SAFETY ANALYSIS REPORT

for

THE MODEL BMI-1 SHIPPING CASK

Revision I

February 28, 1995

from

Isotope Production and Distribution Division NE-46
U. S. Department of Energy
19901 Germantown Road
Germantown, MD 20874

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0. PREFACE FOR REVISION I, February 28, 1995

This revised Safety Analysis Report for Packaging (SARP) for the BMI-1 cask consolidates the last complete revision of the SARP, Revision G, with additional documents submitted since Revision G in support of amendments to the Certificate of Compliance. A subsequent Revision H incorporated four minor changes, as listed in Section 0.2 as "REVISION H CHANGES to Safety Analysis Report for The Model BMI-1 Shipping Cask, November 8, 1988. The current changes to the SARP are listed in Section 0.3 as "Revision I Changes to Safety Analysis Report for The Model BMI-1 Shipping Cask, February 28, 1995.

0.1 Revision History since 1985

On February 29, 1988, the Certificate of Compliance was amended (Rev. 14) at the request of Cintichem to include an increase in the U-235 enrichment for BRR/MTR fuel. No supporting analysis was included in the Cintichem request.

On November 8, 1988, the Certificate of Compliance was amended (Rev. 15) at the request of Cintichem to permit an alternate spacer for the TRIGA basket. In addition, a requirement was added that a drain hole be present when the fuel is shipped wet. This modification permits the shipment of up to three instrumented fuel rods, fuel followed control rods, or normal fuel rods in addition to the 35 normal length TRIGA rods.

Simultaneous with the issue of Rev. 15 of the Certificate of Compliance, Revision H of the SARP was issued, involving changes to only 4 pages. These are listed in the accompanying sheet titled "REVISION H CHANGES to Safety Analysis Report for The Model BMI-1 Shipping Cask, November 8, 1988.

On May 17, 1990, the Certificate of Compliance was amended (Rev. 16), adding the provision that the procedures of Chapters 7 and 8 be followed.

On September 27, 1990, the Certificate of Compliance was amended (Rev. 17) at the request of the University of Missouri, Columbia, to include Missouri University Research Reactor (MURR) fuel in a new basket design.

On January 15, 1993 the Certificate of Compliance was amended (Revs. 18 and 19) at the request of the Massachusetts Institute of Technology (MIT) to include MIT Reactor (MITR) fuel in the MURR basket. Revision 19 was issued immediately after Revision 18 to correct a typographical error in Revision 18. This revision also changed the name of the Certificate holder from Cintichem to the Department of Energy.

On November 17, 1993, the Certificate of Compliance was amended (Rev. 20) to require that the fuel remain correctly positioned with respect to the poisoned section of the cask and to generalize permission to use removable spacers to achieve this end. This amendment served to highlight the importance of criticality control in the use of the cask.

On May 24, 1994, the Certificate of Compliance was amended (Rev. 21) at the request of the U. S. Department of Energy, to include HFBR fuel in form of MTR fuel assemblies.

In keeping with the scheme described in the preface for Revision A, dated March 28, 1980, portions of the documents which support the above changes to the Certificate of Compliance have been incorporated into the SARP. The means of incorporation of these documents into the SARP is as follows:

> These documents are listed in Table 0.2, Index of Documents Newly Incorporated into the BMI-1 SARP as of Revision I, beginning with document 18, to avoid confusion with the documents listed in Table 0.1. The appropriate document number appears at the upper right corner of each page that contains data from any of these new documents. Where new data or information is included or changes to the previously submitted data have been made, the bottom of the page bears the identification "REV. I, February 28, 1995" and the changed lines are identified by a solid vertical bar in the margin. If the entire page is new or has been changed, the vertical bar is omitted.

REVISION H CHANGES

to

Safety Analysis Report

for

The Model BMI-1 Shipping Cask

November 8, 1988

PAGE NUMBERS	NATURE OF CHANGE
1.8	"Canister" replaced with "Basket"
2.77	"Canister" replaced with "Basket"
2.78	Reference to "No Plugs" removed
2.79	"Canister" replaced with "Basket"

REVISION I CHANGES
to the
Safety Analysis Report for Packaging
for the Model BMI-1 Shipping Cask

February 28, 1995

PAGE NUMBER	NATURE OF CHANGE
i - xvii	Numbered pages in Table of Contents, removed references to deleted items, added references to new items.
0.1,2	Added Preface for Revision I.
0.3	Added Revision H changes.
0.4-8	Added Revision I changes.
0.9-13	Renumbered pages from Rev. A
0.14	Added Table 0.2, "Index of Documents Newly Incorporated into the BMI-1 Sarp as of Revision I."
1.6	Deleted Section 1.2.1.2 (c), "Enrico Fermi Copper Basket."
1.8	Deleted Section 1.2.1.2.(f), "S8DR Fuel Basket."
1.15-17	Deleted Section 1.2.3.2 (b), "Enrico Fermi Fuel Elements."
1.19	Added reference to thermocoupled and fuel followed TRIGA fuel elements. Deleted Section 1.2.3.2.(d), "S8DR Fuel Elements."

REVISION I CHANGES
(continued)

1.20	Deleted Section 1.2.3.2 (e), "CP-5 Fuel Elements."
1.23	Added Section 1.2.3.2.k, referring to MURR fuel assemblies. Added Section 1.2.3.2.l, referring to MITR fuel assemblies.
1.24	Added Section 1.2.3.2.m, referring to Brookhaven HFBR fuel assemblies. Appendix relocated.
1.25-1.31	Pages renumbered.
1.32	Fermi Drawing deleted, GA drawing added.
1.33	Cintichem drawing added.
1.34-1.37	Pages renumbered.
1.38	S8DR Drawing deleted
1.38	Page renumbered
1.39-1.43	MURR drawings added.
1.44-1.47	HFBR drawings added.
2.78	Added Section 2.10.2.3 referring to alternate spacer for TRIGA fuel, renumbered §2.10.2.3 and 2.10.2.4.
2.79A	Added Figure 2.10A.
2.96	Deleted Section 2.11.1.

REVISION I CHANGES
(continued)

2.122	Added Section 2.11.3 referring to MURR fuel assemblies Added Section 2.11.4 referring to MITR fuel assemblies Added Section 2.11.5 referring to HFBR fuel assemblies
2.200-2.202	Added Section 2.12.6 "Structural Evaluation of BMI-1 Cask with Eight MURR Spent Fuel Elements"
2.203	Added Section 2.12.7 "Analysis of MITR Fuel Assemblies in BMI-1 Cask"
2.204-2.210	Added Section 2.12.8 "Stress Analysis - HFBR Baskets"
3.2	Deleted Section 3.1.2 (b), "Fermi Fuel."
3.4, 3.4A	Added discussion of thermal analysis of MURR, MITR and HFBR fuel assemblies.
3.15-18	Deleted Section 3.4.2.2, "Fermi Fuel."
3.37	Final Paragraph, deleted reference to Fermi Fuel
3.50,51	Deleted Section 3.5.4.2 (b), "Fermi Fuel, Loss of Coolant."
3.58-66	Deleted Section 3.6.2, "Experimental Tests of Copper Shot."
3.58-3.64	Added 3.6.3, "Thermal Evaluation - BMI-1 Cask with Eight MURR Fuel Elements."
3.65-3.67	Added 3.6.4, "Thermal Evaluation - BMI-1 Cask with Eight MITR Fuel Elements."
3.68-69	Added 3.6.5, "Decay Heat Analysis of HFBR Fuel."

REVISION I CHANGES
(continued)

5.11	Deleted Section 5.4.1.2 (B), "Fermi Fuel."
5.12	Added Section 5.4.1.2.E, "MURR Fuel Assemblies." Added Section 5.4.1.2.F, "MITR Fuel Assemblies." Added Section 5.4.1.2.G, "HFBR Fuel Assemblies."
5.16-5.17	Added 5.5.2, "Shielding Evaluation - BMI-1 Cask with Eight MURR Fuel Elements."
5.18-5.25	Added 5.5.3, "Shielding Evaluation - BMI-1 Cask with Eight MITR Fuel Elements."
5.26	Added 5.5.4, "Shielding Evaluation of Model BMI-1 Package with HFBR Fuel."
6.3, 6.3A	Added "• MURR Fuel Assemblies" "• MITR Fuel Assemblies" "• HFBR Fuel Assemblies" Deleted "• Fermi Fuel Elements"
6.4	Corrected reference to Appendix.
6.22	Deleted Section 6.5, "Criticality Evaluation for Fermi Fuel Elements."
6.39, 40	Added 6.9, <u>Criticality Evaluation for MURR Fuel Assemblies</u> Added 6.10 <u>Criticality Evaluation for MITR Fuel Assemblies</u> Added 6.11 <u>Criticality Evaluation for HFBR Fuel Assemblies</u>
6.41	Relocated and renumbered Section 6.12, <u>Appendix</u>.

REVISION I CHANGES
(continued)

6.42-6.52	Added 6.12.2 "MURR Criticality Analysis for BMI-1 Shipping Container"
6.53	Added 6.12.3 "MITR Criticality Studies of BMI-1 Shipping Container"
7.1-7.26	Procedures Chapter rewritten.
8.1	New References added, Title of ANSI-N-14.5 changed.
8.2	Reference changed in 8.2.2.3 (a) 8.2.2.3 (b) rewritten to specifically cite BMI-1 SARP.
8.3	Reference changed in 8.2.2.4 (b)
8.6	References changed in 8.3.2.1 (k) and (m)
8.8	References changed in 8.2.4.3 and 8.2.4.4
8.10	Reference changed in 8.2.6.3
8.11	Reference changed in 8.2.7, and requirement to send records to holder of DOE CoC added.

0. PREFACE FOR REVISION A, 3-28-80

0.1 Document Index

This revised Safety Analysis Report for Packaging (SARP) for the BMI-1 cask contains a compilation of 17 documents including the original license application of 1963, 15 subsequent revisions amendments, or communications, and the certificate of compliance. In this revised SARP, the 17 documents have been reorganized into the standard format suggested in Regulatory Guide 7.9.1.* The information in those 17 documents is presented unchanged except in a few instances. In addition, some new sections prepared specifically for this revision have been included. In order to enable ready identification of the source of the data and information presented, the following identification system is used:

> The 17 documents previously submitted are listed in Table 0.1 in chronological order. Each document has been assigned a "Document" Number as shown in Table 0.1. The appropriate Document Number appears at the upper right side of each page that contains data from any of these 17 documents. Where new data or information is included or changes to the previously submitted data have been made, the bottom of the page bears the identification "REV. A, 3-28-80" and the changed lines are identified by a solid vertical bar in the right hand margin. If the entire page is new or has been changed, the vertical bar is omitted. When the only change to

*U.S. Nuclear Regulatory Guide 7.9, Standard Format and Content of Part 71 Applications for Approval of Packaging of Type B, Large Quantity, and Fissile Radioactive Material, Revision 1, January, 1980.

a page is to the section titles, in order to conform to those suggested in Regulatory Guide 7.9, the vertical bar and the identification "REV. A, 3-28-80" are omitted.

TABLE 0.1 INDEX OF DOCUMENTS PREVIOUSLY SUBMITTED

Document Number	Title of Document
1.	Safety Analysis for Battelle Research Reactor Spent Fuel Shipping Cask, dated November 14, 1963.
2.	Addendum to Structural Integrity Analysis, BMI-1 Shipping Cask, dated January 27, 1964.
3.	Safety Analysis for the Shipment of Power Reactor Development Company, Irradiated Fermi Fuel Subassemblies, dated July 19, 1965.
4.	Addendum to Safety Analysis for BRR Spent Fuel Shipping Cask BMI-1, to Show Compliance with 10CFR-71 Regulations and to List Maximum Quantities of Nuclear Materials to Be Shipped, dated September 8, 1969.
5.	Addendum II to Safety Analysis for Nuclear Material Shipping Cask BMI-1, to Show Compliance with 10CFR-71 Regulations and to List Maximum Quantities of Nuclear Material to Be Shipped, dated May 7, 1970.
6.	Addendum III to Safety Analysis for Nuclear Material Shipping Cask BMI-1, to Show Compliance with 10CFR-71 Regulations and to List Maximum Quantities of Nuclear Material to Be Shipped, dated July 15, 1970.
7.	Telegram to Transportation Branch/D.M.L. from B.C.L. correcting Addendum Number II, dated July 24, 1970.

TABLE 0.1 (Continued)

Document Number	Title of Document
8.	Addendum IV to Safety Analysis for Nuclear Shipping Cask BMI-1 to Show Compliance with 10CFR-71 Regulations for Shipment of Battelle Research Reactor Fuel Having an Increased Loading of U-235, dated September 21, 1970.
9.	Addendum V to Safety Analysis for Nuclear Shipping Cask BMI-1 to Show Compliance with 10CFR-71 Regulations for Shipment of Battelle Research Reactor Fuel Having an Increased Loading of U-235, dated January 18, 1971.
10.	Safety Analysis Report for Shipment of TRIGA Fuel by the University of Arizona, dated December 8, 1971.
11.	Safety Analysis Report for Shipment of TRIGA Fuel by the University of Arizona, Upgraded Analysis, dated December 8, 1971.
12.	Supplement Number 1 to Request for License to Transport Irradiated TRIGA Fuel in BMI-1 Shipping Cask, dated June 15, 1972.
13.	Results of Loading-to-Critical Experiment in the University of Arizona TRIGA, dated September 14, 1972.
14.	Safety Analysis Report for Shipment of MTR Fuel by Texas A&M University, dated September 29, 1972.
15.	Safety Analysis Report for Shipment of PULSTAR Fuel by The State University of New York at Buffalo, dated October 13, 1977.

TABLE 0.1 (Continued)

Document Number	Title of Document
16.	U.S. Nuclear Regulatory Commission Certificate of Compliance 5957, Revision 5, Docket Number 71-5957; Package Identification Number USA/5957B ( ) F.
17.	Safety Analysis Report for Shipment of EPRI Crack Arrest Capsules in BMI-1 Shipping Cask, dated February 8, 1980.

TABLE 0.2 INDEX OF DOCUMENTS NEWLY INCORPORATED INTO THE BMI-1 SARP AS OF REVISION I.

Document Number	Description of Document
18.	U. S. Nuclear Regulatory Commission Certificate of Compliance 5957, Revision 21, Docket Number 71-5957; Package Identification Number USA/5957B( ) F.
19.	"Alternate TRIGA Fuel Basket Spacer," Addendum to SARP, dated June 15, 1988.
20.	"Structural Evaluation BMI-1 Cask with Eight MURR Spent Fuel Elements," Addendum to structural evaluation, for MURR fuel assemblies, dated August 8, 1990.
21.	Addendum to containment analysis, for MITR-II fuel elements, dated January 11, 1993.
22.	"BNL Request for Amendment to the BMI-1 Package," Rev. 2, January 1994.
23.	Thermal Evaluation of BMI-1 Cask with Eight MURR Spent Fuel Elements," Addendum to thermal evaluation, for MURR fuel assemblies, dated August 8, 1990.
24.	"Thermal Evaluation of BMI-1 Cask with Eight MITR Fuel Elements," addendum to thermal analysis, for MITR-II fuel elements, dated October 19, 1992.
25.	"Shielding Evaluation BMI-1 Cask with Eight MURR Fuel Elements," second revision to addendum to shielding evaluation, for MURR fuel assemblies, dated August 8, 1990.
26.	"Shielding Evaluation of BMI-1 Cask with Eight Spent MITR Fuel Elements," addendum to shielding analysis, for MITR-II fuel elements, dated October 19, 1992.
27.	Addendum to criticality analysis, for MURR fuel assemblies, dated April 18, 1990
28.	"Criticality Studies of BMI-1 Shipping Container," addendum to criticality analysis, for MITR-II fuel elements, dated October 19, 1992.

1. GENERAL INFORMATION

1.1 Introduction

The Safety Analysis Report for Packaging (SARP) demonstrates that the Model No. BMI-1 shipping cask meets the current regulatory requirements[1] for shipment of the contents listed below in Section 1.2.3. as Fissile Classes I, II, and III. This SARP shows that an infinite number of packages can be transported per shipment with Fissile Class I contents, and up to 25 packages may be transported per shipment with Fissile Class II contents.

1.2 Package Description

1.2.1 Packaging

1.2.1.1 Description of Cask

Cask Design Drawing Number 43-6704-0001 accompanying this safety analysis report presents the configuration of the modified BMI-1 nuclear-material-shipping cask. The modified cask has a measured shipping weight of 23,660 pounds. The total envelope dimensions, including the lifting trunnions, are 59.12 inches in diameter x 78 inches high.

The basic cask body is 33.37 inches in diameter x 73.37 inches high. It consists of two concentric stainless steel shells which form an annular region which is filled with lead. The outer shell is of a laminated steel construction. The innermost layer of the two laminates is made of 0.50-inch Type 304 stainless plate. This layer is the body of the cask as first constructed. The 0.12-inch outer layer of the laminated outer shell is welded to the inner layer at the corners of the cask and at all penetrations of the shell. This added outer shell is spaced 0.06 inch from the original shell by weld spots spaced on approximate 8-inch centers.

(1) References to Section 1. found in Section 1.3.1.

The inner shell is made of 0.25-inch-thick stainless steel plate and is unchanged from the original design. With the cover in place, the internal cavity dimensions are 15.5 inches in diameter x 54 inches long. The cover fits into a recess in the cask body formed by stepping the internal cavity diameter to about 18.5 inches. This recess is about 8-inches deep and has tapering sides. The top of the cask body is made of 0.75-inch-thick steel plate welded to the inner and outer shells. Lead shielding consists of an 8.0-inch annulus on the sides with a 7.75-inch slab section in the cover and a 7.5-inch slab section in the bottom under the cavity. Lead-expansion space was provided in the former design by peripheral cones welded in both ends of the cask. In the modified design, the void space at the top end of the cask will be filled with lead.

A liquid drain line penetrates the inner cavity at about the center of the cavity bottom. The drain line terminates in the side of the shell about 5.5 inches from the bottom. A stainless steel needle valve with the discharge end closed with a pipe plug affords a closure of this drain. The closure is protected from mechanical damage by a housing made of 0.50-inch thick stainless steel welded to the 0.50-inch thick cask shell. Safety plugs (Patent Number 3,466,444*) are welded into the cask wall and cover plate as an added safety feature in case water should enter the lead cavity or in case the cask should be exposed to a fire which exceeds the prescribed test fire.

The safety plug, shown on Drawing 420040, consists of a nominal 1/4-inch stainless steel pipe plug, which screws into a stainless steel body. The body, which is 1.0-inch diameter x 0.62-inch thick, has stainless steel filter welded to the back side. The body is welded in the shell of the cask with the filter toward the lead. The 1/4-inch pipe plug has a 1/8-inch hole drilled clear through and is filled with a low melting alloy. The pipe plug screws into the body so it is flush at the outside surface.

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* Patent included in Section 1.3.3

In the event of extreme temperature, the low melting alloy melts and permits venting of gases through the filter and pipe plug. The porous stainless steel disc readily passes gases, including steam, but it is substantially impermeable to liquid lead, thus retaining the shielding material, should it become molten.

Four lugs are welded to the top plate of the cask as a means of tying the cask to the vehicle. The thickness of these lugs has been increased to 1.5-inch, to comply with the 10G, 5G, and 2G combined load prescribed in the regulations.

Twelve 1.0-inch-diameter stainless steel studs are welded into the top plate of the cask on a 23.37-inch-diameter bolt circle to secure the cover. Two alignment pins are provided in the same bolt circle to protect the threads on the studs. A tapered surface is machined on the circular edge at the joint between the inner cavity shell and the top plate of the cask. This surface is the seat for the O-ring used to provide a seal for the cask cavity.

The cover of the cask is nominally 26.5 inches in diameter x 9.75 inches thick. The sides are tapered to fit the recess in the cask body. The sides of the cover are 0.25 inch thick and the bottom is 0.75 inch thick. The top plate of the cover is laminated. The inner layer is 1.0-inch-thick stainless steel and the outer layer is 0.12-inch-thick stainless steel. The outer layer is cut out and seal welded at all penetrations and around the outer periphery. The cover-lift device is made of two 0.25-inch-thick Type 304 stainless steel plates. An alternate cover lifting device consists of a U-bolt welded to the top of the cover. The chemical lead-filled section between the top and bottom plates of the cover is 7.75 inches thick providing 0.25 inch of space between the top cover plate and the lead. The cover is fitted with a thermocouple/thermometer well for monitoring internal cavity temperatures.

Lifting trunnions 3.5 inches in diameter are mounted on the sides of this cask and are positioned above the shell of the cask. In this position, it is not possible for the trunnions to act as rods to penetrate the shell in an accident. The trunnions have outboard supports to fit unloading equipment at ICPP.

The cask is mounted on a mild steel beam-type skid measuring 6 ft x 8 ft. This skid serves to spread the weight of the cask on the floor and to add stability in shipment. Four tie rods 1.5 inches in diameter with adjustable turnbuckles are attached to the cask at a height of 38 inches from the skid and extend to the corners of the skid. In addition, eight 1-inch-diameter A325 steel bolts are used to anchor the cask to the skid. Bumper blocks are also used to prevent shearing of the bolts between the cask and skid. A 0.75-inch-thick stainless steel plate is positioned between the cask proper and the skid. This plate is attached to the skid by the same bolt-block system as the cask base plate. The plate is used to comply with the unloading facility at the ICPP. This plate also provides greater resistance to heat flow through the cask bottom from the fire test than does the laminated construction used on the side wall of the cask.

The BMI-1 cask is designed to be used either for dry or water-filled shipments. A pressure gauge, pressure-relief valve, and filter are provided at the top of the cask. These items are protected by a housing of 0.50-inch-thick stainless steel similar to that which protects the drain valve.

Some of the basic information pertaining to the cask is summarized in the following information.

(a) Total maximum weight, 23,660 pounds
(b) Outside diameter, 33.37 inches
(c) Inside cavity diameter, 15.5 inches
(d) Outside shell thickness, 0.50 inch
(e) Inside shell thickness, 0.250 inch
(f) Over-all length, 73.37 inches
(g) Operating pressure, 50 psig
(h) Design pressure, 100 psig

(i) Maximum operating temperature (inside cavity), 320 F
(j) Lid weight, 1,100 pounds
(k) Contents weight, 1,110 pounds
(l) Skid weight, 1,700 pounds

1.2.1.2 Description of Product Containers and Baskets

(a) BMI-1 Canister. The containment canister to be used inside the BMI-1 cask cavity as shown on Drawing 00-000-421 Rev. C., is constructed of 304 type stainless steel. The wall of the can is 0.125 inch thick, and the ends are 0.50 inch thick. Ten 0.213-inch socket head cap screws secure the cover to the can. A silastic rubber O-ring located in a groove in this cover provide the seal. The canister is designed to fit into the cask cavity with 0.25-inch clearance on the diameter and 0.50-inch clearance on the length.

(b) BMI-1 Basket. Fuel assemblies are positioned within the central cavity by two stainless steel baskets, with one basket supported on top of the other, BMI Drawing Numbers BCL-000-500, Rev. A and -501. The basic basket structure, Drawing BCL-000-500, Rev. A consists of twelve cells, each 3.31 inch square x 25.12 inches long. A solid cruciform divides the basket into four quadrants of three cells each. The cruciform consists of boral, a permanent neutron poison, which is clad with stainless steel for structural strength and corrosion protection. The walls between the three cells within each quadrant as well as the outside basket walls are open at the center over about 21 inches of length. These open regions facilitate free convection heat transfer from the fuel elements to the cask inner wall.

A removable bottom, Drawing BCL-000-501 bolts to the bottom of the basic basket structure. The bottom consists of a grid of

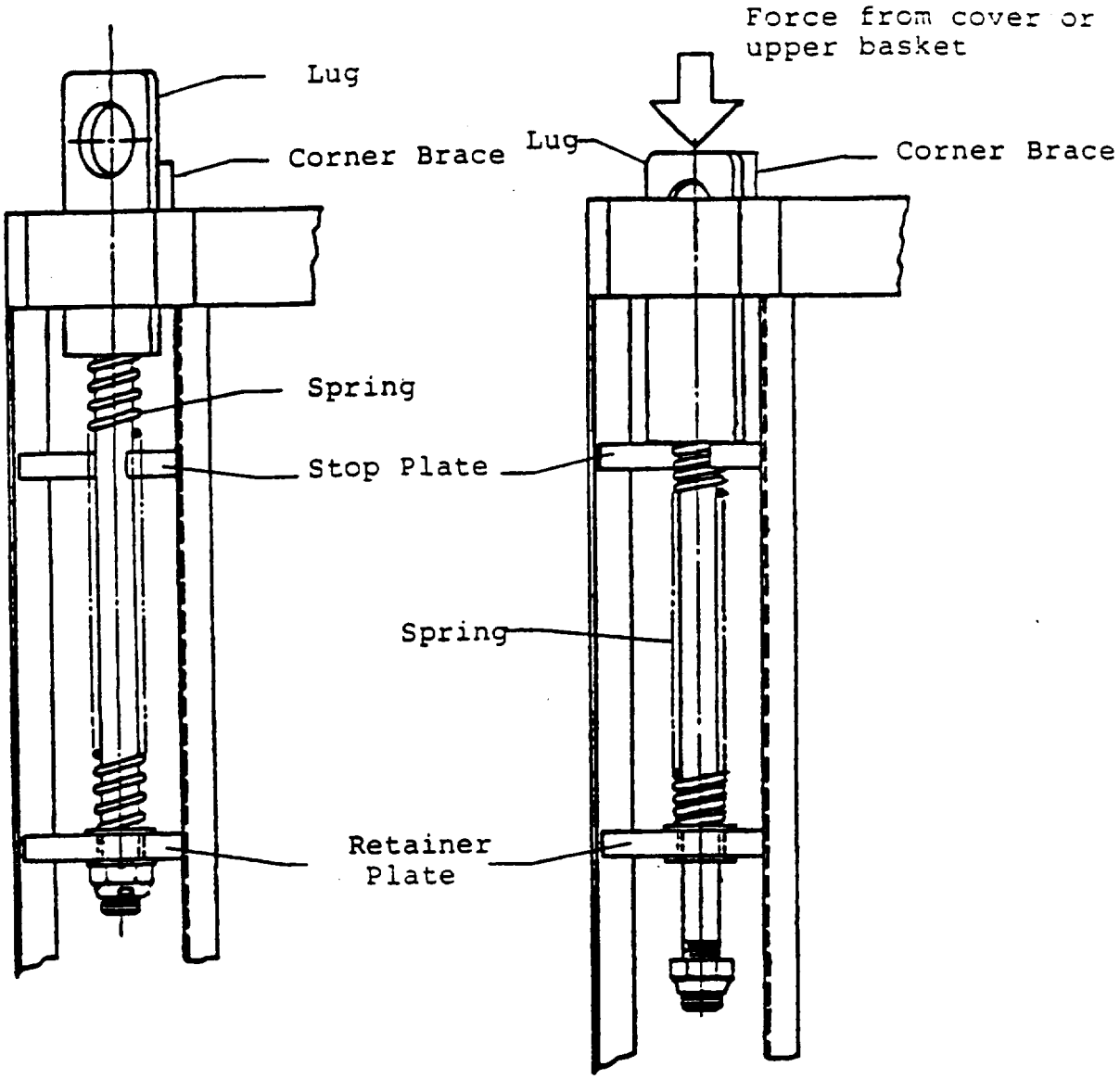
six parallel stainless steel bars, 7/16 inch square, welded to an outer 7/16-inch thick ring. Four lugs on the periphery are used to attach the removable bottom to the basket.

Two lifting lugs are located on opposite sides at the top of the basket. The lugs are designed to recess axially into the basket during transport. When the shipping cask cover (or the upper basket) is removed, the lifting lugs emerge from the top of the basket under the force of the lug spring, see sketch on Page 1.7 . One end of the spring bears on the retaining plate while the other end of the spring bears on the lower edge of the lifting eye. The spring only serves to raise the lug so that a lifting sling may easily be attached to the lug. The spring force is only slightly more than the weight of the lifting lug, thus, the lug may easily be forced down as the cask cover is installed. No structural functions are performed by either the lug or the spring.

Two corner braces extend 1.0 inch above the top of the basket. These braces extend about 0.5 inch above the fuel elements (which protrude about 0.5 inch above the basket top). The braces support the basket in the inverted position and prevent the basket from resting on the fuel elements.

(c) Enrico Fermi Copper Basket

(Paragraph deleted)



Lug in Extended Position

Lug in Retracted Position

Document 11,16,15

(d) University of Arizona Basket for TRIGA fuel

Two special baskets have been designed (BMI Dwg. 1020, Rev. B and GA Dwg. 9590001, Rev. A) to individually support up to either 24 or 38 TRIGA fuel elements in the BMI-1 cask. The TRIGA fuel will be shipped dry in these baskets. Each basket is made of stainless steel. Any fuel element with failed cladding will be placed in a seal welded Al or SS container with at least 0.015" thick wall and end fittings.

(e) Texas A&M Basket

Basket assembly defined by BMI Drawing Number BCL-000-500, as modified by BMI Drawing Number 00-000-236, Rev. C.

(f) S8DR Fuel Basket

(Paragraph deleted)

(Paragraph deleted)

(g) Union Carbide Process Uranium Oxide Container

Union Carbide uranium oxide waste form process shipping container as shown on Union Carbide Corporation Drawing No. 101501, Rev. A.

(h) Union Carbide Target U^{235} Special Form Capsule

Union Carbide target material special form capsules having nominal outside dimensions of 1.25 inches OD x 18 inches long, and made of AISI 300 Series stainless steels.

1.2.2 Operational Features

Operation of the BMI-1 is discussed in Section 1.2.1. That Section and the referenced drawings clearly explain operation of the cask and show all valves, openings, seals, etc.

1.2.3 Contents of Packaging

1.2.3.1 Description of Cask Contents

In accordance with the requirements of § 71.22(b) of 10-CFR-71-Subpart B, the materials planned for shipment in the BMI-1 cask are described as follows.

(1) Radioactive Constituents - Identification and Maximum Radioactivity

(a) Shipments by Any Transport Vehicle (Except Aircraft) Assigned for Sole Use. The radioactive contents of the cask may include any radionuclide(s) classified according to the transport grouping in Appendix C of 10-CFR-71. Quantities (in curies) of the respective radionuclides may be equal to or less than any of the following group limits:

Transport Group*	Quantity (in curies)
I	1,000
II	8,120
General Mixed fission products	Unlimited**
III	4,960
IV	11,070
V	8,120
VI and VII	800,000

* As defined in § 173.390 of 49 CFR and Appendix C of 10-CFR-71.

** Limit will be imposed by dose-rate limits specified in § 173.393 (i) of 49 CFR.

Also, 40,000 curies of Co-60, as licensed in Amendment 71-3, License Number SNM-7, Docket Number 70-8, July 17, 1969, or equivalent sources of nonfissile isotopes having gamma or Bremsstrahlung emission energies less than 1.33 Mev may be shipped in the modified BMI-1 cask with the copper basket or other additional internal shielding.

(b) Shipments by Commercial, Contract, Governmental, and Private Carriers. The radioactive contents of the cask may include any radionuclide(s) classified according to the transport grouping in Appendix C of 10-CFR-71. Quantities (in curies) of the respective radionuclides may be equal to or less than any one of the following group limits:

Transport Group*	Quantity (in curies)
I	1,000
II	2,520
General mixed fission products	Unlimited**
III	1,540
IV	3,440
V	5,000
IV and VII	800,000

(2) Identification and Maximum Quantities of Fissile Constituents

(a) Without Leakproof Inner Container. Fissile constituents planned for shipment in the cask without the leakproof inner container along with respective quantities are as follows:

U-233 . . . . . 280 grams
Pu-239. . . . . 280 grams
U-235 . . . . . 500 grams

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* As defined in § 173.390 of 49 CFR and Appendix C of 10-CFR-71.

** Limit will be imposed by dose-rate limits specified in § 173.393 (i) of 49 CFR.

(b) With Leakproof Inner Container. Fissile constituents planned for shipment in the cask with the leakproof inner container along with respective quantities are as follows:

U-233 . . . . . 480 grams
Pu-239. . . . . 480 grams
U-235 . . . . . 8450 grams

(3) Chemical and Physical Form

Radioactive and fissile radioactive materials of the following chemical and physical forms may be shipped in the BMI-1 cask:

(a) Special form, as defined in § 71.4(0)of 10-CFR-Part 71.

(b) Normal form, providing that the materials are solid and are securely confined in the leakproof inner containers, Drawing 00-000-421, Rev. C., or Drawing No. 101501, Rev. O., during all normal and accident conditions.

(c) Normal form providing that all materials are packaged and securely confined in the cask cavity. Normal form shall be defined as solid material nonpowder that must remain solid up to 500 F. Only special form materials may be shipped in the cask with water coolant.

(4) Extent of Reflection, Neutron Absorbers, and H/X Atomic Ratios

(a) Without Inner Container. Reflection, absorption, and atomic characteristics of the package contents without the inner container are summarized as follows:

Extent of reflection . . . . . Maximum reflection

Nonfissile neutron absorbers present. . . . . None assumed (although various types would be present)

Atomic ratio of moderator to fissile constituents*:

Isotope	H/X
U-233	450
U-235	500
Pu-239	800

(b) With Inner Container. Reflection, absorption, and atomic characteristics of the package contents with the inner container are summarized as follows:

Extent of reflection . . . . . Maximum reflection

Nonfissile neutron absorbers present. . . . . Not assumed (although various types would be present)

Atomic ratio of moderator
to fissile constituents*:

Isotope	H/X
U-233	20
U-235	20
Pu-239	20

(5) Maximum Weight

The maximum weight of the package contents is 1,110 pounds.

(6) Maximum Amount of Decay Heat

A decay heat load of 1.5 kw is the maximum analyzed for the package contents.

1.2.3.2 Type and Form of Contents Material

(a) BRR/MTR Type Fuel Elements

Intact irradiated MTR or BRR fuel assemblies containing not more than 200 grams U-235 per assembly prior to irradiation. Uranium may be enriched to a maximum 93 w/o in the U-235 isotope. Active fuel length shall be approximately 25 inches.

This report presents a safeguards evaluation of the design and proposed uses of a shielded cask for transporting irradiated fuel assemblies from the Battelle Research Reactor to the Idaho Falls Chemical Processing Plant. The shipment of irradiated fuel is to be made by truck-trailer according to regular commercial conditions and regulations.

---

* Most reactive H/A (Reference 2).

Document 14

The Texas A&M University requests a special permit to make shipments of MTR reactor fuel in the BMI-1 shipping cask (Number SP5957). This request involves the shipment of 23 partially irradiated and 13 unirradiated elements from the Texas A&M Nuclear Science Center to the University of Virginia.

The BMI-1 fuel basket has been modified according to Battelle Memorial Institute Drawing Number 00-000-236, Rev. B, (attached) to individually support 10 MTR fuel elements in the BMI-1 cask.

(b) Enrico Fermi Fuel Elements

(Paragraphs deleted up to Section 1.2.3.2 (c)., page 1.17.)

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Document 11, 16

(c) TRIGA Fuel Elements

Irradiated TRIGA fuel assemblies containing not more than 55 grams U-235 unpoisoned or 135 grams U-235 with poison per assembly prior to irradiation. Uranium may be enriched to a maximum of 93.2% in the U-235 isotope. Active unirradiated fuel length shall be nominally 15 inches or less.

TABLE 1.1 COMPARISON OF REQUESTED SHIPMENT OF TRIGA FUEL TO PRESENT LICENSE

Item	Conditions of Present Request	Conditions of Present License SNM-7(a)
Contents	38 Irradiated TRIGA fuel assemblies Al or SS clad	Various fuels and radiation sources
Maximum decay heat generation per package	112.5 Watts	1,500 Watts maximum
Maximum external dose rate	0.6 mr/hr maximum at 3 ft from the cask external surface	10 mr/hr at 3 ft from external surface of the cask
Criticality	Subcritical (Not to exceed 0.90 k_{eff})[b]	All packages subcritical
Contents in maximum impact accident situation	Basket maintains integrity after experiencing 87 G impact force	Maximum impact force of 87 G experienced

(a) BMI License SMN 7, Amendment Number 71-4.

(b) Nominal critical loading for a water moderated core equals 60 elements.

Table 1.1 summarizes the pertinent aspects of shipments of this fuel in the BMI-1 cask and compares nominal TRIGA fuel shipments to the referenced cask license. As shown in Table 1.1, the TRIGA fuel to be shipped has a very low heat and radiation content and the number of elements to be shipped is well below the number required to achieve criticality. The discussions expanding on the areas of criticality, thermal, and structural analysis of TRIGA fuel shipments are given in latter sections. Also included is a shipping procedure for the TRIGA fuel.

In addition to regular TRIGA fuel elements, up to three normal TRIGA fuel elements may be replaced by thermocoupled or fuel followed elements by using an alternate spacer as shown in the drawing, CI334D2193.

(d) S8DR Fuel Elements

Paragraph Deleted

(e) CP-5 Fuel Elements

(Paragraph deleted)

(f) Fissile Material

Greater than Type A quantities of radioactive material which may include the uranium enriched in the U-235 isotope, U-233, plutonium, as metal, oxides, or compounds which are thermally stable up to 600 F.

(g) Byproduct Material

Greater than Type A quantities of byproduct material in special form.

Greater than Type A quantities of byproduct material in normal form as metal, oxides, or compounds which are thermally stable up to 600 F.

(h) EPRI Crack Arrest Capsules

This Safety Analysis Report shows that the EPRI Crack Arrest Capsules shown in Figure 1.1 can be shipped in the BMI-1 cask. The capsules are essentially rectangular parallelepipeds made of aluminum and containing carbon steel specimens. Lesser amounts of other materials are present as shown in Table 1.2.

FIGURE WITHHELD UNDER 10 CFR 2.390

Spec
Area

FIGURE 1.1. CRACK ARREST IRRADIATION CAPSULE

TABLE 1.2. MATERIALS IN THE EPRI CRACK ARREST CAPSULES

Material	Component	Weight, lb
Aluminum	Capsule walls Piping	68 5
Carbon Steel	Specimens	123
Stainless Steel (Type 304 and 347)	Seal Plugs, T/C & Heater Sheath	10
Constantan Wire	Thermocouples	∿1
Magnesium Oxide	T/C Insulation	6
Nickel	Heaters	∿2
Inconel	Heaters	∿2
U^{238}	Fission Monitor	36 mg
Np^{237}	Fission Monitor	60 mg

(i) Union Carbide Process Uranium Oxide Containers

This Safety Analysis Report shows that up to twenty-four (24) containers can be shipped in the BMI-1 cask. Twelve containers are transported in each of the two baskets. Since the basket cavity length is 26.12 inches (Drawing 41-4409-0004, Rev. B) and the containers are only 16.0 inches long, a nominally 9.62-inch long spacer will be placed in the bottom of each basket cell prior to inserting the container. This will limit the axial motion of the container to a maximum of about 0.5 inch.

Each container may be loaded with up to 352 grams of U^{235} in the form of processed uranium oxide. The oxide is formed in the capsules through pyrolysis of a liquid solution of the uranium. The resulting oxide is in the form of flakes and powder of random size.

(j) Union Carbide Target U^{235} Special Form Capsules

This Safety Analysis Report shows that up to twenty-four (24) U^{235} special form capsules can be shipped in the BMI-1 cask. The special form capsules are nominally 18 inches long. One capsule will be loaded in each basket cell. The 1.25 inch capsules will be held within the basket cell by a rack designed to permit free air connection around the capsule. The axial motion of the capsules will be restricted to a maximum of 0.5 inch by a spacer placed in the bottom of each gasket cell before inserting the special form capsule.

Each capsule may contain up to 100 grams of U^{235}.

(k) University of Missouri Research Reactor (MURR) Fuel Assemblies

This Safety Analysis Report shows that up to eight (8) intact irradiated MURR fuel assemblies containing not more than 775 grams of U^{235} per assembly prior to irradiation can be safely shipped in the BMI-1 cask. The maximum enrichment of the uranium in the assemblies prior to irradiation is 93.5 w/o. The minimum cooling time of each fuel assembly is 150 days, and the maximum radiation source term per package is 400,000 curies. The fuel assemblies have an active fuel length of 24 inches. They are to be confined within the cask cavity in a basket described by University of Missouri Research Reactor (MURR) Drawing No. 2234, Sheets 1 through 5, revision 0.

(l) MITR-II Fuel Assemblies

This Safety Analysis Report shows that up to eight (8) intact irradiated MITR fuel assemblies containing not more than 510 grams of U^{235} per assembly prior to irradiation can be safely shipped in the BMI-1 cask. The maximum enrichment of the uranium in the assemblies is 93.5%. The maximum decay heat per package is 200 watts. The fuel assemblies have an active fuel length of approximately 24 inches. They are to be confined within the cask

cavity in a basket described by University of Missouri Research Reactor (MURR) Drawing No. 2234, Sheets 1 through 5, revision 0.

(m) High Flux Beam Reactor (HFBR) Fuel Assemblies

This Safety Analysis Report shows that twenty (20) intact irradiated HFBR fuel assemblies containing not more than 351 grams of U^{235} per assembly prior to irradiation can be safely shipped in the BMI-1 cask. Each shipment must contain twenty (20) assemblies. The maximum enrichment of the uranium in the assemblies prior to irradiation is 93.5 w/o. The maximum burnup is approximately 130 MWD per assembly, and the minimum cooling time is 470 days. The fuel assemblies have a nominal active fuel length of 24 inches. They are to be confined within the cask cavity in two baskets separated by a spacer plate as described by Brookhaven National Laboratory Drawing Nos. BNL 93-01, Sheets 1, 2 and 3, Rev. 2 and BNL 93-02, Sheet 1, Rev. 2.

1.3 Appendix

1.3.1 References

(1) Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions; U. S. Nuclear Regulatory Commission, Title 10, Chapter 1, Part 71, June 30, 1978.

(2) Paxton, H. C. et. al. "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233," USAEC, TID 7028 (1964).

1.3.2 Drawings

The drawings of the cask, skid and the various containers and baskets follow.

FIGURE WITHHELD UNDER 10 CFR 2.390

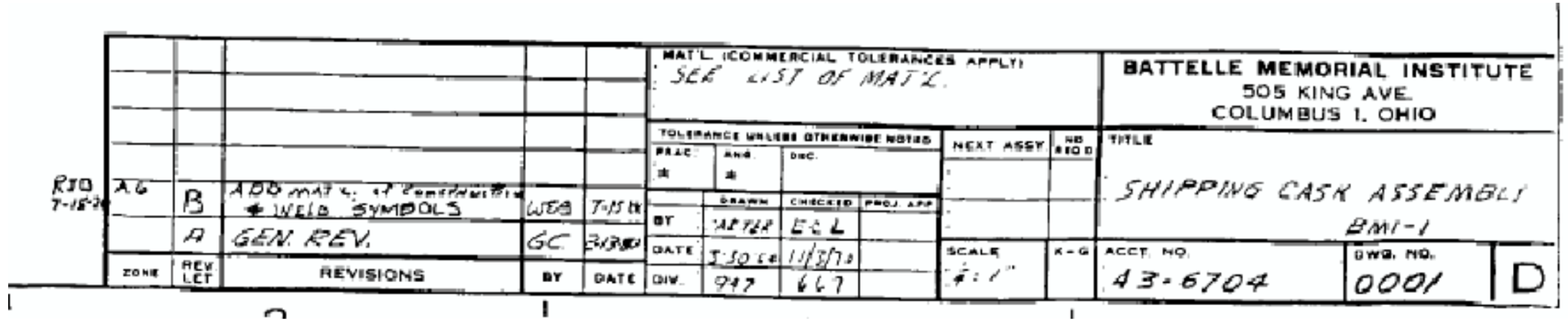


FIGURE WITHHELD UNDER 10 CFR 2.390

					MAT'L (COMMERCIAL TOLERANCES APPLY) 304 STAINLESS STEEL					BATTELLE MEMORIAL INSTITUTE 505 KING AVE. COLUMBUS 1, OHIO	
					TOLERANCE UNLESS OTHERWISE NOTED FRAC. ± ANG. ± 1° DEC. ± .03			NEXT ASSY. .0001	NO. REQ'D 1	TITLE LID	
	B	ADD. FREE SHIELDS ITEM 7	GC	2-15-80	BY	DRAWN WRD	CHECKED RJH	PROJ. APP.			BMI-1
6-D											

FIGURE WITHHELD UNDER 10 CFR 2.390

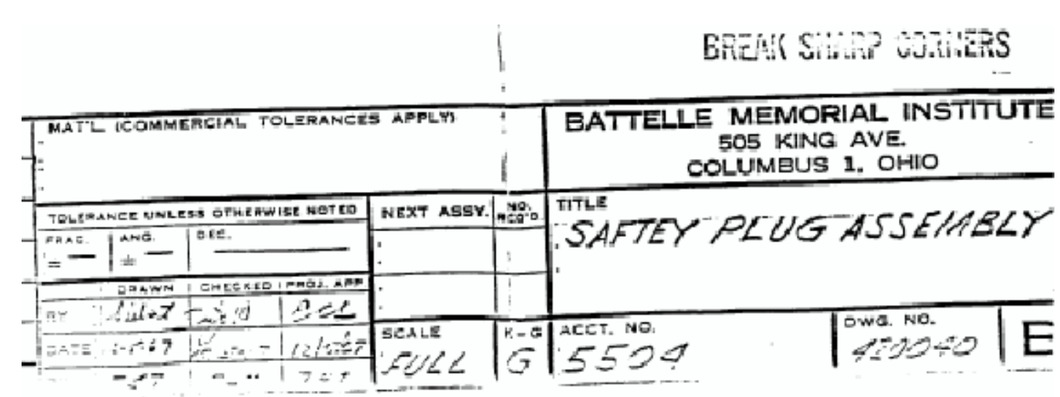


FIGURE WITHHELD UNDER 10 CFR 2.390

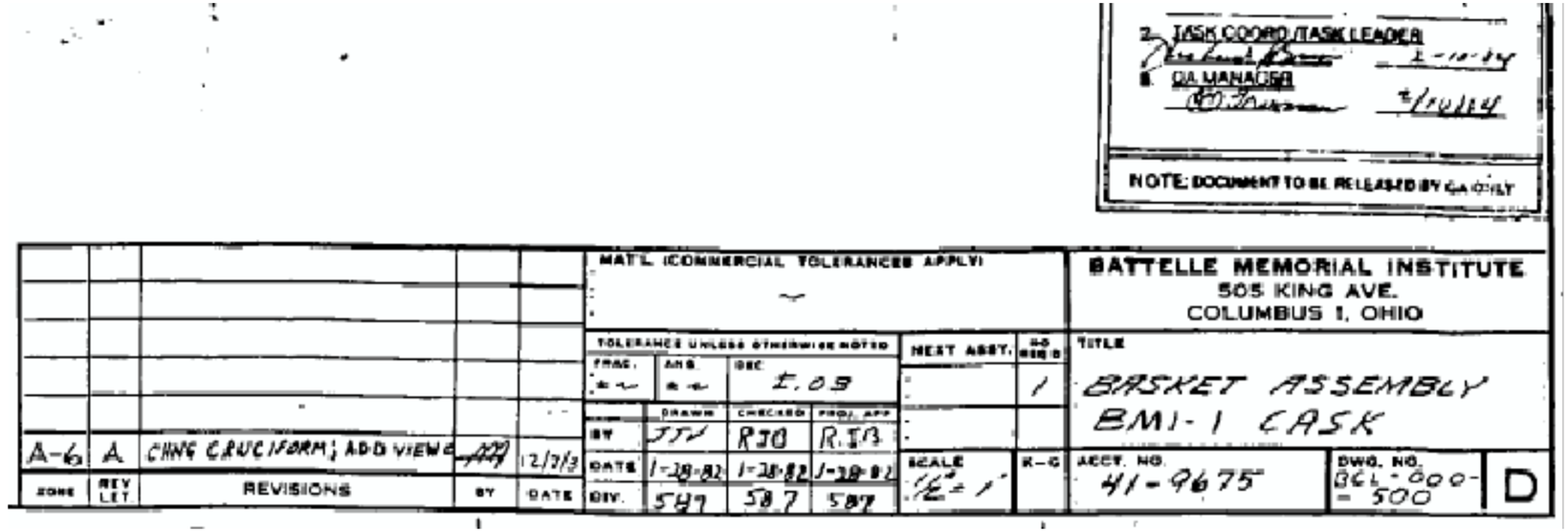


FIGURE WITHHELD UNDER 10 CFR 2.390

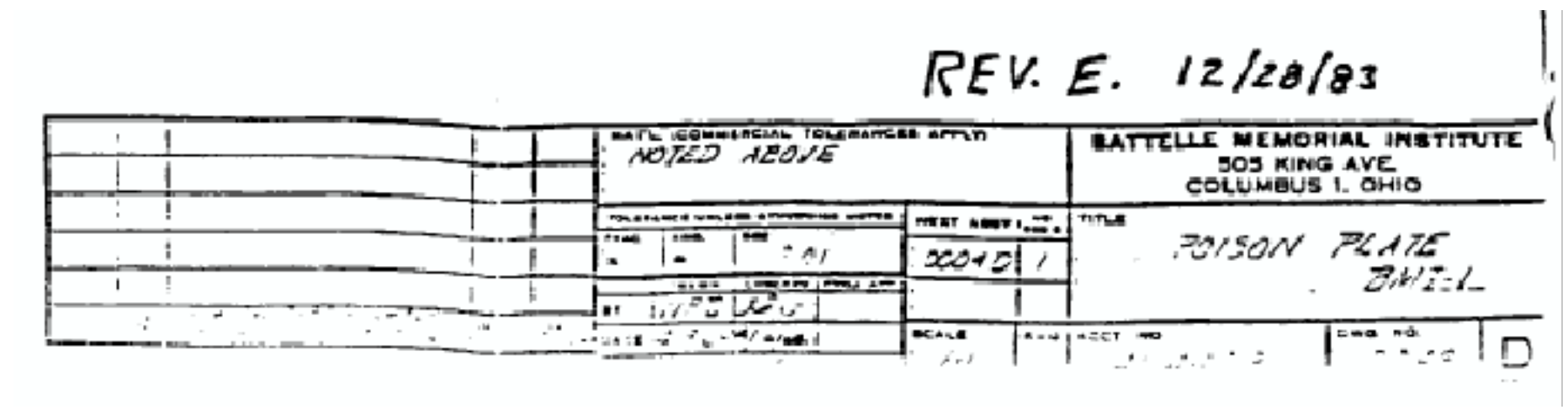


FIGURE WITHHELD UNDER 10 CFR 2.390

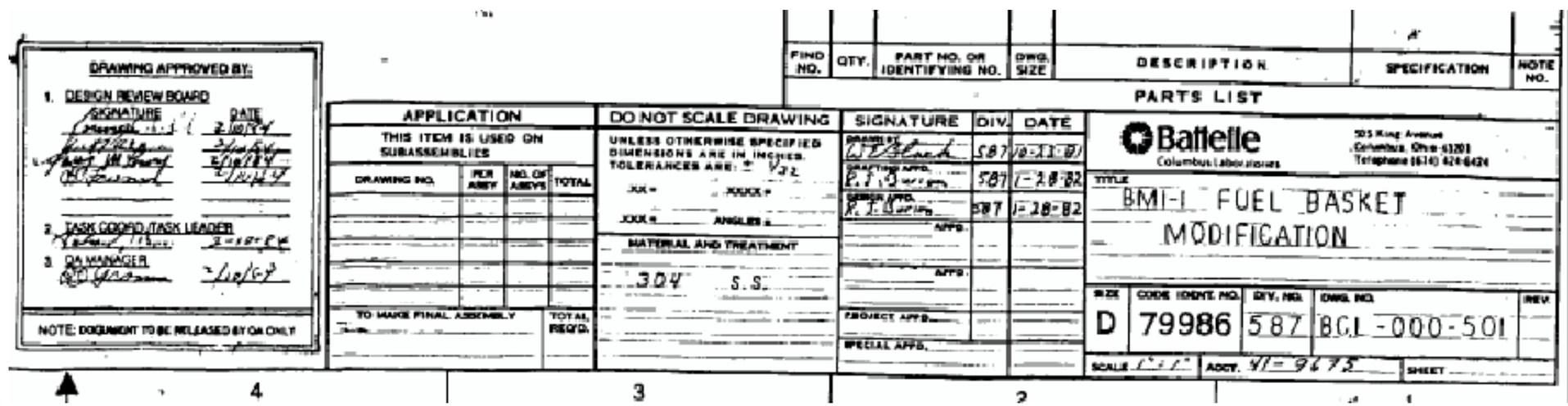
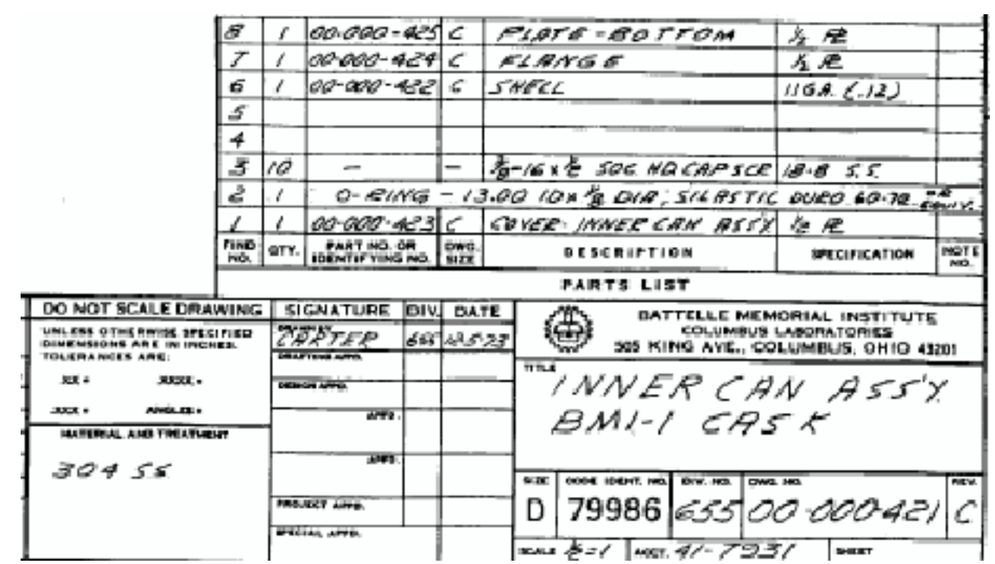


FIGURE WITHHELD UNDER 10 CFR 2.390



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
8	1	00-000-425	C	PLATE - BOTTOM	1/2 PL	
7	1	00-000-424	C	FLANGE	1/2 PL	
6	1	00-000-422	C	SHELL	11GA. (.12)	
5						
4						
3	10	—	—	3/8-16 x 1 1/2 SOC HD CAP SCR	18-8 S.S.	
2	1	O-RING - 13.00 ID x 3/8 DIA; SILASTIC DURO 60-70				
1	1	00-000-423	C	COVER: INNER CAN ASS'Y	1/2 PL	

PARTS LIST

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX ± .XXX ±

.XXX ± ANGLES ±

MATERIAL AND TREATMENT

304 SS

SIGNATURE	DIV.	DATE
DRAWN BY CARTER	655	11-5-73
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

BATTELLE MEMORIAL INSTITUTE
COLUMBUS LABORATORIES
505 KING AVE., COLUMBUS, OHIO 43201

TITLE INNER CAN ASS'Y BMI-1 CASK

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	655	00-000-421	C

SCALE 1/2=1 MOD. 41-7931 SHEET

FIGURE WITHHELD UNDER 10 CFR 2.390

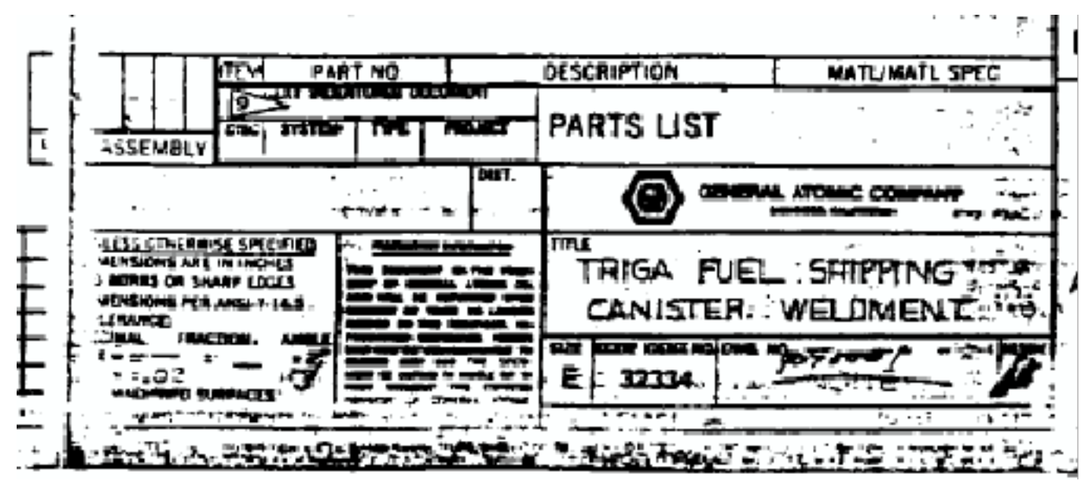


FIGURE WITHHELD UNDER 10 CFR 2.390

APPR.	DATE	DESCRIPTION	REV
		REVISIONS	

DRAWN CJG	5-26-88	CINTICHEM, INC. a wholly owned subsidiary of Medi-Physics, Inc. P.O. BOX 818, TUXEDO, NEW YORK 10987
DESIGN		
CHK./APPR.		

EQUIP. AT	UNLESS OTHERWISE NOTED: TOLERANCE FRAC	DEC	ANGLE		SIZE	DRAWING NO.
	± 1/8"	±.12	±.5°	MODIFIED SPACER BASKET	D	334D2193
				SCALE NTS	DIMENSIONS IN	SHEET

FIGURE WITHHELD UNDER 10 CFR 2.390

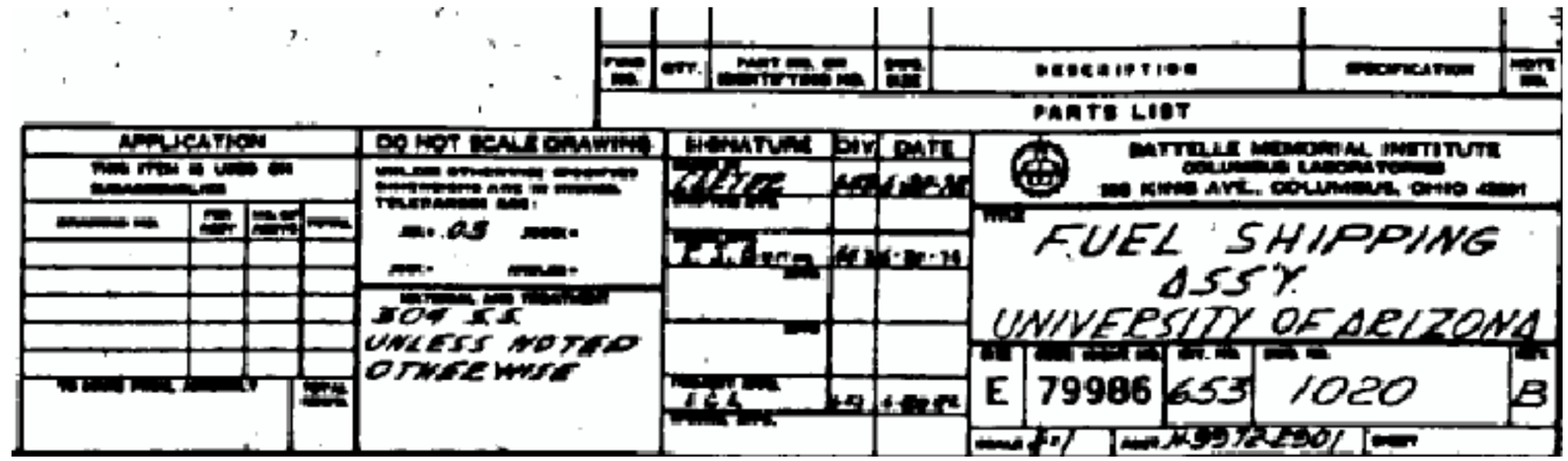
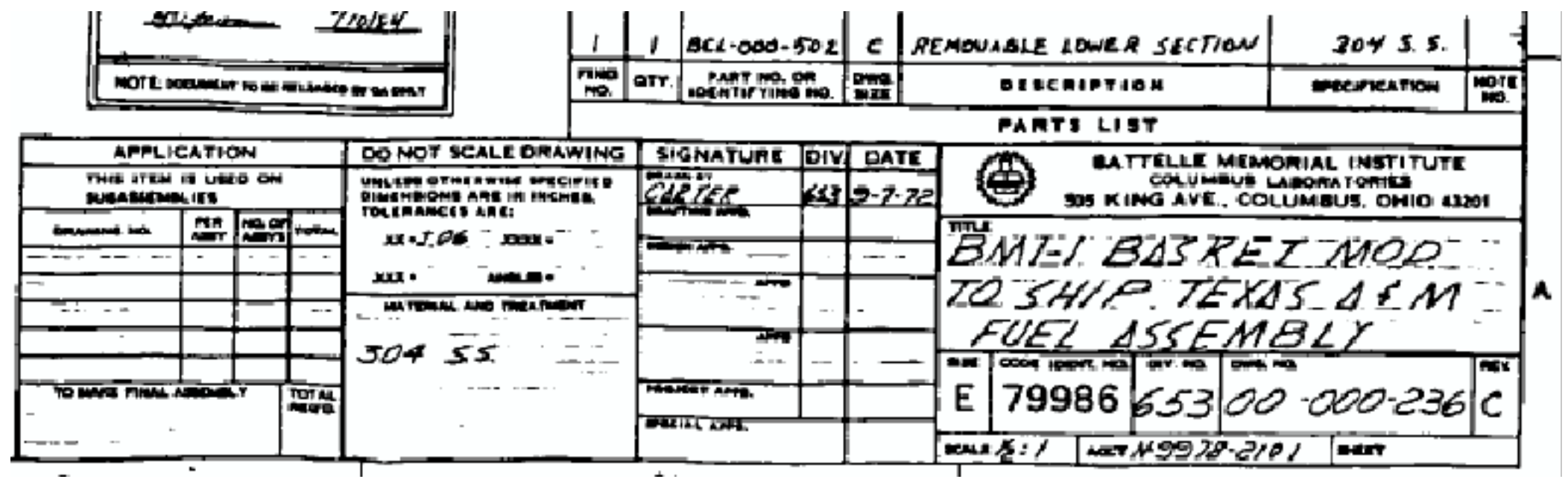


FIGURE WITHHELD UNDER 10 CFR 2.390



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
1	1	BCL-000-502	C	REMOVABLE LOWER SECTION	304 S.S.	

PARTS LIST

NOTE: DOCUMENT TO BE RELEASED BY SA DRAFT

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

XX = ±.06 XXXX =

XXX = ANGLES =

MATERIAL AND TREATMENT

304 S.S.

SIGNATURE	DIV.	DATE
DRAWN BY CARTER	653	9-7-72
DRAFTING APPR.		
DESIGN APPR.		
APPR.		
APPR.		
PROJECT APPR.		
SPECIAL APPR.		

BATTELLE MEMORIAL INSTITUTE
COLUMBUS LABORATORIES
505 KING AVE., COLUMBUS, OHIO 43201

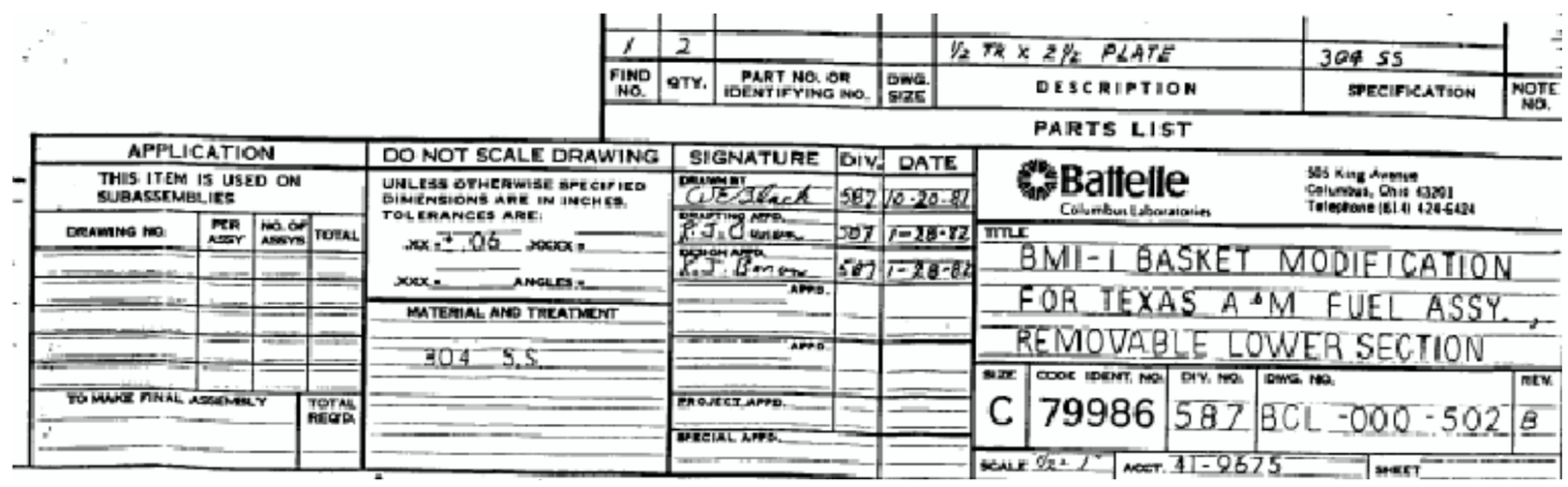
TITLE: BMT-1 BASKET MOD TO SHIP TEXAS A&M FUEL ASSEMBLY

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	653	00-000-236	C

SCALE 1/2 : 1 — MODEL N9978-2101 — SHEET

A

FIGURE WITHHELD UNDER 10 CFR 2.390



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
1	2			1/2 TK x 2 1/2 PLATE	304 SS	

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = ± .06 .XXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT

304 S.S.

SIGNATURE	DIV.	DATE
DRAWN BY	587	10-20-81
DRAFTING APPD.	587	1-28-82
DESIGN APPD.	587	1-28-82
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPS.		

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424

TITLE
BMI-1 BASKET MODIFICATION
FOR TEXAS A&M FUEL ASSY.,
REMOVABLE LOWER SECTION

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	587	BCL-000-502	B

SCALE 1/2 = 1" ACCT. 41-9675 SHEET

FIGURE WITHHELD UNDER 10 CFR 2.390

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
4	6	00-000-392	C	INSERT		
3	6	4" O.D. x .12 WALL COLD DRAWN MECH. TUBING MIN. YIELD 55,000 PSI				
2	3	00-000-393	C	PLATE		
1	1	00-000-394	C	LIFTING LUG		

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX - ±.12 .XXX -

.XXX ± ANGLES ±

MATERIAL AND TREATMENT

NOTED

SIGNATURE	DIV	DATE
DRAWN BY		
ENGINEERING APPR.		
DESIGN APPR.		
APPR.		
APPR.		
PROJECT APPR.		
SPECIAL APPR.		

Battelle

Columbus Laboratories

505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE

BASKET
BMI-1 CASK
(A1)

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV
E	79986	655	00-000-391	C

SCALE 1/4 : 1 MODEL G-5904-4301 SHEET

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES ±	UNION CARBIDE CORPORATION CORPORATE RESEARCH LABORATORY TUXEDO, NEW YORK		
DRAWN: M.J.R. 15 JUL'80	WASTE FORM PROCESS SHIPPING CONTAINER OUTLINE DRAWING		
CHECKED: M.N.V. 17 NOV'80			
DATE:	SCALE: FULL SIZE	SIZE: D	DRAWING NO.: 101501 A

FIGURE WITHHELD UNDER 10 CFR 2.390

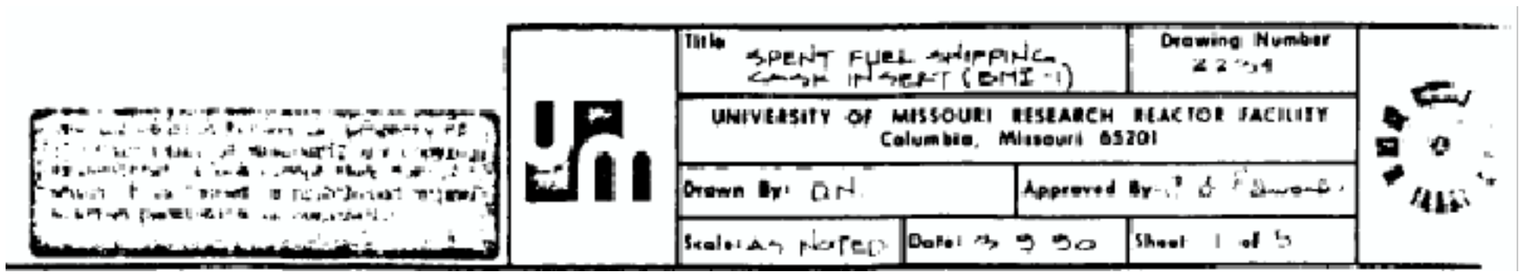


FIGURE WITHHELD UNDER 10 CFR 2.390

NOTES

1. PIPE 85 304 STAINLESS STEEL 14" O.D. - 13.50" I.D.
2. (A) - 8 DRAIN GROOVES, 1/2" DEEP FROM BOTTOM EDGE, 1/4" WIDE.
3. SLOTS ARE TO BE FILL WELDED TO SECURE INTERIOR [illegible] (VARIES FOR [illegible]).
   (B) - 20 SLOTS. EACH SLOT IS 2" LONG X 3/8" WIDE AND SPACED AS SHOWN. (4 COLUMNS, 5 SLOTS PER COLUMN)
   (C) - 20 SLOTS. EACH SLOT IS 2" LONG X 5/16" WIDE AND SPACED AS SHOWN. (4 COLUMNS, 5 SLOTS PER COLUMN)
4. LEVELING TABS MAY BE ADDED TO BOTTOM OF FINISHED ASSEMBLY.

	Title: SPENT FUEL SHIPPING CASK INSERT (BMI-1)		Drawing Number: 2234
	UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY Columbia, Missouri 65201		
	Drawn By: D.H.	Approved By: [illegible]	
	Scale: [illegible]	Date: [illegible]	Sheet 2 of 5

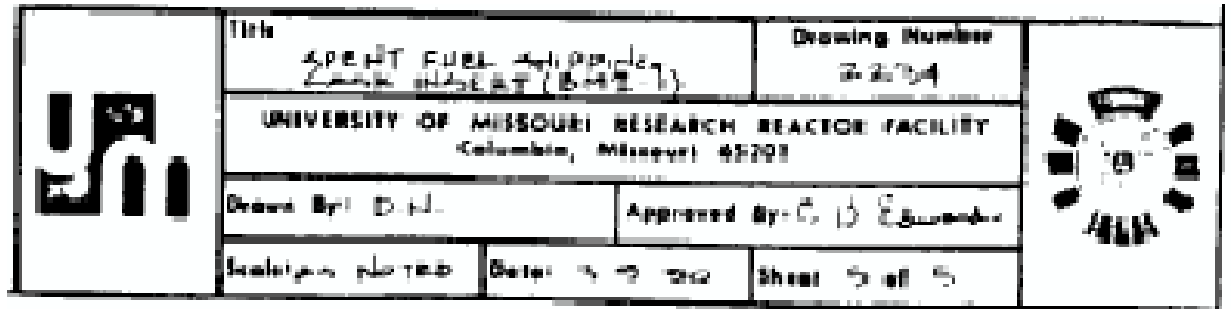
FIGURE WITHHELD UNDER 10 CFR 2.390

	Title: SPENT FUEL SHIPPING CASK INSERT (BMI-1)		Drawing Number: 2234
	UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY Columbia, Missouri 65201		
	Drawn By: D N	Approved By: C. J. Edwards	
	Scale: AS NOTED	Date: 5 9 90	Sheet 3 of 5

FIGURE WITHHELD UNDER 10 CFR 2.390

	Title SPENT FUEL SHIPPING CASK INSERT (BMI-1)		Drawing Number 2.2.54
	UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY Columbia, Missouri 65201		
	Drawn By: D N	Approved By: C. B. Brooks	
	Scale: AS PLOTTED	Date: [illegible]	Sheet 1 of [illegible]

FIGURE WITHHELD UNDER 10 CFR 2.390



DRAWING: BNL 93 ,01 SHEET 1 OF 3, REV 2
DRAWN BY/DATE: AG / 3-30-94
APPROVED BY/DATE: K. Tart 3/30/94

FIGURE WITHHELD UNDER 10 CFR 2.390

DRAWING: BNL 93 001 SHEET 2 OF 3, REV 2
DRAWN BY/DATE: AG / 3-30-94
APPROVED BY/DATE: K Tait 3/30/94

FIGURE WITHHELD UNDER 10 CFR 2.390

DRAWING: BNL 93 001 SHEET 3 OF 3, REV 2
DRAWN BY/DATE: AG / 3-30-94
APPROVED BY/DATE: K Tait 3/30/94

FIGURE WITHHELD UNDER 10 CFR 2.390

DRAWING: BNL 93 J02
SHEET 1 OF 1, REV 2

DRAWN BY/DATE:
AG / 3-30-94

APPROVED BY/DATE:
K Tuck 3/30/94

FIGURE WITHHELD UNDER 10 CFR 2.390