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APPLICATION
for
NRC CERTIFICATE OF COMPLIANCE

Model SPEC-300
Type B(U) Radioactive Material Package
June 28, 1999

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1. GENERAL INFORMATION

1.1 Introduction

The SPEC-300 is a Cobalt-60 industrial radiography device that also serves as a type B transport package. The SPEC-300 is designed for a maximum quantity of 11.1 tBq (300 Ci) of Cobalt-60 in the form of a sealed source. It is anticipated that the SPEC-300 will be transported both domestically and internationally by authorized users in private carriage and by common carriers.

1.2 Package Description

1.2.1 Packaging

Maximum Gross Weight: 354 kg (780 lb)

Materials of construction:
Enclosure: 300 series CRES (corrosion resisting steel)
Lock box: 300 series CRES
Shield: depleted Uranium, 98% pure with a Titanium or Titanium alloy or zircalloy S-tube.
Foam fill: polyurethane
Nameplates: 300 series CRES
Lock module: Titanium, 300 series CRES, polyacetal resin, bronze, Buna rubber
Lock cap: Titanium, Tungsten, CRES
Safety plug: 300 series CRES, Tungsten

Materials used as neutron absorbers or moderators: Not applicable. The SPEC-300 is not intended for use with fissionable or neutron-producing materials.

External dimensions: 66 cm (26 in) long, 35.6 cm (14 in) wide, and 36.1 cm (14.2 in) high.

Cavity size: 13 mm (0.50 in) I.D. S-shaped tube running through the depleted Uranium shield between the lock end and outlet end bulkheads.

Internal structures: Refer to appendix 1.3 for a general arrangement drawing and a shield drawing. The major internal structure is the depleted Uranium shield. The depleted Uranium shield is secured in the SPEC-300 by two supports welded to the lock-end and outlet-end bulkheads. These support the "ears" cast into the shield and transmit reaction forces from the shield to the device enclosure. Four tubular structural posts are welded between the outlet and lock end bulkheads. Attached to these structural posts are a hot top ring support and, on the opposite side, a dome top support. These provide additional shield support. Polyurethane foam fills the void between the depleted Uranium shield and the device enclosure.

External structures: Refer to appendix 1.3 for a general arrangement drawing. An outlet panel is attached to the outlet-end bulkhead to provide a means of attaching a safety plug to the package. This plug is required for transport. A lock box is attached to the lock end

bulkhead. This lock box houses the automatic securing mechanism/lock module and the transport lock. The automatic securing mechanism/lock module employed on the SPEC-300 is interchangeable with the SPEC-150, an Iridium-192 industrial radiography device of which hundreds are currently employed in various industries and environments, and has maintained an excellent safety record.

Receptacles, valves, sampling ports, means of heat dissipation, volumes and types of coolant, outer and inner protrusions: Not applicable. The SPEC-300 is a simple package and these components are not needed.

Lifting and tie down devices: Refer to appendix 1.3 for a general arrangement drawing. Hinged lifting rings are provided on top of the device. These fold down when not in use. They are rated to carry 25 times the weight of the device. Four tie-down holes are provided at the upper corners of the device. Since they could possibly be used to lift the device, they also are rated to carry 25 times the weight of the device.

Amount of shielding: The depleted Uranium shield has a maximum weight of (525 lb) has a spherical diameter of 25 cm (10 in). With the source assembly capsule in the fully shielded position at the center of the shield, approximately 12.5 cm (5 in) of depleted Uranium shielding is present all around the radioactive source. "Ears" cast into the shield compensate for the depleted Uranium not present in the S-shaped tube running through the shield. Since the radiation shielding properties of cast depleted Uranium shields can vary slightly from unit to unit, shielding pads made from Tungsten or depleted Uranium may be used to locally improve the attenuation characteristics of a given shield if necessary to meet transport radiation level requirements. Shielding pads are attached to the depleted Uranium shield with an epoxy adhesive. The pads are further secured by the high density polyurethane foam material filling the interior space between the depleted Uranium shield and the device housing. The most common need for a pad is on the hot top of the DU shield. Shielding pads will only be used on shields that already meet type B hypothetical accident condition testing radiation level requirements.

Pressure relief system: Not applicable. The SPEC-300 enclosure is vented to the atmosphere; a change in ambient pressure would not result in a pressure differential within the device.

Closures: Not applicable. Structural closures of openings are not employed to contain the radioactive material within the packaging.

Means of containment: The primary containment means preventing release of radioactive material is the sealed source capsule, which meets the requirements of special form radioactive material in 10 CFR 71.75 pursuant to IAEA Certificate of Competent Authority Number USA/0095/S. This capsule measures approximately 10 mm (0.38 in) diameter by 19 mm (0.75 in) long. Source assemblies consist of the sealed source capsule swaged onto a flexible cable to which is also swaged two locking balls and a source cable connector. See appendix 1.3 for a general arrangement drawing showing the source assembly.

1.2.2 Operational Features

Features for Securing the Source in the Device:
The source assembly is held in the secured position by the following features:

Automatic securing mechanism housing design:

The locking ball is larger than the hole at the lock end of the automatic securing mechanism housing. This prevents the source assembly from being pulled out of the device toward the lock end even when the source assembly and device locks are not engaged.

The source assembly is automatically secured by the automatic securing mechanism when it is retracted to the fully shielded position inside the device. This prevents movement of the source assembly toward the outlet end unless the release plunger is in the depressed and latched position.

Source Assembly Lock:

The source assembly is locked in the secured position by the manually operated source assembly lock which prohibits movement of the source assembly in both directions when engaged.

Safety Plug and Lock Cap:

During transportation and storage, the lock cap and safety plug provide additional means to prohibit movement of the source assembly in either direction in the event of an accident.

Transport Lock:

The package is fitted with a transport lock that must be engaged during transport and storage. The transport lock provides another securing method for the source assembly preventing movement in either direction during transport and storage. The design of the source model and transport lock is such that even in a catastrophic accident condition that would be severe enough to cause the lock box to be completely separated from the device, the transport lock would still retain the source assembly in the fully shielded position. The locking ball that engages the transport lock has a higher pull-off strength than the connector at the end of the source assembly. If the lock box were to be separated from the package, the connector at the end of the source assembly would be pulled off, but the source assembly would be retained in the fully shielded position.

1.2.3 Contents of Packaging

The sealed source assembly capsule meets the requirements of special form radioactive material stated in 10 CFR 71.75.

1 mm (0.039 in) diameter by 1 mm (0.039 in) long Cobalt-60 solid cylinders are encapsulated in a welded CRES cylindrical inner capsule measuring approximately 6.4 mm (0.25 in) diameter by 6.4 mm (0.25 in) long. This capsule is encapsulated in a welded CRES outer capsule measuring approximately 10 mm (0.38 in) diameter by 19 mm (0.75 in) long. The outer capsule is crimped onto a flexible CRES cable approximately 279 mm (11 in) long.

The density of Cobalt-60 is approximately 9 gm/cm^3 (0.32 lb/in^3). The weight of the Cobalt-60 contents is negligible.

Cobalt-60 is not a fissile material, therefore moderator ratios and criticality configurations are not applicable.

The heat of decay for a maximum of 11.1 TBq (300 Ci) of Cobalt-60 is negligible and the Cobalt-60 pellets do not produce gases. Forces resulting from pressure buildup are insignificant.

Appendix 1.3

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REVISIONS

REV	DESCRIPTION	DATE	APPROVED

NOTES:

1. MAXIMUM WEIGHT: 780 LBS
2. PACKAGE IS FILLED WITH POLYURETHANE FOAM WITH A MINIMUM DENSITY OF 13 LB/CU. FT
3. OVERALL DIMENSIONS OF PACKAGE: 14" X 12.65" X 26" NOMINAL.

△4 SPEC-300 NAMEPLATE LOCATED ON BACK SIDE.

△5 CAUTION PLACARD IS PLACED ON BOTH SIDES

QTY REQD -3	QTY REQD -1	UM	MANUF	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO.
1	1	EA	OPT	190500-1	SOURCE ASSEMBLY	N/A	26
1	1	EA	OPT	190757-1	SAFETY PLUG	N/A	25
1	1	EA	OPT	190772-1	SOURCE TAG	N/A	24
1	1	EA	OPT	150009-1	WARNING PLATE	N/A	23
1	1	EA	OPT	190737-1	NAMEPLATE	N/A	22
2	2	EA	OPT	150006-1	CAUTION PLACARD	N/A	21
1	1	EA	OPT	190725-1	TRANSPORT LOCK	N/A	19
1	1	EA	OPT	150916-1	LOCK CAP	N/A	18
1	1	EA	OPT	190705-1	ENCLOSURE BASE	N/A	17
2	2	EA	OPT	190741-1	EUTECTIC BARRIER KIT	N/A	16
1	1	EA	OPT	190703-1	OUTLET BULKHEAD	N/A	15
2	2	EA	OPT	190706-1	EYE MOUNTING BLOCK	N/A	14
1	1	EA	OPT	190719-1	INLET BASE PLATE ASSY	N/A	13
1	1	EA	OPT	150007-1	LM-200	N/A	12
1	1	EA	OPT	190640-1	LOCK BOX ASSY	N/A	11
1	1	EA	OPT	190702-1	INLET BULKHEAD	N/A	10
4	4	EA	OPT	190742-L	STRUCTURAL POST	N/A	9
1	1	EA	OPT	190769-1	BOTTOM COPPER PAD	N/A	8
2	2	EA	OPT	190746-1	SHIELD SUPPROT ASSY	N/A	7
1		EA	OPT	190769-1	1/2 OUTLET PANEL ASSY	N/A	6
	1	EA	OPT	190734-1	3/8 OUTLET PANEL ASSY	N/A	5
4	4	EA	OPT	190712-1	LIFTING DOUBLER	N/A	4
1	1	EA	OPT	190701-1	ENCLOSURE COVER	N/A	3
2	2	EA	OPT	190747-1	LIFTING EYE	N/A	2
1	1	EA	OPT	190700-1	DU SHIELD	N/A	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE N/A

DO NOT SCALE DRAWING

TREATMENT NONE

FINISH NONE

APPROVALS		DATE
DRAWN	RAM	8/22/99
CHECKED	FW	6/28/99
APPROVED	[illegible]	6/28/99
QA CLASS	Q-B	

SOURCE PRODUCTION & EQUIPMENT CO., INC.
113 TEAL ST. ST ROSE, LA 70087

GENERAL ARRANGEMENT, SPEC-300 EXPOSURE DEVICE

SIZE C | DWG NO. 19B000 | REV 0

SCALE: 1/2 | 00085200 | SHEET 1 OF 3

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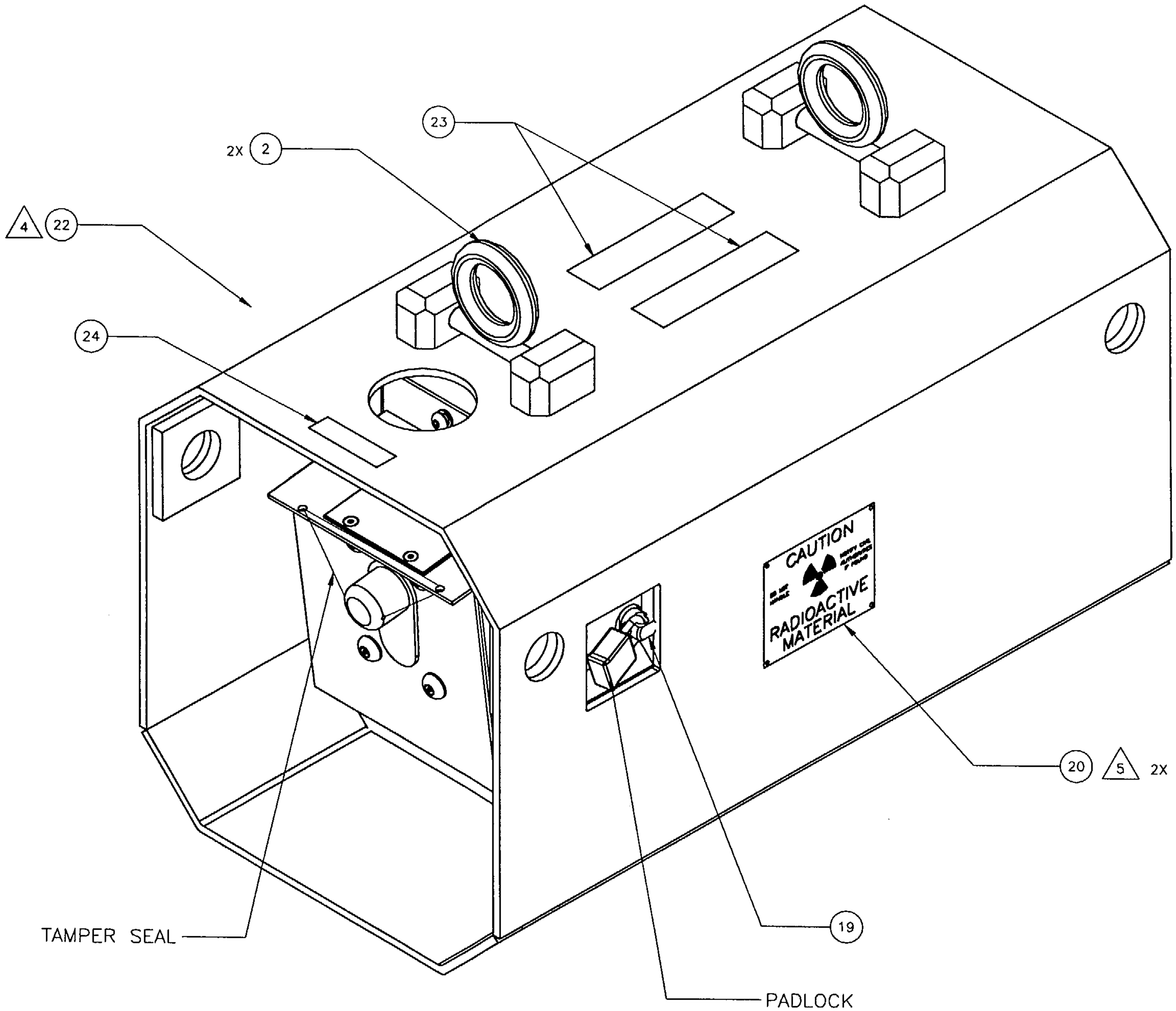
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL ST. ST ROSE LA 70087	SIZE C	DWG NO 19B000	REV 0
APPROVED 6/28/99	SCALE: 1/2	00085200	SHEET 2 OF 3

FIGURE WITHHELD UNDER 10 CFR 2.390

SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL ST. ST ROSE LA 70087	SIZE C	DWG NO 19B000		REV 0
APPROVED 6/28/99	SCALE: 1/2	00085200	SHEET 3 OF 3	

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE .XX±.50			SOURCE PRODUCTION & EQUIPMENT CO., INC. 113 TEAL ST, ST ROSE, LA 70087
	APPROVALS	DATE	DU SHIELD- CO-60, SPEC-300 EXPOSURE DEVICE
DO NOT SCALE DRAWING	DRAWN RAM	9/2/98	
TREATMENT NONE	CHECKED PW	9/23/98	SIZE C
	ISSUED RDD	9/24/98	DWG NO. B190700
FINISH NONE			REV 1
	QA CLASS Q-A		SCALE: 1/2 / M 00058101 / SHEET 1 OF 1

2. STRUCTURAL EVALUATION

2.1 Structural Design

2.1.1 Discussion

The principal structural elements of the SPEC-300 consist of the depleted Uranium shield, shield supports, lock end and outlet end bulkheads, structural posts, and the enclosure.

The depleted Uranium shield is a single solid casting surrounding a small Titanium, Titanium alloy, or zircalloy S-shaped tube. The spherical primary shape of the shield is extraordinarily strong and tough. A SPEC depleted Uranium shield has never been damaged as a result of normal conditions or hypothetical accident conditions testing. The thick "ears" cast into the shield transfer the reaction forces from the shield to the shield supports welded onto the lock-end and outlet-end bulkheads. During hypothetical accident condition testing, the first drop was made at -40° C (-40° F) since depleted Uranium exhibits a ductile-brittle transition at a temperature of about 0° C (32° F). Shielding efficiency was unaffected after the drop.

The shield supports are solid 300 series CRES, continuously welded to the lock-end and outlet-end bulkheads. These welds are sized to maximize joint strength, typically equaling the thickness of the thinnest member joined. Copper eutectic barrier strips prevent the shield from contacting the shield supports. A two-component chocking compound fills the gap between the shield supports and the shield "ears".

The lock end and outlet end bulkheads transmit the reaction forces from the shield supports to the package enclosure. The bulkheads are 7.9 mm (0.31 in) thick CRES, and are continuously welded around the perimeter to the package enclosure cover and base. Welds typically equal the thickness of the thinnest member joined.

The structural posts, made of CRES pipe, connect the lock-end and outlet-end bulkheads and are continuously welded to both. During a significant impact to the lock-end or outlet-end of the package, the structural posts transfer a portion of the shock load from the loaded bulkhead (the one the shield is reacting against) to the unloaded bulkhead at the other end of the package. This effect was demonstrated during hypothetical accident condition testing. The structural posts are also used to attach the shield hot top support ring and on the opposite side of the shield, the dome top support. Reaction forces from these supports are transmitted through the structural posts to the lock-end and outlet-end bulkheads.

The outer enclosure consists of the enclosure base and enclosure cover. These parts are made from 6.4 mm (0.25 in) thick CRES and are continuously welded at the two joining seams. The joint design allows for a full penetration weld, including a backing bar. The lock-end and outlet-end bulkheads are continuously welded to the enclosure base and cover. The result is a monolithic shell that, if not for miscellaneous small penetrations, would act as a pressure vessel. The lock-end and outlet-end bulkheads are recessed, creating a protective flange. Hypothetical accident condition testing proved this protective flange highly effective; the lock box and automatic securing mechanism/lock module were undamaged after four nine meter (30 foot) drops.

2.1.2 Design Criteria

See Appendix 2.10 for the SPEC-300 design criteria matrix.

2.2 Weights and Centers of Gravity

The SPEC-300 weighs a maximum of 354 kg (780 lb). The center of gravity is approximately the geometric center of the package. There are no major subassemblies of any significant weight relative to the total weight of the package.

2.3 Mechanical Properties of Materials

2.3.1 Materials List

300 series CRES:
Yield stress: 268895 kPa (39,000 psi)
Ultimate stress: 599843 kPa (87,000 psi)
Modulus of elasticity: $1.931*10^8$ kPa (28,000,000 psi)
Ultimate strain: 65%
Poisson's ratio: 0.29
Density: 8.03 g/cm^3 (0.290 lb/in^3)
Coefficient of thermal expansion: $1.8*10^{-5}$ m/m*degree C ($9.9*10^{-6}$ in/in*degree F)

Depleted Uranium:
Yield stress: 193053 kPa (28,000 psi)
Ultimate stress: 386106 kPa (56,000 psi)
Modulus of elasticity: 1.655 10^8 kPa (24,000,000 psi)
Ultimate strain: 4%
Poisson's ratio: 0.21
Density: 18.97 g/cm^3 (0.685 lb/in^3)
Coefficient of thermal expansion: $1.1*10^{-5}$ m/m*degree C ($6*10^{-6}$ in/in*degree F)

Data taken from Mark's Standard Handbook for Mechanical Engineers 10th edition.

Two-component chocking compound:
Compressive strength: 1336 kg/cm^2 (19,000 psi)

2.4 General Standards for All Packages

The SPEC-300 meets the general standards for all packages in accordance with the provisions of 10 CFR Sections 71.43, 71.45 and 71.47 as demonstrated below:

2.4.1 Chemical and Galvanic Reactions

300 series CRES contacts Titanium in the automatic securing mechanism/lock module of the SPEC-300. Galvanic reaction is not expected since these two metals are relatively close on the electromotive scale and both are cathodic. Other packages produced by SPEC with this

material combination have not demonstrated galvanic reaction.

The depleted Uranium shield is prevented from contacting 300 series CRES by the use of Copper pads. These pads also act as a barrier to possible eutectic alloying at elevated temperatures. The shield is subject to corrosion when exposed to moisture. It is protected in the SPEC-300 by a coat of paint and by the closed-cell polyurethane foam completely surrounding it. This protection method has been used on other SPEC designs and has proven adequate, even in offshore applications. A SPEC-150 package was accidentally dropped into the Gulf of Mexico and was recently recovered after being submerged in seawater for several weeks. The package was cleaned, inspected, and returned to service showing no evidence of chemical or galvanic reaction.

2.4.2 Positive Closure

For the purpose of this discussion, "opened" will be defined as release of radioactive material from the source assembly capsule. The primary containment system preventing the direct release of radioactive material from the package is the special form sealed source capsule which can only be opened destructively.

Regarding release of the radioactive source assembly from the package; when configured for transport the SPEC-300 cannot be inadvertently opened. The transport lock is positioned in the locked position and secured by a commercially available padlock. Even if this lock was defeated, a specific sequence of operations must be performed before the source can be removed from the shielded position. Since the equipment required to accomplish this is not readily available to unauthorized persons, and since untrained persons would not know how to use it, inadvertent release of the source assembly from the SPEC-300 is unlikely.

2.4.3 Lifting Devices

See Appendix 2.10 for design criteria and regulatory requirements of lifting devices.
See Appendix 2.10 for a general arrangement drawing of the SPEC-300 showing lifting devices.
See Appendix 2.10 for design Verification for Fillet Weld Size Calculations. This includes design calculations for the strength of lifting devices.

In summary, the lifting eyes and tie-down holes (since it is conceivable that the tie-down points could be used as lifting points) are rated to carry 25 times the weight of the package.

2.4.4 Tiedown devices

See Appendix 2.10 for design criteria and regulatory requirements of tie-down devices.
See Appendix 2.10 for a general arrangement drawing of the SPEC-300 showing tie-down devices.
See Appendix 2.10 for Design Verification for Fillet Weld Size Calculations. This includes design calculations for the strength of tie-down devices.

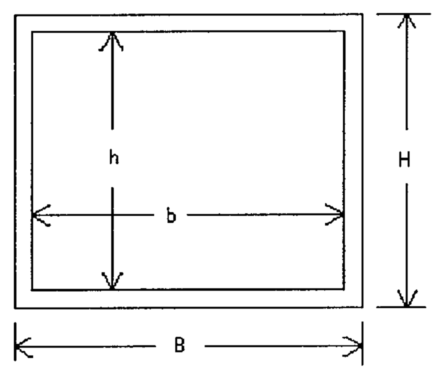
In summary, the tie-down holes and lifting eyes (since it is conceivable that the lifting eyes

could be used as tie-down points) are rated to carry 25 times the weight of the package.

2.5 Standards for Type B Packaging

2.5.1 Load Resistance

A load resistance test was not performed on the SPEC-300. The following analysis considers the package as a simply supported hollow rectangular beam with uniform loading. The package is loaded in the weakest axis, although since the cross section is nearly square, the difference is not great. The regulation requires a compressive force of 5 times the package weight or 1769 kg (3900 lb) to be uniformly distributed across the top of the package. The SPEC-300 consists of a (0.25 in) thick CRES housing with (0.31 in) thick CRES bulkheads. The housing is joined to the bulkheads by continuous (0.25 in) fillet welds. This configuration does not have the potential for failure under the load specified, as proven below:



Cross-sectional view of the SPEC-300 enclosure
Orientation is worst-case, i.e. H < B

$$R_a = R_b = 1/2wL$$

$$w = \text{distributed load} = 26269.025\,N/m$$

$$L = \text{length of distributed load} = .6604\,m$$

$$R_a = R_b = 1/2(26269.025)(.6604)$$

$$R_a = R_b = 8674.032\,N$$

$$MaximumMoment = Ma = Rb(L)$$

$$Ma = 5728.33N*m$$

Moment of Inertia for Rectangular Tube = $I = \frac{BH^3 - bh^3}{12}$

$B = .321m$

$b = .315m$

$H = .3556m$

$h = .349m$

$I = .000087m^4$

$$\sigma = \frac{M_a c}{I}$$

where σ = axial stress (Pa)

where c = distance to the neutral axis =.178m

$$\sigma = \frac{(5728.33)(.178)}{.000087}$$

$\sigma = 11720033.195Pa$ $(1699.78psi)$

This stress level is significantly below the material yield strength.

2.5.2 External Pressure

An external pressure test was not performed on the SPEC-300 containment vessel. The SPEC-300 containment vessel is the special form capsule. This capsule consists of a cylindrical welded 300 series CRES capsule with a minimum wall thickness of 0.8 mm (0.030 in). The capsule must resist a 172 kPa (25 lb/in^2) external pressure. For this exercise, the capsule is considered to be a thick walled vessel under uniform external loading.

Maximum circumferential stress is calculated as:

$$MaxCircumferentialStress = \frac{-Pressure * 2 * OutsideDiameter^2}{OutsideDiameter^2 - InsideDiameter^2}$$

$$MaxCircumferentialStress = \frac{-172000Pa * 2 * .010^2 M^2}{0.010^2 M^2 - 0.008^2 M^2}$$

$$MaximumCircumferentialStress = -956KPa(-138lb/inch^2)$$

Maximum radial stress is calculated as:

$$MaxRadialStress = -pressure$$

$$MaximumRadialStress = -172KPa(-25lb/inch^2)$$

These stress levels are negligible.

Equations taken from Roark's Formulas for Stress and Strain, 6th edition, page 638, table 32.

2.6 Normal Conditions of Transport

The SPEC-300, when subjected to the normal conditions of transport specified in Appendix A to 10 CFR part 71, meets the standards specified in paragraph 71.35 of 10 CFR part 71, as demonstrated in the following paragraphs.

2.6.1 Heat

The thermal evaluation for the heat test is reported in section 3.4.

2.6.1.1 Summary of Pressures and Temperatures.

Approximate temperature at which the package was constructed: 27°C (80°F)
Minimum operating temperature: -40 deg.C (-40 deg.F)
Maximum operating temperature: +54 deg.C (+130 deg.F)
Minimum operating pressure: 1/2 atmospheric pressure, 51 kPa (absolute) (7.3 psia)
Maximum operating pressure: 25 psig

2.6.1.2 Differential Thermal Expansion.

The SPEC-300 enclosure is made of 300 series CRES. The shield is made of depleted Uranium. The coefficient of thermal expansion of these two materials differs slightly. The only possible significant result of this is a binding condition at low temperature if the enclosure shrinks more than the shield. This is calculated below. The shield is 350mm (13.875 in) long. The thermal expansion coefficients in the equations below are for 300 series CRES and for depleted Uranium, respectively.

$$\Delta ThermalExpansion = Length * \Delta Temperature * \Delta CoefficientOfThermalExpansion$$

$$\Delta ThermExp = 350mm * (27°C-(-40°C)) * (1.8*10\text{-}5mm/mm*°C)-(1.1*10\text{-}5m/m*°C)$$

$$\Delta ThermExp = -0.16mm(-0.006inch)$$

This differential thermal expansion is negligible.

2.6.1.3 Stress Calculations.

During normal conditions, the only significant stress is bearing stress of the depleted Uranium shield resting on the two shield supports welded to the lock-end and outlet-end bulkheads. The interface between the shield and the shield support is filled with a two-component chocking compound, a material intended for this purpose. Contact area for each of the two supports is approximately 6.5 cm^2 (1 in^2) for a total contact area of approximately 13 cm^2 (2 in^2) . The two-component chocking compound has a compressive strength of 1336 kg/cm^2 (19,000 psi). Bearing stress can then be calculated as:

$$BearingStress = \frac{238kg}{13cm^2}$$

$$BearingStress = \frac{BearingLoad}{BearingArea}$$

$$BearingStress = 18\frac{kg}{cm^2} \qquad (263\frac{lb}{inch^2})$$

2.6.1.4 Comparison with allowable stresses.

The bearing stress is orders of magnitude below the compressive strength of the material it rests on. This analysis was based on the worst case orientation of the SPEC-300; that is, the orientation where the weight of the shield bears on the smallest area. This happens to be the normal orientation of the package, with the lifting rings at the top.

2.6.2 Cold

The test at an ambient temperature of -40° C (-40° F) in still air and isolation was not performed because the materials and methods of construction would not be adversely affected in a manner that would cause a loss or dispersal of the radioactive contents or a loss of shielding integrity. A greater than 20% increase in the radiation level at any external surface of the package would not be expected. Incidentally, as part of the preparation for the first hypothetical accident condition 9 m (30 ft) free drop test, the SPEC-300 was chilled in dry ice to a temperature below -40° C (-40° F). No adverse effect resulted either before or after the free drop test.

The effects of cold were considered during the design of the SPEC-300. The 300 series CRES chosen for the package enclosure is a face centered cubic metal. Metals of this type are preferred for cryogenic equipment because they do not exhibit a ductile to brittle transition at low temperatures. In general, the mechanical properties of these materials improve with lower temperatures:

1. Young's modulus at 22°K (-420° F) is 5% to 20% greater than at 294° K (69.5° F).

2. Yield strength at 22°K (-420° F) is considerably greater than at 294° K (69.5° F).

3. Fatigue properties at low temperatures are also improved.

This information was taken from Mark's Mark's Standard Handbook for Mechanical Engineers 10th edition, Page 19-32, 33.

The depleted Uranium shield does exhibit a ductile to brittle transition at approximately 0° C (32°F). For this reason the SPEC-300 was chilled in dry ice to a core temperature below -40° C (-40° F) prior to and during the first 9 m (30 ft) free drop test. A radiation survey performed after this test showed no measurable increase in radiation levels, indicating no significant damage to the shield. Incidentally, three additional 9 m (30 ft) free drop tests were

subsequently performed. Had fracture or other damage related to the ductile to brittle transition occurred during the first free drop, it is likely the remaining three free drop tests would have caused some increase in post-test radiation levels. This did not occur.

Information relating to the ductile to brittle transition temperature of depleted Uranium was taken from Physical Metallurgy of Uranium Alloys, Proceedings of the Third Army Materials Technology Conference, Held at Vail, Colorado, February 12-14, 1974. Sponsored by Army Materials and Mechanics Research Center, Watertown, Massachusetts. Pages 315-317.

Effect of freezing liquids:
Not applicable. There are no liquids present in the SPEC-300 under normal conditions.

2.6.3 Pressure

Not applicable. The enclosure of the SPEC-300 is vented to the atmosphere. A pressure equal to 0.5 standard atmospheric pressure would not create a pressure differential anywhere in the package with the exception of the sealed source capsule on the source assembly. Paragraph 2.5.2 of this application demonstrates the ability of the sealed source capsule to withstand 172 kPa (25 lb/in^2) external pressure. This is equivalent to 1.7 atmospheres above normal atmospheric pressure. Since stresses resulting from negative (external) pressure are calculated with the identical equations to those used for positive pressure(internal) pressure, only reversing the sign for pressure, the equations given in paragraph 2.5.2 of this application demonstrate that the sealed source capsule will withstand the forces produced by this condition.

2.6.4 Vibration

The effect of vibration on the package and materials of constructions incident to normal transportation is negligible. Many similar SPEC packages have been transported over a period of 20 years via all common modes of private and common transportation on water, highway and air without vibration-induced damage. The SPEC-300 enclosure is stiff and rigid. It's natural frequency is estimated to be above 500 Hz. The package is also damped by the high density polyurethane foam filling the cavity between the shield and the enclosure. Vibration incident to normal transportation will not reduce the effectiveness of the packaging.

2.6.5 Water Spray

A water spray test was not conducted on the SPEC-300. The enclosure, lock box, transport lock, and automatic securing mechanism/lock module are all made of corrosion resisting materials. The depleted Uranium shield is protected by the enclosure, by the polyurethane foam surrounding it, and by a layer of paint. No materials of construction in the SPEC-300 would be affected by water spray.

2.6.6 Free Drop

A SPEC-300 prototype package was dropped from a distance of 4 feet onto an essentially unyielding surface. SPEC's on-site drop target exceeds the requirements outlined in IAEA Safety Series No. 37 "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material" (1985 Edition as amended 1990), which recommends a steel plate as the upper surface of a concrete block. It specifies that the combined mass of the steel and

concrete should be at least 10 times that of the specimen to be dropped; that the block should be set on firm soil; that the steel plate should be at least 4.0 cm (1.6 in) thick and floated onto the concrete while it is still wet; and that the plate should have protruding steel structures on its lower surface to ensure tight contact with the concrete. SPEC's drop target consists of a solid steel plate measuring 77 cm x 90 cm x 4.4 cm thick (30.25 in x 35.25 in x 1.8 in thick) weighing 239 kg (528 lb). The thickness of the steel plate meets the minimum 4.0 cm (1.6 in) IAEA requirement. The steel plate was wet floated onto the top surface of a flat horizontal concrete block weighing approximately 4491 kg (9,900 pounds). No damage or separation of the steel plate from the concrete block occurred as a result of any test. The total weight of the drop target is over 4763 kg (10,500 lb) which exceeds ten times the mass of the 354 kg (780 lb) package. The concrete block is metal reinforced and rests in firm soil. A 12 meter (40 ft) tall structure was erected over the drop target and used to raise and release the test package over the top surface of the target. See Appendix 2.10 for a drawing of the drop target.

The point of impact for the SPEC 300 was flat on the lock end flange. See Appendix 2.10 for a justification of the impact point and for a photos of the test (photos #1 through #7). There was no effect on the operation or the shielding capability of the package. The four foot free drop did not result in loss of radioactive contents from the package, increased radiation levels or reduction in the effectivuness of the package.

2.6.7 Corner Drop

Not applicable. The package is not constructed of wood or fiberboard.

2.6.8 Penetration

A SPEC-300 prototype was subjected to the impact of a 1-1/4 inches diameter steel cylinder weighing 13 lbs falling a distance of 40 inches. The point of impact was directly on the safety plug which is located at the outlet end of the package. See Appendix 2.10 for a justification of the impact point and for photos of the test (photos #8 through #13). The safety plug is the weakest structural point on the package that would also cause the most significant increase in radiation level if it were to break off. IAEA Safety Series No. 6 Regulations for the Safety Transport of Radioactive Material 1985 Edition (As Amended 1990) states in Paragraph 537(b) that the normal condition of transport test should not result in more than a 20% increase in surface radiation levels. The impact caused the outlet nipple on the outlet end panel to bend downward. The safety plug and outlet nipple remained intact. There was no increase in radiation levels. The penetration test did not result in loss of radioactive contents from the package, increase radiation levels, or reduce the effectiveness of the SPEC-300 package.

A second penetration test was performed on the lock end cap. The impact caused only minor damage to the lock end cap. There was no increase in radiation levels. The penetration test did not result in loss of radioactive contents from the package, increase radiation levels, or reduce the effectiveness of the SPEC-300 package.

2.6.9 Compression

This test was not performed on the SPEC-300. The regulation requires a compressive force

of 1769 kg (3900 lb) to be uniformly distributed across the top of the package. The SPEC-300 is constructed of 6 mm (.25 in) CRES with 8 mm (.31 in) thick bulkheads. The enclosure and bulkheads are continuously joined with 6 mm (0.25 in) fillet welds. This configuration would not be affected by the compression load specified. In addition, paragraph 2.5.1 of this application describes a load resistance analysis where an identical load is concentrated at the ends of the package. Calculated stresses are well within limits.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

The technique used to assess the SPEC-300 was prototype testing. The SPEC-300 prototype was subjected to four successive free drops from a height of 9 meters (30 feet) onto the drop test target described in paragraph 2.6.6 of this application. A 0.55 tBq (14.9 Ci) source was loaded in the package during testing. Although not required under the test criteria, multiple drops were made with the same prototype package to thoroughly demonstrate the durability of the package and to address any questions concerning the proper selection of the impact point and orientation for which maximum damage is expected. See Appendix 2.10 for a justification of the impact points and for photos of the test, as noted below.

1st 9 Meter Drop Test

The point of impact for this test was flat on the dome top side of the package (when looking at the lock-end of the package, this would be the left side). The package was suspended from the opposite side and adjusted to ensure a flat impact. See appendix 2.10, photos #14 through #16.

1st drop damage assessment: The shield shifted slightly toward the dome top, warping the lock-end bulkhead approximately 6 mm (0.25 in). One outlet panel screw was slightly bent. The shackle on the padlock securing the transport lock was pulled through the hole in the side of the package, opening the lock. The transport lock remained engaged on the source assembly. Some paint was transferred from the drop test target to the housing. There was no measurable increase in radiation levels at 1 meter. All weld joints remained intact. See appendix 2.10, photos #17 through #20. Photo #21 depicts the package core temperature, -53.7° C (-47.6° F).

2nd 9 Meter Drop Test

The point of impact for this test was flat on the outlet end. The package was suspended from the lock end and adjusted to ensure a flat impact. See appendix 2.10, photos #22 and #23.

2nd drop damage assessment

The flange around the package was bent slightly inward, except for the left side which was bent outward. The shield pushed the outlet-end bulkhead slightly outward, approximately 6 mm (0.25 in) at the highest point. There was no measurable increase in radiation levels at 1 meter. All weld joints remained intact. See appendix 2.10, photos #24 through #28.

3rd 9 Meter Drop Test

The point of impact for this test was flat on the lock end. The package was suspended from the outlet-end and adjusted to ensure a flat impact. See appendix 2.10, photos #29 through #31.

3rd drop damage assessment

The lock-end bulkhead was pushed out approximately 12 mm (0.5 in). This caused the lock box flange to bend outward slightly. The reaction from the automatic securing mechanism/lock module pushed the lock box slightly outward. The transport lock jammed in the locked position. The outlet nipple broke off of the outlet end of the package (opposite end from the impact). The radiation level at the outlet end at the broken-off outlet nipple increased to 1.2 mSv/hr (120 mR/hr). When extrapolated to 11.1 tBq (300 Ci), this equates to 24.2 mSv/hr (2.4 r/hr). At 1 meter, the radiation level increased to .03 mSv/hr (2.8 mR/hr). When extrapolated to 11.1 tBq (300 Ci), this equates to 0.57 mSv/hr (57 mR/hr). The outlet-end bulkhead returned almost to its original position. All weld joints remained intact. See appendix 2.10, photos #32 through #36.

Note that the outlet nipple was bent by the normal conditions penetration test (see paragraph 2.6.8). It is unlikely that the outlet nipple would have broken off if it had not been already damaged.

4th 9 Meter Drop Test

The point of impact for this test was on the edge formed by the top of the package and the lock-end. The package was suspended from the opposite corner and adjusted to ensure that the center of gravity was above the impact point. See appendix 2.10, photos #37 through #39.

4th drop damage assessment

The edge of the package striking the drop target was significantly deformed, almost to the point where the lock box would contact the drop target. The side flanges bent inward and the top corners bent outward. The welds securing the doubler plates to the tie-down holes cracked. All other weld joints remained intact. There was no measurable increase in radiation levels at 1 meter. See appendix 2.10, photos #40 through 42.

Performance Requirements

10 CFR 71.51 (a) (2) specifies that as a result of testing, the radiation dose rate will not exceed one REM/hr at one meter from the external surface of the package. The four damage assessments above confirm that the SPEC-300 meets this requirement.

2.7.2 Puncture

Following the 9 meter (30 ft) free drop tests, the SPEC-300 prototype was dropped from a distance of 1 meter (40 inches) onto the center of a 15 cm (6 in) diameter by 36 cm (14 in) high steel cylindrical bar. The bar was bolted to the drop test target described in paragraph 2.6.6 of this application. The same 0.55 tBq (14.9 Ci) sealed source installed in the SPEC-300 for the series of drop tests remained in the package for the puncture test. The point of impact was on the lock cap. The SPEC-300 was suspended from the outlet end and oriented with the long axis of the package vertical. See Appendix 2.10 for a justification of the impact

point and photos #43 through #46 for the test setup, as noted below.

Damage assessment

The lock cap was scratched and bent. The release plunger on the automatic securing mechanism/lock module was stuck in the up (auto-securing) position. There was no other effect on the overall package. There was no measurable increase in radiation levels at 1 meter. See appendix 2.10, photos #47 and #49.

Performance Requirements

10 CFR 71.51 (a) (2) specifies that as a result of testing, the radiation dose rate will not exceed one REM/hr at one meter from the external surface of the package. The damage assessments above confirm that the SPEC-300 meets this requirement.

2.7.3 Thermal

See section 3.5 for the thermal analysis.

2.7.3.1 Summary of Pressures and Temperatures.

Pressure: Not applicable. The SPEC-300 is vented to the atmosphere. Pressure buildup inside the package will not occur due to increased ambient temperature.
Temperature: 800°C (1475° F)

2.7.3.2 Differential Thermal Expansion.

The coefficient of linear thermal expansion of the 300 series CRES enclosure is greater than that of the depleted Uranium shield. For this reason, no binding condition would exist between the enclosure and the shield at elevated temperature.

2.7.3.3 Stress Calculations.

Not applicable. See paragraph 2.7.3.2 above.

2.7.3.4 Comparison with allowable stresses.

Not applicable. See paragraph 2.7.3.2 above.

2.7.4 Water immersion.

Not applicable. The SPEC-300 is not a fissile package.

2.7.5 Summary of Damage

Damage as a result of hypothetical accident condition testing was remarkably minor. The transport lock moved as a result of one of the 9m (30 ft) free drop tests, but remained engaged. The ends of the enclosure buckled as a result of the cumulative damage of the 4 9m (30 ft) free drop tests. The depleted Uranium shield also shifted slightly and the safety plug on the outlet nipple came adrift when the outlet nipple broke off. The puncture test caused the release plunger on the automatic securing mechanism/lock module to stick. None of this damage defeated the redundant safety systems of the SPEC-300. The source always remained secured in the package. Radiation levels remained well below the requirement.

2.8 Special Form

The sealed source assembly used and transported in the SPEC-300 is special form. The material meets special form requirements given in 10 CFR paragraph 71.4 (o) when subjected to the applicable test conditions of Appendix D to 10 CFR Part 71, as demonstrated in the following paragraphs.

2.8.1 Description

The sealed source assembly used in the SPEC-300 meets the requirements of special form radioactive material as demonstrated by IAEA Certificate of Competent Authority No. USA/0095/S. Cobalt-60 pellets in the form of 1 mm (0.039 in) diameter x 1 mm (0.039 in) long cylinders are encapsulated in a welded CRES cylindrical inner capsule measuring approximately 6.4 mm (0.25 in) diameter by 6.4 mm (0.25 in) long. This capsule is encapsulated in a welded CRES outer capsule measuring approximately 10 mm (0.38 in) diameter by 19 mm (0.75 in) long. The outer capsule is crimped onto a flexible CRES cable approximately 279 mm (11 in) long.

2.8.2 Free Drop

Since the sealed source assembly is very light and ruggedly constructed it is apparent that effects of its impact onto a flat, horizontal, essentially unyielding surface would be negligible.

2.8.3 Percussion

The design and yield strength will permit the capsule to withstand impacts much greater than that which would be incurred from the specified three pound steel billet falling from a height of one meter onto the capsule while it rests on a lead sheet, maximum 25 mm thick, which is supported on a flat, smooth, essentially unyielding surface.

2.8.4 Bending

This test is not applicable since the sealed source capsule is less than 10 cm long.

2.8.5 Heating

The capsule and the Cobalt-60 wafers will withstand sustained temperatures greater than 800° C (1475° F) for ten minutes without adverse effects.

2.8.6 Summary

As a result of previously performed evaluations resulting in the issuance of IAEA Certificate of Competent Authority No. USA/0095/S and on the basis of the above summary assessment the primary containment vessel in the SPEC-300 package, the sealed source capsule meets or exceeds the requirements for special form radioactive material as specified in 10 CFR 71.4(o).

2.9 Fuel Rods

Not applicable. The SPEC-300 does not use fuel rods.

Appendix 2.10

Design Criteria For Part 71 Application Approval Form

Project: SPEC-300 EXPOSURE DEVICE

June 24, 1999

Revision Number: 0

Approved:	Donny Dicharry	**Title**	President	**Date**	6/24/99
Approved:	Pete Weber	**Title**	General Manager	**Date**	6.24.99
Approved:	Kelley Richardt	**Title**	QA Manager	**Date**	6/24/99
Approved:	Richie Melancon	**Title**	Engineering Manager	**Date**	6/24/99
Approved:	Kenny Carrignton	**Title**	Special Projects Mgr.	**Date**	6/24/99

Source Production & Equipment Company
St. Rose, Louisiana

Design Criteria for SPEC-300 Exposure Device

Date: 6/24/99
REV 0

CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
Requirements for Overall Dimensions	1	10 CFR PART 71 SUBPART E SECTION 71.43a	The smallest overall dimension of a package may not be less than 10 cm (4 in).	Overall dimensions are 14 x 14.15 x 26 inches	
Requirements Seals on Type B Packages	2	10 CFR PART 71 SUBPART E SECTION 71.43b	The outside of a package must incorporate a feature, such as a seal, that is not readily breakable and that, while intact, would be evidence that the package has not been opened by unauthorized persons.	Seal through lock cap	Not readily breakable: Requires intentional effort to remove the seal.
	3	10 CFR PART 71 SUBPART E SECTION 71.43c	Each package must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package.	Welded special form capsule.	
Requirements for Materials in Type B Packages	4	10 CFR PART 71 SUBPART E SECTION 71.43d	A package must be made of materials and construction that assure that there will be no significant chemical, galvanic, or other reaction among the packaging components, among packaging contents, including possible reaction resulting from inleakage of water, to the maximum credible extent. Account must be taken of the behavior of materials under irradiation.	Eutectic Barrier Camera Fill	This requirement will be met by suppling a eutectic barrier between the depleted uranium and the stainless steel case. This barrier will not allow for the depleted uranium to come in contact with the stainless steel, therefore, there should not be a galvanic, chemical or other type of reaction between the two dissimilar materials.

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
					Account must be taken: The design must ensure that the materials used in the device will not be adversely affected by radiation.
Requirements for Radiation Levels in Shipping Packages	5	10 CFR PART 71 SUBPART E SECTION 71.43f	A package must be designed, constructed, and prepared for shipment so that under the test specified in Sec. 71.71 ("Normal Conditions of Transport") there would be no loss or dispersal of radioactive contents, no significant increase in radiation levels, and no substantial reduction in the effectiveness of the packaging.	Tested	Significant increase is defined as 20%. Substantial Reduction: maximum increase of 20%.
	6	10 CFR PART 71 SUBPART E SECTION 71.47a	Each package of radioactive materials offered for transportation must be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 2 mSv/hr (200 mrem/h) at any point on the external surface of the package, and the transport index does not exceed 10.	Tested	Transport index will not exceed five, as per ANSI N432. (5 mr/hr @ 1meter)
Temperature Requirements for Shipping Type B	7	10 CFR PART 71 SUBPART E SECTION 71.43g	A package must be designed, constructed, and prepared for transport so that in still air at 38 deg C (100 deg F) and in the shade, no accessible surface of a package would have	Engineering Analysis	

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
Packages			a temperature exceeding 50 deg. C (122 deg. F) in a nonexclusive use shipment, or 85 deg. C (185 deg. F) in an exclusive use shipment.		
Requirements for Venting during Shipment of Type B Packages	8	10 CFR PART 71 SUBPART E SECTION 71.43h	A package may not incorporate a feature intended to allow continuous venting during transport.	Not Applicable	Donny has consulted with Dr. Parker.
Requirement for Lifting Means of Type B Packages	9	10 CFR PART 71 SUBPART E SECTION 71.45a	Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package that could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport, or must be designed with strength equivalent to that required for lifting attachments.	Engineering Analysis. Refer to Project #98007-02	Eye must fail before the welds fail, or eye rip out of block before block rips off of the enclosure. Also, flanges must be able to withstand 3x the weight. The intent is not to breech the case and expose the foam. Intended manner: Lifting the device by the designed lifting attachments. Any other structural part of the package that could be used to lift the package: An area on the device which is not designed to be used as a lifting means, but is reasonably

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
					foreseeable to be used as a lifting point. Inoperable: Must not be able to utilize as a lifting point.
Requirements for Tie down on Type B Packages	10	10 CFR PART 71 SUBPART E SECTION 71.45b1	If there is a system of tie-down that is a structural part of the package, the system must be capable of withstanding, without generating stress in any material of the package in excess of its yield strength, a static force applied to the center of gravity of the package having a vertical component of 2 times the weight of the package with its contents, a horizontal component along the direction in which the vehicle travels of 10 times the weight of the package with its contents, and a horizontal component in the transverse direction of 5 times the weight of the package with its contents.	Engineering Analysis. Refer to Project #98007-02	Tie down: places on the camera which can be utilized to tie the device down.
	11	10 CFR PART 71 SUBPART E SECTION 71.45b2	Any other structural part of the package that could be used to tie down the package must be capable of being rendered inoperable for tying down the package during transport, or must be designed with strength equivalent to that required for tie-down devices.	Engineering Analysis. Refer to Project #98007-02	Lifting eyes are the only other structural part that could be used as a tie down point.
	12	10 CFR PART 71	Each tie down device that is a structural part	Excessive load to tie	

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
		SUBPART E SECTION 71.45b3	of the package must be designed so that failure of the device under excessive load would not impair the ability of the package to meet other requirement of this part.	down points will cause failure outside the package critical structural. Engine-ring analysis	
Cold Requirements	13	10 CFR PART 71 SUBPART E SECTION 71.71c2 (Normal Condition Test)	Cold test. An ambient temperature of -40 degrees F. in still air and shade.	Tested	
External Pressure Requirements	14	10 CFR PART 71 SUBPART E SECTION 71.71c3 (Normal Condition Test)	Reduced external pressure. An external pressure of 25 kPa (3.5 psi) absolute.	N/A due to package open to Atsmospheric Pressure	Donny has consulted with Dr. Parker.
Internal Pressure Requirements	15	10 CFR PART 71 SUBPART E SECTION 71.71c4 (Normal Condition Test)	Increased external pressure. An external pressure of 140 kPa (20 psi) absolute.	N/A due to package open to Atsmospheric Pressure	Donny has consulted with Dr. Parker.
Vibration of Class M Devices	16	10 CFR PART 71 SUBPART E SECTION 71.71c5 (Normal Condition Test)	Vibration normally incident to transport.	Engineering Analysis	
Water Spray Requirements	17	10 CFR PART 71 SUBPART E SECTION 71.71c6	Water Spray that simulates exposure to rainfall of approximately 5 cm/h (2 in/h) for at least 1 hour.	Engineering Analysis	Materials not subject to damage from water.

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
		(Normal Condition Test)			
Drop Test Requirements	18	10 CFR PART 71 SUBPART E SECTION 71.71c7 (Normal Condition Test)	Free drop between 1.5 and 2.5 hours the conclusion of the water spray test, a free drop through a distance specified below onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.	Tested	Maximum Damage: 20% increase in radiation levels.
Excessive Load	19	10 CFR PART 71 SUBPART E SECTION 71.71c9 (Normal Condition Test)	The package must be subjected to 24 hours of a compressive load applied uniformly to the top and bottom of the package in the position in which the package would normally be transported. The compressive load must be the greater of the following: a. the equivalent of 5 times the weight of the package. b. the equivalent of 13 kPa (2 psi) multiplied by the vertically projected area of the package.	Engineering Analysis	
Penetration Requirements	20	10 CFR PART 71 SUBPART E SECTION 71.71c10 (Normal Condition Test)	Penetration. Impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in) diameter and 6 chg. (13 lbs) mass, dropped from a height of 1 m (40 in) onto the exposed	Tested	Most Vulnerable: Position that would cause the greatest increase in radiation levels.

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
			surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.		
30 Foot Free Drop	21	10 CFR PART 71 SUBPART E SECTION 71.73c1 (Hypothetical Accident Conditions)	Free drop. A free drop of the specimen through a distance of 9 m (30 ft) onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.	Tested	Maximum damage: 1 rem/hr at 1 meter.
Puncture Test	22	10 CFR PART 71 SUBPART E SECTION 71.73c3 (Hypothetical Accident Conditions)	Puncture. A free drop of the specimen through a distance of 1 m (40 in) in a position for which maximum damage is expected, onto the upper end of a solid, vertical, cylindrical, mild steel bar mounted to an essentially unyielding, horizontal surface. The bar must be 15 cm (6 in) diameter, with the top horizontal and its edge rounded to a radius of not more than 6 mm (.25 in), and of a length as to cause maximum damage to the package, but not less than 20 cm (8 in) long. The long axis of the bar must be vertical.	Tested	Mounted: bolted. Maximum Damage: 1rem/hr at one meter.
Thermal Test	23	10 CFR PART 71 SUBPART E SECTION 71.73c4	Thermal. Exposure of the specimen fully engulfed, except for a simple support system, in a hydrocarbon fuel/air	Engineering Analysis	

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
		(Hypothetical Accident Conditions)	fire of sufficient extent, and in sufficiently quiescent ambient temperatures, to provide an average emisstivity coefficient of 0.9, with an average flame temperature of 800 C (1475 F) for a period of 30 minutes, or any other thermal test that provides the equivalent total heat input to the package and which provides a time averaged environmental temperature of 800 C. The fuel source must extend horizontally at least 1 m (40 in), but may not extend more than 3 m (10 ft), beyond any external surface of the specimen, and the specimen must be positioned 1 m (40 in) above the surface of the fuel source. For purposes of calculation, the surface absorptivity coefficient must be either that value which the package may be expected to posses if exposed to the fire specified or 0.8, whichever is greater; and the convective coefficient must be that value which may be demonstrated to exist if the package were exposed to the fire specified. Artificial cooling may not be applied after cessation of external heat input, and any combustion of materials of construction, must be allowed to proceed until it terminates naturally.		
Heat Requirements	24	10 CFR PART 71 SUBPART E SECTION 71.71c1	An ambient temp. of 100 F in still air, and insolation according to the following	Engineering Analysis	

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CRITERIA	#	ORIGINATOR OF CRITERIA	REQUIREMENT	IMPLEMENTATION	COMMENTS
		(Normal Condition Test)	Form and Location Total Insolation of 12 hours Flat Surface transported Horizontally: Base--------------------------------None Other surfaces ------------------800 Flat Surface not transported Horizontally ----------------------200 Curved Surfaces ---------------400		
Immersion Test	25	10 CFR PART 71 SUBPART E SECTION 71.73c6 (Hypothetical Accident Conditions)	Immersion. A separate, undamaged specimen must be subjected to a water pressure equivalent to immersion under a head of water of a least 15 m (50 ft).	Engineering Analysis	

Special Note: Some tests must be done in succession.

h:/spec300/appcrit0.xls

CONTROLLED COPY NO	

REVISIONS

REV	DESCRIPTION	DATE	APPROVED

NOTES:

1. MAXIMUM WEIGHT: 780 LBS
2. PACKAGE IS FILLED WITH POLYURETHANE FOAM WITH A MINIMUM DENSITY OF 13 LB/CU. FT
3. OVERALL DIMENSIONS OF PACKAGE: 14" X 12.65" X 26" NOMINAL.

△4 SPEC-300 NAMEPLATE LOCATED ON BACK SIDE.

△5 CAUTION PLACARD IS PLACED ON BOTH SIDES

	QTY REQD -3	QTY REQD -1	UM	MANUF	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO.
	1	1	EA	OPT	190500-1	SOURCE ASSEMBLY	N/A	26
	1	1	EA	OPT	190757-1	SAFETY PLUG	N/A	25
	1	1	EA	OPT	190772-1	SOURCE TAG	N/A	24
	1	1	EA	OPT	150009-1	WARNING PLATE	N/A	23
	1	1	EA	OPT	190737-1	NAMEPLATE	N/A	22
	2	2	EA	OPT	150006-1	CAUTION PLACARD	N/A	21
	1	1	EA	OPT	190725-1	TRANSPORT LOCK	N/A	19
	1	1	EA	OPT	150916-1	LOCK CAP	N/A	18
	1	1	EA	OPT	190705-1	ENCLOSURE BASE	N/A	17
	2	2	EA	OPT	190741-1	EUTECTIC BARRIER KIT	N/A	16
	1	1	EA	OPT	190703-1	OUTLET BULKHEAD	N/A	15
	2	2	EA	OPT	190706-1	EYE MOUNTING BLOCK	N/A	14
	1	1	EA	OPT	190719-1	INLET BASE PLATE ASSY	N/A	13
	1	1	EA	OPT	150007-1	LM-200	N/A	12
	1	1	EA	OPT	190640-1	LOCK BOX ASSY	N/A	11
	1	1	EA	OPT	190702-1	INLET BULKHEAD	N/A	10
	4	4	EA	OPT	190742-L	STRUCTURAL POST	N/A	9
	1	1	EA	OPT	190769-1	BOTTOM COPPER PAD	N/A	8
	2	2	EA	OPT	190746-1	SHIELD SUPPROT ASSY	N/A	7
	1		EA	OPT	190769-1	1/2 OUTLET PANEL ASSY	N/A	6
		1	EA	OPT	190734-1	3/8 OUTLET PANEL ASSY	N/A	5
	4	4	EA	OPT	190712-1	LIFTING DOUBLER	N/A	4
	1	1	EA	OPT	190701-1	ENCLOSURE COVER	N/A	3
	2	2	EA	OPT	190747-1	LIFTING EYE	N/A	2
	1	1	EA	OPT	190700-1	DU SHIELD	N/A	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE N/A

DO NOT SCALE DRAWING

TREATMENT NONE

FINISH NONE

APPROVALS	DATE
DRAWN RAM	8/22/99
CHECKED PW	6/25/99
APPROVED [illegible]	6/28/99
QA CLASS Q-B	

SOURCE PRODUCTION & EQUIPMENT CO., INC.
113 TEAL ST, ST ROSE, LA 70087

GENERAL ARRANGEMENT,
SPEC-300 EXPOSURE DEVICE

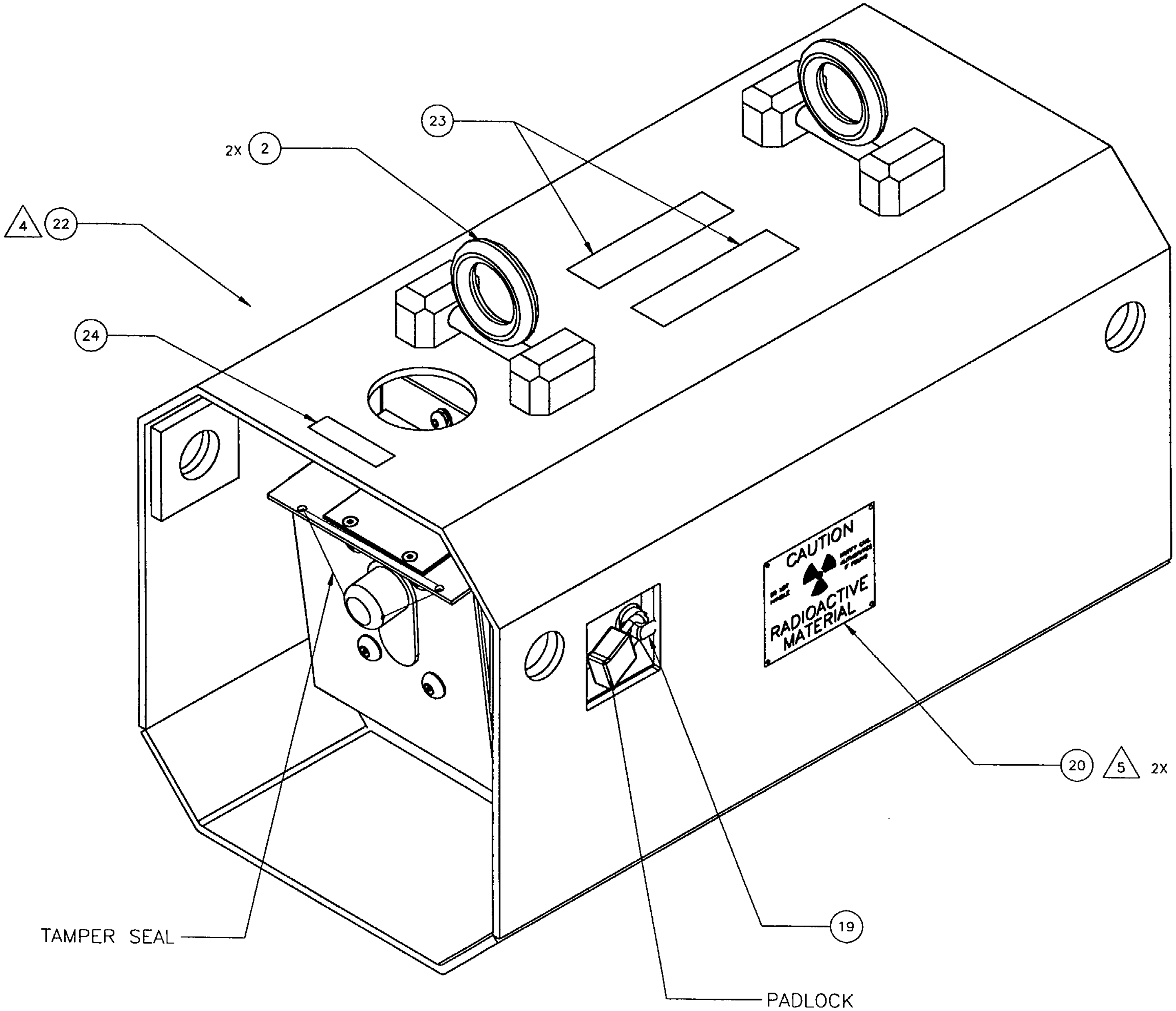
SIZE	DWG NO.	REV
C	19B000	0

SCALE: 1/2 | 00085200 | SHEET 1 OF 3

CONTROLLED COPY NO	

REVISIONS

REV	DESCRIPTION	DATE	APPROVED



SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL ST. ST ROSE LA 70087	SIZE C	DWG NO 19B000	REV 0
APPROVED [illegible] 6/29/99	SCALE: 1/2	00085200	SHEET 2 OF 3

FIGURE WITHHELD UNDER 10 CFR 2.390

SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL ST. ST ROSE LA 70087	SIZE C	DWG NO 19B000		REV 0
APPROVED [signature] 6/28/99	SCALE: 1/2	00085200	SHEET 3 OF 3	

SPEC-300
Design Verification for Fillet Weld Size Calculations

Project #98007-02

Prepared by: Richie A. Melancon
Date: 6/23/99
Rev 3

Design Verification for Fillet Weld size Calculations

Weld #	Drawing Number	Weld Size	Description	Verification Code
1	190610 sht 3 of 3	1/4	Hot top ring support to structural post	D
2	190610 sht 3 of 3	1/4	Structural post to bulkheads	D
3	190620 sht 2 of 3	3/16	Eye mounting block to enclosure cover	A,B
4	190620 sht 3 of 3	3/16	Lifting doubler to enclosure cover	A,C
5	190620 sht 3 of 3	1/8	Lock hasp to enclosure cover	A
6	190630 sht 2 of 2	1/4	Enclosure cover to base and bulkheads	A
7	190640 sht 2 of 3	1/8	Lock box parts	A
8	190650 sht 2 of 2	1/4	Base to both bulkheads	A
9	190710	1/4	Lock end shield support to bulkhead	A
10	190710	1/16	Holding block to bulkhead	A
11	190711	1/4	Outlet end shield supports to bulkhead	A
12	190728	1/16	Knob on block	Does not meet standard; however, the part does not carry load besides its own weight
13	190730	1/8	Outlet boss to outlet plate	A

Weld #	Drawing Number	Weld Size	Description	Verification Code
14	190734	1/8	Outlet boss to outlet plate	A
15	190745	1/8	Ring to base plate	A
16	190746	1/4	Four sides of shield support together	A
17	190748	1/8	lock has assembly	A

filename: h:\spec300\weldsrv3.wpd

Verification Codes

Code A Code A implies that the weld design complies with the following standards:

UBC, 2.689, J2
UBC, 2-691, TABLE J2.4
D1.1, 2.3
UBC, 2-1.691, J2.2b
D1.1, 2.7.1.1, TABLE 2.2
AISC, 5-26, J2
D1.1, 2.7.1.1

UBC - Uniform Building Code
D1.1 - American Welding Society, D1.1 - 94
AISC - American Institute of Steel Construction, 9ed.

Code B Code B implies that the weld design was calculated to certain criteria. This criteria is listed in the SPEC-300 design criteria. The criteria applies to lifting devices on the package. The welds for this part must be able to withstand 25 times the weight of the package. The eye mounting block must rip off the enclosure before the enclosure cover tears. These calculations are attached.

Code C Code C implies that the weld design was calculated to certain criteria. This criteria is listed in the SPEC-300 design criteria. The criteria applies to tie down points on the device. The lifting points of the camera must be able to withstand certain forces. These forces can be found on the calculation sheets attached to this report.

Code D Code D implies that the weld size for the particular weld is oversized for requirements given in Code A. Code A gives the maximum effective weld size for a particular weld. However, Code D will allow for a larger weld. The reasoning for the larger weld is to allow for inconsistences within the weld due to the welding process. Therefore, a Code D weld surpasses that of Code A by allowing for a larger weld.

SPEC-300 Weld Verification
Code B

Part I. Calculate the force in pounds required to have the eyebolt fail.

Solution: 28,000 lb

Part II. Calculate the force in pounds required to have the welds for the mounting block fail.

Solution: 11,721 lb

Part III. Calculate the force in pounds required to have the enclosure cover to tear open.

Solution: 32,136 lb

Part IV. Calculate the force in pounds required to have the mounting block to fail (eyebolt rips out of block).

Solution: 20,769 lb

According to the criteria, each lifting point must withstand at least 25 times the weight of the device. This amount requires the eyebolt to withstand 20,000 lb, and each mounting block weld to hold 10,000 lb. The analysis shows that the lifting points for the device can withstand this load. The analysis also proves that the weld for the mounting block to the enclosure cover will fail before the case tears open. This feature is desirable to eliminate exposing the DU shield.

SPEC-300 Weld Verification
Code B

Part I. Calculate the force in pounds required to have the eyebolt fail.

The SPEC-300 is equipt with an eyebolt from RUD-Chain. The eyebolt is TYPE RBS 3. The specifications for this item reveals that the working load is 7,000 pounds, and the ultimate load 28,000 lb.

Solution: 28,000 lb

Part II

Problem:

Calculate the force in pounds required to have the welds for the mounting block fail.

Analysis:

Dimensions of mounting block are 2.5" x 1.5"
Weight of Package = 800 lb
25 times the weight = 20,000 lb

If load is applied to only one eyebolt, then each mounting block will have 10,000 lb force.
Applied load = 10,000 lb

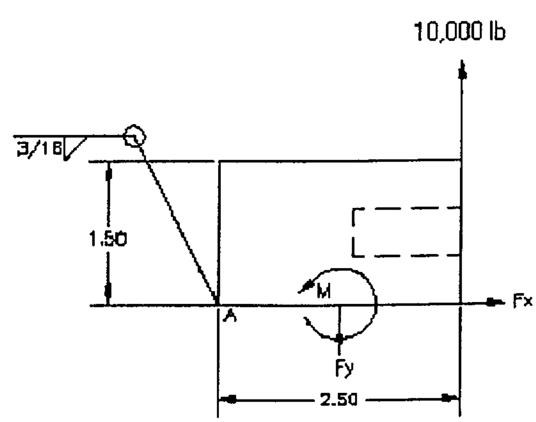
Assumptions: Eyebolt will not tear out of mounting block

Weld size = 3/16"
Area of weld = A = 1.414h(b+d)

Where: h = height of weld leg
b = length of side 1 (1.5")
d = length of side 2 (2.5")

$A = 1.414(3/16)(1.5 + 2.5)$

$A = 1.0605\ in^2$



From free body diagram

M = 10000(1.25) = 12500 lb*in

Fx = 10000 (cos 90) = 0

Fy = 10000 (sin 90) = 10000 lb

Moment of Inertia = Iu

$$Iu = \frac{d^2}{6}(3b + d) = \frac{(2.5)^2}{6}(3(1.5) + 2.5) = 7.29in^3$$

Second Moment of Inertia about axis = I

$$I = .707(h)(Iu) = .707(3/16)(7.29) = .9666in^4$$

A shear stress due to moment and Fy are additive. The total shear stress for the weld metal is as follows:

$$\tau = \frac{Fy}{A} + \frac{M}{I} = \frac{10000}{1.0605} + \frac{12500(1.25)}{.9666}$$

$$\tau = 25594.396psi$$

Shear stress due to Fx = 0

Properites of stainless steel

Ultimate Strength = Su = 75 ksi

Yeild Stength = 30 kpsi

Resultant stress in weld material

$$\tau = (\tau_x^2 + \tau_y^2)^{1/2} = 25594psi$$

$$Factor\ of\ Safety = n = \frac{Sy}{\tau} = \frac{30000}{25594} = 1.172$$

Stress in the parent material (enclosure cover) is as follows:

A = l x w = 1.5 x 2.5 = 3.75 in2

$$\tau xy = \frac{Fx}{A} = 0$$

$$Section\ Modulus = S = \frac{bd^2}{6} = \frac{(3.75)^2}{6} = 2.343 in^3$$

$$Tensile\ strength = \sigma\ y = \frac{Fy}{A} + \frac{M}{S} = \frac{10000}{3.75} + \frac{12500}{2.343} = 8001.707 psi$$

$$Factor\ of\ Safety = n = \frac{30000}{8001.707} = 3.749$$

This analysis proves that the weld around the mounting block will not fail under a load 25 times heavier than the package. To determine at what load will the mounting block welds fail, the calculation must be performed with a shear stress of 30 ksi.

$$\tau = 30000 psi$$

$$A = 1.0605 in^2$$

$$I = .9666 in^4$$

$$c = 1.25 in$$

$$M = Fy(c)$$

$$\tau = \frac{Fy}{A} + \frac{Mc}{I} = (substitute\ for\ M) = \frac{Fy}{A} + \frac{(Fy(c))c}{I}$$

$$30000 = \frac{Fy}{1.0605} + \frac{Fy(1.25)(1.25)}{.9666}$$

$$30000 = 2.559 Fy$$

$$Fy = 11721 lb$$

Therefore, a load of 11721 pounds is required for the mounting block welds to fail.

Part III.

Problem:

Calculate the force in pounds required to have the enclosure cover to tear open.

Analysis:

From Part II

$$\sigma y = \frac{Fy}{A} + \frac{M}{I / c}$$

$$30000 = \frac{Fy}{3.75} + \frac{Fc(c)}{2.343}$$

$$30000 = Fy.9335$$

$$Fy = 32135.5lb$$

Therefore it requries a force of 32135 pounds to shear the enclosure cover open.

Part IV.

Problem:

Calculate the force in pounds required to have the mounting block to fail (eyebolt rips out of block).

Analysis:

Assumptions:

1. Mounting block is fixed to cover
2. Eyebolt will not fail

d = .625 in
w = 1.5 in
d/w = .4166 in

From reference #1

Kt = 3.25 (Pg 749)
For safety allow Kf = Kt (Pg 291)

$$\sigma = Kf\frac{Fy}{A}$$

$$\sigma = 3.25\frac{10000}{(1.5)(1.5)} = 14444psi$$

Maximum load until the block fails:

$$30000 = \frac{Fy}{A}$$

$$Fy = 20769lb$$

Therefore, it requries a force of 20769 pounds to have the eyebolt tear through the mounting block.

Miscellaneous Lifting Stress calculation

To remain in compliance with the criteria for this package, and means that can be used to lift the device muse be able to withstand 25 times the weight of the package. The worst case scenario that could be used includes lifting the device by the top enclosure cover at the ends of the flange. If these lifting points are utilized, the stress must not exceed the ultimate stress of the material. Unfortunately, there is no way of predicting exactly how much area will be used upon lifting. Therefore, we will assume a ½ in^2 of area. This will produce 19,000 psi, which is less than 30000 psi (ultimate strength). Also, if smaller area is utilized the stress would increase. However if the plate begins to deform from the stress, the contact between the lifting means and the enclosure cover will increase thus increasing the area and decreasing the stress at the lifting point.

SPEC-300 Weld Verification
Code C

Part I. Static force applied at the center of gravity with vertical component of 2 times the weight.

Solution: Passes

Part II. Static force applied at the center of gravity with horizontal component along the direction of the vehicle travel os 10 times the weight.

Solution: Passes

Part III. Static force applied at the center of gravity with horizontal component in transverse direction of vehicle travel of 5 times the weight

Solution: Passes

Each criteria that must me met is considered in each part listed above. The passing criteria requires that no part of the package will exceed the yield strength of the material (30,000 psi). Part III will not be calculated because if the device can withstand Part II, then it will also pass Part III.

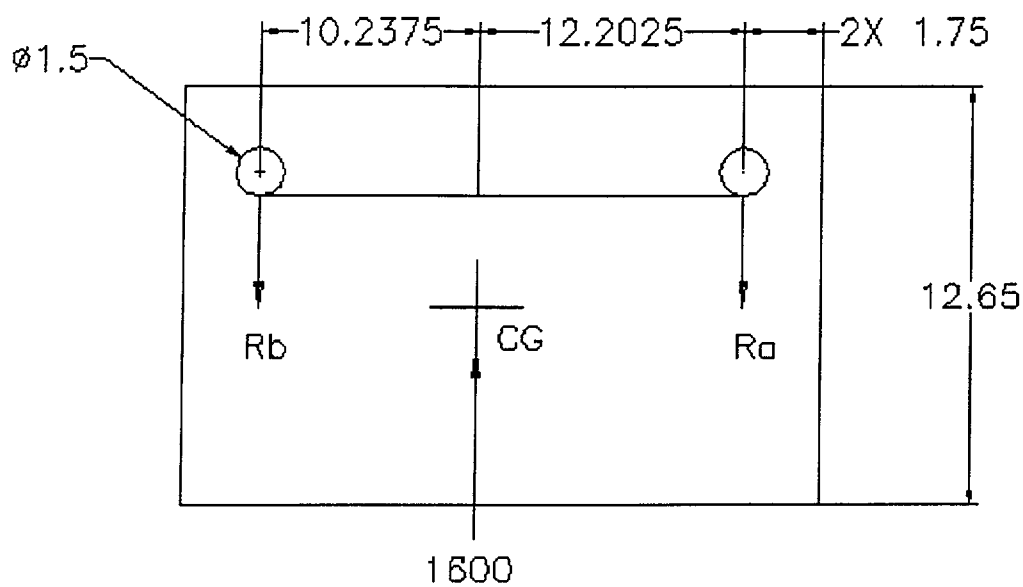
SPEC-300 Weld Verification
Code C

Part I.

Problem:

Static force applied at the center of gravity with vertical component of 2 times the weight.

Analysis:



Total thickness of the cover and doubler plates = .6875"

Sum the forces in the Y direction
Fy = Ra + Rb - 1600 = 0

Sum the forces in the X direction
Fx = 0

Sum the moments at Ra
Ma = -1600(12.2025) + Ra(0) + Rb(22.5) = 0

Solving the equations above gives

Rb = 872 lb
Ra = 728lb

The reactions Ra and Rb are divided by two because the load is equally distributed between all four holes. Therefore:

Ra = 364 lb and Rb = 436 lb

If Rb passes the criteria, the Ra will pass the criteria.

$$\sigma = \frac{Fy}{A} = \frac{436}{1*.6875} = 634.18 psi$$

634.18 < 30,000

Because the stress is lower than 30,000 psi, it passes the criteria.

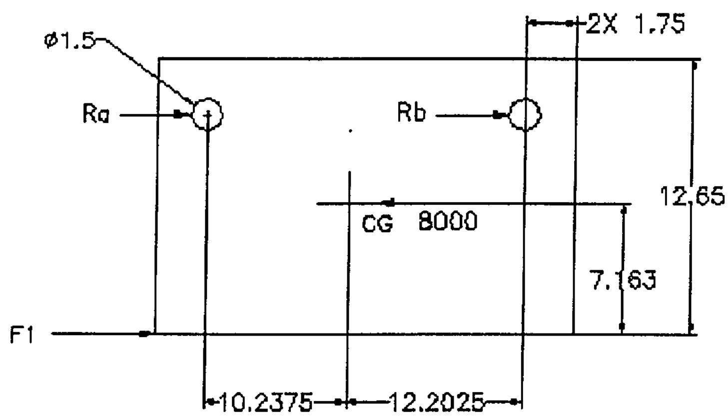
If the lifting eyes are used for tie down points, then they will be subject to more load in Part II then in Part I. Therefore, no calculations for lifting are included in Part I.

Part II.

Problem:

Static force applied at the center of gravity with horizontal component along the direction of the vehicle travel os 10 times the weight.

Analysis:



Sum the forces in the X direction

$Fx = Ra + Rb + F1 - 8000 = 0$

$F1 = N\mu$

$N = normal\ force$

$\mu = Coefficient\ of\ friction\ (steel\ on\ steel\ is\ .74)$

$F1 = (800)(.74) = 592 lb$

$Ra + Rb = 7408$

Sum the moment

$Mc = Ra(8.625) + Rb(8.625) - 8000(7.163)$

$Ra + Rb = 6673.94$

Combining the two equations gives;

$Ra = 7026 lb$

$Rb = 382.02 lb$

Ra is the worst case, therefore:

$$\sigma = \frac{Ra}{A} = \frac{7026}{1*.6875} = 5109.82 psi$$

Since 5,109.82 is less than 30,000, it passes the criteria.

If the lifting eyes are used as tie down points, then:

weld area = 1.0605 in^2

The sum of the forces in the X direction:

$Fx = \mu N + R - 8000 = 0$

$gives\ R = 7408 lb$

$Divide\ R\ by\ 2 = 3704 lb$

Therefore:

$$\sigma = \frac{R}{A} = \frac{3704}{1.0605} = 3492.69 psi$$

Since 3,492.69 is less than 30,000, it passes the criteria.

Part III.

Problem:

Static force applied at the center of gravity with horizontal component in transverse direction of vehicle travel of 5 times the weight

Analysis:

The forces must also be applied 90 degrees to that of Part II. However, because the device will experience the same stress as that in Part II (force and area are the same), the calculations are not necessary. If the package is strong enough to withstand the conditions of Part II, then the package will be able to withstand this configuration.

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE .XX±.250 .XXX±.010			SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL ST, ST ROSE, LA 70087
	APPROVALS	DATE	DROP TEST TARGET
	DRAWN JAF	6/18/97	
DO NOT SCALE DRAWING	CHECKED PJ	6/23/97	
TREATMENT NA	APPROVED PJ	6/23/97	SIZE C DWG NO. 50890-1 REV 1
FINISH NA	QA CLASS NA		SCALE: 1"=1' 00000242 SHEET 1 of 2

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE .XX ± .03 .XXX ± .010	APPROVALS	DATE	SOURCE PRODUCTION & EQUIPMENT CO., INC. 113 TEAL ST, ST ROSE, LA 70087
	DRAWN RAM	3/25/99	BASE- PUNCTURE TEST, 10 CFR PART 71.73 (C)(3)
DO NOT SCALE DRAWING	CHECKED [illegible]	[illegible]	
TREATMENT NONE	APPROVED [illegible]	[illegible]	SIZE C DWG NO. 990084 REV 0
FINISH NONE	QA CLASS N		SCALE: 1/2 00074100 SHEET 1 OF 1

FIGURE WITHHELD UNDER 10 CFR 2.390

.XX ±.09
.XXX ±.030

NONE

NONE

RAM 3/25/99

SOURCE PRODUCTION & EQUIPMENT CO., INC.
113 TEAL ST, ST ROSE, LA 70087

PIN–
PUNCTURE TEST,
10 CFR PART 71.73 (C)(3)

C 990085 0

SCALE: 1/2 00074200 SHEET 1 OF 1

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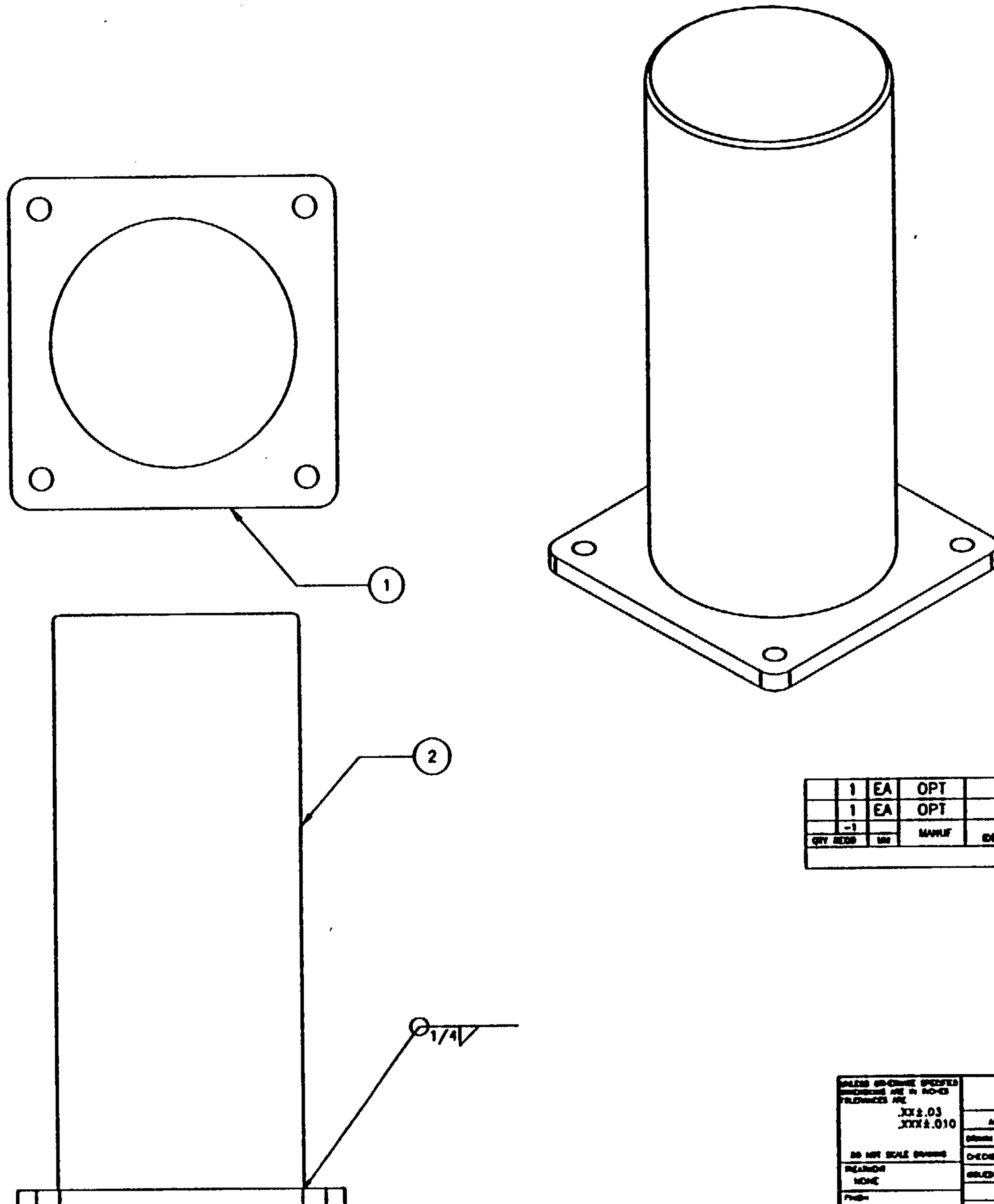
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

NOTES:

1. -1 SHOWN.



	1	EA	OPT	990085-1	PIN	N/A	2
	1	EA	OPT	990084-1	BASE	N/A	1
	-1		MANUF	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO
QTY REQD		UM					

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE .XX ±.03 .XXX ±.010	APPROVALS	DATE	SOURCE PRODUCTION & EQUIPMENT CO., INC. 113 TEAL ST, ST ROSE, LA 70087
	DRAWN RAM	3/25/99	ASSEMBLY- PUNCTURE FIXTURE, 10 CFR [ART 71.73(C)(3)
DO NOT SCALE DRAWING	CHECKED 3LB	3/25/99	
TREATMENT NONE	ISSUED PW	3.26.99	SIZE C DWG NO. 990086 REV 0
FINISH NONE	QA CLASS II		SCALE: 1/2 00074300 SHEET 1 OF 1

SOURCE PRODUCTION AND EQUIPMENT COMPANY
ST. ROSE, LOUISIANA

SPEC-300 Exposure Device
Justification of Package Orientation for:
4 Foot Free Drop
30 Foot Free Drop
Puncture Test

Prepared by: Kenny Carrington and Pete Weber
Date: 6/8/99
Rev: 1

Purpose:
10 CFR 71.71 (c) (7) describes a drop test consisting of a 4 foot free drop onto a flat, essentially unyielding horizontal surface striking in a position for which a maximum damage is expected.

10CFR 71.71 (c) (10) describes a penetration test consisting of an impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in) diameter and 6 kg (13 lbs) mass, dropped from a height of 1 m (40 in) onto the exposed surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.

10 CFR 71.73 (c) (1) describes a drop test consisting of a 30-foot free drop onto a flat, essentially unyielding horizontal surface striking in a position for which a maximum damage is expected.

10 CFR 71.73 (c) (2) describes a puncture test consisting of a 40" free drop onto a 6" diameter mild steel bar. The package should strike the bar in a position for which maximum damage is expected.

This document defines the test package orientation expected to produce maximum damage for the four tests described above, and states the rationale for the orientation chosen.

Scope:
The following radioactive material package will be considered:
SPEC-300 Exposure Device/Type B transport package.
Testing is scheduled for the week of June 7, 1999.

Maximum Damage definition:

4 foot free drop and penetration tests:

"Maximum damage" is not defined in 10CFR 71.71, but 10CFR 71.43 (f) states: A package must be designed, constructed, and prepared for shipment so that under the tests specified in Sec. 71.71 (``Normal conditions of transport'') there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging. It is highly unlikely that the sealed radioactive source assembly will shift in the depleted Uranium shield as a result of these tests, and only minimum damage is expected to the device enclosure. For these tests, maximum damage will be defined as a test-induced condition that results in a 20% or greater increase in radiation level, when compared to a pre-test radiation level at the same location, and this will be attempted by trying to jar either the safety plug or the lock cap (safety cap) off of the device.

30 foot free drop and puncture tests:
"Maximum damage" is not defined in 10 CFR 71.73, but 10 CFR 71.51 (a) (2) specifies that as a result of testing, the radiation dose rate will not exceed one REM/hr at one meter from the external surface of the package. For these tests, maximum damage will be considered as the condition that provides maximum movement, or chance of movement, of the sealed radioactive source assembly away from the fully shielded position within the depleted Uranium shield. This is the condition most likely to result in increased radiation levels outside the device.

SPEC-300 construction overview:
The SPEC-300 exposure device is a depleted Uranium shield weighing approximately 500 pounds enclosed in a robust rectangular welded stainless steel enclosure. The shield is retained in the enclosure by two tabs or "ears" that are cast integrally with the shield. Each tab is fastened to the corresponding end bulkhead of the enclosure by means of a solid support welded to the bulkhead. Two additional internal brackets support the depleted Uranium shield. The interior of the enclosure is filled with a dense structural foam that further supports and cushions the depleted Uranium shield. The foam also increases the overall strength of the enclosure. Attached to the lock-end bulkhead on the outside of the enclosure is a sheet metal lock box containing a lock module and transport lock. The transport lock is the primary mechanism maintaining the radioactive pigtail assembly at the desired location in the depleted Uranium shield. Attached to the opposite-end bulkhead is a panel containing a quick connect nipple. A safety plug is attached to this nipple. The safety plug includes a length of wire rope cable that when inserted and secured to the nipple, acts to prevent the source from moving significantly in the direction of the outlet end of the device. The ends of the device are designed to act as "crumple zones". The bulkheads are recessed several inches into the ends of the device, forming a large "lip" all around, which during testing is expected to crush and deform, absorbing significant impact energy. This feature has been demonstrated on both the SPEC-150 and SPEC 2-T, which share a common design.

SPEC-300 4 foot free drop package orientation:
The failure criterion for the 4 foot free drop test is a 20% increase in radiation levels after the test. Considering that the device is designed to withstand a 30 foot drop, significant damage is not expected when the device is dropped only 4 feet. Movement of the radioactive source assembly away from the fully shielded position in the depleted Uranium shield therefore will not be a goal of this test. The most likely means of increasing radiation levels by 20% would be to cause one of the protective caps located at each end of the device to come adrift. Considering the design of the

device and end caps, it is most likely that this will occur if the device is dropped flat on the lock end. Deformation of the "crumple zone" at the lock end of the device could result in an impact to the lock cap. Such an impact could damage the boss that retains the cap in place, and cause the cap to come adrift. Removal of the lock end cap does result in an increase in radiation level at the lock end of at least 20%. SPEC has therefore decided that this concept will be used in the 4 foot free drop test.

Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

SPEC-300 penetration test package orientation:
The failure criterion for the penetration test is a 20% increase in radiation levels after the test. Considering that the device is designed to withstand a 30 foot drop, significant damage is not expected when the device is subjected to this test. Movement of the radioactive source assembly away from the fully shielded position in the depleted Uranium shield therefore will not be a goal of this test. The most likely means of increasing radiation levels by 20% would be to cause one of the protective caps located at each end of the device to come adrift. The most effective means of causing this failure would be to perform the test twice, impacting the device on the safety plug at the outlet end and then on the lock cap at the lock end of the device. Removal of the safety plug or lock end cap would result in a localized increase in radiation level of at least 20%. SPEC has therefore decided that this concept will be used in the penetration test.

Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

SPEC-300 30 foot free drop test package orientation:
In an attempt to drop the exposure device on a point that would cause maximum damage as defined above, several ideas were considered and discussed with NRC:

The first concept involves dropping the device flat on the outlet end. An impact at this point could cause the mass of the shield to deform the outlet-end bulkhead, resulting in the shield shifting toward the outlet end of the device, effectively pulling the radioactive source assembly out of the fully shielded position. An observation about this concept is that the ends of the device are designed to act as "crumple zones", and the deformation of one of these zones would absorb significant impact energy before the shield would begin to shift. In addition, the dense foam in the device would act to further absorb impact energy and prevent shifting of the shield.

The second concept involves dropping the device flat on the lock end. An impact at this point could cause the mass of the shield to deform the lock-end bulkhead, resulting in the shield shifting toward the lock end of the device. The lip around the end of the device would also be expected to crush. The combination of these two effects would potentially crush the lock box and transport lock, possibly even tearing them off. If this were to occur, the radioactive source could be pulled out of the fully shielded position. An observation about this concept is that since all of the forces expected are compression forces, it is likely that the lock box would simply be crushed, but still retain the source assembly in the fully shielded position.

The third concept involves dropping the device flat on the side opposite the hot top. The predicted failure mode would be a direct shock to the depleted Uranium casting causing failure (cracking) of the casting where the two tabs or "ears" join the spherical portion of the casting. These cast-in tabs are the thinnest and weakest part of the casting, and would bear most of the shock load. A side impact would induce significant bending stress in the tabs where they join the spherical portion of the casting. Chilling the device to -40°F or colder would cause low temperature embrittlement of the depleted Uranium casting, allowing for a worst case condition. Contrary to the first and second concepts, there exists no crumple zone to attenuate the forces resulting from the impact. An observation about this concept is that a depleted Uranium shield has never failed during testing at SPEC, even in devices containing no foam. Also, considering the configuration of the shield (no stress risers) and the mechanical properties of depleted Uranium it is not expected that an impact of this magnitude would crack the shield. It is calculated that the device will only be traveling at 44ft/s or 30MPH at the end of the 30 foot fall.

The fourth concept involves dropping the exposure device on the edge formed by the top of the device and the lock end. An impact at a similar location has caused failures in early SPEC-150 prototype devices, which share a common design. The failure mode consists of shearing the welds attaching the lock end bulkhead to the device enclosure, particularly near the impact point. Whereas failure of these welds may not cause a direct increase in radiation levels, a breach in the device enclosure would cause the device to be much more vulnerable to the thermal test, which follows the 30 foot free drop test. A second failure mode would be shearing off the lock box and transport lock. Since the lock box and transport lock are the means of retaining the radioactive source assembly in the fully shielded position, this failure could allow the radioactive source to be pulled out of the fully shielded position. An observation about this concept is that the transport lock and lock box are redundant mechanisms, and the transport lock is very securely fastened to the lock end bulkhead. The likelihood of both the transport lock and the lock box being sheared off due to this type of impact is low.

The four concepts described above each offer the possibility of maximum damage to the package. SPEC has therefore decided to perform the test 4 times, once in each orientation described above. Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, tests 1, 2, and 4 will be conducted with the enclosure at ambient temperature. Test 3 will be performed with the casting at low temperature as described above.

When the test is performed, steps will be taken to ensure that the center of gravity of the exposure device is directly above the impact point at the time of release. This will ensure that maximum energy will be focused at the desired impact point.

SPEC-300 Puncture test package orientation:

Considering the size of the puncture test pin relative to the SPEC-300 exposure device, as well as the overall design of the device, it is not expected that the puncture test pin will penetrate the device or cause internal damage. The next best chance for this test to cause maximum damage would be to damage the lock box, possibly compromising the means to position the radioactive source assembly at the fully shielded position in the depleted Uranium shield. The lock box

consists of a relatively thin sheet metal enclosure that attaches externally to the lock-end bulkhead of the device. Inside the lock box is the transport lock, a mechanism that acts as the primary means of positioning the radioactive source assembly at the fully shielded position in the depleted Uranium shield. If the lock box can be moved out of position, coupled with failure to the transport lock or the source assembly, it could drag the source assembly out from the center of the depleted uranium shield. This shift of position of the source assembly could result in abnormally high radiation levels.

Since the lock box is the only externally mounted item whose damage could result in maximum damage, SPEC has decided that this concept will be used in the puncture drop test. When the test is performed, steps will be taken to ensure that the center of gravity of the exposure device is directly above the impact point at the time of release. This will ensure that maximum energy will be focused at the desired impact point. Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

Assessment Conducted By: [signature] Date 6/8/99
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Approved By: [signature] Date 6/9/99
Donny Dicharry, President

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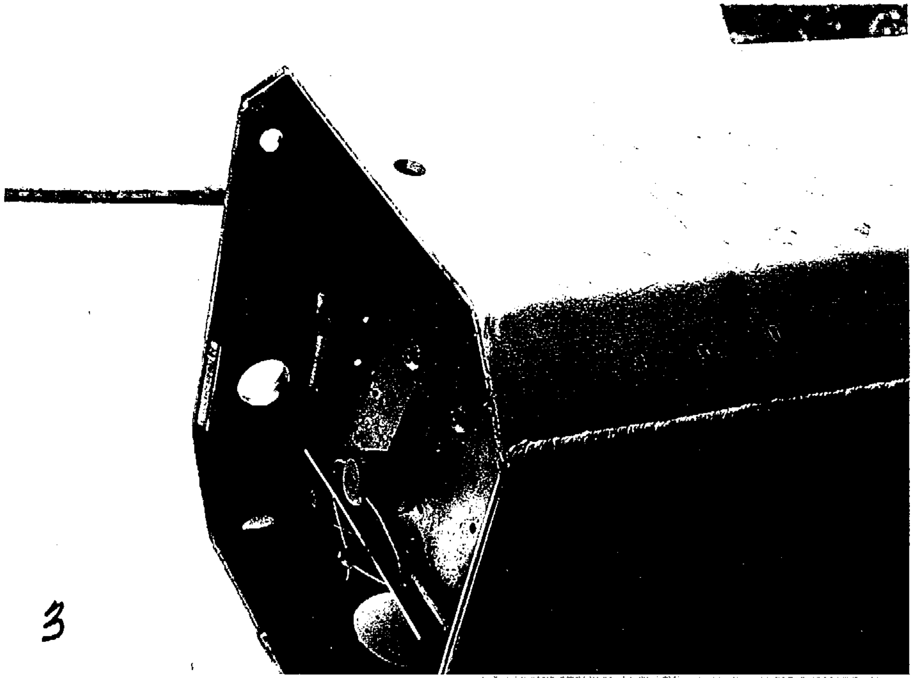
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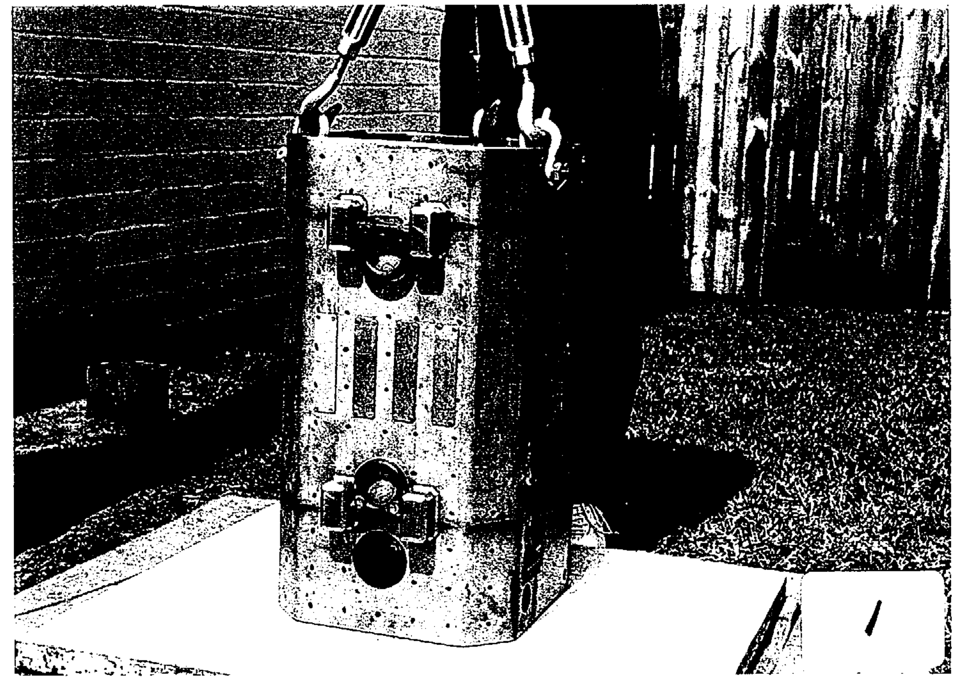
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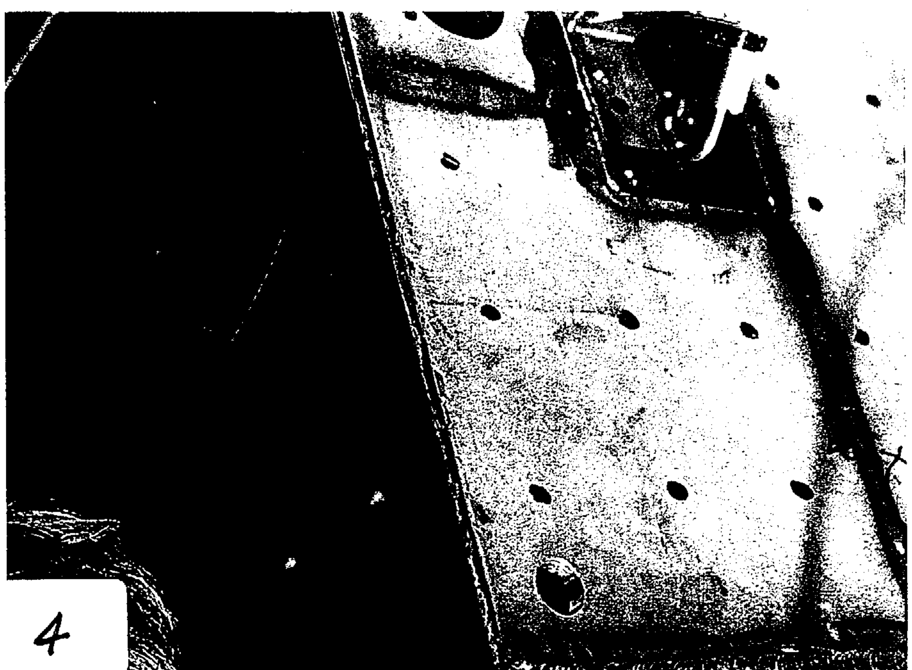
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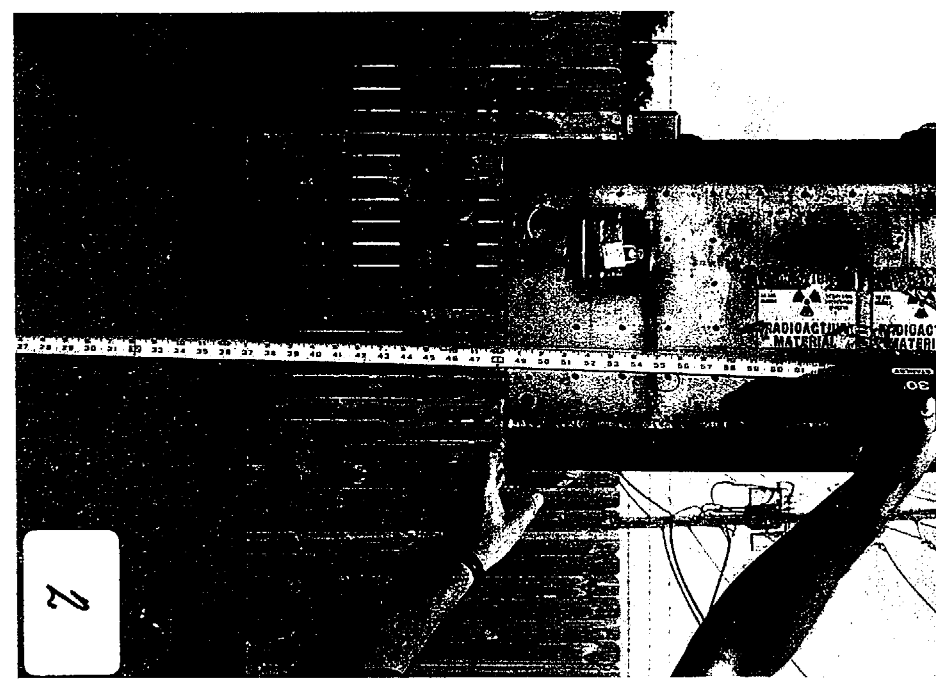
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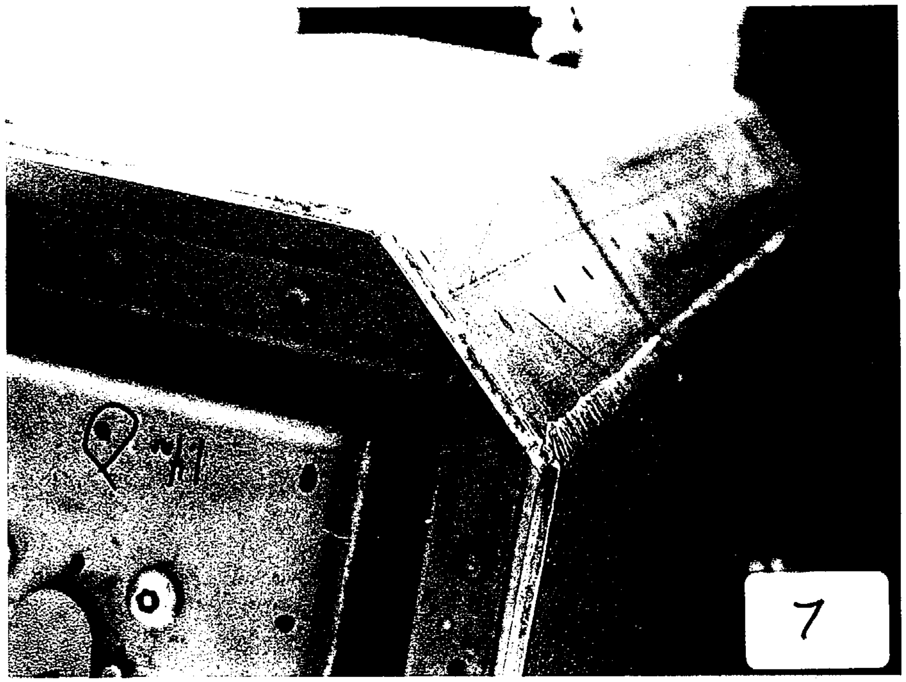

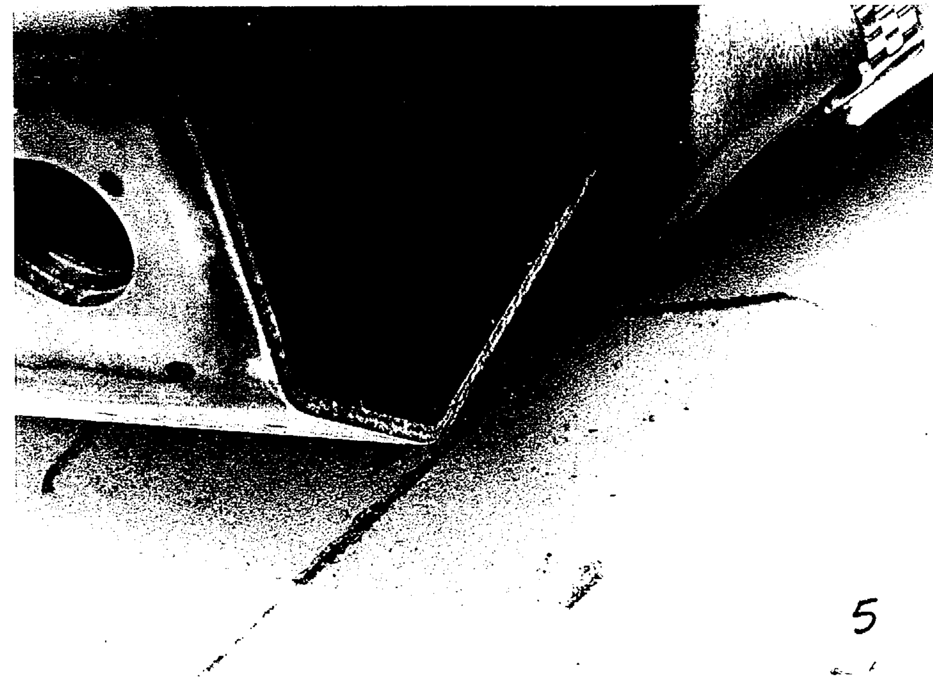

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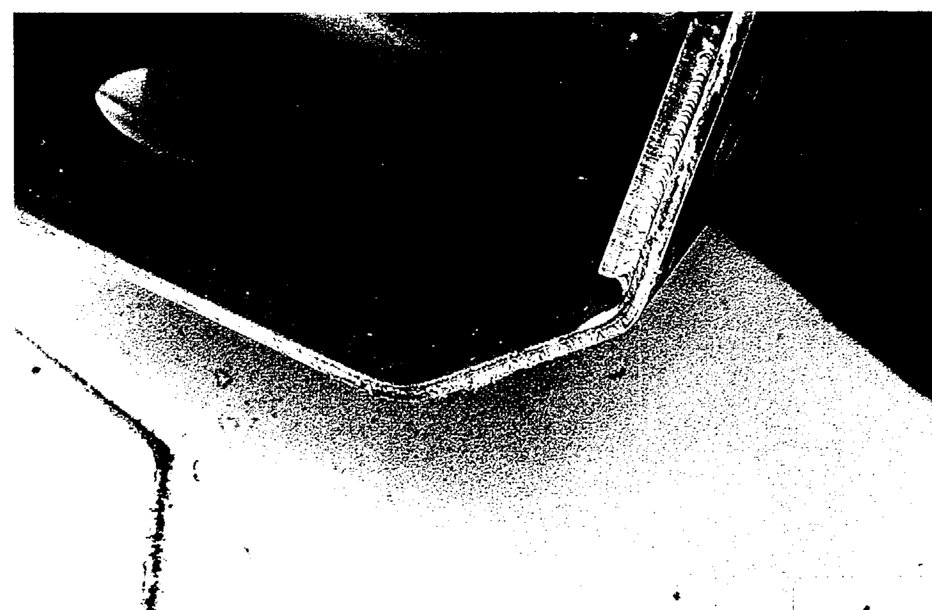

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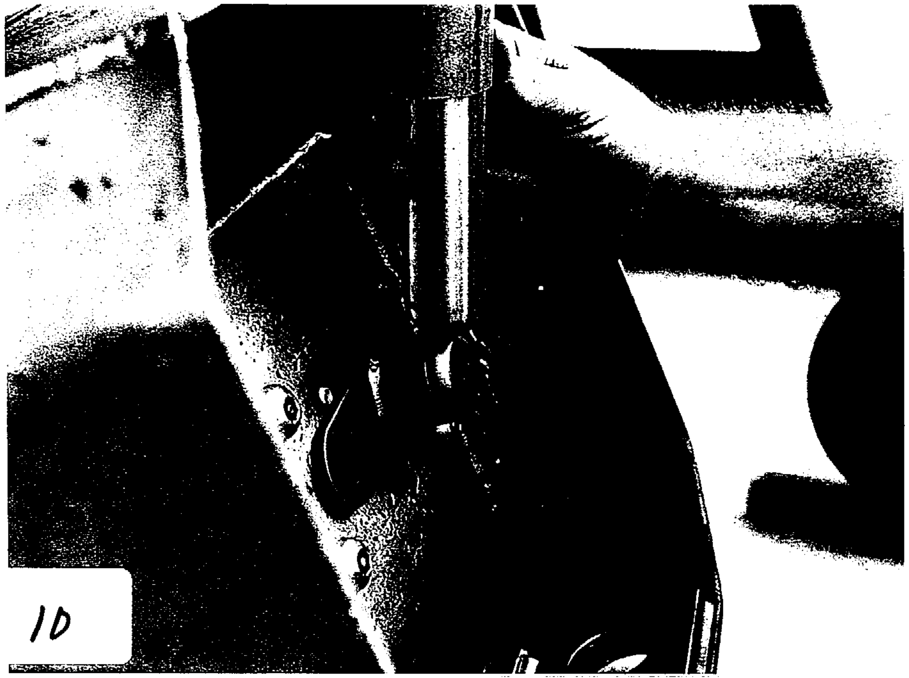
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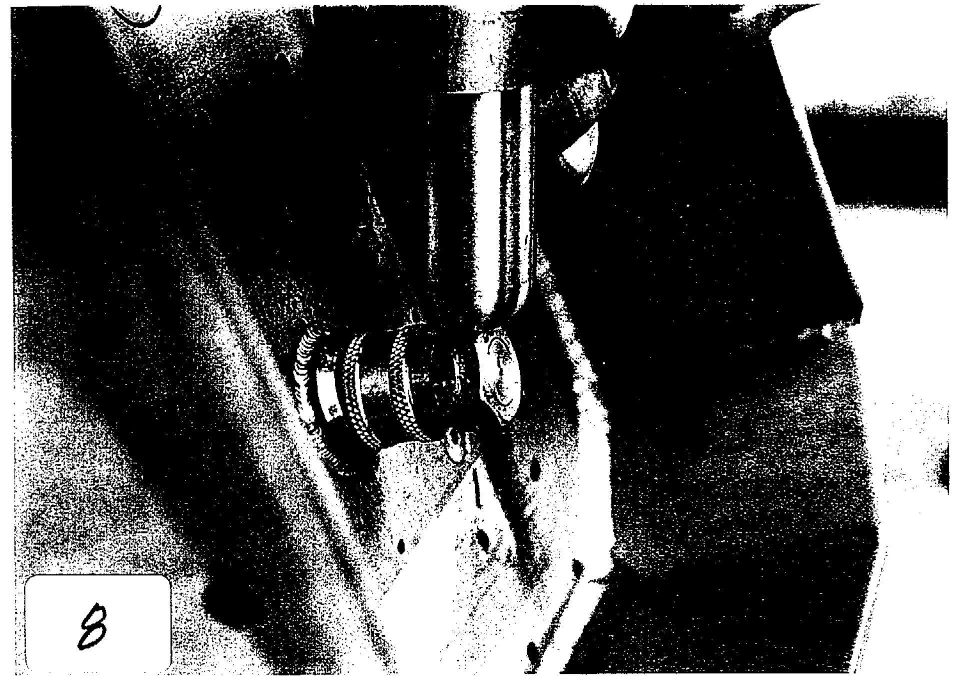
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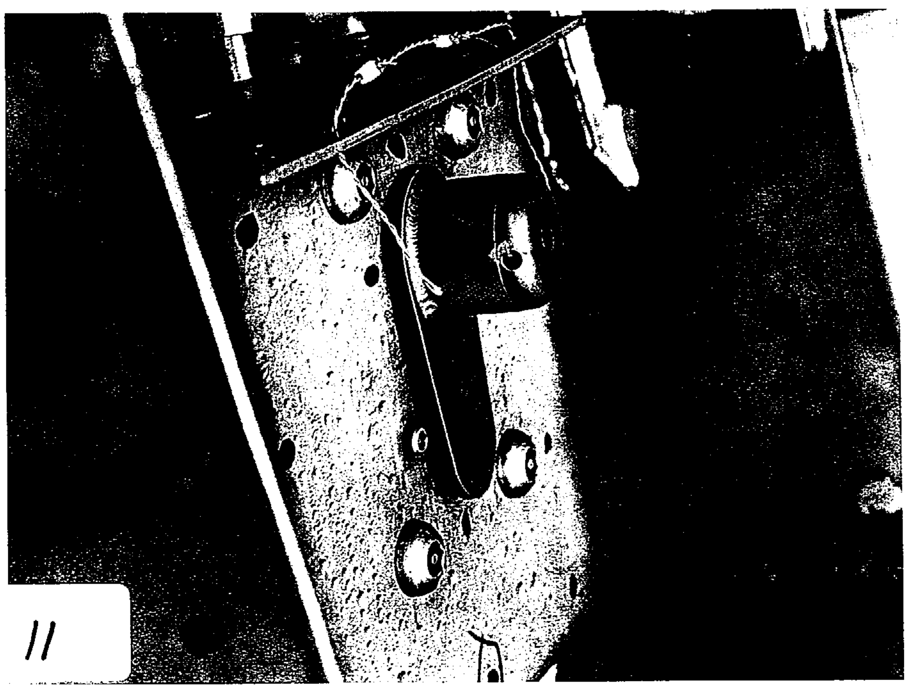
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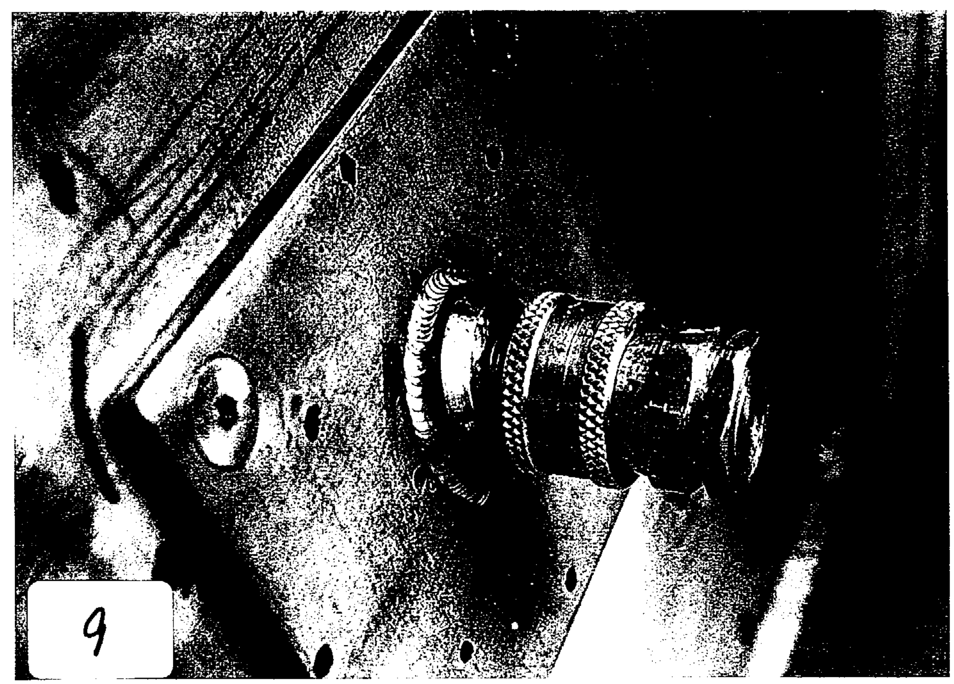
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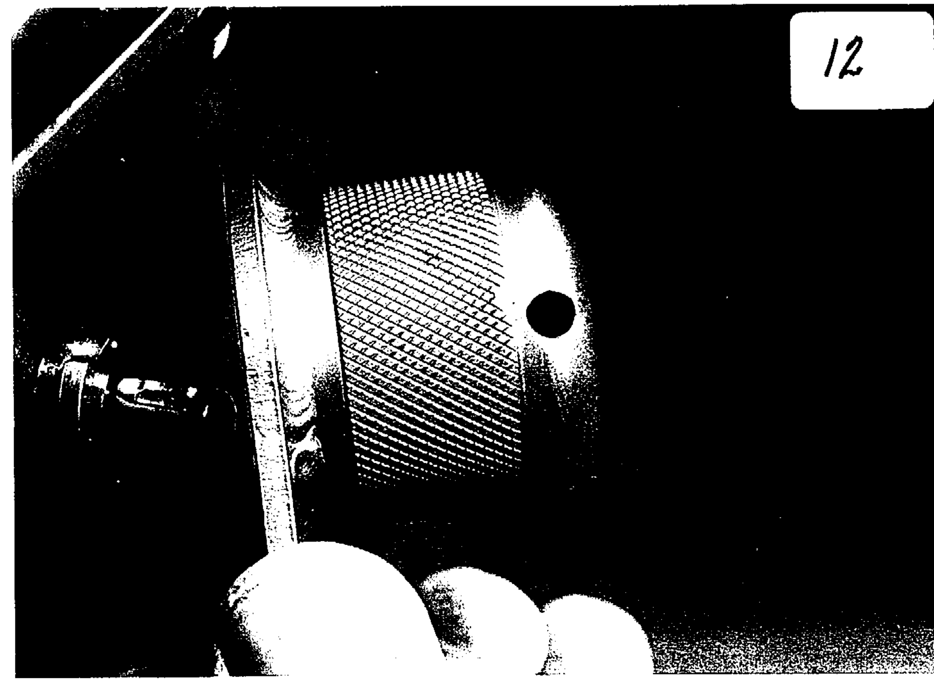
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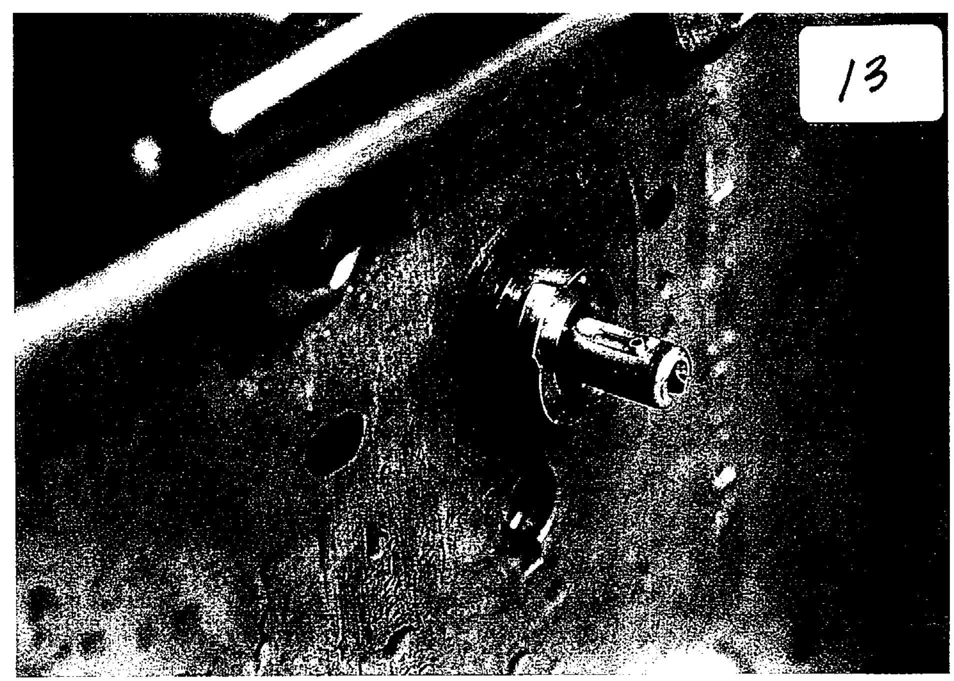
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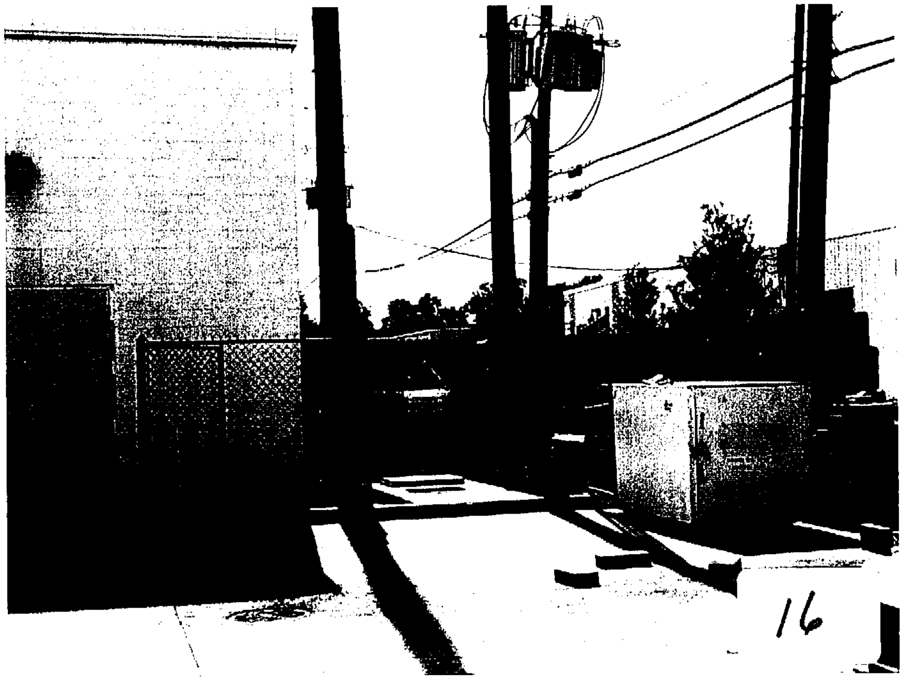
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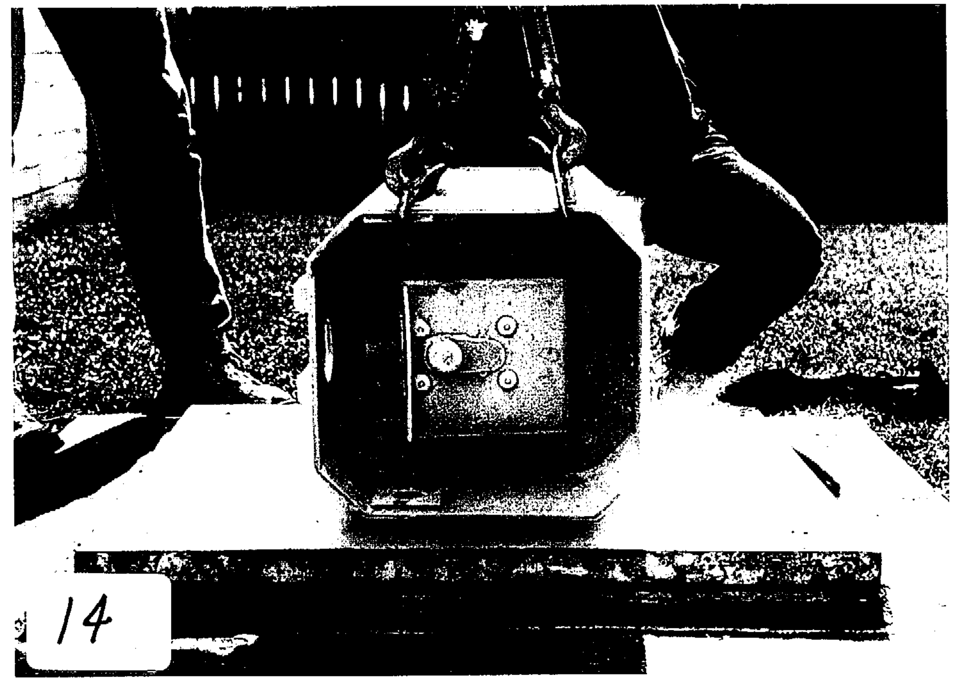
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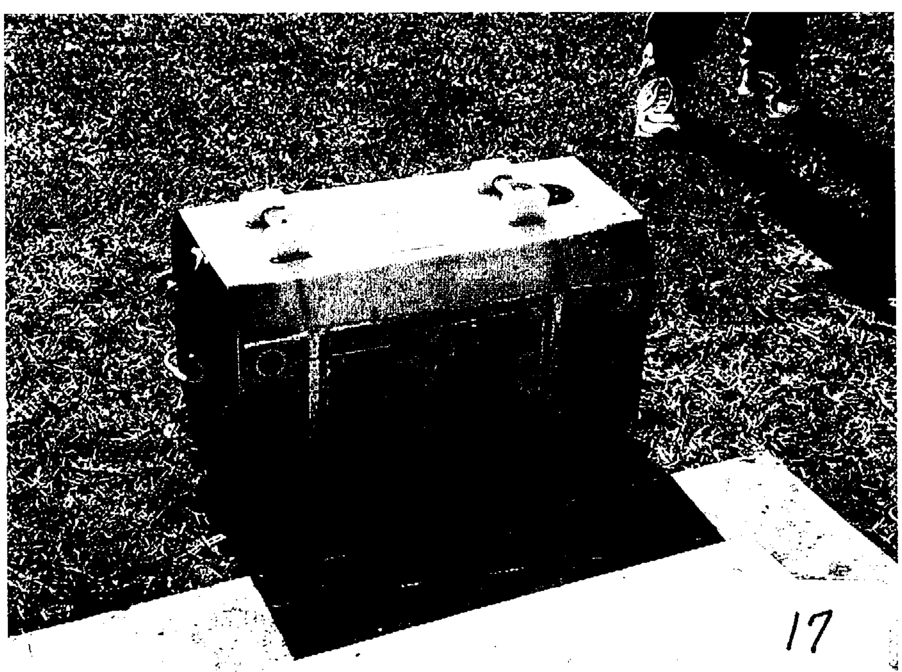
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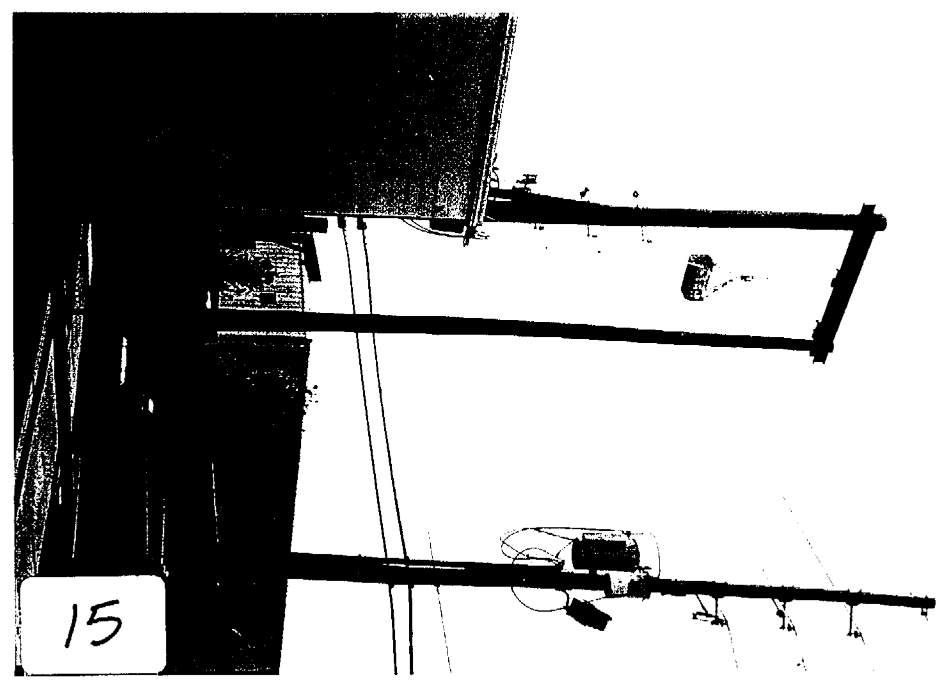
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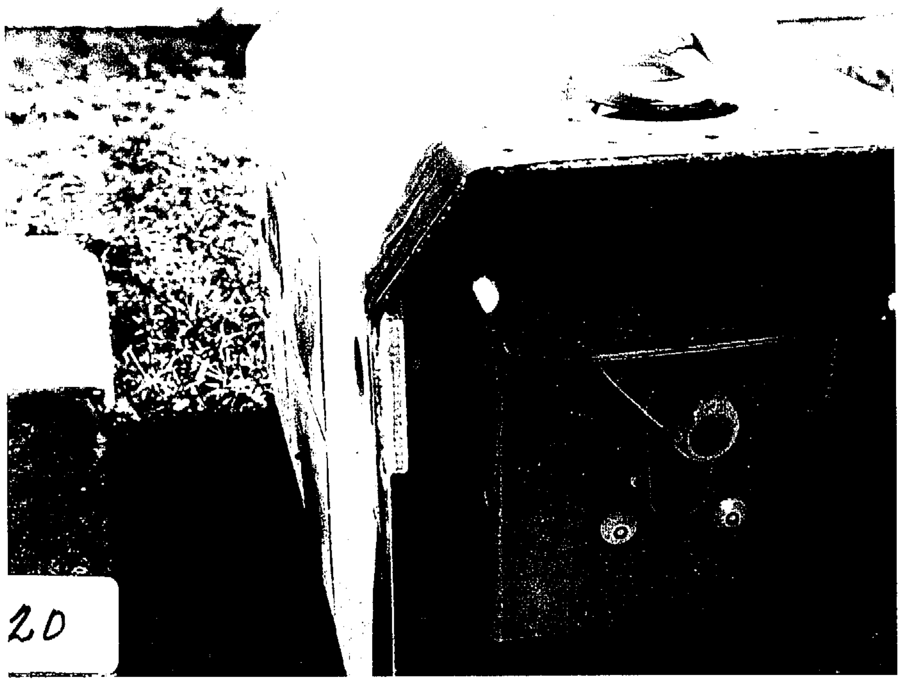

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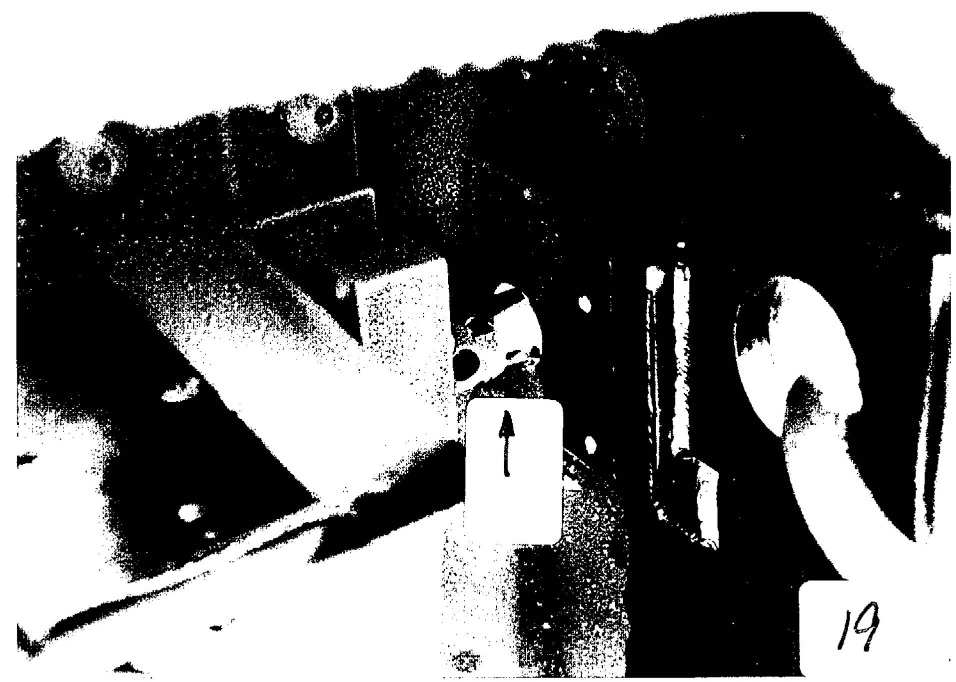

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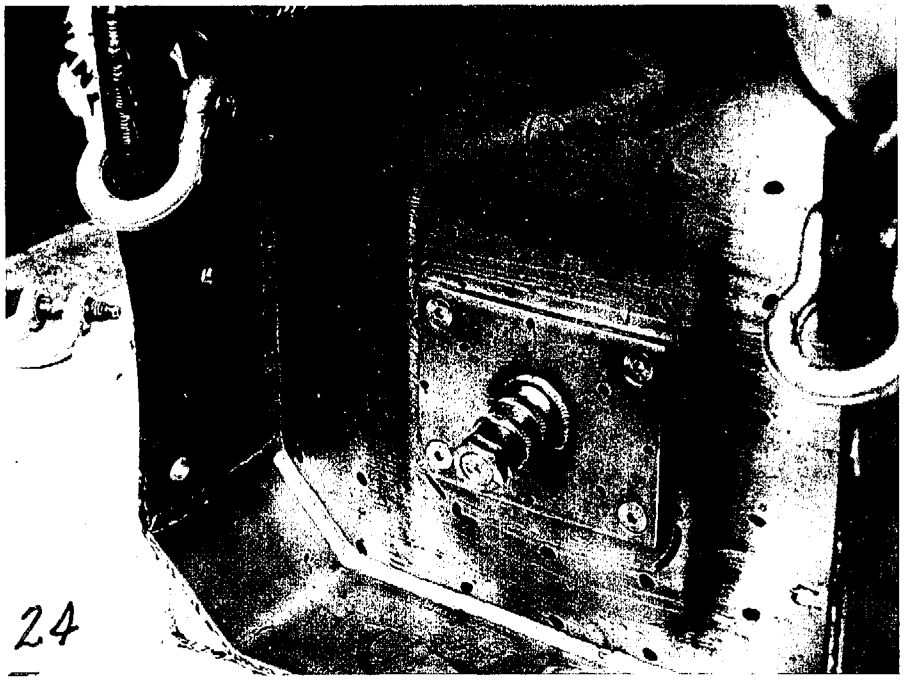

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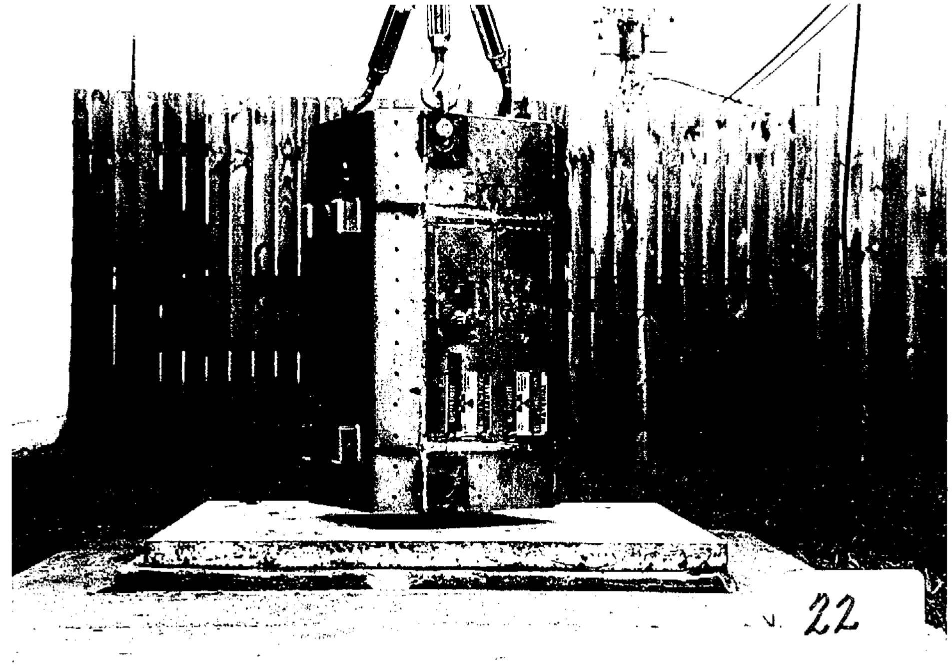

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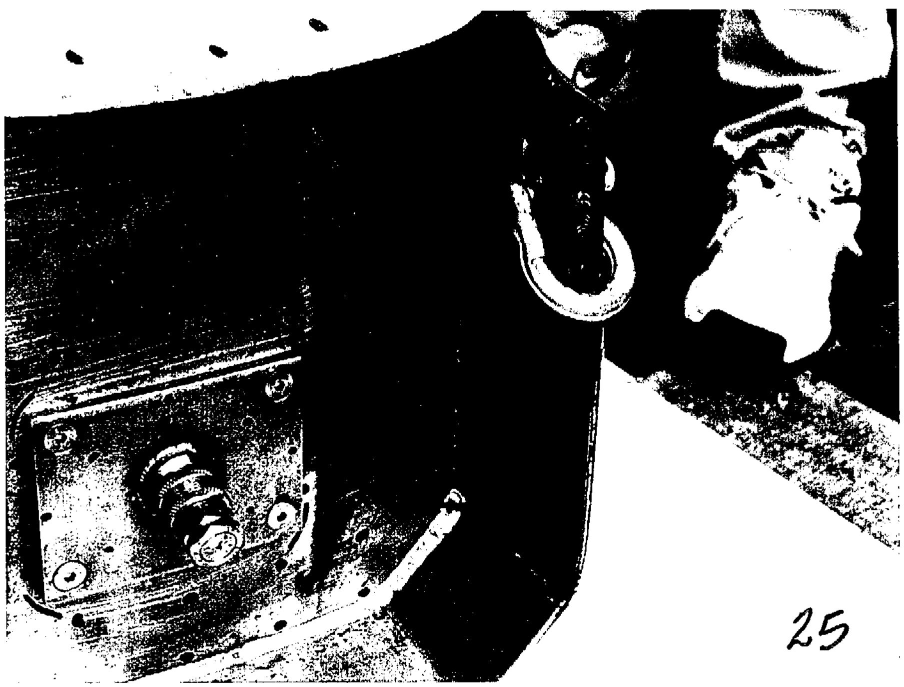

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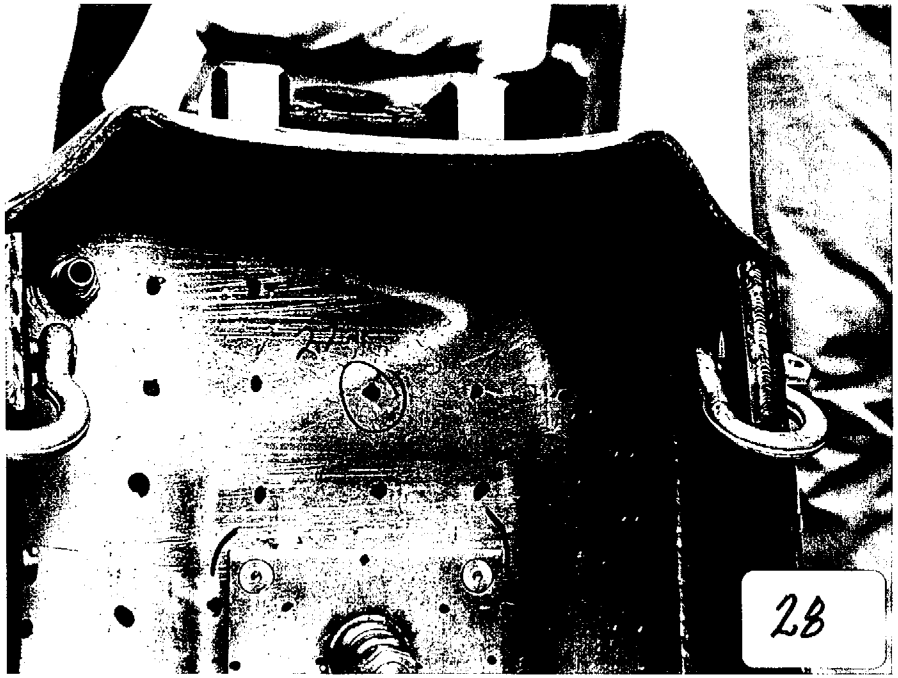
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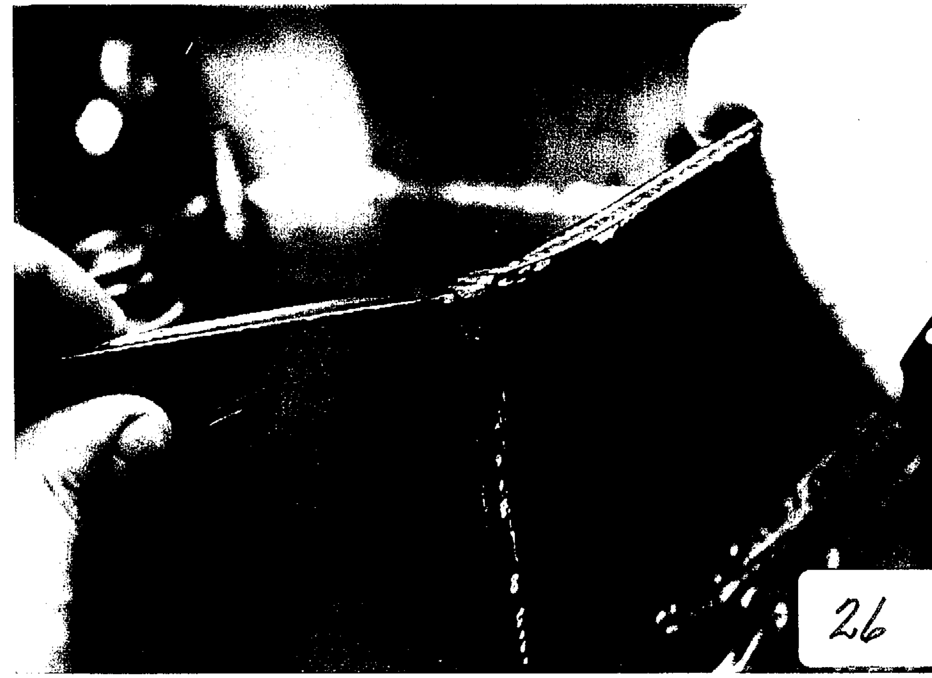
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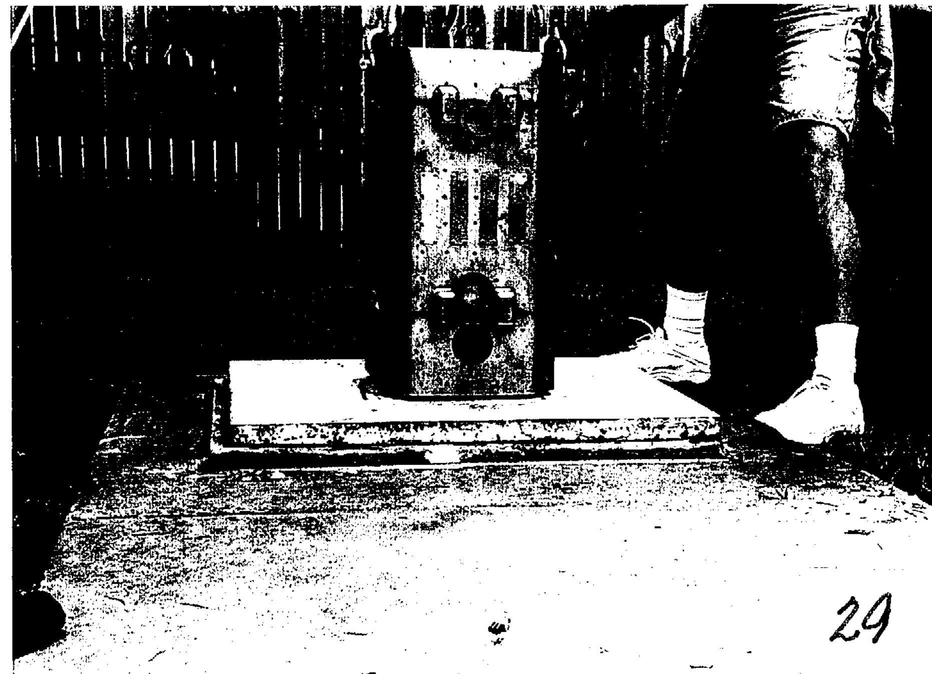
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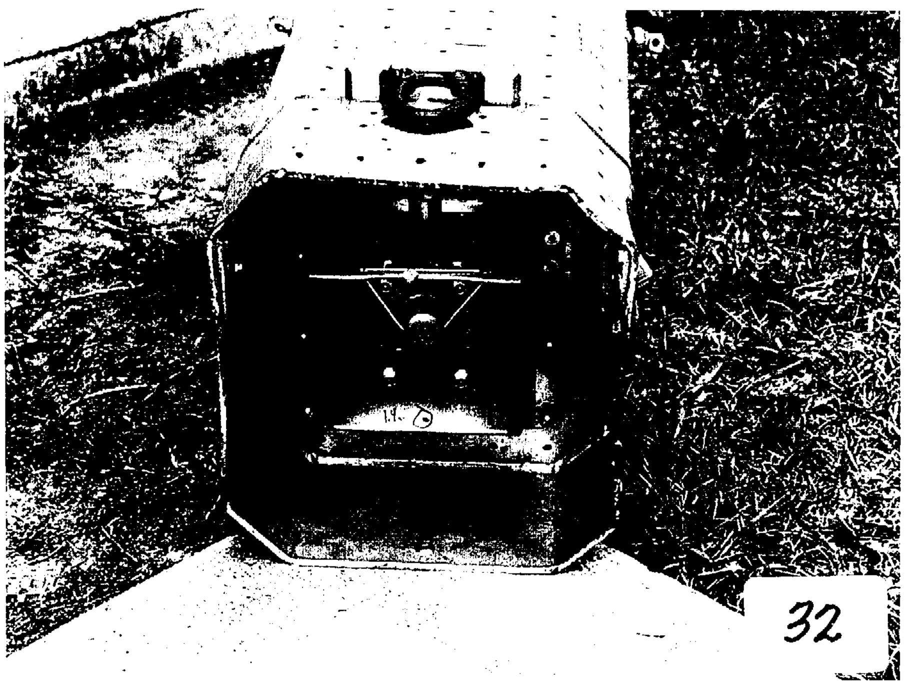
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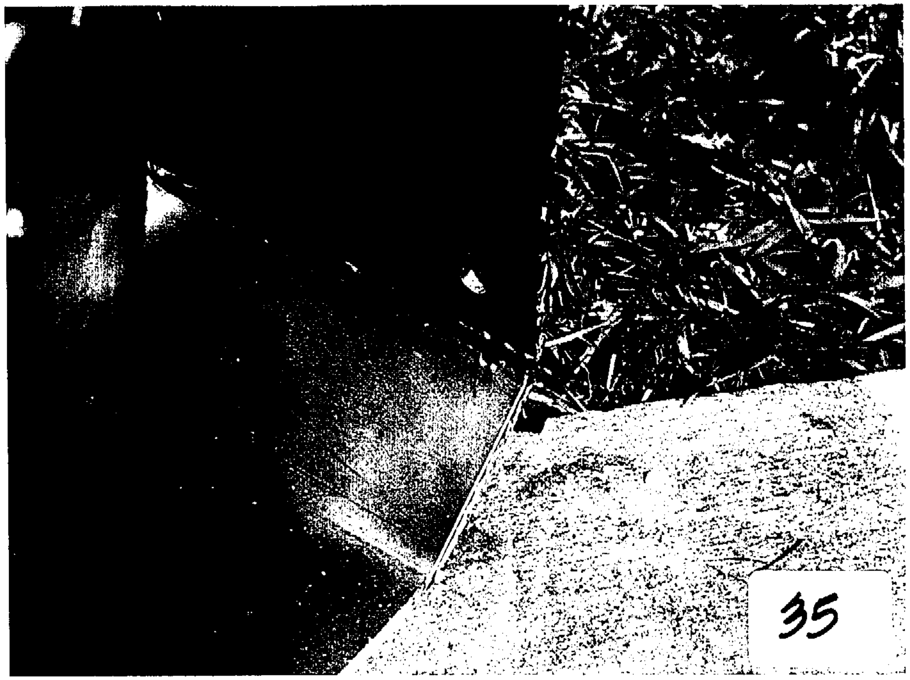

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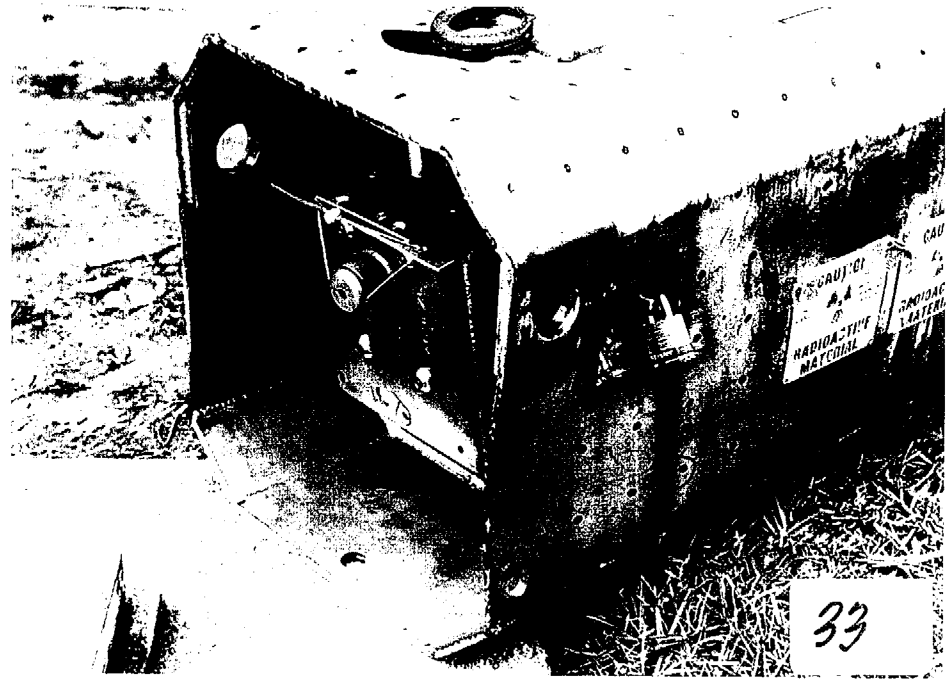

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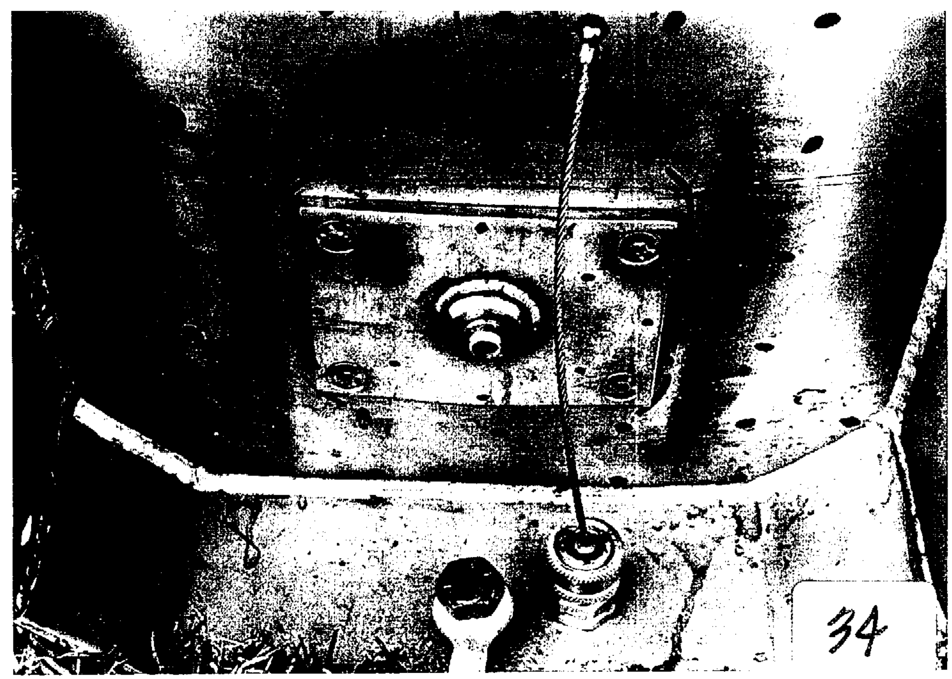

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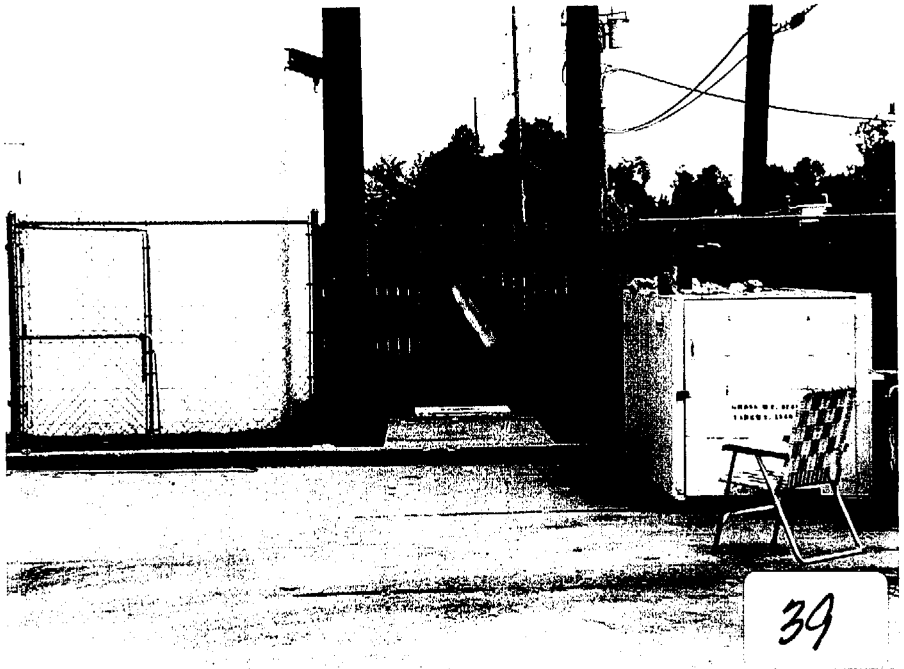
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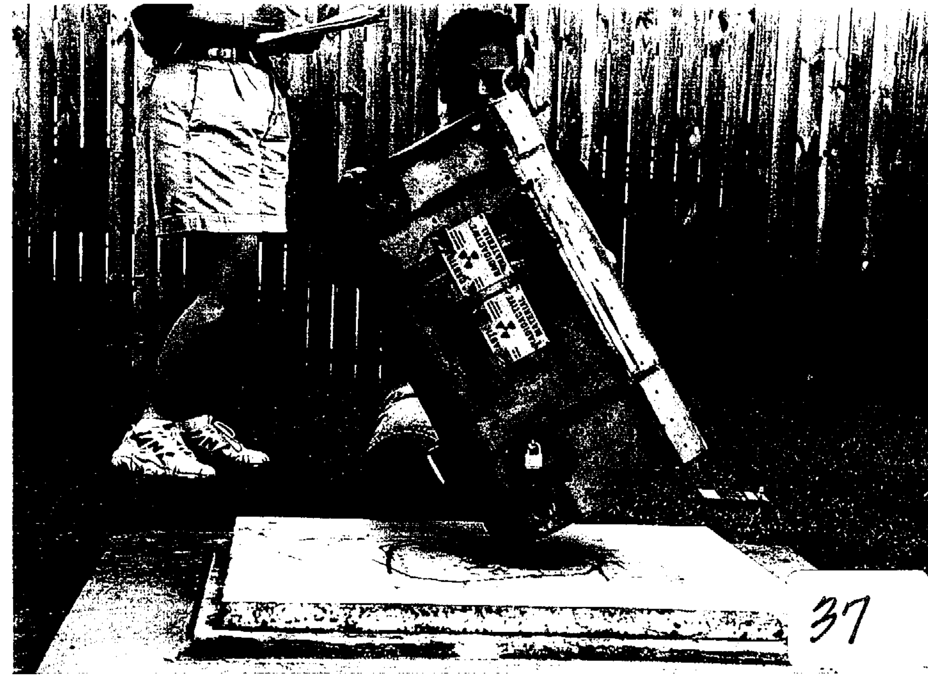
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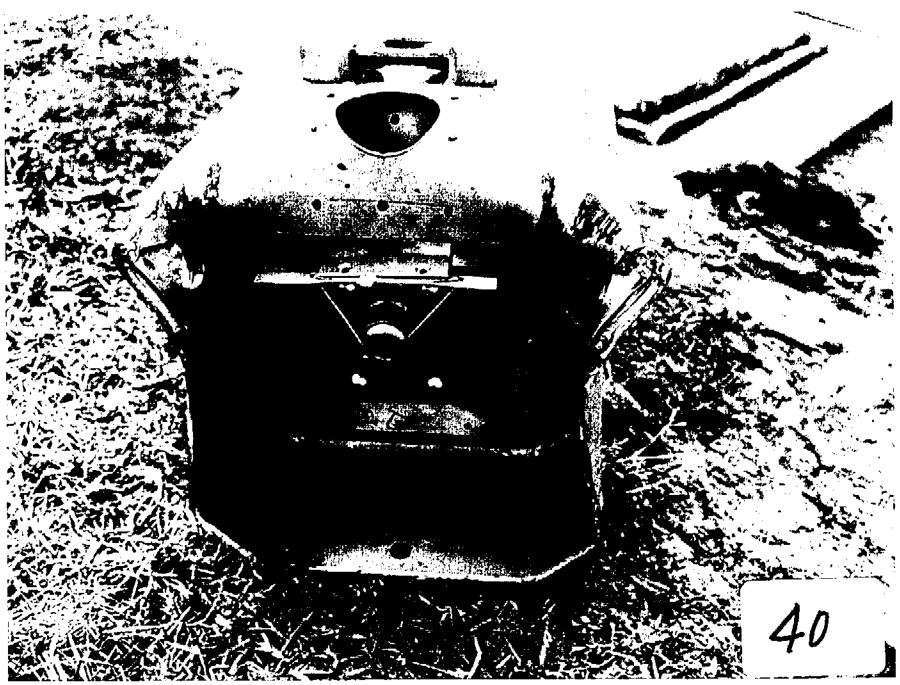
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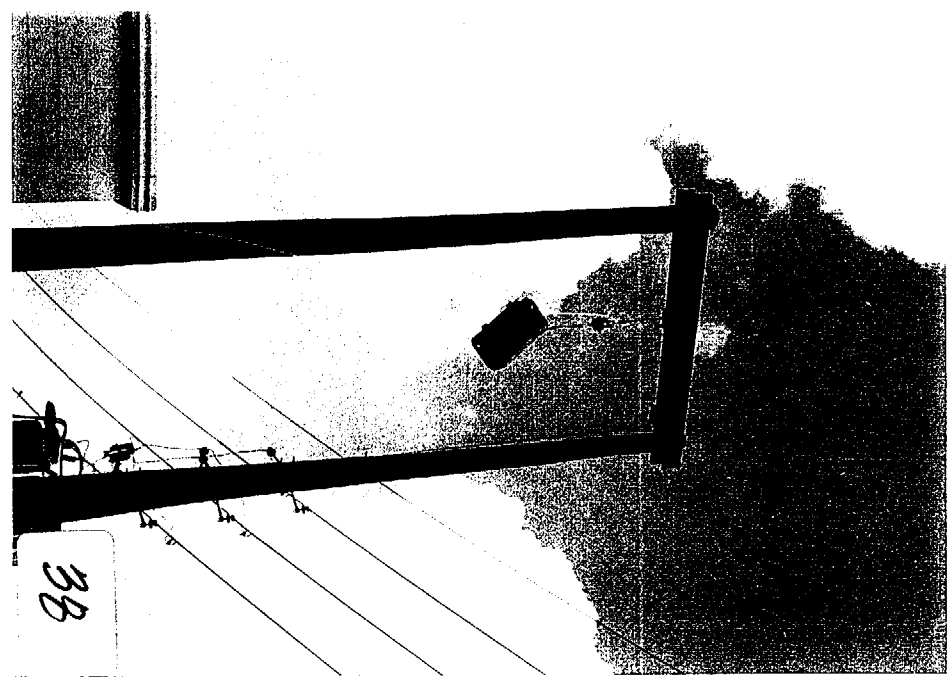
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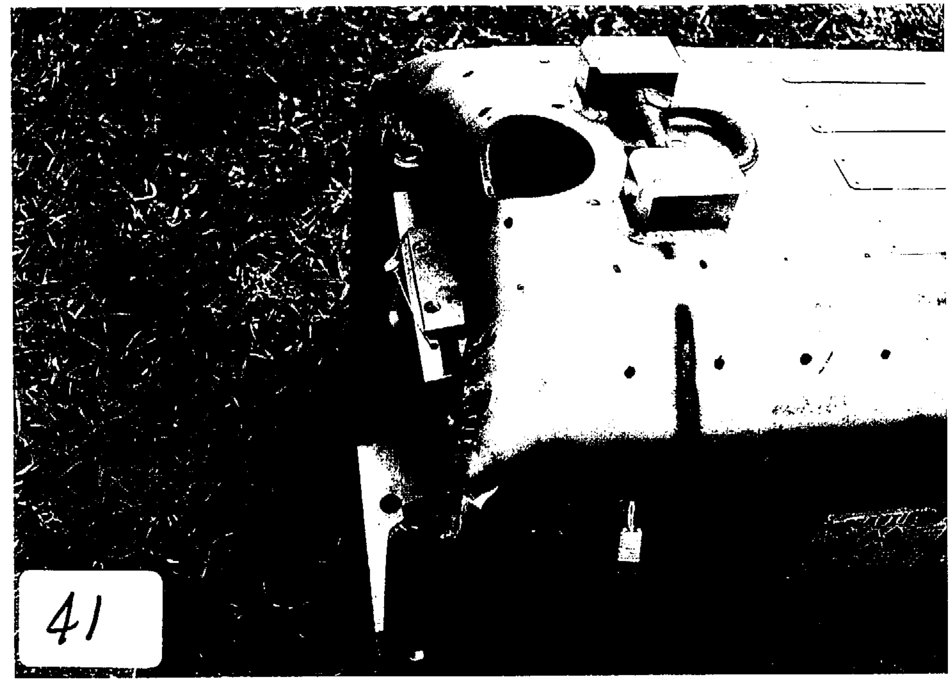
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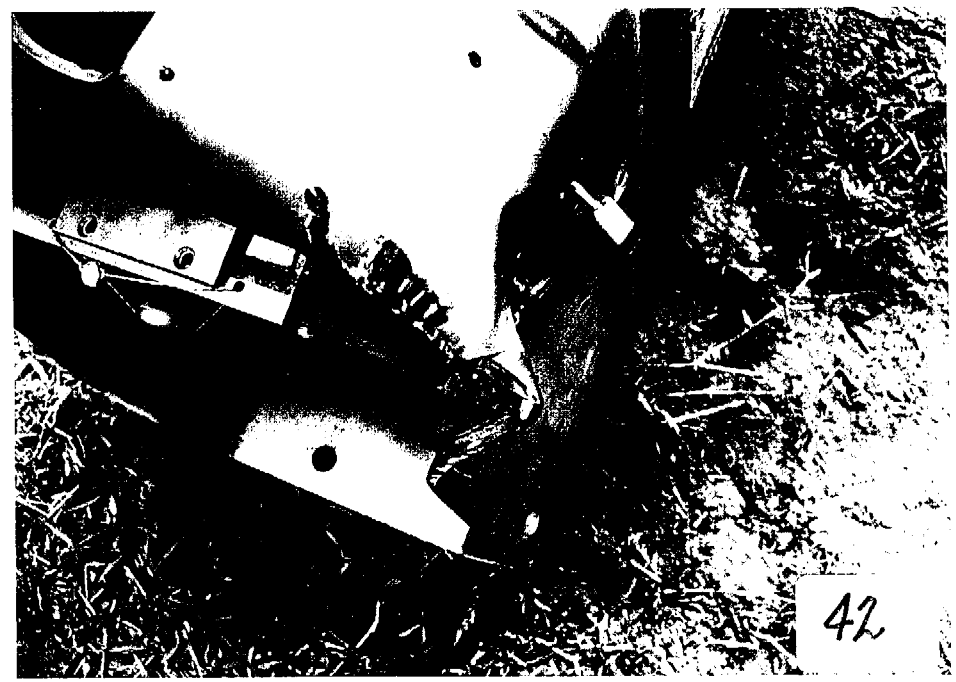
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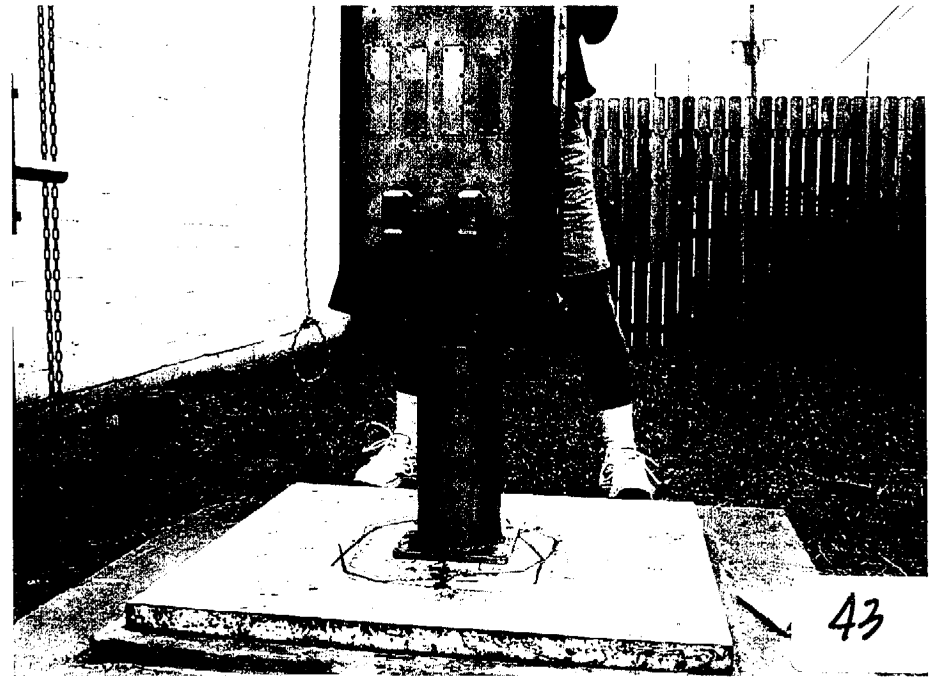
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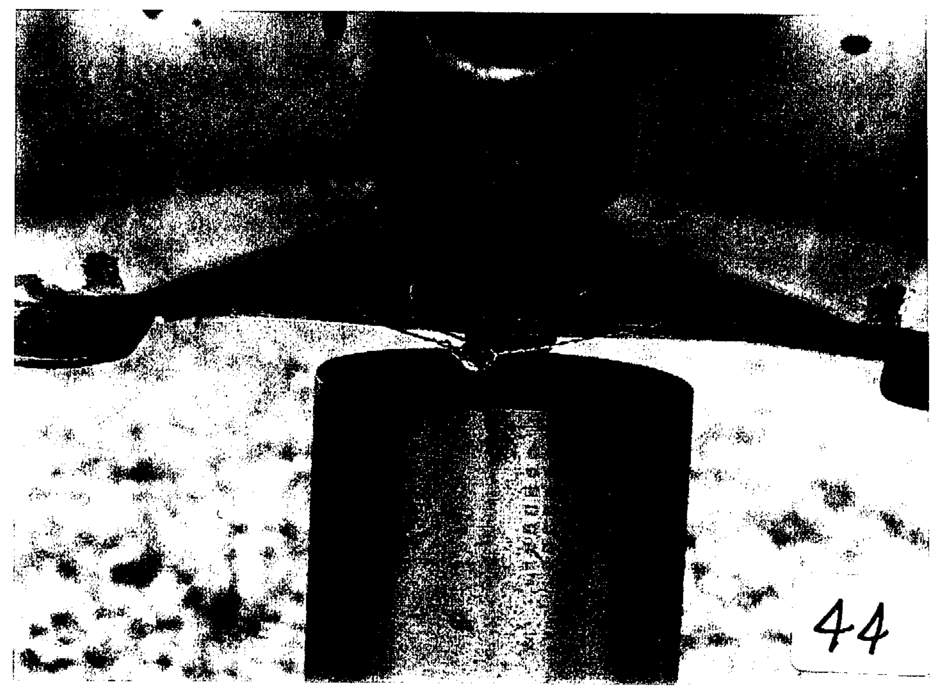
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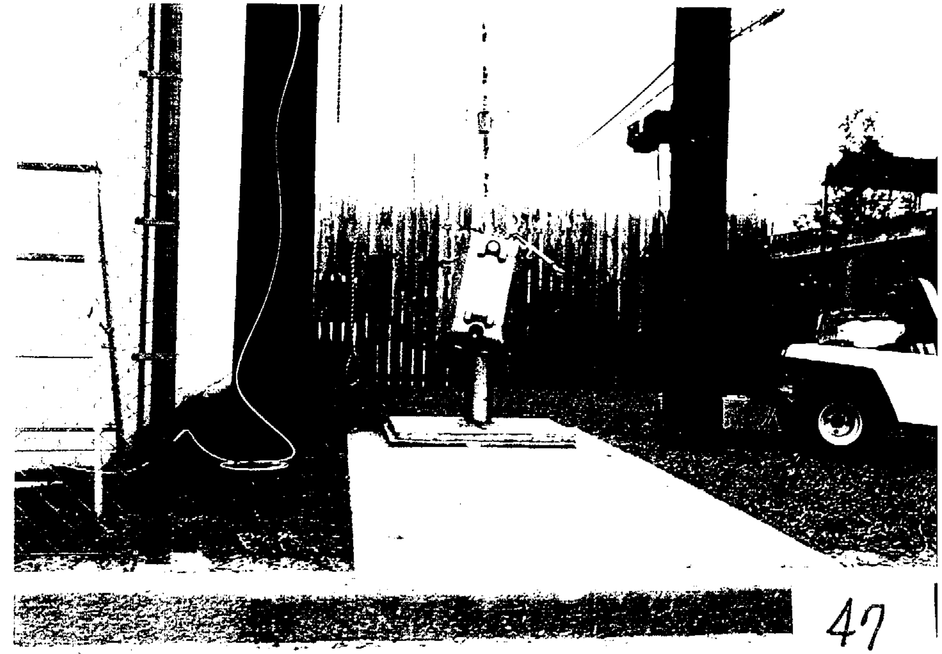

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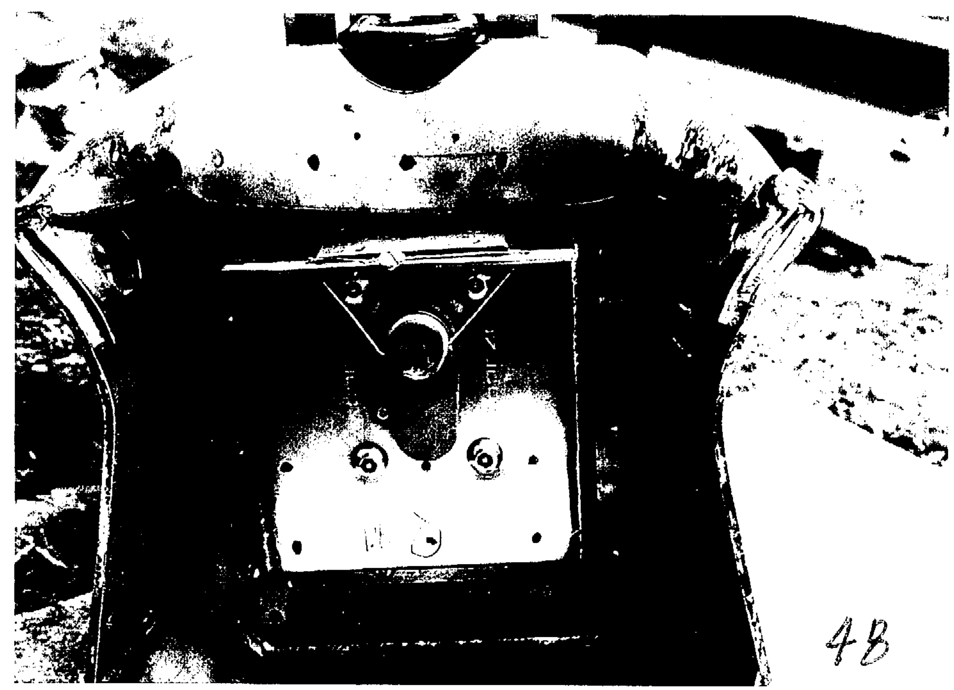

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3. THERMAL EVALUATION

Due to the materials of construction of the SPEC-300 which are known to have stable thermal properties and which will not be affected by the prescribed 800° C (1475° F) heat test it was not necessary to incorporate any special thermal engineering features in the package for it to comply with the normal conditions of transport and the hypothetical accident conditions.

3.1 Discussion

The heat of decay from the maximum activity 11.1 TBq (300 Ci) Cobalt-60 source is negligible. There are no fluids in the SPEC-300 package, it is not hermetically sealed, it is vented to the atmosphere, and there can be no pressure build up in the package. The effects of the free drop and percussion tests do not affect the thermal characteristics of the package since the individual materials of construction are not affected by a temperature of 800° C (1475° F). Buna rubber, foam and epoxy potting compound are the only materials which will be affected by the 800° C (1475° F) test temperature, but they are not critical to the safety of the packaging. Bronze has the next lowest melting point which is not lower than 704° C (1300° F). Melting of the bronze bushing in the automatic securing mechanism/lock module would only prevent unlocking the package. The hypothetical accident temperature of 800° C (1475° F) would affect the temper of the springs in the automatic securing mechanism/lock module, but it would remain in the locked position. A temperature of -40° C (-40° F) would have no adverse effect on the materials of construction since there are no moving operational parts of the package.

3.2 Summary of Thermal Properties of Materials

References: ASM International, Guide to Materials Engineering Data and Information, 1986.
Private Communication - Nuclear Metals, Incorporated.
Private Communication - Mitech Metals, Inc.

The materials of construction are as follows:

Structural Materials	Melting Temperature	
Depleted Uranium	1132° C	(2070° F)
CRES (Stainless Steel); 304, 316	1399° C	(2550° F)
Titanium Grade 2	1649° C	(3000° F)
Tungsten (alloy)	1649° C	(3000° F)
Zircalloy 2	1799° C	(3270° F)

The following non-structural materials are assumed to melt or be volatilized above 800° C (1475° F)

Aluminum
Bronze, Imperial
Epoxy
Polyurethane Foam

Rubber 70 Buna
Enamel Paint

From the above table it is apparent that a temperature of 800° C (1475° F) would have no effect on the package.

There have been reports indicating a possibility of a iron-Uranium eutectic formation at temperatures above 727° C (1340° F). Such eutectic formation has been associated with metallurgically clean surfaces and vacuum heat treatment. The depleted Uranium casting in the SPEC-300 is coated with enamel paint at the factory. Foam and epoxy potting compound would come in contact with the enamel paint on the shield exterior, but the iron-bearing SPEC-300 enclosure does not come in direct contact with the depleted Uranium shield. Copper pads are used as eutectic barriers at all locations where contact could occur. Depleted Uranium castings have employed Titanium S-tubes for years without any indication of a Titanium-Uranium eutectic.

3.3 Technical Specification of Components

This section is not applicable. The only operating component in the SPEC-300 package is the source assembly lock which is a one piece component made of stainless steel which is not affected by an 800° C (1475° F) temperature. The SPEC-300 is locked when the package is prepared for transport. There are no operating components during transport.

3.4 Thermal Evaluation for Normal Conditions of Transport

The radiation level shielding and containment of the source assembly within the SPEC-300 is totally dependent on materials which are not adversely affected by temperatures in the range of -40° C (-40° C) to 70° C (158° F). Therefore, the SPEC-300 package will not release it contents, will not allow increased radiation levels, and will not incur any reduction in the effectiveness of the package.

3.5 Hypothetical Accident Thermal Evaluation

The purpose of the thermal test assessment is to supply information that the SPEC-300 meets IAEA-85 thermal test requirements. To prove that the SPEC-300 complies with the thermal regulations, there are two issues to be investigated. The first issue is the effect of temperature on the materials of construction, and the second issue is the rate of heat transfer into the package, and particularly into the depleted Uranium shield.

Issue #1:

The SPEC-300 is comprised of several different materials. The shielding material is depleted Uranium, and the support structure and enclosure are composed of 300 series stainless steel. Both of these materials have melting temperatures higher than the temperature of 800° C (1475°F) required by the thermal test in Part 71.73(c)(4). This results in no structural complications on the SPEC-300 package when exposed to the thermal test.

The other materials used in this package which are not considered structural parts, but still have a

higher melting temperature than 800° C (1475°F) are: copper, tungsten, bronze, titanium, and the paint around the shield. These materials would neither be affected by a thermal test, nor lead to structural changes which would cause the loss of any radioactive material from the package.

The materials used in the SPEC-300 which are not structural parts and have a lower melting temperature than 800° C (1475°F) are: potting compound, polyurethane foam, and the buna rubber. These materials are expected to melt or volatilize to some degree during a thermal test. When these materials began to melt during the test, some of them will produce gases. These gases will not increase the pressure in the SPEC-300 because the package is not hermetically sealed. The gases will naturally vent to the exterior of the package. Loss of these materials during a thermal test will neither reduce the shielding effectiveness of the package nor lead to structural changes which would cause the loss of any radioactive material from the package.

Issue #2:

The purpose of this assessment is to supply additional information to support our assertion that the SPEC-300 meets IAEA-85 thermal test requirements, with particular emphasis placed on the effects from forced convection (high convective velocity).

The thermal analysis included in discussion #1 was mainly a comparison of the melting temperatures of package materials compared against the specified test temperature. While this analysis is valid, other effects such as high temperature oxidation of the Depleted Uranium casting were not discussed.

The primary concern is the temperature of the Depleted Uranium shield at the end of the test. A recent test on another manufacturer's design has demonstrated that shielding effectiveness can be compromised if the shield reaches a temperature where severe high temperature oxidation occurs. There are three modes by which the shield can increase in temperature during the test; conduction, convection, and radiation.

Conduction:
The means for the shield to be heated by conduction is heat transfer from the CRES housing of the package through the two-component chocking compound used to constrain the shield and through the polyurethane foam encasing the shield. Assuming the temperature of the stainless steel housing of the package to be 800° C (1475°F), and considering the fact that only a small portion of the shield is in contact with the potting compound, and considering the thermal conductivity of the chocking compound, significant temperature rise is not expected. Assuming the temperature of the stainless steel housing of the package to be 800° C (1475°F), an average foam thickness of 50 mm (2 in), and considering the thermal conductivity of the foam, significant temperature rise is again not expected.

Convection:
Significant convective heat transfer is expected between the heat source and the 300 series CRES housing of the package. Our analysis assumes forced convection (high convective velocity) to be the primary means of heat transfer to the housing. For this reason we assume the housing will quickly reach equilibrium temperature with the 800° C (1475°F) environment. Convective heat transfer cannot occur inside the package since there is no convective heat transfer medium. For this reason the temperature of the Depleted Uranium shield is not expected to increase due to direct convection.

Radiation:
Radiation is expected to be the primary means of heat transfer between the package enclosure and the Depleted Uranium shield. For purposes of radiative heat transfer the two-component chocking compound and the polyurethane foam are assumed not to exist. Considering the large thermal mass of the shield and the 30 minute duration of the test, it is expected that the shield temperature will remain well below the point at which oxidation or combustion could begin.

Summary:
To comply with the thermal requirement, the SPEC-300 package was designed such that the Depleted Uranium shield is well protected from the primary means of heat transfer from the fire to the package, convection. The package housing is robust enough not be breached as a result of the four 9 meter (30 ft) tests and a 1 meter (39.4 in) puncture test that precede the thermal test. Prototype testing proved this, and post test inspection confirmed that the welds did not crack.

Conclusion:
The package meets the IAEA-85 thermal test criteria because the Depleted Uranium shield is well protected from high convective velocity heat transfer, which is the primary means of heat transfer.

4. CONTAINMENT

4.1 Containment Boundary

4.1.1 Containment Vessel

The sealed source capsule containing the Cobalt-60 pellets described in Section 2.8.1 represents the primary containment boundary and vessel. This capsule meets the requirements of 10 CFR 71.75 and 49 CFR 173.469 for special form radioactive material.

4.1.2 Containment Penetrations

None.

4.1.3 Seals and Welds

The sealed source capsule is fused in a thermal metal joining procedure to meet the requirements of special form radioactive material and there are no mechanical or chemical seals pertaining to the primary containment capsule.

4.1.4 Closure

The special form, sealed source capsule may only be opened destructively and there are no mechanical closure provisions.

4.2 Requirements for Normal Conditions of Transport

4.2.1 Release of Radioactive Material

Based on the results of the evaluations for normal conditions of transport performed in Section 2.8 above, there is no release of radioactive material from the primary containment vessel.

4.2.2 Pressurization of Containment Vessel

No gas is produced inside the sealed source capsule; the only gasses present in the capsule are those found in the atmosphere at the time the capsule is loaded and welded. The only increase in stress due to the pressure from gasses inside the capsule would result from a decrease in pressure outside the capsule. The maximum value for is pressure is one atmosphere 101 kPa (14.7 psi) if the capsule were placed in a "hard" vacuum environment. Paragraph 2.5.2 of this application demonstrates the adequacy of the sealed source capsule under this condition.

4.2.3 Coolant Contamination

Not applicable. No coolants are used in the package.

4.2.4 Coolant Loss

Not applicable. No coolants are used in the package.

4.3 Containment Requirement for the Hypothetical Accident Conditions

4.3.1 Fission Gas Products

Not applicable. No fissionable radioactive material is used in the SPEC-300 package.

4.3.2 Releases of Contents

Based on the results of the Type B performance tests described in Paragraph 4.1.1 the special form sealed source capsule was not affected in any manner. Therefore, there can be no release of radioactive material from the primary containment vessel due to the conditions specified in the hypothetical accident conditions.

5. SHIELDING EVALUATION

Adequate shielding design for the SPEC-300 was confirmed by actual measurements of radiation profiles from the prototype shield, and by actual measurements of resulting radiation levels after the numerous tests performed for normal conditions of transport and hypothetical accident conditions. Theoretical calculations were not used.

5.1 Package Shielding

A depleted Uranium casting weighing 238 kg (525 lb) max is used for the principal shielding material. See appendix 5.5 for a drawing of the shield. A Titanium, Titanium alloy, or zircalloy S-Tube permits the source assembly to pass through the depleted Uranium shield for use as an industrial radiography exposure package. When the SPEC-300 is used as a transport package, the sealed source capsule is positioned at or very near the center of the depleted Uranium shield primarily by the transport lock mechanism. A redundant mechanism is the automatic securing mechanism/lock module which independently secures the source during transport. The transport lock and the source assembly lock must be locked in order to prepare the package for shipment. The source assembly lock cannot be locked unless the source assembly is positioned with the source capsule in the in fully shielded position. The transport lock, automatic securing mechanism, device lock, lock cap and safety plug provide mutually redundant safety systems for securing the source assembly at the proper position in the shield. The curvature of the S-Tube and the elongated shape of the depleted Uranium shield attenuate primary radiation.

Measurements were taken on the surface of the prototype before the normal conditions of transport and hypothetical accident condition tests. Radiation readings were taken at points on an approximately 50 mm (2 in) by 50 mm (2 in) grid located on each of the six sides of the package. This provided 91 points each on the top and bottom, 78 points each on the left and right sides, 67 points on the outlet end plate, and 50 points on the lock end plate, for a total of 455 measurement points. A correction factor was applied to compensate for the diameter of the detector probe. Measurements were taken with a 1.27 tBq (34.4 Ci) Cobalt-60 source and the results were extrapolated to 11.1 TBq (300 Ci) Cobalt-60.

Surface readings extrapolated to 11.1 tBq (300 Ci) Cobalt-60

Package Surface	Number of Points	Maximum mSv/hr(mR/hr)		Minimum mSv/hr(mR/hr)		Average mSv/hr(mR/hr)	
Top	91	1.98	(198)	13	(2)	53	(30)
Bottom	91	0.59	(59)	8	(2)	56	(13)
Left Side	78	0.18	(18)	21	(2)	64	(8)
Right Side	78	1.8	(180)	18	(6)	50	(38)
Lock End	50	1.2	(120)	18	(6)	34	(25)
Outlet End	67	0.9	(90)	13	(6)	25	(21)

Measurements were taken of the maximum radiation level at one meter (39.4 in) from each of the six

surfaces of the prototype package using a 1.27 tBq (34.4 Ci) Cobalt-60 source and the results were extrapolated to 11.1 tBq (300 Ci) Cobalt-60.

Readings at one meter (39.4 in) from Surface extrapolated to 11.1 tBq (300 Ci) Cobalt-60:

Package Surface	Maximum mSv/hr	Maximum mR/hr
Top	0.01	1.2
Bottom	0.02	1.7
Left Side	0.02	1.7
Right Side	0.02	1.7
Lock End	0.02	1.7
Outlet End	0.04	3.5

Measurements were taken of the maximum radiation level at 30 cm (11.8 in) from each of the six surfaces of the prototype package using a 1.27 tBq (34.4 Ci) Cobalt-60 source and the results were extrapolated to 11.1 tBq (300 Ci) Cobalt-60.

Readings at 30 cm (11.8 in) from Surface extrapolated to 11.1 tBq (300 Ci) Cobalt-60:

Package Surface	Maximum mSv/hr	Maximum mR/hr
Top	0.16	16
Bottom	0.05	5.2
Left Side	0.04	3.5
Right Side	0.05	5.2
Lock End	0.07	7.0
Outlet End	0.05	5.2

Measurements were taken of the maximum radiation level at 5 cm (2 in) from each of the six surfaces of the prototype package using a 1.27 tBq (34.4 Ci) Cobalt-60 source and the results were extrapolated to 11.1 tBq (300 Ci) Cobalt-60.

Readings at 5 cm (2 in) from Surface extrapolated to 11.1 tBq (300 Ci) Cobalt-60:

Package Surface	Maximum mSv/hr	Maximum mR/hr
Top	1.22	122
Bottom	0.30	30
Left Side	0.09	9
Right Side	0.82	82
Lock End	0.37	37
Outlet End	0.24	24

5.2 Normal Conditions of Transport

See appendix 5.5 for selection and justification of package orientation for normal conditions of transport tests. Radiation surveys were performed before and after each normal conditions of transport test: free drop and penetration. Radiation levels were measured at sufficient locations to determine if there was significant change compared with the pre-test radiation level. There was no measurable change in radiation levels after the free drop test or either of the two penetration tests.

Maximum radiation level for each of the six sides was measured before the normal conditions free drop test. Post-test radiation levels were measured at the same locations. A 1.26 tBq (34.1 Ci) source was used for the tests. The results were not extrapolated since the criterion refers to a percent increase in radiation levels. The results are tabulated below:

Free drop test:

	Max pre-test mSv/hr(mR/hr)		Max post-test mSv/hr(mR/hr)	
Top	0.21	(21)	0.21	(21)
Bottom	0.06	(6.4)	0.06	(6.2)
Right Side	0.18	(18)	0.17	(17)
Left Side	0.02	(2)	0.01	(1)
Outlet End	0.04	(4)	0.04	(4)
Lock End	0.14	(14)	0.13	(13)

Penetration tests:

Radiation levels at points expected to be most affected by the penetration tests were measured before the normal conditions penetration tests. Post-test radiation levels were measured at the same points. A 1.26 tBq (34.1 Ci) source was used for the tests. The results were not extrapolated since the criterion refers to a percent increase in radiation levels. The results are tabulated below:

Penetration test #1:

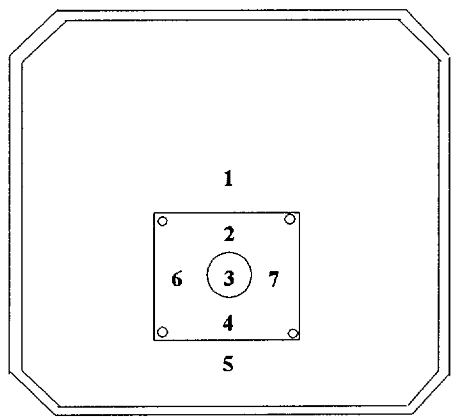

Illustration of the outlet end of the package
showing radiation measurement points

1st penetration test (outlet end)

	pre-test mSv/hr(mR/hr)		post-test mSv/hr(mR/hr)	
Point #1	0.01	(1.2)	0.01	(1.2)
Point #2	0.04	(4.0)	0.04	(3.6)
Point #3	0.14	(14.0)	0.13	(13.0)
Point #4	0.03	(3.2)	0.02	(2.0)
Point #5	0.01	(1.2)	0.01	(1.0)
Point #6	0.02	(2.0)	0.02	(2.0)
Point #7	0.03	(3.2)	0.03	(3.0)

Penetration test #2:

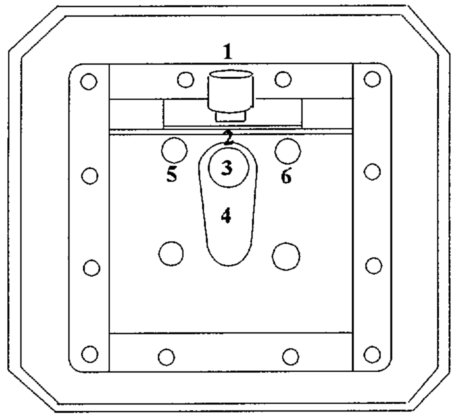

Illustration of the lock end of the package
showing radiation measurement points

2nd penetration test
(lock end)

	pre-test mSv/hr(mR/hr)		post-test mSv/hr(mR/hr)	
Point #1	0.01	(1.2)	0.01	(1.0)
Point #2	0.03	(2.6)	0.02	(2.4)
Point #3	0.02	(2.2)	0.02	(2.0)
Point #4	0.01	(1.2)	0.01	(1.2)
Point #5	0.02	(2.2)	0.02	(1.8)
Point #6	0.02	(1.6)	0.02	(1.6)

The maximum increase in surface radiation levels after the free drop and penetration tests tabulated above was 0% which is less than the 20% maximum allowable increase in surface radiation specified in IAEA Safety Series No. 6 Regulations for the Safe Transport of Radioactive Material 1985 Edition (As Amended 1990). Based on the low surface readings, readings at one meter (39.4 in) were not taken as they would be too low to be reliably measured.

5.3 Hypothetical Accident Conditions

Four successive 9 meter (30 ft) drop tests were conducted on the prototype package to address any questions concerning the proper selection of the impact point and orientation for which maximum damage is expected. These tests were followed by the puncture test. Safety radiation surveys were

performed between each test. Damage to the package was cumulative. Maximum surface radiation levels were taken for each side of the device at the conclusion of the free drop and puncture tests. Readings were also taken at one meter (39.4 in), but with the exception of the outlet end, readings were too low to be reliably measured. A 0.55 tBq (14.9 Ci) Cobalt-60 source was used for the hypothetical accident conditions tests. The maximum radiation level at one meter (39.4 in) from each of the six surfaces, extrapolated to 11.1 tBq (300 Ci) are tabulated below:

Post-test Radiation Levels at the surface of the package, corrected and extrapolated to 11.1 tBq (300 Ci)
Readings taken after free drop and puncture tests.

	Radiation levels	
	mSv/hr	mR/hr
Top	1.82	(182)
Bottom	0.68	(68)
Right Side	1.61	(161)
Left Side	0.28	(28)
Lock End	0.83	(83)
Outlet End	27.60	(2760)

Post-test Radiation Levels one meter (39.4 in) from the surface of the package, corrected and extrapolated to 11.1 tBq (300 Ci)
Readings taken after free drop and puncture tests.

	Radiation levels	
	mSv/hr	mR/hr
Top	0.04	(4)
Bottom	0.04	(4)
Right Side	0.04	(4)
Left Side	0.04	(4)
Lock End	0.04	(4)
Outlet End	0.56	(56)

The highest radiation level at one meter (39.4 in) is 0.56 mSv/hr (56 mR/hr), far below the allowable limit of 10 mSv/hr (1000 mR/hr) at one meter (39.4 in).

5.4 Source Specification

As noted above, The source assembly used in the normal conditions of transport testing was a SPEC model G-70 Cobalt-60 source with an activity of 1.26 tBq (34.1 Ci). The source assembly used in hypothetical accident condition testing was a SPEC model G-70 Cobalt-60 source with an activity of 0.55 tBq (14.9 Ci).

5.5 Model specification

Not applicable. Physical radiation measurements were performed on a prototype package and radiation surveys were performed on the prototype test package after the tests for normal conditions of transport and hypothetical accident conditions. Theoretical calculations or scale models were not used.

5.6 Shielding Evaluation

Test results showed that radiation levels are within limits for a type B package. There was no significant increase in radiation levels after normal condition or hypothetical accident condition tests. The maximum radiation level of 0.56 mSv/hr (56 mR/hr) at one meter (39.4 in) from the surface of the prototype package after the conclusion of free drop tests and puncture test demonstrates the SPEC-300 meets the 10mSv/hr (1.0 R/hr) at one meter (39.4 in) criteria for hypothetical accident condition tests. The shielding evaluation of the prototype confirms that the package meets the shielding criteria for a Type-B package. The maximum radiation levels after the conclusion of the four 30-foot drop tests and puncture test on the prototype conclusively demonstrates that the SPEC-300 meets the shielding requirements for a Type B package.

Appendix 5.7

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
.XX±.50

DO NOT SCALE DRAWING

TREATMENT
NONE

FINISH
NONE

APPROVALS	DATE
DRAWN RAM	9/2/98
CHECKED PW	9/23/98
ISSUED RDD	9/24/98
QA CLASS Q-A	

SOURCE PRODUCTION & EQUIPMENT CO., INC.
113 TEAL ST, ST ROSE, LA 70087

DU SHIELD–
CO–60,
SPEC–300 EXPOSURE DEVICE

SIZE C | DWG NO. B190700 | REV 1

SCALE: 1/2 | M 00058101 | SHEET 1 OF 1

SOURCE PRODUCTION AND EQUIPMENT COMPANY
ST. ROSE, LOUISIANA

SPEC-300 Exposure Device
Justification of Package Orientation for:
4 Foot Free Drop
30 Foot Free Drop
Puncture Test

Prepared by: Kenny Carrington and Pete Weber
Date: 6/8/99
Rev: 1

Purpose:
10 CFR 71.71 (c) (7) describes a drop test consisting of a 4 foot free drop onto a flat, essentially unyielding horizontal surface striking in a position for which a maximum damage is expected.

10CFR 71.71 (c) (10) describes a penetration test consisting of an impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in) diameter and 6 kg (13 lbs) mass, dropped from a height of 1 m (40 in) onto the exposed surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.

10 CFR 71.73 (c) (1) describes a drop test consisting of a 30-foot free drop onto a flat, essentially unyielding horizontal surface striking in a position for which a maximum damage is expected.

10 CFR 71.73 (c) (2) describes a puncture test consisting of a 40" free drop onto a 6" diameter mild steel bar. The package should strike the bar in a position for which maximum damage is expected.

This document defines the test package orientation expected to produce maximum damage for the four tests described above, and states the rationale for the orientation chosen.

Scope:
The following radioactive material package will be considered:
SPEC-300 Exposure Device/Type B transport package.
Testing is scheduled for the week of June 7, 1999.

Maximum Damage definition:

4 foot free drop and penetration tests:

"Maximum damage" is not defined in 10CFR 71.71, but 10CFR 71.43 (f) states: A package must be designed, constructed, and prepared for shipment so that under the tests specified in Sec. 71.71 (``Normal conditions of transport'') there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging. It is highly unlikely that the sealed radioactive source assembly will shift in the depleted Uranium shield as a result of these tests, and only minimum damage is expected to the device enclosure. For these tests, maximum damage will be defined as a test-induced condition that results in a 20% or greater increase in radiation level, when compared to a pre-test radiation level at the same location, and this will be attempted by trying to jar either the safety plug or the lock cap (safety cap) off of the device.

30 foot free drop and puncture tests:
"Maximum damage" is not defined in 10 CFR 71.73, but 10 CFR 71.51 (a) (2) specifies that as a result of testing, the radiation dose rate will not exceed one REM/hr at one meter from the external surface of the package. For these tests, maximum damage will be considered as the condition that provides maximum movement, or chance of movement, of the sealed radioactive source assembly away from the fully shielded position within the depleted Uranium shield. This is the condition most likely to result in increased radiation levels outside the device.

SPEC-300 construction overview:
The SPEC-300 exposure device is a depleted Uranium shield weighing approximately 500 pounds enclosed in a robust rectangular welded stainless steel enclosure. The shield is retained in the enclosure by two tabs or "ears" that are cast integrally with the shield. Each tab is fastened to the corresponding end bulkhead of the enclosure by means of a solid support welded to the bulkhead. Two additional internal brackets support the depleted Uranium shield. The interior of the enclosure is filled with a dense structural foam that further supports and cushions the depleted Uranium shield. The foam also increases the overall strength of the enclosure. Attached to the lock-end bulkhead on the outside of the enclosure is a sheet metal lock box containing a lock module and transport lock. The transport lock is the primary mechanism maintaining the radioactive pigtail assembly at the desired location in the depleted Uranium shield. Attached to the opposite-end bulkhead is a panel containing a quick connect nipple. A safety plug is attached to this nipple. The safety plug includes a length of wire rope cable that when inserted and secured to the nipple, acts to prevent the source from moving significantly in the direction of the outlet end of the device. The ends of the device are designed to act as "crumple zones". The bulkheads are recessed several inches into the ends of the device, forming a large "lip" all around, which during testing is expected to crush and deform, absorbing significant impact energy. This feature has been demonstrated on both the SPEC-150 and SPEC 2-T, which share a common design.

SPEC-300 4 foot free drop package orientation:
The failure criterion for the 4 foot free drop test is a 20% increase in radiation levels after the test. Considering that the device is designed to withstand a 30 foot drop, significant damage is not expected when the device is dropped only 4 feet. Movement of the radioactive source assembly away from the fully shielded position in the depleted Uranium shield therefore will not be a goal of this test. The most likely means of increasing radiation levels by 20% would be to cause one of the protective caps located at each end of the device to come adrift. Considering the design of the

device and end caps, it is most likely that this will occur if the device is dropped flat on the lock end. Deformation of the "crumple zone" at the lock end of the device could result in an impact to the lock cap. Such an impact could damage the boss that retains the cap in place, and cause the cap to come adrift. Removal of the lock end cap does result in an increase in radiation level at the lock end of at least 20%. SPEC has therefore decided that this concept will be used in the 4 foot free drop test.

Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

SPEC-300 penetration test package orientation:
The failure criterion for the penetration test is a 20% increase in radiation levels after the test. Considering that the device is designed to withstand a 30 foot drop, significant damage is not expected when the device is subjected to this test. Movement of the radioactive source assembly away from the fully shielded position in the depleted Uranium shield therefore will not be a goal of this test. The most likely means of increasing radiation levels by 20% would be to cause one of the protective caps located at each end of the device to come adrift. The most effective means of causing this failure would be to perform the test twice, impacting the device on the safety plug at the outlet end and then on the lock cap at the lock end of the device. Removal of the safety plug or lock end cap would result in a localized increase in radiation level of at least 20%. SPEC has therefore decided that this concept will be used in the penetration test.

Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

SPEC-300 30 foot free drop test package orientation:
In an attempt to drop the exposure device on a point that would cause maximum damage as defined above, several ideas were considered and discussed with NRC:

The first concept involves dropping the device flat on the outlet end. An impact at this point could cause the mass of the shield to deform the outlet-end bulkhead, resulting in the shield shifting toward the outlet end of the device, effectively pulling the radioactive source assembly out of the fully shielded position. An observation about this concept is that the ends of the device are designed to act as "crumple zones", and the deformation of one of these zones would absorb significant impact energy before the shield would begin to shift. In addition, the dense foam in the device would act to further absorb impact energy and prevent shifting of the shield.

The second concept involves dropping the device flat on the lock end. An impact at this point could cause the mass of the shield to deform the lock-end bulkhead, resulting in the shield shifting toward the lock end of the device. The lip around the end of the device would also be expected to crush. The combination of these two effects would potentially crush the lock box and transport lock, possibly even tearing them off. If this were to occur, the radioactive source could be pulled out of the fully shielded position. An observation about this concept is that since all of the forces expected are compression forces, it is likely that the lock box would simply be crushed, but still retain the source assembly in the fully shielded position.

The third concept involves dropping the device flat on the side opposite the hot top. The predicted failure mode would be a direct shock to the depleted Uranium casting causing failure (cracking) of the casting where the two tabs or "ears" join the spherical portion of the casting. These cast-in tabs are the thinnest and weakest part of the casting, and would bear most of the shock load. A side impact would induce significant bending stress in the tabs where they join the spherical portion of the casting. Chilling the device to -40°F or colder would cause low temperature embrittlement of the depleted Uranium casting, allowing for a worst case condition. Contrary to the first and second concepts, there exists no crumple zone to attenuate the forces resulting from the impact. An observation about this concept is that a depleted Uranium shield has never failed during testing at SPEC, even in devices containing no foam. Also, considering the configuration of the shield (no stress risers) and the mechanical properties of depleted Uranium it is not expected that an impact of this magnitude would crack the shield. It is calculated that the device will only be traveling at 44ft/s or 30MPH at the end of the 30 foot fall.

The fourth concept involves dropping the exposure device on the edge formed by the top of the device and the lock end. An impact at a similar location has caused failures in early SPEC-150 prototype devices, which share a common design. The failure mode consists of shearing the welds attaching the lock end bulkhead to the device enclosure, particularly near the impact point. Whereas failure of these welds may not cause a direct increase in radiation levels, a breach in the device enclosure would cause the device to be much more vulnerable to the thermal test, which follows the 30 foot free drop test. A second failure mode would be shearing off the lock box and transport lock. Since the lock box and transport lock are the means of retaining the radioactive source assembly in the fully shielded position, this failure could allow the radioactive source to be pulled out of the fully shielded position. An observation about this concept is that the transport lock and lock box are redundant mechanisms, and the transport lock is very securely fastened to the lock end bulkhead. The likelihood of both the transport lock and the lock box being sheared off due to this type of impact is low.

The four concepts described above each offer the possibility of maximum damage to the package. SPEC has therefore decided to perform the test 4 times, once in each orientation described above. Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, tests 1, 2, and 4 will be conducted with the enclosure at ambient temperature. Test 3 will be performed with the casting at low temperature as described above.

When the test is performed, steps will be taken to ensure that the center of gravity of the exposure device is directly above the impact point at the time of release. This will ensure that maximum energy will be focused at the desired impact point.

SPEC-300 Puncture test package orientation:

Considering the size of the puncture test pin relative to the SPEC-300 exposure device, as well as the overall design of the device, it is not expected that the puncture test pin will penetrate the device or cause internal damage. The next best chance for this test to cause maximum damage would be to damage the lock box, possibly compromising the means to position the radioactive source assembly at the fully shielded position in the depleted Uranium shield. The lock box

consists of a relatively thin sheet metal enclosure that attaches externally to the lock-end bulkhead of the device. Inside the lock box is the transport lock, a mechanism that acts as the primary means of positioning the radioactive source assembly at the fully shielded position in the depleted Uranium shield. If the lock box can be moved out of position, coupled with failure to the transport lock or the source assembly, it could drag the source assembly out from the center of the depleted uranium shield. This shift of position of the source assembly could result in abnormally high radiation levels.

Since the lock box is the only externally mounted item whose damage could result in maximum damage, SPEC has decided that this concept will be used in the puncture drop test. When the test is performed, steps will be taken to ensure that the center of gravity of the exposure device is directly above the impact point at the time of release. This will ensure that maximum energy will be focused at the desired impact point. Since the 300 series stainless steel used for the device enclosure becomes stronger and tougher as temperature is reduced, the test will be conducted with the enclosure at ambient temperature.

Assessment Conducted By: [signature] Date 6/8/99
Kenny Carrington, Special Projects Manager

[signature] Date 6.8.99
Pete Weber, General Manager

Reviewed By: [signature] Date 6/8/99
Richie Melancon, Engineering Manager

Approved By: [signature] Date 6/9/99
Donny Dicharry, President

Filename: H:\WP\DOCS\IMPACT.WPD

6. CRITICALITY EVALUATION

This section is not applicable. The SPEC-300 does not contain and is not designed to transport fissile material.

7. OPERATING PROCEDURES

7.1 Procedures for Preparing and Loading the Package

Training of personnel who prepare, offer and transport hazardous material shipments, including the SPEC-300, for transport is required pursuant to 49 CFR 172.700, and Section 10 of the Louisiana Radiation Regulations.

The source assembly is loaded into the SPEC-300 at the SPEC facility under the provisions of Louisiana Radioactive Material License LA-2966-L01 in accordance with the procedures and radiation protection standards established under that license.

7.1.1 General Package Inspection

Visually inspect the SPEC-300 to determine if it is in unimpaired condition for shipment. The SPEC-300 should be inspected to determine that it is not damaged, that the locks operate properly, that the source assembly is securely locked in the package, and that the safety plug and lock cap are securely positioned. Verify that the package identification plate is present and legible, which identifies the package as a SPEC-300 and displays the Certificate of Compliance identification number.

7.1.2 Packaging

Verify that the source assembly is properly secured and locked in the SPEC-300. The source safety plug and the lock cap must be firmly attached.

Measure the maximum surface radiation level of the package. This radiation level must not exceed 2 mSv/hr (200 mR/hr). Measure the maximum radiation level at one meter (39.4 in) from the surface. This radiation level must not exceed 0.1 mSv/hr (10 mR/hr).

If the lock key is to be shipped in the same container with the camera, then seal the lock key in an envelope which will be destroyed when opened.

7.1.3 Outer Package Surface Contamination

Packages may be shipped on a non-exclusive use basis only if outer surface contamination levels are less than the values given below. It is it is the shipper's responsibility to ensure that the following conditions are met.

10 CFR Part 71.87(I)(1) requires that the non-fixed (removable) contamination on the external surfaces of the outer package being shipped on a non-exclusive use basis not exceed 10^{-5} $\mu Ci/cm^2$ (0.00001 $\mu Ci/cm^2$) averaged over a 300 cm^2 (46.5 in^2)area of any part of the surface. This may be determined by measuring the activity on wipes taken from representative areas. The above criterion is met if the activity on any sample averaged over the surface area wiped does not exceed 10^{-5} $\mu Ci/cm^2$ (0.4 Bq/cm^2 or 22 dpm/cm^2).

7.1.4 Transportation Requirements

The SPEC-300 package will be properly marked, labeled and described on a shipping paper in accordance with U.S. Department of Transportation regulations. Placards will be offered to carriers transporting a Radioactive Yellow III labeled package. Shipping papers will be

retained for one year in accordance with U.S. Department of Transportation regulations.

7.1.5 Type B Quantity Consignee Notification

Prior to each shipment of a SPEC-300 containing more than 0.4 tBq (10.8 Ci) Cobalt-60 the shipper shall notify the consignee of the dates of shipment and expected arrival.

7.2 Procedures for Receipt and Unloading the Package

7.2.1 Unloading

The consignee must establish written procedures for receiving the SPEC-300 package in accordance with applicable NRC and agreement state regulations. Such procedures should provide for inspection, monitoring, notification and records. The SPEC-300 package becomes an industrial radiography exposure device after receipt by the licensed industrial radiographer user. The source assembly is temporarily removed and then returned to the exposure device frequently throughout its use in accordance with the licensed user's procedures and in accordance with applicable NRC or agreement state regulations.

7.2.2 Receiving the SPEC-300

A. Delivery, Pick Up and Acceptance from Carrier

Regulations require that the consignee must make arrangements to receive the SPEC-300 when it is offered for delivery by the carrier; or must make arrangements to receive notification from the carrier at the time of arrival for pick up at the carriers facility.

The consignee must expeditiously pick up the SPEC-300 upon receipt of notification from the carrier.

B. Receipt Survey and Inspection

Before the delivered package is opened and as soon as practicable after receiving the SPEC-300, but no later than three hours after it is received at the consignee's facility during normal working hours or within three hours beginning the next work day if received after normal working hours the package must be monitored and inspected.

The outside package, as received, should be inspected for any indication of damage to the SPEC-300, and the maximum external radiation levels at the surface of the outside package and at one meter (39.4 in) from the surface of the outside package must be measured and recorded. Dents and abrasions to any crating or other ancillary shipping materials normally encountered in handling, loading and unloading are not generally considered evidence of damage to the SPEC-300.

Since the sealed source in the SPEC-300 is classified as special form radioactive material it is not required to monitor the external surfaces of the SPEC-300 package

for removable contamination.

C. Notification

If the measured maximum radiation level at the surface of the outside package or at one meter (39.4 in) from the surface of the outside package exceeds either of the following limits:

Location	Max mSv/hr	Max mR/hr
Surface of Outside Package	2	200
One Meter from Surface of Outside Package	0.1	10

Then the consignee must immediately notify the final delivering carrier, and either the agreement state radiation control agency, if applicable, or the NRC regional office having jurisdiction over the location where the package was received. It is also recommended that the shipper be notified. Care should be exercised in performing the survey that the radiation levels are measured at the proper distances, that the survey meter is calibrated and operating properly.

D. Records

Records of the receiving survey should be maintained for a period of three years which include at least: date and time package received or picked up; date and time monitored; identification of package by serial number; identification of source by serial number, isotope and activity (includes date of measurement); identification of individual performing survey; identification of survey meter by serial number; maximum radiation levels at surface of outside package and at one meter (39.34 in) from surface of outside package; and corrective action and notification to carrier and regulatory agency, if applicable.

7.3 Preparation of an Empty Package for Transport

Test to verify that the SPEC-300 does not contain a radioactive source (authorized source, unauthorized source, modified source, or a source capsule that has been removed from the source assembly) by the following method. This test should be performed by authorized and monitored personnel who have been trained in radiation safety and equipped with a properly operating survey instrument.

First, remove the safety plug and survey the open outlet nipple. The depleted Uranium shield is radioactive and will emit radiation even when no sealed source is installed in the package, but the highest radiation level should not exceed approximately 0.02 mSv/hr (2 mR/hr). Second, remove the lock cap and visually inspect the package to verify that no source assembly connector is protruding.

Third, attach a control assembly to the package and crank the drive cable forward through and out of the package while monitoring the survey instrument for a radiation hazard. An exposed source must be treated as an emergency. Fourth, attach a dummy connector or dummy source assembly to the end of the drive cable. Retract the drive cable fully, then disconnect and remove the control assembly from the package, and install the safety plug and lock cap. If a dummy connector was used it will be removed with the controls. If a dummy source assembly was used it will remain in the package and must be disconnected from the control drive cable to remove the controls. Inspect the connector of the dummy source assembly to verify that it has no serial number.

The empty packaging contains 238 kg (525 lb) of depleted Uranium and may be shipped as either a labeled radioactive material package or as an excepted package, article manufactured from depleted Uranium as required by applicable U.S. Department of Transportation regulations.

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

Components and materials for package construction are subject to a QA receiving inspection, in process inspections as appropriate, and final acceptance inspections. These inspections are conducted in accordance with SPEC's quality assurance program under NRC Certificate of Compliance No. 0102 prior to shipment to a customer. Prior to shipment, each packaging is conspicuously and durably marked with its model number, serial number, gross weight, and a package identification number as assigned by the NRC.

8.1.1 Visual Inspections and Measurements

Receiving, in process and final acceptance inspections are performed to verify that the packaging has been fabricated and assembled in accordance with approved engineering documents including drawings listed on the certificate of compliance. Dimensions and tolerances specified on engineering documents are confirmed by measurement. Nonconforming material is handled in accordance with SPEC's quality assurance program.

8.1.2 Weld Examinations

Internal and external weld examinations are performed to verify packaging fabrication in accordance with approved engineering documents. The location, type and size of the welds are confirmed by measurement. These visual and dye penetrant weld examinations are performed by trained and qualified personnel in accordance with SPEC quality assurance program.

8.1.3 Structural and Pressure Tests

Structural acceptance tests on the model SPEC-300 are not indicated because of the rugged design and durable materials of construction. Weld examinations and visual inspections verify structural integrity. Pressure tests are not indicated because there is no possibility of a pressure build up which would affect the structure of the containment or the integrity of the package.

8.1.4 Leak Tests

Leak tests are performed by trained personnel in accordance with a SPEC approved work instruction. Source capsules and source assemblies are tested for leakage and rejected if there is removable contamination in excess of 74 Bq (0.002 μCi). Prior to shipment, the outer surfaces of the packaging are tested for leakage and rejected if there is removable contamination in excess of 220 dpm/cm^2 averaged over 300 cm^2.

8.1.5 Component and Material Tests

Packaging material is inspected prior to use to verify that engineering specifications are met. Appropriate tests and acceptance criteria are specified for components that affect package performance such as the automatic securing mechanism. These tests must be performed prior to shipment to verify that components meet performance specifications.

8.1.6 Shielding Tests

A radiation survey is performed on the SPEC-300 as part of the final inspection. This test assures that no voids or streaming paths exist in the shielding. Prior to shipment with a source assembly, the package is surveyed to assure compliance with transportation requirements. Radiation levels must not exceed 2 mSv/hr (200mR/hr) on the surface when readings are corrected and extrapolated to 11.1 mSv (300 Ci). Radiation levels must not exceed 0.05 mSv (5 mR/hr) at one meter (39.4 in) from the surface when readings are extrapolated to 11.1 tBq (300 Ci).

8.1.7 Thermal Acceptance Tests

Thermal tests are not appropriate (or required) to demonstrate the heat transfer capability of the packaging because the heat of decay for the maximum permissible activity Cobalt-60 source 11.1 tBq (300 Ci) is negligible.

8.2 Maintenance Program

The SPEC-300 transport package requires no periodic maintenance. As a normal part of package preparation and receipt, the package is routinely inspected for damage, faulty operation, and excessive radiation levels. See chapter 7 of this application.

8.2.1 Structural and Pressure Tests

Periodic maintenance is normally not required to ensure continued structural performance of the SPEC-300 because of the rugged design and durable materials of construction. Periodic pressure tests are not required because there is no possibility of a pressure build up which would affect the structure of the containment or the integrity of the package.

Quarterly inspection of the package by licensed radiography users as required by 10 CFR 34.28(b) is sufficient structural maintenance. The quarterly inspection requirements that are relevant to assure that the SPEC-300 operates properly as a Type-B package consist of a visual inspection and operational tests of the lock cap, device lock, source assembly lock, safety plug and outlet nipple. There are no quarterly maintenance requirements such as disassembly, cleaning, replacement of components or lubrication. The inspection and maintenance procedures are described in the SPEC-300 users manual and are required to be included in the licensed radiography users' Operating Procedures in accordance with 10 CFR Part 34.32(j).

8.2.2 Leak Tests

Leak tests for removable contamination are required to be performed at least every six months on the sealed source assembly pursuant to 10 CFR 34.27 or equivalent state regulations. A leak test should also be performed whenever there is indication of damage to the sealed source capsule. If the test indicates 185 Bq (0.005 Ci) or more of removable contamination, the sealed source must be removed from use, action taken to prevent the spread of contamination, and a report filed with applicable radiation control agency within five days. It is also recommended that SPEC be notified.

8.2.3 Subsystems Maintenance

Not applicable. The model SPEC-300 has no subsystems.

8.2.4 Valves, Rupture Discs, and Gaskets on Containment Vessel

Not applicable. The primary containment vessel is a small sealed source capsule.

8.2.5 Shielding

The daily and quarterly inspection program performed by the licensee pursuant to 10 CFR 34.28 or equivalent agreement state regulations, and the daily surveys of the package performed pursuant to 10 CFR 34.39(b) or equivalent agreement state regulations are sufficient to establish the continuing integrity of the shield.

8.2.6 Thermal

Periodic thermal tests on the model SPEC-300 are not indicated since the heat of the decay for the maximum permissible activity Cobalt-60 source (300 Ci) is negligible. There are no components which would be thermally degraded by typical use and transport.