ASEA BROWN BOVERI

July 27, 1990
LD-90-052

File Docket No. 70-0036

Docket No. 6294
Certificate of Compliance No. 6294

Mr. Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards and Transportation
Office of Nuclear Material Safety
and Safeguards
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Subject: Certificate of Compliance No. 6294 Renewal Application

Reference: Letter, J. F. Conant (C-E) to C. E. MacDonald (NRC), LD-90-051, Dated July 25, 1990

Dear Mr. MacDonald:

Provided herewith is Combustion Engineering's renewal application for its UNC-2901 (Certificate of Compliance No. 6294) shipping container (Enclosure I). The current Certificate of Compliance (Revision No. 13) expires August 31, 1990.

Supplemental materials provided to the Nuclear Regulatory Commission in order to arrive at the present Revision 13 level have been incorporated into the renewal application. Minor editorial and typographical errors have been corrected, and modifications have been made to address the application discrepancy error discussed in the Reference letter. We have also upgraded Sections 7 and 8 of the application, "Operating Procedures" and "Acceptance Tests and Maintenance Program", respectively. All page revision numbers have been reset to zero.

R-51

ABB Combustion Engineering Nuclear Power

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Enclosure II contains a check No. 513659 in the amount of $150.00 to cover the application fee required by 10CFR170.31. Six (6) copies of Enclosure I are provided for your use.

If you have any questions on this matter, please do not hesitate to call me or Mr. C. M. Molnar of my staff at (203) 285-5205.

Very truly yours,

COMBUSTION ENGINEERING, INC.

John F. Conant

John F. Conant
Manager
Nuclear Materials Licensing

JFC:nlv

Enclosures: As Stated

cc: R. Chappell (NRC)
G. France (NRC - Region III)
N. Osgood (NRC)
J. Roth (NRC - Region I)

Enclosure I to
LD-90-052

COMBUSTION ENGINEERING, INC.

CERTIFICATE OF COMPLIANCE NO. 6294

UNC-2901 SHIPPING CONTAINER

RENEWAL APPLICATION

JULY, 1990

APPLICATION FOR USE OF
SHIPPING CONTAINER MODEL NO. UNC-2901
FOR THE
TRANSPORT OF SPECIAL NUCLEAR MATERIAL
CERTIFICATE OF COMPLIANCE NO. 6294

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1. GENERAL INFORMATION

1.1 Introduction

The UNC-2901 container is designed for shipment of uranium oxide pellets manufactured, inspected and certified in accordance with reactor fuel specifications. The container can also be used for the shipment of rejected pellets and/or pieces (hard scrap).

The maximum number of containers per shipment shall be limited to:

Fissile Class I	-	None
Fissile Class II	-	Maximum 100 containers (Transport index is 0.50 per container for a total transport index of 50 per shipment).
Fissile Class III	-	Maximum 216 containers

1.2 Package Description

1.2.1 Packaging

The UNC-2901 container consists of a standard steel drum (see Drawing NFM-D-4540, UNC-2901 Shipping Drum) with a 10 3/4" square inner container centered in the drum. The inner container is centered by hardboard support rings. Asbestos or ceramic sheet, plywood and fiberlite insulation provide thermal protection to the inner container. The inner container closure is fitted with a gasket capable of withstanding temperatures up to at least 500°F.

1.2.1.1 Package for Pellets

The uranium oxide pellet package consists of covered steel trays which can be stacked to a maximum of 16 trays (4 high x 2 wide x 2 deep). Each row of trays is secured with a single piece weblock strapping assembly. The weblock buckle is part of the tray holder and the buckle is attached to the holder by a rod and angle bracket assembly. A typical arrangement is depicted in Drawing D-5018-2001, Rev. 01.

1.2.1.2 Package for Reject Pellets

Rejected uranium oxide pellets and/or pieces may be packaged in the same manner as pellets which is described above in Section 1.2.1.1.

1.2.2 Operational Features

The UNC-2901 shipping container is of relatively simple design, and does not incorporate cooling systems, shielding, etc.

1.2.3 Contents of Packaging

1.2.3.1 Pellets or Rejected Pellets

Maximum Enrichment 5.0 wt.%
Type Material: Sintered (high fired) uranium oxide pellets.
Maximum quantity per container:

a) Maximum net weight:
Maximum net weight of pellets: 320 pounds
Pellets and packaging material (contents of inner container) 427 pounds.

b) Gross Weight:
Gross weight of the container as assembled for shipment shall not exceed 660 pounds.

1.3 Appendix

Details of construction and assembly are shown on drawings:

a) D-5007-8086, Rev. 06, S.W.O.P.P. Upgrade UNC 2901 Shipping Drum for UO_2 Powder & Pellets Assembly & Details
b) B-5007-8112, Rev. 01, Suggested Assembly of 2901 Plywood Insert
c) D-5018-2001, Rev. 01, Pellet Shipping Package
d) NFM-D-4263 Rev. 02, Pellet Tray Holder
e) NFM-D-4540, Rev. 01, UNC 2901 Shipping Drum

2. STRUCTURAL EVALUATION

The UNC 2901 shipping container was subjected to the hypothetical accident test condition in accordance with 10CFR71.36 and 49CFR173.398(c). The actual tests and results are discussed in detail in the report "Design and Structural Evaluation of a Low Enriched UO_2 Pellet and Powder Shipping Package, Model UNC 2901", dated April 1970. (Appendix 2.1-A).

The container was again subjected to a thirty foot drop test while loaded with the powder drums. The actual tests and results are set forth in the supplement to the above referenced report. The supplement is dated November 1970. (Appendix 2.1-B).

2.1 Appendix

2.1-A Design and Structural Evaluation of a Low Enriched UO_2 Pellet and Powder Shipping Package

2.1-B Evaluation of UO_2 Powder Drums for use in Model UNC 2901 Shipping Package

APPENDIX 2.1-A

Design and Structural Evaluation of a Low Enriched UO_2 Pellet and Powder Shipping Package

DESIGN AND STRUCTURAL EVALUATION OF A LOW ENRICHED UO_2 PELLET AND POWDER SHIPPING PACKAGE

1.0 SUMMARY

A shipping package was designed for shipment of low enriched UO_2 pellets and powder. The package consisted basically of a square metal inner container supported and insulated inside an ~55 gallon steel outer drum. Pellets were packaged inside the inner container on Polyethylene coated corrugated trays. The shipping package was subjected to a series of drop, fire, and water tests to evaluate its structural stability. The results indicated that a structurally sound, fire-proof, leak resistant package had been developed.

2.0 DESCRIPTION OF SHIPPING PACKAGE

Details of the tested shipping container and pellet package are illustrated on drawings nos. D-5007-8086, Revision 1 and D-5008-8192, Revision 2. The shipping container is to be identified as a UNC Model 2901.

The basic components of the shipping package are:

1. A 10.75" square inner container with a 1/2" thick flange and cover.
2. Twelve 1/2" diameter bolts securing the cover to the flange.
3. A full-faced 1/8" thick asbestos gasket on the inner container.
4. Three 1-1/2" thick hardboard support rings.
5. Angle iron welded completely around inner container for securing the hardboard.
6. A 1/8" thick asbestos sheet on top and bottom of outer drum.
7. 1" Thick plywood on bottom and 1-1/4" thick plywood on top of drum.
8. Fiberlite insulation, .75#/ft.^{3}, between inner and outer container.

Design and Structural Evaluation of a
Low Enriched UO_2 Pellet and Powder Shipping Package
Page Two

2.0 Description of Shipping Package (continued)

The pellet package consisted of Polyethylene coated corrugated metal trays encased in gum rubber and hardboard as shown on the aforementioned drawings. The pellet loaded trays were held in compression and securely banded to insure no movement of pellets. The exact size and UO_2 capacity is dependent on the pellet diameter. The packaging design allows for one or more individual packages inside the inner container with the overall size not exceeding the 10.75" square.

3.0 STRUCTURAL EVALUATION

3.1 Conditions

The shipping package was subjected to the hypothetical accident conditions of the tests specified in 10 CFR 71.36 and 49 CFR 173.398(c). Tests were conducted at two different loading levels. One package of depleted pellets, assembled as shown on drawing number D-5008-8192 Revision 2, and three lead-filled wood boxes comprised the test load for Test #1. The second test was performed at a greater loading, but with only the lead filled boxes. The weight conditions tested were as follows:

	Test #1	Test #2
Tare Weight (Assembled Container Without Product Packages)	231 Lbs.	228 Lbs.
Net Weight (Pellets & Packaging)	313 "	427 "
Equiv. Pellet Weight	227 "	302 "
Equiv. Pellet Packaging Weight	86 "	125 "
Total Gross Weight	544 Lbs.	655 Lbs.

3.2 Discussion of Results

Pictures of the package in its various stages of assembly and test are included in the Appendix of this report.

Design and Structural Evaluation of a
Low Enriched UO_2 Pellet and Powder Shipping Package
Page Three

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.1 Thirty Foot Drop Test

Conditions - The impact of the 30 foot drop was designed to occur at approximately 45° on the top corner of the square inner container. The selected corner for the first test condition was the corner containing the actual pellet package. These conditions were chosen as the most severe for the following reasons:

1. Experience from the same test performed on other packages indicated that maximum damage occurs from angular impact.

2. Impact on the top end was most likely to break loose the outer drum lid and expose the inner container during the fire and water tests.

3. Impact on the top end subjected the flange of the inner container to the maximum force and the seal on the gasket to the greatest potential for destruction.

4. The weld on the bottom plate was evaluated to be stronger than the parent metal, therefore, the point of failure from dropping on the bottom would have been the sides of the inner container. By dropping on the top corner, the sides were subjected to the same load and equal conditions existed.

5. The corners of the square insert had the least support. Therefore, impact at this point was directly on the weakest member.

Design and Structural Evaluation of a
Low Enriched UO_2 Pellet and Powder Shipping Package
Page Four

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.1 Thirty Foot Drop Test (continued)

6. Striking at an angle caused a greater rebounding effect and a minimum degree of support surface. (i.e., the top corner hit first and then the bottom as opposed to a single flat hit on side or end only.) A flat hit would allow an equal support distribution by the hardboard, plywood, cushioning, etc. and eliminate a greater concentrated force on one point.

7. The pellet package was subjected to brunt of impact from both the initial hit and the weight of the three simulated packages atop it.

<u>Results</u> - The damage to the outer drum for Test #1 (544 lbs.) is depicted in picture 3. The decrease in drum diameter as a result of impact was a maximum of 1-1/2" on the top corner. The small hole just below the lid retainer ring was inflicted by a small bolt which had been tied to a measuring cord used to verify the 30 foot height.

Damage to the plywood and hardboard supports for the inner container was not detrimental. The two 1" thick plywood disks encasing the inner container flange cracked on the corners but remained in position. The bottom hardboard support broke on three corners and the middle hardboard broke on the corner of impact. However, all pieces stayed in place and there was no warpage or shifting of the inner container. (See pictures 11, 13, 14, 17 and 18.) The hardboard supports remained bolted to the angle iron and all welds between the inner container and angle iron were sound. All flange bolts were in tact and securely tightened. There was no deformation of the flanged closure.

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.1 Thirty Foot Drop Test (continued)

The condition of the drum in Test #2 (655 lbs.) is shown in picture 3A. The outer drum deformed ~2" in diameter at the point of contact only, but otherwise showed no significant damage. Since the pellet package proved to uphold its tray-pellet-tray arrangement in the first test, it was not necessary to re-evaluate its stability and, therefore, the load was composed solely of lead-filled boxes.

As was the case for Test #1, a few of the plywood and hardboard supports cracked but no damage occurred to the inner container. (See pictures 5B, 5C, 5D and 5E). All welds and bolts remained in tact and there was no shifting of either the inner container or the supports. The increased loading had no significant effect on the integrity of the inner container following the drop test.

3.2.2 Piston Drop Test

Conditions - For both loading conditions, the drum was dropped 5 ft. on to a 6" diameter x 8" long concrete piston. In Test #1, the point of impact was approximately midway between the center and upper hardboard support. This location was selected to determine if the outer drum would puncture and permit the piston to penetrate to the inner container. For Test #2, the selected impact point was directly on the center hardboard. This condition was evaluated to determine if the direct impact on the hardboard would drive it inward and deform the inner container.

Results - The condition of the outer drum after the piston drop for Tests #1 and #2 is shown in pictures 5 and 5A. In Test #1, a semi-circular hole was punctured through the outer drum in line with a corner of the inner container. No insulation or support material was lost through the hole and no damage was incurred by the inner container.

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.2 Piston Drop (continued)

For Test #2 (Picture 5-A), the piston hit directly on the hardboard and only a small hole, ~1/2" in diameter, was punctured in the outer drum. The hardboard was broken and chipped away for approximately a 3" x 2" area, but not completely through to the inner container (pictures 5C and 5D). The inner container suffered a minor crease ~1/32" high and 3" long at the point where the hardboard was supported against the insert. The inner container suffered no major damage and remained in its original position.

3.2.3 <u>Fire Test</u>

<u>Conditions</u> - The fire test was conducted using diesel fuel fed trough piping manifolds placed lengthwise down each side of the shipping package. The flame was directed upward so it engulfed sides, top, and bottom of the package. The location and condition of the package before, during and after the fire test is shown in pictures 6, 7, and 8. The shipping package was placed with the punctured hole facing upward on a grated metal framework ~6" above the ground. The flame temperature as read on an optical pyrometer was in excess of 1650°F throughout the 30 minute test. It is probable that the flame was well above this, an intense black smoke tended to bias the reading low.

The fire test was conducted only for the Test #1 loading condition. Since the extra loading had no significant effect on the package condition after drop and piston testing, the parameters of the fire and water test were identical for both cases. Therefore, the fire and water test results of Test #1 were also applicable for the loading condition of Test #2.

Design and Structural Evaluation of a
Low Enriched UO_2 Pellet and Powder Shipping Package
Page Seven

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.3 Fire Test (continued)

Results - Pictures 9-18 illustrate the condition of the shipping package after all the tests were completed. As shown in picture 9, the 1/8" thick asbestos sheet and top 5/8" thick plywood were completely charred. The remaining plywood disks, pictures 10 and 11, were charred only around the edges, from 2-4 inches radially inward for the outermost piece and 3/4" to 1" for the inner disk. The uniform burn completely around the periphery of the plywood indicated an even heat distribution throughout the package. The hardboard was charred slightly as indicated in pictures 12-16, but no substantial loss in strength resulted. Similar results were found on the bottom.

As shown in picture 13, the Fiberlite insulation was charred radially inward from the outer container for approximately 2 inches. However, the insulation in contact with the inner container was unimpaired. The temperatures reached on the inside wall of the inner container are indicated in figure 1, page 9. The temperature template on the underside of the container during the test registered 180°F. A template on the top side during the test showed that portion of the container reached 200°F. (These temperatures verify that the heat was well distributed from top to bottom.) This temperature range had no detrimental effect on the Ethafoam cushioning inside the inner container. Pictures 15 and 16 show the undamaged condition of the cushioning. The asbestos flange gasket and pellet package were undamaged by the fire test; which is very apparent in Picture 15.

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.4 Water Immersion Test

Conditions - The drum was immersed in the horizontal position so that a minimum of three feet of water completely covered the shipping package.

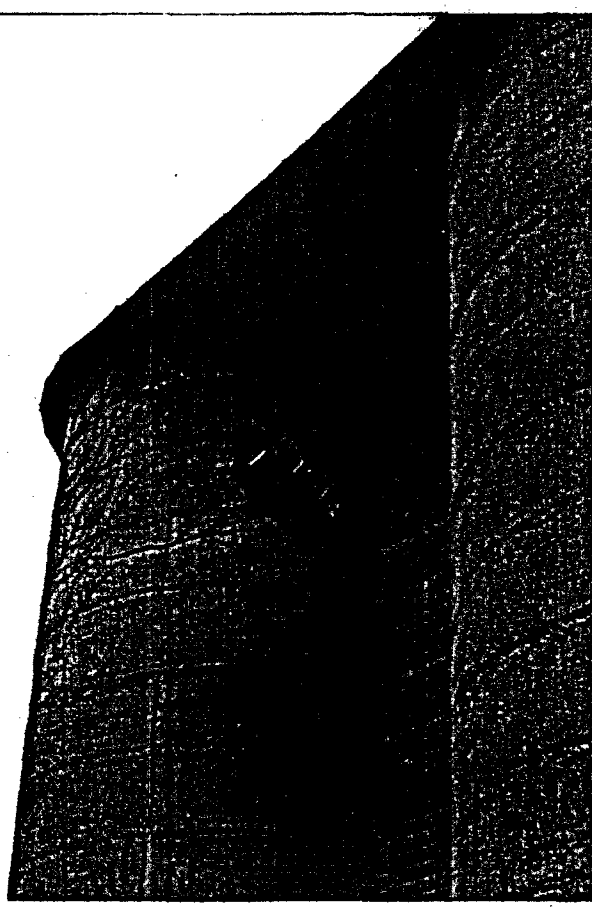
Results - Since the outer container had been punctured in the piston drop, the outer drum was thoroughly flooded. However, the inner container did not show any evidence of leakage after immersion for 8 hours. Some of the Ethafoam cushioning material had been crimped under the asbestos gasket during assembly, but even so, no leakage occurred. Pictures 17 and 18, which were taken immediately after the water test, show no evidence of leakage.

3.2.5 Condition of Pellet Package

The condition of the inner container contents after completion of the tests is shown in pictures 16-22. Although about 25% of the pellets were cracked or broken, (picture 22), the pellet package remained in tact, (Pictures 19 and 20), and less than 1/2% of the pellets became dislodged (picture 21). Picture 19 shows the ends and center of the trays crimped together where the hardboard supports were located. The general condition of the pellet package was "good" with the pellet-tray arrangement remaining unchanged from the original assembled configuration. Picture 23 shows the loaded pellet trays before assembly. Picture 22 shows the same general configuration after completion of the tests. All four packages remained in the exact position in which they were loaded (picture 15) and the inside of the inner container was not damaged in any manner.

UNC-2901 SHIPPING CONTAINER

PICTURE 1 - Assembly of shipping package for Test #1.



PICTURE 2- Shipping package in upper position for 30' drop test.

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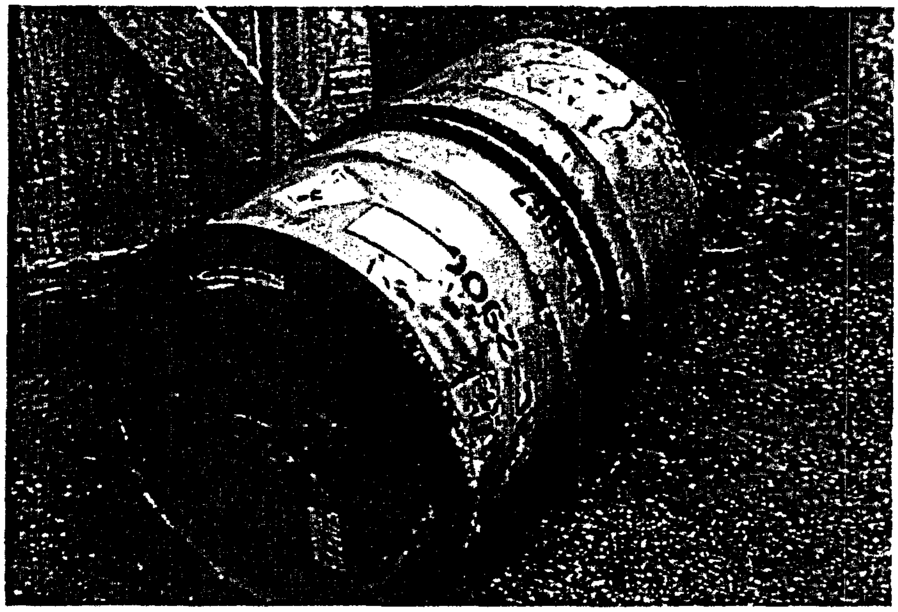
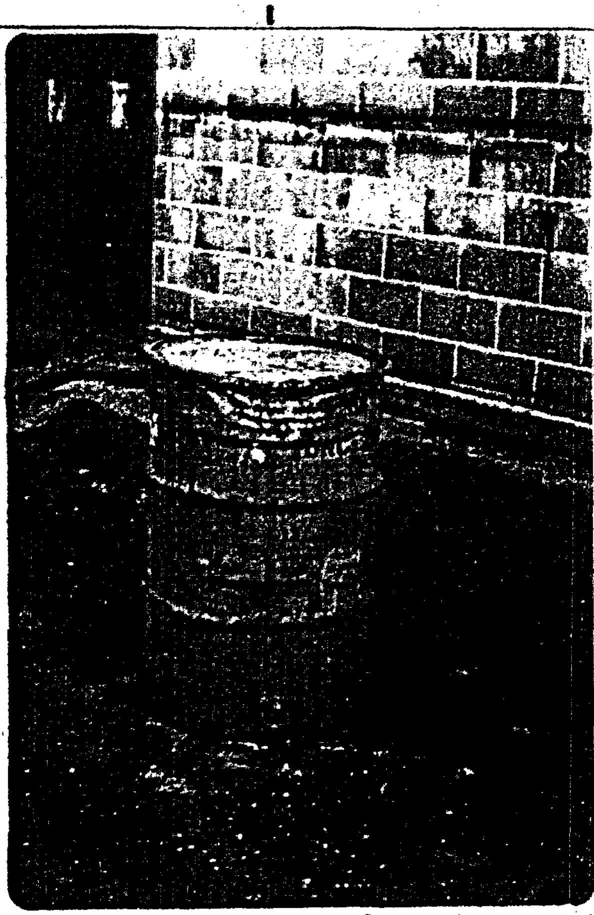


PICTURE 3 - Condition of outer drum after 30' drop test (Test #1).



PICTURE 3A - Condition of outer drum after 30' drop test - (Test #2).

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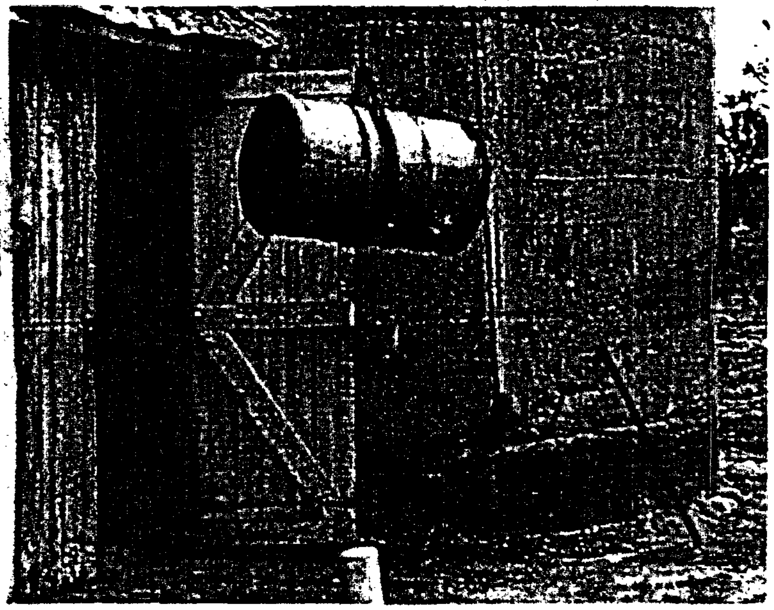
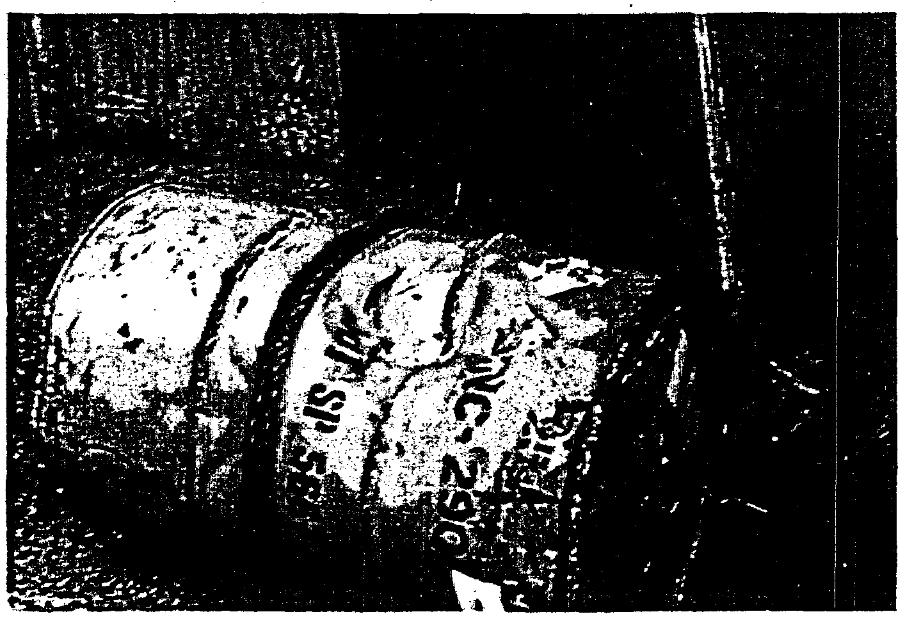


PICTURE 4 - Shipping package in upper position for piston drop.



PICTURE 5 - Condition of drum after piston drop - (Test #1).

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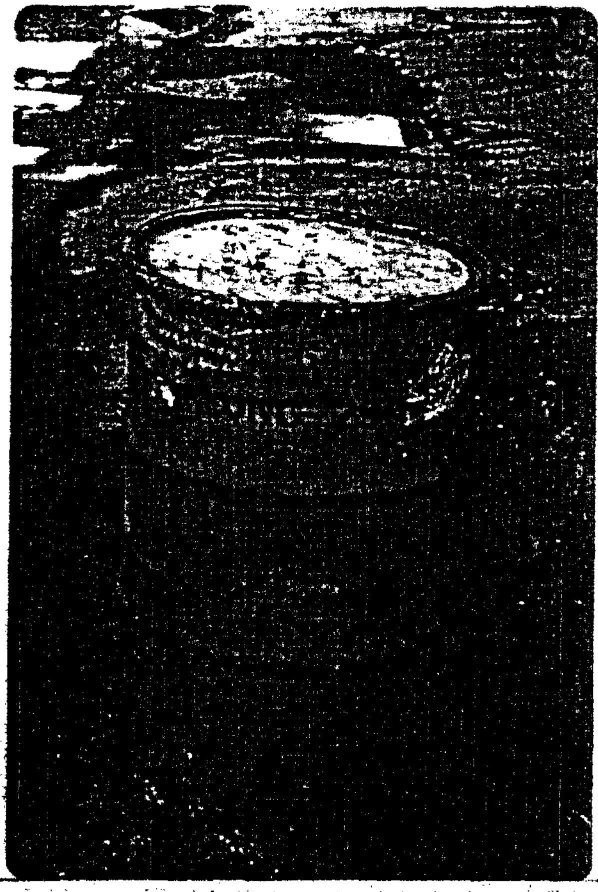
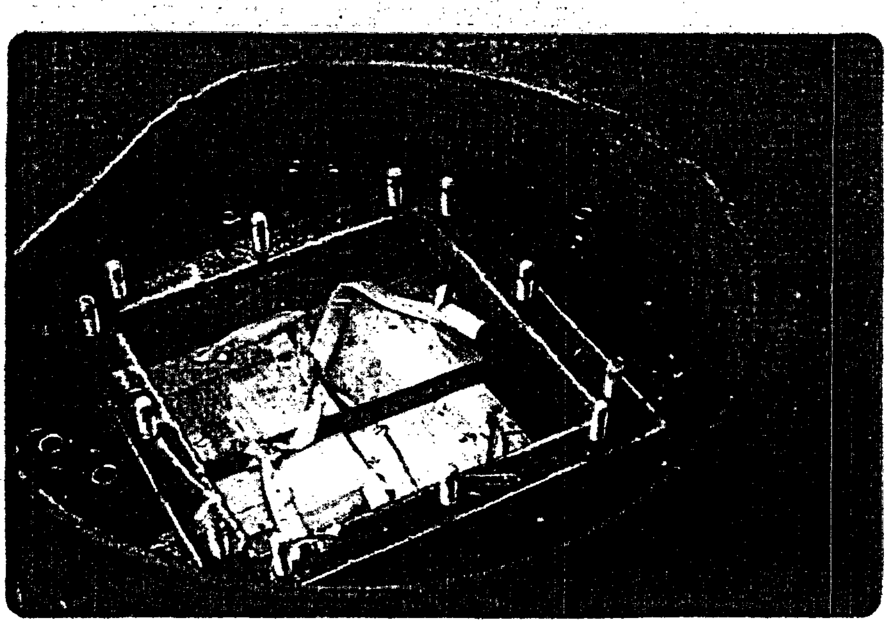


PICTURE 5A - Condition of drum after 30' drop and piston drop - (Test #2).



PICTURE 5B - Condition of flange after 30' drop and piston test - (Test #2).

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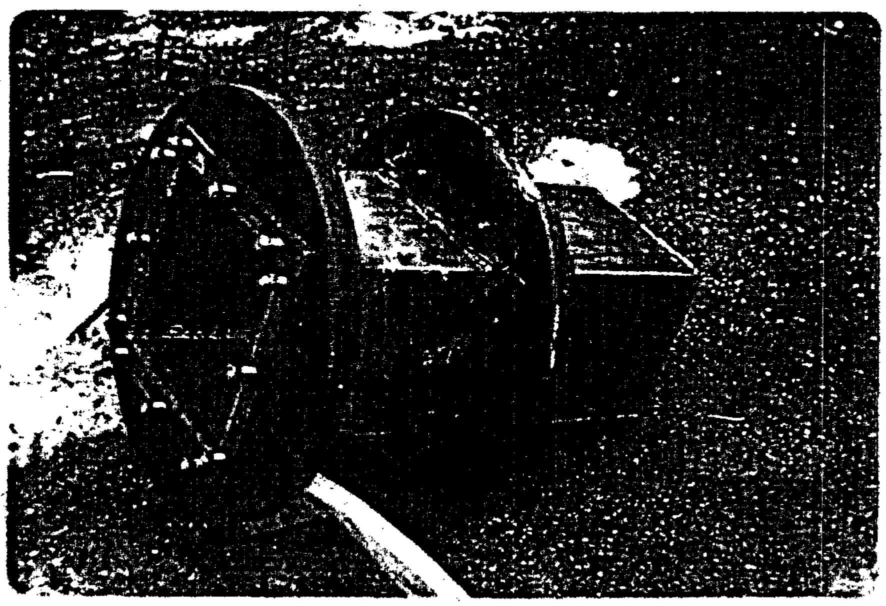
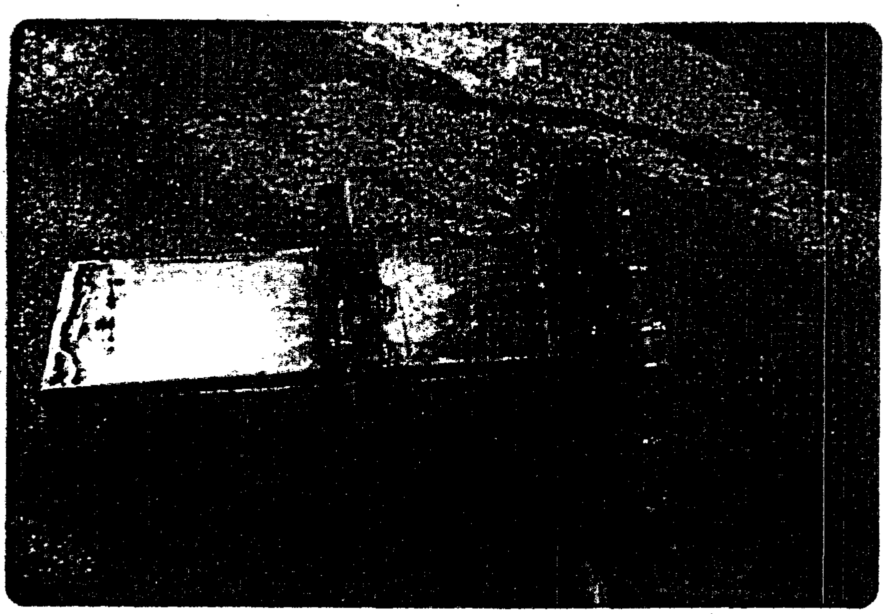
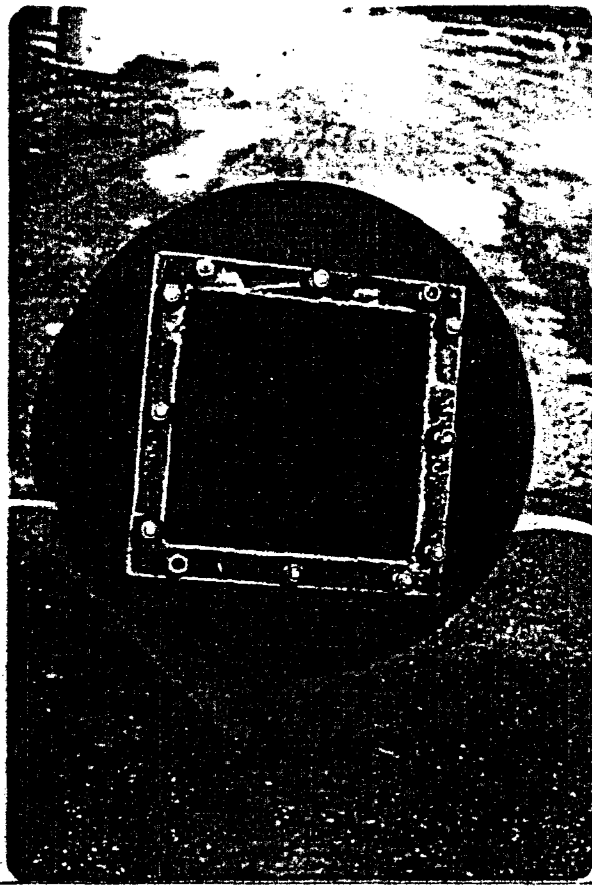


PICTURE 5C - Condition of inner container and hard-board after 30' drop and piston test- (Test #2).

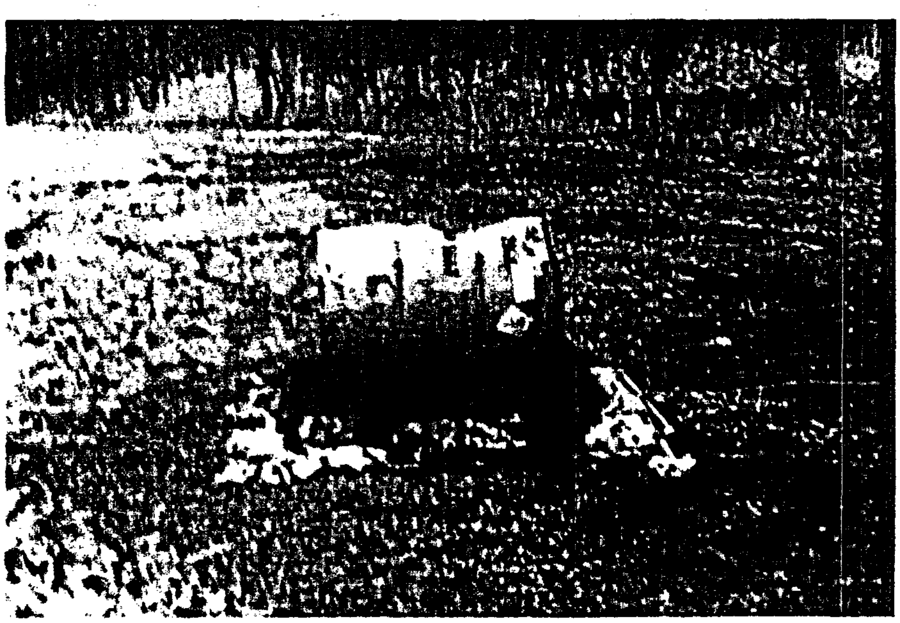


PICTURE 5D - Condition of inner container after 30' drop and piston test - (Test #2).

UNC-2901 SHIPPING CONTAINER



PICTURE 5E - View inside inner container after 30' drop and piston test - (Test #2).



PICTURE 6 - Shipping package in position for fire test.

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PICTURE 7 - Shipping package engulfed in flames during fire test.

PICTURE 8 - Condition of outer drum after fire test.

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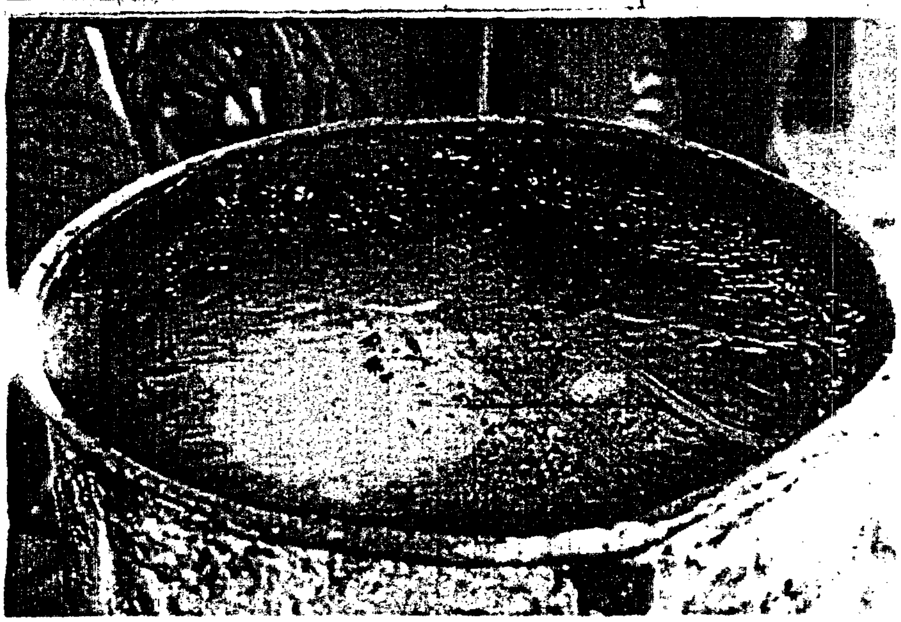
PICTURE 9 - Condition of asbestos and top plywood sheet after fire and water test.



PICTURE 10 - Condition of second plywood sheet after fire and water test.

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PICTURE 11 - Condition of flange cover and plywood disk around flange after fire and water test.

PICTURE 12 - Cut-out view of insulation and hardboard after fire and water test.

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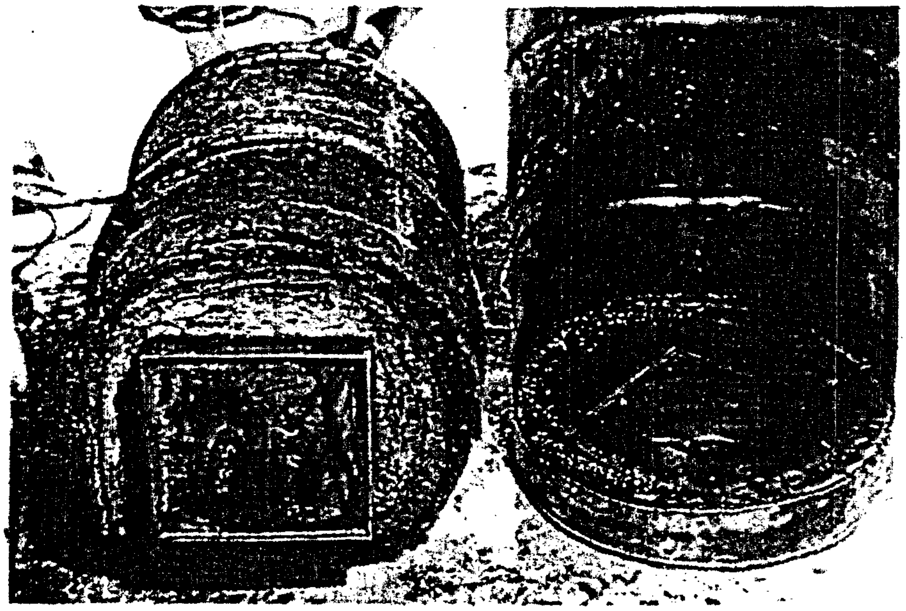
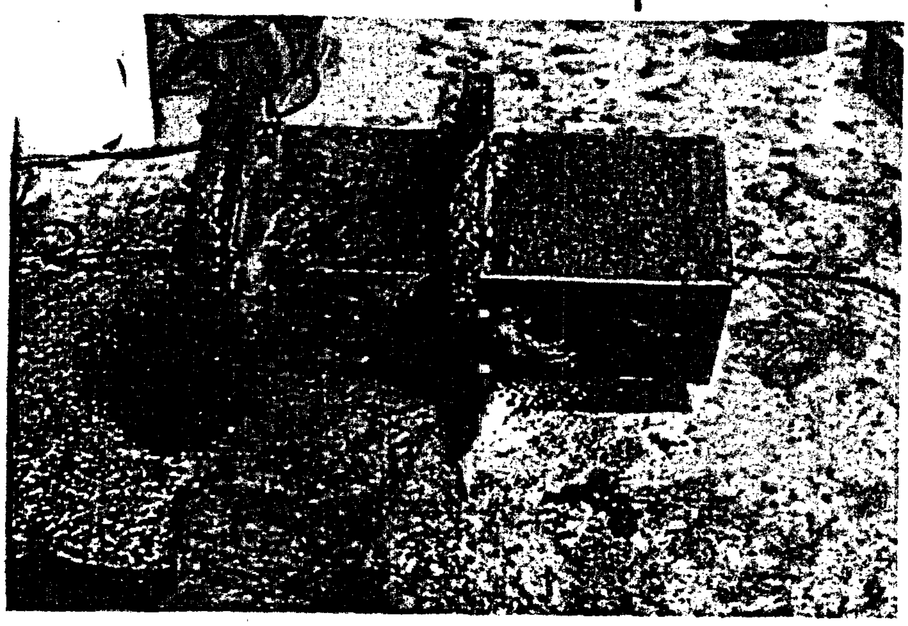
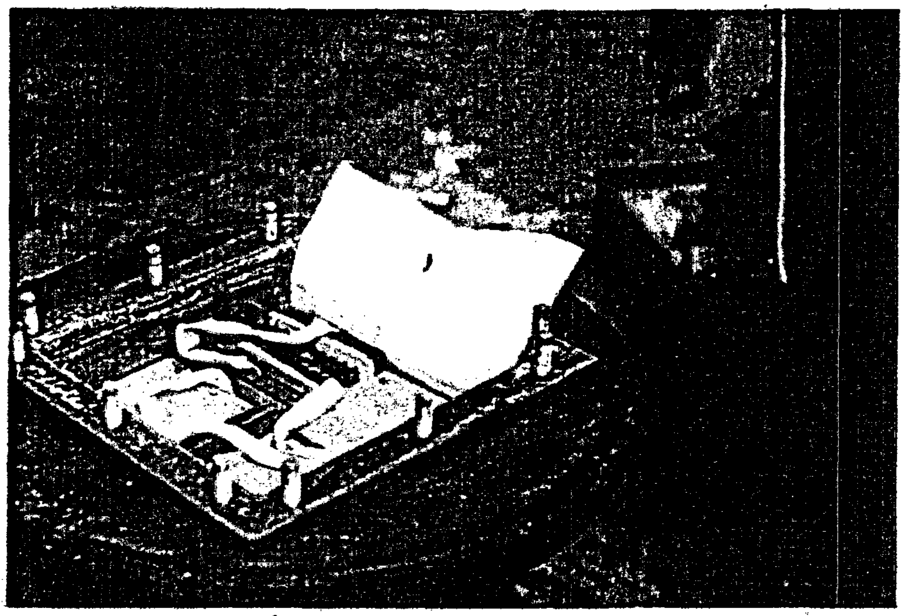


PICTURE 13 - Condition of bottom of inner and outer containers after completion of all tests.



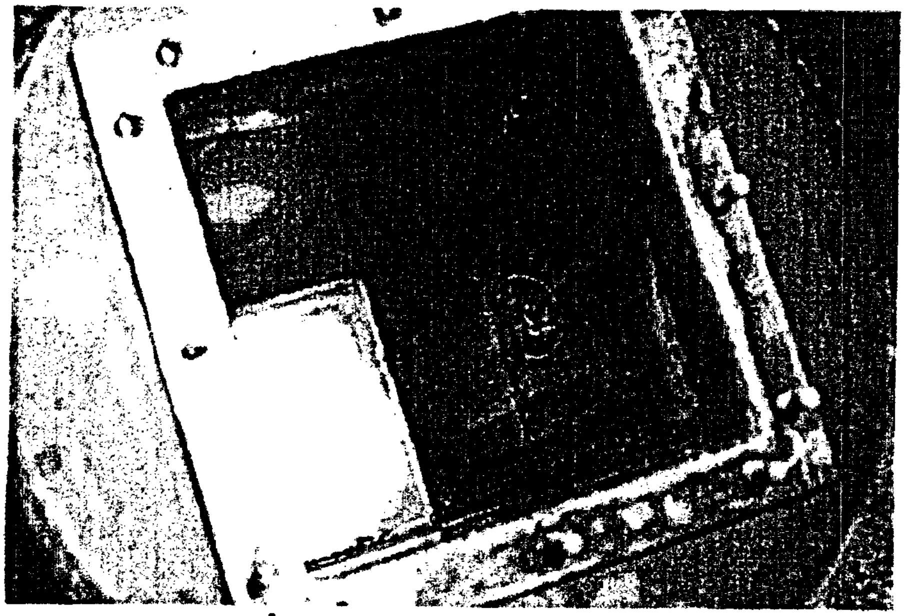
PICTURE 14 - View of inner container with insulation removed after completion of all tests.



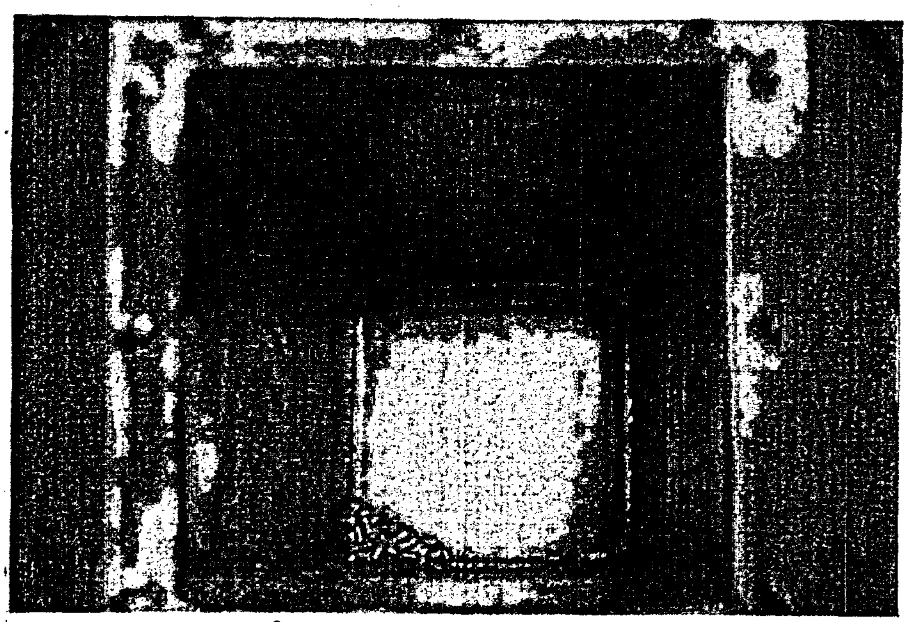
PICTURE 15 - Condition of pellet packages and cushioning material after completion of all tests.

PICTURE 16 - Removal of pellet package after completion of tests.

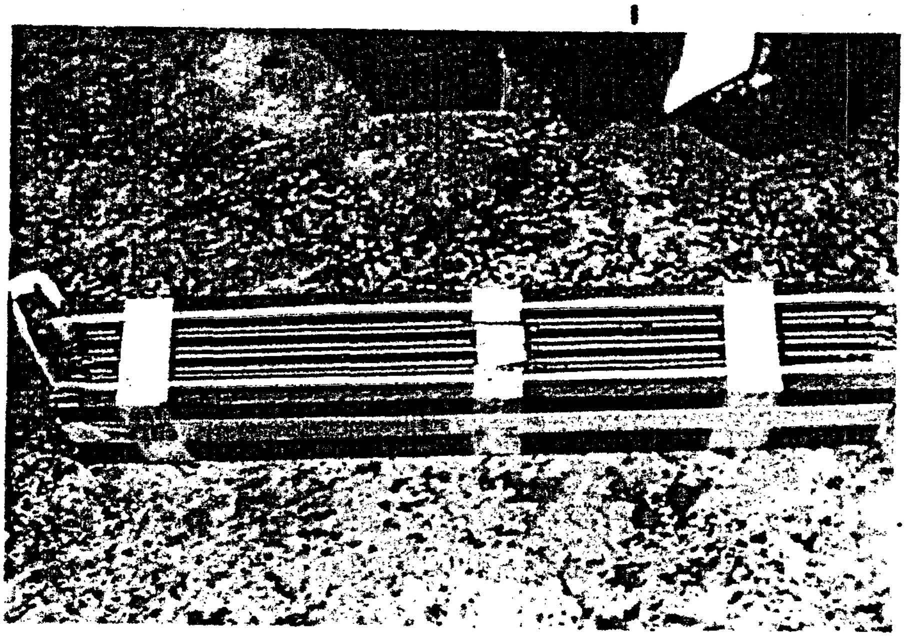
UNC-2901 SHIPPING CONTAINER



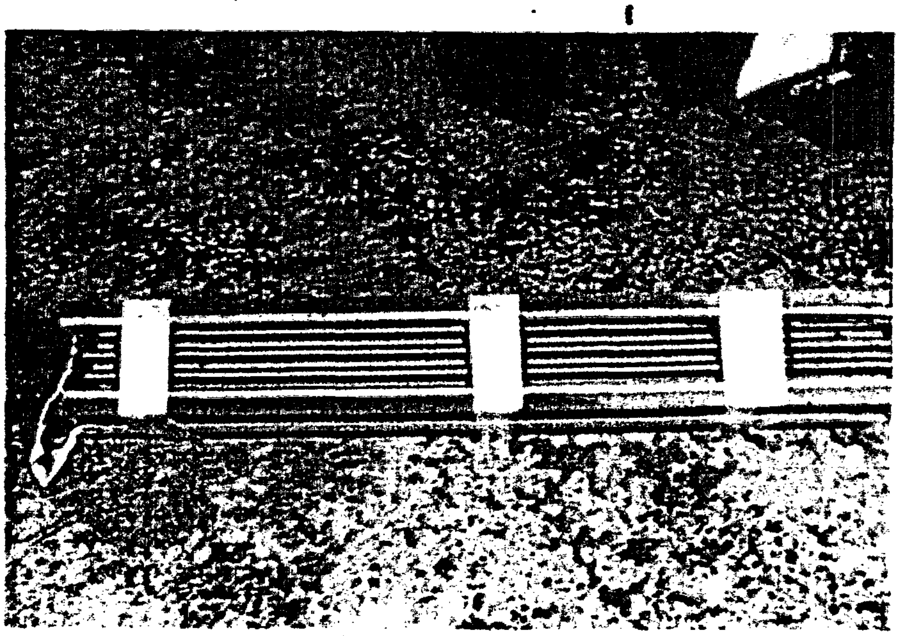
PICTURE 17 - Condition of inner container after completion of tests.



PICTURE 18 - Inner container and broken pellets after completion of tests.

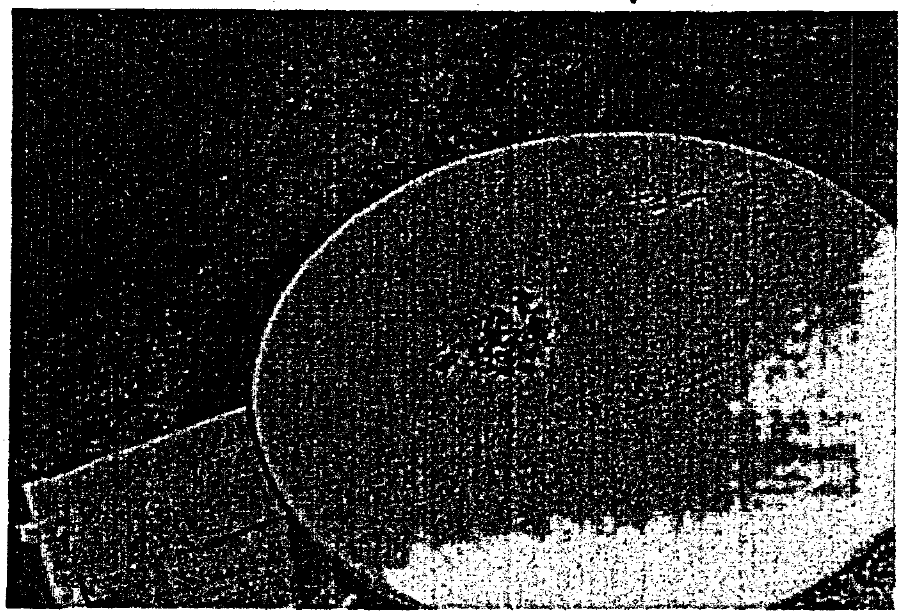


PICTURE 19 - Side of pellet package facing container wall during test.

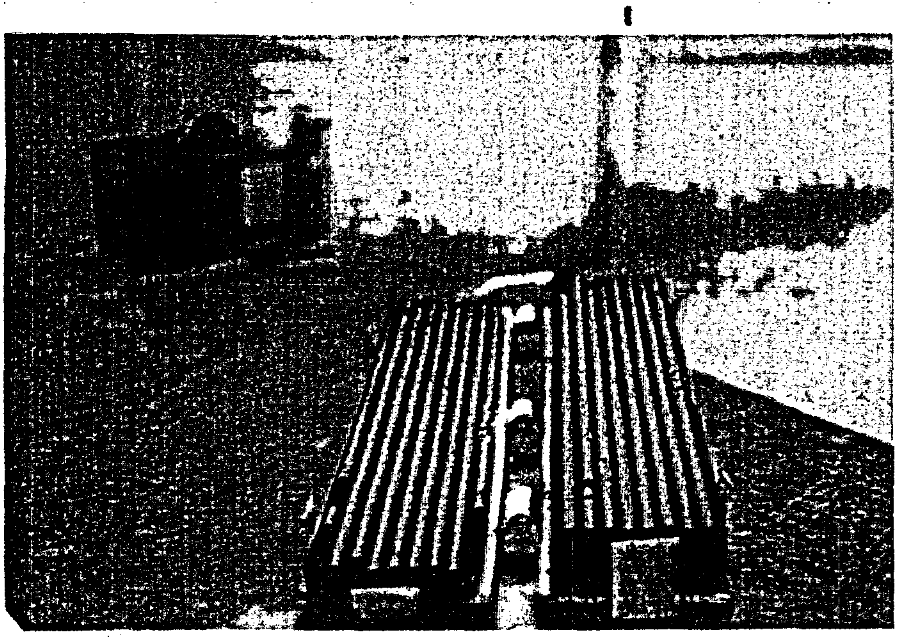


PICTURE 20 - Side of pellet package facing other package during test.

UNC-2901 SHIPPING CONTAINER

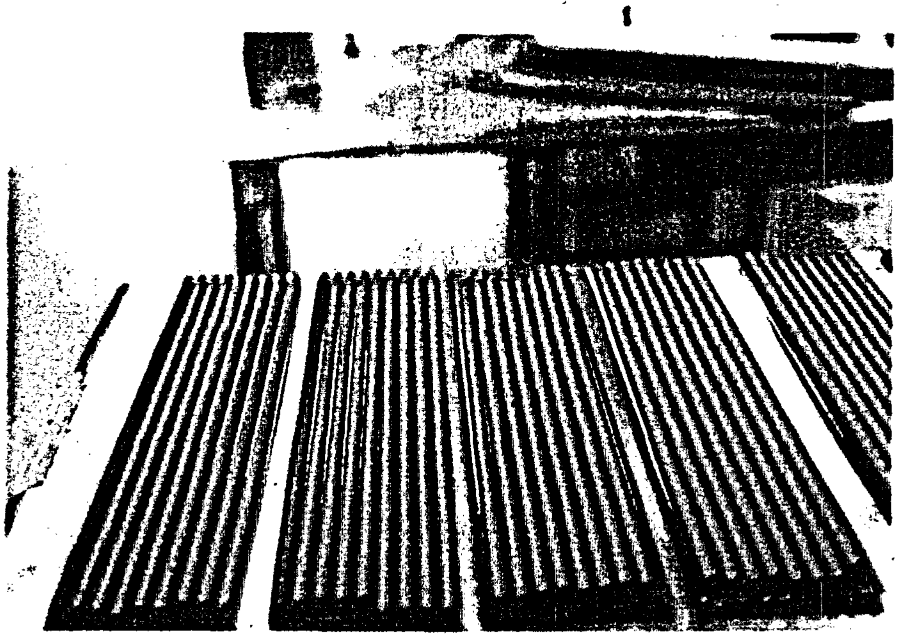


PICTURE 21 - Amount of pellets dislodged in test.



PICTURE 22 - Top row of disassembled package after test.

UNC-2901 SHIPPING CONTAINER



PICTURE 23 - Loaded pellet trays as assembled. Before testing.

APPENDIX 2.1-B

Evaluation of UO_2 Powder Drums for Use in Model UNC 2901 Shipping Package

EVALUATION OF UO_2 POWDER DRUMS
FOR USE IN MODEL UNC 2901 SHIPPING PACKAGE

1.0 SUMMARY

A metal drum and inner cushions were designed for the shipment of low enriched UO_2 powder in the Model UNC 2901 shipping container. The drums were filled with the maximum test weight and packaged inside the shipping container. The shipping container was subjected to a 30 foot drop test to evaluate the structural stability of the UO_2 powder drum. The results indicated that the powder drum was structurally sound for UO_2 powder shipments.

2.0 DESCRIPTION OF UO_2 POWDER DRUMS & INNER CUSHION

Details of the UO_2 powder shipping container assembly are illustrated on the attached drawing, #A-5007-2011. MIL specifications of the drum and drawing #A-5007-8111 of the inner cushion are shown in the Appendix.

The basic components of the shipping assembly are:

1. Two (2) re-usable metal shipping drums as per Specification MIL D-6055, Part No. MS 24347-8. The drum was modified in the following manner to meet UNC requirements.
   a. The inside depth was increased to 13-1/4 inches.
   b. A steel ring was added to the top lip of the container.
   c. The locking lugs were welded in addition to being rivited.
2. Three (3) 10-3/4 inches square x 1 inch thick Ethafoam.
3. Two (2) inner cushions of large bead Polystyrene.

Evaluation of UO_2 Powder Drums
for use in Model UNC 2901 Shipping Package
Page Two

3.0 STRUCTURAL EVALUATION

3.1 Conditions

The shipping package was subjected to one of the hypothetical accident conditions of the tests specified in 10 CFR 71.36 and 49 CFR 173.398 (c). This test was the 30 foot drop test. Original testing performed for the pellet shipment has demonstrated structural integrity of the inner and outer container including the ability to prevent water in-leakage. The net weight of the contents in that test was 427 pounds. Since the net weight of the contents for UO_2 powder is only 229.5 pounds, the original fire test, water test and "piston" drop test is applicable to this requirement; current testing was performed to demonstrate the ability of the powder drum to retain its contents.

One test was conducted. The 2901 container was assembled with two UO_2 powder drums. Each was filled with 110 pounds of lead shot and sand. The weight conditions were as follows:

Tare Weight (Assembled Container without Product Package)	227.5 pounds
Net Weight (Sand, Lead Shot, Drums & Packaging)	229.5 pounds
Equivalent Powder Weight	220.0 pounds
Equivalent Drum & Cushion Weight	9.5 pounds
Total Gross Weight	457.0 pounds

3.2 Discussion of Results

Photographs of the shipping drum and cushioning in its various stages of assembly are included in the Appendix of this report.

Evaluation of UO_2 Powder Drums
for use in Model UNC 2901 Shipping Package
Page Three

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.1 Thirty Foot Drop Test

Conditions - The impact of the 30 foot drop test was designed to occur at approximately 45° on the top corner of the drum aligned with the side of the square inner container. The lugs of the powder drums were centered on that side of the inner container. The conditions were chosen as the most severe conditions for the following reasons:

1. Experience from the same test performed on other packages indicated that maximum damage occurs from angular impact.

2. The lugs on the locking ring were indicated to be the weakest structural point of the Powder drum.

3. Striking at an angle caused a greater rebounding effect and a minimum degree of support surface (i.e. the top corner hit first and then the bottom as opposed to a single flat hit on side or end only). A flat hit would allow an equal support distribution by the cushions and metal drums and eliminate a greater concentrated force on one point.

4. The top powder drum was subjected to the brunt of impact from both the initial hit and the weight of the second drum.

Results - The decrease in drum diameter as a result of impact was a maximum of 1-3/4 inches on the top corner. The drum, drum lid and the locking ring remained intact. No significant damage to the plywood discs was noted. All flange bolts were intact and securely fastened. There was no deformation of the flanged closure.

Evaluation of UO_2 Powder Drums
for use in Model UNC 2901 Shipping Package
Page Four

3.0 Structural Evaluation (continued)

3.2 Discussion of Results (continued)

3.2.1 Thirty Foot Drop Test (continued)

Results (continued)
The top & center 1 inch thick Ethafoam cushions were completely severed by the impact of the powder drums. Both of the polystyrene cushions were broken into two pieces. Deformation of the cushion was not severe and both powder drums were securely in place.

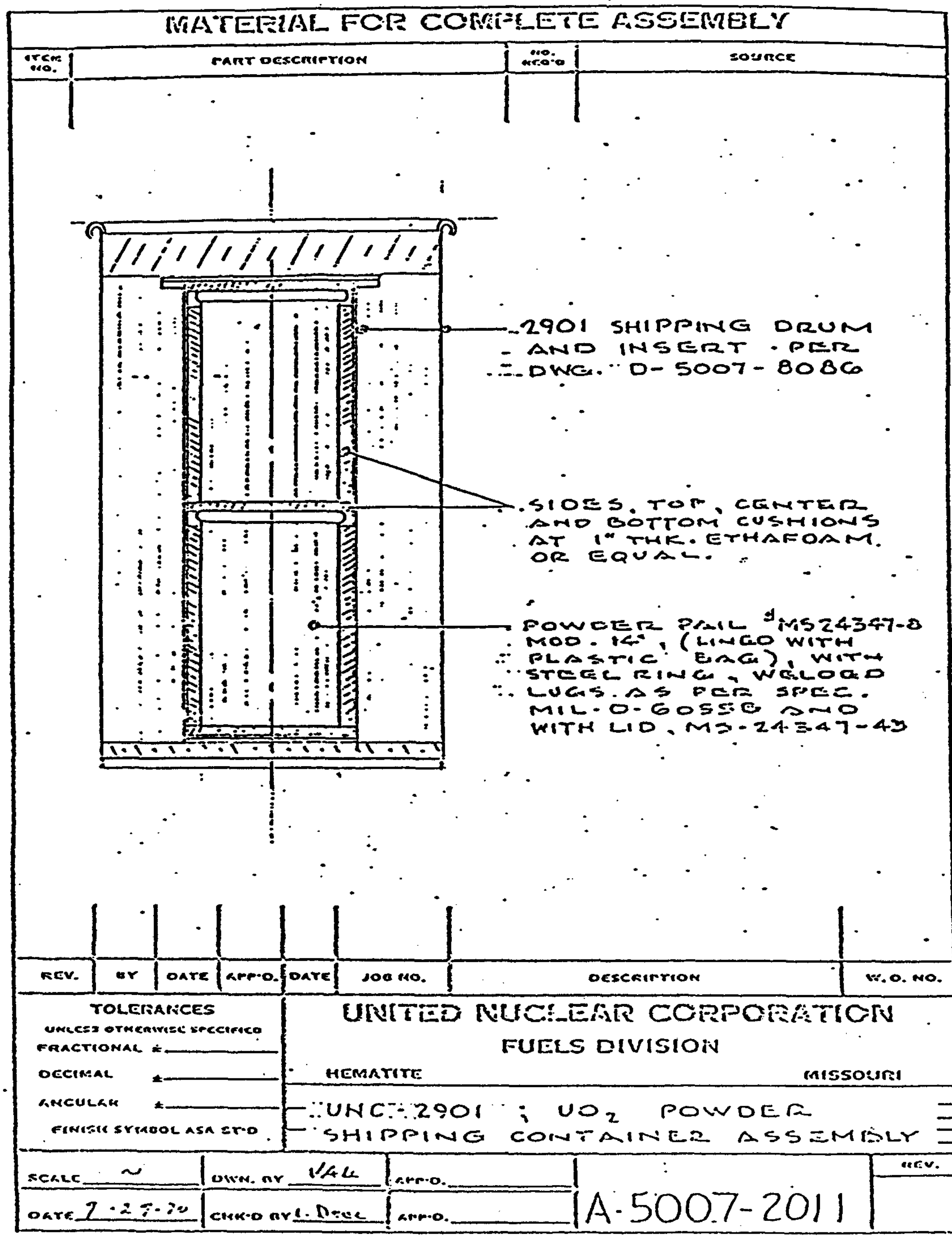
The locking ring and top flange of both powder drums were deformed. The bottom of the top powder drum was also badly deformed by the impact of the bottom powder drum. Although the drums were deformed, the locking rings and lid remained in place. There was no leakage noted at the drum lid or bottom seam.

UNC-2901 SHIPPING CONTAINER

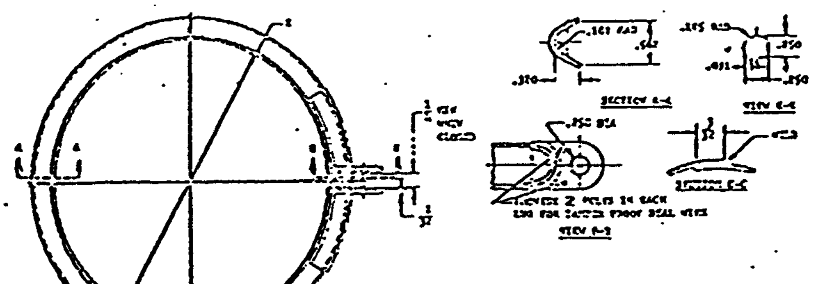
APPENDIX

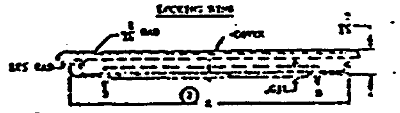
1. UO_2 Powder Shipping Container Assembly - A-5007-2011
2. UOL Powder Drum Specifications - MIL D-6055
3. Insert Pail Cushion - A-5007-8111
4. Photographs - Reproducible copies are no longer available. Original photographs were submitted with the June 20, 1980 application.

UNC-2901 SHIPPING CONTAINER

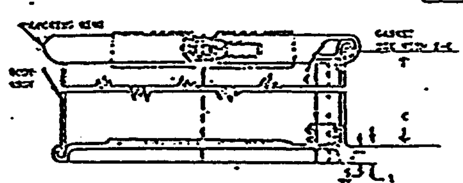


UNC-2901 SHIPPING CONTAINER





SPARE PARTS					
RINGS	EA.	COVERS	EA.	GASKETS	EA.
MS24347-61 (5")	.24	MS24347-41	.22	MS24347-81	.10
MS24347-62 (6½")	.26	MS24347-42	.24	MS24347-82	.12
MS24347-63 (8½")	.30	MS24347-43	.28	MS24347-83	.14
CLOSURE BOLT, ROUND SLOTTED HEAD 1/4-20 X 1 1/4, WITH HEXNUT, CAD PLATED					.04 PER SET



TYPE I

				QUANTITY - PRICES PER SHIPMENT						
SIZE NO.	DRUM ASSEMBLY	DIA. -A-	INSIDE DEPTH -C-	1 TO 11	12 TO 99	100 TO 499	500 TO 2499	2500 AND OVER	UNITS PER CTN	WT. PER CTN.
1	MS24347-1	5.00"	4.50"	1.52	1.38	1.22	1.10	1.05	24	27
2	MS24347-2	5.00"	8.50"	1.70	1.56	1.37	1.24	1.18	12	20
3	MS24347-3	6.50"	4.50"	1.64	1.50	1.33	1.20	1.14	12	22
4	MS24347-4	6.50"	6.75"	1.76	1.62	1.43	1.30	1.24	12	25
5	MS24347-5	6.50"	8.50"	1.83	1.74	1.55	1.40	1.30	12	31
6	MS24347-6	8.50"	6.00"	2.00	1.87	1.74	1.60	1.52	12	36
7	MS24347-7	8.50"	7.50"	2.10	1.95	1.83	1.74	1.64	12	42
8	MS24347-8	8.50"	9.00"	2.15	2.04	1.94	1.80	1.74	12	46

INSIDE PACKING HEIGHT WITH COVER IN PLACE IS 1/4" LESS THAN INSIDE DEPTH -C-.

MATERIAL: STEEL, COLD ROLLED SPEC QQ-S-698.
BODY, BOTTOM & COVER: ITEM 1 & 2 26 GAUGE ALL OTHERS 24 GAUGE.
LOCKING RINGS 20 GAUGE AND LUGS 14 GAUGE.
GASKET, SYNTHETIC RUBBER WEATHER RESISTANT, SHORE HARDNESS 60.

ABOVE PRICES BASED UPON DELIVERY QUANTITY PER ITEM.

PACKAGING CHARGE FOR NON STANDARD CARTON - $2.00.

Minimum Order: $5.00

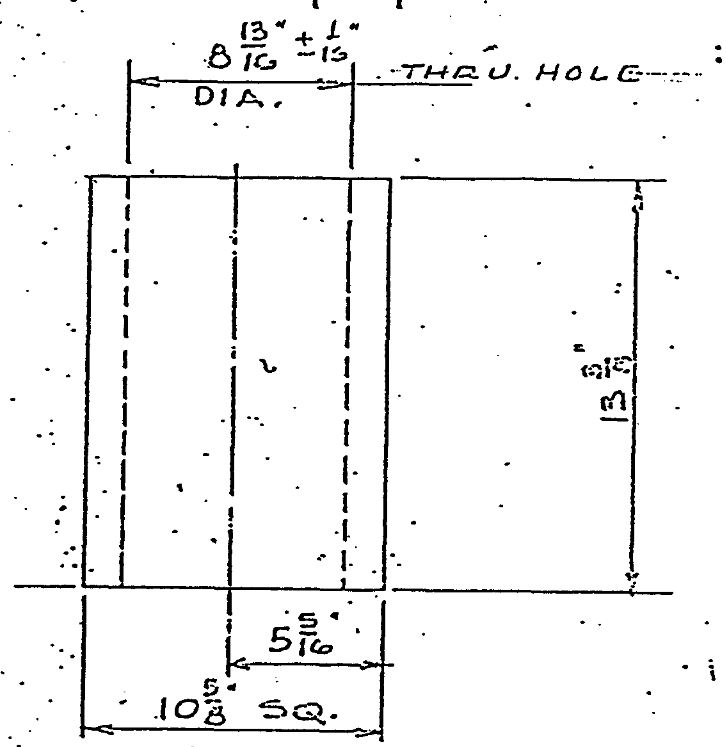
Terms ½ % 10; Net 30 F.O.B. St. Louis

PROCUREMENT SPECIFICATION MIL-D-6055 No. 3169 March 1, 1969	DRUM Metal Reusable Interior and Exterior Shipping and Storage MIRAX CHEMICAL PRODUCTS CORPORATION Metal Container Division 4999 FYLER AVENUE ST. LOUIS, MISSOURI 63139	MILITARY STANDARD MS24347 SUPERSEDES: AN6029

UNC-2901 SHIPPING CONTAINER

MATERIAL FOR COMPLETE ASSEMBLY

ITEM NO.	PART DESCRIPTION	NO. REQ'D	SOURCE



MATL:

LARGE BEAD "POLYSTYRENE"

DOW CHEM. CO. TYRILL FOAM OR EQUAL.

REV.	BY	DATE	APP'D.	DATE	JOB NO.	DESCRIPTION	W.O. NO.

TOLERANCES UNLESS OTHERWISE SPECIFIED

FRACTIONAL ± 1/16"

DECIMAL ± —

ANGULAR ± —

FINISH SYMBOL ASA STD

UNITED NUCLEAR CORPORATION

FUELS DIVISION

HEMATITE MISSOURI

INSERT PAIL CUSHION FOR 2901 POWDER SHIPPING DRUM

SCALE — DWN. BY VAL APP'D.

DATE 11-17-73 CHK'D BY APP'D.

A-5007-8111

REV.

3. THERMAL EVALUATION

The testing and results of the thermal evaluation for the UNC-2901 shipping container are discussed in Chapter 2 of this application.

4. CONTAINMENT

4.1 Containment Boundary

4.1.1 Containment Vessel

Within the UNC 2901 shipping container a square inner container provides the containment boundary for the radioactive contents. The top closure is be means of steel plate bolted to an external flange welded to the square body. A seal is formed by a gasket capable of withstanding temperatures up to at least 500°F.

4.1.2 Containment Penetrations

There are no penetrations into the inner containment vessel.

4.1.3 Seals and Welds

The seal of the inner container closure is formed by a gasket 0.125 inch thick between the surfaces of a flange welded to the outer surface of the square body and the top closure cover. The gasket is rated for at least 500°F service and since there is no significant heat generated by the package payload, the seal is unaffected by temperatures encountered in normal conditions of transport. Also, testing described in Section 2.1 has shown that the gasket is unaffected by the temperatures attained in the Hypothetical Accident Conditions.

All welds are visually inspected to ensure that parent metals are well fused, weld (or heat affected zone) is free of cracks, craters, or burnouts.

4.1.4 Closure

The inner container closure is formed by a 0.5 inch steel plate bolted to an external flange welded to the square inner container. Material specifications for the plate and the bolts and nuts are listed on Drawings NFM-D-4540 and D-5007-8086 in Appendix 1.3. The bolted inner container closure lid with a 0.125 inch thick gasket is sufficient to maintain a positive seal during normal and accident conditions of transport.

4.2 Requirements for Normal Conditions of Transport

Submittal of the UNC 2901 shipping container to the tests specified in 10 CFR 71.71.36 and 49CFR 173.398(C) has shown that there will be no loss or dispersal of radioactive contents, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging. Fully loaded containers subjected to the full series of spray, free drop and penetration tests showed no degradation of effectiveness of the inner container and no leakage of water into the inner container.

4.3 Containment Requirements for Hypothetical Accident Conditions

The effect on the loaded UNC 2901 container of conditions hypothesized to occur in an accident was assessed during the testing as described in Section 2.1. These tests demonstrated that no radioactive material would be released. It was also demonstrated 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.

5. SHIELDING EVALUATION

The UNC-2901 shipping containers are used for the shipment of oxides of low enriched uranium ($\leq$5 wt.% U-235) in pellet or powder form. Thus, shielding is not a consideration in the design and construction of this shipping container.

6. CRITICALITY SAFETY EVALUATION

6.1 Discussion and Results

This section discusses the demonstration of compliance with the criticality safety requirements of 10 CFR Part 71.

6.1.1 Individual Container - Pellets

The individual container with 16 pellet trays holding a total of 91 Kg of 0.325 inch OD pellets, fully flooded with water in the pellet trays, the inner container, the outer container annulus and reflected, resulted in a Keff of 0.8404 +/- .0050. This loading is lower than the minimum loading, consequently the above multiplication factor is conservative for the designated minimum loading of 104 Kg.

6.1.2 Array of Containers - Pellets

6.1.2.1 Normal Transportation

The hypothetical accident test demonstrated that water cannot enter the inner container. Therefore, the pellets remain dry and moderation is only that provided by the packaging materials. A reflected rectangular array of 512 containers (8x8x8), with each container holding 145 Kg of 0.325 inch OD pellets, was analyzed to have a Keff of 0.72388 +/- .00461. Applying the standard safety factors in accordance with 10CFR71.59 and 10CFR71.61 (5 for Fissile Class II and 2 for Fissile Class III) the allowable number of containers would be:

Fissile Class II	102 containers
Fissile Class III	256 containers

6.1.2.2 Accident Conditions

The hypothetical accident test demonstrated that:

1) Water cannot enter the inner container.
2) The total container remained intact.
3) The inner container is not deformed.

Moderation, therefore, is only provided by the wood blocking and the water between the inner container and the outer shell. For conservatism, however, a maximum reactivity scenario was evaluated in which the inner container was flooded and the space between the inner container and the outer shell was modeled as a void. Additionally, the medium between UNC-2901 shipping containers in a water reflected 6x6x6 array (216 containers) was modeled as a void. The model, therefore, accounts for the maximum interaction of the 216 shipping containers for the hypothethical accident conditions.

The UNC-2901 shipping container will be packaged with 16 pellet trays and incorporate the wood blocking, depicted on Drawing D-5018-2001, Rev. 01, to help minimize the movement of contents. Because of the presence of the wood blocking, the pellets cannot escape from their trays during shipment (see Section 6.1.2.3 for discussion). The maximum Keff under these highly improbable conditions for a loading of 104 Kg of UO_2 pellets of 0.3765 inch OD or less is $\leq$ 0.95 when a pellet size correction effect (0.325" to 0.3765") and twice the KENO-IV standard deviation is added to the KENO-IV derived multiplication factor for 0.325 inch OD pellets (see Section 6.4.2.3 for discussion). Applying the standard safety factors in accordance with 10CFR71.59 and 10CFR71.61 (2 for Fissile Class II and 1 for Fissile Class III), the allowable number of containers are:

Fissile Class II	108
Fissile Class III	216

6.1.2.3 Escape of Pellets from Pellet Trays

The wood blocking used in the packaging for the UNC-2901 shipping container prevents the escape of pellets from the bulk pellet trays. The total height of the aluminum skid, the stack of trays, and the wood slab is 10.575 inches. The inner height of the inner container is 10.75 inches, leaving a nominal gap of 0.175 inch. Since the lip of the tray cover is 0.375 inch, the cover cannot come off and contents will not escape from the tray.

6.1.2.4 Summary

Based on the information presented above, 102 containers can be safely shipped as Fissile Class II and 216 containers can be safely shipped as Fissile Class III. Each UNC-2901 shipping container has an individual Transportation Index of 0.50. Since the Aggregate Transport Index is limited to 50, only 100 UNC-2901 containers will be allowed per transport vehicle.

6.2 UNC-2901 Shipping Container Fuel Loadings Limits

6.2.1 Fuel Pellets

The UNC-2901 will be shipped with a minimum of 16 pellet trays. When less than 16 loaded pellet trays need to be shipped, the 16 tray packaging complement may be made up of dummy trays (fabricated of wood) or empty trays with a wood block insert to preclude the potential for tray collapse during a hypothetical accident scenario. Trays containing pellets will be loaded with a minimum of 6.5 Kg and a maximum of 9.07 Kgs of pellets having a diameter of $\leq$ 0.3765 inch.

6.3 Model Specifications

The KENO-IV model for the UNC-2901 shipping container is shown in Figure 6.1. The overall height of the shipping container outer shell used in the model was 35.5 inches which is less than the overall height, 36.625 inches (see Drawing D-5007-8086, Rev. 6). The smaller overall height (and consequently smaller volume) as compared to the actual outer shell dimension is conservative for the purpose of assessing criticality safety.

6.3.1 Pellet Non-Accident Calculational Model Assumptions

The following assumptions were made for the analysis of fuel pellet shipments:

a. Pellet tray lids do not open.
b. No water enters the inner container.
c. 8x8x8 array of shipping containers surrounded by one foot of water.
d. Full interaction of shipping containers which produced the maximum reactivity:
   - no water between inner container and outer shell of UNC-2901 shipping container.
   - no water between UNC-2901 shipping containers.
e. Sixteen pellet trays are modeled with equal uranium weight per tray.
f. Non-accident dimensions for shipping container were:
   I.D.= 22.5 inches, O.D.= 22.6 inches
g. Density of pellets = 10.25 g-UO2/cc.
h. Pellet diameter of 0.325 inch.
i. Pellets are assumed to be internally dry.
j. Enrichment of uranium is 5.0 wt % U-235.
k. The analysis of the isolated shipping container assumes each pellet tray holds 5.67 Kgs of pellets and is fully flooded with water. This loading is less than the minimium loading thus assuring a conservative estimate of the multiplication factor for this analysis. The inner container is also assumed to be flooded. In the outer container, the Fiberlite insulation has been replaced with water. The shipping container is reflected by 30 cm of water.

6.3.2 Pellets - Accident Calculational Model Assumptions

The following assumptions were made for the analysis of fuel pellet shipments:

a. Pellet tray lids do not open. As such, pellets do not escape from the trays and are not floating in high water to fuel ratio regions.
b. Inner container is fully flooded with water.
c. 6x6x6 array of shipping containers surrounded by one foot of water.

d. Full interaction of shipping containers which produced the maximum reactivity:
   - no water between inner container and outer shell of UNC-2901 shipping container.
   - no water between UNC-2901 shipping containers.
e. Sixteen pellet trays are modeled with equal uranium weight per tray.
f. Accident dimensions for shipping container were:
   I.D.= 21.0 inches, O.D.= 21.1 inches
g. Density of pellets = 10.25 g-UO_2/cc.
h. Pellet diameter of 0.325 inch.
i. Pellets are assumed to be internally dry.
j. Enrichment of uranium is 5.0 wt % U-235.

6.4 Criticality Calculation

6.4.1 Calculational Method

For the fuel pellet analysis the NITAWL code (Ref. 4) was used to generate self-shielded 123-group cross sections from a master AMPX library (Ref. 5). The Dancoff correction supplied as input to NITAWL is based upon the modeled water to fuel ratio inside the pellet trays. The resulting working library was then collapsed into a homogenized 16-group library based on an infinite lattice of uniformly spaced fuel pellets representative of the environment in the pellet tray using XSDRNPM (Ref. 4). XSDRNPM was also used to obtain separate 16-group cross section sets for the structural materials, insulation, and the moderator areas external to the fuel area. Reactivities were calculated using KENO-IV (Ref. 1), a three-dimensional Monte Carlo criticality code.

6.4.2 KENO-IV Results and Input Models

Table 6-1 summarizes the K-effectives for pellet evaluations discussed herein. Sections 6.4.2.1 through 6.4.2.3 below provide further details of the analyses performed for each of the scenarios evaluated.

6.4.2.1 Pellets - Isolated Container

A KENO-IV case was performed for an isolated UNC-2901 shipping container with 16 loaded pellet trays. Each tray contained 5.67 Kg (91 Kg total in container) of 0.325 inch OD pellets for a conservative estimate of the multiplication factor. The pellet trays, the inner container and the space between the inner and outer container were fully flooded with water. The individual container was also reflected with full-density water. The KENO-IV calculated Keff for this scenario is 0.8404 +/- .0050. The KENO-IV input model for this analysis is given in Figure 6.1 and the input parameters are provided in Table 6-2.

6.4.2.2 Pellets - Non-Accident Geometry

The KENO-IV calulated Keff for the 8x8x8 array of UNC-2901 shipping containers, each containing 145 Kg of 0.325 inch OD pellets, is 0.72388 +/- .00461. The KENO-IV input data for this scenario is given in Table 6-3.

6.4.2.3 Pellets - Accident Geometry

In practice, the UNC-2901 shipping container is loaded with approximately 127 Kg of pellets. KENO-IV cases were performed with 145, 127, 109, 98 and 91 Kg of 0.325 inch OD pellets per shipping container in a 6x6x6 array of accident geometry containers. The following table summarizes the KENO-IV results:

Total Weight of Pellets, Kgs.	Avg. Weight per tray, Kgs	V_{H2O}/V_{UO2}	K-eff
145.1	9.07	0.740	0.90854 +/- .00475
127.0	7.94	0.989	0.92661 +/- .00363
108.8	6.80	1.320	0.93387 +/- .00460
97.6	6.10	1.730	0.94030 +/- .00438
90.7	5.67	1.784	0.94391 +/- .00449

The KENO-IV input data for the 98 Kg scenario is given in Table 6-4.

Section 6.6 provides a discussion of the effect of pellet diameter and volume ratio of water to oxide on reactivity. It is concluded that at volume ratios below approximately 2.5, reactivity increases with pellet diameter. Since the KENO-IV analyses presented herein are done at a pellet diameter of 0.325 inch and the highest water to oxide volume ratio is less than 2.5, it may be concluded that these analyses are conservative for pellet diameters $\leq$ 0.325 inch.

For pellet diameters larger than 0.325 inch, reactivity is expected to increase with pellet diameter when the water to oxide volume ratio is less than 2.5. To estimate the reactivity effect when 0.3765 inch OD pellets are substitued for 0.325 inch OD pellets in the pellet trays, for a given weight loading per tray, the data of Figure 6.2 were employed. The reactivity increase was computed by taking the fractional increase in infinite multiplication factor times the KENO-IV derived effective multiplication factor. For conservatism, the data for a water to oxide volume ratio of 1.320 was used since the limiting case of interest (minimum Kg UO_2 per tray) has a volume ratio between 1.32 and 1.784. The fractional increase in infinite multiplication factor was taken to be (1.470-1.464)/1.464 in going from 0.325 inch to 0.3765 inch OD pellets. It was thus concluded that the reactivity adjustment was the above fractional increase in infinite multiplication factor times the effective multiplication factor for 6.1 Kg UO_2 per tray, or 0.00385.

To estimate the minimum loading per tray required so that the sum of the KENO-IV calculated multiplication factor plus twice the KENO-IV standard deviation plus the pellet size correction is $\leq$ 0.95, the following data were used:

Avg Weight per Tray	Adjusted K-eff
6.80 Kg	0.93387 + 2(0.00460) + 0.00385 = 0.94692
6.10 Kg	0.94030 + 2(0.00438) + 0.00385 = 0.95291

The limiting weight per tray based on a target value for Keff of 0.95 is 6.44 Kg using linear interpolation. This value was rounded up to 6.5 Kg UO_2 per tray or 104 Kg UO_2 for 16 trays.

Because of the magnitude of the pellet size correction factor as compared to the magnitude of Keff, no pellet diameter adjustments were made to the calculations reported above in Sections 6.4.2.1 and 6.4.2.2.

6.5 Code Validation

6.5.1 Homogeneous UO_2 - Moderator Mixtures

Validation of a calculational scheme employing the KENO-IV code (Reference 1) and the sixteen group Hansen-Roach cross section set distributed under the SCALE code system (Reference 2) is contained in Reference 3. To ascertain whether the conclusions of the latter reference are applicable to analyses carried out at Combustion Engineering, Inc., the following comparisons were made.

1) The Hansen-Roach cross section library at Combustion Engineering, Inc. was verified as being identical to that distributed under SCALE, and

2) Eight of the sample problems distributed with the code were run for purposes of comparing the calculated eigenvalues with those obtained by ORNL.

Table 6.5 summarizes the eigenvalue comparison; it is noted that the eigenvalues agree within the stated statistical deviation. Thus, it may be concluded that the conclusions of Reference 3 concerning bias and deviation are applicable to homogeneous analyses performed by Combustion Engineering, Inc.

6.5.2 Heterogeneous UO_2 - Moderator Mixtures

Heterogeneous UO_2 - moderator lattices for fuel shipping containers are analyzed with the KENO-IV code and a sixteen group library generated for the lattice of interest. The latter library is prepared with the NITAWL and XSDRNPM codes (Reference 4). Lattice dependent Dancoff factors are calculated for input to NITAWL to generate self-shielded 123 group cross sections from the super - XSDRN library (Reference 5). This library is employed with XSDRNPM to calculate 123 group constants which are collapsed to sixteen group flux weighted fuel cell averaged cross sections. XSDRNPM is also used to obtain separate 16 group cross section sets for the structural materials, insulation, and the moderator areas external to the UO_2 regions.

Validation of this calculational scheme is based on analysis of two sets of experiments: (1) the dissolution and storage experiments carried out by the Department of Nuclear Safety of the French Atomic Energy Commission (Reference 6), and (2) the consolidated fuel rod experiments carried out at the Babcock and Wilcox Facility under the auspices of the U.S. Department of Energy (Reference 7).

Emphasis was placed on the analysis of the storage aspect of the French experiments. In these experiments, the reactivity effects of replacing water in the inter-fuel assembly gap by air, expanded polystyrene ($(C_8H_8)n$), polyethylene powder ($(CH_2)n$), and polyethylene balls were examined for gap thickness of 2.5, 5.0, and 10.0 cm. Application of the calculational scheme outlined above resulted in the KENO-IV results noted in Table 6.6.

The consolidated fuel rod experiments covered five core types. The first three employed a triangular spacing of the close pack fuel rods within a storage module; differences between the three cores were the nominal intermodule spacing (1.78 to 3.81 cm). The fourth core employed close packed fuel rods in a square pitch while the fifth core employed an open square pitch. All cores were critical at full water height using soluble boron as the variable.

The following tabulation summarizes the KENO-IV multiplication factors for the first three cores.

Core No.	KENO-IV KEFF
I	1.008 ± 0.002
II	0.996 ± 0.002
III	0.978 ± 0.002

The above results demonstrate that the calculational scheme for heterogeneous lattices based in the NITAWL - XSDRNPM - KENO-IV computer codes does give acceptable agreement with experiment for use in criticality evaluations. The systematics of the deviations between calculation and experiment indicate the model to be conservative for the French experiments. In the case of the fuel consolidation experiments the same trend is observed in the calculational results as reported in Reference 7.

6.6 Pellet Size Reactivity Effects Sensitivity Study

The purpose of this section is to explore the reactivity effects of pellet size. A range of pellet sizes are employed in the various PWR and BWR fuel rods. In addition, there are a range of dimensions associated with hard scrap resulting from broken pellets. Since the KENO-IV analyses for the 4x2x2 array of bulk pellet trays was done for 0.325 inch diameter pellets, it is of interest to examine the consequences of larger or smaller pellet/particle dimensions. Two types of data are employed, critical mass data versus pellet size, and infinite multiplication factor data versus pellet size and volume ratio of water to UO_2.

The critical mass data is extracted from Reference 8 since data are tabulated in this reference for pellet sizes varying from 0.05 to 0.60 inch in diameter. Figure 6.3 shows plots of critical mass in Kg U-235 versus volume ratio of water to UO_2 for five pellet diameters in addition to that for UO_2 powder (i.e., 0" pellet diameter). In addition, the variation of migration area, M^2, is shown versus water to UO_2 volume ratio to show that M^2 is not a strongly varying quantity. Thus, it can be expected that these data or variation in critical mass can be directly related to changes in reactivity for varying pellet diameter when other variables remain unchanged.

The variation of critical mass with volume ratio of water to UO_2 for the differing pellet diameters shows a markedly different behavior at volume ratios below approximately 2.5. In this regime, the critical mass decreases with increasing pellet diameter; thus, it is expected that at a fixed volume ratio, increasing the pellet size leads to an increase in reactivity. Consequently, for a fixed volume container, a given mass loading limit results in a given limit in the water to fuel ratio, and at this loading limit an increase in pellet diameter leads to an increase in reactivity providing the volume ratio is below approximately 2.5.

Conversely, at the higher water to fuel ratios and especially at the point of optimum moderation for a given pellet diameter, the critical mass decreases with decreasing pellet size to a minimum in the range of 0.05 to 0.1 inch pellet diameter depending how over moderated the lattice becomes. For the bulk pellet trays employed in the 4x2x2 packaging arrays, the UO_2 loading per tray varies from 5.67 to 9.07 Kg; the corresponding range of water to UO_2 volume ratios is 1.78 to 0.74. Thus, the cases of interest fall below 2.5 in water to UO_2 volume ratio.

Figure 6.2 shows plots of the infinite multiplication factor versus pellet diameter for volume ratios between 0.740 and 1.784. The variation of the infinite multiplication factor is as deduced from the variation of critical mass with pellet diameter from Figure 6.3 (viz. the infinite multiplication factor is increasing with pellet diameter for these very dry mixtures of pellets and water).

6.7 References

1. L. M. Petrie and N. F. Cross, "KENO-IV, An Improved MONTE CARLO Criticality Program," ORNL-2938, November, 1975.

2. "SCALE: A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluation - Book II", NUREG/CR-0200.

3. G. R. Handley and C. M. Hopper, "Validation of the "KENO" Code for Nuclear Criticality Safety Calculations of Moderated, Low-Enriched Uranium Systems", Y-1948, June 13, 1974.

4. N. M. Green, et al, "AMPX: A Modular Code System for Generating Coupled Multigroup Neutron-Gamma Libraries from ENDF/B", ORNL/TM-3706, March 1976.

5. W. R. Cable, "123 Group Neutron Cross Section Data Generated from ENDF/B-II Data for use in the XSDRN Discrete Ordinates Spectral Averaging Code", DLC-16, Radiation Shielding Information Center, 1971.

6. J. C. Manarache, et al, "Dissolution and Storage Experiment With 4.75 w/o U-235 Enriched UO_2 Rods", Nuclear Technology, Vol. 50, pg 148, September 1980.

7. G. S. Hooper, et al, "Critical Experiments Supporting Storage of Tightly Packaged Configurations of Spent Fuel Rods," BAW-1645-4, November, 1981.

8. H. K. Clark, "Critical and Safe Masses and Dimensions of Lattices of U and UO_2 Rods in Water", DP-1014 Savannah River Laboratory, February 1966.

TABLE 6-1

SUMMARY OF CRITICALITY EVALUATION

KENO IV RESULTS FOR THE UNC-2901 SHIPPING CONTAINER - UO_2 PELLETS (0.325" OD)

Array	Geometry Dev. No. of Trays	UO_2 Weight Kgs/Container	K-Effective	(+ or -)
8x8x8	Non-Accident	145	0.7238	0.0046
6x6x6	Accident	145	0.9085	0.0048
6x6x6	Accident	127	0.9266	0.0036
6x6x6	Accident	109	0.9339	0.0046
6x6x6	Accident	98	0.9403	0.0044
6x6x6	Accident	91	0.9439	0.0045

Table 6-2
KENO-IV Input
Pellets (0.325" OD)
Isolated Container - 91 Kgs

```
    5.00    50     500      3      16
     15     29       6     29      13
      1      6       6      6     -29
      1      0    1010     00       1
      1      1       0      0       0
     00      0       0
 0.0  0.0  0.0  0.0  0.0  0.0
 1  -92235   3.541897E-4
 1   92238   6.644599E-3
 1    8016   3.378829E-2
 1    1001   3.958142E-2
 1   26012   3.232260E-5
 1  224000   1.679824E-3
 1  225055   1.766620E-4
 1  226000   6.156296E-3
 1  228000   6.612613E-4
 1  214028   1.727761E-4
 2   26012   3.1691E-4
 2  224000   1.647E-2
 2  225055   1.7321E-3
 2  226000   6.036E-2
 2  228000   6.4834E-3
 2  214028   1.694E-3
 3   38016   3.342984-2
 3   31001   6.685969-2
 4   58016   9.852100-3
 4   66012   1.612600-2
 4   51001   2.812100-2
 5   46012   3.921000-3
 5  426000   8.349100-2
 6   26012   3.3435E-4
 6  224000   1.7376E-2
 6  225055   1.8274E-3
 6  226000   6.3682E-2
 6  228000   6.8402E-3
 6  214028   1.7872E-3
BOX TYPE  1
CUBOID     1   13.3350  -13.3350  52.0700    0.0000    7.71525 -13.11275 16*0.5
CUBOID     3   13.3350  -13.3350  59.6900    0.0000    7.71525 -13.11275 16*0.5
CUBOID     3   13.3350  -13.3350  59.6900    0.0000    7.71525 -13.43025 16*0.5
CUBOID     3   13.3350  -13.3350  59.6900   -5.0800    7.71525 -13.43025 16*0.5
CUBOID     4   13.3350  -13.3350  59.6900   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     3   13.3350  -13.3350  60.9600   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     4   13.3350  -13.3350  60.9600  -13.9700   13.43025 -13.43025 16*0.5
CUBOID     3   13.6525  -13.6525  .60.9600  -13.9700   13.65250 -13.65250 16*0.5
CUBOID     5   13.85087 -13.85087 62.2300  -14.16837  13.85087 -13.85087 16*0.5
YCYLINDER  3   26.6700   67.3100  -22.61895                               16*0.5
YCYLINDER  5   26.7970   67.46875 -22.74595                               16*0.5
YCYLINDER  3   57.2770   97.94875 -53.22595                               16*0.5
CUBOID     0   57.2770  -57.2770  97.94875 -53.22595 57.27700 -57.27700 16*0.5
END KENO
```

Table 6-3
KENO-IV Input
Pellets (0.325" OD)
8x8x8 Array - 145 Kgs
Non-Accident Geometry

```
  10.00     50     500      3      16
      6     11       5     11      14
      1      8       8      8      11
      1      0    1010     00       1
      1      1       0      0       0
     00      0       0
 0.0  0.0  0.0  0.0  0.0   0.0
 1  -92505   4.719479E-5
 1  -92506   5.195087E-4
 1   92803   9.708311E-3
 1   92804   9.230486E-4
 1    8100   2.239613E-2
 2     200   1.0
 3     502   1.0
 4    8100   9.852100-3
 4    6100   1.612600-2
 4    1102   2.812100-2
 5     100   1.0
BOX TYPE  1
CUBOID     1   13.3350  -13.3350  52.0700    0.0000    7.71525 -13.11275 16*0.5
CUBOID     0   13.3350  -13.3350  59.6900    0.0000    7.71525 -13.11275 16*0.5
CUBOID     0   13.3350  -13.3350  59.6900    0.0000    7.71525 -13.43025 16*0.5
CUBOID     0   13.3350  -13.3350  59.6900   -5.0800    7.71525 -13.43025 16*0.5
CUBOID     4   13.3350  -13.3350  59.6900   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     0   13.3350  -13.3350  60.9600   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     4   13.3350  -13.3350  60.9600  -13.9700   13.43025 -13.43025 16*0.5
CUBOID     0   13.6525  -13.6525  60.9600  -13.9700   13.65250 -13.65250 16*0.5
CUBOID     5   13.85087 -13.85087 62.2300  -14.16837  13.85087 -13.85087 16*0.5
YCYLINDER  0   28.5750   67.3100  -22.61895                               16*0.5
YCYLINDER  5   28.7020   67.46875 -22.74595                               16*0.5
CUBOID     0   28.7020  -28.7020  67.46875 -22.74595 28.7020  -28.7020    16*0.5
CORE BDY   0  459.2320    0.0000 721.7176    0.0000 459.2320    0.0000    16*0.5
CUBOID     3  489.7120  -30.4800 752.1976  -30.4800 489.7120  -30.4800    16*0.5
END KENO
```

Table 6-4
KENO-IV Input
Pellets (0.325" OD)
6x6x6 Array - 98 Kg
Accident Geometry

```
     5.00     50      500      3        16
       15     29        6     29        14
        1      6        6      6       -29
        1      0     1010     00         1
        1      1        0      0         0
       00      0        0
   0.0  0.0  0.0  0.0  0.0  0.0
   1  -92235   3.810509E-4
   1   92238   7.148507E-3
   1    8016   3.407407E-2
   1    1001   3.802985E-2
   1   26012   3.232260E-5
   1  224000   1.679824E-3
   1  225055   1.766620E-4
   1  226000   6.156296E-3
   1  228000   6.612613E-4
   1  214028   1.727761E-4
   2   26012   3.1691E-4
   2  224000   1.647E-2
   2  225055   1.7321E-3
   2  226000   6.036E-2
   2  228000   6.4834E-3
   2  214028   1.694E-3
   3   38016   3.342984-2
   3   31001   6.685969-2
   4   58016   9.852100-3
   4   65012   1.612600-2
   4   51001   2.812100-2
   5   46012   3.921000-3
   5  426000   8.349100-2
   6   26012   3.3435E-4
   6  224000   1.7376E-2
   6  225055   1.8274E-3
   6  225000   6.3682E-2
   6  228000   6.8402E-3
   6  214028   1.7872E-3
BOX TYPE  1
CUBOID     1    13.3350  -13.3350  52.0700    0.0000    7.71525 -13.11275 16*0.5
CUBOID     3    13.3350  -13.3350  59.6900    0.0000    7.71525 -13.11275 16*0.5
CUBOID     0    13.3350  -13.3350  59.6900    0.0000    7.71525 -13.43025 16*0.5
CUBOID     3    13.3350  -13.3350  59.6900   -5.0800    7.71525 -13.43025 16*0.5
CUBOID     4    13.3350  -13.3350  59.6900   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     3    13.3350  -13.3350  60.9600   -5.0800   13.43025 -13.43025 16*0.5
CUBOID     4    13.3350  -13.3350  60.9600  -13.9700   13.43025 -13.43025 16*0.5
CUBOID     3    13.6525  -13.6525  60.9600  -13.9700   13.65250 -13.65250 16*0.5
CUBOID     5    13.85087 -13.85087 62.2300  -14.16837  13.85087 -13.85087 16*0.5
YCYLINDER  0    26.6700   67.3100  -22.61895                              16*0.5
YCYLINDER  5    25.7970   67.46875 -22.74595                              16*0.5
CUBOID     0    26.7970  -26.7970  67.46875 -22.74595 25.7970 -26.7970    16*0.5
CORE BOY   0   321.5640    0.0000 541.2882    0.0000 321.5640   0.0000    16*0.5
CUBOID     3   352.0440  -30.4800 571.7682  -30.4800 352.0440 -30.4800    16*0.5
END KENO
```

Table 6.5

Comparison of KENO-IV Calculated Eigenvalues for Sample Problems

Problem Number	Eigenvalues C-E	Eigenvalues ORNL
1	1.00387 +/- .00448	1.00569 +/- .00446
2	0.99733 +/- .00426	1.00099 +/- .00442
10	0.74638 +/- .00446	0.75215 +/- .00436
11	0.99846 +/- .00487	0.99380 +/- .00515
12	0.92957 +/- .00449	0.93089 +/- .00419
13	2.26645 +/- .00603	2.26172 +/- .00566
14	0.98487 +/- .00625	0.98060 +/- .00558
19	0.99726 + - .00452	1.00014 +/- .00567

Table 6.6

Results of Experiements and Benchmark Calculations in the Case of Interposition of Hydrogeneous Compounds Between Four Assemblies of 18 x 18 (4.75%) UO_2 Rods at 13.5 mm Square Pitch

Experiemental Results

* Δ (cm)		Compounds: Nature	Compounds: Density (g/cm^3)	Compounds: Concentration Hydrogen (g/cm^3)	Water Critical Height (mm)	Calculated Results KENO-IV
0	1.	Water	1.0	0.1119	238 ± 0.6	-
	2.	Box + air	0	0	290.3 ± 0.9	0.99641 ± 0.00407
	3.	Box + $(C_8H_8)n$	0.0323	0.0025	286.1 ± 0.8	0.99913 ± 0.00384
2.5	4.	Box powder $(CH_2)n$	0.2879	0.0414	269.8 ± 0.6	1.01567 ± 0.00378
5.0	5.	Box + balls $(CH_2)n$	0.5540	0.0800	255.4 ± 0.6	-
	6.	Box + water	1.0	0.1119	256.8 ± 0.7	1.02362 ± 0.00362
	7.	Water	1.0	0.1119	244.8 ± 0.6	0.99775 ± 0.00391
	8.	Box + air	0	0	344.8 ± 0.7	1.00412 ± 0.00422
	9.	Box + $(C_8H_8)n$	0.0262	0.0020	343.9 ± 0.8	1.00647 ± 0.00421
5.0	10.	Box + powder $(CH_2)n$	0.3335	0.0480	301.6 ± 0.6	-
	11.	Box + balls $(CH_2)n$	0.5796	0.0833	307.3 ± 0.8	-
	12.	Box + water	1.0	0.1119	238.8 ± 0.8	-
	13.	Water	1.0	0.1119	314.7 ± 0.6	-
	14.	Box + air	0	0	460.8 ± 0.7	1.00117 ± 0.00396
	15.	Box + $(C_8H_8)n$	0.0288	0.0022	456.2 ± 0.8	1.00748 ± 0.03378
10.0	16.	Box + powder $(CH_2)n$	0.3216	0.0464	420.5 ± 0.6	-
	17.	Box + balls $(CH_2)n$	0.5680	0.0816	499.4 ± 0.6	-
	18.	Box + water	1.0	0.1119	641.2 ± 0.9	-
	19.	Water	1.0	0.1119	643.4 ± 0.8	-

* The symbol Δ is the value of the gap width between the assemblies, thus it is the value of cross-shaped box width. The actual thickness of hydrogeneous compounds is Δ (H) = Δ 0.6 cm.

UNC-2901 SHIPPING CONTAINER

FIGURE 6.1
KENO MODEL FOR UNC-2901 SHIPPING CONTAINER

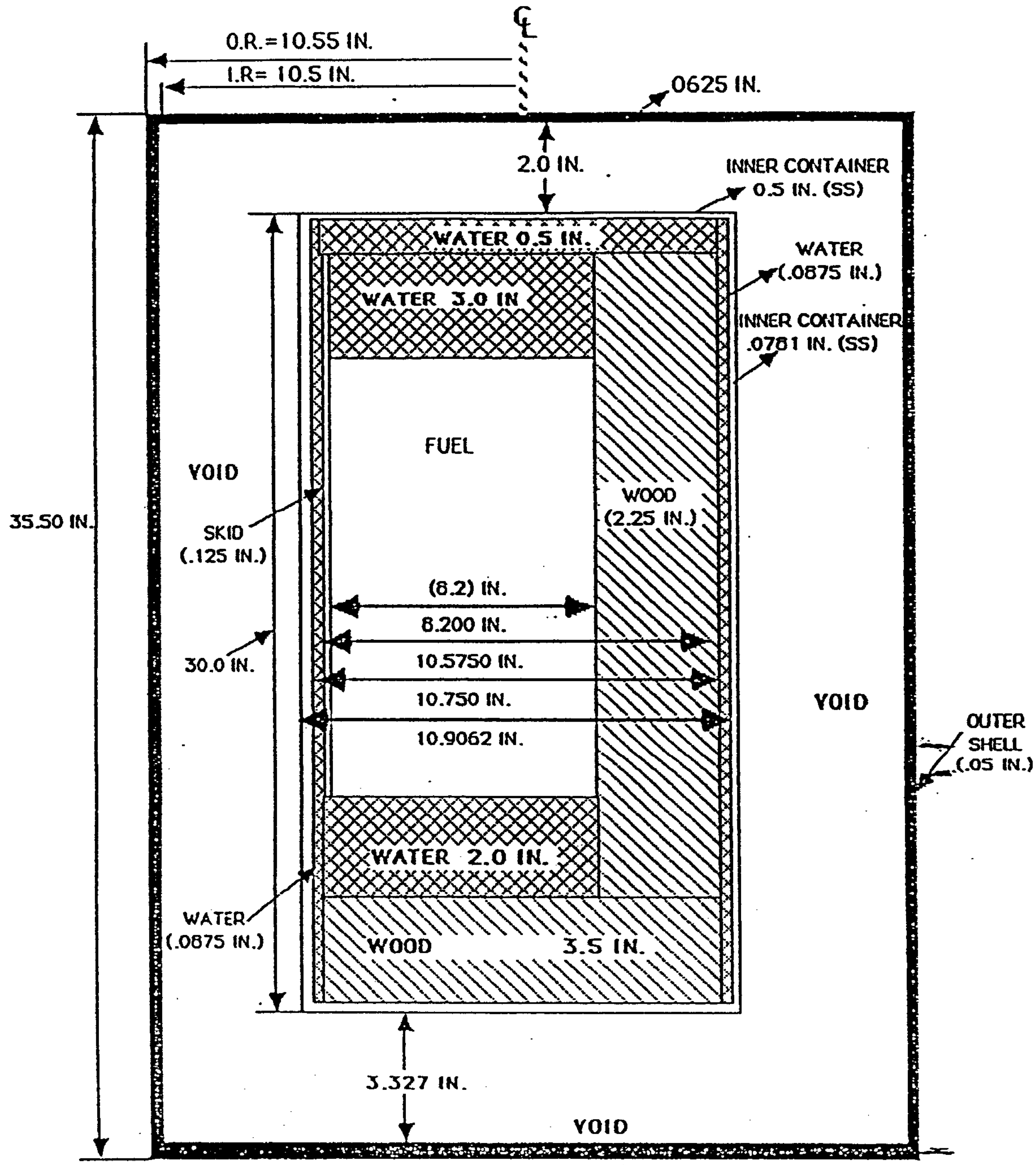


FIGURE 6.2
INFINITE MULTIPLICATION FACTOR
VERSUS PELLET DIAMETER FOR WATER
TO UO_2 VOLUME RATIOS

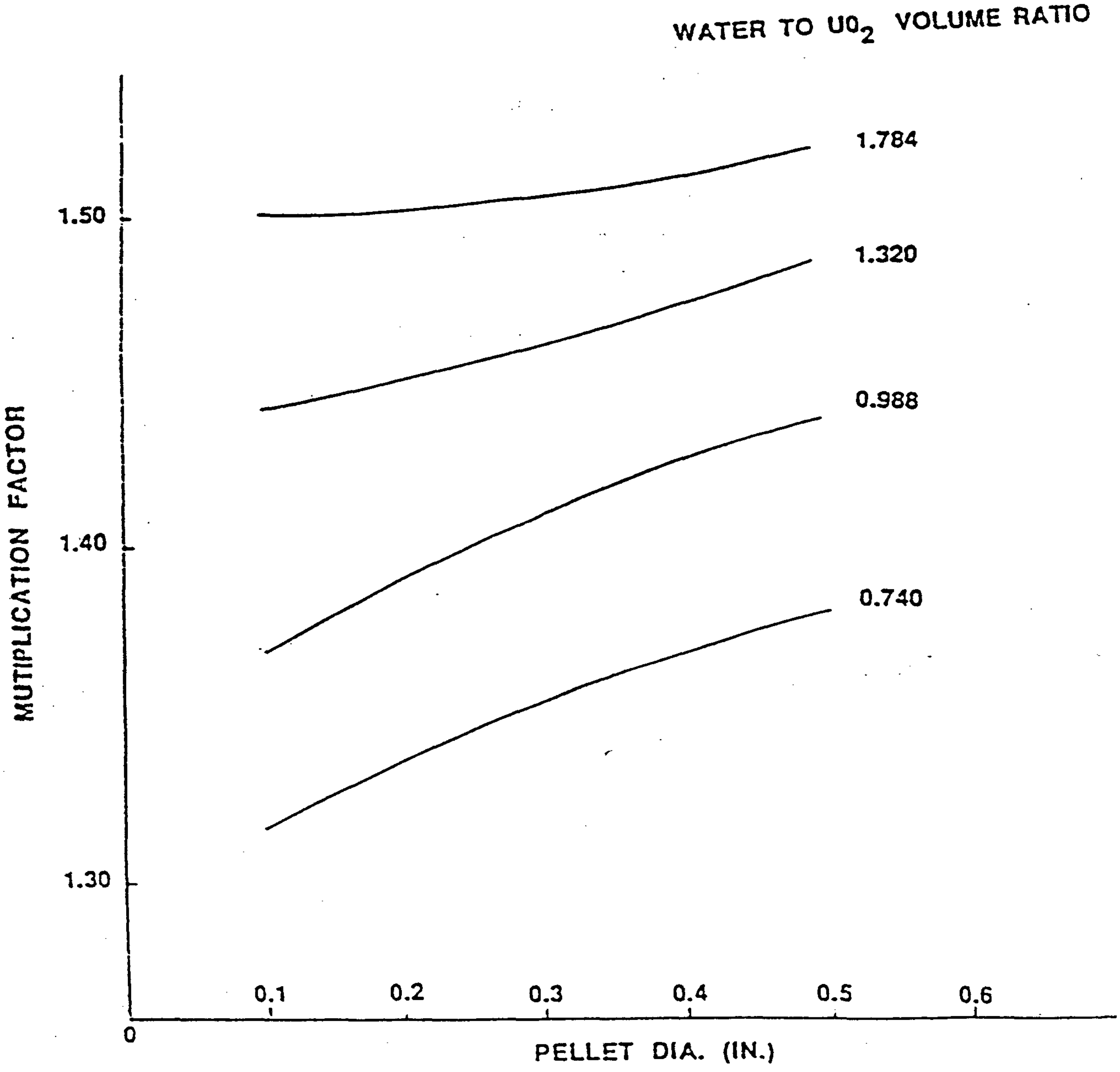
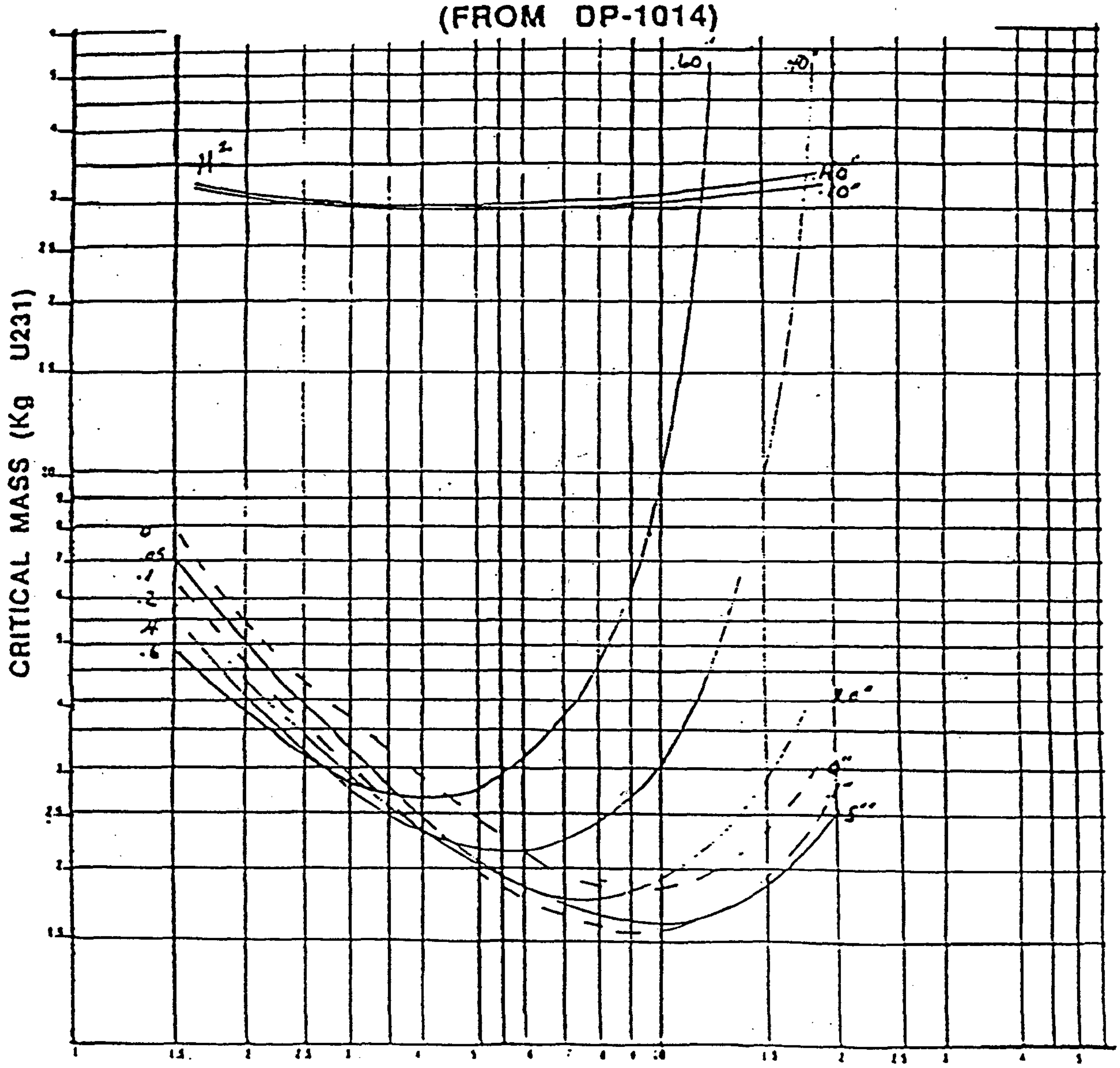


FIGURE 6.3
REFLECTED CRITICAL MASS VERSUS WATER TO UO_2 VOLUME RATIO FOR 5 w/o UO_2 PELLETS OF VARIOUS DIAMETERS
(FROM DP-1014)



7. OPERATING PROCEDURES

Loading and unloading of the package are relatively simple, straight forward operations, however, to ensure proper and safe packaging, detailed procedures are employed. New fuel pellets, reject pellets and/or hard scrap are shipped in the UNC-2901 shipping container. The following generalized description provides a brief overview of the detailed procedures for loading and unloading the containers. Typically, fuel pellets are manufactured at the Hematite Nuclear Fuel Manufacturing facility and shipped to the Windsor Nuclear Fuel Manufacturing facility for fabrication into completed fuel assemblies. In general, the information provided below for loading and unloading pellets also applies, except for the point of origin, to reject pellets and/or hard scrap.

7.1 Procedures for Loading the Container

Pellet trays are filled with fuel pellets and transferred to the scale area where they are weighed and their weight is adjusted to be within the loading limits established by the criticality analyses (see Section 6.2).

Prior to loading pellet trays into the shipping container, the outer shell is inspected to assure that there are no holes or tears in the drum. The shipping pallet, upon which the shipping containers rest, is also inspected to assure it is in reasonable condition prior to use, i.e., bent legs, straps in place, etc. Once the shipping container and shipping pallet, are determined to be acceptable for use, pre-packaged pellet trays are loaded.

The ring clamp, outer drum lid, circular wooden top spacer, inner container cover and cover gasket are removed from the shipping container. The skid on to which the pellet trays are loaded is inspected to assure that the straps, used to secure the pellet trays, are properly locked on the back end of the skid. The skid is placed in the drum and, as each tray is loaded onto the skid, pertinent information is recorded for the record. Four layers of 4 trays each are loaded on the skid. If there are less than 16 trays for shipment, then wood spacer(s) are substituted for the missing pellet trays, as necessary.

A wood spacer is then placed on top of the trays and the straps are tightened over the top wood spacer and trays using a ratchet. The placement of any required wood block spacer(s) is verified in the package. Before reinstalling the inner container cover and cover gasket, the gasket is inspected for acceptability. After the gasket and inner container cover are installed, the cover is bolted to the inner container. The circular wood top spacer is replaced, the outer lid of the drum secured with the ring clamp and the drum is smeared and surveyed. Finally, the shipping container is appropriately labeled, a tamper-proof seal is applied, and the shipping container removed to a storage area to await shipment.

7.2 Procedures for Unloading the Container

Upon arrival the shipping containers are inspected for potential shipping or handling damage and to verify the integrity of the tamper-proof seal. If the container is found to be damaged and/or the seal has been tampered with, management is informed. If the container is undamaged and the tamper-proof seal is intact, the UNC-2901 shipping containers, on their shipping pallet, are brought into the fuel manufacturing facility in accordance with facility license requirements. The license defines the number of shipping containers which may be in the facility and how many containers may be opened at any one time.

Once located in the designated unloading area, the ring clamp, outer drum lid, and circular wooden top spacer are removed. The inner container cover, gasket, and wooden top spacer are removed and the pellet trays removed from the shipping container. Each tray of pellets is transferred to the pellet receiving scale station and inspected. After completing receipt inspection, the tray of pellets is transferred to a storage area or into the manufacturing process, as necessary.

Once the inner container has been unloaded, the packaging material is replaced and the inner container cover secured, the outer drum lid is secured with the ring clamp and an "EMPTY" sticker attached to the outside of the container. The empty shipping containers are then decontaminated, as necessary, and moved to a storage area.

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Containers will be fabricated only in accordance with approved drawings and specifications. Any changes in design which fall outside of the safety envelope specified in this application will be submitted to NRC for approval. Repair and maintenance will also be performed only in accordance with approved drawings and specifications. The shipping containers have no moving parts which require periodic maintenance. Inspections of the drum and internals are performed during loading and unloading operations as specified in the pellet tray loading and unloading procedures (see Section 7). Any unacceptable condition discovered during these inspections is noted and the container appropriately tagged for maintenance.

Enclosure II to
LD-90-052

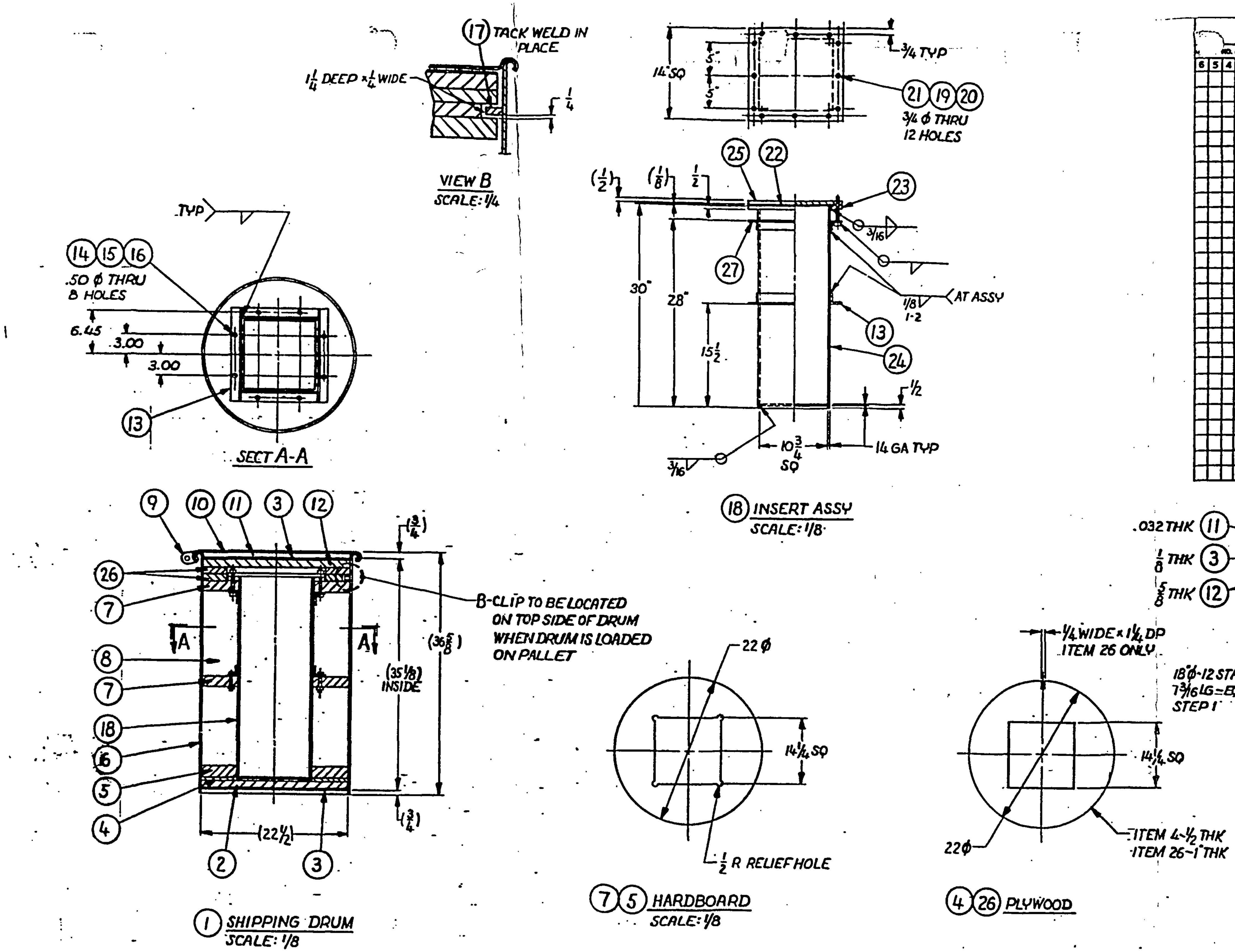
COMBUSTION ENGINEERING, INC.

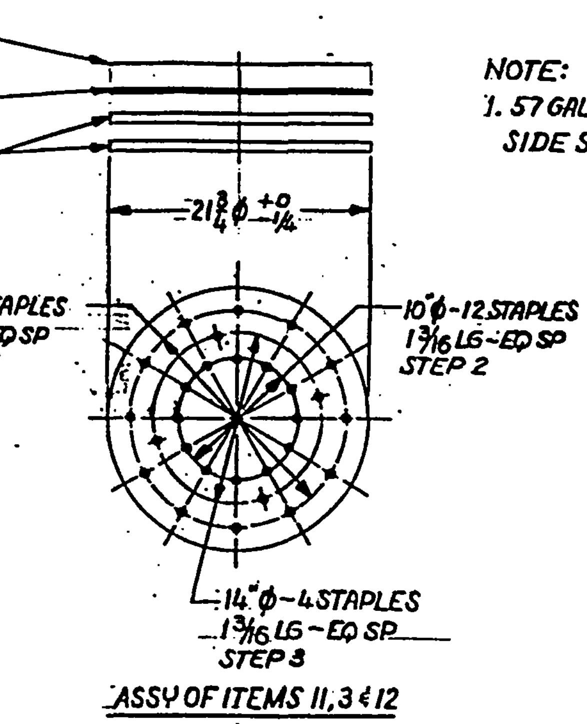
CERTIFICATE OF COMPLIANCE NO. 6294

UNC-2901 SHIPPING CONTAINER

RENEWAL APPLICATION FEE

JULY, 1990





NOTE:
1. 57 GALLON, 18 GAGE BODY & BOTTOM SIDE SEAM RESISTANCE WELDED

BILL OF MATERIALS
QUANTITIES ARE FOR

6	5	4	3	2	1	ITEM NO.	NAME	PIECE NO.	MATERIAL	REMARKS
					X	1	SHIPPING DRUM	NFM-D-4540-1		
					1	2	PLYWOOD	-2	PLYWOOD	1" THK × 22" ϕ
					2	3	CERAMIC SHEET	-3	CERAMIC PAPER	CONTRONICS CORP [illegible]
					1	4	PLYWOOD	-4	PLYWOOD	1/2 THK × 22 ϕ
					1	5	HARDBOARD	-5	BENELEX 70 OR BENELEX 402	1½ THK × 22 ϕ
					1	6	SHIPPING DRUM	-6	STL	NOTE 1
					2	7	HARDBOARD	-7	BENELEX 70 OR BENELEX 402	1½ THK × 22 ϕ
					AS REQ	8	THERMAL INSULATION	-8		OWEN CORNING PF-3350 1" THK FIBERGLASS OR [illegible]
					1	9	CLAMP RING	-9	STL	DOT 17 H/A CFR 49 PART 178.118
					1	10	DRUM LID	-10	STL	16 GAGE WITH AT LEAST ONE CORRUGATION
					1	11	COVER	-11	ALUM	.032 THK
					2	12	PLYWOOD	-12	PLYWOOD	5/8 THK × 22 ϕ
					AS REQ	13	ANGLE	-13	STL	1½ × 1½ × 1/8
					8	14	HEX HD BOLT	-14	STL	5/16-18 × 2" LG
					8	15	HEX NUT	-15	STL	5/16-18
					16	16	WASHER	-16	STL	5/16
					1	17	CLIP	-17	C.S.	1/8 × 1/2 × 1"
				X	1	18	INSERT ASSY	-18		
				12		19	HEX HD BOLT	-19	STL	1/2-13 × 3½ LG
				12		20	HEX NUT	-20	STL	1/2-13
				12		21	WASHER	-21	STL	1/2
				1		22	GASKET	-22		BUSHAK #400 NON ASBESTOS
				1		23	FLANGE	-23	STL	1/2 × 14 × 14
				AS REQ		24	INSERT	-24	STL	14 GA
				7		25	COVER	-25	STL	1/2 × 14 × 14
					2	26	PLYWOOD	-26	PLYWOOD	1" THK × 22 ϕ
					AS REQ	27	ANGLE	-27	STL	1½ × 1½ × 1/8

NFM-D-4540 | 01

AMENDMENT DATE:
JULY 27, 1990.
REV. 0
PAGE 1-7

REV.	DESCRIPTION	BY & DATE	CHK. & DATE	ENG. APPD	FINAL APPD
01	1- ITEM 1 SHIPPING DRUM INSIDE DIM WAS (34) & OVERALL (35½) 2- REVISED REMARKS OF ITEMS 6 & 10 [3- DELETED "12 GA" FROM NAME OF ITEM 10] PER REV REQ 90-485	[signature] 7-17-90	—	[signature]	—

UNLESS OTHERWISE SPECIFIED			
DIMENSIONING & TOLERANCING PER ANSI Y14.5 1973			
DIMENSIONS APPLY AT 68°F (20°C)			
DO NOT SCALE DRAWING			
DIMENSIONS	UNDER 6	6 - 18	OVER 18
DECIMAL	± .005	± .005	± .010
FRACTION	± 1/64	± 1/32	± 1/16
BREAK CORNERS 1/64 APPROX. R OR CHAM — FILLETS 1/64 TO 1/32 R			
FINISH 1/ AA125 MICRO IN.			
ANGLES ± 0° - 30'	CHAM ± 5°		

POWER SYSTEMS
COMBUSTION ENGINEERING, INC
NUCLEAR POWER SYSTEMS

CUSTOMER: NUCLEAR FUELS MANUFACTURING WINDSOR

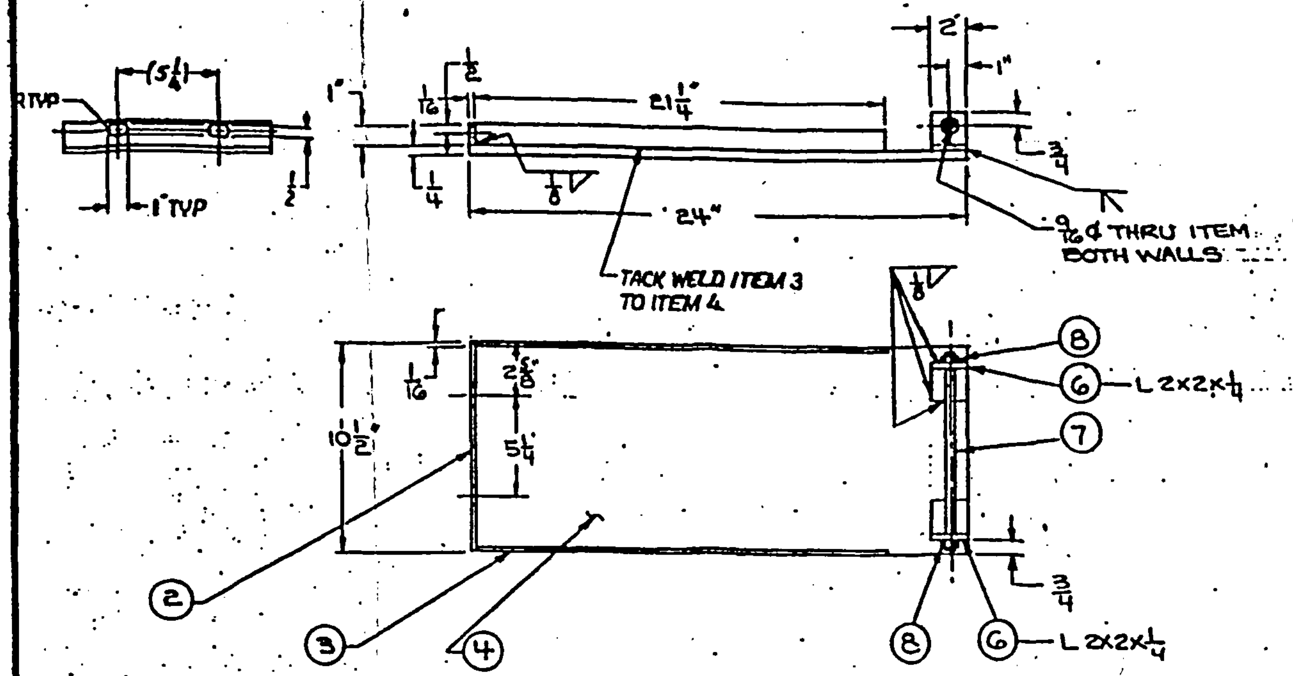
NEXT ASSY: | SUPERSEDES:
JOB NO. 776219 | COMPONENT CODE | SCALE NOTED

DRAWN BY MASLOSKI 8-30-88
CHECKER
APPROVALS [signature] 10-11-88
[signature] 7-17-90

TITLE: UNC 2901 SHIPPING DRUM

DWG. NO. NFM-D-4540 | REV. 01
SHEET OF

E
A



① PELLET TRAY HOLDER
SCALE: 1/4

BILL OF MATERIALS
QUANTITIES ARE FOR

GROUP NO. & QUANTITY 6	5	4	3	2	1	ITEM NO.	NAME	PIECE NO.	MATERIAL	REMARKS
					X	1	PELLET TRAY HOLDER	NFM-D-4263-1	6061	ALUM.
					1	2	END RAIL	NFM-D-4263-2	6061	ALUM.
					2	3	SIDE RAIL	NFM-D-4263-3	6061	ALUM.
					1	4	BASE	NFM-D-4263-4	6061	ALUM.
						5				
					2	6	ANGLE	NFM-D-4263-6	6061 ALUM	L2x2x1/4x2LG
					1	7	THREADED ROD	NFM-D-4263-7	C.S	1/2-13UNC-2A x 10 LG
					2	8	HEX HD NUT	NFM-D-4263-8	C.S	1/2-13UNC-2B

NFM-D-4263
02

AMENDMENT DATE:
JULY 27, 1990
REV. 0
PAGE 1-6

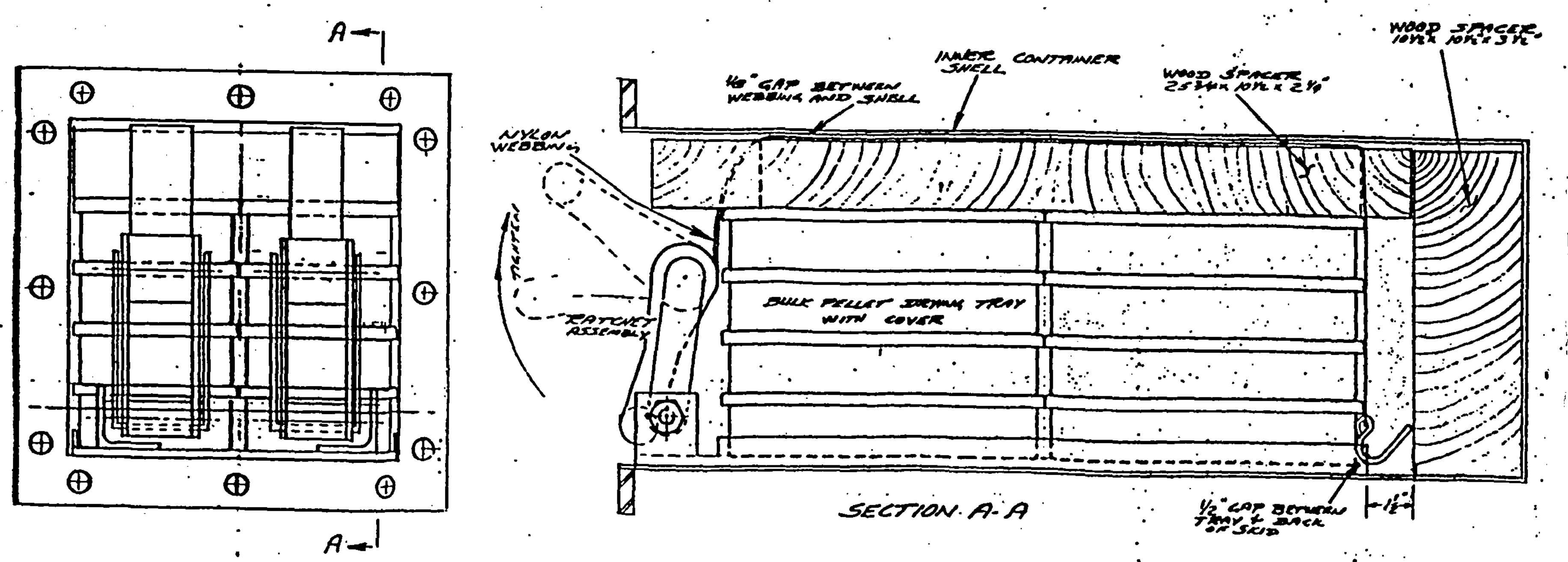
REV.	DESCRIPTION
01	1-BM FACE OF DWG DELETED ITEM 5 & ADDED ITEMS 6,7 & 8 & RELATED DIMS PER RBD REQ # 87-450
02	1-CHGD 1/2 ∅ HOLE TO 1/2 W x 1 LG SLOTS [2-WELDS WERE 1/16] 3-ADDED TACK WELD NOTE PER REV REQ 88-799

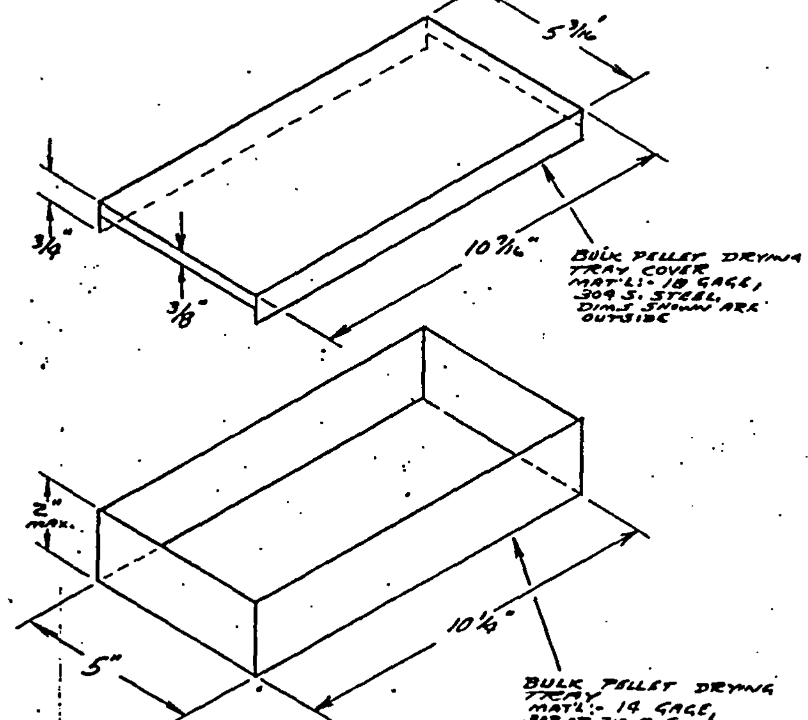
UNLESS OTHERWISE SPECIFIED
DIMENSIONING & TOLERANCING PER ANSI Y14.5 1973
DIMENSIONS APPLY AT 68°F (20°C)
DO NOT SCALE DRAWING

DIMENSIONS	UNDER 6	6-18	OVER 18
DECIMAL	±.005	±.005	±.010
FRACTION	±1/64	±1/32	±1/16

BREAK CORNERS 1/64 APPROX. R OR CHAM — FILLETS 1/64 TO 1/32 R
FINISH (√) AA125 MICRO IN.
ANGLES ± 0° - 30' CHAM ± 5°

CE POWER SYSTEMS
COMBUSTION ENGINEERING INC
NUCLEAR POWER SYSTEMS
CUSTOMER
NEXT ASSY
SUPERSEDES
JOB NO. 776219
COMPONENT CODE
SCALE 1/4
DRAWN BY
CHECKER
APPROVALS
TITLE PELLET TRAY HOLDER
DWG NO. NFM-D-4263 REV. 02
SHEET 1 OF 1





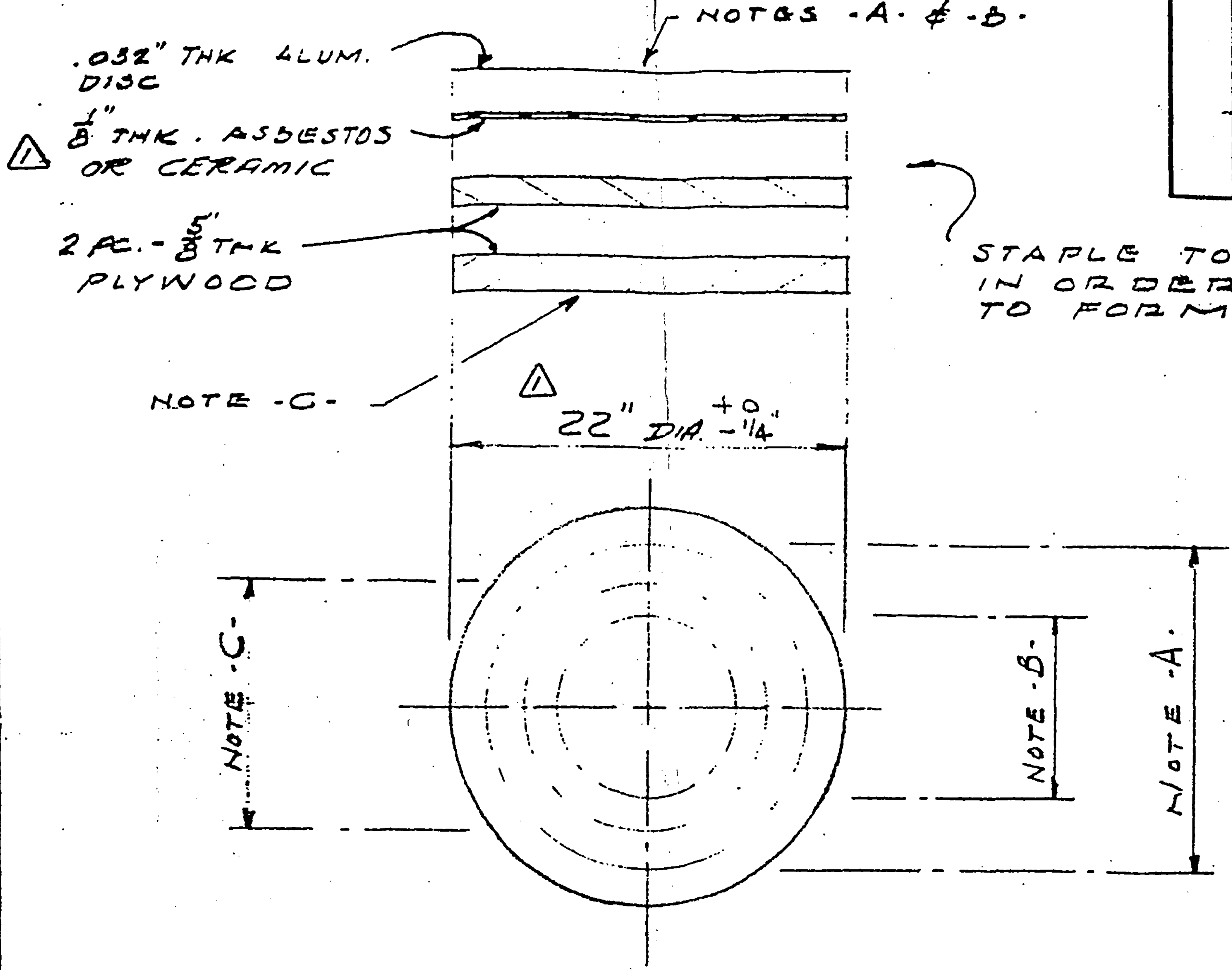
AMENDMENT DATE:
JULY 27, 1990.
REV. 0
PAGE 1-5

REV.	BY	DATE	APP'D	DATE	DESCRIPTION
1	RR	3/4/4			TRAY AND LID ADDED

DRAWN BY R L REED	1-19-90.	COMBUSTION ENGINEERING
CHECKER		
APPROVALS: R W Goldsmith	2-13-90	NUCLEAR POWER SYSTEMS
SCALE: 1/8" = 1"	DO NOT SCALE DWG	
TOLERANCES UNLESS OTHERWISE SPECIFIED: FRACTIONAL ±, DECIMAL ±, ANGULAR ±	PELLET SHIPPING PACKAGE 16 TRAYS (PELLETS) IN 2901	
SUPERSEDES:	DRAWING NO D-5018-2001	REV 1
SUPERSEDED BY		
COMPONENT CODE NO	SHEET 1 OF 1	

MATERIAL FOR COMPLETE ASSEMBLY

ITEM NO.	PART DESCRIPTION	NO. REQ'D	SOURCE



NOTE A.. USING A 18" CIRCLE, PLACE ON 4" CTRS. 13/16" LG. STAPLES.

NOTE B.. USING A 10" CIRCLE, PLACE ON 3" CTRS. 13/16" LG. STAPLES.

NOTE C.. USING A 14" CIRCLE PLACE 4 @ 90° - 13/16" LG. STAPLES.

AMENDMENT DATE:
JULY 27, 1990.
REV. 0
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REV.	BY	DATE	APP'D.	DATE	JOB NO.	DESCRIPTION	W.O. NO.
1	RR	10/13/87				1/8" TK. ASB. OR CERAMK. WAS ASBESTOS - DIA'S WERE 21 3/4	

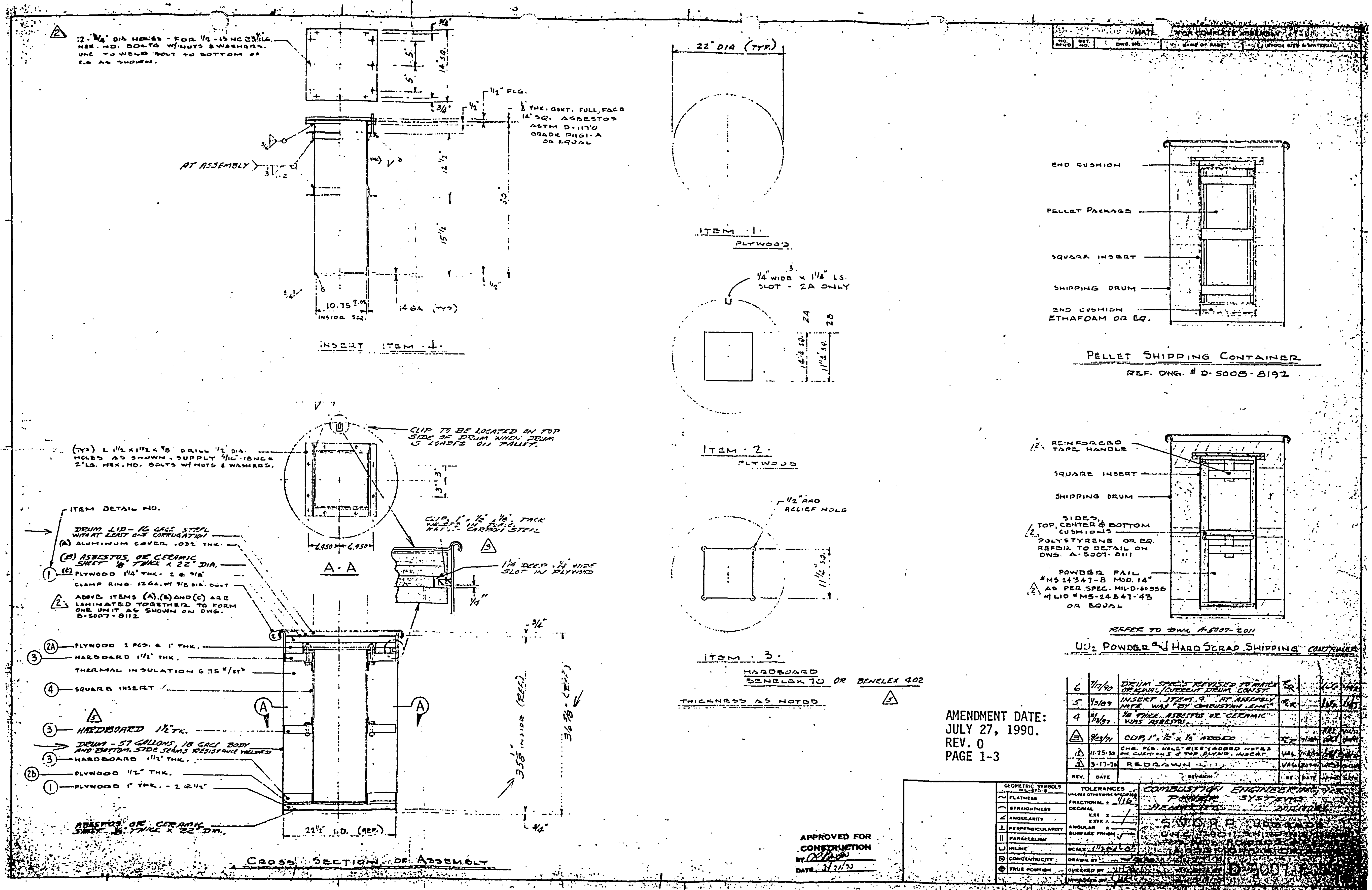
TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONAL ± 1/8
DECIMAL ±
ANGULAR ±
FINISH SYMBOL ASA ST'D

COMBUSTION ENGINEERING, INC.
POWER SYSTEMS
HEMATITE MISSOURI

SUGGESTED ASSEMBLY OF 2901 PLYWOOD INSERT

SCALE 1 1/2" = 1'-0" DWN. BY VAL APP'D. [illegible]
DATE 11-24-70 CHK'D BY RAA APP'D.

B-5007-8112 REV. 1



AMENDMENT DATE:
JULY 27, 1990.
REV. 0
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