Tech/Ops

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

15 July, 1982

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

Dear Mr. MacDonald:

We request issuance of a USNRC Certificate of Compliance for Radioactive Materials Package for Tech/Ops Model 864 Type B Package - Source Changer. We are enclosing eight copies of the Safety Analysis Report of the Model 864 for your review. In accordance with 10CFR170.31 Item 11.E., we are also enclosing a check for $200 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:lh
Enclosures

xc: R.R. Rawl, U.S. DOT

Tech /Ops

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

15 July, 1982

Mr. Richard R. Rawl, Chief
Radioactive Materials Branch
Office of Hazardous Materials Regulation
Materials Transportation Bureau
Research and Special Program Administration
U.S. Department of Transportation
400 Seventh Street N.W.
Washington, DC 20590

Dear Mr. Rawl:

We request issuance of 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 for Tech/Ops Inc. Model 864 Type B Package. We are enclosing two copies of the Safety Analysis Report for this package for your review.

We have applied to the U.S. Nuclear Regulatory Commission for issuance of a Certificate of Compliance for this package. We will forward this certificate to you as it becomes available.

We trust 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:lh
Enclosures

xc: C.E. MacDonald, USNRC

Tech/Ops

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

SAFETY ANALYSIS REPORT

TECH/OPS INC.

MODEL 864

TYPE B(U) PACKAGE

1. General Information

1.1 Introduction

The Tech/Ops 864 is designed for use as a source changer and shipping container for Type B quantities of radioactive material in special form. The Model 864 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 864 is 6.0 inches (152mm) in diameter and 8.96 inches (228mm) high. The package also incorporates a handle which rotates out of position when not in use. The handle assembly is 7.38 inches (187mm) wide at its widest point. With the handle fully extended, the overall height of the package is 11.95 inches (304mm). The gross weight of the package is 67 pounds (31kg).

The radioactive material is sealed in source capsules which conform to the requirements of special form radioactive material. These source capsules are installed in source holder assemblies. These source holder assemblies are 0.275 inch (7.0mm) in diameter and 6.13 inches (156mm)long.

The source holder assemblies are housed in brass source tubes. The source tubes have an outside diameter of 0.313 inch (7.9mm) and and inside diameter diameter of 0.281 inch (7.1mm).

The source tubes are surrounded by uranium metal as shielding. The mass of the uranium shield is 43 pounds (20kg).

The uranium shield assembly is encased in a carbon steel (ASTM 1020) housing. The shield is supported on the bottom by the base plate. The base plate is welded to the carbon steel shell. The shield assembly is supported on the top by the deck plate. The deck plate is also welded to the shell. The deck plate and base plate providesupport for the shield in both vertical and horizontal directions. Copper separators are positioned between the shield and these plates to prevent any iron-uranium interfaces.

The void space between the uranium shield assembly and the steel housing is filled with a castable rigid polyurethane foam. This foam is installed through two one inch (25mm) diameter pour holes in the deck plate.

Mounted on the deck plate is the source latching assembly. This assembly is used to secure the radioactive sources and source holder assemblies in a shielded position during transport.

An outer package cover, also fabricated from carbon steel, is bolted to the package to provide protection to the latching assembly.

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 painted steel finish to provide for easy decontamination.

The radioactive material is sealed inside stainless steel source capsules. The capsules act as the containment vessel for the radioactive material.

1.2.2 Operational Features

The source holder assemblies are secured in the proper position by means of the source latching assembly. With the source in the proper storage position, the source holder connector is located at the level of the source latch bar. With the source latch bar in the engaged or latched position, an interference is created with the change in diameter of the source connector. This interference prevents the removal of the source holder assembly from the source changer.

The package cover is designed such that it cannot be installed on the package unless all latch bars are in the engaged or latched position. Additionally, the latch bars are held in the engaged position by two safety pins.

1.2.3 Contents of Package

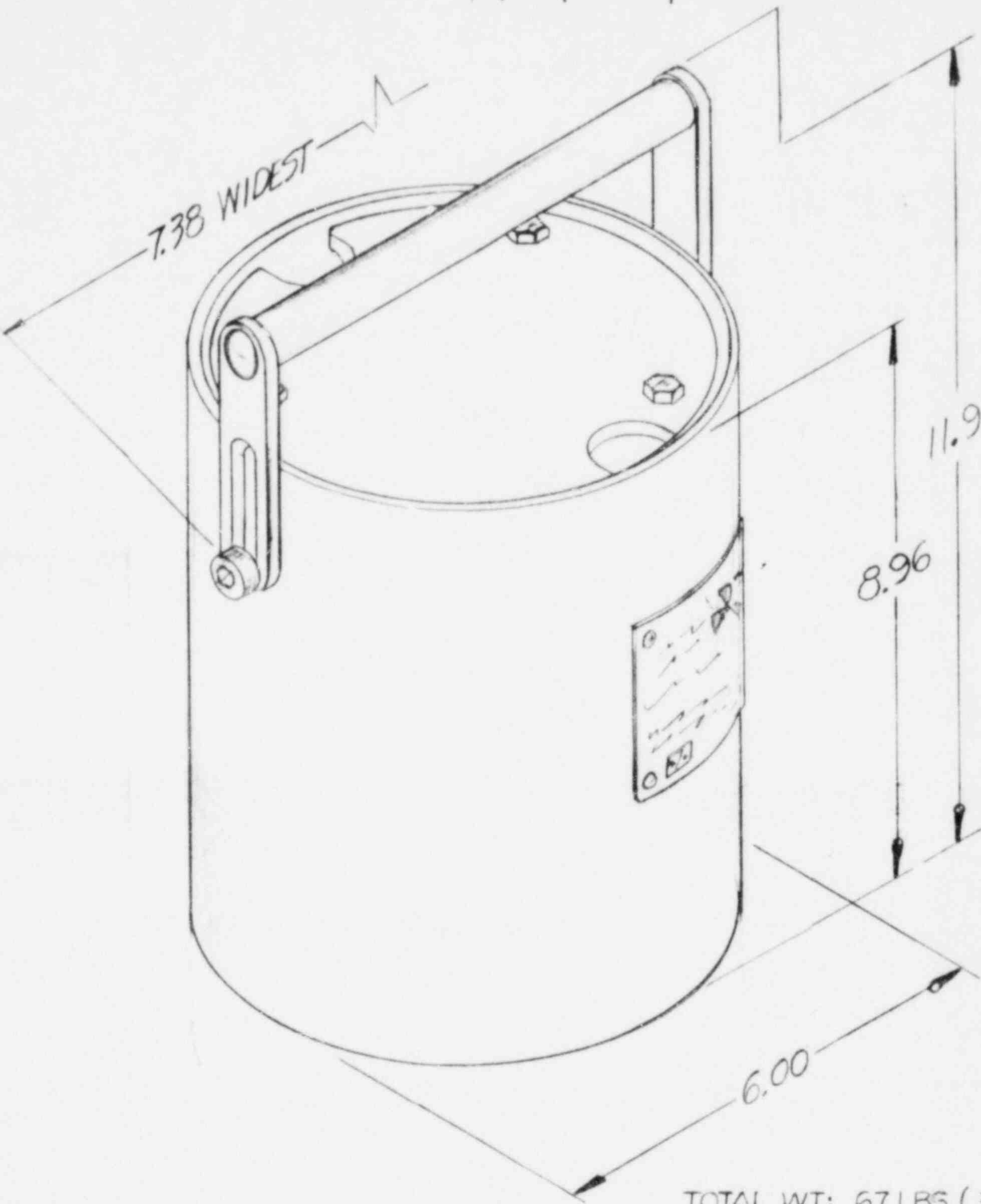
The Model 864 is designed for the transport of iridium-192 in quantities up to 360 curies in Tech/Ops source capsules 90004 and 90005. These source capsules satisfy the criteria for special form radioactive material in accordance with 10CFR71 and IAEA Safety Series No. 6. 1973 revised edition (Section 2.8).

1.3 Appendix

Drawing 86490 Sheets 1 through 6

Drawing 86491

Drawing 86492

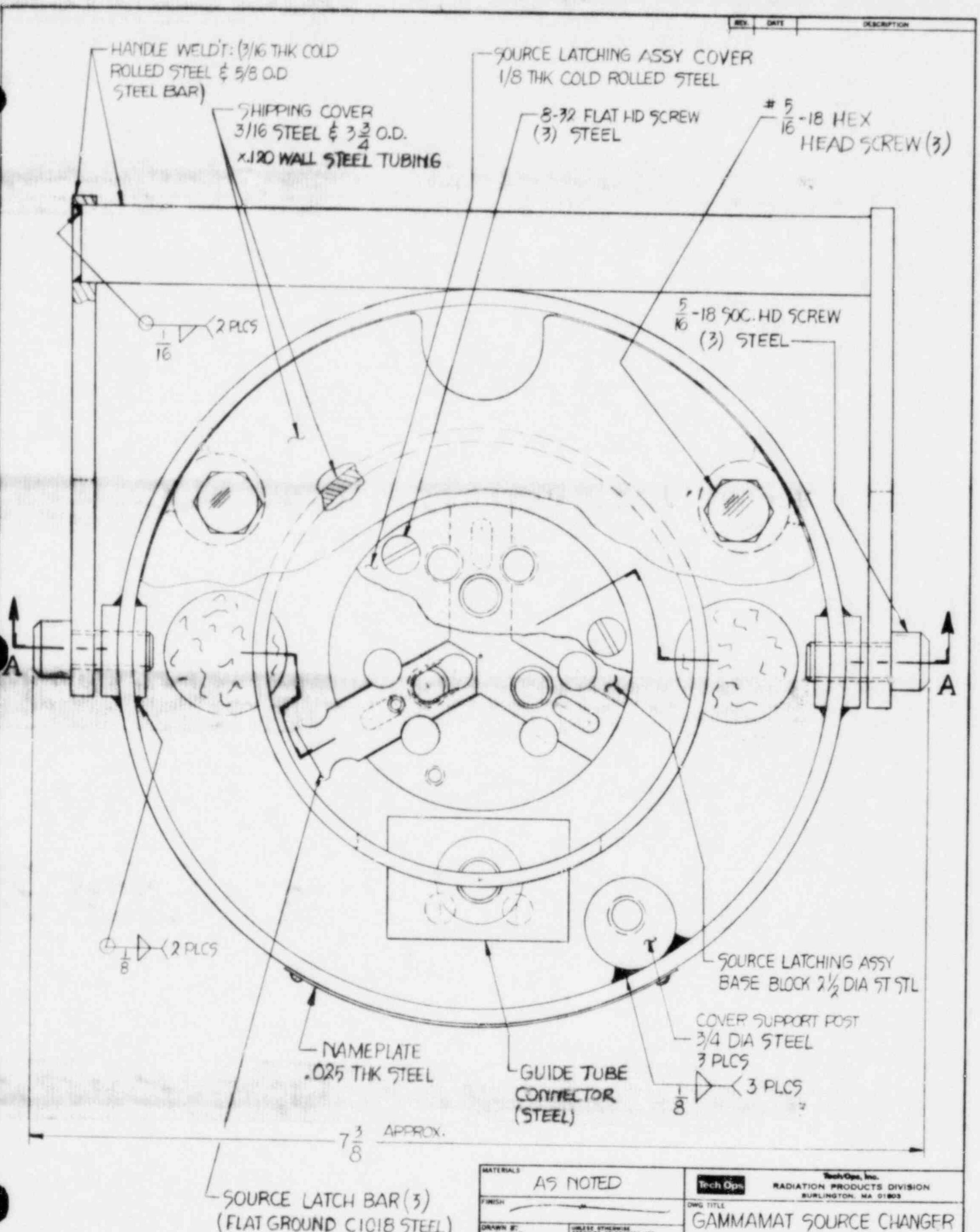


TOTAL WT: 67 LBS (31 KG)

MATERIALS: SEE SHTS 2 THRU 6		Tech/Ops, Inc. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803			
FINISH: —		DWG TITLE: GAMMAMAT SOURCE CHANGER DESCRIPTIVE ASSEMBLY			
DRAWN BY: [signature] 7-10-82	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ±				
CHECKED BY	.XX ±				
	.XXX ±	CLASSIFICATION	SIZE: A	DWG. NO. 86490	REV.
APPROVED BY	ANGLES ±				
	FRACTIONS ±	SCALE —		SHEET 1 OF 6	

REV.	DATE	DESCRIPTION

SPAULDING CO., INC. 21-25486



MATERIALS	AS NOTED
	Tech/Ops, Inc. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
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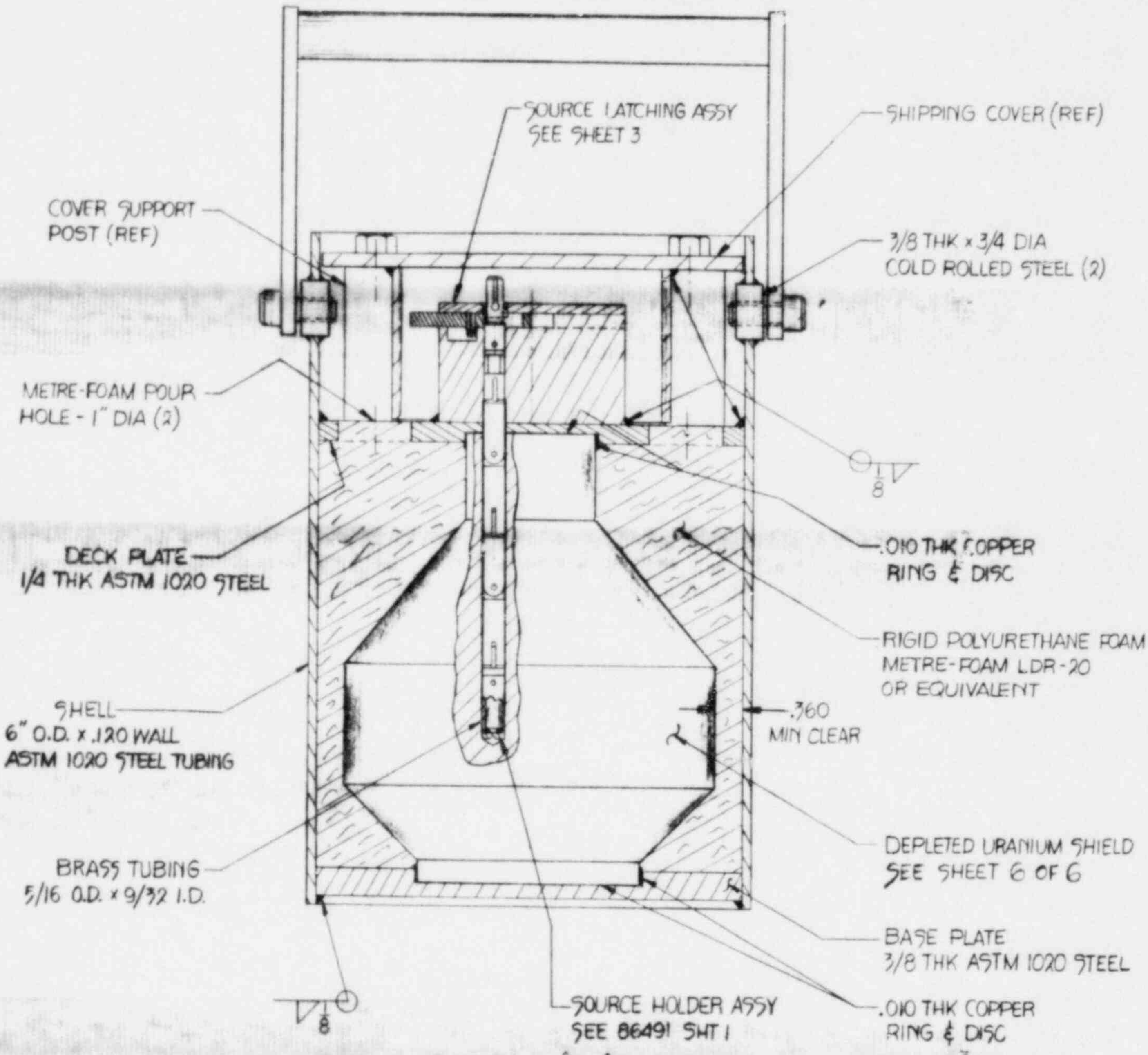
SIZE	C
DWG. NO.	86490
SHEET	2 OF 4



SECTION A-A

MATERIALS: AS NOTED	Tech Ops — TechOps, Inc. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
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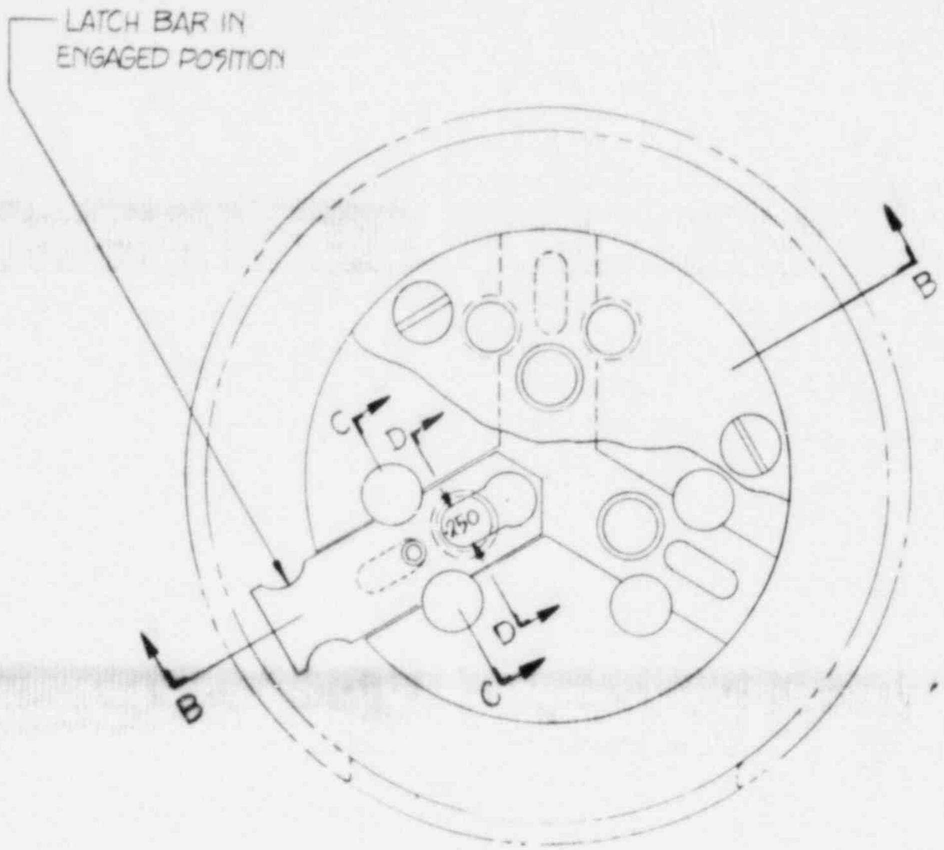
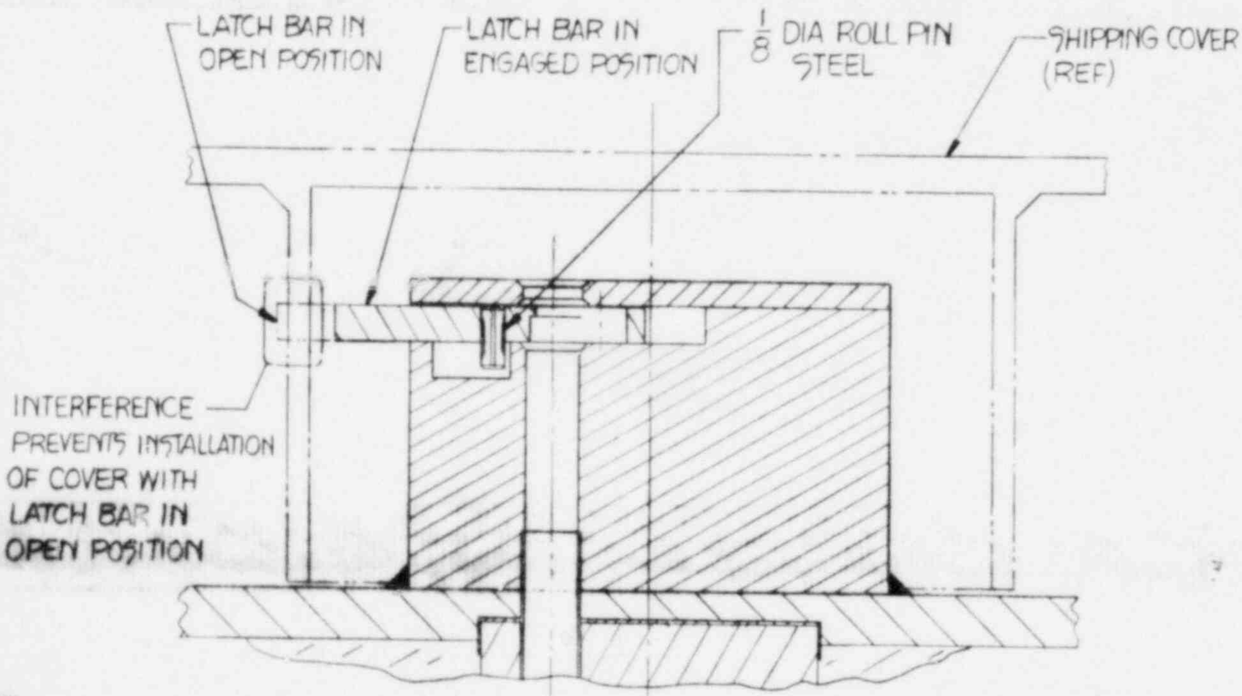
CLASSIFICATION	SIZE: C — DWG. NO. 86490
SCALE: 1	SHEET

REV	DATE	DESCRIPTION



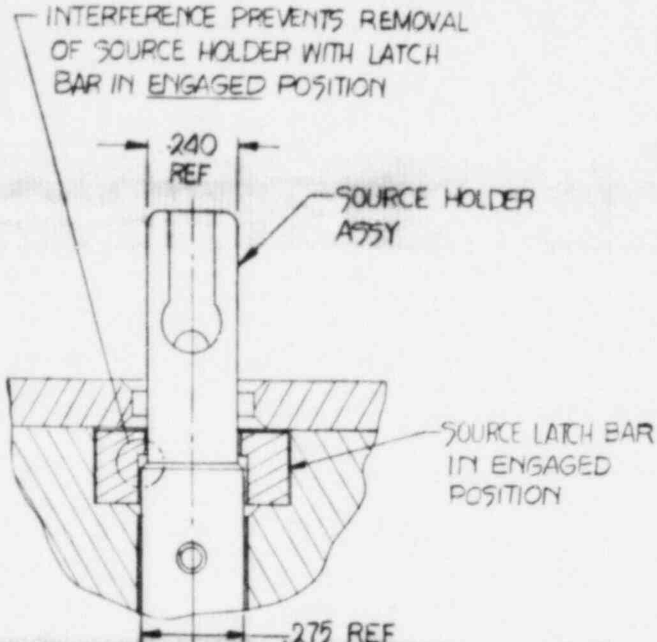
SOURCE LATCHING ASSY



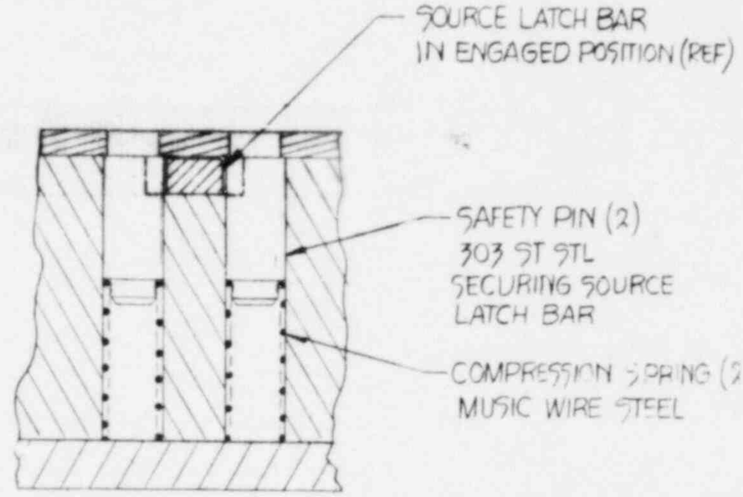
SECTION B-B

(ROTATED 30° C.W.)

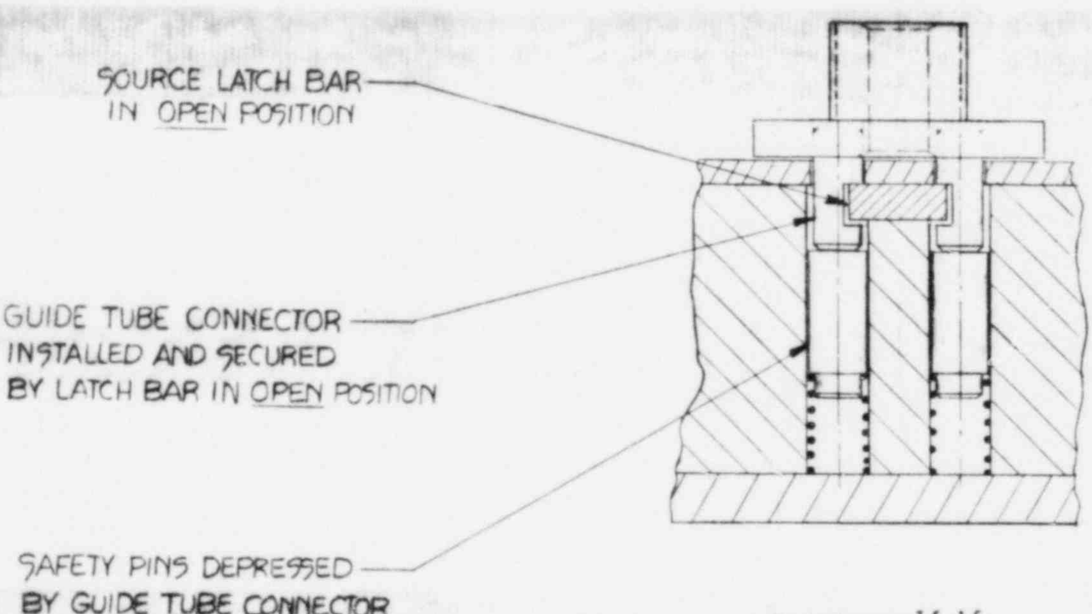
MATERIALS: AS NOTED	Tech Ops — Tech/Ops, Inc. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: GAMMAMAT SOURCE CHANGER DESCRIPTIVE ASSEMBLY
DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± .XX ± .XXX ± ANGLES ± FRACTIONS ±
CHECKED BY	CLASSIFICATION — SIZE: C — DWG. NO. 86490
APPROVED BY	SCALE 2:1 — SHEET 4 OF 6



SECTION D-D
TYP 3 PLACES
SCALE 4:1



SECTION C-C
TYP 3 PLACES
SCALE 2:1

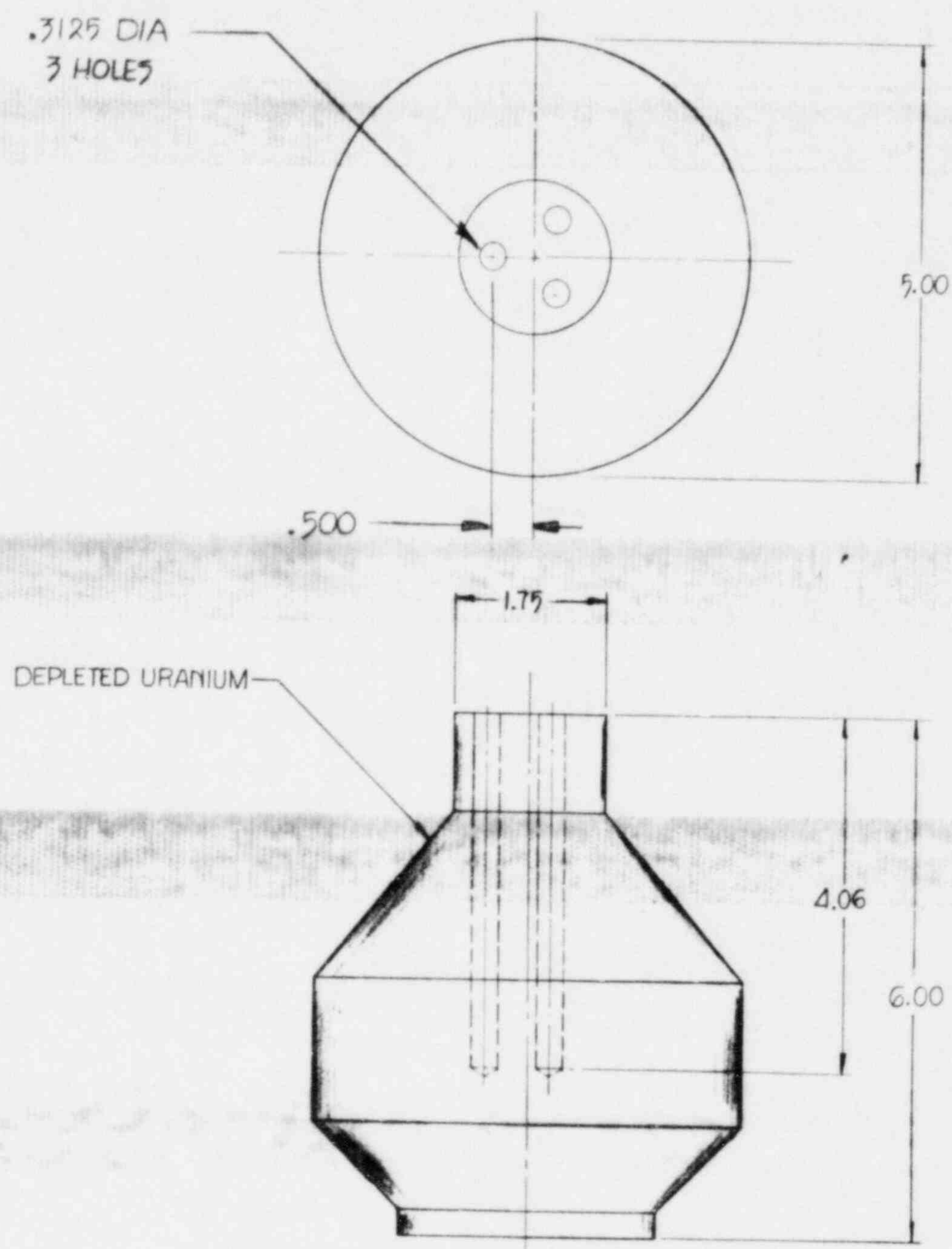


SECTION X-X
SCALE 2:1

MATERIALS: AS NOTED
FINISH: —
DRAWN BY: [signature] 2-16-82
CHECKED BY:
APPROVED BY:
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ±, .XX ±, .XXX ±, ANGLES ±, FRACTIONS ±

Tech/Ops, Inc.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

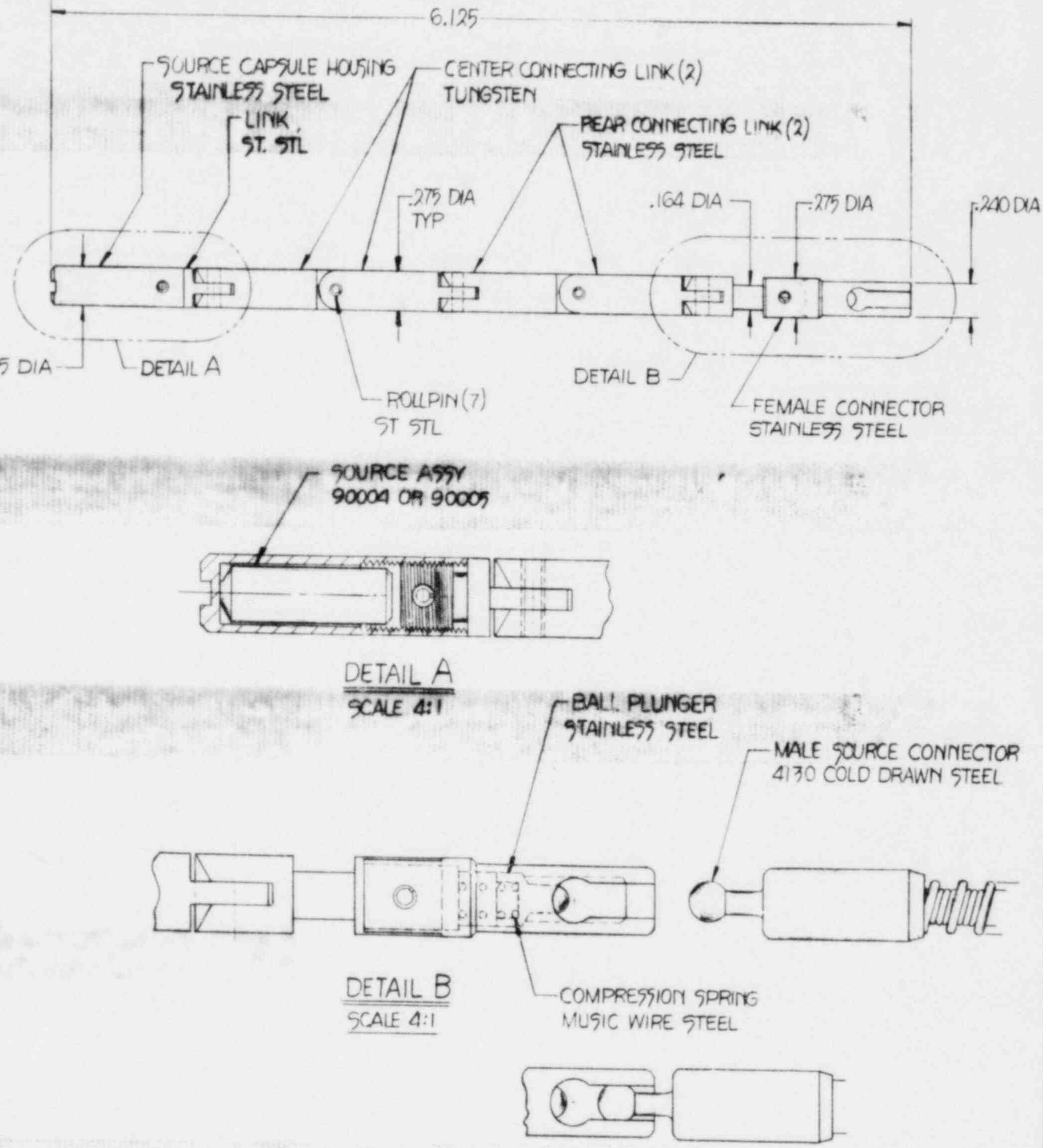
DWG TITLE: GAMMAMAT SOURCE CHANGER DESCRIPTIVE ASSEMBLY
CLASSIFICATION | SIZE C | DWG NO. 86490
SCALE | SHEET 5 OF 6



SHIELD DATA

WEIGHT: 43 LBS

MATERIALS: AS NOTED	Tech/Ops, Inc. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
	DWG TITLE: GAMMAMAT SOURCE CHANGER DESCRIPTIVE ASSEMBLY
	SIZE: C; DWG NO: 86490



MATERIALS: AS NOTED

Tech/Ops, Inc.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

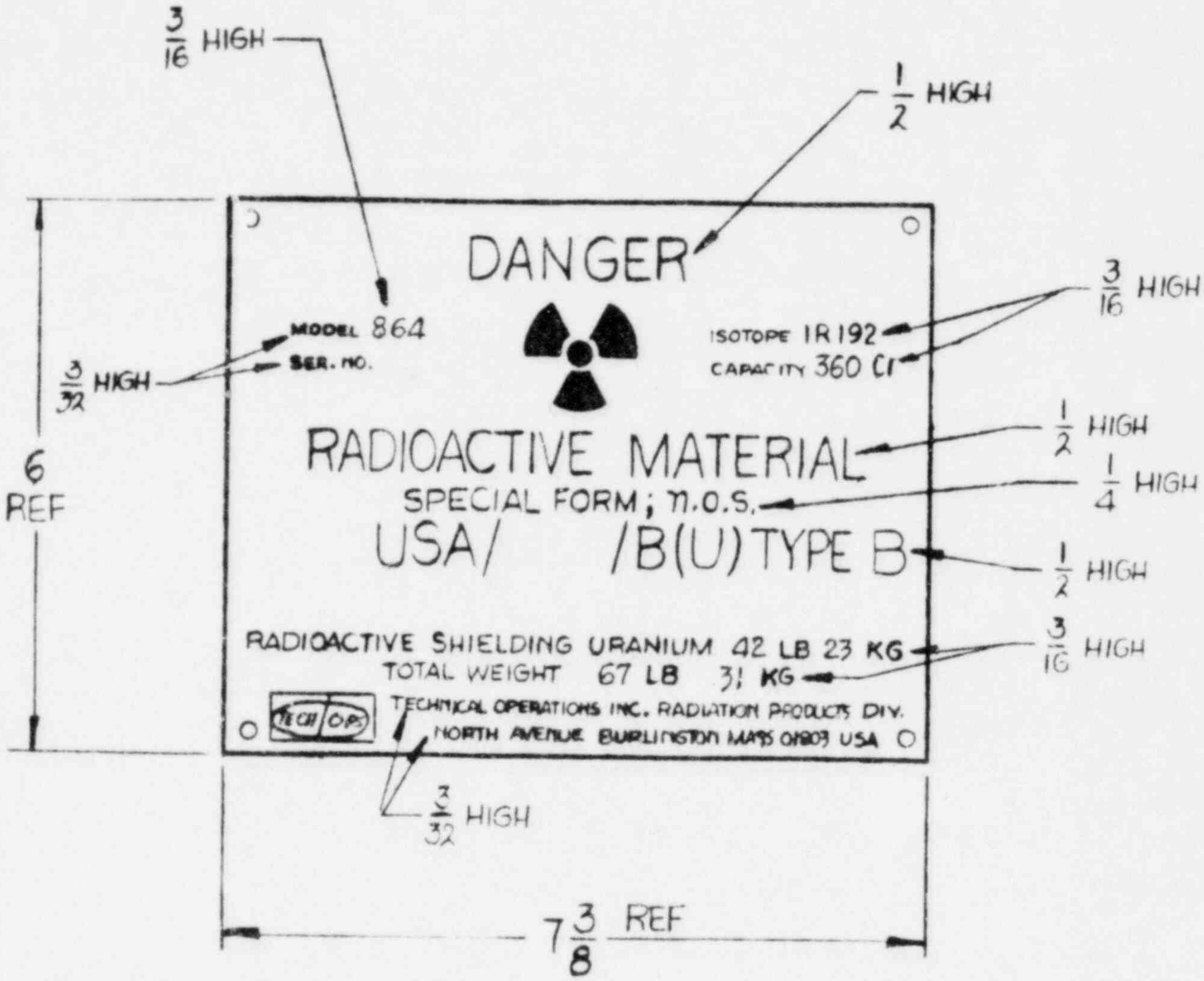
DWG TITLE: GAMMAMAT SOURCE ASSY-DESCRIPTIVE ASSEMBLY

SIZE: C DWG NO: 86491

SCALE: 2:1 & 4:1

86492

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

FINISH: NOTES 2 & 3

DRAWN BY: F. Tingley 7-10-82

CHECKED BY:

APPROVED BY:

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE

.X	±
.XX	±
.XXX	±
ANGLES	±
FRACTIONS	±

tech/ops

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE: NAMEPLATE

CLASSIFICATION	SIZE	DWG. NO.	REV
	A	86492	

SCALE NONE | SHEET 1 OF 1

2. Structural Evaluation

2.1 Structural Design

2.1.1 Discussion

Structurally, the Model 864 consists of five components: a source capsule, source holder assembly, 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 latching assembly and source holder assembly, assures proper positioning of the source.

The outer housing is fabricated from six inch (152mm) diameter, 0.120 inch (3.0mm) thick wall carbon steel tube (ASTM 1020). The housing provides the structural strength of the package. The cover protects the latching assembly. The latching assembly secures the source holder assemblies in the shielded position at the bottom of the sourcetubes, and assures positive closure.

2.1.2 Design Criteria

The Model 864 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 864 weighs 67 pounds (31kg.). The shield assembly contains 43 pounds (20kg) of depleted uranium. The center of gravity was located experimentally. It is located along the cylindrical axis at a distance of 3.0 inches (76mm) above the bottom surface.

2.3 Mechanical Properties of Materials

The Model 864 housing is fabricated from carbon steel (ASTM 1020). This material has a yield strength of 55,000 pounds per square inch (380 MN/m^2).

Drawings of the source capsules used in conjunction with the Model 864are 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 installed in a source holder assembly. The capsules are sealed by tungsten inert gas welding. The source holder is tensile tested on a production basis to 100 pounds (445 newtons).

2.4 General Standards for All Packages

2.4.1 Chemical and Galvanic Reactors

The materials used in the construction of the Model 864 are uranium metal, steel, brass, tungsten 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 ironuranium at temperatures below the melting temperatures of the individual metals has been considered. The iron-uranium eutectic alloy temperature is approximately 1337°F. 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 864 cannot be exposed without opening a latch bar. Access to the latch bar requires removal of the cover. The cover is seal wired and provided with a tamperproof seal.

2.4.3 Lifting Devices

The Model 864 is designed to be lifted by its handle. The handle is attached to the package by two 5/16-18 UNC socket head capscrews. The cross sectionalarea of each of these screws is 0.0464 in^2 (29.95 mm^2). The minimum shear strength of these screws is 20,000 pounds per square inch (138 MN/m^2). Therefore the minimum shear strength of each bolt is 928 pounds (4135 newtons) which is more than thirteen times the weight of the package. Therefore, the lifting device can support five times the weight of the package without exceeding the yield strength of the material.

2.4.4 Tiedown Devices

There is no system of tiedown devices on the Model 864 which is a structural part of the package.

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:

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

Where S: Maximum Stress
F: Total load (335 pounds; 1.5 kN)
l: Length of Beam (8.96 inches; 228mm)
Z: Section Modulus (3.19 in^3, 52,352mm^3)

(Reference: Machinery's Handbook, 21st Edition, P 373)

The load is assumed to be 335 pounds (1.5 kN). The container is assumed to be a cylinder with an outside diameter of 6.0 inches (152mm), a wall thickness of 0.120 inch (3.0mm) and a length of 8.96 inches (222mm). Consequently, the section modulus of the beam is 3.19 in^3.

Therefore, the maximum stress generated in the beam is 117 pounds per square inch (0.81 MN/m^2) which is far below the yield strength of the material.

2.5.2 External Pressure

The Model 864 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 (0.205 inch)

(Reference: Machinery's Handbook, 21st Edition, p 440)

The collapsing pressure of the source capsules is calculated to be 7070 pounds per square inch(49 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 864 is performed in Chapter 3. From this evaluation, it can be concluded that the Model 864 can withstand the normal heat transport condition.

2.6.2 Cold

The metals used in the manufacture of the Model 864 can all withstand a temperature of $^-40^oC$. The lower operating limit of the polyurethane foam is -100^oF (-73^oC). Thus, it is concluded that the Model 864 will withstand the normal transport cold conditions.

2.6.3 Pressure

The Model 864 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 864 is similar in construction to our Model 820 Type B package (Certificate No. 9137). The Model 820 has been in use for two years. During that time, there have been no vibrational failures reported.

On that basis, we contend that the Model 864 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 864. We contend that the materials used in construction of the Model 864 are all highly water resistant and that exposure to water will not reduce the shielding effectiveness 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 864 will withstand the free drop without loss of shielding effectiveness of loss of package integrity.

2.6.7 Corner Drop

Not Applicable

2.6.8 Penetration

A penetration test of the Model 864 was performed. There was no loss of shielding effectiveness 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 864 is 67 pounds (31 kg). The maximum cross sectional area is 54 in^2 (0.035 m^2). Thus, five times the weight of the package (335 pounds; 1492 newtons) is greater than two pounds per square inch times the maximum cross sectional area (108 pounds, 481 newtons).

A compression test of a prototype Model 864 was conducted. The package was subjected to a compressive load of 370 pounds (1648 newtons) for a period of twenty-four hours. At the conclusion of this test, there was no loss of structural integrity nor loss or shielding effectiveness. There was no failure of any part of the package. A copy of the test report is included in Section 2.10.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

The Model 864 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 864 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 864, 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 source tubes which protrude through the deck plate. The shield is restricted from vertical movement by the deck plate and the base plate.

Thus, it is concluded that the Model 864 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 864 is designed for use with Tech/Ops source capsule Models 90004 and 90005. These source capsules have been certified as special form radioactive material under IAEA Certificate of Competent Authority No. USA/0179/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 Capsules

Test Report: Uranium Thermal Test

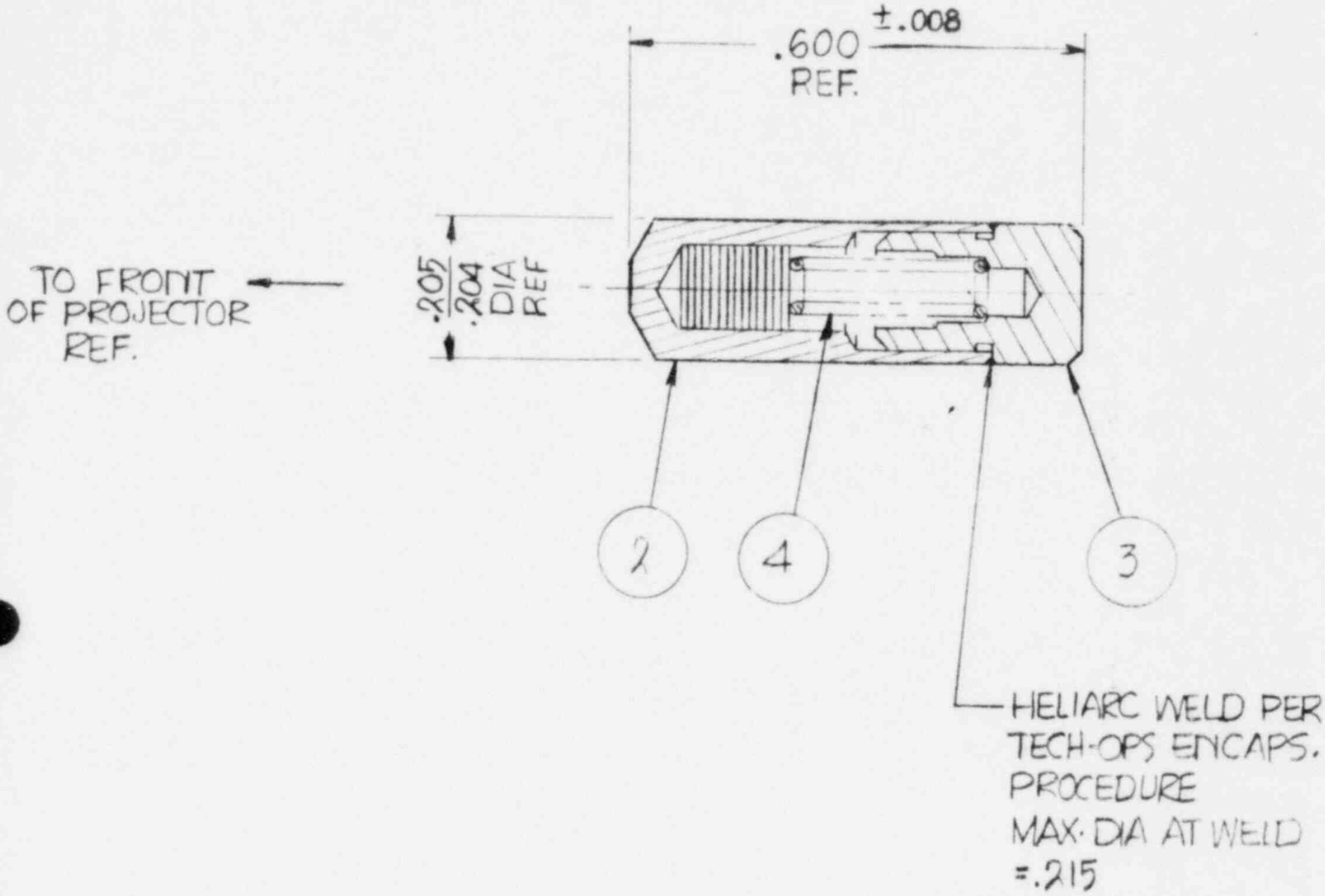
Test Report: Model 864 Penetration Test

Test Report: Model 864 Compression Test

Test Report: Model 864 Free Fall and Puncture Tests

IAEA Certificate of Competent Authority USA/0179/S

REV.	DATE	DESCRIPTION
A	14 JAN '80	REDRAWN FROM "B" SIZE - NO OTHER CHANG
B	15 JUNE '81	.205/.204 DIA REF WAS .205 ±.002 DIA REF
C	18 JUNE 81	.600 ±.008 REF WAS .650 ±.008 REF



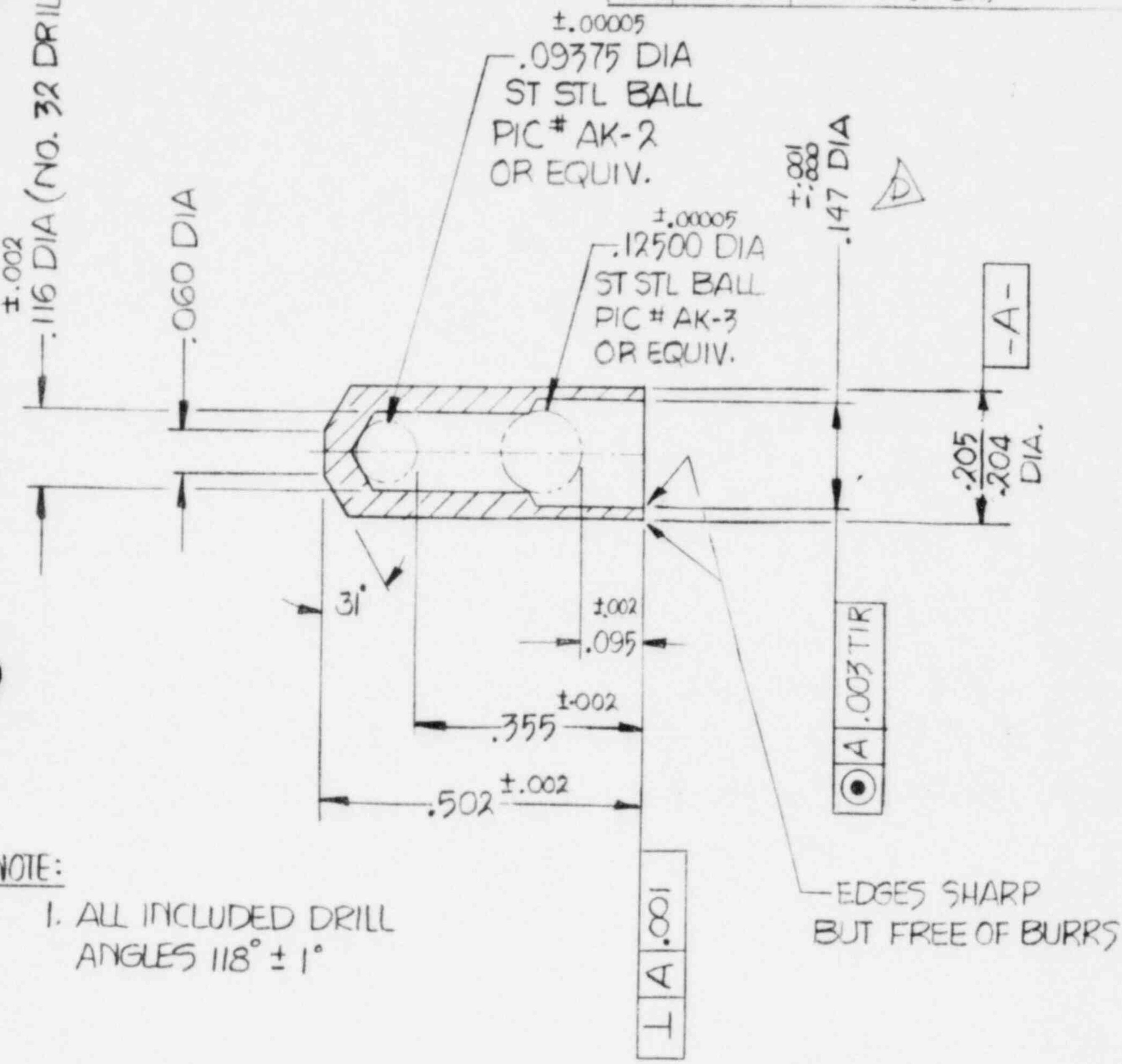
MATERIALS	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
SEE BM 90004	
FINISH	DWG TITLE: GENESIS 8B IR 192 CAPSULE ASSEMBLY

DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE
[illegible] 14 JAN '80	.X ±
CHECKED BY	.XX ±
[illegible] 14 JAN 80	.XXX ±
APPROVED BY	ANGLES ±
	FRACTIONS ±

CLASSIFICATION	SIZE	DWG. NO.	REV
	A	90004	C

SCALE 4:1 SHEET 1 OF 1

REV.	DATE	DESCRIPTION	
A	14 JAN '80	REDRAWN FROM "B" SIZE - NO OTHER CHANGES	
B	16 JUNE '81	DIA "A" WAS .205 ±.002	RGT
C	31 JUL '81	REDRAWN, WAS 90004-1 REV B	RGT
D	10-6-81	WAS .161 DIA	



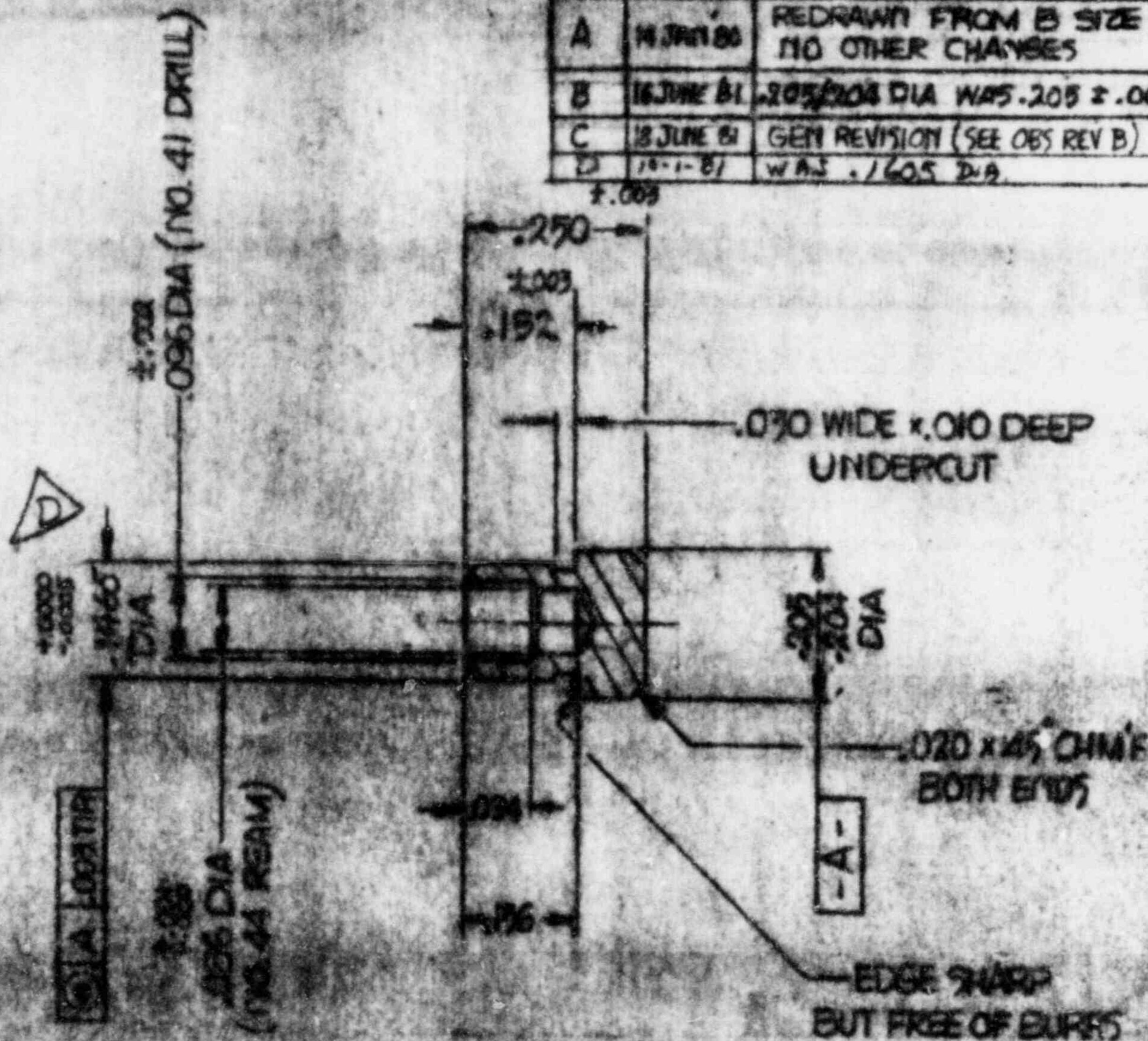
NOTE:

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] 14 JAN 80	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE		
	.X ±		
CHECKED BY	.XX ±		
R. Drennon 14 JAN 80	.XXX ± .005	CLASSIFICATION	SIZE A · DWG. NO. 90004-1 · REV D
APPROVED BY	ANGLES ± 1/2°		
	FRACTIONS ±	SCALE 4:1	SHEET 1 OF 1

SPAULDING CO., INC. 21-60169

REV.	DATE	DESCRIPTION
A	14 JAN 80	REDRAWN FROM B SIZE; NO OTHER CHANGES
B	16 JUNE 81	.205/.204 DIA WAS .205 ± .002 DIA
C	18 JUNE 81	GEN REVISION (SEE OBS REV B)
D	10-1-81	WAS .1605 DIA.

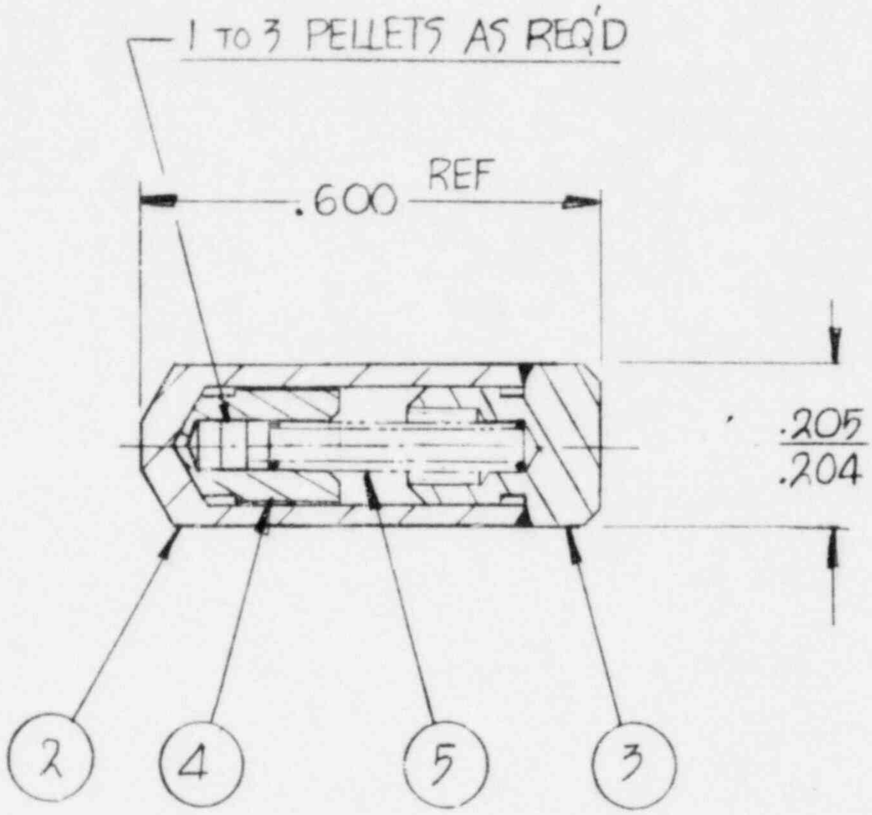


NOTE:

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:	SIZE: A
CHECKED BY:	DWG NO. 90004-2
APPROVED BY:	SHEET 1 OF 1

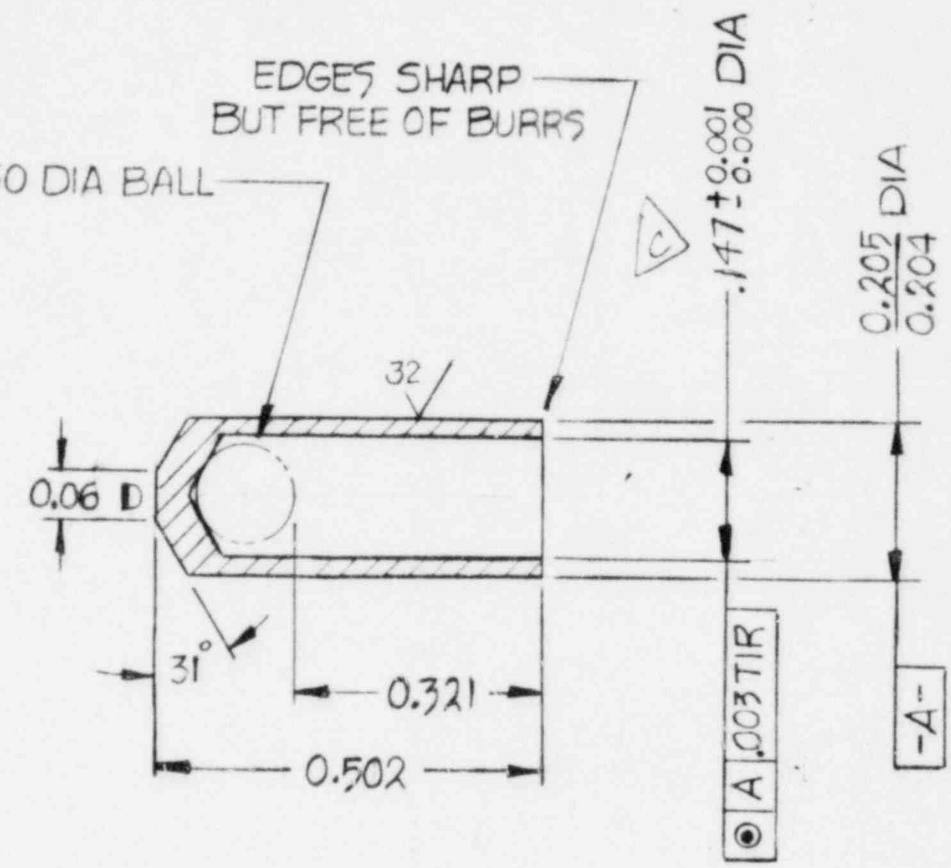
REV.	DATE	DESCRIPTION
D	8 OCT 81	REPLACES DWG A90005 REV C



MATERIALS SEE BM 90005		Tech Ops	TECH/OPS, INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH — " —		DWG TITLE IR[192] SOURCE CAPSULE ASSY (PELLET STYLE)	
DRAWN BY A. Tinsley 8 OCT 81	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE .X ±		
CHECKED BY	.XX ±		
	.XXX ±	CLASSIFICATION	SIZE A / DWG. NO. 90005 / REV. D
APPROVED BY	ANGLES ±		
	FRACTIONS ±	SCALE 4:1	SHEET 1 OF 1

A90005-1

REV.	DATE	DESCRIPTION	
A	16 JUNE '81	DIA "A" WAS .205 ±.002	FGT
B	18 JUNE '81	0.321 WAS 0.341 & 0.502 WAS 0.522 (OBS. RECORD SEPIA REV A ON FILE)	FG
C	19-6-81	WAS .161 DIA	



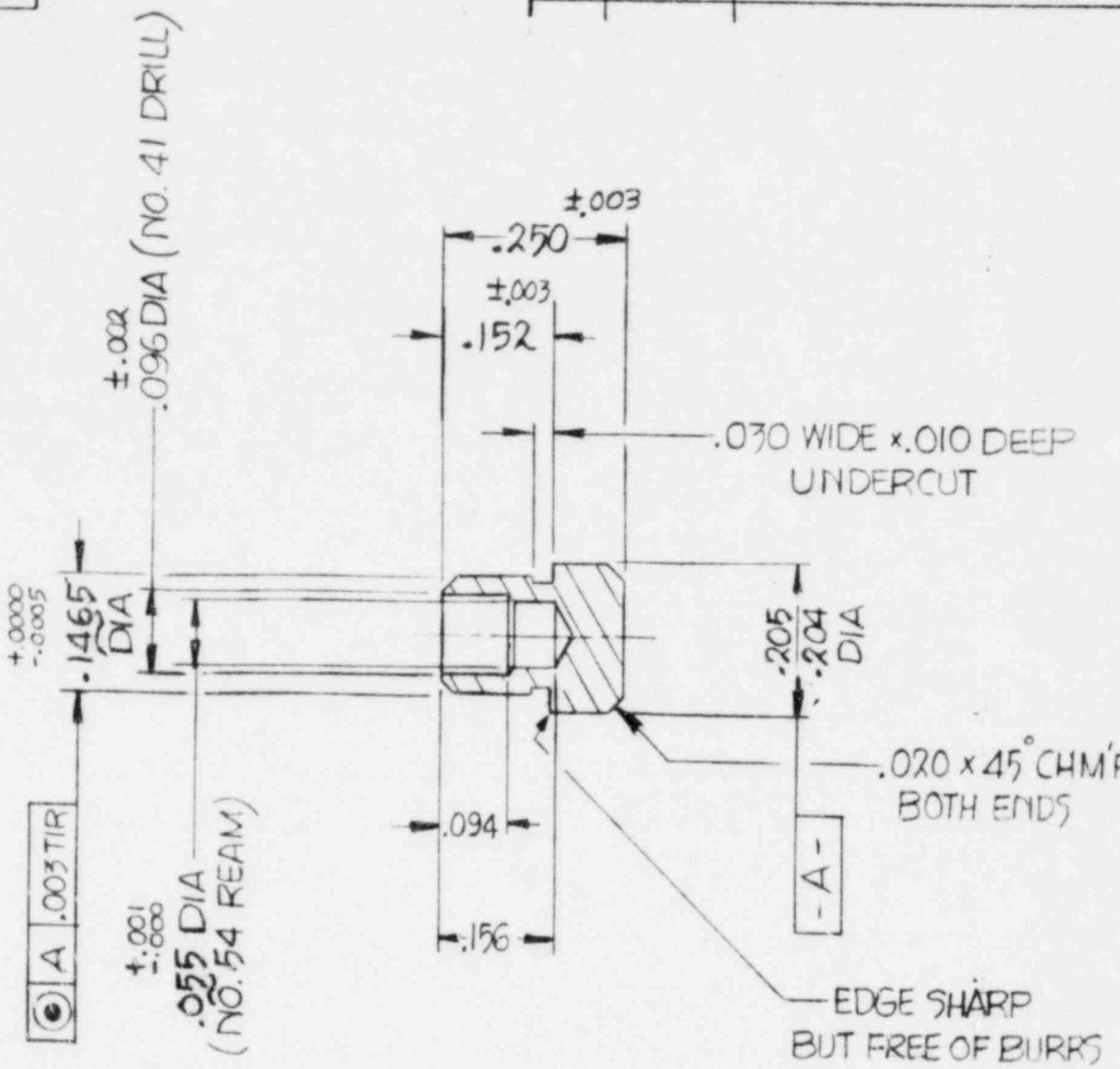
NOTE: INCLUDED DRILL ANGLE - 118°

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: Tingley 9 JUL 80	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± ; .XX ± 0.01 ; .XXX ± 0.005 ; ANGLES ± 1° ; FRACTIONS ±
CHECKED BY	CLASSIFICATION: ; SIZE: A ; DWG. NO. 90005-1 ; REV C
APPROVED BY	SCALE 4:1 ; SHEET 1 OF 1

SPAULDING CO., INC. 21-60169

A90005-2

REV.	DATE	DESCRIPTION



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	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE
	.X ±
CHECKED BY	.XX ±
	.XXX ± .005
APPROVED BY	ANGLES ± 1/2°
	FRACTIONS ±

CLASSIFICATION	SIZE	DWG. NO.	REV
	A	90005-2	

SCALE 4:1 — SHEET 1 OF 1

NUCLEAR METALS, INC.

2229 MAIN STREET
CONCORD MASSACHUSETTS 01742

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

REVISION 0
15 JUL 1982

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: Ford Tingley

DATE: 23 June 1982

SUBJECT: Model 864 Penetration Test

On 10 May 1982 a Model 864 source changer was subjected to an impact of the hemispherical end of a vertical steel cylinder $1\frac{1}{4}$ inches in diameter and weight of 13 pounds. The cylinder was dropped three times; twice on the outside of the shell, and once onto the cover plate of the container, all from a height of 40 inches. The long axis of the cylinder was perpendicular to the container surface for each trial.

The Model 864 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.

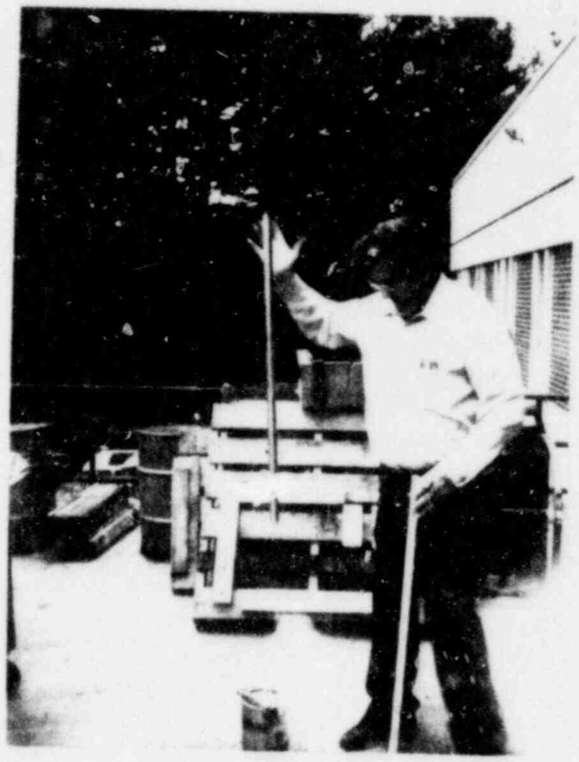
Therefore, it is concluded that the Model 864 meets the requirements of the penetration test outlined in 10CFR71 Appendix A and Paragraph 714 of IAEA Safety Series No. 6, 1973.

Witnessed Angelo Kiklis

Angelo Kiklis

REVISION 0

JUL 15 1982



Penetration Test

REVISION O
JUL 1 5 1982

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: Ford Tingley

DATE: 27 May 1982

SUBJECT: Model 864 Compression Test

On 10 May 1982 a Model 864 source changer was subjected to a compressive load of 370 pounds. A shipping package weighing 370 pounds was placed on the top of the unit. The load was left in place from 1:45 P.M. 27 May 1982 to 1:45 P.M. 28 May 1982.

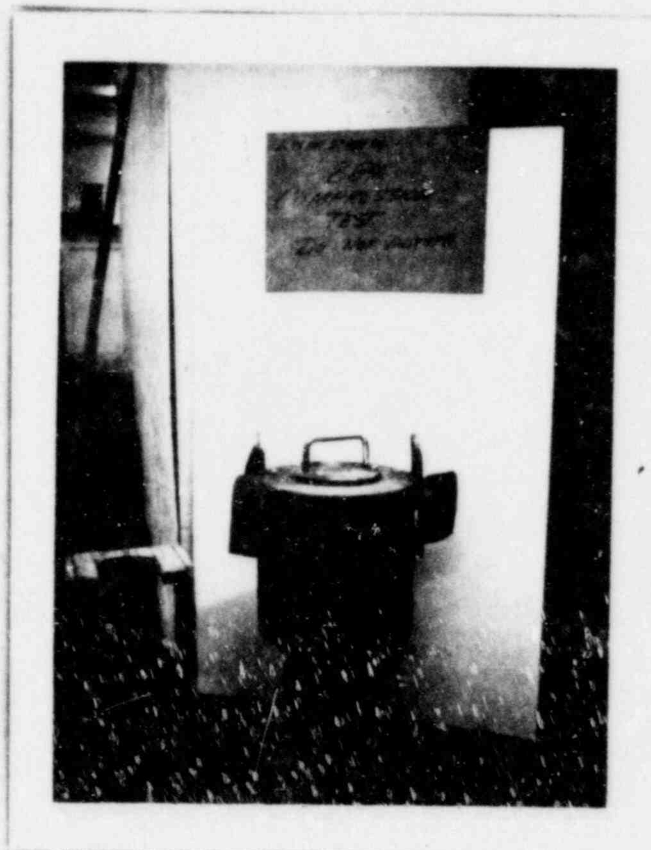
The package was not adversely affected as a result of the test. The package did not suffer any loss of structural or shielding integrity. Thus, it is concluded that the Model 864 meets the requirements of the compression test as described in Appendix A of 10CFR71 and Paragraph 713 of IAEA Safety Series No. 6, 1973 Edition.

Witnessed Anthony Gentile

Anthony Gentile

REVISION O

JUL 1 5 1982



Compression Test

RADIATION PRODUCTS DIVISION

TEST REPORT

BY: Ford Tingley

DATE: 24 June 1982

SUBJECT: Model 864 Drop Test and Puncture Test

On the 24 June a Model 864 source changer was twice submitted to free fall of 30 feet onto two steel plates; one measuring 3 feet by 3 feet x 1/2 inch and the other measuring 4 feet x 4 feet x 3/8 inch, which were lying on top of a hard-packed gravel surface.

The Model 864 struck a different corner each time, first the bottom and then the top, causing minor deformation of the outer shell. There was no loss of structural integrity.

The model 864 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 radium 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. There was no loss of structural integrity.

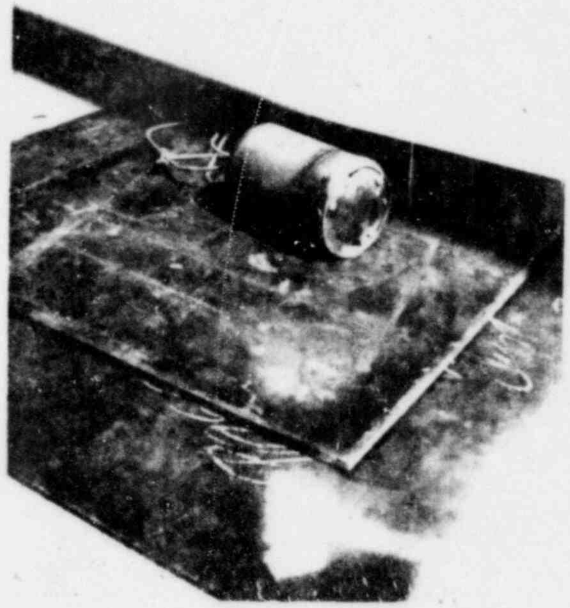
Upon removal of the lock mechanism at the conclusion of the test, a radiation profile was performed (See Section 5.) and from that it was concluded that there was no loss of shielding integrity. Therefore, it is concluded that the Model 864 meets the requirements of the free fall and puncture tests outlines in 10CFR71 Appenidix A and IAEA Safety Series No. 6, 1973.

Witnessed Angelo Kiklis

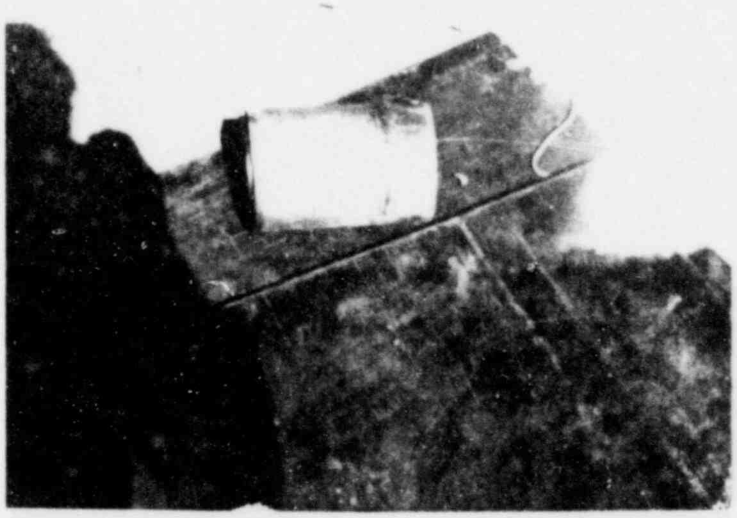
Angelo Kiklis

REVISION O

JUL 15 1982



Drop Test



REVISION 0

JUL 1 5 1982

Puncture Test

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 2)

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, 1983.

This certificate is issued in accordance with Paragraph 803 of the IAEA Regulations and in response to the November 12, 1980 petition by Tech/Ops, Burlington, Massachusetts, and in consideration of the associated information therein.

Certified by:

R. R. Rawl
Chief, Radioactive Materials Branch
Office of Hazardous Materials Regulations
Materials Transportation Bureau

January 15, 1981
(date)

1/ "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materia 1975 Revised 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.

Revision 2 issued to reflect conformance with the 1973 IAEA Regulations.

3. Thermal Evaluation

3.1 Discussion

The Model 864 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 360 curies of iridium-192. The corresponding decay heat is 3.09 watts.

3.2 Summary of Thermal Properties of Materials

The melting points of the metals used in the construction of the Model 864 are:

Tungsten	6098°F	(3370°C)
Steel	2453°F	(1345°C)
Uranium	2070°F	(1133°C)
Copper	1940°F	(1060°C)
Brass	1706°F	(930°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 by products 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 864 is a maximum of 360 curies of 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 360 curies of iridium-192 would be 3.09 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 49.1°C and the maximum temperature when insolated would be less than 73°C.

3.4.3 Minimum Temperatures

The minimum normal operating temperature of the Model 855 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 864. The applicable conditions of IAEA Safety Series No. 6, 1973 for Type B(U) packages have been shown to be satisfied by the Model 864.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Thermal Model

The Model 864 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 864 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 864 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 is was concluded that the formation of the alloy was notalikely eventuality.

3.5.4 Maximum Internal Pressures

The Model 864 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 54psi (373 kN/m^2)

The critical location for failure is the weld. An internal pressure of 54 psi (373 kN/m^2) will generate a maximum stress of 223psi (1.54 MN/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 864 will undergo no loss of structural integrity or shielding effectiveness 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 864 Type B(U) Thermal Analysis: Paragraphs 231 and 232 of IAEA Safety Series No. 6, 1971

3.6.2 Model 864 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 864 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 864 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(3.09 watts) is deposited in the exterior faces of the Model 864.

2) The interior of the Model 864 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 (0.77 watts)

h: Free convective heat transfer coefficient for air ($1.32 \left[\frac{\Delta T}{d}\right]^{1/4}$ W/m^2 - °C)

A: Area of the face of interest (0.0182 m^2)

T_w: Maximum temperature of the wall of the package

T_a: Ambient temperature (38°C)

From this relationship, the manimum temperature of the wall is 49.0°C. This satisfies the requirement of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973.

3.6.2 Model 864 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 864 will not exceed 82°C when the package is in an ambient temperature of 38°C and isolated in accordance with paragraph 240 of IAEA Safety Series No. 6, 1973.

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

1) The package is insolated at the rate of 775W/m^2 (800 cal/cm^2 - 12h) on the top surface, 388W/m^2 (400 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 a painted 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 inthe 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 0.0182m^2. The surface area of the side is 0.109m^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 (56.4 watts)

q_d: Decay heat rate (3.1 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:

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

where σ Stefan Boltzmann Constant (5.669×10^{-8} W/m^2-$^oK^4$)

ε: Emissivity (0.8)

Iteration of this relationship demonstrates that the wall temperature of the Model 864 is 72.3C which satisfies the requirement of paragraph 240 of IAEA Safety Series No. 6, 1973.

3.3

Model 864 Type B(U)

Source Capsules-Thermal Analysis

Paragraph 238 of IAEA Safety Series Series No. 6, 1973

This analysis demonstrates that the pressure inside the source capsules used in conjunction with the Model 864, 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 0.205 inch (5.21mm). 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 iridiun 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/m^2). 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/m^2 (5[illegible]psi).

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

The maximum longitudinal stress is calculated from:

$$\sigma_1 A_1 = PA_p$$

where σ_1: Longitudinal stress

A_1: 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 686 kN/m^2 (99psi).

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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 (0.600 inch)

t: Thickness of cylinder (0.020 inch)

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

At a temperature of 1600^oF (870^oC), the yield strength of type 304 stainless steel is 10,000psi ($69MN/m^2$). 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.

4. Containment

4.1 Containment Boundary

4.1.1 Containment Vessel

The containment systems for the Model 864 are the radioactive source capsules as listed in Section 1.2.3 of this application. These source assemblies 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 304L stainless steel . The capsules are cylinders with a diameter of 0.205 inch (5.21mm) and length of 0.600 inch (15.2mm).

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.

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 864 is shielded with 43 pounds of depleted uranium. A radiation profile of Model 864 Serial No. 1 containing 242 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 360 curies of iridium-192 is presented in Table 5.1. As the Model 864 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
164	4.5	119	0.30	0.30	0.42

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 360 curies.

5.2.2 Neutron Source

Not Applicable

5.3 Model Specification

Not Applicable

5.4 Shielding Evaluation

The Model 864 shielding evaluation was performed on Model 864, Serial No. 1 containing 242 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 864, Serial Number 1

5.5.2 Radiation Profile - Model 864, Serial Number 1 after hypothetical accident conditions

5.5.1 RADIATION PROFILE

Model 864 Serial No. 1

Containing Source Capsules Model 90004

S.N. 1066 81CI
S.N. 1067 81CI
S.N. 1068 80CI

Total Activity 242 curies of iridium-192

Maximum Dose Rates (mR/hr)

	@ Surface	@ One Meter
Top	3	0.2
Sides	110	0.2
Bottom	80	0.3

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

5.5.2 RADIATION PROFILE

Model 864 Serial No. 1

After Hypothetical Accident Conditions

Containing Source Capsules Model 90004

S.N. 1082 107CI
S.N. 1083 106CI
S.N. 1084 106CI

Total Activity: 319 Curies of iridium-192

	Maximum Dose Rates (mR/hr)	
	@ Surface	@ One Meter
Top	4.5	0.7
Sides	120	1.0
Bottom	90	1.0

Measurements were made with an 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. The procedure for loading the source assemblies into the package is presented in Section 7.4.

7.2 Procedure 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.

7.4 APPENDIX

Procdeure for Encapsulation of Sealed Sources

Model 864 Operating Instructions

tech/ops

ENCAPSULATION OF SEALED - MODELS 90004 and 90005

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 2000 curies.

This cell is designed to be operated at less than atmospheric pressure. The exhaust blower 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 .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 differntial 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 $100^{o}C$ 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 of rivet.

9. Assemble capsule components.

10. Weld adhering to the following conditions:

    a. Electrode spacing .021" to .024" centered on joint ±.002"; use jib 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 .005uCi of contamination. If the patch shows more than .005uCi, the capsule must be cleaned and rewiped. If the rewipe patch still shows more than 0.005uCi 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 100lbs. Extension under the load shall not exceed 0.05 in. 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 gauze and count with scaler counting system. This assay must show no more than 0.005uCi. 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 864

SOURCE CHANGER-SHIPPING CONTAINER

OPERATION MANUAL

Technical Date

Size:	6.00 inches diameter; 8.96 inches high (152 mm diameter; 228mm high)
Weight:	67 Pounds (31kg)
Capacity:	360 Curies of iridium-192 as special form
Transport Status:	Type B(U) USNRC USA/ /B IAEA USA/ /B(U)
Shiedling:	Depleted Uranium 43 pounds (20kg)

General

The Model 864 source changer-shipping container is designed for transferring encapsulated radioisotope sources into radiographic devices and for transporting these sources.

The US 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 Tech/Ops, 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
Office of Nuclear Material Safety and Safeguards
US Nuclear Regulatory Commission
Washington, DC 20555

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

Transportation Certification Branch
Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
US Nuclear Regulatory Commission
Washington, DC 20555

General Safety Considerations

All personnel who enter a restricted area or are present during source changing operations should wear a direct reading pocket dosimeter with a range from zero to at least 200 milliroengens and either a film badge or a thermoluminescent dosimeter (TLD). The pocket dosimeter should be recharged prior to the start of the source changing operation. The operator should periodically check the pocket dosimeter reading throughout the operation. Records of the initial and final readings of the pocket dosimeter should be maintained.

In the event that an individual's pocket dosimeter is found to be off scale, that person should immediately stop all work with radiation. His film badge or TLD should be immediately sent for processing and he should not reenter a restricted area until it has been determined that he received less than maximum allowable occupational exposure. Source changing personnel should have a calibrated and operable radiation survey meter capable of measuring from 2mr/hr to 1000mr/hr to determine radiation levels when performing source changing operations.

Areas in which source changing operations are being conducted must be restricted to minimize radiation exposure to individuals. Restricted areas should be posted with the appropriate warning signs as required by governmental regulation. Source changing operatiors should guard against unauthorized entry in these areas at all times.

Shipping Information

The Model 864 source changer is shipped to the user with the following items in addition to the radioisotope source(s).

1. For each source
   - A. Source Decay Chart
   - B. Source Leak Test Certification
   - C. Verification of Source Physical Dimensions
   - D. Source Identification Label

2. Tamperproof Seals

3. Return Shipping Labels

4. Source Guide Tube Connector

5. Operation Manual

-NOTE-

The user if 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 changer on all sides to assure that the radiation levels do not exceed 200 milliroentgens per

hour at the surface of the changer nor 10 milliroentgens per hour at three feet from the surface of the changer.

2. Check the source changer for obvious damage.

3. Check the packing list and shipping papers to assure that the shipment is intact and complete.

4. If there are any discrepancies, do not use the source changer and contact Tech/Ops, Inc. immediately to resolve discrepancy. (Tel. 800-225-1383, Telex 949313). If items 1-3 are determined to be in order, place the source changer in a restricted area until ready to use.

Operation

Note: All the precautions used when making radiographic exposures must be followed. Wear personnel monitoring devices during all source changing operations. Monitor all operations with a calibrated, operable survey meter.

1. Survey the source changer upon receipt to ensure that all sources are in the proper storage positions. Radiation levels should not exceed 200 milliroentgens per hour at the surface of the source changer, nor 10 milliroentgens per hour at three feet from the surface.

2. Locate the source changer and exposure device(s) in a restricted area. Position the source changer in an upright position and near the exposure device so that one section of source guide tube will connect them with no sharp turns or bends. The bend radius of the guide tube should never be less than twenty inches. Shorter bend radii can restrict source movement in the source guide tube.

WARNING

The source changer must remain in an upright position during source changing operations. Do not position source changer on its side.

3. Remove any foreign matter from the source guide tube and attach the source guide tube connector to the source guide tube. Attach the source guide tube to the exposure device. Remove the source changer cover by breaking the seal wires and removing the bolts. Attach the source guide tube connector to an empty chamber of the source changer. Assure that the latch assembly of the chambers containing sources are in the engaged (latched) position. Open (unlatch) the latch assembly over the empty chamber.

4. Attach the control unit to the exposure device following the exposure device operating instructions.

5. Ensure that no unauthorized personnel are inside the restricted area. Crank the source rapidly from the exposure device to the source changer.

During this process, the survey meter reading should increase (to approximately 1000 mr/hr for a 100 curie iridium-192 source) as the source is first exposed, fall slightly as the source is being cranked out, then drop to background when the source is in the source changer.

6. Approach the exposure device, source changer and source guide tube with the survey meter. Survey the exposure device on all sides, survey the guide tube and survey the source changer on all sides to ensure that the source is fully within the source changer. The maximum radiation levels should not exceed 200 mr/hr on the surface of the source changer nor 10mr/hr at three feet from the surface.

7. Slide the latch bar to the engaged (latched)position. Upon engaging the latch bar, the source guide tube connector will disengage from the source changer.

WARNING

Do not remove the source guide tube from the source guide tube connector until the latch bar is engaged.

8. Disconnect the drive cable from the source holder assembly.

9. Couple the drive cable to the new source assembly and connect the source guide tube connector to the fitting on the source changer. Disengage (unlatch) the latch bar on the chamber containing the source to be transferred.

10. Return to the controls and ensure that no unauthorized personnel are within this restricted area. Crank the new source or drive cable into the exposure device. If a new source is being transferred, the survey meter should increase as the source leaves the source changer and approaches the exposure device, then drop background level when the source is shielded in the exposure device. If a source is not being transferred, the survey meter should indicate only background radiation levels.

11. Approach the exposure device with a survey meter. Survey the exposure device on all sides, survey the guide tube and survey the source changer on all sides to ensure that the process has been properly completed. Radiation levels should be not more than 200mR/hr at the surface of the exposure device if it has been loaded to maximum capacity. Lock the exposure device.

12. Assure that all sources are secure in the source changer by assuring the latch bars are engaged. When the latch bar over the empty chamber is engaged, the source guide tube connector will disengage from the source changer.

13. Disconnect the control unit and source guide tube from the exposure device as described in the exposure operating instructions and disconnect the

the source guide tube from the source guide tube connector. Install the source guide tube connector in its receptical in the source changer.

14. Remove the source identification plate(s) from the exposure device(s) and attach with seal wire to the source changer. Attach the identification plate(s) for the new source(s) to the exposure device(s).

15. Assure that all latch bars are engaged and bolt the cover plate to the source changer. Secure the bolts with seal wires using security seals.

16. Survey all exterior surfaces of the source changer to ensure that radiation levels do not exceed 200 milliroentgens per hour at contact. Measure the radiation level three feet from all exterior surfaces of the source changer and ensure that the radiation level is less than 10 milliroentgens per hour. The maximum radiation level measured three feet from any exterior surface is the transport index. (Example: With a maximum radiation level of 2.2 milliroentgens per hour, the transport index is 2.2).

17. Select the proper shipping labels according to the radiation levels at the surface and at 3 feet from the surface of container as described in the following table. Complete two labels listing the radioisotope contained (iridium-192) the activity (the number of curies) and the transport index as determined above.

18. Assure that the old shipping labels are removed. Apply the shipping labels, properly completed, to two opposite sides of the container.

19. Properly complete the shipping papers indicating:

    a. Proper shipping names (i.e. Radioactive Material, Special Form, n.o.s. NA 9182 and Radioactive Device, n.o.s., UN 2911)

    b. Name of radionuclide (iridium-192 and uranium-238)

    c. Activity of source (expressed in curies)

    d. Category of label applied (i.e. Radioactive Yellow III)

    e. Transport Index

    f. USNRC Identification Number (USNRC: USA/ /B)

    g. For international shipments, IAEA Identification number IAEA: USA/ /B(U)

    h. 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."

<u>Notes:</u> 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

	Maximum Radiation Levels	
	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

proper condition for carriage by air according to applicable national governmental regulations."

2. For air shipments to, from or through the United States, the package must be labeled with a "CARGO AIRCRAFT ONLY" label and the shipping papers must state:

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

20. Return the container to Tech/Ops,Inc., according to proper procedures from transporting radioactive material as established in Title 49 Code of Federal Regulations, Parts 172-178.

Note: To prepare an empty package for transport, follow the instructions of the operating procedures above beginning with Step 15 with the following exceptions:

a. The proper shipping name is Radioactive Device, n.o.s. UN 2911

b. Radionuclide is Uranium-238

Note: Please return container promptly. Demurage charges will be made for containers held beyond normal transportation time.

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 source holder assembly is subjected to a static tensile test with a load of one hundred pounds.

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

8.2 Maintenance Program

8.2.1 Structural and Pressure Tests

Not Applicable

8.2.2 Leak Test

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.