Tech/Ops

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

SAFETY ANALYSIS REPORT

TECH/OPS

MODEL 850

TYPE B PACKAGE

8012100672

1. General Information

Introduction

Tech/Ops Model 850 is designed for use as a source changer and shipping container for Type B quantities of radioactive material in special form. The Model 850 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 Revised EDITION.

1.2 Package Description

1.2.1 Packaging

The Model 850 is 10.4 inches (264mm) high, 8.5 inches (216mm) wide and 8.8 inches (224 mm) deep. The gross weight of the package is 77 pounds (35kg).

The radioactive source assemblies are housed in titanium "U" tubes. The tube has an outside diameter of 0.56 inch (14.3mm) and a wall thickness of 0.03 inch (0.8mm). A source stop is installed in one side of the "U" tube to provide positive positioning of the source assembly at the appropriate storage location.

The source tubes are surrounded by depleted uranium metal for shielding. The uranium metal is cast around the titanium source tubes. The weight of the uranium shield is 49 pounds (22kg).

The uranium shield assembly is encased in a stainless steel housing. The shield assembly is supported on the bottom by a stainless steel support plate which is attached to the package housing. The shield assembly is supported on the top by the lock assemblies. Horizontal movement of the shield assembly is restrained by the studs which mount the support plate to the housing. Rotation of the shield assembly is prevented by engagement of the titanium "U" tubes with the lock assemblies. Copper separators are used to prevent iron-uranium interfaces.

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

Mounted on the top of the package in the lock plate weldments are the lock assemblies. These lock assemblies are used to secure the radioactive source assemblies in the proper shielded position during transport. Cover plates, fabricated from stainless steel, are installed on the package to provide protection of the locking assemblies.

Tamperproof seals are provided during shipment of these packages. Two vent holes in the package provide passageways for the escape of any

gas generated from the decomposition of the polyurethane foam in the event that 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. The lock slide engages an undercut in the source assembly preventing movement. The lock slide is secured in position by means of a key operated plunger lock.

1.2.3 Contents of the Package

The Model 850 is designed for the transport of iridium-192 in quantities up to 240 curies as Tech/Ops source assembly Model 90003. This source assembly contains either a Model 90004 or Model 90005 source capsule. These capsules satisy the criteria for special form radioactive material in accordance with 10CFR71 and IAEA Safety Series No. 6, 1973 Edition (Section 2.8).

1.3 Appendix

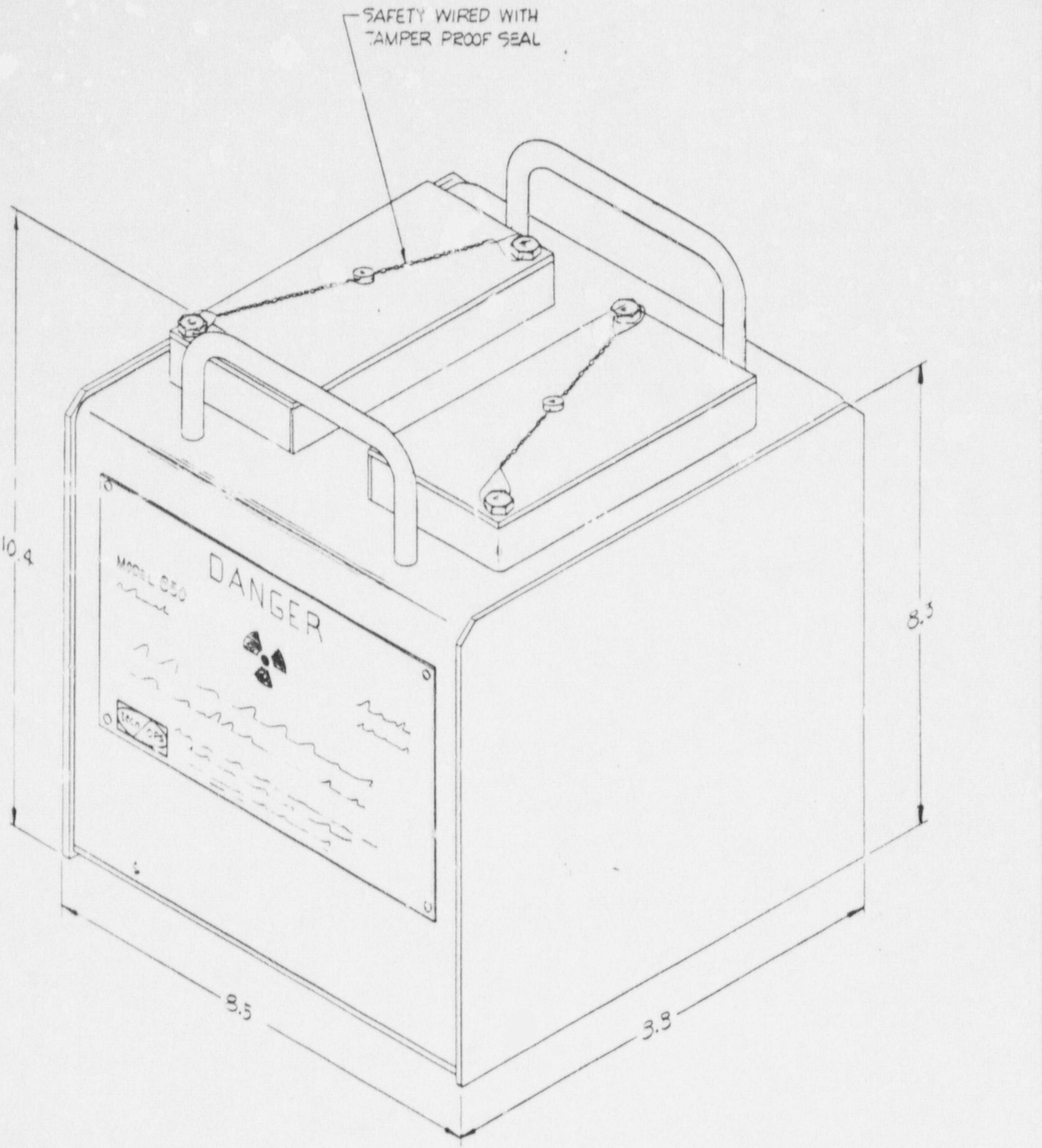
Drawing 85090 Sheets 1 - 5 Descriptive Assembly

Drawing 85092 Label

Drawing 90091 Source Assembly

85090

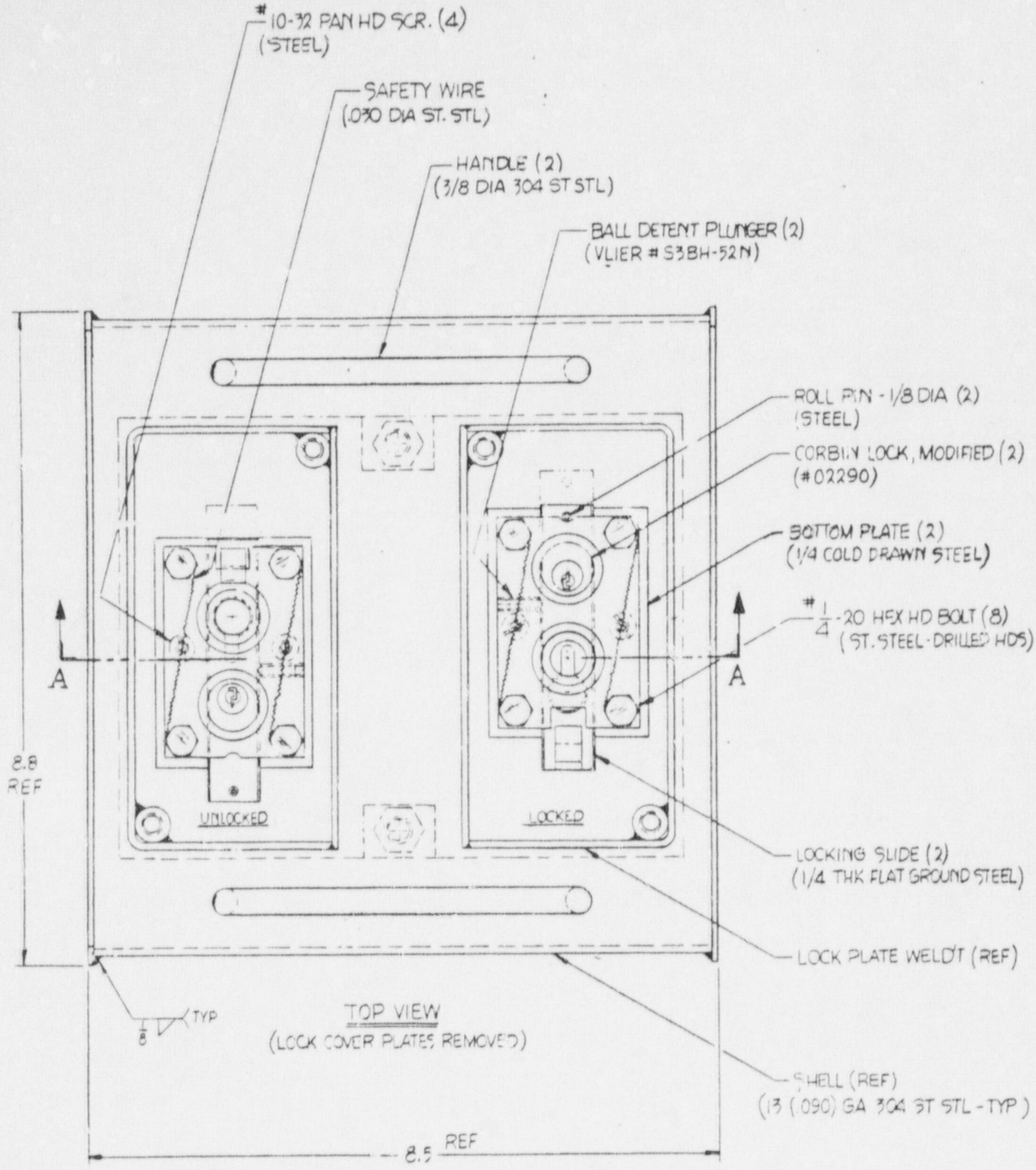
REV.	DATE	DESCRIPTION



TOTAL WEIGHT: 75 LBS (34 KG)

MATERIALS: AS NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: MODEL 850 SOURCE CHANGER DESCRIPTIVE ASSEMBLY
DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE
CHECKED BY	
APPROVED BY	CLASSIFICATION — SIZE: C — DWG. NO: 85090 — REV
	SCALE 3:4 — SHEET 1 OF 5

85090



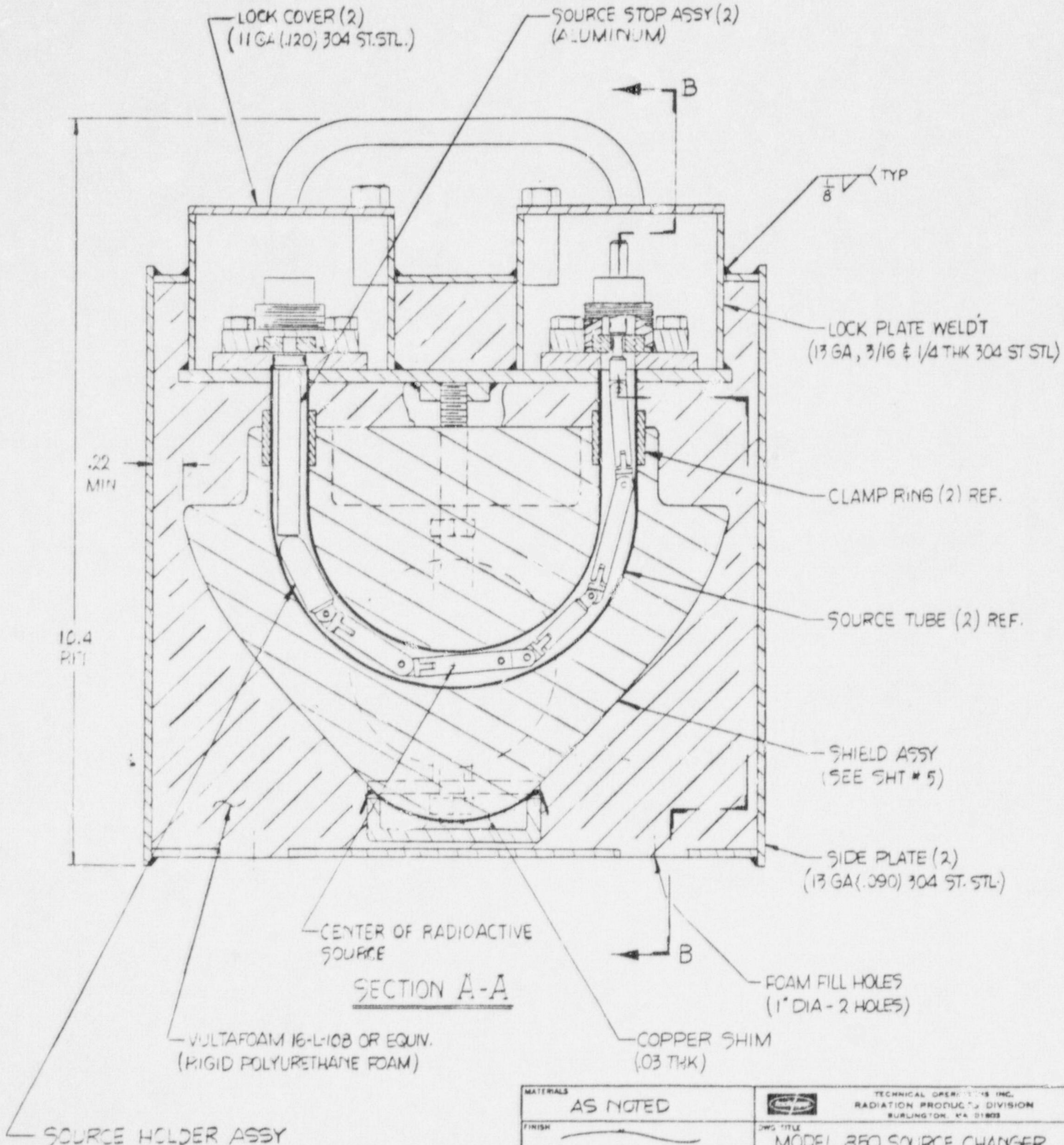
TOP VIEW

(LOCK COVER PLATES REMOVED)

MATERIALS: AS NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: MODEL 850 SOURCE CHANGER DESCRIPTIVE ASSEMBLY
DRAWN BY / CHECKED BY / APPROVED BY	CLASSIFICATION · SIZE C · DWG NO 85090 · REV 0
	SCALE 1:1 · SHEET 2 OF 5

85090

REV.	DATE	DESCRIPTION



SECTION A-A

MATERIALS: AS NOTED

FINISH

DRAWN BY

CHECKED BY

APPROVED BY

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± .XX ± .XXX ± ANGLES ± FRACTIONS ±

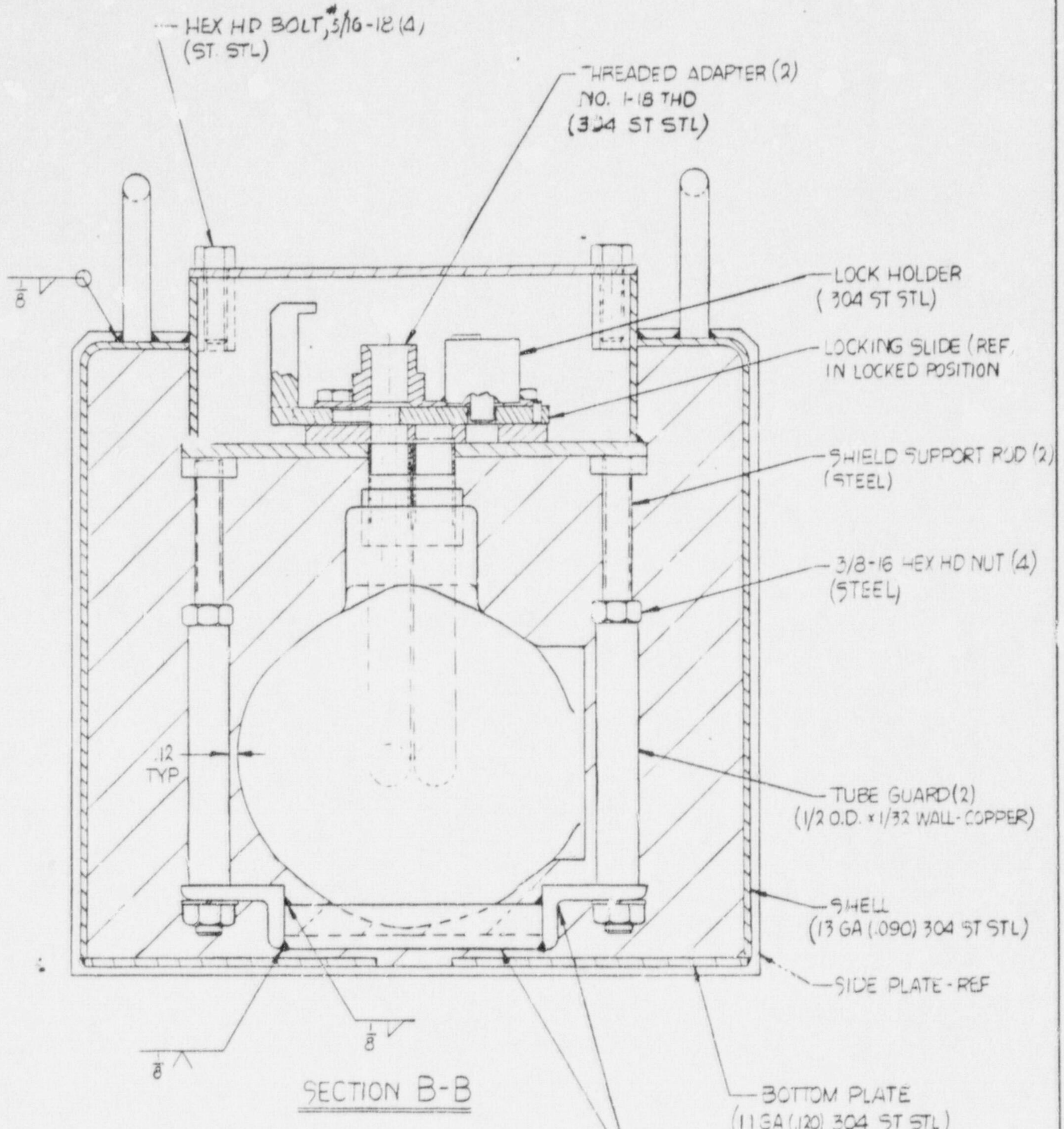
TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE: MODEL 850 SOURCE CHANGER DESCRIPTIVE ASSEMBLY

CLASSIFICATION | SIZE C | DWG NO 85090 | REV 0

SCALE 1:1 | SHEET 3 OF 5

REV	DATE	DESCRIPTION

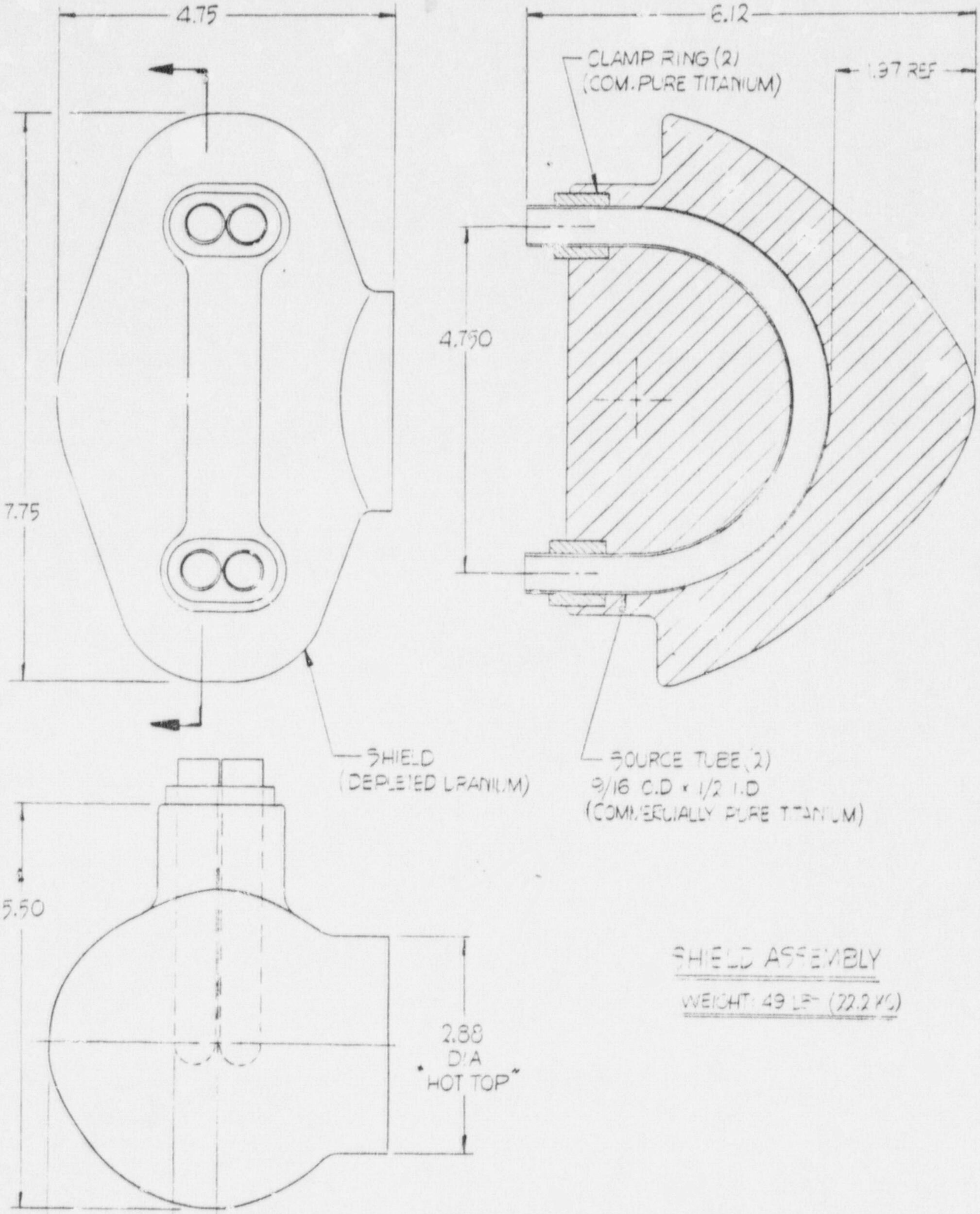


SECTION B-B

MATERIALS: AS NOTED		TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON MA 01803	
FINISH		DWG TITLE: MODEL 850 SOURCE CHANGER DESCRIPTIVE ASSEMBLY	
DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE		
CHECKED BY	.X / .XX / .XXX	CLASSIFICATION SIZE: C	DWG NO: 85090 REV: C
APPROVED BY	ANGLES / FRACTIONS	SCALE 1:1	SHEET 4 OF 5

85090

REV	DATE	DESCRIPTION



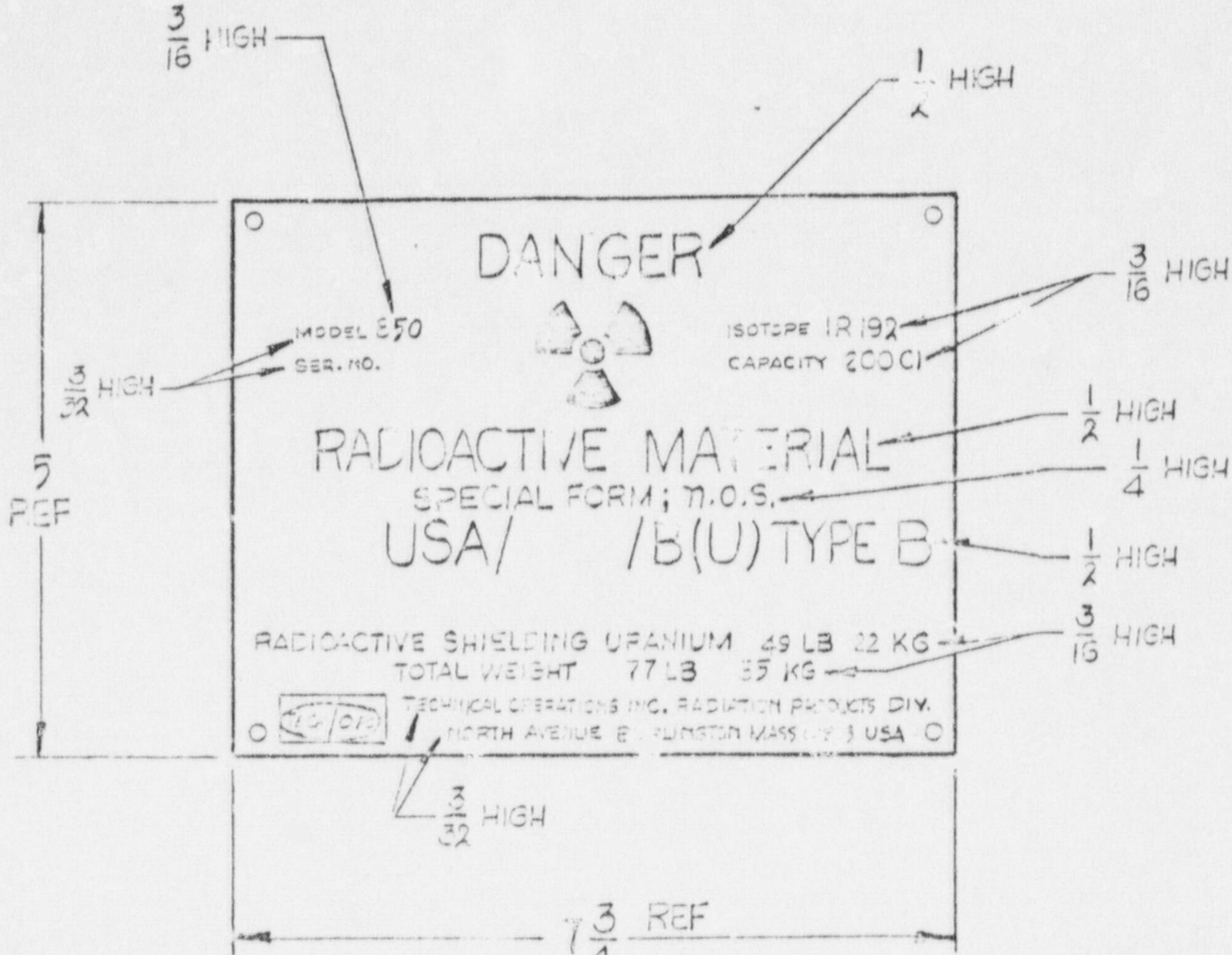
SHIELD ASSEMBLY

WEIGHT: 49 LBS (22.2 KG)

MATERIALS: AS NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH: —	DWG TITLE: MODEL 350 SOURCE CHANGER DESCRIPTIVE ASSEMBLY
DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± / .XX ± / .XXX ± / ANGLES ± / FRACTIONS ±
CHECKED BY	CLASSIFICATION / SIZE: C / DWG NO: 85090 / REV: 0
APPROVED BY	SCALE 1:1 / SHEET 5 OF 5

85095

REV.	DATE	DESCRIPTION



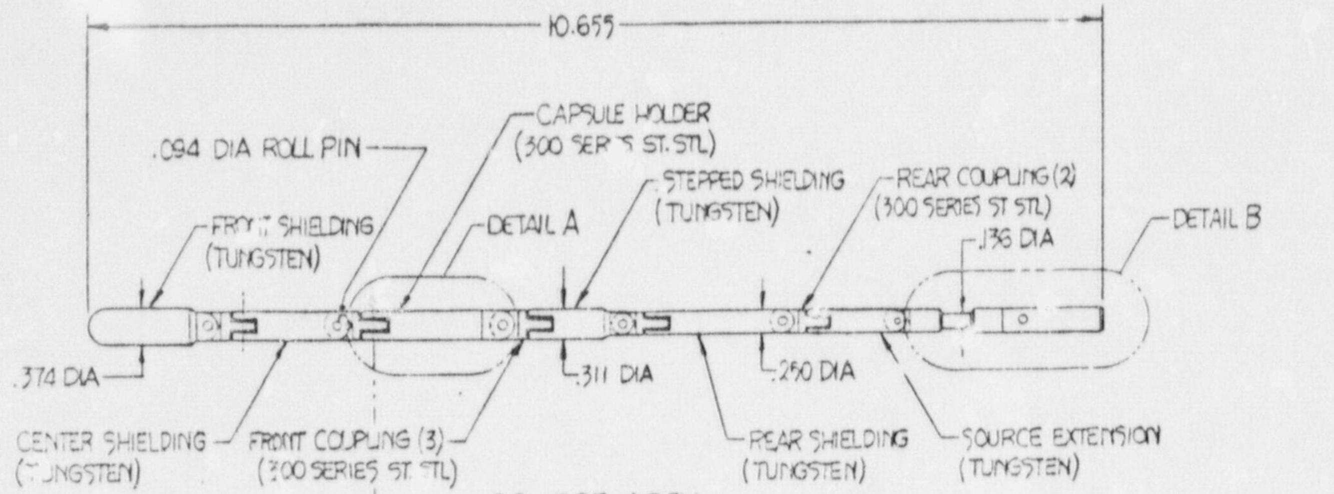
NOTES:

1. ALL CHARACTERS, RADIATION SYMBOL & LOGO ETCHED INTO NAMEPLATE .005 MIN DEEP
2. ENTIRE BACKGROUND PAINTED YELLOW # 13655 PER FED. STD. 595
3. ITEMS PER NOTE 1 PAINTED MAGENTA # 17142 PER FED STD. 595

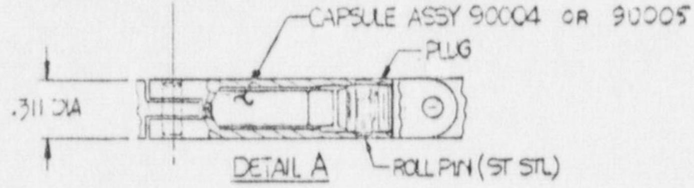
MATERIALS: .025 THK MILD STEEL		TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803	
FINISH: NOTES 2 & 3		DWG TITLE: NAMEPLATE	
DRAWN BY: [signature]	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE .X ±		
CHECKED BY	.XX ±		
	.XXX ±	CLASSIFICATION / SIZE A / DWG. NO. 85095	REV.
APPROVED BY	ANGLES ±		
	FRACTIONS ±	SCALE NONE	SHEET 1 OF 1

9009

REV.	DATE	DESCRIPTION

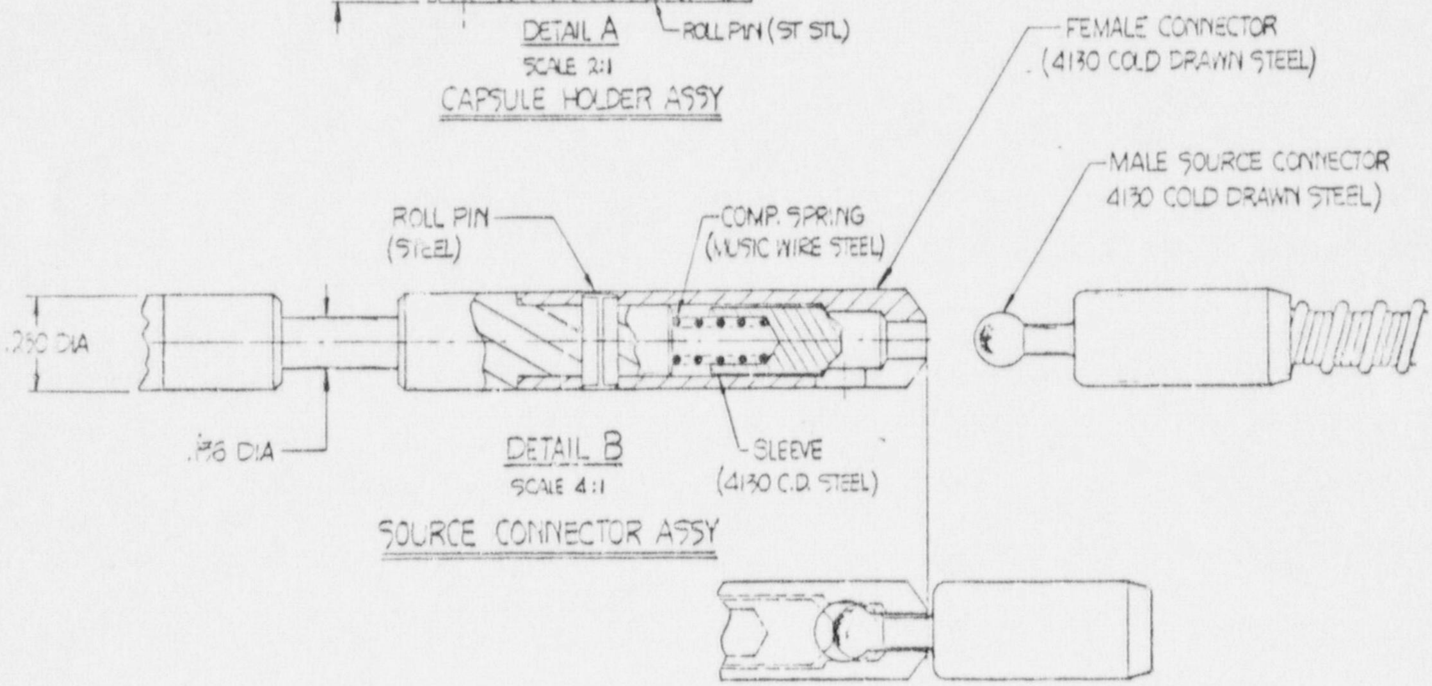


SOURCE ASSY



DETAIL A
SCALE 2:1

CAPSULE HOLDER ASSY



DETAIL B
SCALE 4:1

SOURCE CONNECTOR ASSY

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH: —	DWG TITLE: MODEL 90003 SOURCE ASSY DESCRIPTIVE ASSEMBLY
DRAWN BY: [signature]	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: X ±, XX ±, XXX ±, ANGLES ±, FRACTIONS ±
CHECKED BY	CLASSIFICATION / SIZE: C / DWG NO: 90091 / REV: –
APPROVED BY	SCALE: NOTED / SHEET 1 OF 1

2.0 Structural Evaluation

2.1 Structural Design

2.1.1 Discussion

Structurally, the Model 850 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 radioactive source.

The outer housing is fabricated from 13 gauge (0.09 inch or 2.3mm thick) stainless steel. The housing provides the structural strength of the package. The cover plates protect the lock assemblies. The lock assemblies secure the radioactive source assemblies in the proper shielded position in the package and assures positive closure.

2.1.2 Design Criteria

The Model 850 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 a straightforward application of the appropriate section of 10CFR71 or IAEA Safety Series No. 6.

2.2 Weights and Centers of Gravity

The Model 850 weighs 77 pounds (35 Kilograms). The shield assembly contains 49 pounds (22 kg) of depleted uranium. The center of gravity was located experimentally. It is located along the vertical axis at a distance of 4.3 inches (110mm) above the bottom surface.

2.3 Mechanical Properties of Materials

The Model 850 housing is fabricated from Type 304 stainess steel. This material has a yield strength of 35,000 pounds per square inch ($241 MN/m^2$). (Ref: Metals Handbook, Vol. 1, Eighth Edition).

Drawings of the source capsules used in conjunction with the Model 850 are enclosed in section 2.10. These source capsules are fabricated from Type 304 or Type 304L stainess steel. The capsules are sealed by tungsten inert gas welding.

2.4 General Standards for All Packages

2.4.1 Chemical and Galvanic Reactions

The materials used in the construction of the Model 850 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 indidivual metals has been considered. The iron-uranium eutectic alloy temperatures is approximabely 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 (0.8mm). 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 850 cannot be exposed without opening a key operated lock. Access to the lock requires removal of the cover plate. The cover plate is seal wired with a tamperproof seal.

2.4.3 Lifting Devices

The Model 850 is designed to be lifted by two handles fabricated from 0.38in (9.5mm) diameter staineless steel. These handles are attached to the package by means of 0.09 inch (2.3mm) fillet welds around the entire diameter of the handle on each end. Thus, the stress area of each weld is 0.088 in^2 ($56.8 mm^2$). The yield strength of the weld is assumed to be 35,000 pounds per square inch (241 MN/m^2). Therefore, each weld can support 3080 pounds or forty times the weight of the package without exceeding the yield strength of the material.

2.4.4 Tiedown Devices

The lifting handles of the Model 850 are also used as tiedown devices.

As demonstrated in Section 2.4.3, the weld at each end of each handle can support forty 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

Considerng 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:

$$\sigma = \frac{Fl}{8Z}$$

Where: σ: Maximum Stress
F: Total Load
l: Length of the Beam
Z: Section Modulus

(Ref: Machinery's Handbook, 21st Edition, P404)

The Load is assumed to be 385 pounds. The package is assumed to be a rectangular shell 8.5 inches (216mm) wide, 8.8 inches (224mm) deep and a wall thickness of 0.09 inch (2.3mm). Consequently, the section modulus is 8.78 in^3 (143,858mm^3). The length of the beam is assumed to be 10.4 inches (264mm).

Therefore, the maximum stress generated in the beam is 57 pounds per square inch (393 kN/m^2) which is less than 0.2% of the yield strength of the material.

2.5.2 External Pressure

The Model 850 is open to the atmosphere. Therefore, there will be no differential pressure acting on it. The collapsing pressure of the source capsule is calculated assuming that the capsule is a thin wall tube with a wall thickness equal to the minimum depth of weld penetration (0.020 inch; 0.5mm). The collapsing pressure is calculated from:

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

Where: P: Collapsing Pressure
t: Wall Thickness
d: Outside Diameter

(Ref: Machinery's Handbook, 21st Edition, P440)

The collapsing pressure of the source capsule is calculated to be 7070 pounds per square inch ($49 MN/m^2$). Therefore, the source capsules can withstand an external pressure of 25 psig.

2.6 Normal Conditions of Transport

2.6.1 Heat

The thermal evaluation of the Model 850 is performed in Chapter 3. From this evaluation, it can be concluded that the Model 850 can withstand the normal heat transport condition.

2.6.2 Cold

The metals used in the manufacture of the Model 850 can all withstand a temperature of $-40^{o}C$. The lower operating limit of the polyurethane foam is $-100^{o}F$ ($-73^{o}C$). Thus, it is concluded that the Model 850 will withstand the normal transport cold conditions.

2.6.3 Pressure

The Model 850 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 atmosphere ($50.7 kN/m^2$).

2.6.4 Vibration

The Model 850 is basically a welded package. The locking assemblies are similar in principal to the locking assembly of the Model 900 (USA/9141/B).

The Model 900 was subjected to a vibration test. The package was vibrated for seventy minutes with a maximum acceleration of $9.8m/s^2$ at each of the following frequencies: 5, 8, 12, 20, 32 and 80 Hz. At the conclusion of this test, the source assembly remained secured in the proper storage position. There was no reduction in the shielding efficiency or structural integrity of the package.

On the basis of the Model 900 vibration test result and the similarity of the locking assemblies of the Model 900 and Model 850, it is concluded that the Model 850 will withstand the vibration normally incident to transport.

2.6.5 Water Spray Test

The water spray test was not actually performed on the Model 850. We contend that the materials used in construction of the Model 850 are all highly water resistant and that exposure to water will not reduce

th 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 850 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 850 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 850 is 77 pounds (35kg). The maximum cross sectional area of the package is 42 in^2 (0.06m^2). Thus, five times the weight of the package (385lbs; 1715 newtons) is greater than two pounds per square inch multiplied by the maximum cross sectional area (184 pounds; 820 newtons).

The Model 850 was subjected to the conditions of the compression test. A load of 459 pounds (2044 newtons) was applied uniformly to the top and bottom of the pa[illegible]or 68 hours. As a result of this test, there was no loss of [illegible]ing effectiveness nor loss of structural integrity. A copy of the test report is included in Section 2.10.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

The Model 850 was subjected to a drop test through a distance of 30 feet onto a steel plate. There was no loss of shielding efficiency nor loss of structural 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 850 was subjected to the puncture test of 10CFR71. As a result of this test, there was no loss of shielding efficiency nor loss of structurial 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 850, 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 "U" tubes which protude from the package housing. The shield is restricted from vertical movement by the shield support plate, connecting rods and lock assemblies.

Thus, it is concluded that the Model 850 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 850 is designed for use with Tech/Ops Model 90003 Source Assembly. This source assembly contains either Tech/Ops Model 90004 or Model 90005 source capsule. These source capsules satisfy the criteria for special form radioactive material. A copy of IAEA Certificate of Competent Authority No. USA/0179/S is included in Section 2.10.

2.9 Fuel Rods

Not Applicable

2.10 Appendix

Descriptive Assembly Drawings - Model 90004 Source Capsule

Descriptive Assembly Drawing - Model 90005 Source Capsule

Test Report: Uranium Thermal Test

Test Report: Penetration Test

Test Report: Compression Test

Test Report: Free Fall and Puncture Tests

IAEA Certificate of Competent Authority No USA/0179/S

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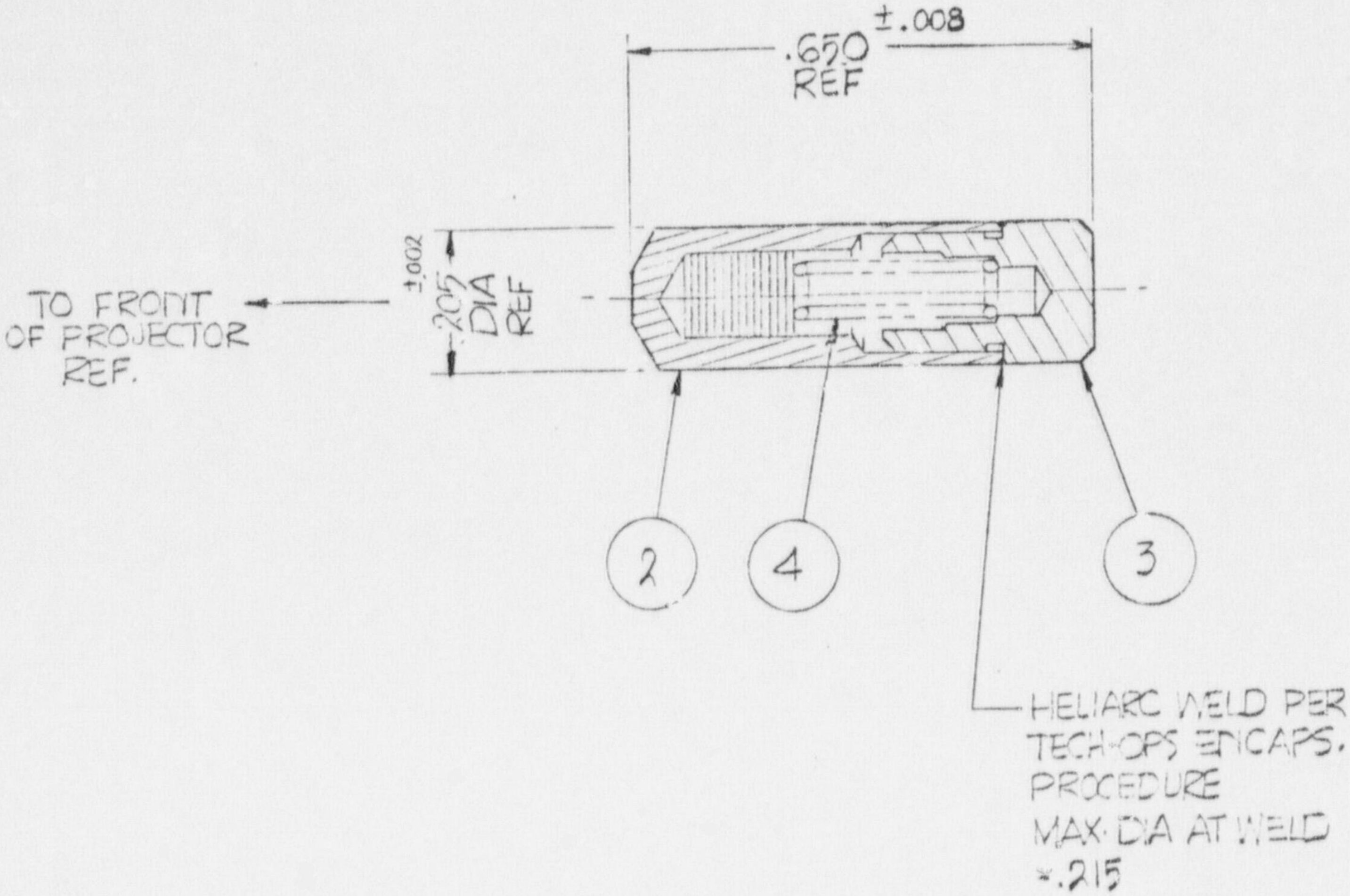

MATERIALS: SEE BM 90004	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: GENESIS 8B IR192 CAPSULE ASSEMBLY 100 CI
DRAWN BY: [signature] JAN 79	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ±
CHECKED BY: [signature]	.XX ± ; .XXX ±
APPROVED BY	ANGLES ± ; FRACTIONS ±
CLASSIFICATION	SIZE: A · DWG. NO.: 90004 · REV: A
SCALE 4:1	SHEET 1 OF 1

REV.	DATE	DESCRIPTION
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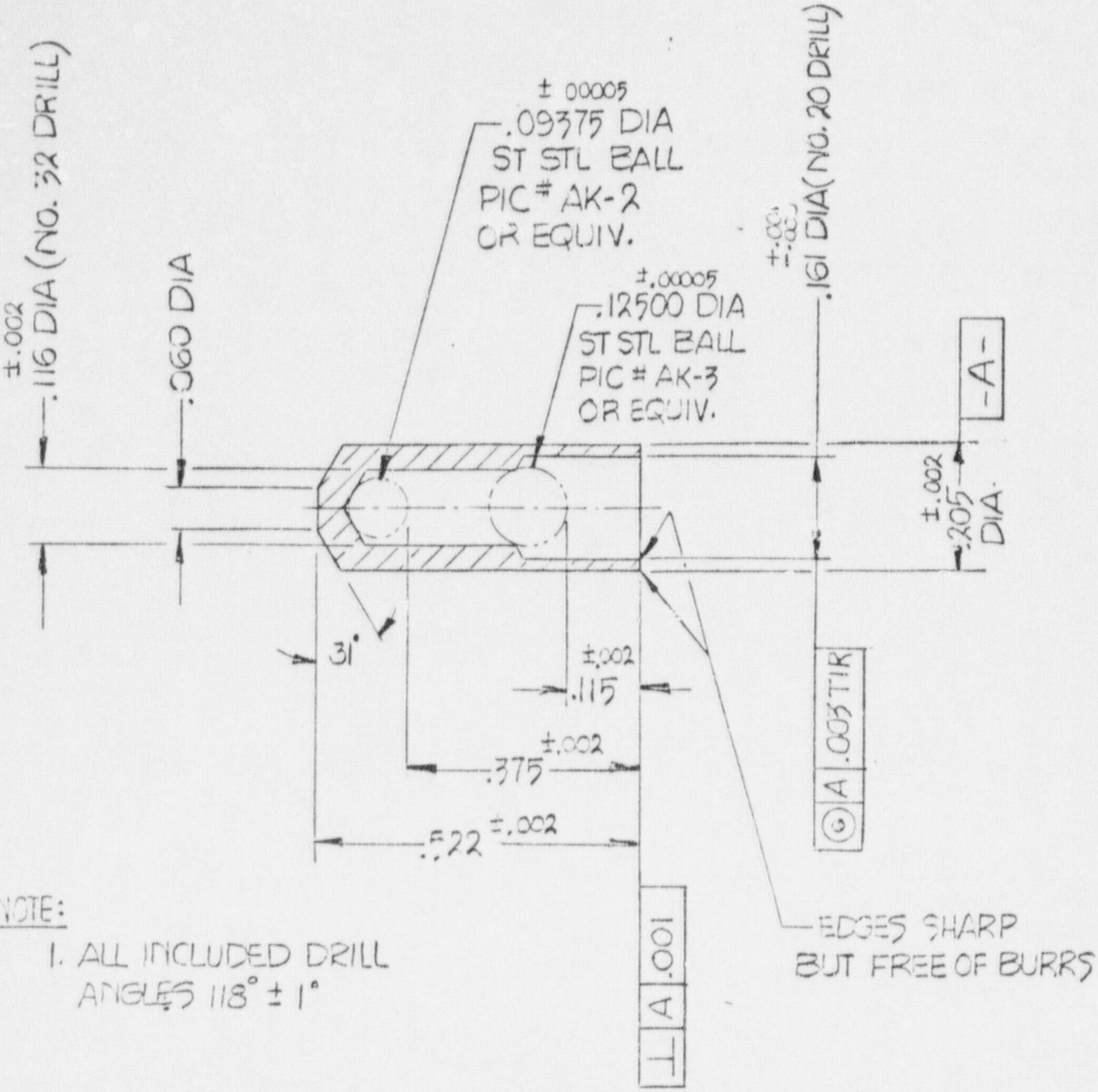

NOTE:

1. ALL INCLUDED DRILL ANGLES 118° ± 1°

MATERIALS 304 OR 304L ST STL MATERIAL CERTIFICATION REQUIRED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE GENESIS 8B SOURCE CAPSULE BOTTOM
DRAWN BY [signature]	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE .X ± .XX ± .XXX ± .005 ANGLES ± 1/2° FRACTIONS ±
CHECKED BY R. Drainard 14 JAN 80	
APPROVED BY	
CLASSIFICATION	SIZE A	DWG. NO. 90004-1	REV. A
SCALE 4:1	SHEET 1 OF 1

SPAULDING CO. INC. 21-60169

REV.	DATE	DESCRIPTION
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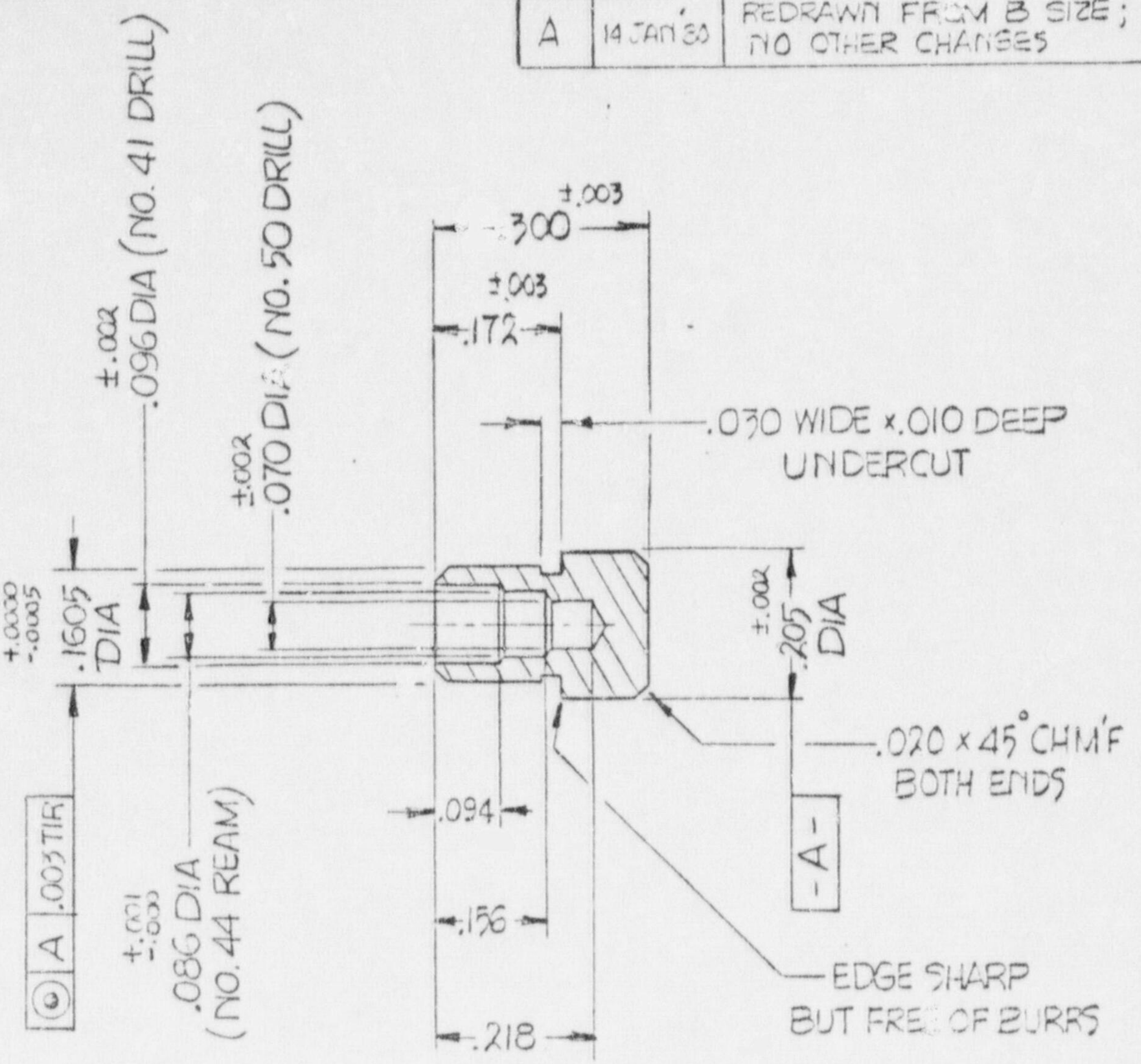


NOTE:

1. ALL INCLUDED DRILL ANGLES 118° ± 1°.

MATERIALS 304 OR 304L ST. STL
MATERIAL CERTIFICATION REQUIRED

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

FINISH

DWG TITLE
GENESIS 8B
SOURCE CAPSULE SHANK

DRAWN BY [illegible] 14 JAN 80

CHECKED BY R. [illegible] 14 JAN [illegible]

APPROVED BY

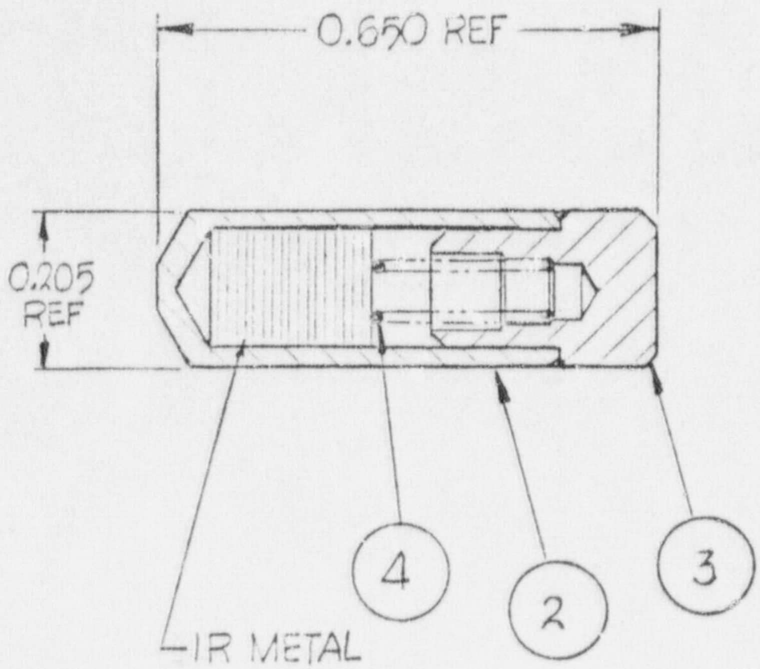
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE

.X	±
.XX	±
.XXX	± .005
ANGLES	± 1/2°
FRACTIONS	±

CLASSIFICATION	SIZE	DWG. NO.	REV.
	A	90004-2	A

SCALE 4:1 SHEET 1 OF 1

REV.	DATE	DESCRIPTION



MATERIALS SEE BM 90005	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH — " —	DWG TITLE SOURCE CAPSULE ASSY

	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE	
DRAWN BY	.X	±
CHECKED BY	.XX	±
	.XXX	±
APPROVED BY	ANGLES	±
	FRACTIONS	±

CLASSIFICATION	SIZE	DWG. NO.	REV.
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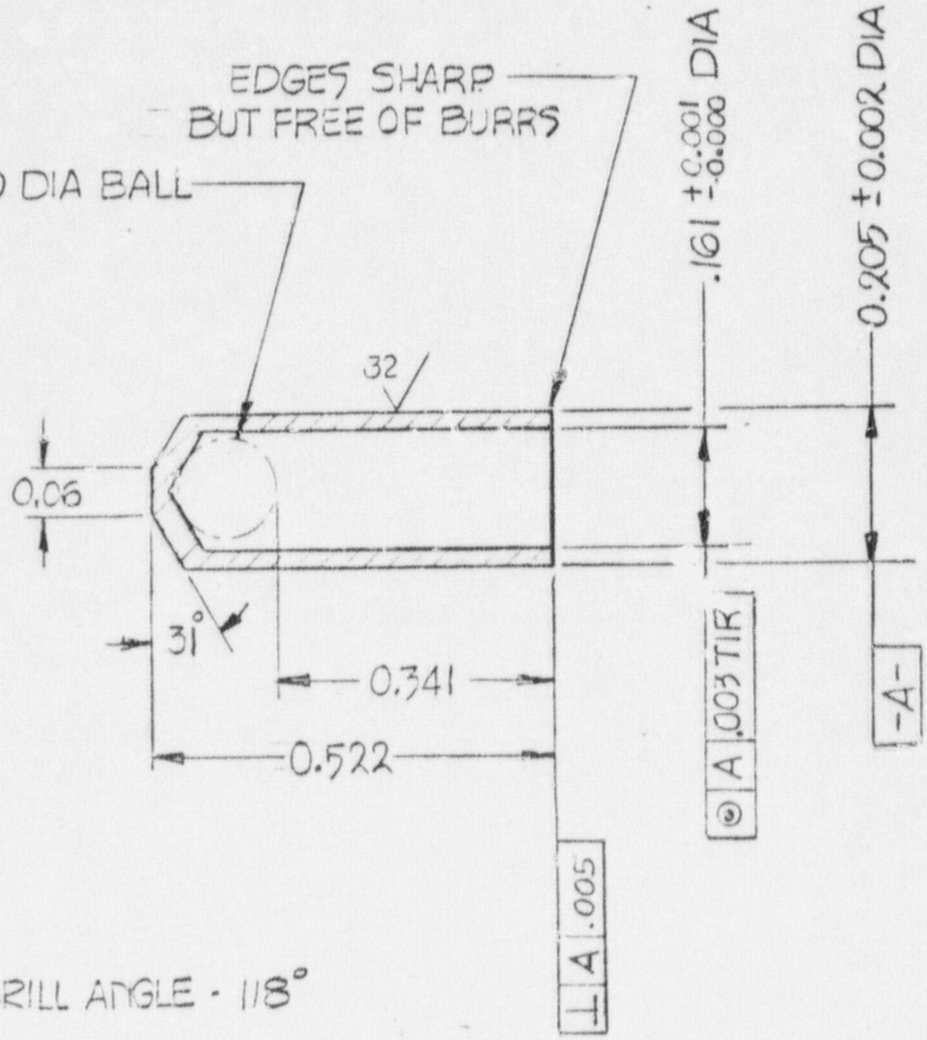
SCALE 4:1		SHEET 1 OF 1	

REV.	DATE	DESCRIPTION



NOTE: INCLUDED DRILL ANGLE - 118°

MATERIALS TYPE 304 OR 304L STAINLESS STEEL	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH NOTED	DWG TITLE SOURCE CAPSULE BOTTOM

DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE	
	.X	±
CHECKED BY	.XX	± 0.01
	.XXX	± 0.005
APPROVED BY	ANGLES	± 1°
	FRACTIONS	±

CLASSIFICATION	SIZE	DWG. NO.	REV.
	A	90005-1	0
SCALE 4:1		SHEET 1 OF 1	

TECHNICAL OPERATIONS, INCORPORATED

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

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

NUCLEAR METALS, INC.

2229 MAIN STREET
CONCORD, MASSACHUSETTS 01742
TELEPHONE 617 269 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

John G. Powers
Project Engineer

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: Keith Spinney KS

DATE: 20 October 1980

SUBJECT: Model 850 Compression Test

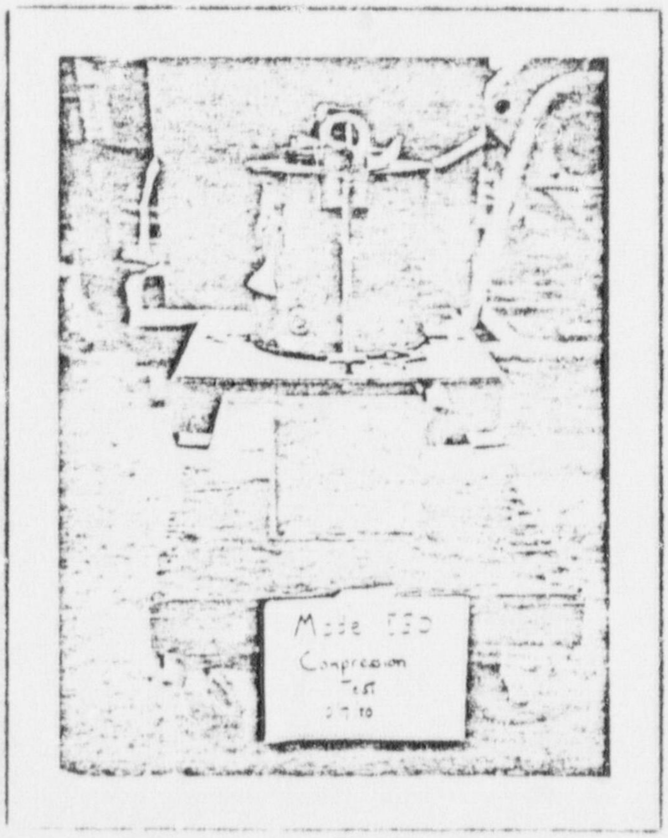
On 17 October 1980 a Model 850 source changer was subjected to a compressive load of 459 pounds. A steel block weighing 24 pounds was placed over the lock plate weldment to provide clearance above the two lifting handles, and a shipping package weighing 435 pounds was placed on the block. The load was left in place from 1:00 P.M. 17 October 1980 to 9:00 A.M. 20 October 1980.

The package was not adversely affected as a result of the test. The package did not suffer any loss of structural or shielding integrity. Thus, it is concluded that the Model 850 meets the requirements of the compression test as described in Appendix A of 10CFR71 and Paragraph 713 of IAEA Safety Series No. 6, 1973 Edition.

Witnessed Angelo C Kiklis
Angelo Kiklis

KS/js

COMPRESSION TEST



TEST REPORT RADIATION PRODUCTS DIVISION

BY: Keith Spinney KS

DATE: 20 October 1980

SUBJECT: Model 850 Penetration Test

On 20 October 1980 a Model 850 source changer was subjected to an impact of the hemispherical end of a vertical steel cylinder 1¼ inches in diameter and weight of 13 pounds. The cylinder was dropped three times from a height of 40 inches onto the front, side, and cover plate of the container. The long axis of the cylinder was perpendicular to the container surface for each trial.

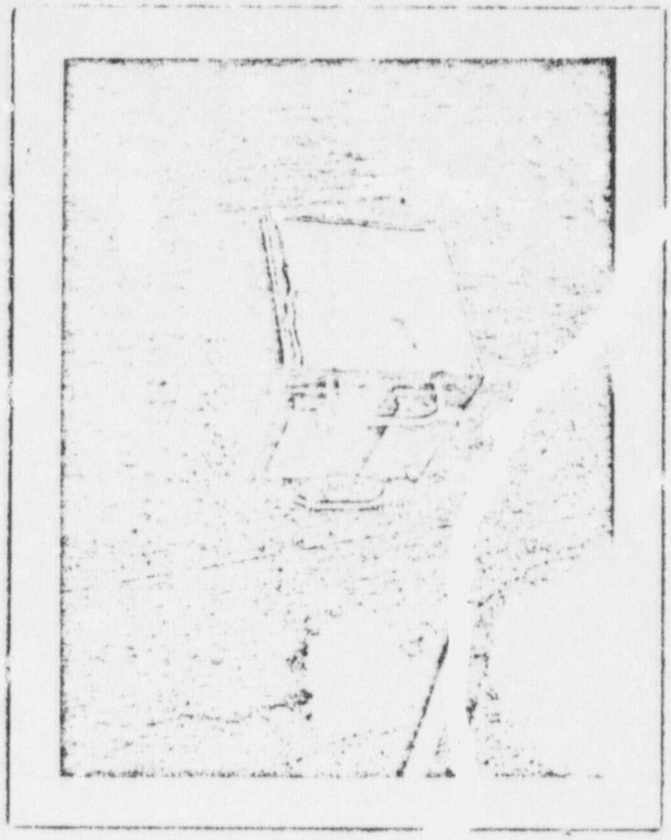
The Model 850 suffered only minor superficial dents to the exterior of the package as a result of this test. There was no loss of structural or shielding effectiveness.

Therefore, it is concluded that the Model 850 meets the requirements of the penetration test outlined in 10CFR71 Appendix A and paragraph 714 of IAEA Safety Series No. 6, 1973.

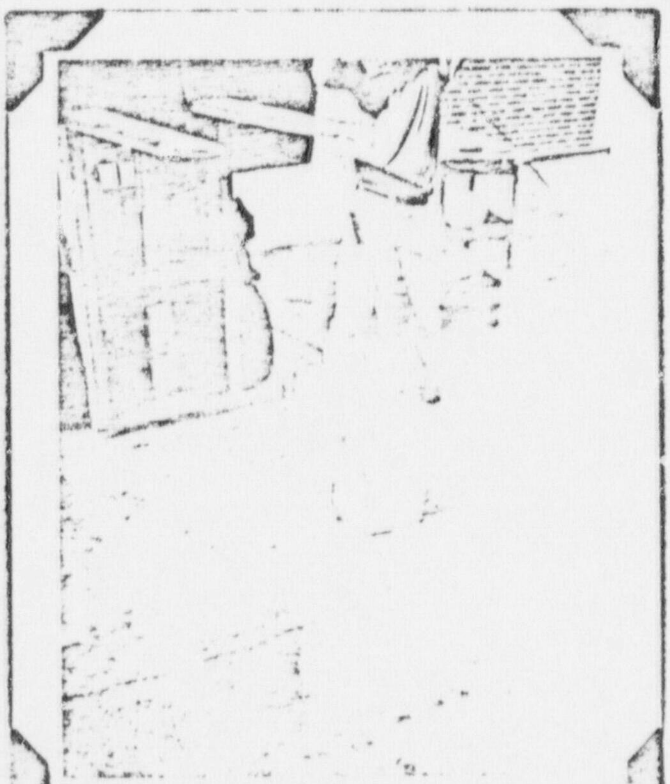
Witnessed Angelo C. Kiklis

Angelo Kiklis

KS/js



PENETRATION TEST



TEST REPORT

RADIATION PRODUCTS DIVISION

BY: Keith Spinney

DATE: 20 October 1980

SUBJECT: Model 850 Drop Test and Puncture Test

On 20 October 1980 a Model 850 source changer was twice submitted to free fall of 30 feet onto a flat horizontal steel plate measuring 4 feet by 4 feet by 3/8 inch which was lying on top of a paved surface.

The Model 850 struck a different corner each time, causing minor deformation of the outer shell. There was no loss of structural integrity.

The Model 850 was then twice submitted to a free fall of 40 inches onto a steel bar 6 inches in diameter and eight inches high. The top surface of the bar was horizontal, with its edges rounded to a radius of not more than one quarter inch.

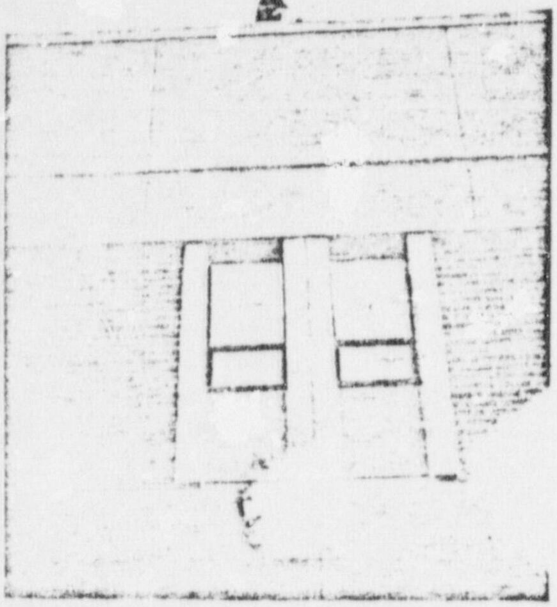
The first time the bottom of the container struck the bar with no effect on the container. The second time, the top of the container struck the bar. As a result one handle was bent. One side of that handle was broken off where it was welded to the container. However, there was no loss of structural integrity.

Upon removal of the lock mechanism at the conclusion of the test, it was observed that the depleted uranium shield had moved approximately one quarter inch. A radiation profile was performed (See Section 5.) and from that it was concluded that there was no loss of shielding integrity. Therefore, it is concluded that the Model 850 meets the requirements of the free fall and puncture tests outlined in 10CFR71 Appendix A and IAEA Safety Series No. 6, 1973.

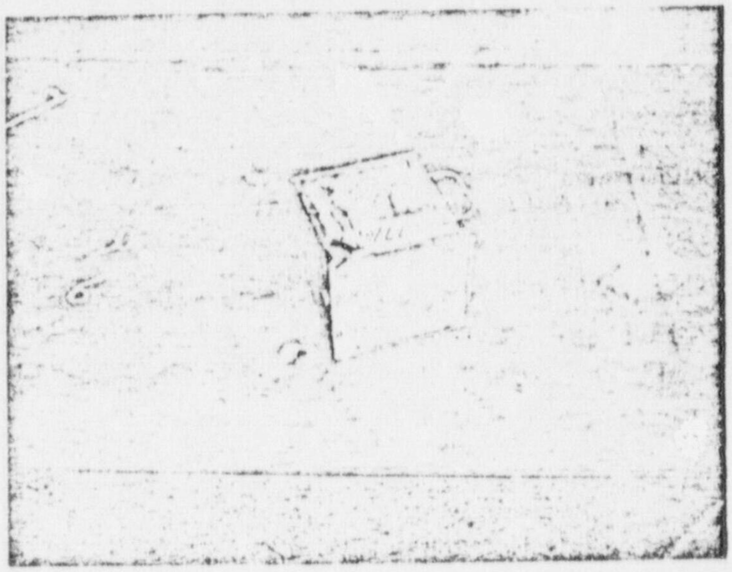
Witnessed Angelo C. Kiklis

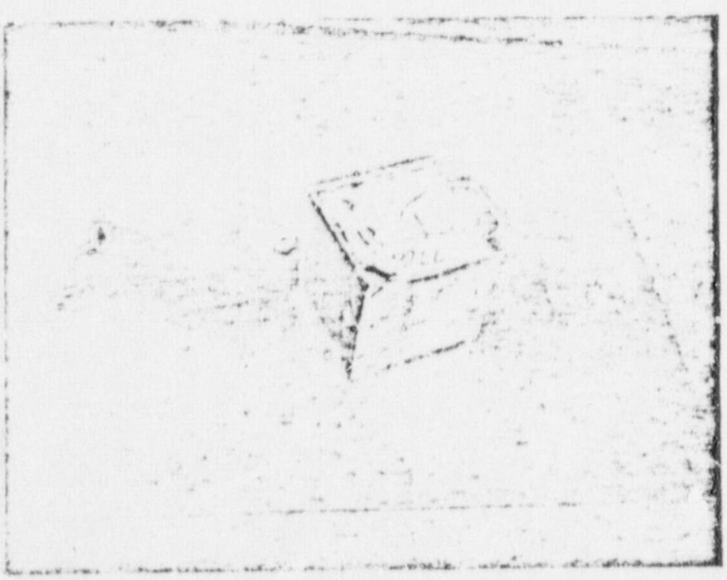
Angelo Kiklis

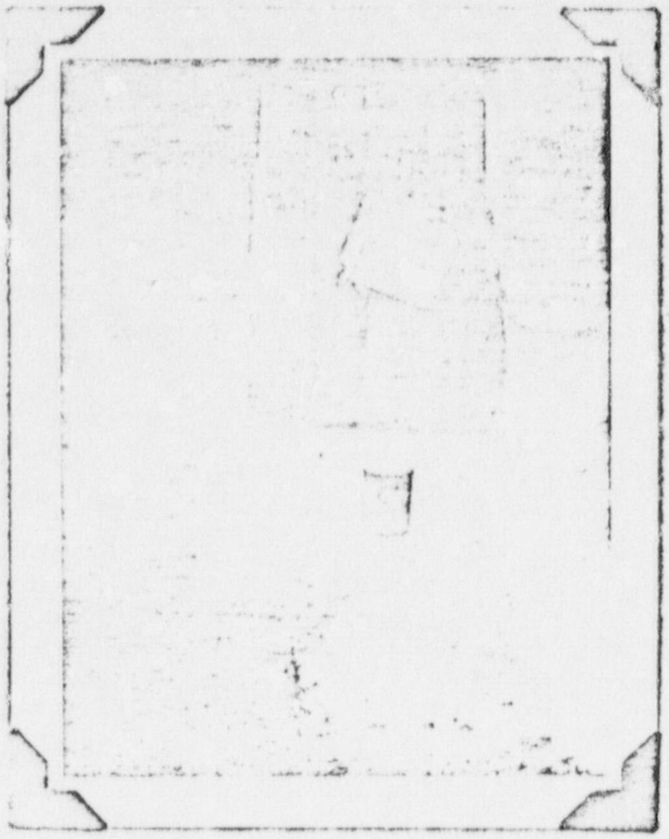
KS/js



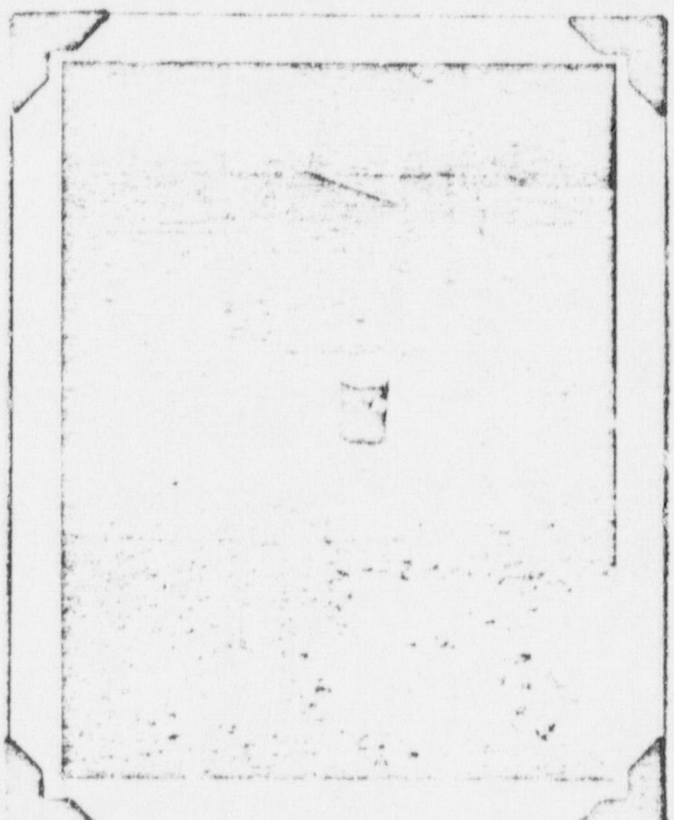
FREE DROP TEST

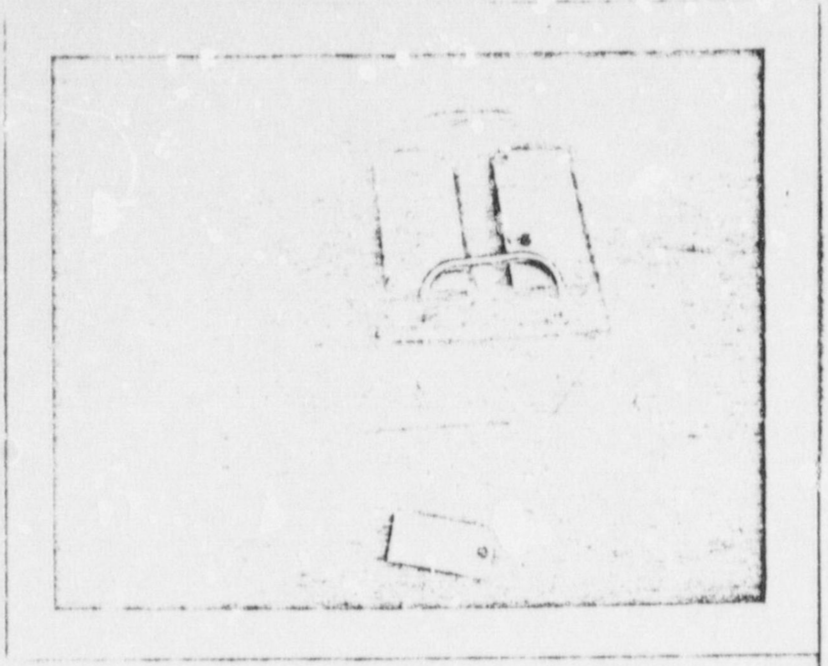


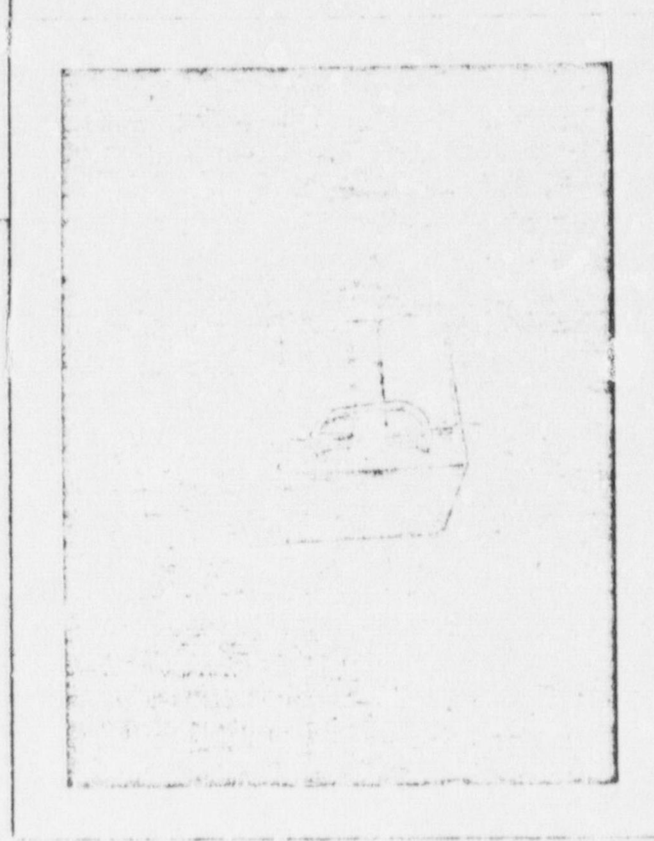




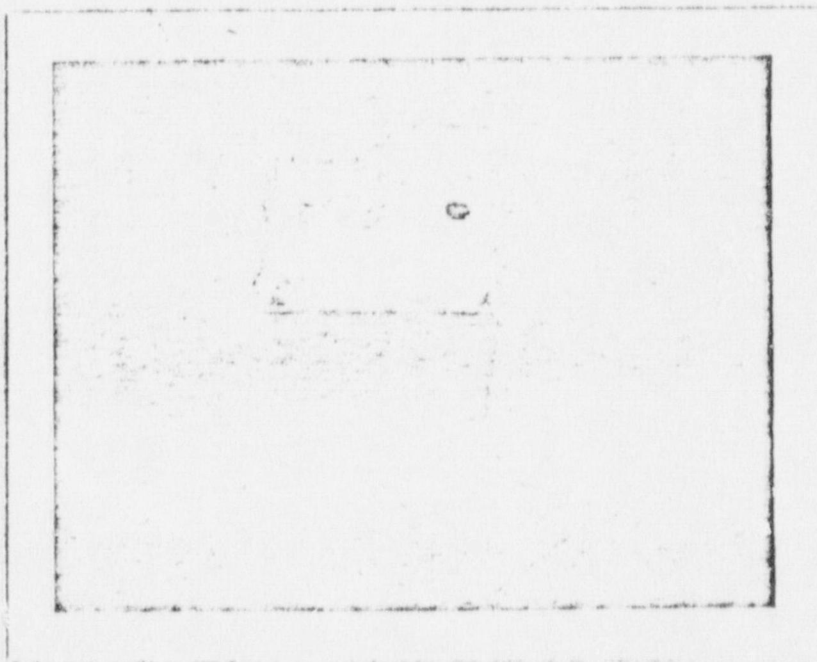
PUNCTURE TEST







MODEL 850 AFTER COMPRESSION,
PENETRATION, FREE DROP, AND
PUNCTURE TESTS



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/0179/S

(Revision 1)

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 Tech/Ops Model 90004 and 90005 which are 304 or 304L stainless steel welded encapsulations measuring 0.205 inch in diameter by 0.65 inch in length.

II. Radioactive Contents - The authorized radioactive contents of this source consist of Iridium-192 in solid metallic form with not more than 120 curies in the Model 90004 or 240 curies in the Model 90005.

III. This certificate, unless renewed, expires on October 31, 1980.

This certificate is issued in accordance with paragraph 803 of the IAEA Regulations and in response to the August 1, 1980 petition by Tech/Ops, Burlington, Massachusetts, and in consideration of the associated information therein.

Certified by:

R. R. Rawl — October 18 1980 (Date)

Designated U.S. Competent Authority for the
International Transportation of Radioactive Materials
Office of Hazardous Materials Regulation
Materials Transportation Bureau
U. S. Department of Transportation
Washington, D.C. 20590

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[1] "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1967 Edition", published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

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

Revision 1 issued to add Model 90005 and to extend expiration date.

3. Thermal Evaluation

3.1 Discussion

The Model 850 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 240 curies of iridium-192. The corresponding decay heat is 2.06 watts.

3.2 Summary of Thermal Properties of Materials

The melting points of the metals used in the construction of the Model 850 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 200F (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 850 is a maximum of 240 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 240 curies of iridium-192 would be 2.06 watts. For this analysis, the heat source will be assumed to be 2.5 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 encounted under normal conditions of transport will have no adverse effect on structural integerity of shielding. As shown in Section 3.6, the maximum temperature in the shade would be less than 43°C and the maximum temperature when insolated would be less than 57°C.

3.4.3 Minimum Temperatures

The minimum normal operating temperature of the Model 850 is -40°F (-40°C). This temperature will have no adverse affect on the package.

3.4.4 Maximum Internal Pressures

Normal operating 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 850. The applicable conditions of IAEA Safety Series No. 6, 1973 for Type B(U) packages have been shown to be satisfied by the Model 850.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Thermal Model

The Model 850, 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 joint.

3.5.2 Package Conditions and Environment

The Model 850 underwent no significant damage during the free drop and puncture tests. The package used in this analysis is considered undamaged.

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 850 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 850 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 55 psi (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 223psi(1.5MN/m^2). At a temperature of 870°C (1600°F), the yield strength of Type 304 stainless steel is 10,000psi (69MN/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 850 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 850 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 850 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 (2.5 watts) is deposited in the exterior faces of the Model 850.

2) The interior of the Model 850 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 (0.63 watts)

h: Free convective heat transfer coefficient for air ($1.84\,(\Delta T)^{1/4}$ $W/m^2\text{-}^oC$)

A: Area of the face of interest ($0.048m^2$)

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 42.8°C. This satisfies the requirement of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973.

3.6.2 Model 850 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 850 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, $194 W/m^2$ ($200 cal/cm^2$ - 12h) on the sides, and no insolation on the bottom.

2) The decay heat load is added to the solar heat load.

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 rectangular parallelepiped resting on an end. The surface areas of the top and bottom are each $0.048 m^2$. The surface area of one side is $0.045 m^2$ and the area of the adjacent side is $0.047 m^2$.

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

$$q \text{ in} = q \text{ out}$$

$$= q_c + q_r$$

where q_c: Convective Heat Transfer
q_r: Radiative Heat Transfer

The heat load applied to the package is

$$q \text{ in} = \alpha q_s + q_d$$

where α: Absorptivity (0.9)
q_s: Solar Heat Load (72.9 Watts)
q_d: Decay Heat Load (0.63 Watts)

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:

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

where σ: Stefan Boltzmann Constant (5.669×10^{-8} W/m^2 - °K)
ε: Emmissivity (0.8)

Iteration of this relationship demonstrates that the wall temperature of the Model 850 is 56.9°C which satisfies the requirement of paragraph 240 of IAEA Safety Series No. 6, 1973.

3.6.3 Model 850 Type B(U) Source Capsule Thermal Analysis, Paragraph 238 of IAEA Safety Series No. 6, 1973 Edition

This analysis demonstrates that the pressure inside the Model 90004 or Model 90005 source capsule, when subjected to the thermal test, does not exceed the pressure which corresponds to the minimum yield strength of the material at the thermal test temperature.

The source capsules are fabricated from stainless steel, Type 304 or 304L. The outside diameter of each capsule is 0.205 inch (5.2mm). The source capsule is seal welded. The minimum weld penetration is 0.020 inch (0.5mm). Under the conditions of internal pressure, the critical location for failure is this weld.

The internal volume of the source capsule contains only iridium metal as a solid and air. It is assumed that the air is at standard temperature and pressure (20°C; 100kN/m^2) at the time of loading. 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 temperature, the internal pressure would be somewhat reduced.

Under the conditions of paragraph 238 of IAEA Safety Series No. 6, it is assumed that the capsule could reach a temperature of 800°C (1475°F). Using the ideal gas law and requiring the air to occupy a constant volume, the internal gas pressure could reach 373kN/m^2 (54psi).

The capsule is assumed to be a thin walled cylindrical pressure vessel.

The maximum longitudinal stress is calculated from:

$$\sigma_1 A_1 = p A_p$$

where σ_1: Longitudinal Stress

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

P : Pressure (373kN/m^2)

A : Pressure Area = πr_i^2

From this relationship, the maximum longitudinal stress is calculated to be 686kN/m^2 (99psi).

The hoop stress can be found by:

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

or $$\sigma h = \frac{P r_i}{t}$$

where σh: hoop stress

l : length of the cylinder

t : thickness of the cylinder

From this relationship, the hoop stress is calculated to be 1.54MN/m^2 (223psi).

At a temperature of 870°C (1600°F), the yield strength of Type 304 stainless steel is 69MN/m^2 (10,000psi). 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.

4. Containment

4.1 Containment Boundary

4.1.1 Containment Vessel

The containment system for the Model 850 is the radioactive source assembly Model 90003. The actual containment for the radioactive material is the welded source capsule as shown in Section 2.10. These source capsules are certified as special form radioactive materials (IAEA Certificate of Competent Authority No. USA/0179/S).

The capsules are fabricated from either Type 304 or Type 304L stainless steel. The capsules are cylinders with a diameter of 0.205 inch (5.2mm) and length of 0.650 inch (16.5mm).

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 capsules 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.

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.

5. Shielding Evaluation

5.1 Discussion and Results

The Model 850 is shielded with 49 pounds of depleted uranium. The uranium metal is cast around the titanium "U" tubes. A radiation profile of Model 850 Serial No. 1 containing 215 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 240 curies of iridium-192 is presented in Table 5.1. As the Model 850 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
100	123	112	1.8	2.0	1.6

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 240 curies.

5.2.2 Neutron Source

Not Applicable

5.3 Model Specification

Not Applicable

5.4 Shielding Evaluation

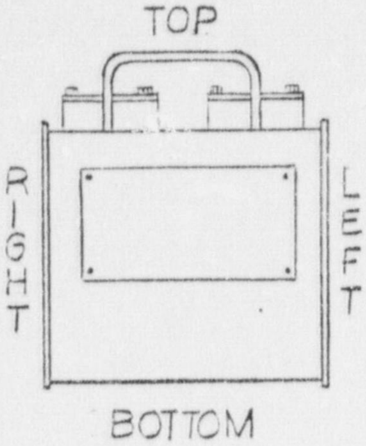
The Model 850 shielding evaluation was performed on Model 850, Serial No. 1 containing 215 curies of iridium-192. The results of this survey (Section 5.5.1) demonstrate that the dose rates surrounding this package are within the regulatory requirements. A radiation profile made on this package after being subjected to the hypothetical accident conditions, (Section 5.5.2) show that there was no significant change in the shielding effectiveness.

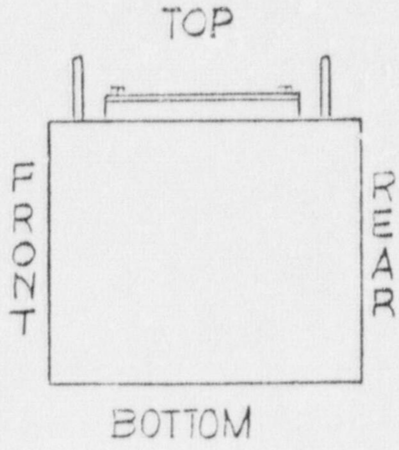
5.5 Appendix

5.5.1 Radiation Profile - Model 850, Serial Number 1

5.5.2 Radiation Profile - Model 850, Serial Number 1 after hypothetical accident conditions

5.5.1 Radiation Profile, Model 850 S.N.1.





Containing Sources:

S.N. 8421: 107Ci iridium-192
S.N. 8422: 108Ci Iridium-192

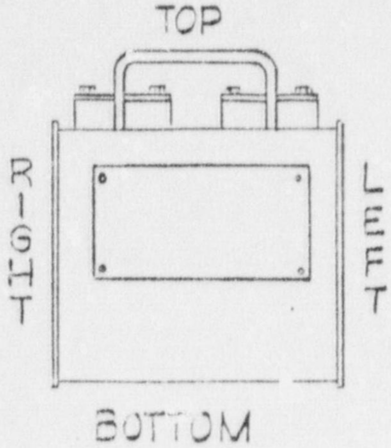
Total Activity: 215 Curies of iridium-192

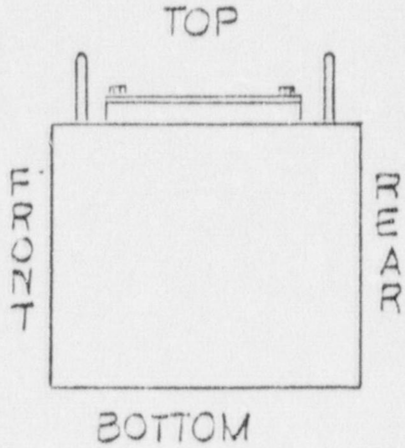
Maximum Dose Rates (mR/hr)

	at surface	at one meter
Top	110	1.8
Front	80	1.4
Right	70	1.2
Rear	90	1.6
Left	60	1.2
Bottom	100	1.4

* Measurements made with AN/PDR-27(J) Survey Instrument

5.5.2 Radiation Profile, Model 850 S. N. 1
After free fall and puncture tests





Containing Sources:

S.N. 8421: 106Ci Iridium-192
S.N. 8422: 107Ci Iridium-192

Total Activity: 213 Curies of Iridium-192

Maximum Dose Rates (mR/hr)

	at surface	at one meter
Top	90	1.8
Front	110	1.9
Right	70	1.2
Rear	90	1.6
Left	60	1.4
Bottom	140	1.8

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

6. Criticality Evaluation

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, Encapsulation of Sealed Sources. The procedure for loading the source assembly into the package is presented in Section 7.4, Operation Manual.

7.2 Procedures for Unloading the Package

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

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, Operation Manual.

7.4 Appendix

Encapsulation of Sealed Sources

Model 850 Operation Manual

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.

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

   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 .005μCi of contamination. If the patch shows more than .005μCi, the capsule must be cleaned and rewiped. If the rewipe patch still shows more than 0.005μCi 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 source loading fixture. Insert the source capsule into the source holder. Screw the source holder together and install the roll pin. Check to assure that the pin does not protrude on either side.

17. Apply the tensile test to assembly by applying proof load of 75lbs. Extension under the load shall not exceed 0.05in. If the extension exceeds 0.05 in., 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 for the operation.

TECH/OPS MODEL 850

SOURCE CHANGER - SHIPPING CONTAINER

OPERATION MANUAL

Technical Data

Size:	10.4in high, 8.5in wide, 8.8in deep (264mm high, 216mm wide, 224mm deep)
Capacity:	240 Curies of ^{192}Iridium Special Form
Transport Status:	Type B USA/ /B( )
Shielding:	Depleted Uranium Metal 49 Lbs. (22kg)
Weight:	77 Pounds (35kg)

General

The Model 850 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

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

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

Shipping Information

When the 850 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.

Receipt (Continued)

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 0-1000mR/hr. In addition, personnel monitoring devices must be worn during these operations. They are a film badge (or Thermoluinescent 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 10mR/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 cover plates.

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.

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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. Move the lock slide to the LOCK position and depress the plunger lock to lock the source in the storage position.

i. Disengage the source guide tube from the source changer and disconnect the source assembly from the drive cable.

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

d. Connect the source to the control unit drive cable. Connect the guide tube to the fitting on the source connector.

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

f. Unlock the plunger lock on the source changer and move the lock slide to the OPEN position.

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

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

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

j. 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.

7. Place the cover plates 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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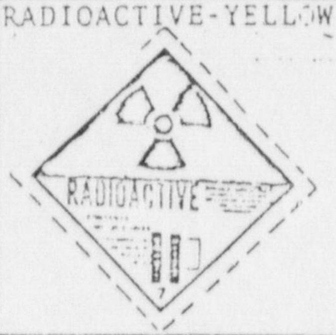
TABLE I

	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.

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.)

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 (USA/ /B)

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:

"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.

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 properaly 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 source assembly 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 thest 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 not 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

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 not 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.