PDR 71-9137

Tech Ops

Radiation Products Division
40 North Avenue
Burlington, Massachusetts 01803
Telephone (617) 272-2000

9 November 1979

Mr. Charles E. MacDonald, Chief
Transportation Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, CD 20555

Dear Mr. MacDonald:

We request issuance of a USNRC Certificate of Compliance for Radioactive Materials Package for Technical Operations Model 820 Type B Package - Source Changer. We are enclosing eight copies of the package description of the Model 820 for your review. In accordance with 10CFR170.31 Item 11.E, we are also enclosing a check for $700 for the application fee.

We plan to apply to the U.S. Department of Transportation for an International Atomic Energy Agency Certificate of Competent Authority for Type B(U) packaging under the 1973 Revised Edition of IAEA Safety Series No. 6. We ask that this package be reviewed for conformance to these requirements also.

We trust that this application satisfies your requirements for issuance of this certificate. If we can provide any additional information, please contact us.

Sincerely,

John J. Munro III
Technical Director

JJM/fb
Encls.

1636 204

14752

7912210289

Tech/Ops

Radiation Products Division
40 North Avenue
Burlington, Massachusetts 01803
Telephone (617) 272-2000

PACKAGE DESCRIPTION

TECHNICAL OPERATIONS

MODEL 820

1. General Information

1.1 Introduction

The Tech/Ops 820 is designed for use as a source changer and shipping container for Type B quantities of radioactive material in special form. The Model 820 conforms to the criteria for Type B packaging in accordance with 10CFR71 and satisfies the criteria for Type B(U) packaging in accordance with IAEA Safety Series No. 6, 1973 Edition.

1.2 Package Description

1.2.1 Packaging

The Model 820 is 19.5 inches (495 mm) in diameter and 21.5 inches (546 mm) high. The gross weight of the package is 222 pounds (101 kg).

The radioactive source assemblies are housed in titanium "J" tubes. The "J" tube has an outside diameter of 0.44 inch (11.1 mm) and a wall thickness of 0.035 inch (0.89 mm). The eight "J" tubes are welded to an octagonal source stop fabricated from titanium to form the source tube assembly. This source stop allows positive positioning of the source assembly at the bottom of the "J" tube.

The source tube assembly is surrounded by depleted uranium metal for shielding. The uranium metal is cast around the titanium source tube assembly.

The uranium shield assembly is encased in a stainless steel housing. The shield is supported on the bottom by a stainless steel shield support ring which is welded to a shield support plate. The shield support plate is welded to the housing shell. The shield is supported on top by a shield spacer ring. This spacer ring is positioned by the housing top plate which is welded to the housing shell.

The shield spacer ring and shield support ring provide support for the shield in both vertical and horizontal directions. Copper shims are positioned between the shield and these rings to prevent any iron-uranium interfaces.

The housing top plate and the shield support plate, in addition to being welded to the housing shell, are mechanically connected by means of shield support posts. These support posts are welded to the shield support plate and bolted to the top plate.

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The void space between the uranium shield assembly and the stainless steel housing is filled with a castable rigid polyurethane foam.

Mounted on the housing top plate are eight locking assemblies. These locking assemblies are used to secure the radioactive source assemblies in a shielded position during transport.

An outer package lid, fabricated from stainless steel, is bolted to the package to provide protection to the locking assemblies.

Tamperproof seals are provided during shipment of these sources. Two vent holes in the package provide passageways for the escape of any gas generated from decomposition of the polyurethane foam in the event the source changer is involved in a fire accident. The outer packaging is designed to avoid the collection and retention of water. The package has a smooth stainless steel finish to provide for easy decontamination.

The radioactive material is sealed inside a stainless steel source capsule. The capsule acts as the containment vessel for the radioactive material.

1.2.2 Operational Features

The source assemblies are secured in the proper storage position by means of the locking assemblies. With a source in the storage position, the "Teleflex" cable portion of the source assembly is located inside the locking assembly. The lock plate is engaged to secure the cable in place. Operation of the lock requires use of a special key.

This lock assembly is similar to that used on Tech/Ops Model 750 Type B package (USNRC Certificate No. 9021).

1.2.3 Contents of Package

The Model 820 is designed for the transport of iridium-192 in quantities up to 1000 curies as Tech/Ops source assemblies A424-1, A424-9, A424-20, 68309, 69701, and 81401. These source assemblies satisfy the criteria for special form radioactive material in accordance with 10CFR71 and IAEA Safety Series No. 6, 1973 Edition (Section 2.8).

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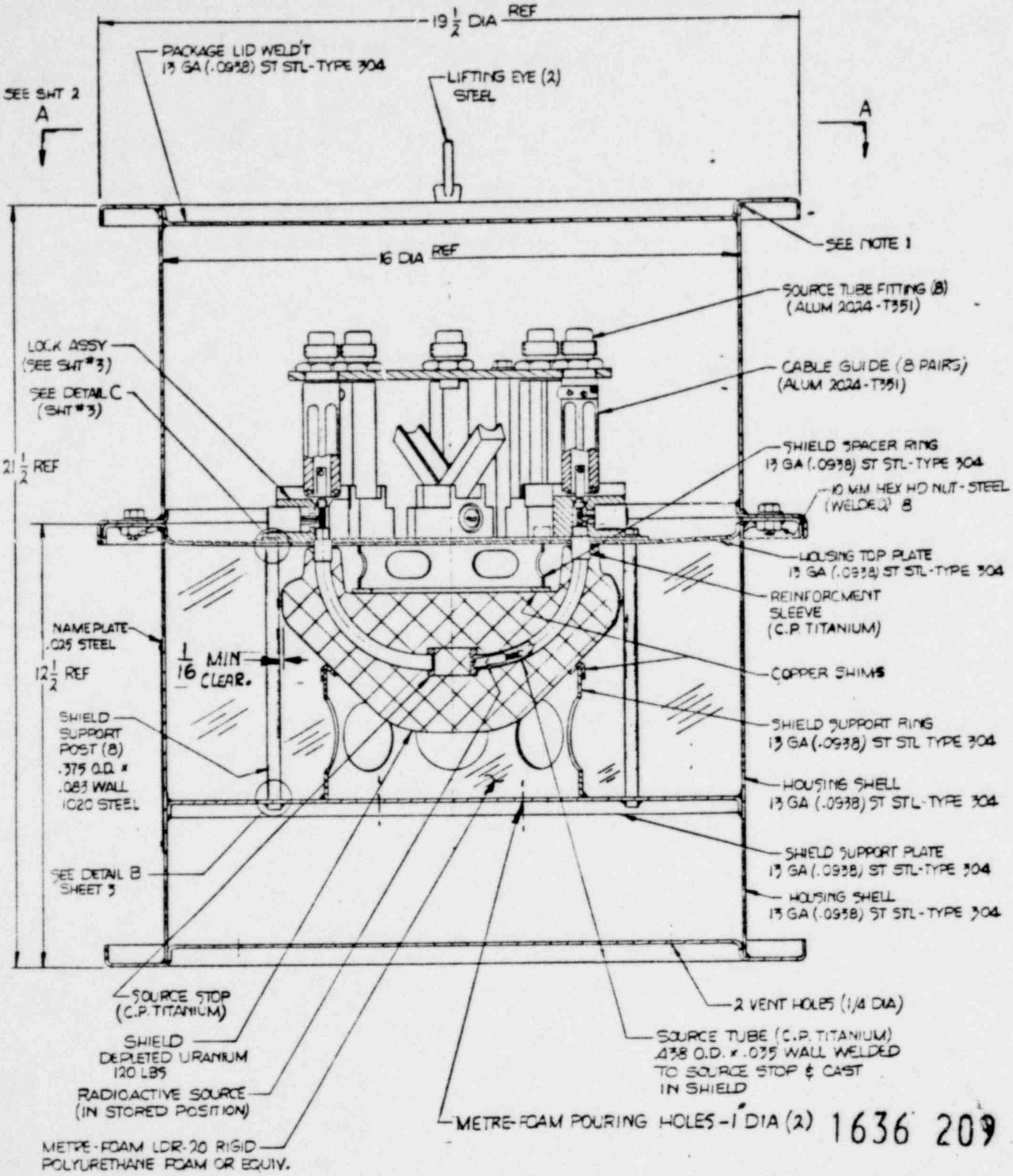
1.3 APPENDIX

Descriptive Assembly Drawing, Model 820

1636 208

C82090



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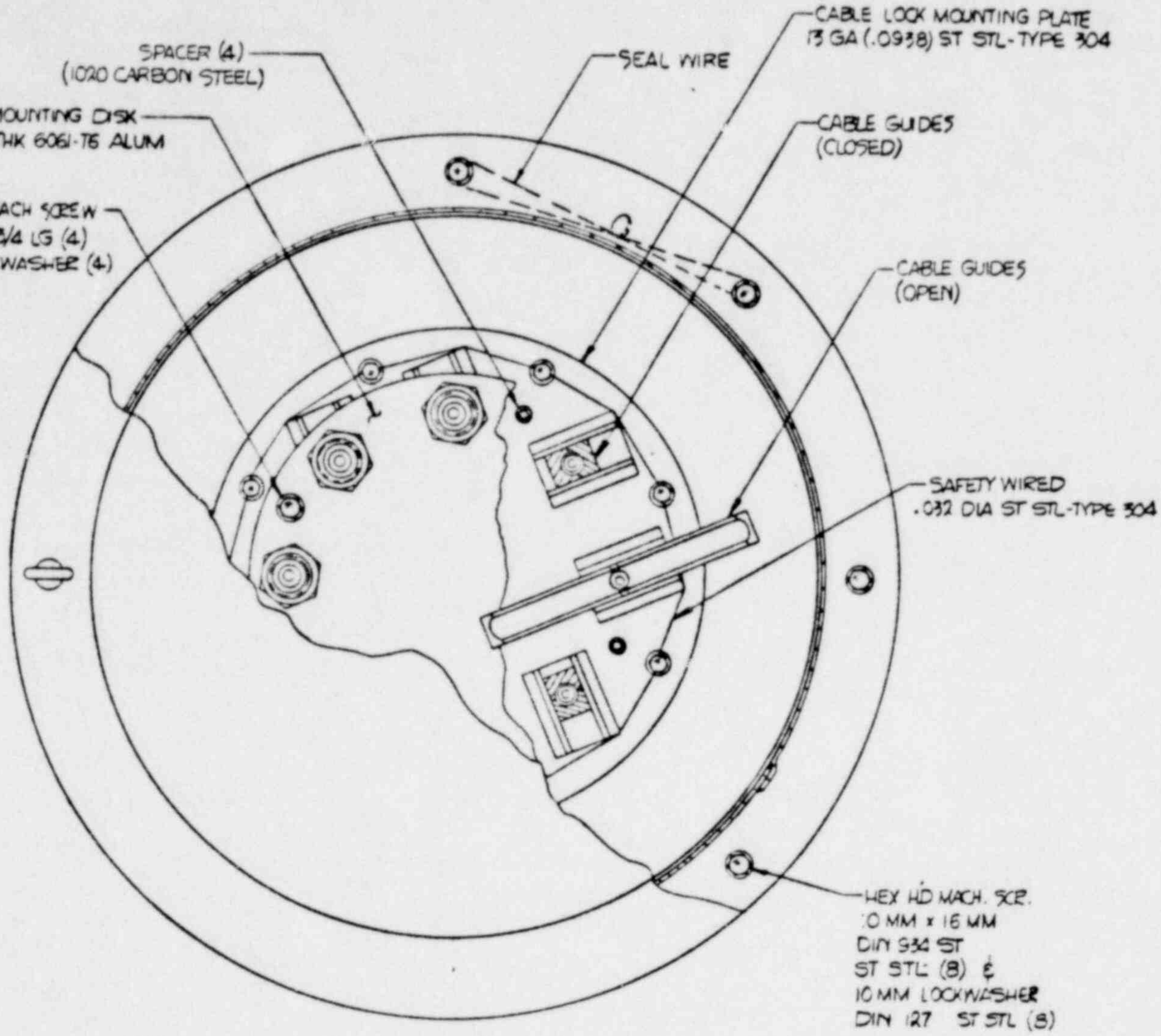
TOTAL WEIGHT: 222 LBS (101 KG)

NOTE:
1. ALL WELDS ARE .09 CONTINUOUS FILLET WELDS

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: DESCRIPTIVE ASSEMBLY - MODEL #820 SOURCE CHANGER & SHIPPING CONTAINER
DRAWN BY	CLASSIFICATION · SIZE C · DWG NO 82090 · REV.
CHECKED BY	SCALE 1:2 · SHEET 1 OF 4
APPROVED BY	

POOR ORIGINAL

C82090



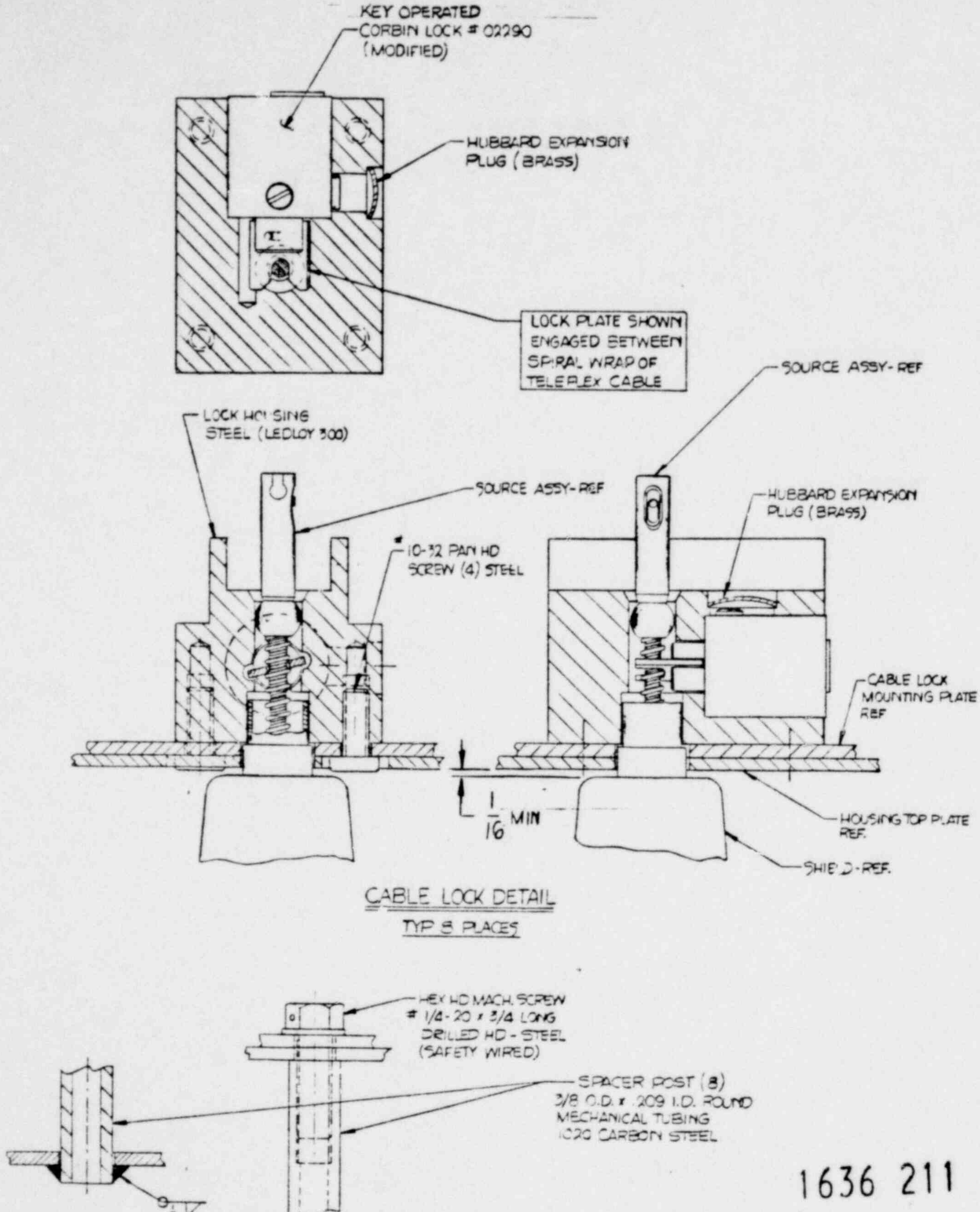
VIEW A-A
(ROTATED 90° CCW)

POOR ORIGINAL

1636 210

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: DESCRIPTIVE ASSEMBLY - MODEL #820 SOURCE CHANGER & SHIPPING CONTAINER
DRAWN BY / CHECKED BY / APPROVED BY	SIZE: C — DWG NO: 82090 — REV: 1
	SCALE 1:2 & 1:1 — SHEET 2 OF 4

G82090



DETAIL B

DETAIL C

1636 211

POOR ORIGINAL

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
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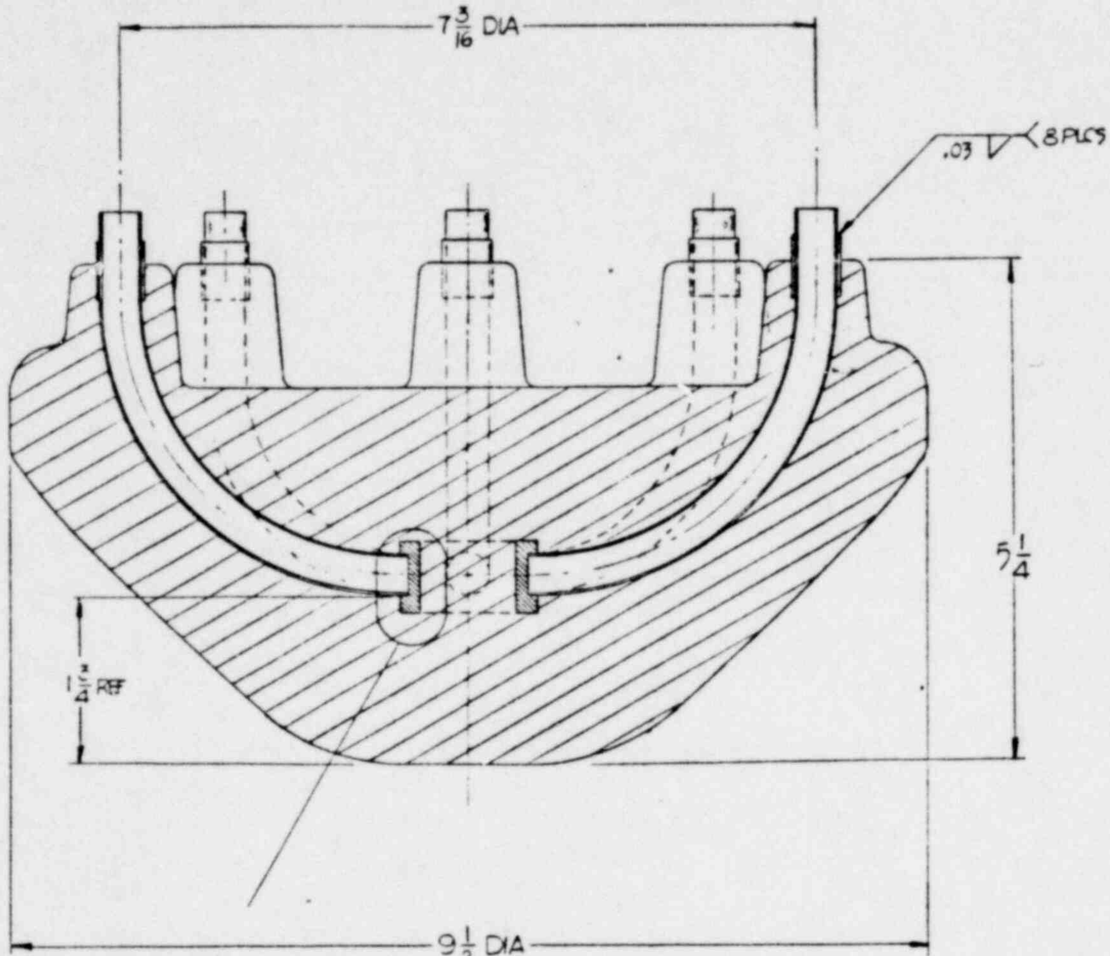
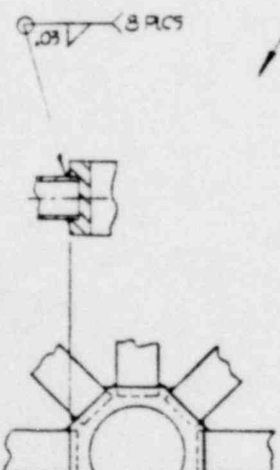
DRAWN BY 10-23-79	CLASSIFICATION · SIZE C · DWG. NO. 82090
CHECKED BY	SCALE 2:1 · SHEET 3 OF 4
APPROVED BY	

C82090

REV.	DATE	DESCRIPTION





SHIELD DATA

WEIGHT: 120 LBS

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MATERIALS: SEE SHT 1	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: DESCRIPTIVE ASSEMBLY- MODEL 820 SOURCE CHANGER & SHIPPING CONTAINER
DRAWN BY	CLASSIFICATION / SIZE: C / DWG. NO. 82090 / REV.
CHECKED BY	SCALE 1:1 / SHEET 4 OF 4
APPROVED BY	

2. Structural Evaluation

2.1 Structural Design

2.1.1 Discussion

Structurally, the Model 820 consists of four components: a source capsule, shield assembly, outer housing and locking assembly. The source capsule is the primary containment vessel. It satisfies the criteria for special form radioactive material. The shield assembly fulfills two functions. It provides shielding for the radioactive material and, together with the lock assembly, assures proper positioning of the source.

The outer housing is fabricated from 13 gauge (0.0938 inch or 2.38 mm thick) stainless steel. The housing provides the structural strength of the package. The top lid protects the lock assemblies. The lock assemblies secure the source assemblies in the shielded position at the bottom of the "J" tube, and assures positive closure.

2.1.2 Design Criteria

The Model 820 is designed to comply with the requirements of 10CFR71 and IAEA Safety Series No. 6, 1973 Edition. The device is simple in design. There are no design criteria which cannot be evaluated by straight forward application of the appropriate section of 10CFR71 or IAEA Safety Series No. 6.

2.2 Weights and Centers of Gravity

The Model 820 weighs 222 pounds (101 kg). The shield assembly contains 125 pounds (57 kg) of depleted uranium. The center of gravity was located experimentally. It is located along the cylindrical axis at a distance of 9.5 inches (0.24m) above the bottom surface.

2.3 Mechanical Properties of Materials

The Model 820 housing is fabricated from Type 304 stainless steel. This material has a yield strength of 35,000 pounds per square inch (241 MN/m^2).

(Reference: Metals Handbook, Vol 1, Eight Edition)

Drawings of the source capsules used in conjunction with the Model 820 are enclosed in Section 2.10. These source assemblies all consist of a source capsule fabricated from Type 304 or Type 304L stainless steel. The source capsule is swaged to a "Teleflex" steel cable. The capsules are sealed by tungsten inert gas welding. The swaged coupling is tensile tested on a production basis to 75 pounds (334 newtons).

2.4 General Standards for All Packages

2.4.1 Chemical and Galvanic Reactions

The materials used in the construction of the Model 820 are uranium metal, steel, titanium, bronze and copper. There will be no significant chemical or galvanic action between any of these components.

The possibility of the formation of the eutectic alloy iron-uranium at temperatures below the melting temperatures of the individual metals has been considered. The iron-uranium eutectic alloy temperature is approximately 1337°F (725°C). However, vacuum conditions and extreme cleanliness of the surfaces are necessary to produce the alloy at this low temperature. Due to the conditions under which the shields are mounted, sufficient contact for this effect does not exist.

In support of this conclusion, the following test results are presented. A thermal test of a sample of bare depleted uranium metal was performed by Nuclear Metals, Inc. The test indicated that the uranium sample oxidized such that the radial dimension was reduced by 1/32 inch (0.8 mm). A subsequent test was performed in which a sample of bare depleted uranium metal was placed on a steel plate and subjected to the thermal test conditions. The test showed no melting or alloying characteristics in the sample, and the degree of oxidation was the same as evidenced in the first test. Copies of the test reports are included in Section 2.10.

Notwithstanding these test results, copper shims are used as separators at all iron-uranium interfaces to prevent contact and to preclude the possibility of the formation of this eutectic alloy.

2.4.2 Positive Closure

The source assemblies in the Model 820 cannot be exposed without opening a key operated lock. Access to the lock requires removal of the lid. The lid is seal wired and provided with a tamperproof seal.

2.4.3 Lifting Devices

The Model 820 is designed to be lifted by two eyenuts attached to the cover by means of 3/8 - 16 UNC bolts. The cross sectional area of each bolt is 0.0693 in^2 (44.7mm^2). The yield strength of these bolts is greater than 40,000 pounds per square inch (276 MN/m^2). Therefore, each eyenut can support 2770 pounds (12.3 kN) or more than twelve times the weight of the package without exceeding the yield strength of the material.

2.4.4 Tiedown Devices

The tiedown devices on the Model 820 are the two eyenuts. As demonstrated in Section 2.4.3, each can support twelve times the weight of the package without generating stress in excess of the yield strength of the material.

2.5 Standards for Type B and Large Quantity Packages

2.5.1 Load Resistance

Considering the package as a simple beam supported on both ends with a uniform load of five times the package weight evenly distributed along its length, the maximum stress can be computed from:

$$S = \frac{F.l}{8Z}$$

where S: Maximum Stress
F: Total Load (1110 pounds; 4.9 kN)
l: Length of Beam (21.5 in; 546 mm)
Z: Section Modulus (19.41 in^3; 318,073 mm^3)

(Reference: Machinery's Handbook, 20th Edition, P 412)

The load is assumed to be 1110 pounds (4.9 kN). The container is assumed to be a cylinder with an outside diameter of 16.375 in (415.9mm), a wall thickness of 0.094 inch (2.4 mm) and a length of 21.5 inches (546 mm). Consequently, the section modulus of the beam is 19.41 in^3.

Therefore, the maximum stress generated in the beam is 154 pounds per square inch (1.06 MN/m^2) which is far below the yield strength of the material.

2.5.2 External Pressure

The Model 820 is open to the atmosphere. Therefore, there will be no differential pressure acting on it. The collapsing pressure of the source capsules is calculated assuming that the capsules are thin wall tubing with a wall thickness equal to the minimum depth of weld penetration (0.020 inch; 0.5 mm). The collapsing pressure is calculated from:

$$P = 86{,}670 \frac{t}{d} - 1386$$

where P: collapsing pressure in pounds per square inch
t: wall thickness (0.020 inch)
d: outside diameter (0.250 in)

(Reference: Machinery's Handbook, 205h Edition, p 448)

The collapsing pressure of the source capsules is calculated to be 5547 pounds per square inch (38 MN/m^2). Therefore, the source capsules can withstand an external pressure of 25psig.

2.6 Normal Conditions of Transport

2.6.1 Heat

The thermal evaluation of the Model 820 is performed in Chapter 3. From this evaluation, it can be concluded that the Model 820 can withstand the normal heat transport condition.

2.6.2 Cold

The metals used in the manufacture of the Model 820 can all withstand a temperature of -40°C. The lower operating limit of the polyurethane foam is -100°F (-73°C). Thus, it is concluded that the Model 820 will withstand the normal transport cold conditions.

2.6.3 Pressure

The Model 820 is open to the atmosphere; thus, there will be no differential pressure acting on the package. In Section 3.5.4, it is demonstrated that the source capsules are able to withstand an external pressure reduction of 0.5 atmospheres (50.7 kN/m^2).

2.6.4 Vibration

The Model 820 is similar in construction to our Model 750 Type B package (Certificate No. 9021). Additionally, the locking assembly of the Model 820 is similar to that used in the Model 750. The Model 750 has been in use for five years. During that time, there have been no vibrational failures reported.

On that basis, we contend that the Model 820 will not undergo a vibrational failure in transport.

2.6.5 Water Spray Test

The water spray test was not actually performed on the Model 820. We contend that the materials used in construction of the Model 820 are all highly water resistant and that exposure to water will not reduce the shielding or affect the structural integrity of the package.

2.6.6 Free Drop

The drop analysis performed in Section 2.7.1 is sufficient to satisfy the requirements of the normal transport free drop condition. On this basis, we conclude that the Model 820 will withstand the free drop without loss of shielding effectiveness or loss of package integrity.

2.6.7 Corner Drop

Not Applicable

2.6.8 Penetration

A penetration test of the Model 820 was performed. There was no loss of shielding or loss of structural integrity as a result of this test. A copy of the test report appears in Section 2.10.

2.6.9 Compression

The gross weight of the Model 820 is 222 pounds (101 kg). The maximum cross sectional area is 420 in^2. (0.27m^2). Thus, five times the weight of the package(1110 pounds; 4945 newtons) is greater than two pounds per square inch times the maximum cross sectional area (840 pounds, 3742 newtons). For this analysis, the load is assumed to be 1110 pounds (4945 newtons).

The maximum stress generated in a flat circular plate with the edge fixed around the circumference and a uniformly distributed load over the surface of the plate can be computed from:

$$\sigma = \frac{0.24F}{t^2}$$

where σ: maximum stress generated in the plate
F: load applied to the plate (1110 pounds)
t: thickness of the plate (0.094 inch)

(Reference: Machinery's Handbook, _0th Edition, p 444)

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From this relationship, the maximum stress generated in the plate is found to be 30,150 pounds per square inch (208 MN/m^2) which is less than the yield strength of the material (35,000psi; 241 MN/m^2). Therefore, it can be concluded that the compression condition will not adversely affect the package.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

The Model 820 was subjected to a drop test through a distance of 30 feet onto a steel plate. There was no loss of shielding nor loss of package integrity as a result of this test A copy of the test report is included in Section 2.10.

2.7.2 Puncture

The Model 820 was subjected to the puncture test of 10CFR71. As a result of this test, there was no loss of shielding nor loss of package integrity. A copy of the test report is included in Section 2.10.

2.7.3 Thermal

The thermal analysis is presented in Section 3.5. It is shown that the melting temperatures of the materials used in the construction of the Model 820, except the polyurethane foam, are all in excess of 1475°F (800°C)

To demonstrate that the radioactive source assemblies will remain in a shielded position following the hypothetical thermal accident, the following analysis is presented. At the conclusion of the thermal test, it is assumed that the polyurethane foam has completely escaped from the package. The shield assembly is prohibited from rotational movement by the titanium "J" tubes which protrude from the package housing. The shield is restricted from vertical movement by the shield support ring and the shield spacer ring.

Thus, it is concluded that the Model 820 satisfactorily meets the requirements for the hypothetical accident - thermal condition of 10CFR71.

2.7.4 Water Immersion

Not Applicable

2.7.5 Summary of Damage

The tests designed to induce mechanical stress (drop, puncture) caused minor deformation but no reduction in the safety features of this package. The thermal condition will result in no reduction of the safety of the package.

It can be concluded that the hypothetical accident conditions have no adverse effect on the shielding effectiveness or structural integrity of the package.

2.8 Special Form

The Model 820 is designed for use with Tech/Ops Source Assemblies Models A424-1, A424-9, A424-20, 69701, 81401 and 68309. These source assemblies have all been certified as special form radioactive material under IAEA Certificate of Competent Authority No. USA/0154/S. A copy of this certificate is included in Section 2.10.

2.9 Fuel Rods

Not Applicable

2.10 Appendix

Descriptive Assembly Drawings - Source Assemblies

Test Report: Uranium Thermal Test

Test Report: Model 820 Penetration Test

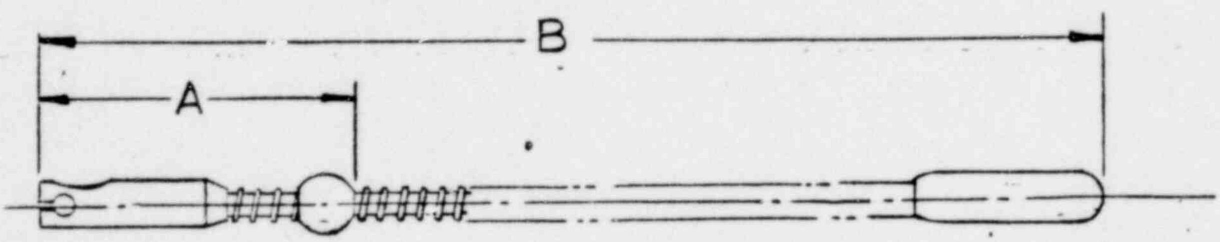
Test Report: Model 820 Free Fall and Puncture Tests

IAEA Certificate of Competent Authority USA/0154/S

A60050

REV.	DATE	DESCRIPTION
A	12-18-78	SEE SHEET 2 FBT

MODEL	CAPACITY (CURIES)	CAPSULE STYLE	DIM A	DIM B
A424-1	120	B60001 OR B60004	2.373	7 7/16
A424-9	120	B60001 OR B60004	1.225	7 3/16
A81401	120	B60001 OR B60004	1.875	7 3/16
A68309	120	C68310	NOT APPLICABLE; ATTACHED DIRECTLY TO DRIVE CABLE	
B69701	120	B60001 OR B60004	2.537	7 11/16
A424-20	240	B60001 OR B60004	1.225	8 15/16
A58101	240	B60006	NOT APPLICABLE NOT WIRE MOUNTED	
A424-6	120	B60001 OR B60004	N.A.	10 11/16



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MATERIALS	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: 192 IRIDIUM SOURCE REFERENCE
DRAWN BY: [signature] 6 OCT 78	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± / .XX ± / .XXX ± / ANGLES ± / FRACTIONS ±
CHECKED BY	CLASSIFICATION / SIZE: A / DWG. NO. 60050 / REV. A
APPROVED BY	SCALE 1:1 / SHEET 1 OF 2

SPAULDING CO., INC. 21-60169

A60050

REV.	DATE	DESCRIPTION
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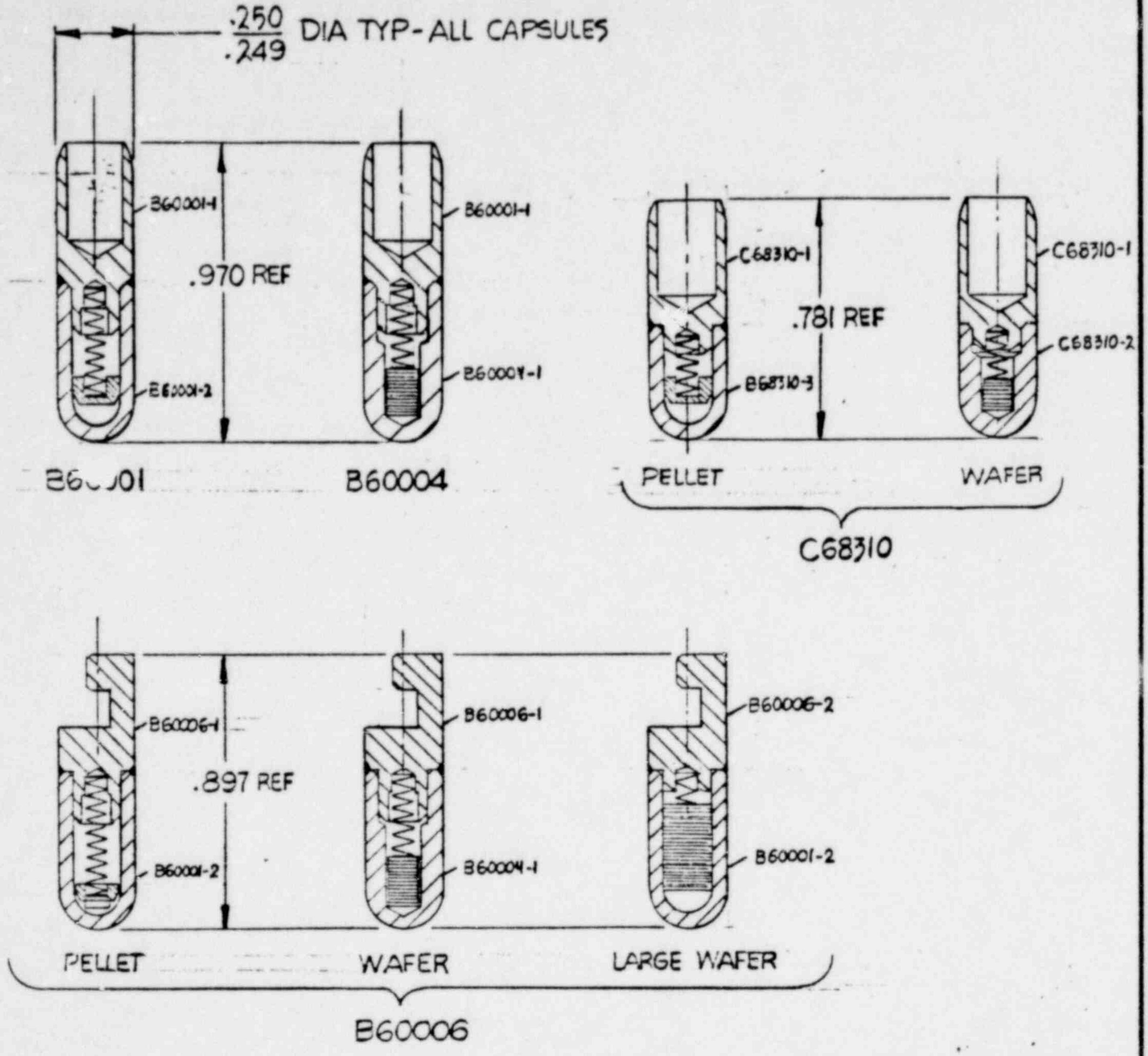

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MATERIALS	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE 192 IRIDIUM SOURCE REFERENCE
DRAWN BY 6 Oct 78 CHECKED BY APPROVED BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± / .XX ± / .XXX ± / ANGLES ± / FRACTIONS ±
CLASSIFICATION	SIZE A — DWG. NO. 60050 — REV. A
SCALE 2:1	SHEET 2 OF 2

SPAULDING CO., INC. 21-60169

RADIATION PRODUCTS DIVISION
NORTHWEST INDUSTRIAL PARK
BURLINGTON, MASSACHUSETTS 01803
(617) 272-2000

tech/ops

Telephone Conversation Record

28 November 1973

Mr. John G. Powers
Project Engineer
Nuclear Metals, Inc.
2229 Main Street
Concord, Massachusetts

and

Joseph Lima
Engineering Manager
Technical Operations, Inc.
Radiation Products Division

Mr. Powers performed a Thermal Test on a sample of bare depleted uranium. The sample, prior to the test, was a right circular cylinder measuring 0.432 inch diameter and 0.495 inch long. The mass of the sample was 22.2 grams.

The sample was placed in a thin wall ceramic crucible and inserted in a resistance heated furnace preheated to 1475^{0} F. The sample was heated for 30 minutes. The sample was then removed and allowed to air cool under a ventilated hood.

Mr. Powers reported that at, the conclusion of the test, the sample measured 0.418 inch diameter and 0.481 inch long. The mass of the sample was 20.8 grams.

Joseph Lima

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NUCLEAR METALS, INC.

2229 MAIN STREET
CONCORD, MASSACHUSETTS 01742
TELEPHONE 617 369-5410

28 January 1974

Technical Operations, Inc.
Radiation Products Division
South Avenue
Burlington, Massachusetts 01803

Attention: Mr. J. Lima

Gentlemen:

In response to a request by Joe Lima of Tech Ops, a simulated fire test was performed on samples of bare depleted uranium in contact with mild steel, the object being to determine what, if any, alloying or melting would occur under these conditions.

TEST DATA:

A 3/4-inch diameter x 5/8-inch long bare depleted uranium specimen was set on a 1-inch diameter x 1/8-inch thick mild steel plate, placed in a thin wall ceramic crucible. A mild steel cover plate was used on top of the crucible to act as a partial air seal. The crucible was loaded in a preheated 1450°F resistance heated furnace, held for 35 minutes, then removed and allowed to air cool under a ventilated hood.

RESULTS:

No reaction was evidenced between the two metals. Both separated readily and showed no alloying or melting characteristics.

Oxidation of the uranium was about the same degree as that reported to Joe Lima on an earlier experiment.

The test was performed by NMI on 25 January 1974.

Very truly yours,

John G. Powers
Project Engineer

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TEST REPORT

RADIATION PRODUCTS DIVISION

BY: David Marzilli

DATE: 8 October 1979

SUBJECT: Model 820 Penetration Test

On 8 October 1979, a penetration test was performed on a Technical Operations' Model 820 Shipping Container in accordance with 10CFR71, Appendix A.8 and IAEA Safety Series No. 6, 1973, paragraphs 714a and 714b.

The hemispherical end of a vertical steel cylinder 1.25 inches in diameter weighing 14 pounds was dropped from the height of 41 inches onto the geometric center of the top surface of the Model 820. There was no deformation and no damage which would affect the shielding or structural integrity of the package.

A second test was conducted using the same cylinder. It was dropped from a height of 41 inches onto the cylindrical surface of the package to attempt to produce penetration to the shield. There was no deformation and no damage which would affect the shielding or structural integrity of the package.

Documentary photographs are enclosed.

Performed by

David Marzilli

Witnessed by

William Urban

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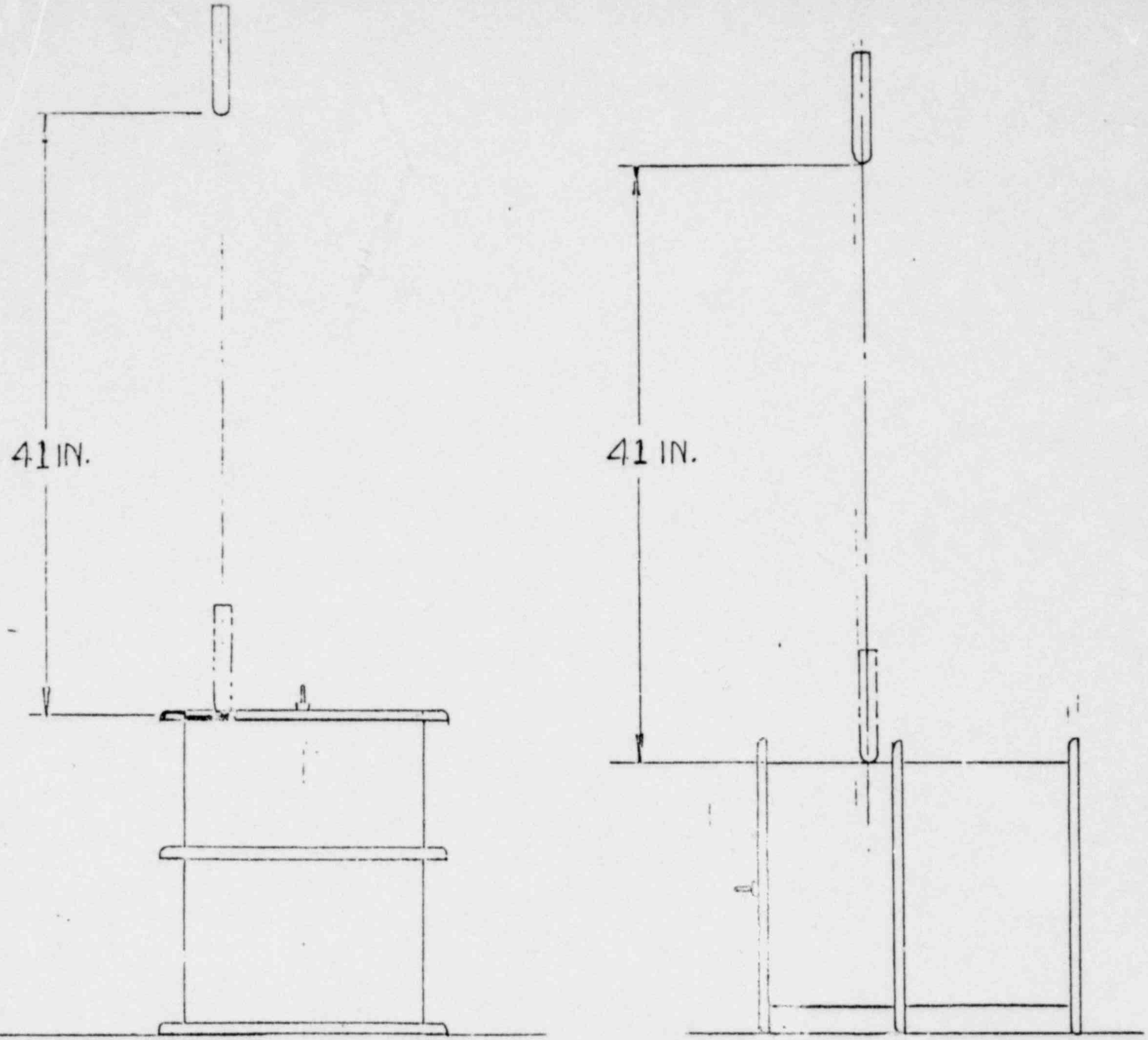
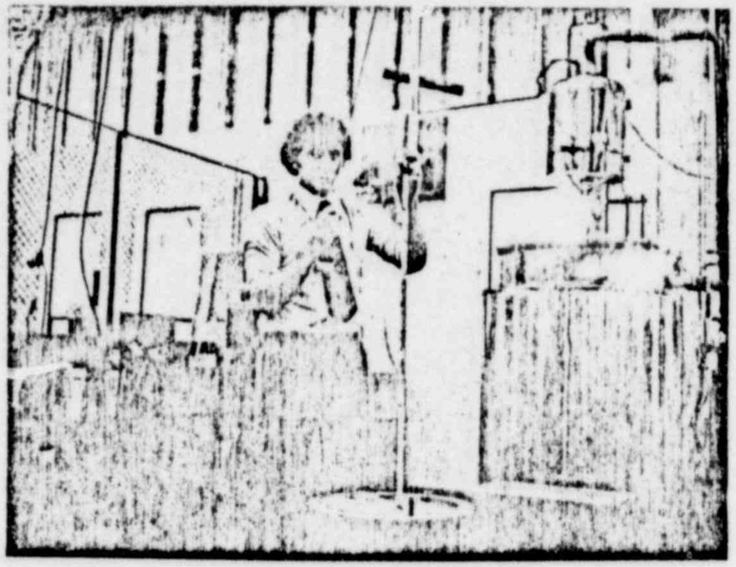
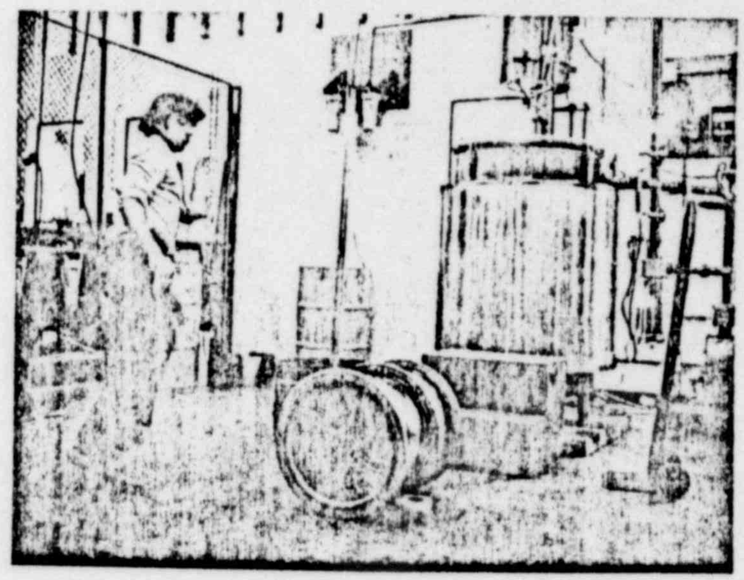


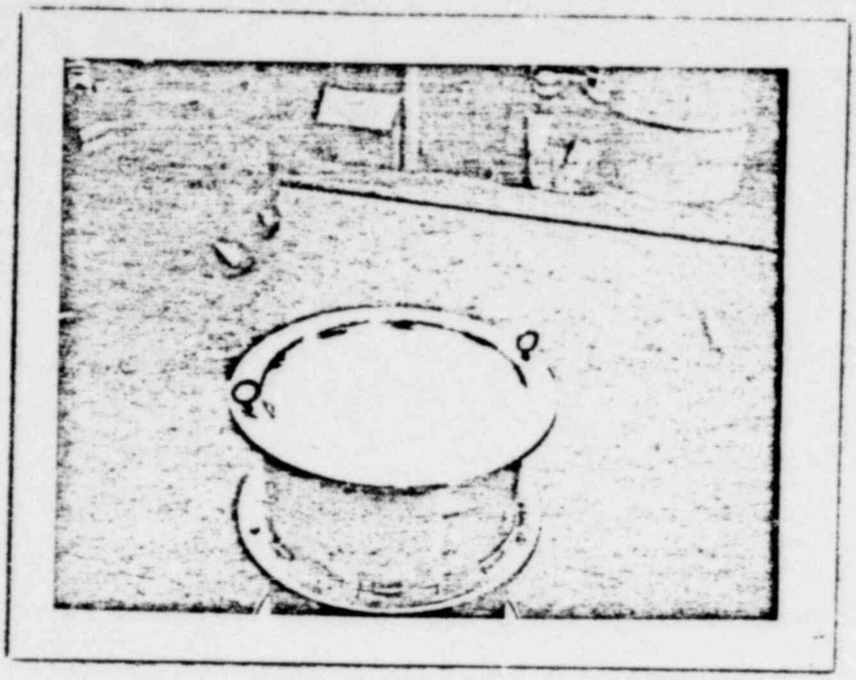
Model 820 Penetration Test

Model 820

Penetration Test







Model 820:

After Penetration Test

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2-16 1636 228

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: John J. Munro III JJM

DATE: 25 October 1979

SUBJECT: Drop and Puncture Tests of Model 820 Shipping Container

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On 25 October 1979, Model 820, Serial No. 1 was subjected to the free fall and puncture conditions of 10CFR71 Appendix B and IAEA Safety Series No. 6, 1973. The tests were conducted at the facilities of Baldwin Crane & Equipment Corporation, 232 Andover St., No. Wilmington, MA. Prior to conducting these tests, a radiation profile of the Model 820 was made. Eight dummy source assemblies were installed in the source changer to allow determination of any displacement of a source assembly during the tests.

Test 1 (Free Fall)

The target for this test was a steel plate 48 inches long, 48 inches wide and 0.5 inch thick. The plate was supported on an asphalt driveway which was supported by crushed rock to a depth of two feet.

The Model 820 was dropped from a height of 30 feet onto this target. The container impacted the target at an angle of approximately 45 degrees from vertical on the bottom rim of the container.

The Model 820 was again dropped from a height of 30 feet onto the target. The container impacted the target at an angle of approximately 75 degrees from the vertical on the top rim of the container.

Test 2 (Puncture)

The target for this test was a steel billet six inches in diameter and eight inches long mounted onto the target of Test 1.

The Model 820 was dropped from a height of forty inches onto the target. The container impacted the target vertically on the top surface.

The Model 820 was again dropped from a height of forty inches onto the target. The container impacted the target horizontally on the cylindrical portion of the lid.

Test Results

The two free fall tests caused deformation of the container housing. The two puncture tests caused minor indentation of the container housing.

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The container remained structurally intact throughout the testing. The dummy source assemblies remained in the proper storage position during the testing.

A result of a radiation profile of the container after being subjected to the test conditions was not significantly different than the earlier radiation profile results. Photographs are attached.

JJM/fb
Attachment

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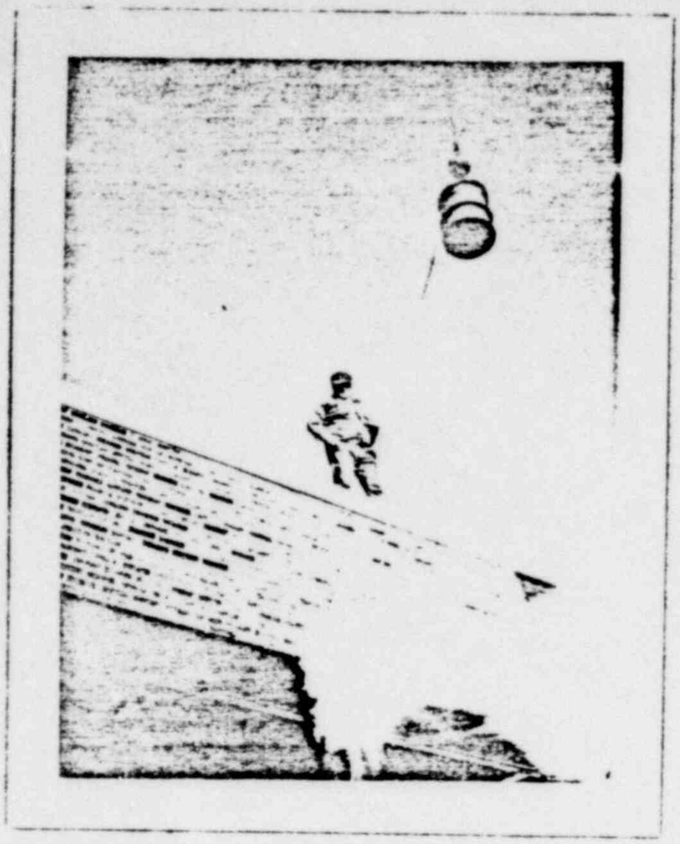

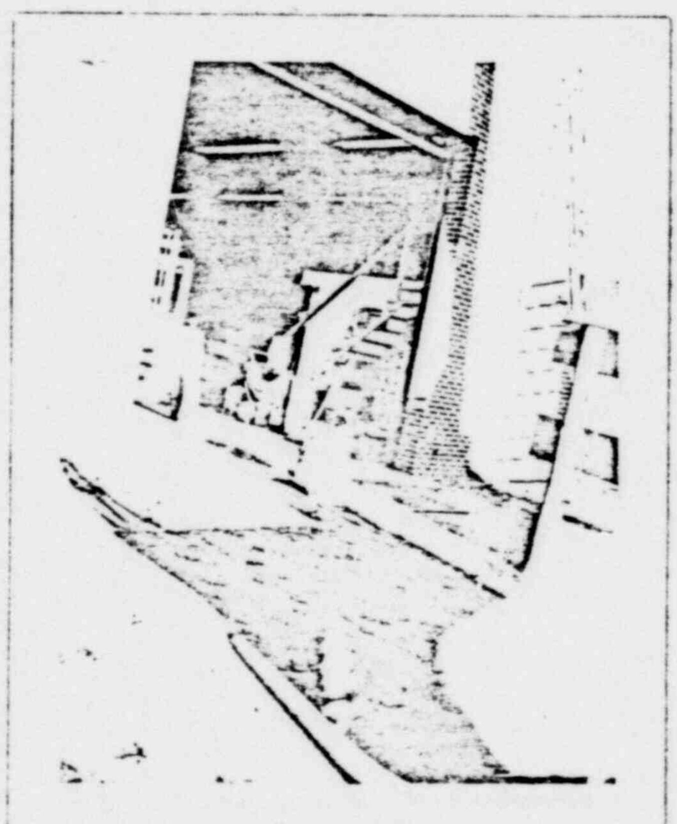

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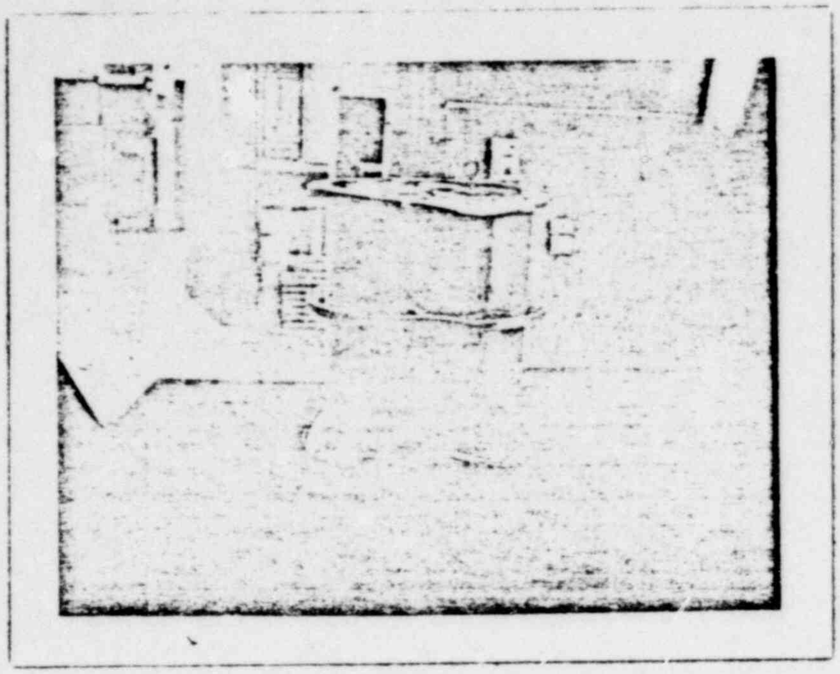

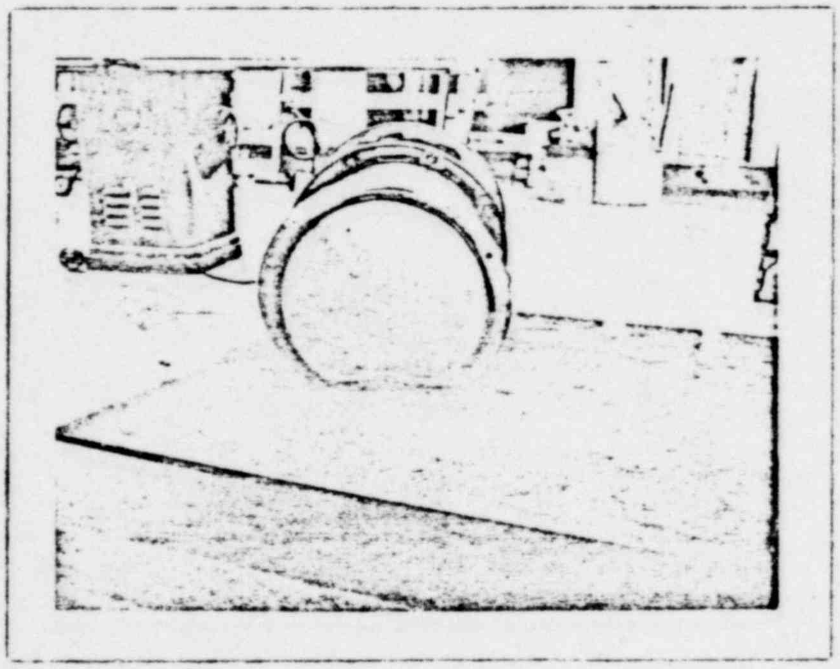

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DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY

Special Form Radioactive Material Encapsulation

REFER TO:

Certificate Number USA/0154/S

This certifies that the encapsulated sources, as described, when loaded with the authorized radioactive contents, have been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in IAEA[1] and USA[2] regulations for the transport of radioactive materials.

I. Source Description - The sources described by this certificate are identified as the Technical Operations, Inc., Models which are described and constructed as follows:

Model No.	Capsule Style	Approximate Size (in inches, diameter x length
A424-1	B60001 or B60004	.25 x .97
A424-6	B60001 or B60004	.25 x .97
A424-9	B60001 or B60004	.25 x .97
A424-20	B60001 or B60004	.25 x .97
A58101	B60006 Pellet, Wafer or Large Wafer	.25 x .90
A68309	C68310 Pellet or Wafer	.25 x .78
A81401	B60001 or B60004	.25 x .97
B69701	B60001 or B60004	.25 x .97

All capsules are constructed of either 304 or 304L stainless steel and conform with the following design drawings:

Capsule Style	Drawing Number
B60001	B60001 - 1 Rev. H and - 2 Rev. F
B60004	B60001 - 1 Rev. H and B60004 - 1 Rev. D
B60006 Pellet	B60006 - 1 Rev. H and B60001 - 2 Rev. F
B60006 Wafer	B60006 - 1 Rev. H and B60004 - 1 Rev. D
B60006 Large Wafer	B60006 - 2 and B60001 - 2 Rev. F
C68310 Pellet	C68310 Rev. B and B68310-3
C68310 Wafer	C68310 Rev. B

II. Radioactive Co tents - The authorized radioactive contents of these sources cons :t of not more than the following amounts of Iridium-192 as solid metal:

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Model No.	Contents (Curies)
A424-1	120
A424-6	120
A424-9	120
A424-20	240
A58101	240
A68309	120
A81401	120
B69701	120

III. This certificate, unless renewed, expires December 31, 1981.

This certificate is issued in accordance with paragraph 803 of the IAEA Regulations[1], and in response to the November 3, 1978, petition by Technical Operations. Inc., Burlington, Massachusetts, and in consideration of the associated information therein.

Certified by:

R R Rawl (signature) December 15, 1978

R. R. Rawl, Health Physicist (Date)
U. S. Department of Transportation
Office of Hazardous Materials Regulation
Washington, D. C. 20590.

[1]"Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1973 Revised Edition", published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2]Title 49, Code of Federal Regulations, Part 170-178, USA.

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3. Thermal Evaluation

3.1 Discussion

The Model 820 is a completely passive thermal device and has no mechanical cooling system nor relief valves. All cooling of the package is through free convection and radiation. The heat source is 1000 curies of iridium-192. The corresponding decay heat is 8.58 watts.

3.2 Summary of Thermal Properties of Materials

The melting points of the metals used in the construction of the Model 820 are:

Titanium	3308°F	(1820°C)
Steel	2453°F	(1345°C)
Uranium	2070°F	(1133°C)
Copper	1940°F	(1060°C)
Bronze	1840°F	(1005°C)

The polyurethane foam has a minimum operating range of -100°F (-73°C) to 200 F (93°C). It will decompose at the fire test temperature (800°C). Decomposition will result in gaseous byproducts which will burn in air.

3.3 Technical Specifications of Components

Not Applicable

3.4 Normal Conditions of Transport

3.4.1 Thermal Model

The heat source in the Model 820 is a maximum of 1000 curies of iridium-192. Iridium-192 decays with a total energy liberation of 1.45 MeV per disintegration or 8.58 milliwatts per curie. Assuming that all of the decay energy is transformed into heat, the heat generation rate for the 1000 curies of iridium-192 would be 8.58 watts. For this analysis, the heat source will be assumed to be 10 watts.

To demonstrate compliance with the requirements of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973 for Type B(U) packaging, an analysis is presented in Section 3.6. The thermal model employed is described in that analysis.

To demonstrate compliance with the requirements of paragraph 240 of IAEA Safety Series No. 6, 1973 for Type B(U) packaging, a separate analysis is presented in Section 3.6. The thermal model employed is described in that analysis.

3.4.2 Maximum Temperatures

The maximum temperatures encountered under normal conditions of transport will have no adverse effect on structural integrity or shielding. As shown in Section 3.6, the maximum temperature in the shade would be less than 44°C and the maximum temperature when insolated would be less than 74°C.

3.4.3 Minimum Temperatures

The minimum normal operating temperature of the Model 820 is -40°F (-40°C). This temperature will have no adverse affect on the package.

3.4.4 Maximum Internal Pressures

Normal operati-g conditions generate negligible internal pressures. Any pressure generated is significantly below that of the hypothetical accident pressure, which is shown to result in no loss of shielding or containment.

3.4.5 Maximum Thermal Stresses

The maximum temperatures that occur during normal transport are low enough to insure that thermal gradients will cause no significant thermal stresses.

3.4.6 Evaluation of Package Performance for Normal Conditions of Transport

The thermal conditions of normal transport are insignificant from a functional viewpoint for the Model 820. The applicable conditions of IAEA Safety Series No. 6, 1973 for Type B(U) packages have been shown to be satisfied by the Model 820.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Thermal Model

The Model 820, including the source assemblies, is assumed to reach the thermal test temperature of 800°C. At this temperature the polyurethane foam will have decomposed and the resulting gases will have escaped the package through vent holes and non-leak tight assembly joints.

3.5.2 Package Conditions and Environment

The Model 820 underwent no significant damage during the free drop and puncture tests. The package used in this analysis is considered undamaged.

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3.5.3 Package Temperatures

As indicated in Section 3.5.1, the entire package is assumed to reach a temperature of 800°C. Examination of the melting temperatures of the materials used in the construction of the Model 820 indicates that there will be no damage to the package as a result of this temperature. The possibility of the formation of an iron-uranium eutectic alloy was addressed in Section 2.4.1 where it was concluded that the formation of the alloy was not a likely eventuality.

3.5.4 Maximum Internal Pressures

The Model 820 packaging is open to the atmosphere. Therefore, there will be no pressure buildup within the package. In Section 3.6, an analysis of the source capsules under the thermal test condition demonstrates that the maximum internal gas pressure at 800°C is 55psi (380 kN/m^2).

The critical location for failure is the weld. An internal pressure of 55psi (380 kN/m^2) will generate a maximum stress of 291psi (2.0 MN/m^2). At a temperature of 870°C (1600°F), the yield strength of Type 304 stainless steel is 10,000psi (69 MN/m^2).

Thus, at 800 C, the maximum stress in the source capsule would be only 3% of the yield strength of the material.

3.5.5 Maximum Thermal Stresses

There are no significant thermal stresses generated during the thermal test.

3.5.6 Evaluation of Package Performance

The Model 820 will undergo no loss of structural integrity or shielding when subjected to the thermal accident condition. The pressures and temperatures have been demonstrated to be within acceptable limits.

3.6 APPENDIX

3.6.1 Model 820 Type B(U) Thermal Analysis: Paragraphs 231 and 232 of IAEA Safety Series No. 6, 1971

3.6.2 Model 820 Type B(U) Thermal Analysis: Paragraph 240 of IAEA Safety Series No. 6, 1973

3.6.3 Iridium Source Capsules Thermal Analysis

3.6.1 Model 820 Type B(U) Thermal Analysis

Paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973

This analysis demonstrates that the maximum surface temperature of the Model 820 will not exceed 50°C with the package in the shade and an ambient temperature of 38°C.

To assure conservatism, the following are used:

1) The entire decay heat (10 watts) is deposited in the exterior faces of the Model 820.

2) The interior of the Model 820 is perfectly insulated and heat transfer occurs only from the exterior wall to the atmosphere.

3) Because each face of the package eclipses a different solid angle, it is assumed that twenty five percent of the total heat is deposited in the smallest face (top).

4) The only heat transfer mechanism is free convection.

Using these assumptions, the maximum wall temperature is found from:

$$q = hA (T_w - T_a)$$

where q : Heat deposited per unit time in the face of interest (2.5 watts)

h : Free convective heat transfer coefficient for air ($1.57(\Delta T)^{1/4}$ $w/m^2\text{-}^oC$)

A : Area of the face of interest ($0.193m^2$)

T_w: Maximum temperature of the wall of the package

T_a: Ambient temperature (38°C)

From this relationship, the maximum temperature of the wall is 43.4°C. This satisfies the requirement of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973.

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3.6.2 Model 820 Type B(U) Thermal Analysis

Paragraph 240 of IAEA Safety Series No. 6, 1973

This analysis demonstrates that the maximum surface temperatures of the Model 820 will not exceed 82°C when the package is in an ambient temperature of 38°C and insolated in accordance with paragraph 240 of IAEA Safety Series No. 6, 1973.

The calculational model consists of taking a steady state heat balance over the surface of the package. The following assumptions are used.

1) The package is insolated at the rate of $775 w/m^2$ ($800 cal/cm^2$ - 12h) on the top surface, $388 w/m^2$ ($400 cal/cm^2$ - 12h) on the sides, and no insolation on the bottom.

2) The decay heat load is considered negligible.

3) The package has an unfinished stainless steel surface.
The solar absorptivity is assumed to be 0.9
The solar emissivity is assumed to be 0.8

4) The package is assumed to undergo free convection from the sides and top, and undergo radiation from the sides, top and bottom. The inside faces are considered insulated so there is no conduction into the package. The faces are considered to be sufficiently thin that no temperature gradients exist in the faces.

5) The package is approximated as a right circular cylinder resting on an end. The surface areas of the top and bottom are each $0.193 m^2$. The surface area of the side is $0.719 m^2$.

The maximum surface temperature is established from a steady state heat balance relationship.

$$q\ in = q\ out$$
$$= q_c + q_r$$

where q_c: Convective Heat Transfer
q_r: Radiative Heat Transfer

The heat load applied to the package is

$$q\ in = \alpha\, q_s$$

where α : Absorptivity (0.9)
q_s: Solar heat lead (429 watts)

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The convective heat transfer is:

$$q_c = \left[(hA)_{top} + (hA)_{sides}\right](T_w - T_a)$$

where h : Convective heat transfer coefficient
A : Area of surface of interest
T_w: Temperature of wall
T_a: Ambient Temperature

The heat transfer due to radiation is:

$$q_r = \sigma \epsilon A(T_w^4 - T_a^4)$$

where σ: Stefan Boltzmann Constant
ϵ: Emissivity (0.8)

Iteration of this relationship demonstrates that the wall temperature of the Model 820 is 73.8 C which satisfies the requirement of paragraph 240 of IAEA Safety Series No. 6, 1973.

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3.6.3 Model 820 Type B(U)

Source Capsules - Thermal Analysis

Paragraph 238 of IAEA Safety Series No. 6, 1973

This analysis demonstrates that the pressure inside the source capsules used in conjunction with the Model 820, when subjected to the thermal test, does not exceed the pressure which corresponds to the minimum yield strength at the thermal test temperature.

The source capsules are fabricated from stainless steel, Type 304 or 304L. The outside diameter of the capsules is 0.250 inch (6.35mm). The source capsules are seal welded. The minimum weld penetration is 0.020 inch (0.5mm). Under conditions of internal pressure, the critical location for failure is this weld.

The internal volume of the source capsules contains only iridium metal (as a solid) and air. It is assumed at the time of loading the entrapped air is at standard temperature and pressure (20°C; 100kN/m²). We contend that this is a conservative assumption because, during the welding process, the internal air is heated, causing some of the air mass to escape before the capsule is sealed. When the welded capsule returns to ambient temperatures, the internal pressure would be somewhat reduced.

Under conditions of paragraph 238 of IAEA Safety Series No. 6, it is assumed that the capsule could reach a temperature of 1475°F (800°C). Using the ideal gas law and requiring the air to occupy a constant volume, the internal gas pressure could reach 373kN/m² (54psi).

The capsule is [illegible]ed to be a thin-walled cylindrical pressure vessel.

The maximum longitudinal stress is calculated from:

$$\sigma_l A_l = P A_p$$

where σ_l: Longitudinal stress

A_l: Stress Area = $\pi (r_o^2 - r_i^2)$

P: Pressure

A_p: Pressure Area = πr_i^2

From this relationship, the maximum longitudinal stress is calculated to be 894kN/m² (129psi).

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The hoop stress can be found by:

$$2\,\sigma_h l t = P l d_i$$

where σ_h : hoop stress

l : length of the cylinder

t : thickness of cylinder

From this relationship, the hoop stress is calculated to be $1.96 MN/m^2$ (284psi).

At a temperature of 1600°F (870°C), the yield strength of type 304 stainless steel is 10,000psi ($69 MN/m^2$). Thus, under the conditions of paragraph 238 of IAEA Safety Series No. 6, 1973, the stress generated is less than 3% of the yield strength of the material.

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4. Containment

4.1 Containment Boundary

4.1.1 Containment Vessel

The containment systems for the Model 820 are the radioactive source assemblies as listed in Section 1.2.3 of this application. The actual containment for the radioactive material is the welded source capsules as shown in Section 2.10. These source assemblies are certified as special form radioactive materials (IAEA Certificate of Competent Authority No. USA/0154/S).

The capsules are fabricated from either Type 304 or Type 304L stainless steel. The capsules are rounded cylinders with a diameter of 0.25 inch (6.35mm) and lengths of either 0.78 inch (19.8mm) or 0.97 inch (24.6mm).

4.1.2 Containment Penetrations

There are no penetrations of the containment.

4.1.3 Seals and Welds

The containment is seal welded by a tungsten inert gas welding process which is described in Tech/Ops Standard Source Encapsulation Procedure (Section 7.4). The minimum weld penetration is 0.020 inch (0.51mm).

4.1.4 Closure

Not Applicable

4.2 Requirements for Normal Conditions of Transport

4.2.1 Release of Radioactive Material

The source assemblies have satisfied the requirements for Special Form Radioactive Material as delineated in IAEA Safety Series No. 6, 1973 edition and 10CFR71. Therefore, there will be no release of radioactive material under the normal conditions of transport.

4.2.2 Pressurization of the Containment Vessel

Pressurization of the source capsules under the conditions of the hypothetical thermal accident was demonstrated to generate stresses well below the structural limits of the capsule (See Section 3.5). Thus, the containment will withstand the pressure variations of normal transport.

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4.2.3 Coolant Contamination

Not Applicable

4.2.4 Coolant Loss

Not Applicable

4.3 Containment Requirements for the Hypothetical Accident Condition

4.3.1 Fission Gas Products

Not Applicable

4.3.2 Release of Contents

The hypothetical accident conditions of 10CFR71, Appendix B will result in no loss of package containment as shown in Sections 2.7.1, 2.7.2 and 3.5.

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5. Shielding Evaluation

5.1 Discussion and Results

The Model 820 is shielded with 120 pounds of depleted uranium. The uranium metal is cast around the titanium "J" tube. A radiation profile of Model 820 Serial No. 1 containing 860 curies of iridium-192 was made. The results of this survey are presented in Section 5.5.1. Extrapolation of this data to a capacity of 1000 curies of iridium-192 is presented in Table 5.1. As the Model 820 has no neutron source, the gamma dose rates are the total dose rates which are presented. As shown in Table 5.1, the maximum dose rates are below the regulatory requirements.

Table 5.1
Summary of Maximum Dose Rates
(mR/hr)

At Surface			At One Meter		
Side	Top	Bottom	Side	Top	Bottom
26	33	56	0.7	2.0	1.7

5.2 Source Specification

5.2.1 Gamma Source

The gamma source is iridium-192 in a sealed capsule as special form in quantities up to 1000 curies.

5.2.2 Neutron Source

Not Applicable

5.3 Model Specification

Not Applicable

5.4 Shielding Evaluation

The Model 820 shielding evaluation was performed on Model 820, Serial No. 1 containing 860 curies of iridium-192. The results of this survey (Section 5.5.1) demonstrate that the dose rates surrounding this package are within the regulatory requirements. A radiation profile made on this package after being subjected to the hypothetical accident conditions, (Section 5.5.2) show that there was no significant change in the shielding effectiveness.

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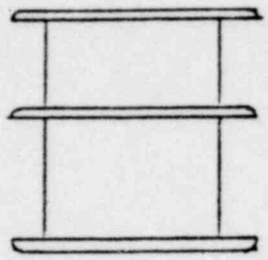
5.5 Appendix

5.5.1 Radiation Profile - Model 820, Serial Number 1

5.5.2 Radiation Profile - Model 820, Serial Number 1 after hypothetical accident conditions

5.5.1 RADIATION PROFILE

Model 820 Serial No. 1



Containing Source Assemblies Model A424-9

S.N.	6431	105Ci	S.N.	6428	107Ci
S.N.	6425	108Ci	S.N.	6429	110Ci
S.N.	6426	109Ci	S.N.	6430	105Ci
S.N.	6427	109Ci	S.N.	6432	107Ci

Total Activity: 860 curies of iridium-192

Maximum Dose Pates (mR/hr)

	@ Surface	@ One Meter
Top	28	1.7
Sides	22	0.6
Bottom	48	1.5

Measurements were made with an AN/PDR-27(J) Survey Instrument.

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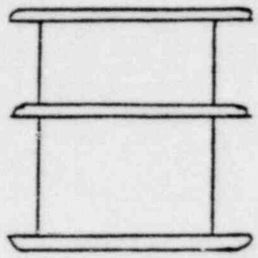
5.5.2

RADIATION PROFILE

Model 820 Serial No. 1

After Hypothetical Accident Conditions



Containing Source Assemblies A424-9 and A424-1*

S.N.	6953	106Ci	S.N.	6957	106Ci
S.N.	6952	107Ci	S.N.	6956	109Ci
S.N.	6951	109Ci	S.N.	6955	107Ci
S.N.	9991*	107Ci	S.N.	6954	99Ci

Total Activity: 850 curies of iridium-192

Maximum Dose Rates (mR/hr)

	@ Surface	@ One Meter
Top	40	1.5
Sides	20	0.7
Bottom	30	1.0

Measurements were made with an AN/PDR-27(J) Survey Instrument.

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6. <u>Criticality Evaluation</u>

Not Applicable

7. Operating Procedures

7.1 Procedures for Loading the Package

The procedure for fabricating the special form source capsule is presented in Section 7.4. The procedure for loading the source assemblies into the package is presented in Section 7.4.

7.2 Procedures for Unloading the Package

The procedure for unloading the package is presented in Section 7.4.

7.3 Preparation of an Empty Package for Transport

The procedure for preparation of an empty package for transport is presented in Section 7.4.

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7.4 Appendix

Procedure for Encapsulation of Sealed Sources

Model 820 Opeesting Manual

RADIATION SAFETY MANUAL
Part II In Plant Operations
Section 2

ENCAPSULATION OF SEALED SOURCES

A. Personnel Requirements

Only an individual qualified as a Senior Radiological Technician shall perform the operations associated with the encapsulation of ^{192}Iridium. There must be a second qualified Radiological Technician available in the building when these operations are being performed.

B. General Requirements

The ^{192}Iridium loading cell shall be used for the encapsulation of solid metallic ^{192}Iridium and the packaging of sealed sources such as ^{170}Thulium, ^{137}Cesium and ^{169}Ytterbium. Solid metallic ^{60}Cobalt not exceeding one curie may be handled in this cell also.

The maximum amount of ^{192}Iridium to be handled in this cell at any one time shall not exceed 1000 curies. The maximum amount of ^{137}Cs to be handled in this cell at any one time shall not exceed 100 curies.

This cell is designed to be operated at less than atmospheric pressure. The exhaust blower provided shall not be turned off except when the cell is in a decontaminated condition.

Sources shall not be stored in this cell overnight or when cell is unattended. Unencapsulated material shall be returned to the transfer containers and encapsulated sources transferred to approved source containers.

When any of the "through-the-wall" tools such as the welding fixture or transfer pigs are removed, the openings are to be closed with the plugs provided. These tools shall be decontaminated whenever they are removed from the hot cell.

C. Preparatory Procedure

1. Check welding fixture, capsule drawer and manipulator fingers from cell and survey for contamination. If contamination in excess of 0.001 μCi of removable contamination is found, these items must be decontaminated.

2. If the welding fixture or the electrodes have been changed, perform the encapsulation procedure omitting the insertion of any activity. Examine this dummy capsule by sectioning thru weld. Weld penetration must be not less than 0.020 inch.

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If weld is sound and penetration is at least 0.020 inch, the preparation of active capsules may proceed. If not, the condition responsible for an unacceptable weld must be corrected and the preparatory procedure repeated.

3. Check pressure differential across first absolute filter, as measured by the manometer on the left side of the hot cell. This is about ½ inch of water for a new filter. When this pressure differential rises to about 2 inches of water, the filter must be changed.

D. Encapsulation Procedure

1. Prior to use, assemble and visually inspect the two capsule components to determine if weld zone exhibits any misalignment and/or separation. Defective capsules shall be rejected.

2. Degrease capsule components in the Ultrasonic Bath, using isopropyl alcohol as degreasing agent, for a period of 10 minutes. Dry the capsule components at 100°C for a minimum of twenty minutes.

3. Insert capsule components into hot cell with the posting bar.

4. Place capsule in weld positioning device.

5. Move drawer of source transfer container into hot cell.

6. Place proper amount of activity in capsule . Disposable funnel must be used with pellets and a brass rivet with wafers to prevent contamination of weld zone.

7. Remove unused radioactive material from the hot cell by withdrawing the drawer of the source transfer container from the cell.

8. Remove funnel or rivet.

9. Assemble capsule components.

10. Weld adhering to the following conditions:

    a. Electrode spacing .021" to .024" centered on joint ±.002"; use jig for this purpose.

    b. Preflow argon, flush 10 seconds.

    c. Start 15 amps.

    d. Weld 15 amps.

    e. Slope 15 amps.

    f. Post flow 15 seconds

11. Visually inspect the weld. An acceptable weld must be continuous without cratering, cracks or evidence of blow out. If the weld is defective, the capsule must be cleaned and rewelded to acceptable conditions or disposed of as radioactive waste.

12. Check the capsule in height gauge to be sure that the weld is at the center of the capsule.

13. Wipe exterior of capsule with flannel patch wetted with EDTA solution or equivalent.

14. Count the patch with the scaler counting system. Patch must show no more than .005 μCi of contamination. If the patch shows more than .005 μCi, the capsule must be cleaned and rewiped. If the rewipe patch still shows more than 0.005 μCi of contamination, steps 8 through 11 must be repeated.

15. Vacuum bubble test the capsule. Place the welded capsule in a glass vial containing isopropyl alcohol. Apply a vacuum of 15 in Hg (Gauge). Any visual detection of bubbles will indicate a leaking source. If the source is determined to be leaking, place the source in a dry vacuum vial and boil off the residual alcohol. Reweld the capsule.

16. Transfer the capsule to the swaging fixture. Insert the wire and connector assembly and swage. Hydraulic pressure should not be less than 1250 nor more than 1500 pounds.

17. Apply the tensile test to assembly between the capsule and connector by applying proof load of 75 lbs. Extension under the load shall not exceed 0.1 inch. If the extension exceeds 0.1 inch, the source must be disposed of as radioactive waste.

18. Position the source in the exit port of hot cell. Withdraw all personnel to the control area. Use remote control to insert source in the ion chamber and position the source for maximum response. Record the meter reading. Compute the activity in curies and fill out a temporary source tag.

19. Using remote control, eject the source from cell into source changer through the tube gauze wipe test fixture. Monitor before reentering the hot cell area to be sure that the source is in the source changer. Remove the tube gauze and count with scaler counting system. This assay must show no more than 0.005 μCi. If contamination is in excess of this level, the source is leaking and shall be rejected.

20. Complete a Source Loading Log (Figure II.2.1) for the operation.

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TECH/OPS MODEL 820

SOURCE CHANGER - SHIPPING CONTAINER

OPERATION MANUAL

Technical Data

Size:	19.5 in. diameter, 21.5 in. high (495 mm diameter, 546 mm high)
Capacity:	1000 Curies of ^{192}Iridium Special Form
Transport Status:	Type B USNRC USA/ /B IAEA USA/ /B( )
Shielding:	Depleted Uranium Metal 120 Lbs. (55kg)

General

The Model 820 Source Changer - Shipping Container is designed for transferring encapsulated radioisotope sources into radiographic devices and for transporting these sources.

The U.S. Nuclear Regulatory Commission allows the use of this source changer only if the user is specifically authorized by the terms of his license.

If the user is not authorized to make source exchanges, contact Technical Operations, Inc. It has personnel who are authorized to perform this operation. If the user wishes to be licensed to make source exchanges, application should be made to:

Radioisotope Licensing Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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Prior to the first shipment of this source changer, the user, in addition should register with:

Transportation Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Shipping Information

When the 820 Source Changer is shipped to the user the following items are included in addition to the radioisotope sources.

1. For Each Source
   a. Source decay chart
   b. Source leak test certification
   c. Verification of source physical dimensions
   d. Source identification tag
2. Tamperproof Seal
3. Return Shipping Labels
4. Instruction Manual

- NOTE -

The user is urged to perform the source changing operation as soon as possible after receipt and to return the source changer immediately upon completion of the changing operation. Only in this way can we keep these source changers in continued use.

Receipt

1. Upon receipt of the source changer, survey the container on all sides to ensure radiation levels do not exceed the following:

Surface	200 mR/hr
At One Meter	10 mR/hr

2. Check surface of container for obvious damage.
3. Check Invoice and Bill of Lading to ensure all are intact and are representative of the shipment.

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4. If there are any discrepancies in Items 1-3 above, do not use the source changer and contact Technical Operations, Inc. immediately to resolve discrepancy. (Tel: 800-225-7383 Telex 949313)

5. If items 1-3 are determined to be in order, place the source changer in a restricted area until ready to use.

Operation

- NOTE -

Personnel performing source changing operation must have a calibrated and operational survey meter with a range of at least 0-1000 mR/hr. In addition, personnel monitoring devices must be worn during these operations. They are, a film badge (or Thermoluminescent Dosimeter, TLD) and a direct reading pocket dosimeter. (10CFR34.33)

1. Survey the container on all sides and ensure radiation levels are not in excess of 200 mR/hr on the surface nor 10 mR/hr at one meter from any surface.

2. Place the source changer and the projector(s) to be loaded in a restricted area which is properly identified.

3. Break the seal wire, unfasten the bolts and remove the top.

4. To transfer the source from the projector to the source changer:

   a. Connect the control unit to the projector as for an exposure.

   b. Connect one length of source guide tube to the projector and to the empty hole on the source changer.

   c. Ensure the lock is open and the source guides are closed.

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d. Ensure that there are no unauthorized personnel in the restricted area and place the projector in the operate condition.

e. Leave the area of the projector and source changer and, using the control unit, crank the source from projector to the source changer.

f. Approach the projector observing the survey meter. Survey the projector on all sides to ensure the source has been properly transferred. The radiation level at the surface of the projector should be less than the original survey readings observed.

g. Approach the source changer observing the survey meter and verify that the source is in the proper storage position.

h. Depress the plunger lock to lock the source in the storage position.

i. Open the source guides and disconnect the source assembly.

j. Disengage source guide tube from source changer.

k. Remove source ID tag from projector and attach to guide tube opening on source changer. Be sure the proper ID tag is attached to the proper source.

5. To transfer a source from the source changer:

a. Survey the source changer on all sides to ensure the sources are properly stored.

b. Survey the projector to ensure it does not have a source in it.

c. Connect the source changer to the projector using one length of source guide tube.

d. Crank the control unit drive cable through the projector until the male connector end protrudes beyond the guide tube enough to make connection to the source.

e. Connect the source to the control unit drive cable.

f. Close the source guides.

g. Ensure all unauthorized personnel are out of the restricted area.

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h. Unlock the plunger lock on the source changer.

i. Return to the control unit and crank the source drive in the retract direction until the source is stored in the projector.

j. Approach the projector observing the survey meter and survey on all sides to ensure the source is in the proper stored position.

k. Lock projector and disconnect guide tubes and control unit.

l. Remove source ID tag from source changer and attach to projector.

6. When source transfers are completed, insure all sources are properly stored and locked in the source changer. Source guides may be left open.

7. Place the cover on the source changer and install all bolts.

8. To return source changer:

   a. Safety lock wire the changer and crimp lead seal.

   b. Survey container at the surface and at one meter, and determine proper shipping label in accordance with Table I.

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TABLE I

	Surface	3 Feet
RADIOACTIVE-WHITE I 	0.5mR/hr	None
RADIOACTIVE-YELLOW II 	50mR/hr	1.0mR/hr
RADIOACTIVE-YELLOW III 	200mR/hr	10mR/hr

c. Fill out information requested on Label indicating:

a. Contents (Isotope)
b. No. of Curies
c. Transport Index

The Transport Index is determined by observing the maximum reading at 1 meter from the source container. This reading becomes the Transport Index.

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d. Remove all old shipping labels.

- NOTE -

Do not remove metal container identification label.

e. Affix new shipping labels to two opposite sides.

f. Properly complete the shipping papers indicating:

Proper shipping name (i.e. Radioactive Material, Special Form, n.o.s.)

Name of Radionuclide (i.e. ^{192}Iridium)

Physical or chemical form (or Special Form)

Activity of Source (expressed in curies or millicuries)

Category of Label applied (i.e. Radioactive Yellow III)

Transport Index

USNRC Identification Number

For export shipments, IAEA Identification Number

Shipper's Certification:

"This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transport according to the applicable regulations of the Department of Transportation."

Notes: 1. For air shipments, the following shipper's certification may be used:

"I hereby certify that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in proper condition for carriage by air according to applicable national governmental regulations".

2. For air shipments, the package must be labeled with a "CARGO AIRCRAFT ONLY" label and the shipping papers must state:

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"THIS SHIPMENT IS WITHIN THE LIMITATIONS PRESCRIBED FOR CARGO-ONLY AIRCRAFT."

G. Return the container to:

Technical Operations, Inc.
40 North Avenue
Burlington, MA 01803
USA

Preparation of an Empty Package for Transport

1. To prepare an empty package for transport, follow the instructions of the operating procedure above beginning with Step 8 with the following exceptions:

   a. The package must be marked "Radioactive Material - LSA-NOS".

   b. The proper shipping name is Radioactive Material - LSA-n.o.s.

   c. Radionuclide is Depleted Uranium.

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8. Acceptance Tests and Maintenance Program

8.1 Acceptance Tests

8.1.1 Visual Inspection

The package is visually examined to assure that the appropriate fasteners are properly seal wired and that the package is properly marked.

The seal weld of the radioactive source capsule is visually inspected for proper closure.

8.1.2 Structural and Pressure Tests

The swage coupling between the source capsule and cable is subjected to a static tensile test with a load of seventy five pounds. Failure of this test will prevent the source assembly from being used.

8.1.3 Leak Tests

The radioactive source capsule (the primary containment) is wipe tested for leakage of radioactive contamination. The source capsule is subjected to a vacuum bubble leak test. The capsule is then subjected to a second wipe test for radioactive contamination. These tests are described in Section 7.4. Failure of any of these tests will prevent use of this source assembly.

8.1.4 Component Tests

The lock assembly of the package is tested to assure that the security of the source will be maintained. Failure of this test will prevent use of the package until the lock assembly is corrected and retested.

8.1.5 Tests for Shielding Integrity

The radiation levels at the surface of the package and at three feet from the surface are measured using a small detector survey instrument (i.e. AN/PDR-27). These radiation levels, when extrapolated to the rated capacity of the package, must not exceed 200 milliroentgens per hour at the surface nor ten milliroentgens per hour at three feet from the surface of the package. Failure of this test will prevent use of the package.

8.1.6 Thermal Acceptance Tests

Not Applicable

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8.2 Maintenance Program

8.2.1 Structural and Pressure Tests

Not Applicable

8.2.2 Leak Tests

As described in Section 8.1.3, the radioactive source assembly is leak tested at manufacture. Additionally, the source assembly is wipe tested for leakage of radioactive contamination every six months.

8.2.3 Subsystem Maintenance

The lock assembly is tested as described in Section 8.1.4, prior to each use of the package. Additionally, the package is inspected for tightness of fasteners, proper seal wires and general condition prior to each use.

8.2.4 Valves, Rupture Discs and Gaskets

Not Applicable

8.2.5 Shielding

Prior to each use, a radiation survey of the package is made to assure that the radiation levels do not exceed 200 milliroentgens per hour at the surface nor ten milliroentgens per hour at three feet from the surface.

8.2.6 Thermal

Not Applicable

8.2.7 Miscellaneous

Inspections and tests designed for secondary users of this package under the general license provisions of 10CFR71.12(b) are included in Section 7.4.

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