SAFETY ANALYSIS REPORT

TECHNICAL OPERATIONS
MODEL 910
TYPE B(U) PACKAGE

8104290638

1. General Information

1.1 Introduction

Tech/Ops Model 910 is designed for use as a radiographic exposure device and shipping container for Type B quantities of radioactive material in special form. The Model 910 conforms to the criteria for Type B (U) packaging in accordance with IAEA Safety Series No. 6, 1973 Edition. The Model 910 is identical to Tech/Ops Model 900 Type B package (Certificate of Compliance No. 9141) with the exception of the uranium shield.

1.2 Package Description

1.2.1 Packaging

The Model 910 is 13 inches (330mm) long, 7.7 inches (195mm) high and 5.3 inches (135mm) wide. The gross weight of the package is 34 pounds (15kg).

The radioactive source capsule is housed in a source assembly which is fabricated from tungsten and stainless steel. The source assembly is housed inside a tungsten source tube with an outside diameter of 0.63 inch (17mm) and inside diameters machined to conform to the configuration of the source assembly.

The source tube is surrounded by depleted uranium metal for shielding. The uranium metal is cast around the tungsten source tube. The mass of the uranium shield is 18 pounds (8.2kg).

The uranium shield assembly is encased in a stainless steel housing. The shield assembly is supported on the front end by the front housing. It is supported on the rear end by the lock assembly which is attached to the rear plate. The front plate and rear plate are attached by means of four spacer rods and screws.

The ends of the package are enclosed with end plates fabricated from 0.09 inch (2.3mm) thick stainless steel. The sides of the package are enclosed by a shell fabricated from 0.06 inch (1.5mm) thick stainless steel.

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

Mounted in the front plate is a source position indicator slide. This slide, in the closed position, closes the exit end of the source tube.

Tamperproof seals are provided during shipment of this package. Four vent holes in the bottom of the package provide passageways for the escape of any gas generated from the decomposition of the polyurethane form in the event that the package is involved in a fire accident.

Revision 0
10 April 1981

The outer packaging is designed to avoid the collection and retention of water. The package has a smooth finish to facilitate 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 assembly is secured in the proper storage position by means of the locking assembly. A lock side engages an undercut in the source assembly preventing movement in either the forward or rearward direction. The lock slide is held in position by the selector ring. The selector ring is secured in the "LOCK" position by means of a key operated lock mounted on the rear plate of the projector.

In the event that the lock failed, the source assembly would be contained within the package. The source position indicator slide would prevent movement in the forward direction. Interference between the source assembly and source tube would prevent movement in the rearward direction.

1.2.3 Contents of Package

The Model 910 is designed for the transport of iridium-192 in quantities of up to 30 curies as Tech/Ops source assembly 91003. This source assembly contains either Tech/Ops Model 90004 or 90005 source capsule which satisfies the criteria for special form radioactive material in accordance with 10CFR71 and IAEA Safety Series No. 6, (IAEA Certificate of Competent Authority Number USA/0179/S).

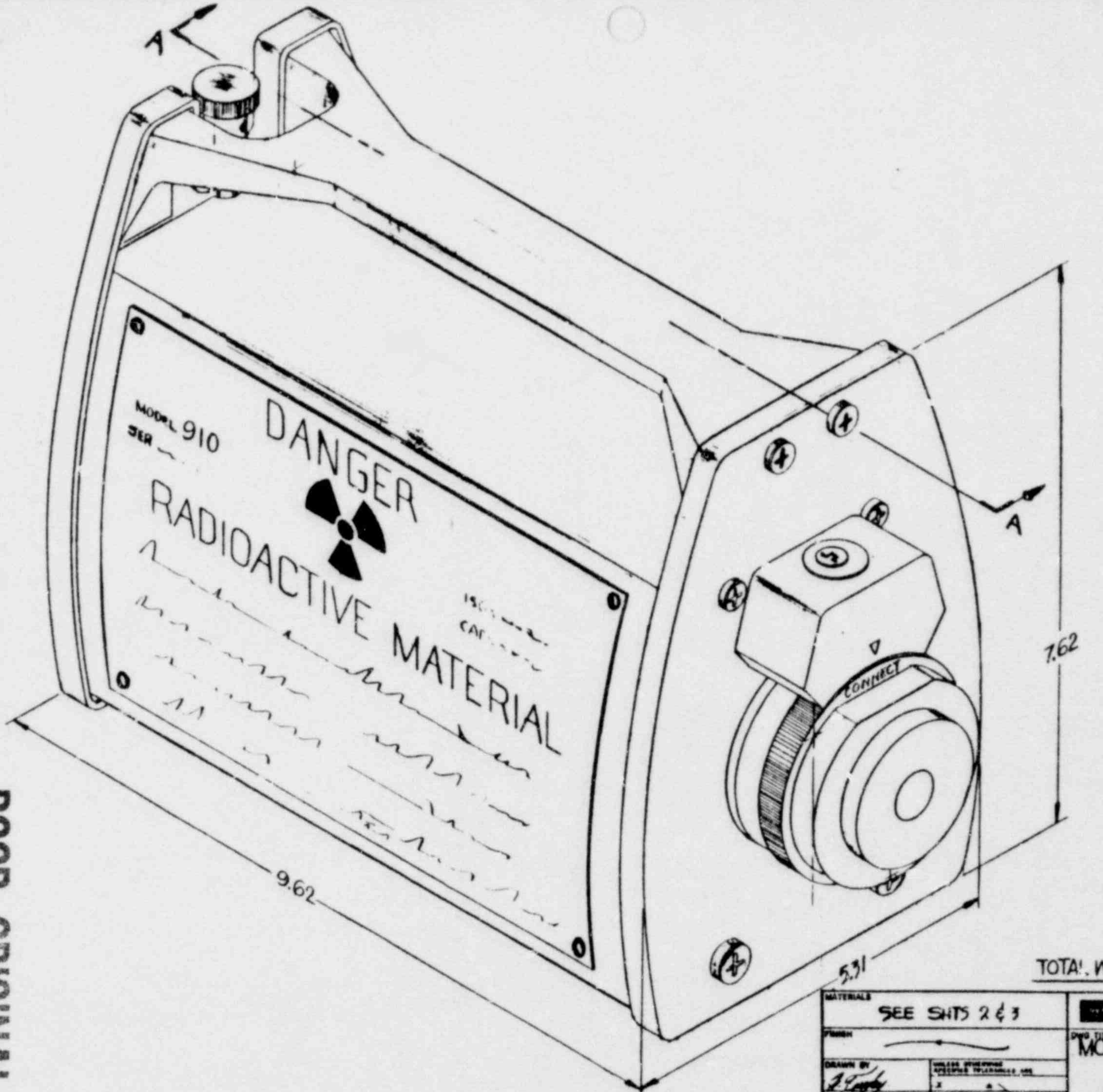
1.3 Appendix

Descriptive Assembly Drawings, Model 910

Dwg 91090 Sheet 1 of 3
Dwg 91090 Sheet 2 of 3
Dwg 91090 Sheet 3 of 3
Dwg 90090 Sheet 3 of 4
Dwg 90090 Sheet 4 of 4
Dwg 91091 Sheet 1 of 1

Revision 0
10 April 1981

91090



TOTAL WEIGHT = 34 LBS (15.4 KG)

MATERIALS	SEE SHTS 2 & 3
FINISH	
DRAWN BY	
CHECKED BY	
APPROVED BY	

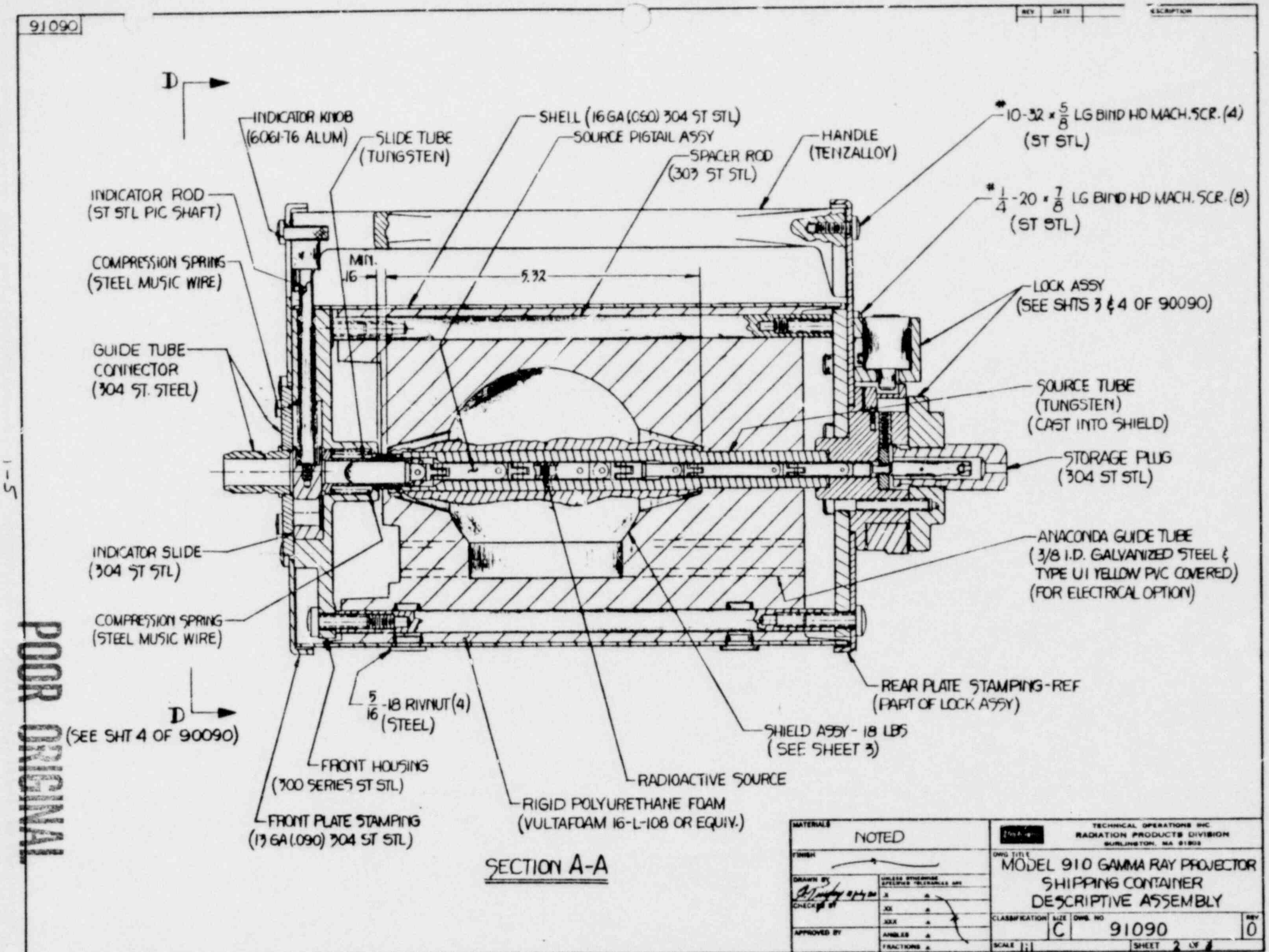
TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE: MODEL 910 GAMMA RAY PROJECTOR SHIPPING CONTAINER DESCRIPTIVE ASSEMBLY

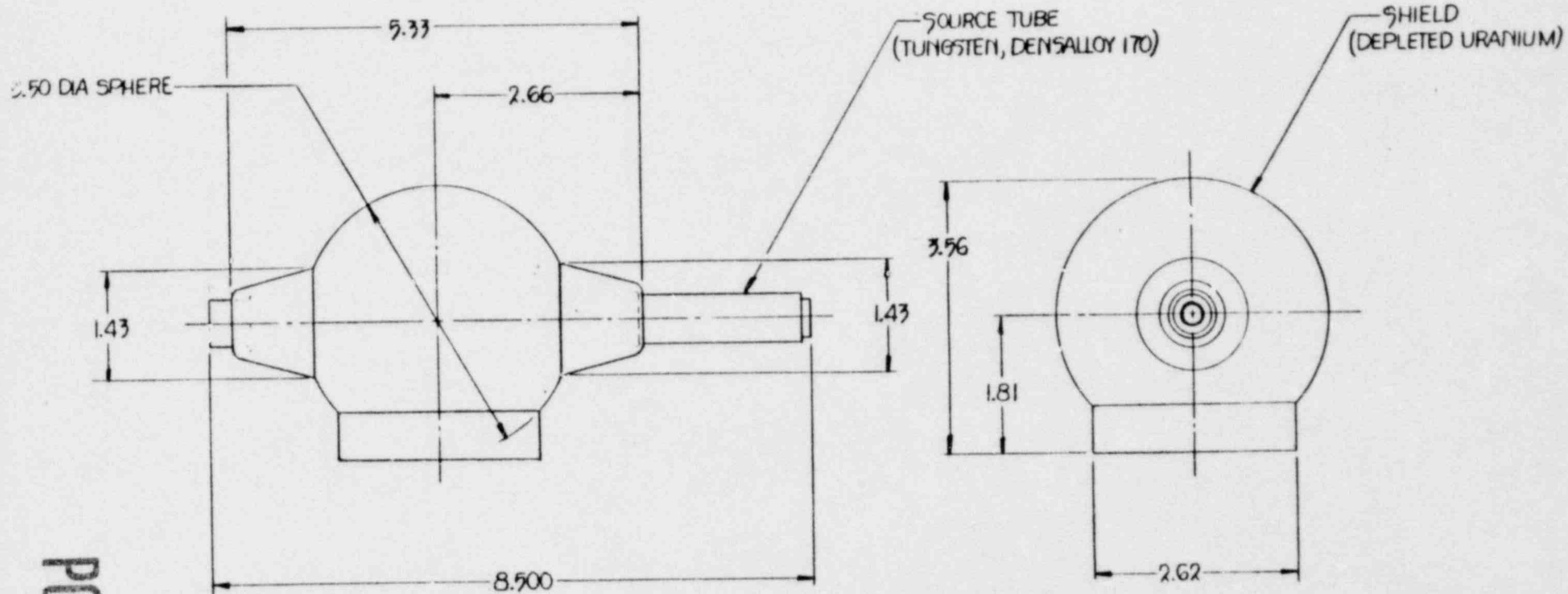
CLASSIFICATION	SIZE	DWG. NO	REV
	C	91090	0

SCALE 1:1 SHEET 1 OF 3

POOR ORIGINAL


91090
D
INDICATOR KNOB (6061-T6 ALUM)
SLIDE TUBE (TUNGSTEN)
SHELL (16 GA (.050) 304 ST STL)
SOURCE PIGTAIL ASSY
SPACER ROD (303 ST STL)
HANDLE (TENZALLOY)
*10-32 × 5/8 LG BIND HD MACH. SCR. (4) (ST STL)
*1/4-20 × 7/8 LG BIND HD MACH. SCR. (8) (ST STL)
INDICATOR ROD (ST STL PIC SHAFT)
COMPRESSION SPRING (STEEL MUSIC WIRE)
MIN. .16
5.32
LOCK ASSY (SEE SHTS 3 & 4 OF 90090)
GUIDE TUBE CONNECTOR (304 ST. STEEL)
SOURCE TUBE (TUNGSTEN) (CAST INTO SHIELD)
STORAGE PLUG (304 ST STL)
INDICATOR SLIDE (304 ST STL)
ANACONDA GUIDE TUBE (3/8 I.D. GALVANIZED STEEL & TYPE UI YELLOW PVC COVERED) (FOR ELECTRICAL OPTION)
COMPRESSION SPRING (STEEL MUSIC WIRE)
REAR PLATE STAMPING-REF (PART OF LOCK ASSY)
5/16-18 RIVNUT (4) (STEEL)
D
(SEE SHT 4 OF 90090)
SHIELD ASSY - 18 LBS (SEE SHEET 3)
FRONT HOUSING (300 SERIES ST STL)
RADIOACTIVE SOURCE
RIGID POLYURETHANE FOAM (VULTAFOAM 16-L-108 OR EQUIV.)
FRONT PLATE STAMPING (13 GA (.090) 304 ST STL)
SECTION A-A
MATERIALS NOTED
TECHNICAL OPERATIONS INC RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
DWG TITLE MODEL 910 GAMMA RAY PROJECTOR SHIPPING CONTAINER DESCRIPTIVE ASSEMBLY
SIZE C
DWG NO 91090
REV 0
SCALE 1:1
SHEET 2 OF 4
POOR ORIGINAL
5-1

91090

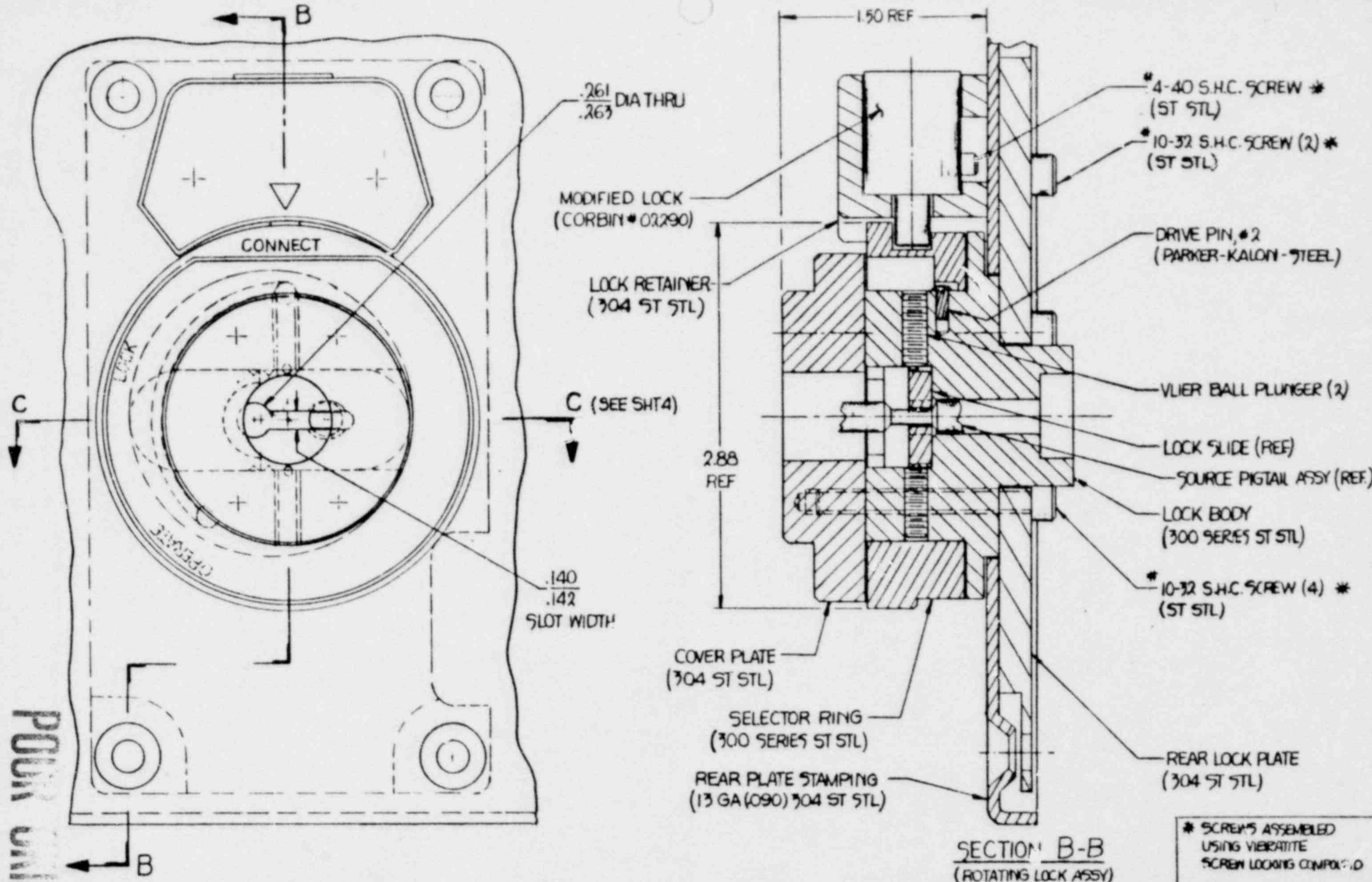


SHIELD DATA

TOTAL WT: 18 LBS

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: MODEL 910 GAMMA RAY PROJECTOR SHIPPING CONTAINER DESCRIPTIVE ASSEMBLY
DRAWN BY / CHECKED BY	SIZE: C · DWG NO: 91090 · REV
APPROVED BY	SCALE: 1:1 · SHEET 3 OF 3

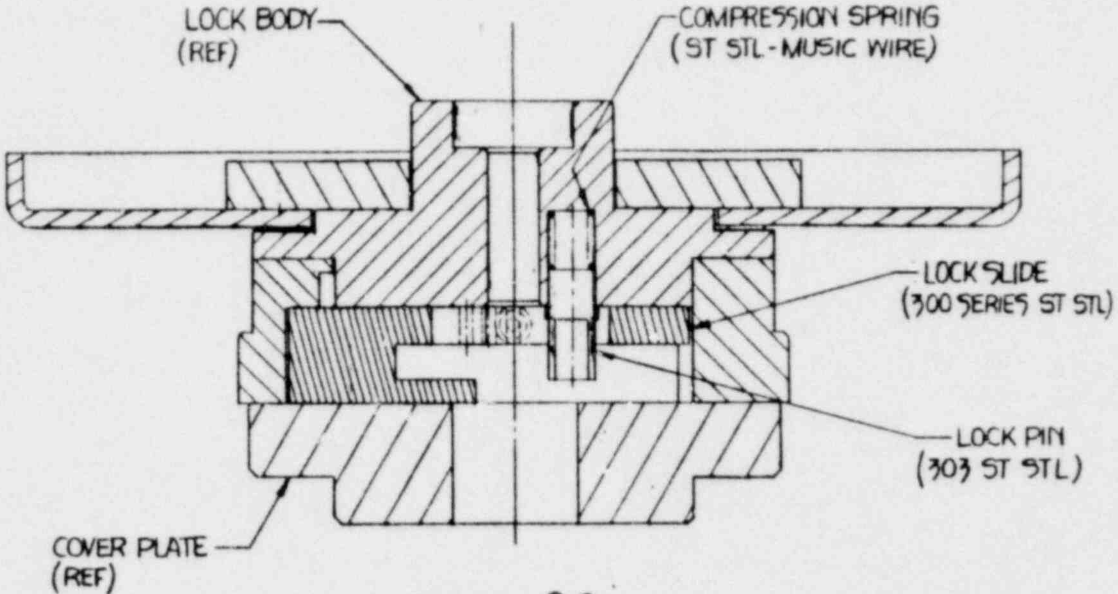
POOR ORIGINAL



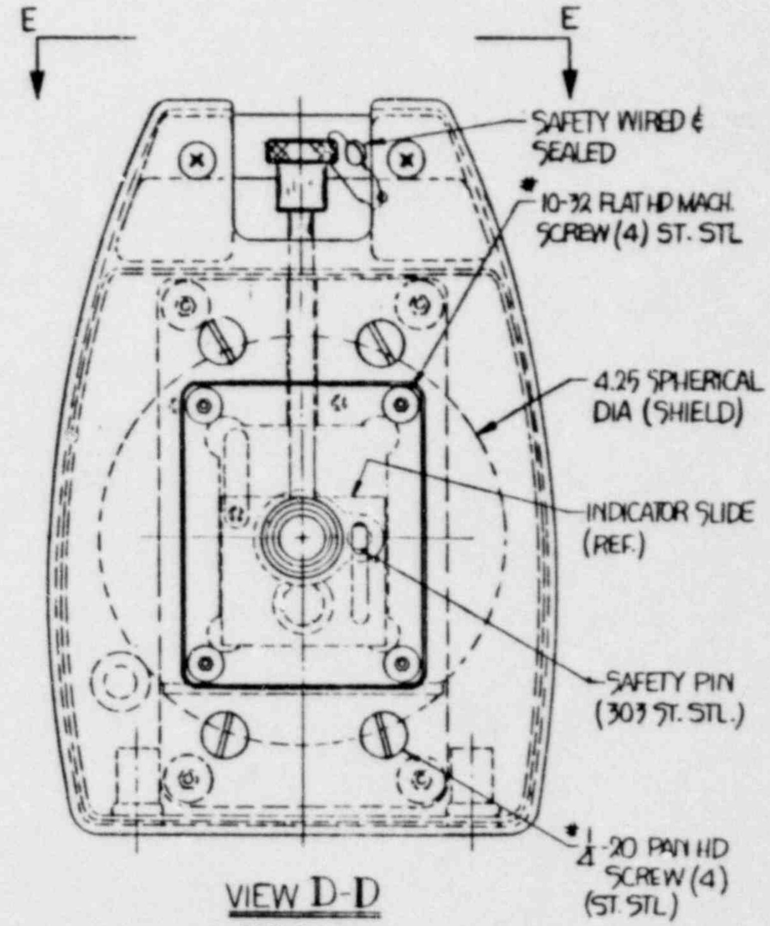
* SCREWS ASSEMBLED USING VIBRATITE SCREW LOCKING COMPOUND

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: MODEL 900 GAMMA RAY PROJECTOR SHIPPING CONTAINER DESCRIPTIVE ASSEMBLY
DRAWN BY / CHECKED BY	CLASSIFICATION — SIZE: C — DWG NO: 90090 — REV: 0
APPROVED BY	SCALE 2:1 — SHEET 3 OF 4

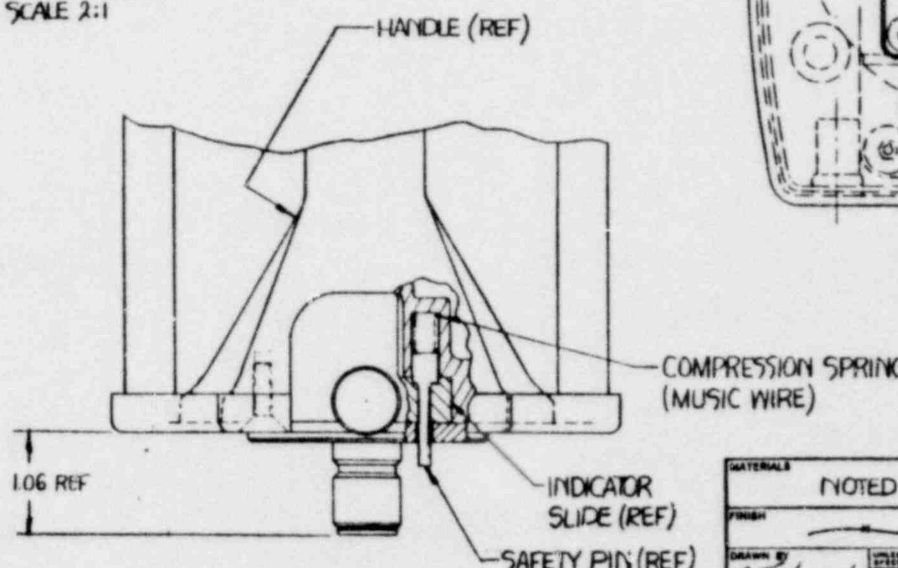
C90090



SECTION C-C
SCALE 2:1



VIEW D-D
SCALE 1:1



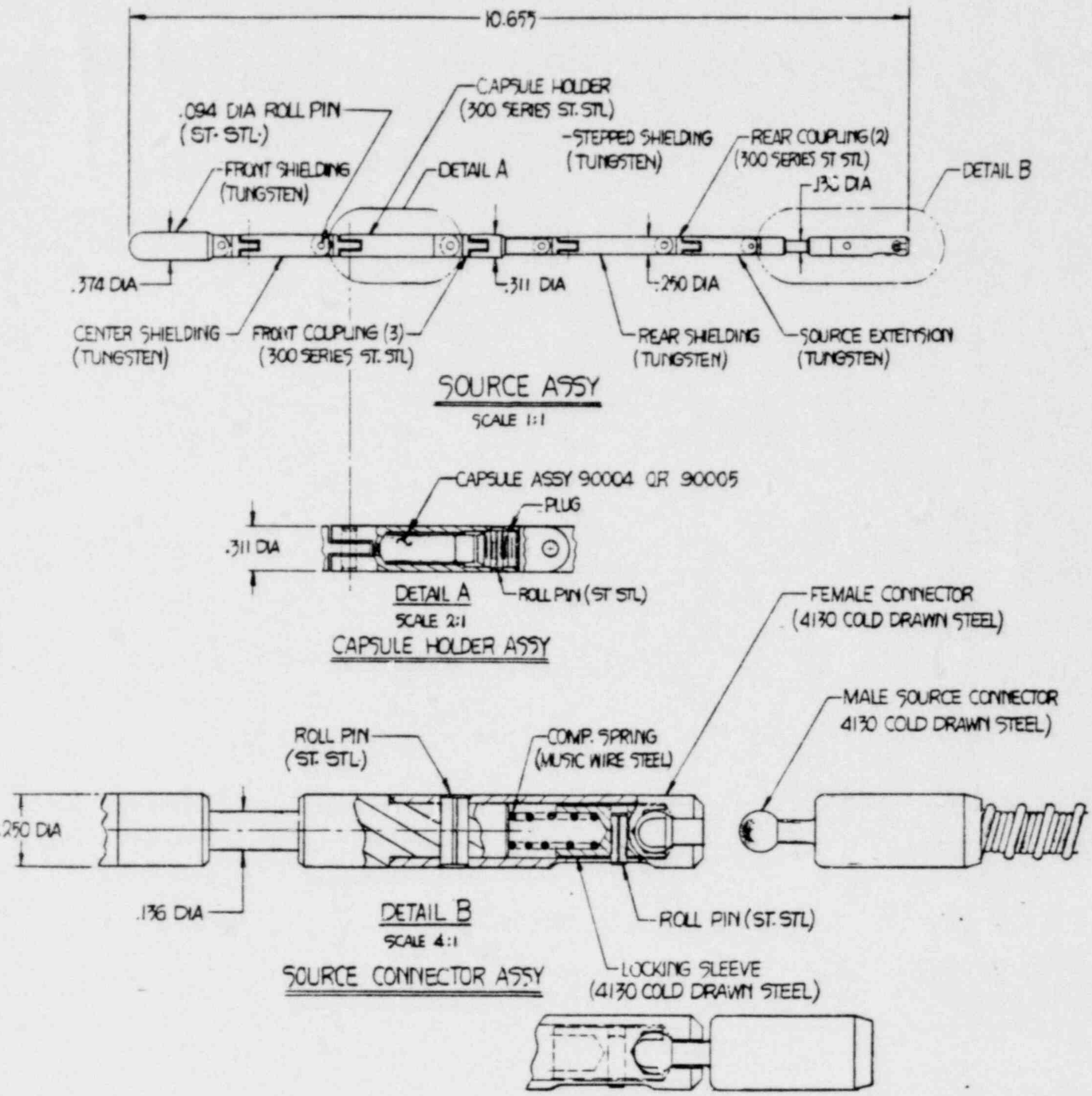
VIEW E-E
SCALE 1:1

POOR ORIGINAL

MATERIALS: NOTED	TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH	DWG TITLE: MODEL 900 GAMMA RAY PROJECTOR SHIPPING CONTAINER DESCRIPTIVE ASSEMBLY
DRAWN BY	SIZE: C
CHECKED BY	DWG NO: 90090
APPROVED BY	REV: 0
	SCALE: 2:1 & 1:1
	SHEET 4 OF 4

91091

REV	DATE	DESCRIPTION
A	2 APR 81	FEMALE CONNECTOR REDESIGNED HST



POOR ORIGINAL

MATERIALS: NOTED

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA

DWG TITLE: MODEL 91003 SOURCE ASSY DESCRIPTIVE ASSEMBLY

SIZE: C — DWG. NO. 91091 — REV. A

SCALE: NOTED — SHEET 1 OF 1

2. Structural Evaluation

2.1 Structural Design

2.1.1 Discussion

Structurally, the Model 910 consists of four components: 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 locking assembly, assures proper positioning of the source. The outer housing provides the structural strength of the package. The locking assembly secures the source assembly in the shielded position in the package and assures positive closure.

2.1.2 Design Criteria

The Model 910 is designed to comply with the requirements of 10CFR71 and IAEA Safety Series No. 6, 1973 Revised Edition.

2.2 Weights and Centers of Gravity

The Model 910 weighs 34 pounds (15kg). The shield assembly contains 18 pounds (8.2kg) of depleted uranium. The center of gravity was located experimentally. It is located approximately 4.5 inches (114mm) from the front surface, 3.0 inches (76mm) from the bottom surface and 2.7 inches (68mm) from the right surface.

2.3 Mechanical Properties of Materials

The housing of the Model 910 is fabricated from Type 304 stainless steel. This material has a yield strength of 35,000 pounds per square inch ($241 MN/m^2$).

Drawings of the Models 90004 and 90005 source capsules are enclosed in Section 2.10. These source capsules are fabricated from Type 304 or Type 304L stainless steel. Each capsule is 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 910 are uranium metal, stainless steel, tungsten, bronze, carbon steel, and aluminum. There will be no chemical or galvanic action between any of these components.

There is no iron-uranium interface in this package. Therefore, there is no possibility of the formation of an iron-uranium eutectic alloy at elevated temperatures.

2.4.2 Positive Closure

The source assembly in the Model 910 cannot be exposed without opening a key operated lock. Thus, positive closure is provided.

2.4.3 Lifting Devices

The Model 910 is designed to be lifted by its handle. The handle is fabricated from aluminum and attached to the end plates by means of four No. 10-32 UNC flat head machine screws. The weakest area of the handle is the screw attachment. The stress area of each screw is 0.175 in^2 ($11.3mm^2$). The yield strength of these screws is greater than 40,000 pounds per square inch ($276MN/m^2$). Therefore, each screw cannot support 700 pounds (3.1kN) or more than twenty times the weight of the package without exceeding the yield strength of the material.

2.4.4 Tiedown Devices

The handle is also used as a tiedown device. As demonstrated in Section 2.4.3, each of the four screws attaching the handle can support more than twenty times the weight of the package without exceeding the yield strength of the material.

2.5 Standards for Type B and Large Quantity Packages

2.5.1 Load Resistance

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

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

Where σ: Maximum Stress Generated
F: Total Load (170 pounds; 757 newtons)
l: Length of Beam (13 inches; 330mm)
Z: Section Modulus (2.32 in^3; 38,018mm^3)

Reference: Machinery's Handbook, 21st Edition, p.404)

The package is assumed to be a rectangular shell 5.04 inches (128mm) wide and 5.75 inches (146mm) high with a wall thickness of 0.06 inch (1.5mm). Consequently, the section modulus is 2.32in^3.

From this relationship, the maximum stress generated in the beam is 119 pounds per square inch ($822kN/m^2$) which is far below the yield strength of the material.

Revision 0
10 April 1981

2.5.2 External Pressure

The Model 910 is open to the atmosphere. Therefore, there will be no differential pressure to act upon the package.

The collapsing pressure of the source capsule is calculated assuming that the capsules are thin wall tubing with the 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 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)

From this relationship the collapsing pressure is computed to be 7070 pounds per square inch ($49MN/m^2$). Therefore, the source capsule can withstand an external pressure of 25psig without adverse affect.

2.6 Normal Conditions of Transport

2.6.1 Heat

The thermal evaluation of the Model 910 is presented in Chapter 3. From this evaluation, it can be concluded that the Model 910 can withstand the normal heat transport condition.

2.6.2 Cold

The metals used in the manufacture of the Model 910 can all withstand a temperature of $-40^{\circ}C$. The lower operating limit of the polyurethane foam is $-100^{\circ}F$ ($73^{\circ}C$). Thus, it is concluded that the Model 910 will withstand the normal transport cold condition.

2.6.3 Pressure

The Model 910 is open to the atmosphere. Therefore, there will be no differential pressure to act upon it.

In Section 3.6.4, it is demonstrated that the source capsule is able to withstand an external pressure reduction of 0.5 atmosphere ($50.7kN/m^2$).

2.6.4 Vibration

A vibration test of the Model 900 was conducted. 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 80Hz. At the conclusion of this test, the source assembly remained secured in the proper storage position. A copy of this test report is included in Section 2.10.

The Model 910 is identical to the Model 900 with the exception of the shield assembly. Because of the satisfactory performance of the Model 900 during the vibration test and the similarity of the Model 910 to the Model 900, it is concluded that the Model 910 will withstand the normal transport vibration condition.

2.6.5 Water Spray Test

The water spray test was not actually performed on the Model 910. The materials used in the construction of the package are all highly water resistant. Exposure to water will not affect the structural integrity nor reduce the shielding effectiveness of the package.

2.6.6 Free Drop

The drop analysis presented in Section 2.7.1 demonstrates that the Model 910 will withstand the normal transport free drop condition without loss of shielding effectiveness nor loss of structural integrity.

2.6.7 Corner Drop

2.6.8 Penetration

A penetration test of the Model 900 was performed. There was no reduction of shielding effectiveness nor loss of structural integrity as a result of this test. A copy of this test report is included in Section 2.10. Because of the satisfactory performance of the Model 900 during the penetration test and the similarity of the Model 910 to the Model 900, it is concluded that the Model 910 will withstand the penetration test condition.

2.6.9 Compression

The maximum cross sectional area of the Model 910 is $100in^2$. The weight of the package is 34 pounds. Therefore, two pounds per square inch times the maximum cross sectional area is greater than five times the weight of the package. The load used is 200 pounds.

The Model 900 was subjected to the conditions of the compression test. There was no reduction of shielding effectiveness nor loss of structural integrity as a result of this test. A copy of this test report is included in Section 2.10. Because of the satisfactory performance of the Model 900 during the compression test and the similarity of the Model 910 to the Model 900, it is concluded that the Model 910 will withstand the compression test condition.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

The Model 900 was subjected to a drop test through a distance of 30 feet (9.1m) onto a steel plate. There was no loss of shielding effectiveness nor loss of structural integrity as a result of this test. A copy of the test report is included in Section 2.10. Because of the similarity of the Model 910 to the Model 900, it is concluded that the Model 910 will withstand the free drop test condition.

2.7.2 Puncture

The Model 900 was subjected to a free drop from the height of one meter onto a steel billet which was six inches in diameter and eight inches long. As a result of this test, there was no loss of shielding effectiveness nor loss of package integrity. A copy of this test report is included in Section 2.10. Because of the similarity of the Model 910 to the Model 900, it is concluded that the Model 910 will withstand the puncture test condition.

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 910 except the polyurethane foam, and the aluminum handle, 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 movement by the front housing, rear plate and lock assembly which are attached by the spacer rods.

Thus, it is concluded that the Model 910 satisfactorily meets the requirements for the hypothetical thermal accident condition of 10CFR71.

Revision 0
10 April 1981

2.7.4 Water Immersion

Not Applicable

2.7.5 Summary of Damage

The tests designed to represent the hypothetical accident conditions caused minor deformation, but no reduction of shielding effectiveness, nor loss of structural integrity.

2.8 Special Form

The Model 910 is designed for use with Tech/Ops Model 91003 Source Assembly which includes either Tech/Ops Model 90004 or 90005 Source Capsule. These capsules have been tested to the criteria for special form radioactive material in accordance with the requirments of 10CFR71 and IAEA Safety Series No. 6, 1973 with satisfactory results. The US Department of Transportation has issued an IAEA Certificate of Competent Authority for this source capsule (USA/0179/S).

2.9 Fuel Rods

Not Applicable

2.10 Appendix

Descriptive Assembly Drawings - Source Capsule

Test Report: Vibration Resistance Test

Test Report: Penetration Test

Test Report: Compression Test

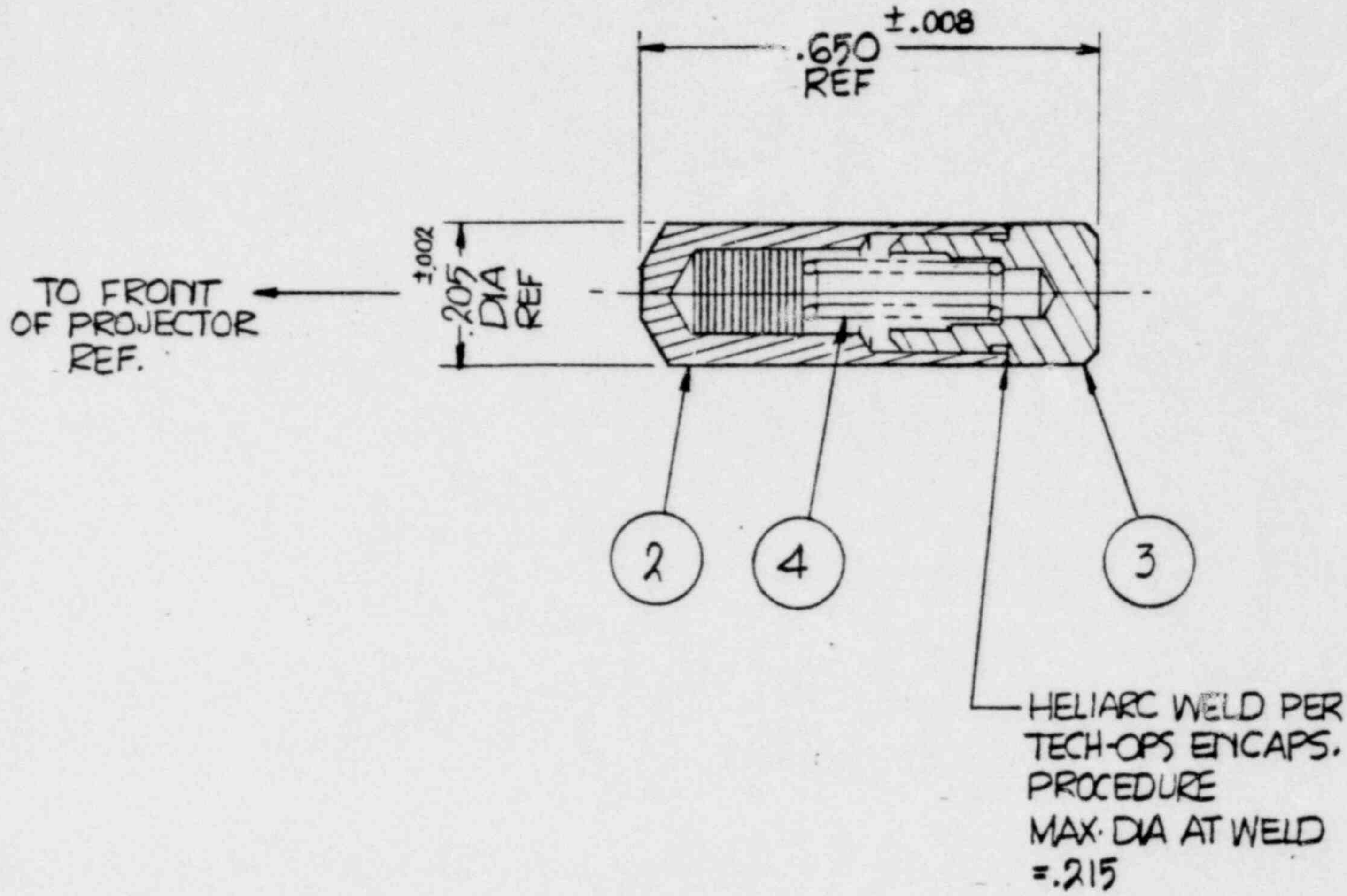
Test Report: Free Fall Test

Test Report: Puncture Test

IAEA Certificate of Competent Authority USA/0179/S

Revision 0
10 April 1981

REV.	DATE	DESCRIPTION
A	14 JAN '80	REDRAWN FROM 'B' SIZE - NO OTHER CHANGES



MATERIALS: SEE BM 90004

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

FINISH:

DWG TITLE: GENESIS 8B
IR192 CAPSULE ASSEMBLY

DRAWN BY: [signature] 1 JAN '79

CHECKED BY: R. [signature] 14 JAN 80

APPROVED BY:

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

CLASSIFICATION	SIZE	DWG. NO.	REV.
———	A	90004	A

SCALE 4:1 SHEET 1 OF 1

SPAULDING CO., INC. 21-60169

POOR ORIGINAL

REV.	DATE	DESCRIPTION
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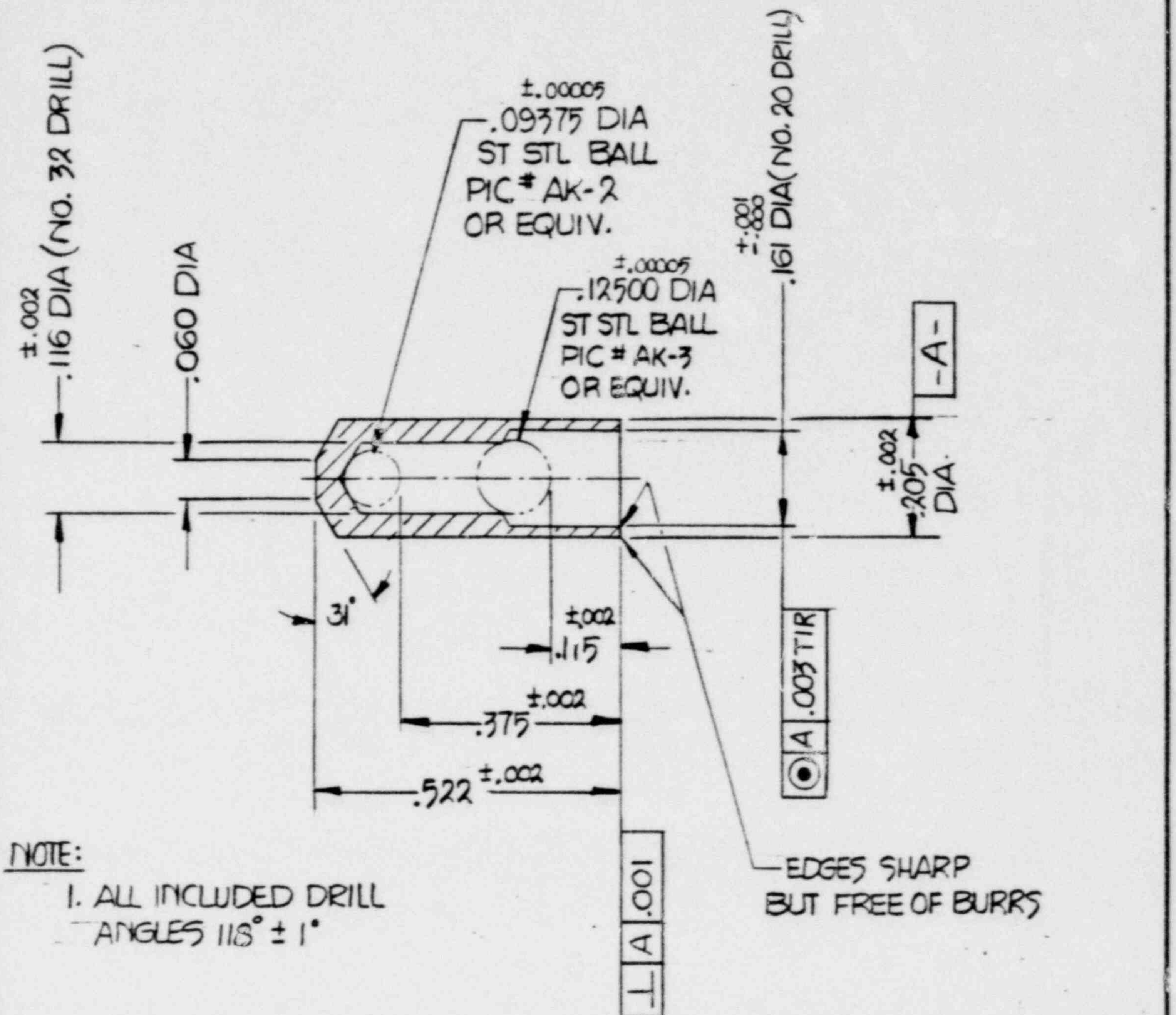

NOTE:

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	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE	
[signature] 14 JAN 80	X	±
CHECKED BY	XX	±
R. Drainone 14 Jan 80	XXX	± .005
APPROVED BY	ANGLES	± 1/2°
	FRACTIONS	±

CLASSIFICATION	SIZE	DWG. NO.	REV.
	A	90004-1	A
SCALE 4:1		SHEET 1 OF 1	

SPAULDING CO., INC. 21-60169

POOR ORIGINAL

REV.	DATE	DESCRIPTION
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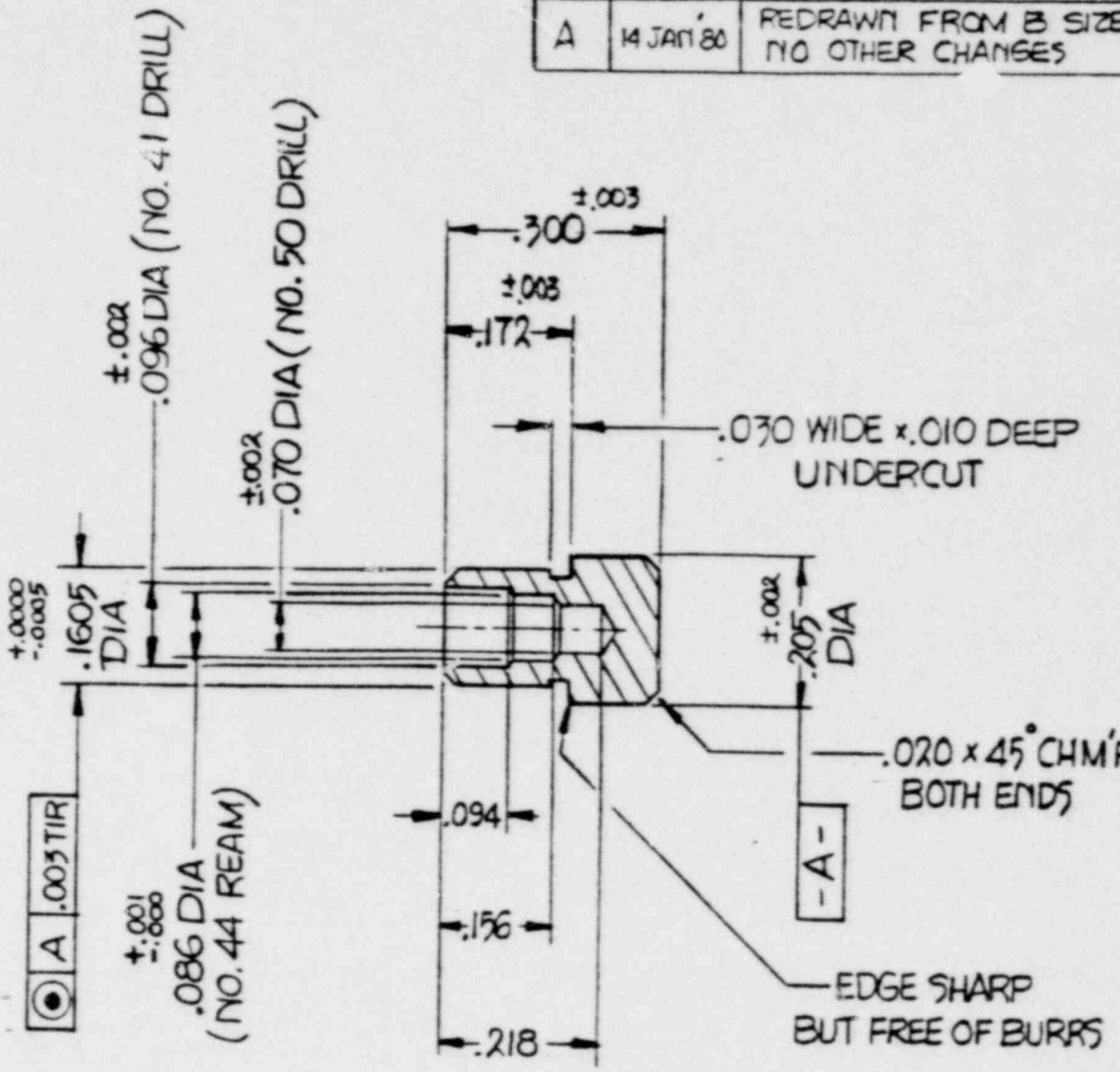


NOTE:

1. ALL INCLUDED DRILL ANGLES 118° ± 1°

MATERIALS	304 OR 304L ST. STL MATERIAL CERTIFICATION REQUIRED
FINISH	

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE	
R. Tumley 14 JAN. 80	.X	±
CHECKED BY	.XX	±
R. Draunoni 14 JAN 80	.XXX	± .005
APPROVED BY	ANGLES	± 1/2°
	FRACTIONS	±

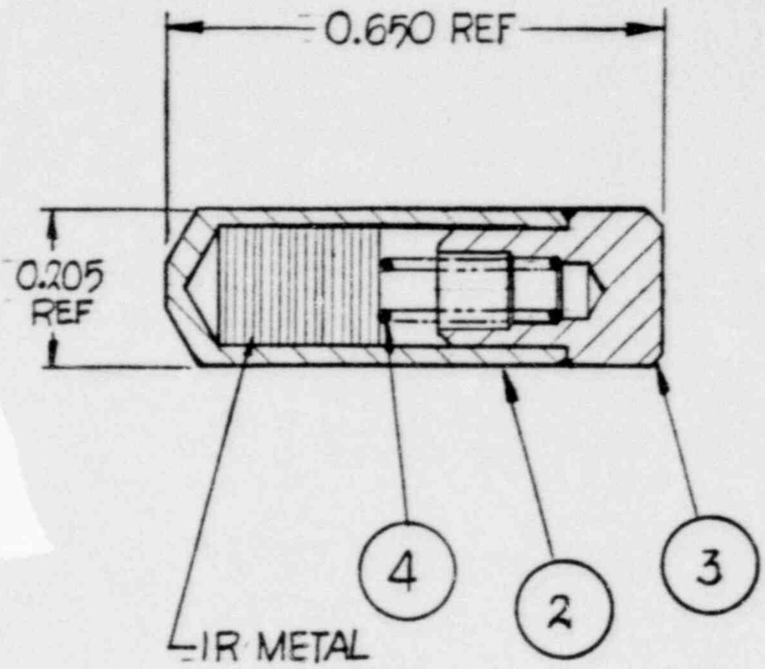
DWG TITLE: GENESIS 8B SOURCE CAPSULE SHANK

CLASSIFICATION	SIZE	DWG. NO.	REV.
	A	90004-2	A
SCALE 4:1		SHEET 1 OF 1	

SPAULDING CO., INC. 21-60169

POOR ORIGINAL

REV.	DATE	DESCRIPTION

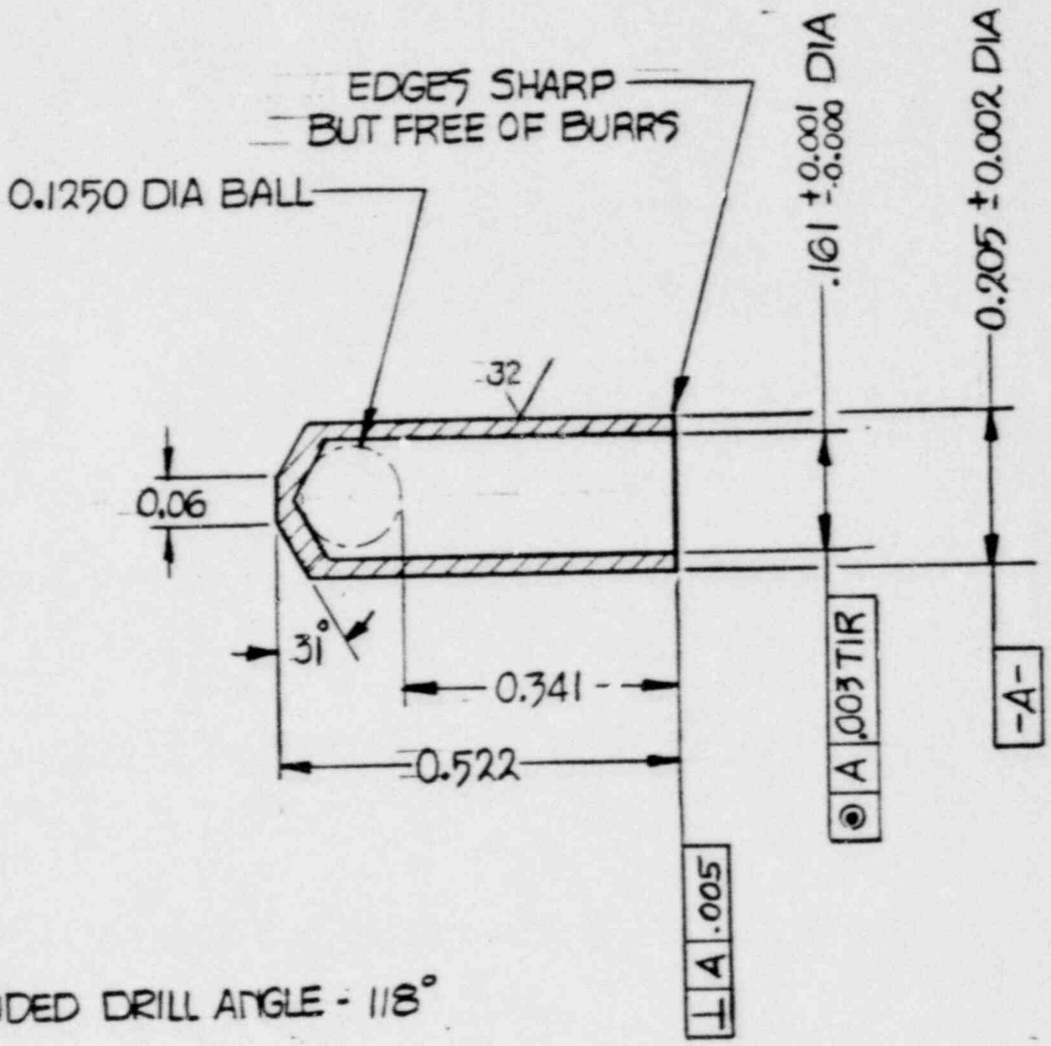


MATERIALS SEE BM 90005		TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH —//—		DWG TITLE SOURCE CAPSULE ASSY
DRAWN BY MUNRO 9 JUL 80	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE .X ±	
CHECKED BY	.XX ± .XXX ±	CLASSIFICATION / SIZE A / DWG. NO. 90005 / REV. 0
APPROVED BY	ANGLES ± FRACTIONS ±	SCALE 4:1 / SHEET 1 OF 1

SPAULDING CO., INC. 21-60169

POOR ORIGINAL

REV.	DATE	DESCRIPTION



NOTE: INCLUDED DRILL ANGLE - 118°

MATERIALS TYPE 304 OR 304L STAINLESS STEEL

FINISH NOTED

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE

SOURCE CAPSULE BOTTOM

DRAWN BY Munro 9 JUL 80

CHECKED BY

APPROVED BY

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

CLASSIFICATION	SIZE	DWG. NO.	REV.
	A	90005-1	0

SCALE 4:1 SHEET 1 OF 1

SPAULDING CO., INC. 21-60159

POOR ORIGINAL

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: George Parsons

DATE: 30 January 1980

SUBJECT: Model 900 Vibration Resistance Test

A vibration resistance test of the Model 900 radiographic exposure device-Type B package was conducted by Associated Testing Laboratory, Burlington, MA, on 9 January 1980 in accordance with International Standard ISO 3999.

The device was fastened to the platform of a vibrating machine and was continuously scanned through a frequency range of 5Hz to 80Hz with a maximum acceleration of $9.8 m/sec^2$ to search for a resonant frequency. This scan was performed on each of three rectilinear axis. Over this range, there was no resonant frequency found.

The device was then vibrated along its longitudinal axis (the axis of the source tube) for 70 minutes at each of the following frequencies: 5, 8, 12, 20, 32, 80Hz.

As a result of this test, there was no loss of structural integrity nor loss of shielding efficiency. There was no loosening of fasteners. The device functioned normally at the conclusion of the test.

GP/fb

Revision 0
10 April 1981

TEST REPORT | RADIATION PRODUCTS DIVISION

BY: David Marzilli

DATE: 14 January 1980

SUBJECT: Model 900 Penetration Test

On 14 January 1980 a penetration test was performed on a Model 900 Gamma Ray Projector. This projector already had been submitted to the shielding efficiency, vibration resistance and shock resistance tests outlined in International Standard ISO 3999.

A 13 pound steel bar, with a hemispherical end 1¼ inches in diameter, was dropped more than 40 inches onto the lock mechanism of the Model 900. A guide tube, 1 5/16 inches square along its inside dimensions, was used to insure positioning over the lock. The test was done twice. The lock mechanism functioned before and after the tests, and no other damage was noted.

Thus, the Model 900 will satisfy the penetration test requirements of 10CFR71.

Witnessed: Angelo Kiklis
Angelo Kiklis

Revision 0
10 April 1981

MODEL 900

PENETRATION TEST

REVISION C

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: David Marzilli

DATE: 7 January 1980

SUBJECT: Model 900 Compression Test

On 3 January 1980 a Model 900 Gamma Ray Projector was subjected to a compression test exceeding the requirements in 10CFR71, Appendix A, Section 9, and IAEA Safety Series No. 6, paragraph 713. The Model 900, weight 20kg (45 pounds), was loaded with 105kg (232 pounds) of lead and steel evenly distributed along the upper surface of the package. The load was applied for 72 hours. There was no evident damage of the package.

David Marzilli
David Marzilli

DM/fb

Revision 0
10 April 1981

TEST REPORT

RADIATION PRODUCTS DIVISION

BY: David Marzilli

DATE: 14 January 1980

SUBJECT: Model 900, 30 Ft. Free Fall Test

On 11 January 1980, a Model 900 Gamma Ray Projector was submitted to a free fall of 30 feet, as outlined in 10CFR71 and IAEA Safety Series No. 6, 1973. The drop was done twice, onto a concrete driveway covered with a 7/16 inch steel plate. On the first drop the machine impacted on its front face, bounced and impacted the rear. The second drop caused the machine to impact on its rear lower left corner (as the machine is faced from the rear).

The first drop caused the indicator cover plate screws (4) and the lower four front end plate screws to shear. The front housing remained secured by the screws mounting it to the spacer rod and the rear plate.

The second drop caused deformation of the rear end plate and shell.

As a result of these tests, there was no loss of shielding effectiveness nor loss of security of the source assembly. Thus, it is concluded that the Model 900 satisfies the requirements of the free fall test as described in 10CFR71, IAEA Safety Series No. 6, 1973 and ISO 3999.

Witnessed: John J. Munro III

Angelo C. Kiklis

Revision 0
10 April 1981

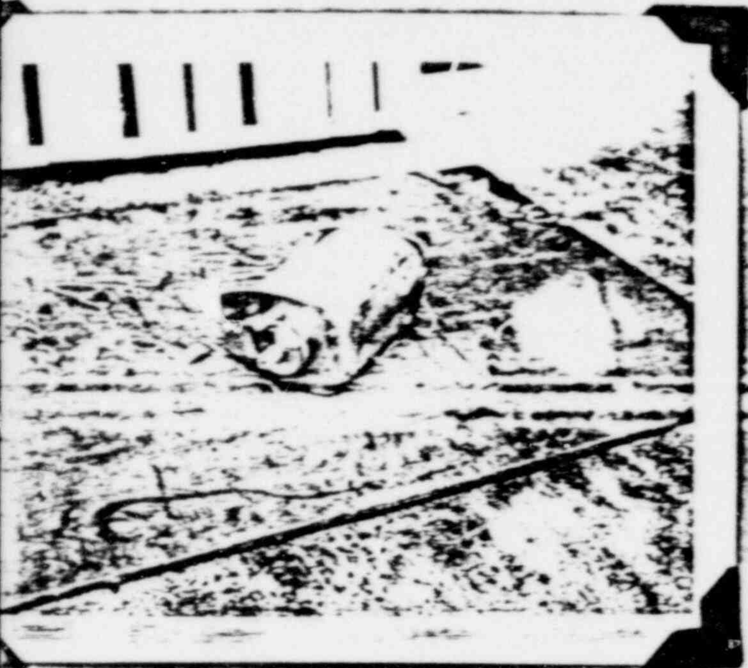
MODEL 900

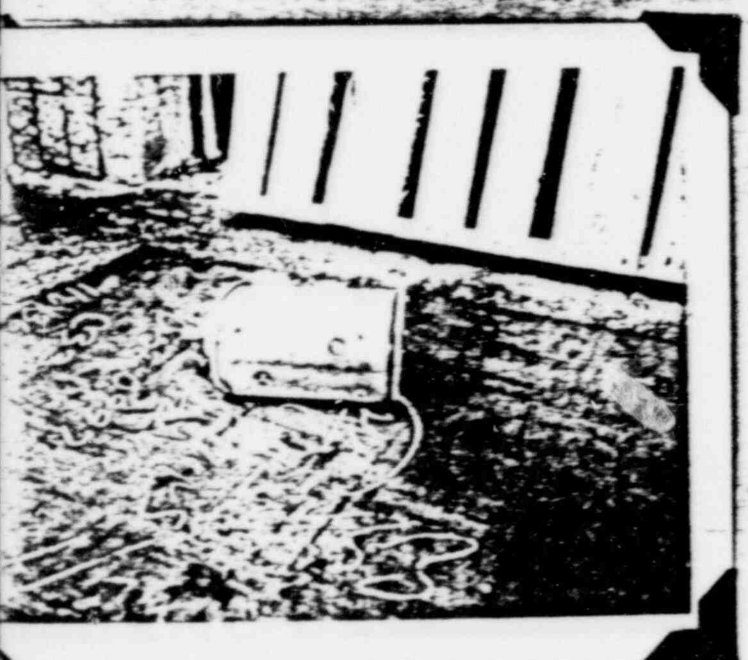
30 FT. FREE FALL

REVISION 0

2-18

POOR ORIGINAL





MODEL 900

AFTER 30 FT. FREE FALL

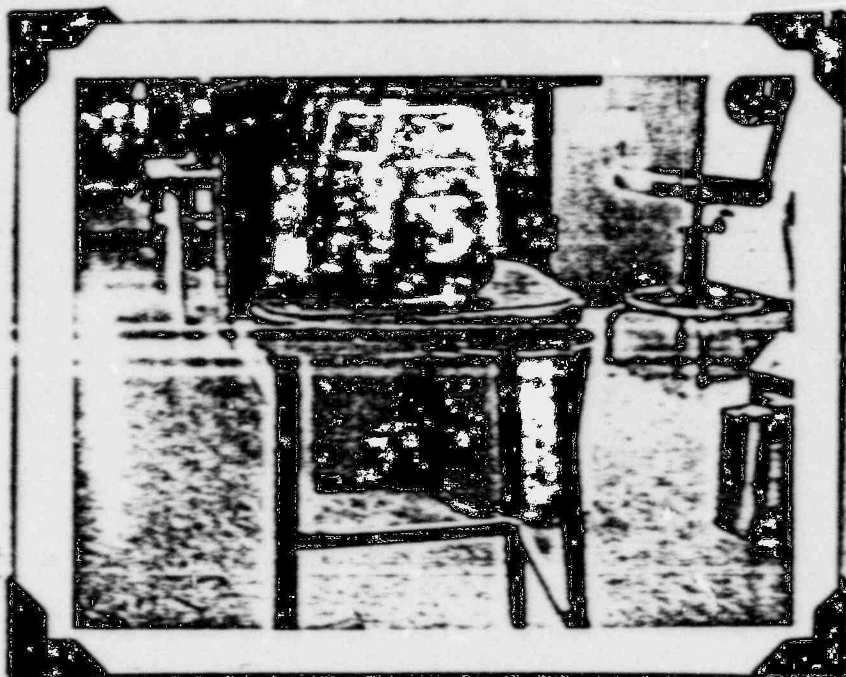
REVISION 6

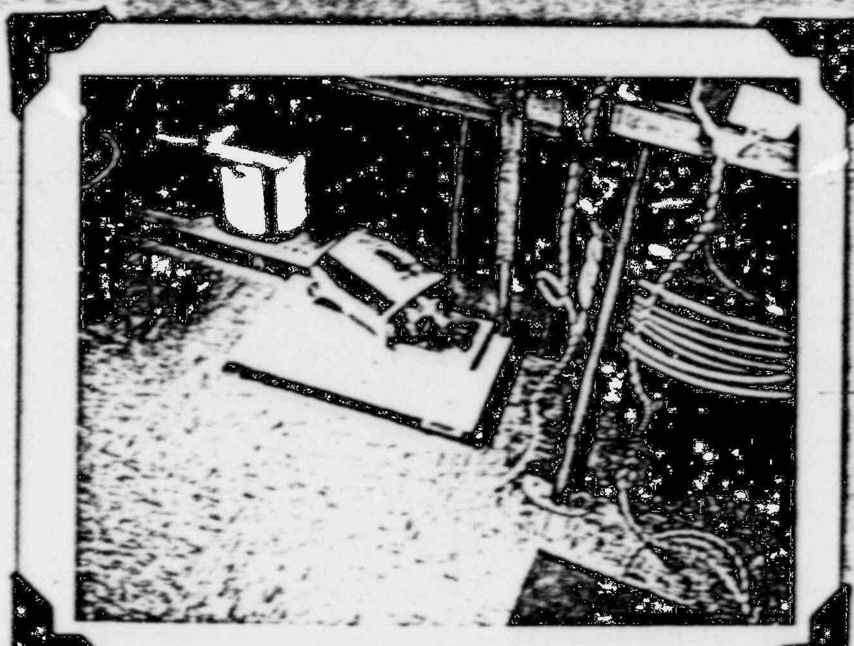
MODEL 900

PUNCTURE TEST

REVISION 6

APR 1 0





MODEL 900

AFTER PUNCTURE AND PENETRATION TESTS

REVISION 0

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

IAEA CERTIFICATE OF COMPETENT AUTHORITY

Special Form Radioactive Material Encapsulation

Certificate Number USA/0179/S REFER TO:
(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 — January 15, 1981 (date)

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

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

3.0 Thermal Evaluation

3.1 Discussion

The Model 910 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 30 curies of iridium-192. The corresponding decay heat is 257 milliwatts.

3.2 Summary of Thermal Properties of Materials

The melting points of the materials used in the construction of the Model 910 are:

Steel	2453°F	(1345°C)
Uranium	2070°F	(1133°C)
Tungsten	6098°F	(3370°C)
Bronze	1840°F	(1005°C)
Aluminum	1220°F	(600°C)

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

3.3 Technical Specification of Components

Not Applicable

3.4 Normal Conditions of Transport

3.4.1 Thermal Model

The Heat source in the Model 910 is a maximum of 30 curies of iridium-192. Iridium-192 decays with a total energy liberation of 1.45 MeV per disintergration or 8.58 milliwatts per curie. Assuming that all of the decay energy is transformed into heat, the heat generation rate for the 30 curies of iridium-192 would be 257 milliwatts.

To demonstrate compliance with the requirements of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973 Edition for Type B(U) packaging, an analysis is presented in Section 3.6.1. The thermal model employed is described in that section.

To demonstrate compliance with the requirements of paragraph 240 of IAEA Safety Series No. 6, 1973 Edition for Type B(U) packaging, an analysis is presented in Section 3.6.2. The thermal model employed is described in that section.

Revision 0
10 April 1981

3.4.2 Maximum Temperatures

The maximum temperatures encountered under normal conditions of transport will have no adverse effect on the structural integrity or shielding. As presented in Section 3.6, the maximum temperature in the shade would be less than 40°C and the maximum temperature when insolated would be less than 63°C.

3.4.3 Minimum Temperatures

The minimum normal operating temperature of the Model 910 is -40°C (-40°F). 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 generated during the hypothetical thermal accident, which is shown to result in no loss of shielding nor 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 910. The applicable conditions of IAEA Safety Series No. 6, 1973 Edition for Type B(U) packages have been shown to be satisfied by the Model 910.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Thermal Model

The Model 910, including the source assembly, 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 eacaped the package through vent holes and non-leak tight assembly joints.

3.5.2 Package Conditions and Environment

The Model 910 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 910 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 910 packaging is open to the atmpsphere. 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 ($373kN/m^2$).

In Section 3.6.3, an analysis is presented which demonstrates that the maximum stress generated in the source capsule (containment) under the thermal test conditions could only be 3% of the yield strength of the material at the test temperature.

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 910 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 910 Type B(U) Thermal Analysis

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

This analysis demonstrates that the maximum surfact temperature of the Model 910 will not exceed 50°C (122°F) with the package in the shade and at an ambient temperature of 38°C (100°F).

To assure conservatism, the following assumptions are used:

a. The entire decay heat (257milliwatts) is deposited in the exterior faces of the Model 910.

b. The interior of the Model 910 is perfectly insulated and heat transfer occurs only from the exterior wall to the atmosphere.

c. 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 (front).

d. The only heat transfer mechanism is free convection.

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

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

and $$h = 1.42\left[\frac{T_w - T_a}{l}\right]^{\frac{1}{4}}$$

Where:
- q: Heat deposited per unit time in the face of interest (64 milliwatts)
- h: Free convective heat transfer coefficient for air in watts/m^2-°C
- A: Area of the face of interest ($0.026m^2$)
- T_w: Maximum temperature of the wall of the package
- T_a: Ambient temperature (38°C)
- l: Height of the face of interest (0.20m)

From this relationship, the maximum temperature of the wall is 39°C (102°F). This satisfies the requirement of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973 Edition.

Revision 0
10 April 1981

3.6.2 Model 910 Type B(U) Thermal Analysis

Paragraph 240 of IAEA Safety Series No. 6, 1973 Edition

This analysis demonstrates that the maximum surface temperatures of the Model 910 will not exceed 82°C (180°F) when the package is in an ambient temperature of 38°C (100°F) and insolated in accordance with paragraph 240 of IAEA Safety Series No. 6, 1973 Edition.

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

a. 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.

b. The decay heat load is added to the insolation heat load.

c. The solar absotptivity is assumed to be 0.9. The solar emissivity is assumed to be 0.8.

d. The package is assumed to undergo free convection from the top and sides and undergo radiation from the top, sides 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.

e. The package is approximated as a rectangular solid of 0.33m length, 0.20m high and 0.14m wide.

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

$$\alpha q_i + q_d = q_c = q_r$$

where α : Absorptivity (0.9)

q_i: Solar Heat Load (72.28 watts)

q_d: Decay Heat Load (0.257watts)

q_c: Convective Heat Transfer

q_r: Radiative Heat Transfer

Revision 0
10 April 1981

The convective heat transfer is:

$$q_c = (hA)_{top} + (hA)_{sides} \quad (T_w - T_a)$$

where h : Convective Heat Transfer Coefficient

A : Area of the Surface of Interest

T_w: Temperature of the 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 : Stephan Boltzman Constant (5.67×10^{-8} $w/m^2 - {}^oK^4$)

ε : Emissivity (0.8)

Iteration of this relationship demonstrates that the wall temperature is 61.6°C which satisfies the requirement of paragraph 240 of IAEA Safety Series No. 6, 1973 Edition.

Revision 0
10 April 1981

3.6.3 Model 910 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:

$$\sigma_l A_l - PA_p$$

Where σ_l: Longitudinal Stress

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

P : Pressure (373kN/m^2)

A_p: Pressure Area = πr_i^2

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

Revision 0
10 April 1981

The hoop stress can be found by:

$$2\sigma_h \ lt - pld_i$$

or $$\sigma_h = \frac{pr_i}{t}$$

where σ_h: 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 910 is the radioactive source capsule as described in Section 2.10.

The source capsule is fabricated from either Type 304 or Type 304L stainless steel. The capsule is cylindrical in shape with a diameter of 0.205 inch (5.2mm) and a 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

This source capsule has 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 capsule under the conditions of the hypothetical thermal accident was demonstrated to generate stresses well below the structural limits of the capsule (Sections 3.5.4, 3.6.2). Thus, the containment will withstand the pressure variations of normal transport.

4.2.3 Coolant Contamination

Not Applicable

Revision 0
10 April 1981

4.2.4 Coolant Loss

Not Applicable

4.3 Containment Requirements for the Hypothetical Accident Conditions

4.3.1 Fission Gas Products

4.3.2 Release of Contents

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

Revision 0
10 April 1981

5. Shielding Evaluation

5.1 Discussion and Results

The Model 910 is shielded with 18 pounds of depleted uranium. The uranium shielding is cast around the tungsten source tube. A radiation profile on Model 910, Serial Number 2 containing 29.5 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 30 curies of iridium-192 is presented in Table 5.1. As the Model 910 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
153	142	92	2.0	1.6	1.1

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 30 curies.

5.2.2 Neutron Source

Not Applicable

5.3 Model Specification

Not Applicable

5.4 Shielding Evaluation

The shielding evaluation was performed on Model 910, Serial No. 2 containing 29.5 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 was made on a Model 900 package after being subjected to the hypothetical accident conditions. That radiation profile showed that there was no significant change in the shielding effectiveness of that package as a result of these tests. Because of the similarity of the Model 910 to the Model 900, it is concluded that there would be no adverse affect on the shielding efficiency of the Model 910 as a result of the hypothetical accident conditions.

Revision 0
10 April 1981

5.5 Appendix

5.5.1 Radiation Profile - Model 910 Serial No. 2

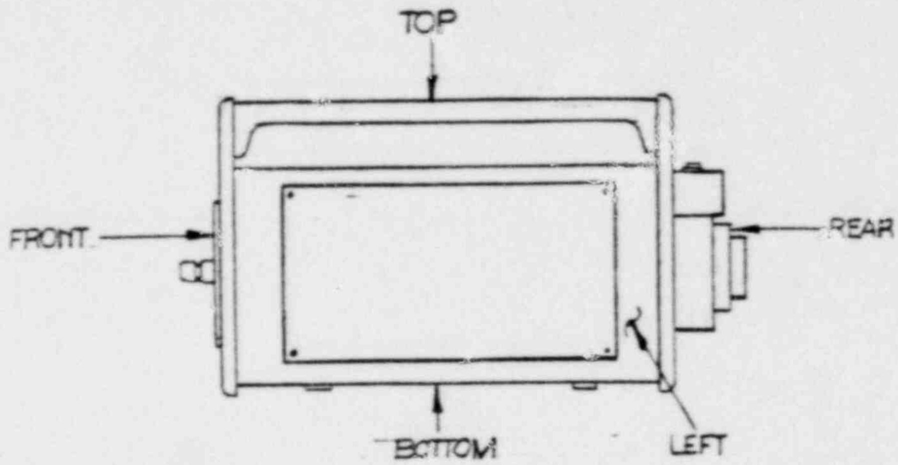
Revision 0
10 April 1981

Tech Ops

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

Radiation Profile

Model 910 Serial Number 2



Containing 29.5 Curies of Iridium

Maximum Exposure Rates (mR/hr)

	At Surface	At 50mm	At 150mm	At 1 Meter
Top	140	45	19	1.6
Front	120	46	9	1.4
Right	150	42	16	1.4
Rear	110	40	20	1.7
Left	120	40	14	2.0
Bottom	90	20	7	1.1

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

Revision 0
10 April 1981

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 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 form 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.

Revision 0
10 April 1981

18931

6. Criticality Evaluation

Not Applicable

Revision 0
10 April 1981

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 assembly into the package is presented in Section 7.4.

7.2 Procedures for Unloading the Package

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

7.3 Preparation of an Empty Package for Transport

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

Revision 0
10 April 1981

7.4 Appendix

Tech/Ops Stand⸗ᵣd Source Encapsulation Procedure

Model ᵃ ˀ Operating Instructions

Revision 0
10 April 1981

ENCAPSULATION OF SEALED SOURCES - MODELS 90003 AND 91003

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 change.

Revision 0
10 April 1981

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 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 hieght gauge to be sure that the weld is at the center of the capsule.

Revision 0
10 April 1981

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 100 lbs. 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 0.005μCi. 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.

Revision 0
10 April 1981

Tech/Ops Model 900, Model 910 and Model 920

Gamma Ray Projector

Operation Manual

Technical Data

Size: 13 in. long, 7.7 in. high 5.3 in. wide (330mm long, 195mm high, 135mm wide)

	Model 900	Model 910	Model 920
Weight:	44lbs (20kg)	34lbs (15kg)	47lbs (21kg)
Shielding (Uranium)	28lbs (13kg)	18lbs (8.2kg)	31lbs (14kg)
Capacity (ir-192)	100Ci	25Ci	200Ci
Transport Status Type B	USA/9141/B	USA/ /B	USA/9143/B
Source Assembly	90003	91003	90003

General

The Models 900, 910 and 920 are designed for use as radiographic exposure devices, storage containers and transport packages for the indicated source assemblies.

The US Nuclear Regulatory Commission allows the use of these devices only by persons who are specifically authorized under the terms of their license. Application for a license to use this device should be made to:

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

Prior to the first shipment of these devices, the user, in addition, should register with:

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

Revision 0
10 April 1981

Tech/Ops

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

Receipt

1. Upon receipt of the projector system, survey the projector on all sides to ensure that radiation levels do not exceed the following:

At Surface	200mR/hr
At 6 Inches from Surface	50mR/hr
At 3 Feet from Surface	10mR/hr

2. Check the projector, control unit and guide tubes for obvious damage.

3. Check packing list and Bill of Lading to ensure that all are intact and are representative of the shipment.

4. Place the projector in a restricted area until ready to use.

Operation

\- NOTE -

Personnel using this projector must have a calibrated and operable survey meter with a range of at least 0 to 1000mR/hr. In addition, personnel monitoring devices must be worn during these operations. They are direct reading pocket dosimeter and either a film badge or a thermoluminescent dosimeter.

Radiographic operations must be conducted in a restricted area and the area must be posted as required in 10CFR20 .

1. Survey the projector on all sides and ensure that the radiation levels do not exceed 50 milliroentgens per hour at six inches from the surface.

2. Locate the projector and controls to afford the operator as much shielding as possible.

Revision 0
10 April 1981

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3. At the radiographic focal point, position and secure the source stop of the guide tube assembly.

4. Connect together as many guide tube assemblies as necessary (maximum of three). Lay out the guide tube assembly as straight as possible (bend radius must be greater than 20 inches).

5. Position the projector at the end of the guide tube assembly.

6. From the projector, lay out the control cables as straight as possible (bend radius must be greater than three feet).

7. Unlock the projector with the key and rotate the selector ring from the LOCK position to the CONNECT position. The storage cover will disengage from the projector.

8. Engage the male connector of the driving cable to the female connector of the source assembly.

9. Slide the control cable connector forward into the locking assembly of the projector. Rotate the selector ring from the CONNECT position to the LOCK position. Depress the lock and remove the key.

10. Attach the guide tube assembly to the exit port of the projector.

11. Thoroughly check all cable connections, bend radii and the position of the source stop.

12. INSURE THAT NO ONE IS WITHIN THE BOUNDARY OF THE RESTRICTED AREA.

13. With a survey meter, approach the projector. Unlock the projector with the key and turn the selector ring from the LOCK position to the OPERATE position.

14. Fully raise the source position indicator knob. The knob will stay in the raised position.

- NOTE -

If cranking becomes difficult at any time, return the source immediately to the stored position.

Revision 0
10 April 1981

Tech/Ops

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15. At the control unit, rapidly rotate the hand crank in the EXPOSE direction. Continue to rotate the hand crank until the source assembly reaches the source stop. The odometer should read the approximate distance of source travel.

16. At the end of the exposure time, rapidly rotate the hand crank in the RETRACT direction. Continue to rotate the hand crank until the source assembly reaches the storage position in the projector, which serves as a mechanical stop for the source assembly. The source position indicator knob should drop to the closed position and the odometer should read approximately 000.

17. Approach the projector with a survey meter. Survey the projector on all sides, survey the guide tube and survey the source stop to assure that the source assembly is in its proper stored position. The radiation level should not exceed 50 milliroentgens per hour at six inches from the projector.

18. Rotate the selector ring to the LOCK position. Lock the projector.

19. Disconnect the guide tube assembly from the projector.

20. Unlock the projector. Rotate the selector ring from the LOCK position to the CONNECT position. Slide the control cable connector back and disconnect the drive cable from the source assembly.

21. Install the storage cover into the locking assembly and rotate the selector ring to the LOCK position. Depress the lock and remove the key.

Daily Inspection

Daily inspection of radiography equipment is recommended to assure that the equipment is in proper working condition. Daily inspection should be performed prior to the start of each shift.

1. Inspect the entire length of each guide tube section and insure that each section is free from dents. Inspect the end fittings to insure that they are tightly attached to the guide tube section. Inspect the threads to insure that they are not galled or damaged. Do not use damaged guide tubes.

Revision 0
10 April 1981

2. Inspect the entire length of control cable housings and insure that each section is free from dents. Inspect the end fittings to insure that they are tightly attached to the control cable housings. Check the control cable connector for damage. Check the male source connector for damage. Do not use a damaged control unit.

3. During the first radiographic operation, note the operation of the selector ring and lock assembly. If operation is difficult, do not operate the equipment.

4. During the first radiographic operation, note the operation of the control crank. If operation is difficult, retract the source to the stored position, and survey the equipment in accordance with the operating instructions.

Periodic Inspection and Maintenance

Periodic inspection and maintenance of radiography equipment is recommended to assure that the equipment remains in proper working condition. Periodic inspection and maintenance should be performed at intervals not to exceed three months.

Projector

1. Remove the source from the projector and install it in a source changer following the projector and source changer operating instructions.

2. Remove the rear plate from the projector. Disassemble the lock assembly.

3. Clean the components of the lock assembly. Examine the components for damage, excessive wear, galling and burrs. Lightly lubricate the lock slide and locking pin with grease MIL-G-23827 or equivalent.

4. Reassemble the locking assembly and test for proper operation.

5. Remove the source position indicator rod. Remove the front end plate and the indicator cover plate. Remove the indicator slide, locking pin, and slide tube.

6. Clean these components. Examine the components for damage, excessive wear, galling and burrs. Lightly lubricate the indicator slide and locking pin with grease, MIL-G-23827 or equivalent.

7. Clean the source tube.

Revision 0
10 April 1981

8. Reassemble the slide tube, locking pin, indicator slide, indicator cover plate and front end plate. Reinstall the source position indicator rod. Reinstall the rear end plate. Test the projector for proper operation.

Control Unit

1. Crank the drive cable in the expose direction until the stop spring reaches the crank gear. Disassemble the control housing from the crank assembly. Remove the stop spring. Remove the drive cable from the control unit.

2. Clean the drive cable. Examine the drive cable for damage or excessive wear. Test the male connector with Tech/Ops no-go gage. Check the male connector for proper connection to the driving cable.

3. Remove the control housings from the control unit. Examine carefully for internal damage by flexing the housings by hand. Internal damage to the reinforcing braid or flexible metallic tube will be evidenced by a crunch feeling when the cable housing is flexed. Cut, flattened or burnt cable housings should be replaced. Superficial cuts or burns may be sealed and reinforced with tape. Clean housings by syringing a few ounces of solvent into bore, and blow out with low pressure air (not more than 20psi). Do not allow solvent to remain in housings. Do not soak in solvent. Check end fittings for secure attachment.

4. Disassemble the crank unit. Wash parts in solvent. Check inside of housing for evidence of galling and wear. A deeply scored (more than 020 deep) line where the cable contacts the inner wall of the housing indicates the need for replacement.

   Check clearance between the hubs of the wheel and the bushings. More than .005 clearance indicates need for replacement.

   Examine teeth of wheel for damage. A bent tooth may be filed off. Two or more adjacent bent teeth will require replacement of the wheel. Lubricate the gear with grease and MIL-G-23837 or equivalent.

5. Reinstall the control housings to the crank unit. Lubricate the driving cable with grease MIL-G-23827 or equivalent. Reinstall the driving cable, installing the stop spring.

Source Guide Tubes

1. Check for cuts, burns or crushed tubes. Check fittings for secure attachment. Examine and test screw threads for function.

Revision 0
10 April 1981

Clean bore of tube with water or solvent and drain out promptly. Do not soak in solvent. Check for free passage of source by holding tube vertical and dropping dummy source assembly through tube. The dummy source assembly should fall through freely.

Final Inspection

1. Check the system for proper reassembly. Check fittings for tightness.

2. Reinstall the source into the projector following the projector and source changer operating instructions. Check for proper operation of the control unit, source position indicator and locking assembly.

3. Survey the projector on all sides to assure that the radiation levels do not exceed the following:

At surface:	200mR/hr
At 6 inches:	50mR/hr
At 3 feet	10mR/hr

4. Assure that the projector is properly labeled.

Leak Testing

The source assembly in the Models 900, 910 and 920 must be leak tested at intervals not to exceed six months. This can be accomplished using Tech/Ops Model 518 Leak Test Kit.

1. Place the projector in a Restricted Area.

2. Moisten the wipe test patch with EDTA solution.

3. Wipe the exit port of the projector and the female connector assembly.

4. Place the wipe test patch in the plastic envelope.

5. Set the survey meter on its most sensitive range and place the meter in a low background area. Move the patch to the meter, not the meter to the patch.

6. If the meter indication is less than 0.2mR/hr above background, place the plastic envelope into the mailing box and mail to Technical Operations. BE SURE TO COMPLETE AND RETURN THE IDENTIFICATION SHEET.

7. If the meter indication is more than 0.2mR/hr, DO NOT MAIL. Contact Technical Operations for special instructions.

Revision 0
10 April 1981

The wipe test swab will be subjected to a precise radioassay when received by Tech/Ops and a leak test certificate will be mailed promptly. This certificate must be kept with your records. It is subject to NRC inspection.

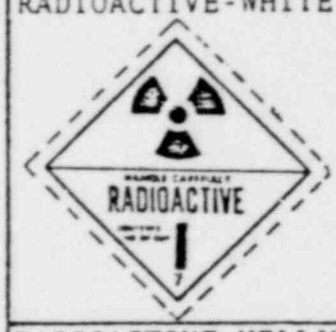
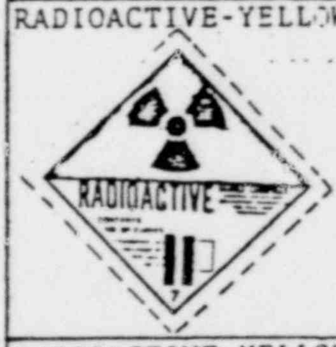
<u>Transportation</u>

1. Assure that the source assembly is in the proper storage position in the projector following the operating instructions. Be sure that the storage cover is installed.

2. Safety lock wire the source position indicator knob and crimp the lead seal.

3. Survey the projector on all sides at the surface and at one meter and determine the proper shipping label to be applied in accordance with Table I.

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

POOR ORIGINAL

Revision 0
10 April 1981

4. 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.

5. Remove all old shipping labels.

- NOTE -

Do not remove metal container identification label.

6. Affix new shipping labels to two opposite sides.

7. Properly complete the shipping papers indicating:

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

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

   Physical or chemical form (or Special Form)

   Activity of source (expressed in curies or millicuries)

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

   Transport Index

   USNRC Identification Number

   For export shipments, IAEA Identification Number

Shipper's Certification:

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

Revision 0
10 April 1981

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."

Preparation of an Empty Package for Transport

1. To prepare an empty package for transport, follow the instructions of the procedure above beginning with Step 2 with the following exceptions:

   a. The package must be marked "Radioactive Material - LSA-n o.s.

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

   c. Radionuclide is depleted uranium.

Revision 0
10 April 1981

8. Acceptance Test 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 secured and 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 also subjected to a vacuum bubble leak test. These tests are described in Section 7.4. Failure of any of these tests will prevent use of this source capsule.

8.1.4 Component Tests

The lock assembly of the package is tested to assure that the security of the source assembly 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 10 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 Test

Not Applicable

Revision 0
10 April 1981