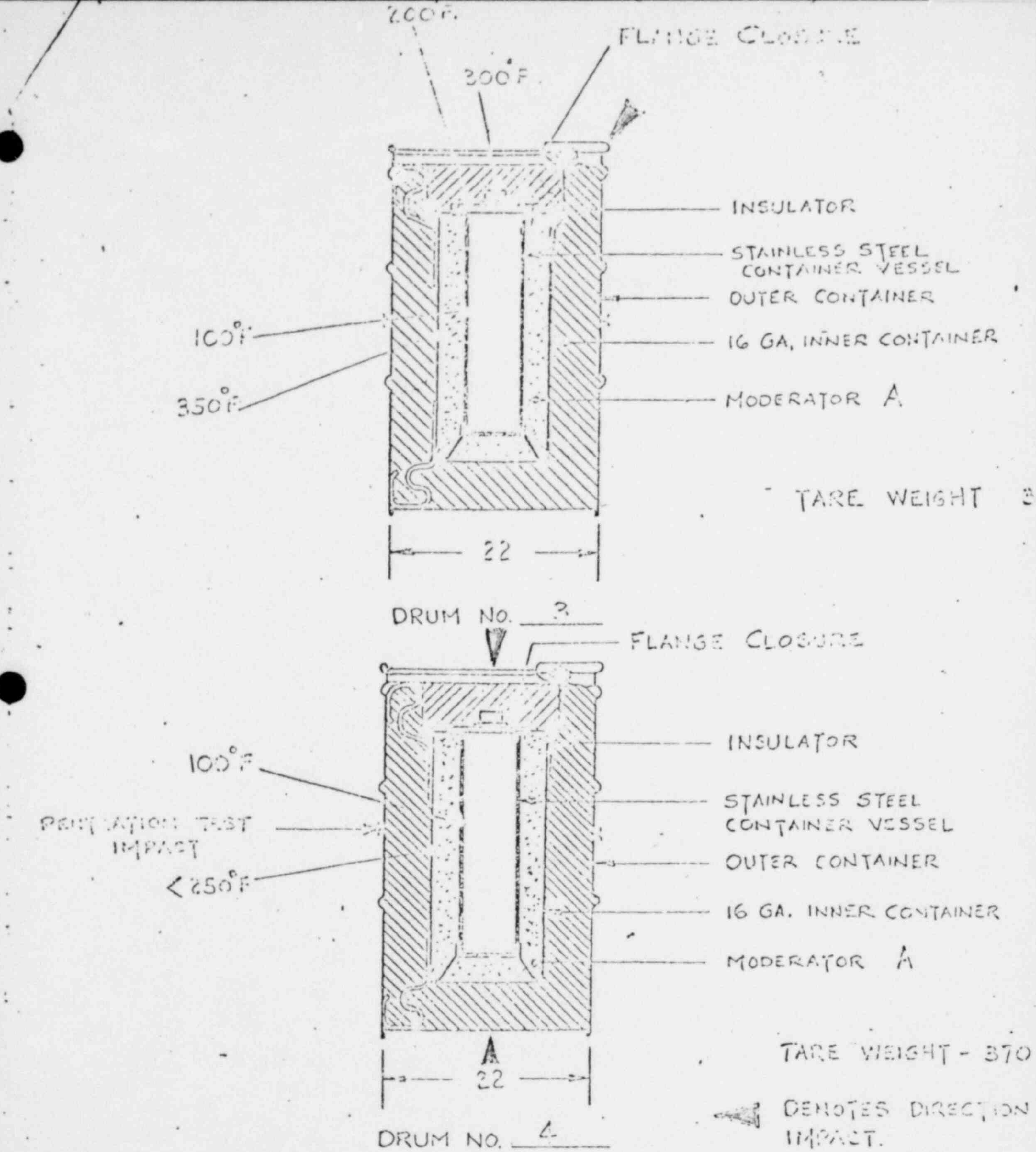

FIG 2

NUMEC PU-10-I
SHIPPING CONTAINER

ASK-1058-D-2

1-21-65 C. SMITH

POOR ORIGINAL

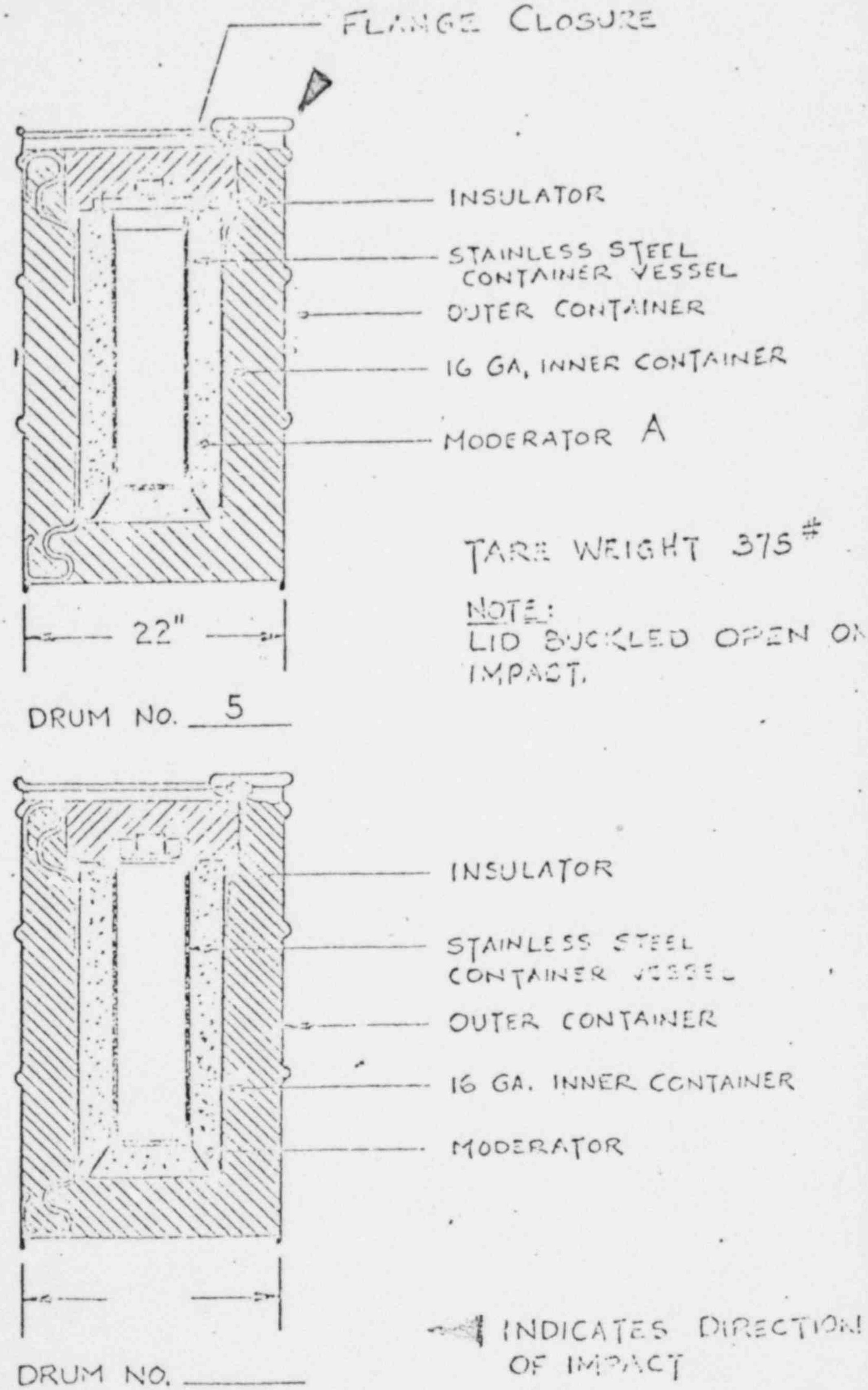

FIG. #3

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

2.4.2 LA-36 Accident Test Conditions[2]

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 B, 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.

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 fingernail 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.

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.

2.5 Additional Evaluation

This section provides the structural design and evaluation for the contents described in Section 1.2.2.3b of this application.

In addition to the information presented in Sections 2.1-2.4 of this chapter, the following additional evaluation is presented for the "Babcock & Wilcox modified BB-250-2" package.

The Babcock & Wilcox modified BB-250-2 uses the Westinghouse inner container[4] with a pellet holder (as shown in Drawing 10-F-676 given in Appendix D of this application) that fits inside. When pellets are shipped in the container, an additional six bolts (making a total of twelve) are used to secure the lid of the inner container in place. When fuel containers such as metal cans or fiberpacks are placed in the inner container, six bolts are used to secure the lid. In both cases, however, the inner container is the same, and only the insert which fits inside the inner container and the number of securing bolts differs.

The drum lid on the Babcock & Wilcox modified BB-250-2 is secured with a lock ring with a bolt and lock nut. In addition, the disc that retains the vermiculite will not be drilled for studs, but will be a plain disc. This change was done to eliminate the potential problem of water seepage into the container from around the bolt holes.

Results and Evaluations of the drop tests (see 2.5.1-2.5.3) show that the pellet insert will retain its geometry when the package is subjected to the accident damage tests.

Prior to initial use, the following tests were done to determine that the inner container was leaktight:

(a) Each inner container was tested in its permanent position within the package using a test lid.

(b) The test lid was bolted in place. The inner container was evacuated to five (5) inches of mercury (gauge).

(c) The tests will be considered satisfactory if no perceptible pressure increase occurs within a one (1) hour period.

This information has been included on the package Drawing No. 10-F-676.

The brass nuts will develop the full tensile strength of the steel thru-studs without shear failure of the threads. This was shown in the drop tests since no failure occurred.

No thread failure occurred during any of the drop tests. This shows that the Tensile Stress in the bolt resulting from the torques used to seat the gasket, plus the additional stress caused by a top-corner impact during the accident damage test, does not exceed the yield stress of the bolt material.

2.5.1 General[4]

The modified BB-250-2 container is shown in Drawing No. 10-F-676.

Both horizontal and vertical drop tests were conducted to evaluate the integrity of the modified container.

The container, as shown in Drawing No. 10-F-676 with deviations as shown in ASK-1324-C (given as Appendix E to this application), was first dropped in the horizontal position. As indicated in Section 2.5.2, the container maintained its integrity.

The container, as shown in NUMEC Drawing No. 10-F-676 (with deviations as shown in NUMEC Sketch No. ASK-1324-C), was then dropped in the vertical position. Because of a minor in-leakage of water into the rectangular insert, the container was modified, as shown in NUMEC Drawing No. 10-F-676, and dropped again. Test results are given in Section 2.5.3. The final modifications represent an improvement in the container and do not affect the validity of the horizontal test results. Therefore, the horizontal drop was not repeated following modifications.

2.5.2 Horizontal Drop[4]

The container shown in NUMEC Drawing No. 10-F-676 (with deviations as shown in NUMEC Sketch No. ASK-1324-C) was dropped from a height of 30 feet onto a one inch thick steel plate placed on a concrete pad. The container was dropped, in a horizontal position, with the rectangular insert oriented such that its widest side was parallel to the steel plate. The rectangular insert was loaded with approximately 250 pounds of lead bricks strapped to an oak board. This loading is similar to actual shipping conditions. Following the drop, the container was immersed in water for eight hours in a horizontal position so that the container was covered by at least three feet of water.

2.5.2.1 Results

a. The rectangular insert was deformed on one side slightly less than one inch in the direction of the drop. This deformity was the only damage to the rectangular insert. We do not feel that this slight deformation affects the nuclear safety of the insert.

b. The inner container was deformed somewhat less than one inch in the direction of the drop. This was caused by pressure produced by the flanges welded to the rectangular insert. This deformity, however, did not cause any loss of integrity.

c. The outer drum was breached at the point where the drum lid contacts the drum. This allowed a small amount of the packing material (vermiculite) to escape.

d. There was no in-leakage of water into either the rectangular insert or the inner container.

2.5.3 Vertical Drop(4)

The container shown in NUMEC Drawing No. 10-F-676 was dropped from a height of 30 feet onto a one inch thick steel plate placed on a concrete pad. The container was canted so that the center of gravity was located directly over the lugs of the closure ring, therefore putting the full impact load on the lugs. The rectangular insert was loaded with approximately 250 pounds of lead bricks strapped to an oak board. This loading is similar to actual shipping conditions. Following the drop, the container was immersed in water for eight hours in a horizontal position so that the container was covered by at least three feet of water. Following the water test, a pressure of 13 psig was applied to the inner container.

2.5.3.1 Results

a. The rectangular insert was not damaged.

b. The top of the inner container was slightly dented at the point of impact.

c. The outer drum was locally deformed by the impact, but the integrity of the outer drum was not breached. There was no loss of packing material.

d. There was no in-leakage of water into either the rectangular insert or the inner container.

e. A pressure of 13 psig was applied to the inner container for a period of sixteen hours. Less than 2 psig was lost during this period.

CHAPTER 3.0

NUCLEAR SAFETY EVALUATION

3.0 Nuclear Safety Evaluation

All calculations were performed using the KENO-IV computer code with the Knight-modified Hansen-Roach 16 group cross-section set except the XSDRNPM-123 group cross-section set was used where pellets were considered.

All arrays were calculated on a rectangular pitch. In all array calculations the only moderation within the inner container was assumed to be due to polyethylene within the fuel region such that the H/U ratio equals the maximum amount allowed per section 1.2.2.

All calculations assumed full reflection by at least 30 cm of water or Oak Ridge concrete.

3.1 For the contents described in 1.2.2.1:

a. An individual shipping container fully flooded and the material (UO_2 - the more reactive) homogeneously mixed with polyethylene at optimum concentrations has a maximum K-effective $\pm 2\sigma$ of $0.963 \pm .011$ which is subcritical at the 95% confidence level.

b. An array of undamaged shipping containers infinite in three dimensions with no moderation between them or between the inner and outer container (other than due to the vermiculite) has a K-effective $\pm 2\sigma$ of $0.942 \pm .007$, which is subcritical at the 95% confidence level.

c. An array of damaged shipping containers 21 x 21 x 6 (2646 units) with no vermiculite between inner and outer containers but an optimum volume fraction water of 0.05 in this region as well as between the shipping containers has a maximum K-effective of $\pm 2\sigma$ of $0.958 \pm .008$, which is subcritical at the 95% confidence level.

3.2 For the contents described in 1.2.2.2:

a. An individual shipping container fully flooded and the material (U-metal) homogeneously mixed with polyethylene at the optimum concentration has a maximum K-effective $\pm 2\sigma$ of $0.985 \pm .010$, which is subcritical at the 95% confidence level.

b. An array of undamaged shipping containers 30 x 30 x 9 (8100 units) with no moderation as described in 3.1 b, has a maximum K-effective $\pm 2\sigma$ of 0.966 ± 0.008, which is subcritical at the 95% confidence level.

c. An array of damaged shipping containers as large as 18 x 18 x 5 (1620 units) and moderated as in 3.1.c has a maximum K-effective $\pm 2\sigma$ of 0.966 ± 0.010, which is subcritical at the 95% confidence level.

3.3 For the contents described in 1.2.2.3 and assuming uniformly spaced unclad rods of full density UO_2 on a square pitch.

a. An individual shipping container fully flooded and the rods (at the optimum pitch) homogeneously mixed with polyethylene at the optimum concentration has a maximum K-effective $\pm$ 2 σ 0.978 $\pm$ 0.013, which is subcritical at the 95% confidence level.

b. An array of undamaged shipping containers no larger than 20 x 20 x 7 (2400 units) with no moderation as described in 3.1.b has a K-effective $\pm$ 2 σ of 0.982 $\pm$ 0.009, which is subcritical at the 95% confidence level.

c. An array of damaged shipping containers no larger than 14 x 14 x 4 (784 units) with no vermiculite between the inner and outer containers and an optimum volume fraction water of 0.03 in this region as well as between shipping containers has a maximum K-effective $\pm$ 2 σ of 0.984 $\pm$ 0.009, which is subcritical at the 95% confidence level.

d. With rods in the rectangular metal container (7.25" x 9" x 63") an evaluation was performed as in 3.3.c with a resulting maximum K-effective $\pm$ 2 σ of 0.832 $\pm$ 0.009, which is subcritical at the 95% confidence level.

3.4 Fissile Class

The maximum number of shipping containers that could be transported due to weight limitations imposed by governmental transportation regulations would be less than 100. Twice that number, or 200 units, is less than one half the smallest damaged array allowed (Section 3.3.c - 784 units).

Thus: $\frac{50}{100} = 0.5$

Therefore any package described in this application would be assigned a transport index of 0.5.

APPENDIX A

BABCOCK AND WILCOX DRAWING 10-F-771

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APPENDIX B

WESTINGHOUSE ELECTRIC CORP. DRAWING C7108D10

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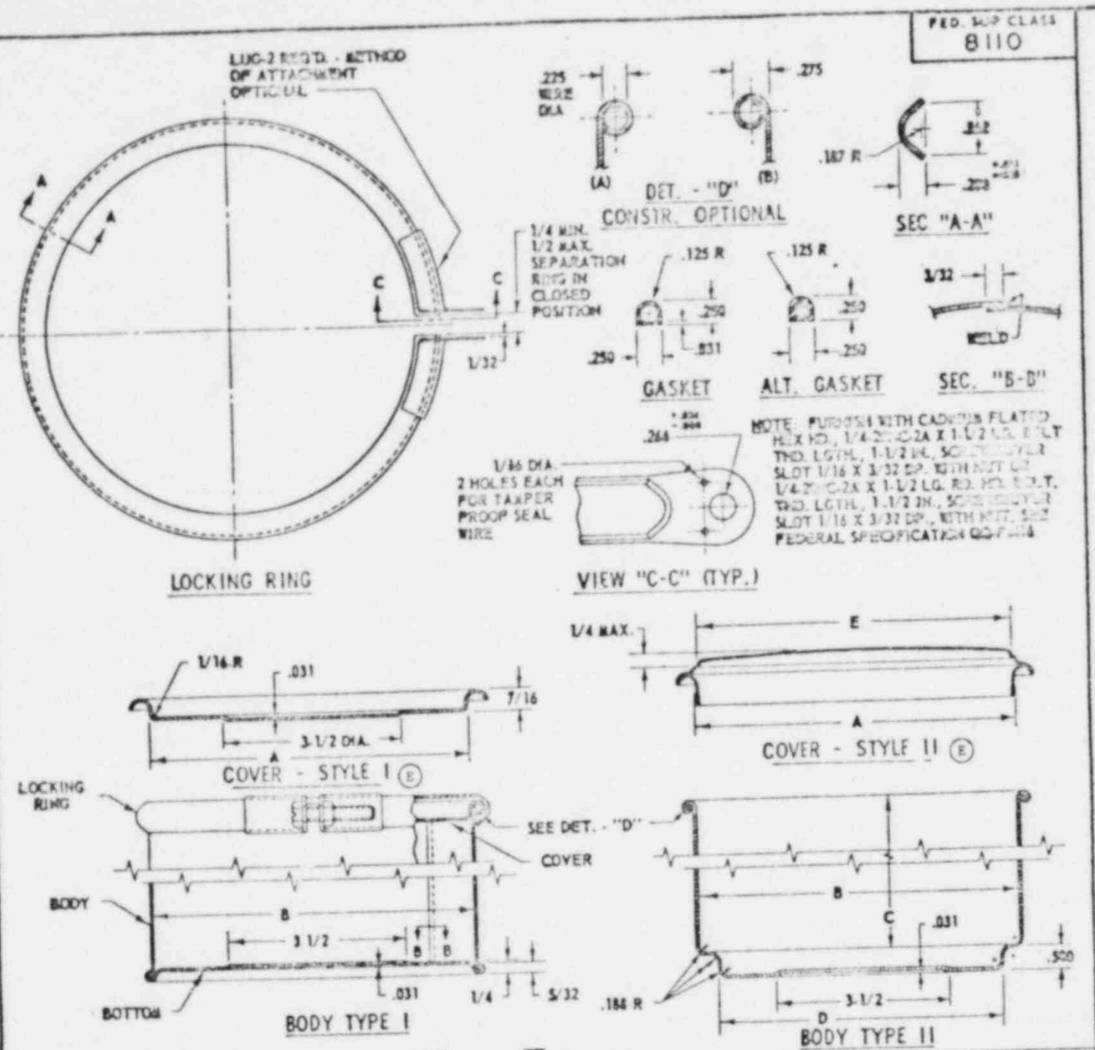
APPENDIX C

U.S. MILITARY STANDARD MS24347



Ⓔ DRUM ASSY (STYLE I COVER)	Ⓔ DRUM ASSY (STYLE II COVER)	BODY TYPE I	BODY TYPE II	Ⓔ COVER STYLE I	Ⓔ COVER STYLE II	LOCKING RING	GASKET	A + 0 - 1/64 DIA	B + 1/64 - 0 DIA	C	D	E
MS24347-1	MS24347-11	MS24347-21	MS24347-31	MS24347-41	MS24347-51	MS24347-61	MS24347-81	5	5	4-1/2	4-1/4	4-11/16
MS24347-2	MS24347-12	MS24347-22	MS24347-32							8-1/2		
MS24347-3	MS24347-13	MS24347-23	MS24347-33	MS24347-42	MS24347-52	MS24347-62	MS24347-82	6-1/2	6-1/2	4-1/2	5-3/4	6-3/16
MS24347-4	MS24347-14	MS24347-24	MS24347-34							6-3/4		
MS24347-5	MS24347-15	MS24347-25	MS24347-35							8-1/2		
MS24347-6	MS24347-16	MS24347-26	MS24347-36	MS24347-43	MS24347-53	MS24347-63	MS24347-83	8-1/2	8-1/2	6	7-3/4	8-3/16
MS24347-7	MS24347-17	MS24347-27	MS24347-37							7-1/2		
MS24347-8	MS24347-18	MS24347-28	MS24347-38							9		

Ⓔ MS part numbers listed above are for steel drums. For aluminum alloy drums, add D in place of the dash in the part number, i.e., MS 24347D1.

TYPE OF CONSTRUCTION: Bodies may be formed as shown in type I or drawn as shown in type II.

MATERIAL: Steel, QQ-S-698: body, bottom, and cover--5" dia drums, 26 gage; 6-1/2 and 8-1/2 dia drums, 24 gage. Locking ring, 20 gage. Lugs, 14 gage.

Alternate steel material: Terne plated steel, QQ-T-191, type II.

For aluminum alloy, gaskets, cubic capacity, and marking, see procurement specification.

REDRAWN

NOTES:
Referenced documents shall be of the issue in effect on date of invitation for bid.
For design feature purposes, this standard takes precedence over procurement documents referenced herein.
Dimensions in inches.
Tolerances, unless otherwise specified: Decimals ± .03, Fractions ± 1/32.

APPROVED 1 FEB 1956 — REVISED Ⓔ 11 Jan 1971

PREPARING ACTIVITY: 69

REVIEW - GL, , MI, SA, 70, 71 USER - MU, WC, 82, 84

PROJECT NO. 8110-0175

This military standard is mandatory for use by all departments and agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

P.A. AIR FORCE-69
Other Cust
ARMY - GL
NAVY - SA

TITLE: DRUMS, METAL, REUSABLE SHIPPING AND STORAGE

MILITARY STANDARD
MS 24347

SHEET 1 OF 1

PROCUREMENT SPECIFICATION MIL-D-6055

SUPERSEDES: MS 24347 REV. D

DD FORM 672-1 (Coordinated)

EDITION OF 1 SEP 57 MAY BE USED

U.S. GOVERNMENT PRINTING OFFICE

AFLC-WPAFB-FEB 70 220

POOR ORIGINAL

APPENDIX D

NUMEC DRAWING #10-F-676

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APPENDIX E

NUMEC SKETCH #ASK-1324-C

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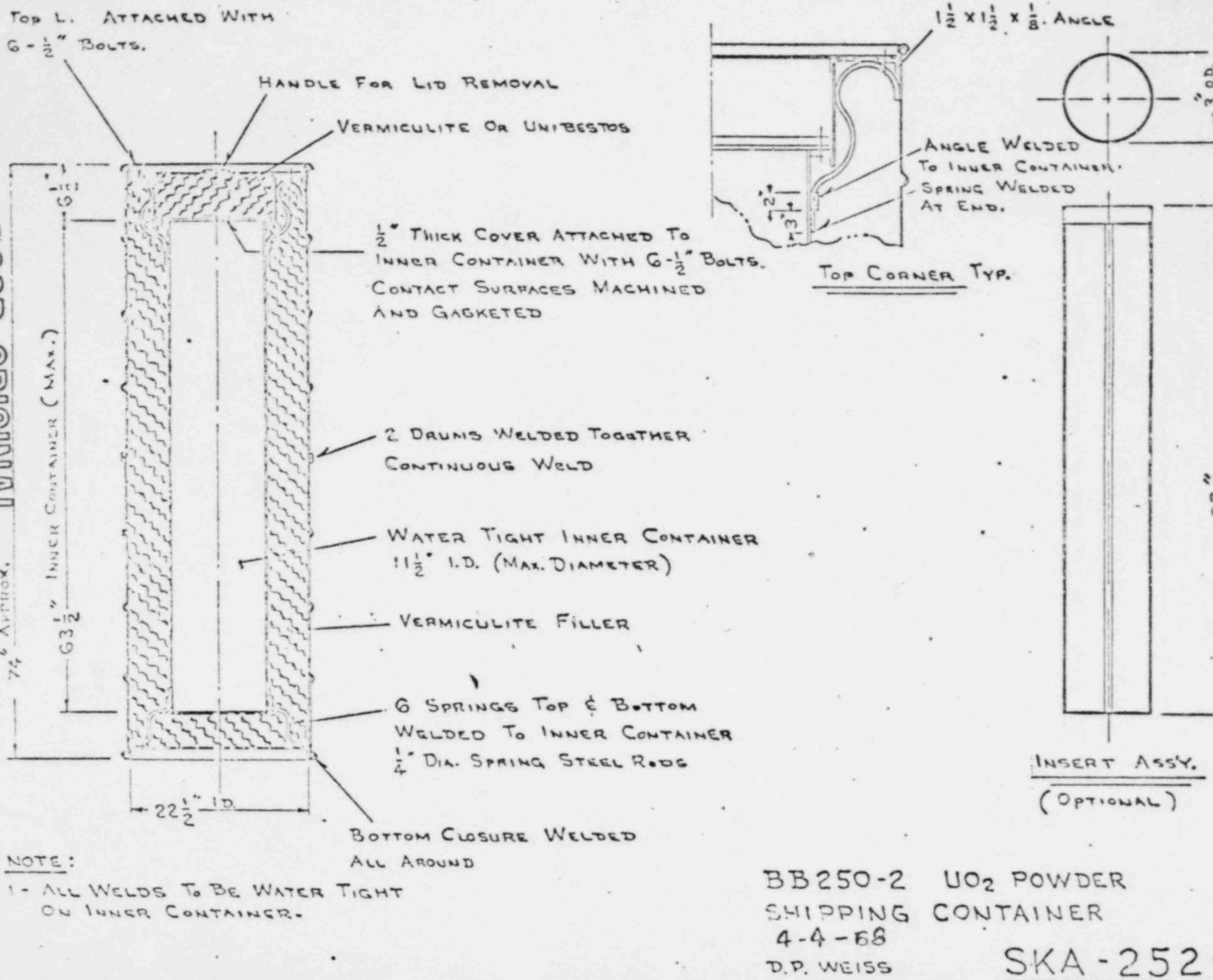
APPENDIX F

WESTINGHOUSE ELECTRIC CORP. SKETCH SKA-252-1



NOTE:
1- All Welds To Be Water Tight On Inner Container.

BB250-2 UO_2 POWDER
SHIPPING CONTAINER
4-4-68
D.P. WEISS

SKA-252-1

POOR ORIGINAL

17505