Tech /Ops

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

PACKAGE DESCRIPTION

TECHNICAL OPERATIONS

MODEL 683

~~8007100~~

8007100376

1. General Information

1.1 Introduction

The Tech/Ops Model 683 shipping container is designed for use as Type B packaging for the transport of the Tech/Ops Model 683 gamma ray projector containing Iridium-192 as a sealed radioactive source in special form. The Model 683 shipping container conforms to the criteria for Type B packaging in accordance with 10CFR Part 71 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 683 shipping container consists of an outer steel drum with inside dimensions of 18.5 inches (470mm) diameter and 14.25 inches (362mm) high. The steel drum is fabricated from 18 gauge (.048 inch, (1.2mm thick) steel, MS27683-7.

The gross weight of the package containing the Model 683 gamma ray projector is 85 lbs. (39kg).

The steel drum is closed by means of a cover secured by a clamp ring head closure. The head closure is fastened by means of a bolt drilled for a seal wire to provide a tamper proof seal.

Inside the drum is a molded rubberized hair filler. This filler is molded to conform to the configuration of the Model 683 gamma ray projector.

The radioactive source assembly is contained inside the Model 683 gamma ray projector. The radioactive material is sealed inside a stainless steel source capsule. The capsule acts as the containment vessel for the radioactive material. The gamma ray projector provides shielding for the radioactive source and also provides a means of securing the radioactive source in its proper storage position. Descriptive drawings of the Model 683 shipping container and gamma ray projector are provided in Section 1.3.

1.2.2 Operational Features

The Model 683 gamma ray projector with the proper guide tubes and controls is installed in the shipping container and positioned so that it fits securely in the molded rubberized hair filler. The top plate of the molded filler is set in place over the projector. The container top is covered with the lid. The clamp ring is then placed around the lid and the bolt is tightened. A seal wire is inserted through the bolt and nut to provide a tamper proof seal.

1.2.3 Contents of the Package

The Model 683 package is designed to be a shipping container for the Tech/Ops Model 683 gamma ray projector.

The maximum radioactive contents would be 120 curies of Iridium-192 as Special Form radioactive material (Source Model No. A68309). This source assembly satisfies the criteria for Special Form radioactive material in accordance with 10CFR Part 71 and IAEA Safety Series No.6, 1973 Edition (Section 2.8).

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1.3 Appendix

1.3.1 Descriptive Assembly Drawing, Model 683 Type B Shipping Container

1.3.2 Descriptive Assembly Drawing, Model 683 Gamma Ray Projector

1.3.3 USNRC Certificate of Compliance USA/9053/B

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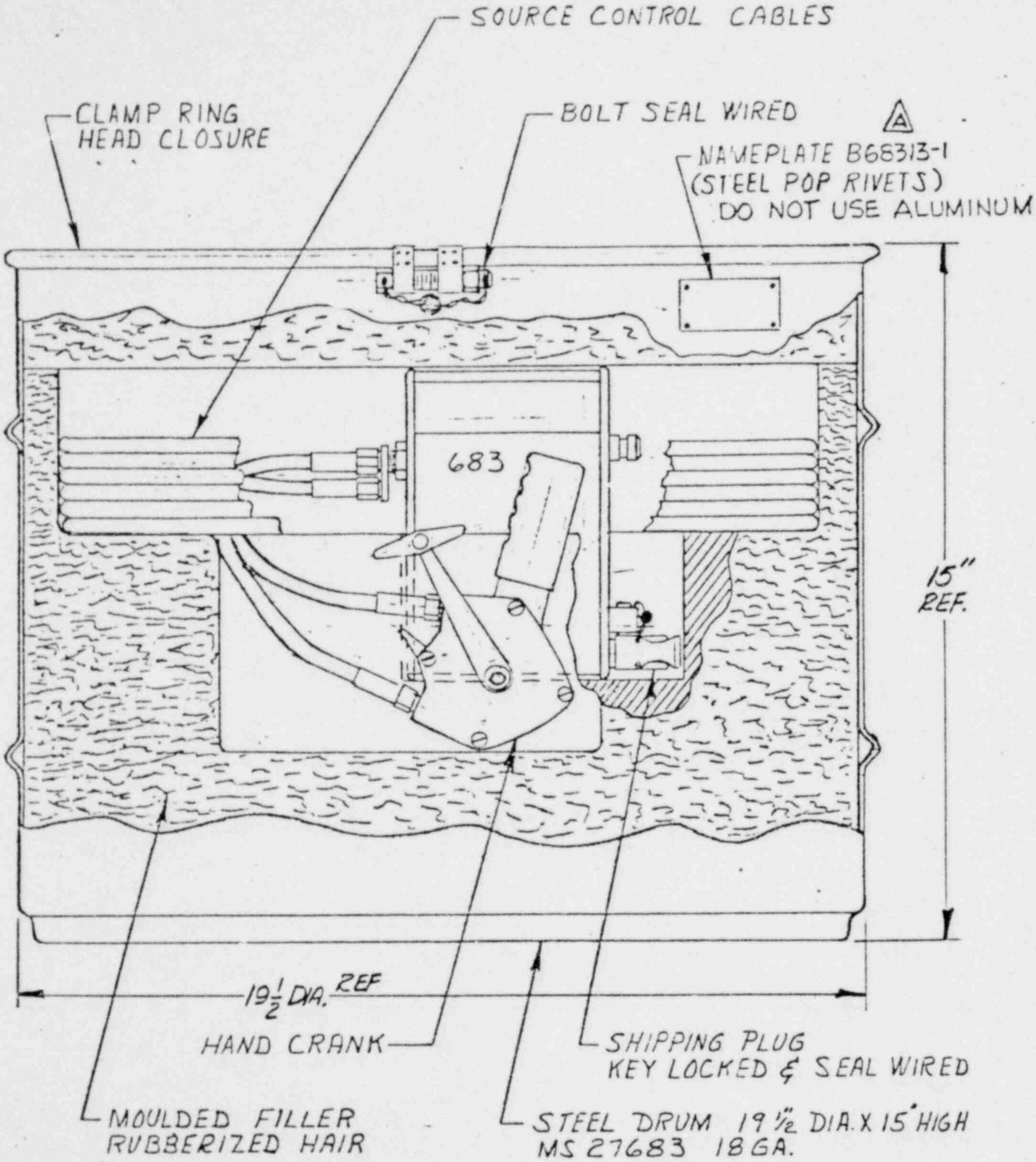
REV.	DATE	DESCRIPTION
A	7 DEC 76	B68313-1 WAS B68302-10

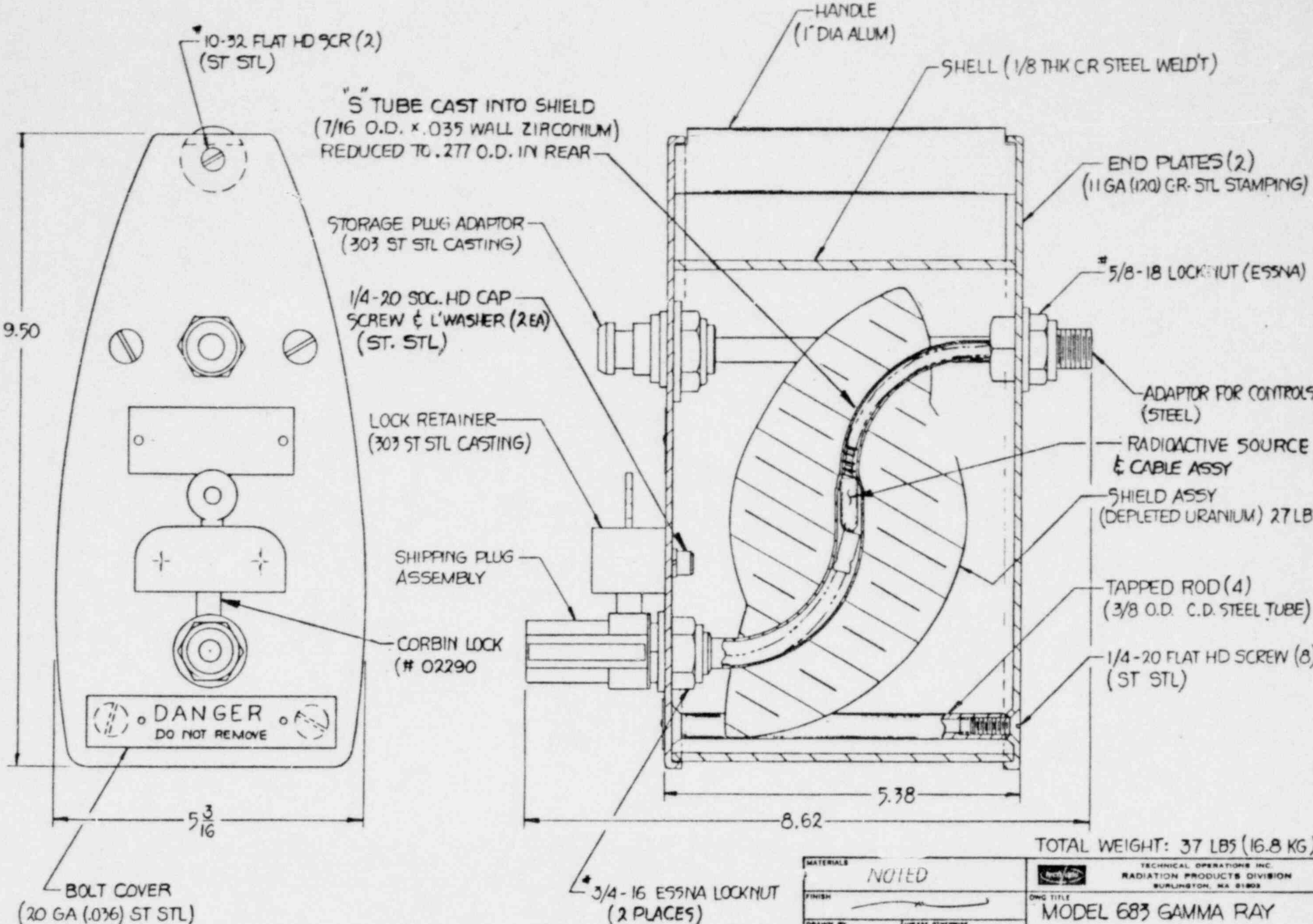


TOTAL WEIGHT - 89 LBS. 40 KG

TECHNICAL OPERATIONS INC
TYPE B SHIPPING CONTAINER ASSY
MODEL 683

REV. A
DWG NO. A68313

68390



TOTAL WEIGHT: 37 LBS (16.8 KG)

MATERIALS: NOTED		TECHNICAL OPERATIONS INC. RADIATION PRODUCTS DIVISION BURLINGTON, MA 01803
FINISH		DWG TITLE: MODEL 683 GAMMA RAY PROJECTOR DESCRIPTIVE ASSY
DRAWN BY	UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .X ± / .XX ± / .XXX ± / ANGLES ± / FRACTIONS ±	
CHECKED BY		CLASSIFICATION — SIZE C — DWG. NO 68390 — REV
APPROVED BY		SCALE 1:1 — SHEET OF

Form NRC-618
(12-73)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE

For Radioactive Materials Packages

1.(a) Certificate Number	1.(b) Revision No.	1.(c) Package Identification No.	1.(d) Pages No.	1.(e) Total No. P
9053	1	USA/9053/B( )	1	2

2. PREAMBLE

2.(a) This certificate is issued to satisfy Sections 173.393a, 173.394, 173.395, and 173.396 of the Department of Transportation Hazar Materials Regulations (49 CFR 170-189 and 14 CFR 103) and Sections 146-19-10a and 146-19-100 of the Department of Transportation Dangerous Cargoes Regulations (46 CFR 146-149), as amended.

2.(b) The packaging and contents described in item 5 below, meets the safety standards set forth in Subpart C of Title 10, Code of Federal Regulations, Part 71, "Packaging of Radioactive Materials for Transport and Transportation of Radioactive Material Unde Certain Conditions."

2.(c) This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the packag will be transported.

3. This certificate is issued on the basis of a safety analysis report of the package design or application—

3.(a) Prepared by (*Name and address*):

Technical Operations, Inc.
Northwest Industrial Park
Burlington, Massachusetts 01803

3.(b) Title and identification of report or application:

Technical Operations, Inc. application dated April 11, 1975, as supplemented

3.(c) Docket No. 71-9053

4. CONDITIONS

This certificate is conditional upon the fulfilling of the requirements of Subpart D of 10 CFR 71, as applicable, and the conditions specifie in item 5 below.

5. Description of Packaging and Authorized Contents, Model Number, Fissile Class, Other Conditions, and References:

(a) Packaging

(1) Model No.: 683

(2) Description

A radiographic exposure device contained within a protective overpack. The overpack is an 18-gage, MS27683 steel drum with a bolted and seal wire clamp closure ring. The drum is filled with molded rubberized hair to maintain a snug fit. Overall dimensions are 19.5" diameter x 15" high. The radiographic exposure device consists of an 11-gage carbon steel shell, depleted uranium shielding, zircalloy "S" tube, polyurethane filler material, source shipping plug and lock assembly. Gross weight of the package is approximately 89 lbs.

(3) Drawings

The packaging is constructed in accordance with the following Technical Operations, Inc. Drawings Nos.: C68302;C68302-1, 3, 4: C68303: B68303-1, Sh. 2; B68302-9, B68307-1; A68307; A68308-1C; A86302-8; A68311; A68309-9.

5. (b) Contents

(1) Type and form of material

Iridium-192 as sealed sources that meet the requirements of special form as defined in §71.4(o) of 10 CFR Part 71.

(2) Maximum quantity of material per package

120 curies

6. Source assemblies for use in this packaging are limited to those assemblies as identified in Technical Operations, Inc. Drawings Nos. A68309, and C68310.

7. Nameplate shall be fabricated of materials capable of resisting the fire test of 10 CFR Part 71 and maintaining their legibility.

8. The packaging authorized by this certificate is hereby approved for use under the general provisions of Paragraph 71.12(b) of 10 CFR Part 71.

9. Expiration date: July 31, 1980.

REFERENCES

Technical Operations, Inc. application dated April 11, 1975.

Supplement dated: June 6, 1975.

FOR THE U.S. NUCLEAR REGULATORY COMMISSIO[N]

Charles E. MacDonald, Chief
Transportation Branch
Division of Fuel Cycle and
Material Safety

Dated: APR 13 1977

2. Structural Evaluation

2.1 Structural Design

2.1.1 Discussion

Structurally the Model 683 consists of three components: a source capsule, gamma ray projector and outer packaging. The outer packaging consists of a molded rubberized hair filler contained in a steel drum. The source capsule is the primary containment vessel. It satisfies the criteria for special form radioactive material. The gamma ray projector fulfills two functions. It provides shielding for the radioactive material and with its lock assembly secures the source assembly in the proper shielded position.

The outer steel drum is fabricated from 18 gauge (.048 inch, 1.2mm thick) steel, MS 27683-7, with inside dimensions of 18.5 inches (469.9mm) diameter and 14.25 inches (362mm) high. The steel drum is closed by means of a cover with gasket (MIL-5-6855) and secured by a clamp ring head closure. The head closure is fastened by means of a bolt drilled for a seal wire to provide a tamperproof seal. The steel drum is lined with a molded rubberized hair filler. This filler is molded to conform to the shape of the Model 683 gamma ray projector, guide tubes and controls to be transported.

The outer housing provides the structural strength of the package and also ensures that the gamma ray projector cannot be accidentally removed from the package and damaged. The filler prevents against shifting of the contents during transport and also prevents damage to the contents. The gamma ray projector secures the source assembly in the shielded position and assures positive closure.

2.1.2 Design Criteria

The Model 683 shipping container is designed to comply with the requirements of 10CFR Part 71 and IAEA Safety Series No. 6, 1973 Edition. The package is simple in design. There are no design criteria which cannot be evaluated by straight forward application of the appropriate section of 10CFR Part 71 of IAEA Safety Series No. 6.

2.2 Weights and Centers of Gravity

The Model 683 shipping container weighs 85 lbs. (38.6kgs) with a Model 683 gamma ray projector secured for shipment. The center of gravity was determined empirically. It is located along the cylindrical axis at a distance of 7 inches (0.18m) above the bottom surface at the geometrical center of the package.

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2.3 Mechanical Properties of Materials

The Model 683 housing is fabricated from cold rolled low-carbon sheet steel. This material has a yield strength of 65,000 pounds per square inch ($448MN/m^2$).

(Reference: Machinery's Handbook, 21st Edition, P. 2118
Edgecomb's Buyers Guide p. 264
Ryerson Data Book 1967, p. 17

A drawing of the source capsule shipped in the Model 683 package is enclosed in Section 2.10. For a description of the Model 683 gamma ray projector see Section 1.3. The source assembly consists of a source capsule fabricated from Type 304 or Type 304L stainless steel with a yield strength of 35,000 pounds per square inch ($241MN/m^2$). The source capsule is swaged to a "Teleflex" steel cable. The capsules are sealed by tungsten - inert gas welding. The swaged coupling is tensile tested on a production basis to 75 pounds (334 newtons) (See Section 7.4).

2.4 General Standards for All Packages

2.4.1 Chemical and Galvanic Reactions

The materials used in the construction of the Model 683 shipping container are a molded rubberized hair filler and low carbon steel for the outer housing. There will be no significant chemical or galvanic action between these components.

2.4.2 Positive Closure

The source assembly of the gamma ray projector in the Model 683 shipping container cannot be exposed without opening a key operated lock on the projector. Access to the lock on the projector requires removal of the Model 683 cover. The cover is sealwired which provides a tamperproof seal.

2.4.3 Lifting Devices

The Model 683 shipping container is designed without any lifting devices. The entire container must be lifted from either end during transport.

2.4.4 Tiedown Devices

The Model 683 shipping container has no tie down devices. To secure container during transport requires the use of restraining devices that wrap around container.

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2.5 Standards fo: 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 (425 lbs; 1.88kn).
l = Length of Beam (15.6 in; 396.2mm)
Z = Section Modulus (13.45 in^3; 207,500mm^3)

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

The load is assumed to be 425 lbs (1.88kn). The container is assumed to be a hollow cylinder with an outside diameter of 18.6 inches (472.3mm), a wall thickness of 0.048 inch (1.2mm) and a length of 15.6 inches (396.2mm). Consequently, the section modulus of the beam is 13.45 in^3 (207,500mm^3).

Therefore, the maximum stress generated in the beam is 61.6 pounds per square inch (0.42MN/m^2) which is far below the yield strength of the material at 65,000 pounds per square inch (448MN/m^2).

2.5.2 External Pressure

The Model 683 shipping container and the Model 683 gamma ray projector are open to the atmosphere. Therefore, there will be no differential pressure acting on them. 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 (0.20 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 (0.02 inch)
d: Outside diameter (0.25 inch)

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

The collapsing pressure of the source capsules is calculated to be 5547 pounds per square inch (58MN/m^2). Therefore, the source capsules can withstand an external pressure of 25 pounds per square inch gauge.

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2.6 Normal Conditions of Transport

2.6.1 Heat

The thermal evaluation of the Model 683 shipping container is performed in Section 3. From this evaluation, it can be concluded that the Model 683 can withstand the normal heat transport condition.

2.6.2 Cold

The metal used in the manufacture of the Model 683 barrel can withstand a temperature of $-40^{\circ}F$ ($-40^{\circ}C$).

The molded rubberized hair filler can also withstand temperatures of less than $-40^{\circ}F$ ($-40^{\circ}C$). Therefore, it is concluded that the Model 683 shipping container will withstand the normal transport cold conditions.

2.6.3 Pressure

The Model 683 transport package containing the Model 683 gamma ray projector is open to the atmosphere; thus, there will be no differential pressure acting on the package. In Section 3.5.4, it is demonstrated that the source capsules are able to withstand an external pressure reduction of 0.5 atmospheres ($50.7kn/m^2$).

2.6.4 Vibration

The Model 683 shipping container (Certificate of Compliance USA/9053/B) has been in use for five years. During that time, there have been no vibrational failures reported.

On that basis, we contend that the Model 783 package will not undergo a vibrational failure during transport.

2.6.5 Water Spray Test

The water spray test was not actually performed on the Model 683 shipping container. We contend that the materials used in construction of the Model 683 are all highly water resistant and that exposure to the water will not reduce the shielding or affect the structural integrity of the package. During the five year period the Model 683 shipping container has been in use, no failures due to exposure to water have been reported.

2.6.6 Free Drop

The drop analysis performed in Section 2.7.1 is sufficient to satisfy the requirements of the normal free drop condition. On this basis, we conclude

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that the Model 683 transport package will withstand the free drop without loss of shielding effectiveness or loss of package integrity.

2.6.7 Corner Drop

Not Applicable

2.6.8 Penetration

A penetration test of the Model 683 shipping container was not actually performed. We contend that the materials used in the construction of the Model 683 barrel are highly resistant to penetration. Furthermore, the nature of the shipping package is such that the source assembly is secured inside the gamma ray projector which is centered inside the container surrounded by the rubberized hair filler.

It is impossible to penetrate the shipping container and affect the integrity of the source assembly inside the gamma ray projector.

2.6.9 Compression

The gross weight of the Model 683 shipping container with the Model 683 gamma ray projector is 85 lbs (38.9kg). The maximum cross sectional area is 271.7 in^2 ($.18m^2$). Thus, 2 pounds per square inch times the maximum horizontal cross section (543.4 lbs; 2420 newtons) is greater than five times the weight of the package (425 lbs; 1893 newtons).

The maximum stress generated on a cylinder of equal cross sections and a uniformly distributed load over the end surfaces can be computed from:

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

where σ: maximum stress generated in the cylinder
F: Load applied to the cylinder (543.4 lbs; 2420 newtons)
t: Thickness of plate (.048 inch; 1.2mm)

(Reference: Machinery's Handbook, 21st Edition, p. 436)

From this relationship, the maximum stress generated in the cylinder is found to be 56604 pounds per square inch ($390MN/m^2$) which is less than the yield strength of the material (65,000psi; $448MN/m^2$). Therefore, it can be concluded that the compression condition will not affect the package.

2.7 Hypothetical Accident Conditions

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2.7.1 Free Drop

Prior to the submittal of the Model 683 shipping container application in April 1975, the Model 683 gamma ray projector was subjected to a drop test through a distance of 30 feet onto an asphalt driveway.

As a result of this test, there was no reduction of shielding effectiveness nor loss of radioactive material.

It is concluded that the Model 683 gamma ray projector installed in the Model 683 steel drum will also satisfactorily meet the requirements of the Free Drop Test. In support of this evaluation, the Model 715 shipping container, a steel drum of similar construction, was subjected to a drop test through a distance of 30 feet onto a steel plate.

The Model 715 shipping container contained a Model 616 gamma ray projector during the test. Damage was limited to minor deformation and some crushing of the insulating liner. There was no increase in radiation intensity nor loss of radioactive material. (See Package Description, Technical Operations, Model 715, submitted 11 April 1980, Docket No. 71-9039).

2.7.2 Puncture

Prior to the submittal of the Model 683 shipping container application in April 1975, the Model 683 gamma ray projector was dropped from a height of 40 inches onto a six inch diameter steel bar 8 inches high.

As a result of this test, there was no reduction of shielding effectiveness nor loss of radioactive material.

It is concluded that the Model 683 gamma ray projector installed in the Model 683 steel drum will also satisfactorily meet the requirements of the Free Drop Test. In addition, the steel drum affords protection to the lock assembly during these accident conditions, insuring that the locking mechanism will not fail and the source assembly remains secured in the shielded position.

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 683 transport package, except the molded rubberized hair filler, are all in excess of $1475^{o}F$ ($800^{o}C$).

The thermal test was not actually performed on the Model 683 transport package. However, the melting temperatures of the materials used in the Model 683 transport package are well above the thermal test temperatures. It can be concluded that the Model 683 transport package will perform satisfactorily under the thermal test conditions.

A further evaluation demonstrates that the Metrefoam will undergo decomposition at the thermal test temperature. The gaseous byproducts will ignite in air. The Model 683 shipping container and gamma ray projector is not a sealed container, and thus will allow the gaseous byproducts of the Metrefoam to vent from the projector enclosure without pressure buildup sufficient to cause loss of the structural integrity.

In conclusion, the Model 683 shipping container with the Model 683 gamma ray projector satisfactorily meets the requirements for the hypothetical accident thermal condition of 10CFR Part 71.

2.7.4 Water Immersion

Not Applicable

2.7.5 Summary of Damage

The tests designed to induce mechanical stress (e.g., free drop test) 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 683 shipping container is designed for use in transporting the Model 683 gamma ray projector containing the source assembly Model A68309. This source assembly has been certified as Special Form Radioactive Material under IAEA Certificate of Competent Authority No. USA/0154/S. A copy of this certificate is included in Section 2.10.

2.9 Fuel Rods

Not Applicable

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2.10 Appendix

Descriptive Assembly Drawings of Sources

IAEA Certificate of Competent Authority USA/0154/S

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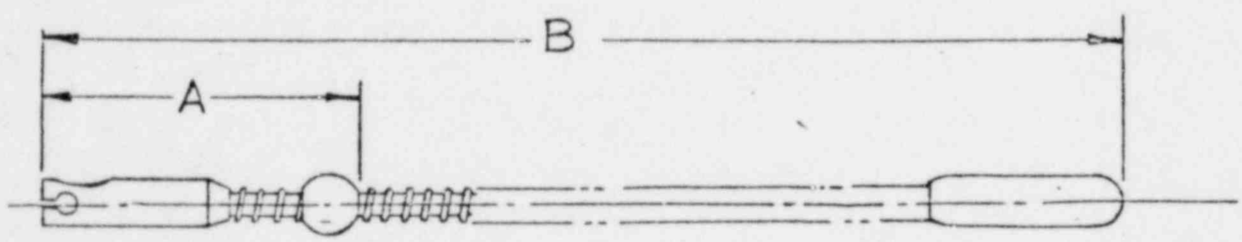
A60050

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

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



MATERIALS

FINISH

DRAWN BY Ti-lev 6 OCT 78

CHECKED BY

APPROVED BY

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

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE

^{192}IRIDIUM SOURCE REFERENCE

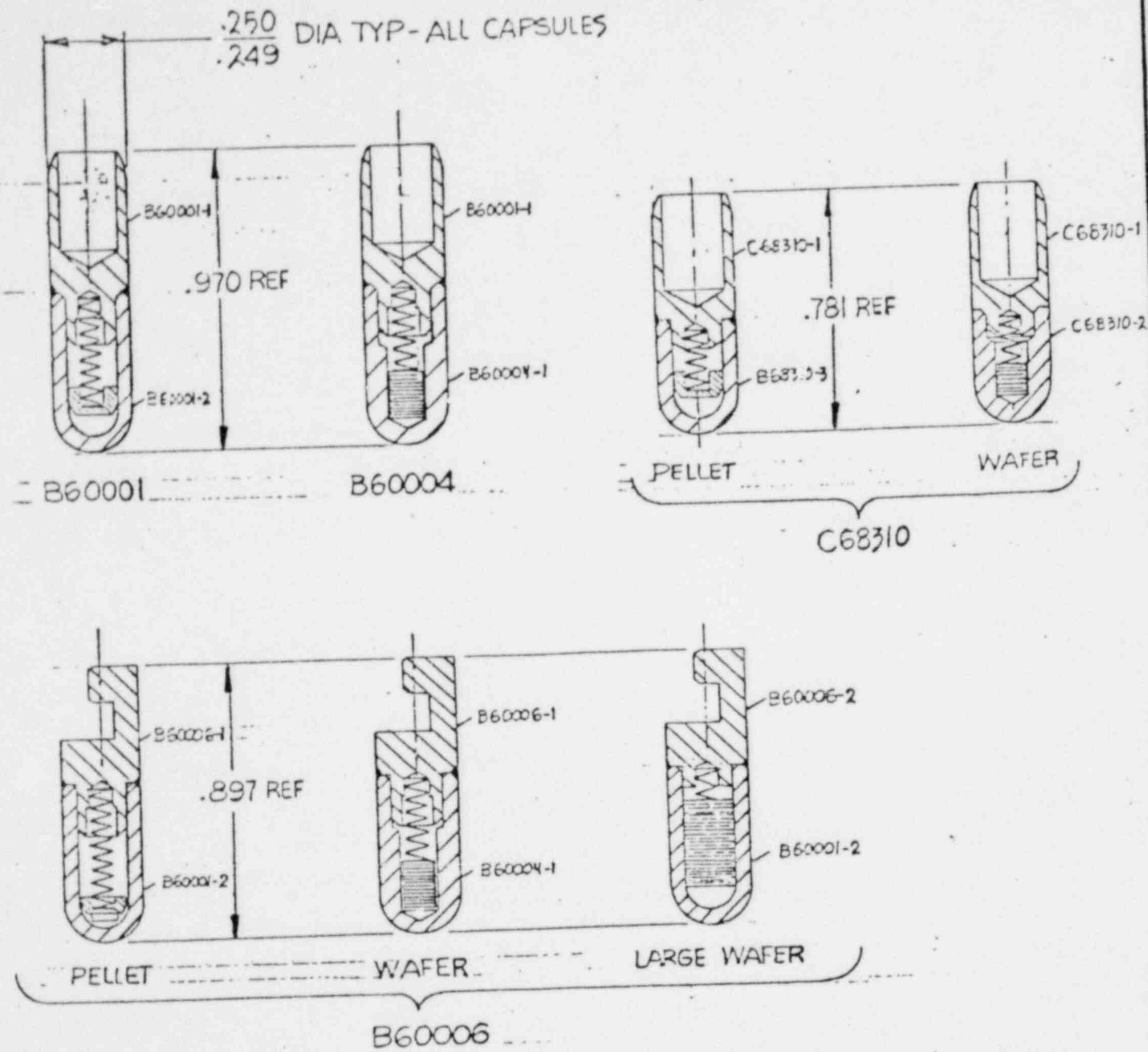
CLASSIFICATION | SIZE A | DWG. NO. 60050 | REV. A

SCALE 1:1 | SHEET 1 OF 2

SPAULDING CO., INC. 21-60169

A60050

REV.	DATE	DESCRIPTION
A	12-18-78	CALLOUT B68310-3 WAS C68310-3 & B60001-2 WAS B6G001-2 (ERRORS).



MATERIALS

FINISH

DRAWN BY 6 OCT 78

CHECKED BY

APPROVED BY

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

TECHNICAL OPERATIONS INC.
RADIATION PRODUCTS DIVISION
BURLINGTON, MA 01803

DWG TITLE

^{192}IRIDIUM SOURCE REFERENCE

CLASSIFICATION | SIZE A | DWG. NO. 60050 | REV. A

SCALE 2:1 | SHEET 2 OF 2

SPAULDING CO., INC. 21-60169

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

REFER TO:

IAEA CERTIFICATE OF COMPETENT AUTHORITY

Special Form Radioactive Material Encapsulation

Certificate Number USA/0154/S

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

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

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

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

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

II. Radioactive Contents - The authorized radioactive contents of these sources consist of not more than the following amounts of Iridium-192 as solid metal:

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

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

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

Certified by:

R. R. Rawl (signature) December 15, 1978

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

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

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

3. Thermal Evaluation

3.1 Discussion

The Model 683 transport package 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 120 curies of Iridium-192. The corresponding decay heat is 1.03 watts.

3.2 Summary of Thermal Properties of Materials

The melting points of the metals used in the construction of the Model 683 transport package are:

Zircalloy	3350°F	(1845°C)
Steel	2453°	(1345°C)
Uranium	2070°F	(1133°C)
Bronze	1840°F	(1005°C)

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 683 transport package is a maximum of 120 curies of Iridium-192. Iridium-192 decays with a total energy liberation of 1.45 MeV per disintegration or 8.59 milliwatts per curie. Assuming that all of the decay energy is transformed into heat, the heat generation rate for the 120 curies of Iridium-192 would be 1.03 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.

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.

As shown 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 74°C.

3.4.3 Minimum Temperatures

The mimimum normal operating temperature of the Model 683 transport package is -40°F (-40°C). This temperature will have no adverse effect 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 683 shipping container. The applicable conditions of IAEA Safety Series No. 6, 1973 for Type B(U) packages have been shown to be satisfied by the Model 683 package.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Thermal Model

The Model 683 shipping container with the Model 683 gamma ray projector and source assembly, is assumed to reach the thermal test temperature of 800°C. At this temperature the polyurethane foam in the projector will have decomposed and the resulting gases will have escaped the package through vent holes and non-leak tight assembly joints. In addition the rubberized hair filler in the shipping container undergoes a small amount of melting.

3.5.2 Package Conditions and Environment

The Model 683 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 Model 683 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 683 transport package (except the potting compound, as noted) indicates that there will be no damage to the package as a result of this temperature.

3.5.4 Maximum Internal Pressures

The Model 683 package is open to the atmosphere. Therefore, there will be no pressure buildup within the package. In Section 3.6, an analysis of the source capsules under the thermal test condition demonstrates that the maximum internal gas pressure at 800°C is 55psi (380kN/m^2).

The critical location for failure is the weld. An internal pressure of 55psi (308kN/m^2) will generate a maximum stress of 291psi (2.0MN/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 683 transport package 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.

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3.6 Appendix

3.6.1 Model 683 Type B(U) Thermal Analysis: Paragraphs 231 and 232 of IAEA Safety Series No. 6, 1971.

3.6.2 Model 683 Type B(U) Thermal Analysis: Paragraph 240 of IAEA Safety Series No. 6, 1973

3.6.3 Iridium Source Capsules Thermal Analysis

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3.6.1 Model 683 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 683 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 (1.03 watts) is deposited in the exterior faces of the Model 683 barrel.

2) The interior of the Model 683 is 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 fifty percent of the total heat is deposited in the smallest face (top).

4) The only heat transfe 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 (0.515 watts)

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

A: Area of the face of interest (0.18m)

T_w: Maximum temperature of the wall of the package

Ta: Ambient temperature (38°C)

From this relationship, the maximum temperature of the wall is 39.5°C. This satisfies the requirement of paragraphs 231 and 232 of IAEA Safety Series No. 6, 1973.

3.6.2 Model 683 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 683 will not exceed 82°C when the package is in an ambient temperature of 38°C and insolated in accordance with paragraph 240 of IAEA Safety Series No. 6, 1973.

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

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

2) The decay heat load is considered negligible.

3) The package has 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 in the faces.

5) The package is approximated as a right circular cylinder resting on an end. The surface areas of the top and bottom are each $0.18m^2$. The surface area of the side is $0.54m^2$.

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

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The heat load applied to the package is:

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

where α : Absorptivity (0.9)

q_s: Solar heat load (149 watts)

The convective heat transfer is:

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

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

The heat transfer due to radiation is:

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

where σ Stefan Boltzmann Constant ($5.669 \times 10^{-8}\ w/m^{2\,0}K$)
ε Emissivity (0.8)

Iteration of this relationship demonstrates that the wall temperature of the Model 683 is 73.2°C which satisfies requirement of paragraph 240 of IAEA Safety Series No. 6, 1973.

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3.6.3 Model 683 Type B(U)

Source Capsules - Thermal Analysis

Paragraph 238 of IAEA Safety Series No. 6, 1973

This analysis demonstrates that the pressure inside the source capsules used in conjunction with the Model 683, when subjected to the thermal test, does not exceed the pressure which corresponds to the minimum yield strength at the thermal test temperature.

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

The internal volume of the source capsules contains only iridium metal (as a solid) and air. It is assumed at the time of loading, the entrapped air is at standard temperature and pressure (20°C; $100kN/m^2$). 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 the 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 (55psi).

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

The maximum longitudinal stress is calculated from:

$$\sigma_1 A_1 = P A_p$$

where σ_1 : Longitudinal Stress

A_1: Stress Area = $\pi(r_o^2 - r_i^2)$

P : Pressure

A_p: Pressure Area = πr_1^2

From this relationship, the maximum longitudinal stress is calculated to be $894kN/m^2$(129psi).

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The hoop stress can be found by:

$$2\sigma_h lt = pld_i$$

where σ_h: hoop stress

l : Length of the cylinder

t : thickness of cylinder

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

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

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4. Containment

4.1 Containment Boundary

4.1.1 Containment Vessel

The containment system for the Model 683 is the radioactive source as stated in Section 1.2.3 of this application. The actual containment for the radioactive material is the welded source capsule as shown in Section 2.10. The source assembly is certified as Special Form radioactive material (IAEA Certificate of Competent Authority No. USA/0154/S).

The capsule is constructed of either Type 304 or Type 304L stainless steel. The capsules are rounded cylinders with a diameter of 0.25 inch (6.35mm) and a length of 0.78 inch (19.8mm).

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 inches (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 USNRC 10CFR Part 71. 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 Conditions

4.1 Fission Gas Products

Not Applicable

4.3.2 Releases 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 683 barrel is designed for use as a Type B shipping container for the transport of the Tech/Ops Model 683 gamma ray projector containing Iridium-192 as a Special Form sealed radioactive source. The radioactive source assembly is contained inside the gamma ray projector. The gamma ray projector provides shielding for the radioactive source and also provides a means of securing the radioactive source in its proper storage position. Descriptive drawings of the Model 683 gamma ray projector and shipping container are provided in Section 1.3.

Radiation profiles of a Model 683 gamma ray projector containing 107 curies of Iridium-192 and a Model 683 shipping container with the projector were done. The results of this survey are presented in Section 5.5.1. Extrapolation to the maximum capacity of 120 curies is presented in Tables 5.1A and B.

The results demonstrate that with the Model 683 gamma ray projector positioned in the Model 683 barrel ready for transport, the radiation levels are well below the regulatory limits for a shipping container. As the Model 683 contains no neutron source, the gamma dose rates are the total dose rates which are presented.

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Table 5.1-A

Model 683 Gamma Ray Projector

Summary of Maximum Dose Rates (mR/hr)

	Surface	6 Inch	1 Meter
Top	78	11	0.8
Bottom	101	15	1.5
Front	230	28	2.5
Back	258	25	1.6
Right	247	22	1.3
Left	269	27	2.0

Table 5.1-B

Model 683 Shipping Container

(with a Model 683 Gamma Ray Projector)

Summary of Maximum Dose Rates (mR/hr)

At Surface			At One Meter		
Top	Sides	Bottom	Top	Sides	Bottom
11	38	39	0.7	1.2	0.9

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 120 curies.

5.2.2 Neutron Source

Not Applicable

5.3 Model Specification

Not Applicable

5.4 Shielding Evaluation

The shielding evaluation was performed on a Model 683 gamma ray projector containing 107 curies of Iridium-192 and on a Model 683 shipping container with the projector secured inside for transport. The source used for measurements was a Model A68309. The results of the measurements demonstrate that when the projector is transported in the Model 683 shipping container the dose rates surrounding the package are well within the regulatory requirements.

To demonstrate the effects of hypothetical accident conditions on the shielding evaluation of the Model 683 shipping container, it is necessary to refer to a previous submittal for Type B packaging certification on the Tech/Ops Model 715 shipping container. The Model 715 shipping container, a steel drum of similar construction to the Model 683, was subjected to a free drop of 30 feet onto a steel plate. During the test the Model 715 barrel contained a Model 616 gamma ray projector. Damage was limited to minor deformation and some crushing of the insulating liner. There was no increase in radiation intensity and no loss of radioactive material. (Package Description, Technical Operations, Model 715, Section 5.4, 11 April 1980).

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5.5 Appendix

5.5.1 Radiation Profile - Model 683 Gamma Ray Projector Serial No. 220

5.5.2 Radiation Profile - Model 683 Shipping Container Serial No. 7

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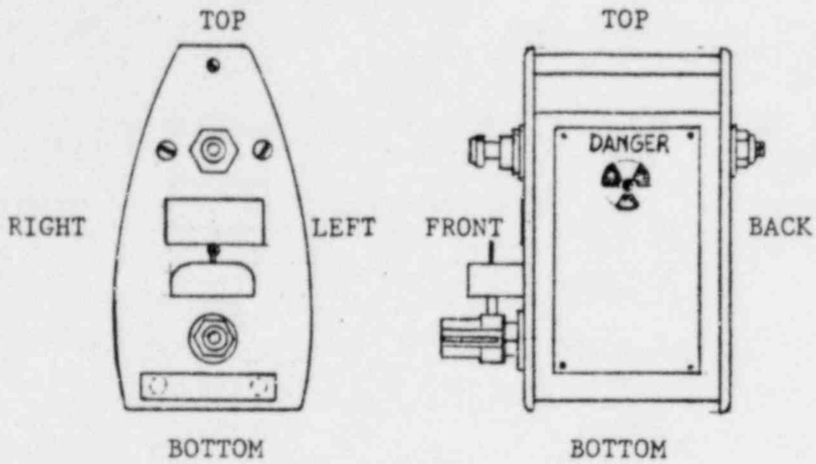
5.5.1 RADIATION PROFILE

Model 683 Gamma Ray Projector Serial No. 220



Source Model A68309 Serial No. S-2831

Activity: 107 Curies on 30 May 1980

Survey Instrument: AN PDR-27J Serial No: 7930 Calib. Date: 15 May 80

Maximum Dose Rates (mR/hr)

	Surface	6 Inch	1 Meter
Top	70	10	0.7
Bottom	90	13	1.3
Front	205	25	2.2
Back	230	22	1.4
Right	220	20	1.2
Left	240	24	1.8

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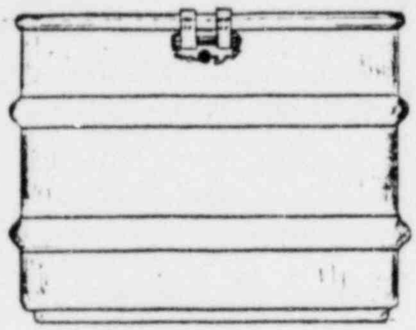
5.5.2 RADIATION PROFILE

Model 683 Shipping Container   Serial No. 7



Source Model: A68309   Serial No: S2831

Activity: 107 Curies on 30 May 1980

Survey Instrument: AN PDR-27J Serial No: 7930 Calib. Date: 15 May 1980

Maximum Dose Rates (mR/hr)

Surface			At One Meter		
Top	Side	Bottom	Top	Side	Bottom
10	34	35	0.6	1.1	0.8

6. Criticality Evaluation

Not Applicable

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7. Operating Procedures

7.1 Procedures for Loading the Package

The procedure for fabricating the special form source capsule is presented in Section 7.4.1. The procedure used in preparing the Model 683 shipping container for transport is presented in Section 7.4.2.

7.2 Procedures for Unloading the Package

The procedure for unloading the Model 683 shipping container is presented in Section 7.4.2.

7.3 Preparation of an Empty Package for Transport

The procedure for preparing an empty package for transport is presented in Section 7.4.2.

7.4 Appendix

7.4.1 Procedure for Encapsulation of Sealed Sources

7.4.2 Model 683 Shipping Container Operating Instructions

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ENCAPSULATION OF SEALED SOURCES

A. Personnel Requirements

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

B. General Requirements

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

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

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

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

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

C. Preparatory Procedure

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

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

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

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

D. Encapsulation Procedure

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

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

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

4. Place capsule in weld positioning device.

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

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

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

8. Remove funnel or rivet.

9. Assemble capsule components.

10. Weld adhering to the following conditions:

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

    b. Preflow argon, flush 10 seconds.

    c. Start 15 amps.

    d. Weld 15 amps.

    e. Slope 15 amps

    f. Post flow 15 seconds.

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

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

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

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

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

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

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

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

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

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

TECH/OPS MODEL 683

SHIPPING CONTAINER

OPERATING INSTRUCTIONS

Technical Data

Size:	18.5 in diameter, 14.25 in high (469.9mm diameter, 362mm high)
Capacity:	120 curies of Iridium-192 as special form sealed radioactive source in the Model 683 gamma ray projector.
Transport Status:	Type B USNRC USA/9053/B IAEA USA/0012/B

General

The Model 683 shipping container is designed as Type B packaging for the transport of the Tech/Ops Model 683 gamma ray projector.

Receipt

1. Upon receipt of the Model 683 shipping container, survey the package on all sides to ensure radiation levels to not exceed the following:

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

2. Check surface of container for obvious damage.

3. Check Invoice and Bill of Lading to ensure all are intact and are representative of the shipment.

4. If there are any discrepancies in Items 1-3, secure the shipping container and contact Technical Operations, Inc. immediately to resolve the discrepancy. (Tel: 800-225-7383, Telex 949313).

5. If Items 1-3 are determined to be in order, place the transport package in a restricted area until the gamma ray projector is to be unpacked.

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Opening the Package

NOTE: During all unloading and loading operations of the Model 683 shipping container, personnel must have a calibrated and operational survey meter with a range of at least 0-1000 mR/hr. In addition, personnel monitoring devices must be worn during the operation. They are, a film badge (or thermoluminescent dosimeter, TLD) and a direct reading pocket dosimeter.

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

2. Place the package in a Restricted Area which is properly identified.

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

4. Examine the contents of the package to determine if any shifting or damage had occured during transport.

5. If items 1 to 4 are in order, remove the Model 683 projector as needed. When stored, secure the Model 683 projector in a Restricted Area.

Preparation for Shipment

1. Wearing a film badge and dosimeter, approach the gamma ray projector to be shipped with a calibrated and operable survey instrument.

2. Survey the exterior surfaces of the gamma ray projector to insure that the radiation intensities are normal. (Less than 50mR/hr at six inches from the surface). Check to insure that the gamma ray projector is locked.

3. Place the Model 683 gamma ray projector in the Model 683 shipping container positioned to sit firmly in the molded rubberized hair filler. Place the top section of the molded filler over the projector. Cover the container top with the gasket and lid.

4. Place the clamp ring on the container and tighten the bolt. Sealwire the bolt and nut using a tamper proof seal.

5. Survey the exterior surfaces of the container and insure that the maximum radiation level is less than 200 milliroentgens per hour.

6. Measure the radiation level three feet from all exterior surfaces of the container and insure that the radiation level is less than 10 milliroentgens per hour.

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7. Determine the proper shipping label to be applied to the package using Table I. The maximum radiation level measured three feet from any exterior surface of the shipping container is the Transport Index.

8. Fill out the information requested on the label indicating:

   a) Contents (Isotope)
   b) No. of curies
   c) Transport Index (Maximum Radiation Level measured at three feet from the surface).

9. Remove all old shipping labels. However, do not remove the metal container identification tag.

10. Affix new shipping labels to two opposite sides.

11. Perform a radioactive contamination wipe test of the shipping package and insure that the wipe test does not exceed 0.001 microcuries per 100 square centimeters.

12. Properly complete the shipping papers indicating:

   a) Proper shipping name (i.e. radioactive material, special form, n.o.s.)

   b) Name of radionuclide (i.e. Iridium-192)

   c) Physical or chemical form (or special form)

TABLE I

	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

d) Activity of source (expressed in curies or millicuries)

e) Category of label applied (i.e. Radioactive Yellow II)

f) Transport Index

g) USNRC Identification Number (USA/9053/B)

h) For export shipments, IAEA Identification Number (USA/0011/B)

Shipper's Certification required:

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

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

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

2. For air shipments, the package must be labeled with a "Cargo Aircraft Only" label and the shipping papers must state:

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

13. Return the Model 683 shipping container to:

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

Shipping Empty Package

NOTE: Wear personnel monitoring devices during all source changing operations. Monitor all operations with a calibrated, operable survey meter.

1. The Iridium-^{192} source is to be secured in a Tech/Ops Model 750 source changer when it is necessary to ship an empty Model 683 package. The procedures for source changing with the Model 750 are to be followed. The precautions used when making a radiographic exposure must also be followed.

2. When shipping an empty Model 683 projector containing depleted uranium as shielding, all the steps 1 through 6 under the procedures for shipment must be followed.

3. If the surface radiation level is less than 0.5 milliroentgens per hour and there is no measurable radiation level at 3 feet from the surface, no label is required. Mark the outside of the package with the statement:

   "Exempt from specification packaging, marking and labeling, and exempt from the provisions of 49CFR173.393 per 49CFR173.391(c). Exempt from the requirements of 49CFR Part 175 per 49CFR175.10(a)(6)."

   Properly complete the shipping papers indicating:

   a) Proper shipping name (Radioactive Marked LSA, n.o.s.)

   b) Name of Radionuclide (Depleted Uranium)

   c) Physical or chemical form (Solid metal)

   d) Activity (in curies or millicuries

   e) The statement as stated above for exemption from specification packaging

   f) Shipper's certification

NOTE: The shipper's certification and the additional certification for air shipments are as stated in the procedures for Preparation for Shipment.

4. If the surface radiation level exceeds 0.5 milliroentgens per hour, or if there is a measurable radiation level at three feet from the surface, use the criteria of Table I to determine the proper radioactive shipping labels to be applied to the package.

   The steps to be followed in shipping the package for this situation are specified in the section on Preparation for Shipment steps 1-13.

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8. Acceptance Tests and Maintenance Program

8.1 Acceptance Tests

8.1.1 Visual Inspection

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

The Model 683 gamma ray projector which is transported in the Model 683 shipping container is also visually examined to assure that the appropriate fasteners are properly sealwired and that the package is properly labeled.

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

8.1.1 Structural and Pressure Tests

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

8.1.3 Leak Tests

The radioactive source capsule (the primary containment) is wipe tested for leakage of radioactive contamination. The source capsule is subjected to a 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 locking assembly of the Model 683 gamma ray projector is tested to assure that the security of the radioactive source will be maintained. Failure of this test prevents use of the gamma ray projector until the lock assembly is corrected and retested. Only when the source assembly is correctly secured in the gamma ray projector is the Model 683 used as a shipping container.

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.

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8.1.6 Thermal Acceptance Tests

Not Applicable

8.2 Maintenance Program

8.2.1 Structural and Pressure Tests

Not Applicable

8.2.2 Leak Tests

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

8.2.3 Subsystem Maintenance

The lock assembly of the gamma ray projector is tested as described in Section 8.1.4, prior to each use of the Model 683 shipping container. Additionally, the Model 683 shipping container 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

8.1.5 Shielding

Prior to each use, a radiation survey of the transport 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 10CFR Part 71.21(b) are included in Section 7.4.2.

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