spec
SOURCE OF QUALITY

March 24, 2000

Mr. Michael D. Waters, Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
One White Flint North
11155 Rockville Pike
Rockville, MD 20852

Subject: Consolidated Application for the SPEC Model 2-T Package (TAC No. L22989)
Docket No.: 71-9056

Dear Mr. Waters:

In response to your letter dated December 16, 1999 requesting that a consolidated application be submitted for the Model SPEC 2-T radioactive material package, Source Production & Equipment Company, Inc. hereby submits three (3) copies of the amended application and is identified as Consolidated Application, Model SPEC 2-T Type B(U) Radioactive Materials Package, dated March 24, 2000.

Background:

The current application on file was submitted on March 13, 1989. The primary purpose for the application was to identify and summarize all prior variations in the SPEC 2-T package and to establish that all previously fabricated and proposed current production SPEC 2-T packages met the 1973 IAEA criteria for Type B(U) packages pursuant to 10 CFR 71.13(c). There were four (4) supplements submitted to the original March 13, 1989 application which are dated July 6, 1989, August 21, 1989, August 28, 1989 and July 27, 1990.

On July 10, 1991, a revision was made to the application. Its primary purpose was to amend the maximum weight of the SPEC 2-T packaging and to amend the maximum weight of the SPEC 2-T Overpack configuration packaging. This was required due to a slightly revised design of the depleted uranium shield and to account for the addition of a tungsten or depleted uranium shielding pad inside the package which is described in the Certificate of Compliance No. 9056, Revision 9 Approval Record. There were four(4) supplements submitted to the July 10, 1991 revision which are dated November 4, 1991, January 5, 1992, June 21, 1994 and July 1, 1997.

This consolidated application consists of excerpts from the above listed submittals as required to provide only current and correct information. To facilitate the review, each section in the application is identified by the information submittal date (supplement date). Documents, such as older revisions to drawings, which are no longer current are not being resubmitted. Only current revisions are being submitted and the text within the body of the application is amended and identified by strike out (~~strike out~~)and replaced by italics text (*italics text*). Any additional text added is indicated by italics text.

The Liquid Penetrant Inspection Procedure, QA Procedure 10.8, Revision (1) previously submitted has

Source Production & Equipment Co., Inc.
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been revised. The instruction is now identified as Work Instruction No. QA 28 and titled Liquid Penetrant Inspection. The revised instruction is provided in Appendix 9.5 of this consolidated application.

All references to "generic overpack for private carriage" has been deleted since it has been shown that the SPEC 2-T package meets the requirements of private carriage when transported in accordance with 49 CFR 173.441(b) as specified in the Certificate of Compliance.

The July 6, 1989 supplement provided information supporting an amendment to authorize contents to 110 curies Iridium 192 for the SPEC 2-T radiography exposure device as a stand alone package and contents to 240 curies to conform to the maximum source activity as authorized in the device approval for the SPEC 2-T radiography exposure device. However, the Certificate of Compliance has not been amended to authorize these transport conditions. Since the SPEC 2-T can no longer be used as an exposure device in the United States (because it does not meet exposure device requirements of 10 CFR 34) and since these quantities are no longer germane to industry requirements, this request is being withdrawn. The text within the body of the application is amended to conform to the current conditions of the Certificate of Compliance and identified by strike out and italics text.

In addition to the Hypothetical Accident Conditions tests that are described in the application dated March 13, 1989 and the revision dated July 10, 1991, the SPEC 2-T package was again subjected to these tests whereas the 30 foot Drop Test and Puncture Tests are highlighted to meet the requirements of 10 CFR 71.73 and IAEA Safety Series No. 6, Regulations for the Safe Transport of Radioactive Material, 1985 Edition (As Amended 1990). The complete test report for these additional tests is provided in Appendix 9.4 of this consolidated application.

Currently, SPEC is not manufacturing these packages since the package does not obtain the "-85" designation in accordance with 10 CFR 71.13(b). However, it is estimated that approximately 800 of these existing transport packages remain in use today. Renewal of the USNR Certificate of Compliance is therefore required to allow the continued use of these existing packages that were fabricated prior to April 1, 1999 in accordance with 10 CFR 71.13(b)(1) and SPEC's Quality Assurance Program Approval for Radioactive Material Packages, Approval Number 0102. A copy of the QA Program Approval Certificate is provided in Appendix 9.3 of this consolidated application.

Please do not hesitate to call if you need any assistance or if clarification is needed.

Sincerely,

Kenneth N. Carrington
Regulatory Affairs

/knc

Enclosures: Three (3) copies SPEC 2-T Consolidated Application dated March 214, 2000

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SOURCE OF QUALITY

APPLICATION FOR AMENDMENT
NRC CERTIFICATE OF COMPLIANCE NO. USA/9056/B(U)

Consolidated Application

Model SPEC 2-T
Type B(U) Radioactive Material Package
March 24, 2000

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APPLICATION FOR AMENDMENT
NRC CERTIFICATE OF COMPLIANCE NO. USA/9056/B(U)

Consolidated Application

Model SPEC 2-T
Type B(U) Radioactive Material Package

March 24, 2000

Source Production & Equipment Company, Inc.
St. Rose, Louisiana USA

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1.0 General Information

1.1 Purpose of Application

A. To consolidate the information listed as References in the Certificate of Compliance, USA/9056/B(U), Revision 10.

B. The information provided in this application is excerpted from the following references: Application dated March 13, 1989 as supplemented on July 6, 1989, August 21, 1989, August 28, 1989, July 27, 1990, July 10, 1991, November 4, 1991, January 5, 1992, June 21, 1994 and July 1, 1997.

1.2 Introduction to Application ***(Excerpts from July 6, 1989 Supplement)***

A. The Source Production & Equipment Company, Inc. (SPEC) Model 2-T is an industrial radiography exposure device approved for use by the Louisiana Nuclear Energy Division, and it is authorized to contain a maximum source activity of 240 Ci of Iridium-192 as a sealed source. It is used as a package to transport the sealed Iridium-192 source by licensed industrial radiographers as private carriers to perform nondestructive testing, and it is transported by common carriers for transfer of the device and source between domestic licensees and for export and import.

B. The SPEC 2-T has been manufactured since 1975 and several minor modifications have been made to improve its use as a radiography device and/or as a package for transportation. To establish that the modifications to the package have not compromised the qualification of the SPEC 2-T as a Type B package a substandard test model was constructed which represents a composite package whose integrity is significantly below any package that could have possibly been constructed. This "worst case" test package repeatedly passed the Type B package tests demonstrating that all previously constructed SPEC 2-T packages with the identified variations meet the criteria established for a Type B(U) package specified in 10 CFR 71.71 and 71.73, and the 1973 International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Materials (Safety Series No. 6).

A second SPEC 2-T test package was constructed in response to inquiries from the U. S. Nuclear Regulatory Commission which included certain configurations from the original design which had previously passed the Type B hypothetical accident condition tests. This second test package was subjected to specified four foot drop, 30 foot drop and puncture tests.

C. An overpack configuration for common or private carrier transport is described for use when the SPEC 2-T contains more than ~~110 Ci~~ *45 curies* and no more than ~~240 Ci~~ *225 curies* Iridium-192. This overpack has been in satisfactory use since 1975. This commercial overpack configuration with the SPEC 2-T inside package successfully passed the test conditions for normal conditions of transport. Since the

SPEC 2-T has been shown to have successfully passed the hypothetical accident conditions, and since the overpack can in no way adversely affect the results of the SPEC 2-T test, then the overpack configuration with the SPEC 2-T inside package meets the criteria for a Type B(U) package.

1.3 SPEC 2-T Packaging

1.3.1 Gross weight: Maximum 56 pounds ***(Excerpted from July 10, 1991 Supplement)***

1.3.2 Description

(Excerpts from July 6, 1989 (for package dimensional revision and use of shielding pads) and July 10, 1991 Supplements)

A. The SPEC 2-T is constructed of commercial grade Series 300 stainless steel plates to form a rectangular box approximately 13-1/4 inches long, 4-11/16 inches high and a maximum of 4-5/8 inches wide which contains and supports a depleted uranium shield weighing approximately 35 pounds. Depleted uranium is cast around a titanium or zircalloy S-tube to provide approximately 1-7/8 inches of radiation shielding from the center of the shield which contains a sealed source Iridium-192 capsule. The S-tube and depleted uranium shield is designed to prevent direct streaming of radiation through the S-tube and to reduce scattered radiation through the "S" to acceptable levels for an industrial radiography exposure device. Low level radiation streaming in the vicinity of the ends of the S-tube is not uniform among depleted uranium castings. The revised SPEC 2-T design incorporates the use of a tungsten or depleted uranium shielding pad inside either side of the package, and a revised design for the depleted uranium shield. All other previous dimensions, parts, materials of constructions, and method of fabrication are unchanged.

(Excerpts from July 6, 1989 Supplement)

B. Iridium-192 is neither fissionable nor a neutron emitter, therefore no materials are used as neutron absorbers or moderators.

C. The depleted uranium shield is secured in the SPEC 2-T package by two stainless steel brackets and by a stainless steel ring around the "hot top" of the depleted uranium shield casting. The principal system to prevent movement of the shield is provided by the basic design of the package. The shield is mounted in the SPEC 2-T with the sides and end plates of the 2-T flushed against the shield to resist movement of the shield. A stainless steel lock insert is fused to the end plate and a stainless steel lock housing is affixed to the top panel of the SPEC 2-T to contain a commercial spring lock mechanism which secures the source assembly ("pigtail") with the sealed source capsule inside the SPEC 2-T radiography exposure device to meet the requirements of 10 CFR 34.22(a) and equivalent agreement state regulations.

D. An outlet nipple, a commercially available male quick disconnect pressure coupling, is screwed into one end plate on the SPEC 2-T and accepts one end of the S-tube protruding from the depleted uranium shield. The outlet nipple provides a means of connecting a source tube when the SPEC 2-T is used as a radiography exposure device and serves no structural purpose. During shipment a source safety plug, a brass female quick disconnect coupling with a stainless steel cable and a stainless steel cap, is coupled with the outlet nipple as a redundant mechanism to prevent the movement of the source assembly through the S-tube.

E. An aluminum handle attached with stainless steel rods are provided as a convenience to carry the SPEC 2-T in the field when it is being used as an industrial radiography device. The carrying handle is not a structural part of the package and serves no function during transport of the package. No lifting or tie down devices are provided since the SPEC 2-T may be lifted and secured from movement during transports without structural provisions for such devices.

F. A brass lock cap at one end protrudes approximately 2-1/2 inches beyond the lip of SPEC 2-T. It protects the source assembly connector from damage, which would only affect its operation as an industrial radiography exposure device, and it is not a structural part of the SPEC 2-T shipping package. On the other end the outlet nipple and source safety plug do not protrude beyond the lip of the SPEC 2-T, and is not subject to damage during normal transport.

G. The SPEC 2-T is not hermetically sealed and is opened to ambient pressure, therefore a pressure relief system is not applicable.

H. The primary containment vessel to prevent the 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. Approximate dimensions of the stainless steel capsule is 3/4 inches long by 1/4 inches diameter. Source assemblies ("pigtails") consist of the sealed source capsule swaged onto a flexible cable to which is swaged a stainless steel locking ball and a connector. Several source assembly models are approved for use in the SPEC 2-T. The source capsule to locking ball distance is the same in all models. There are two basic overall lengths of source assemblies and several connectors which are approved for use. The approximate overall length of the source assemblies are either 7-1/8 inches and 7-7/8 inches. See Drawing G-1 Revision 0 which represents a typical configuration.

I. Containment of the source assembly in the SPEC 2-T package is achieved by (1) the diameter of the locking ball which can not pass through the smaller diameter orifice at the lock end of the SPEC 2-T when it is unlocked; (2) the key operated lock mechanism which engages the locking ball to prevent movement through the S-tube; (3) the lock cap which provides a redundant safety feature preventing the source assembly from coming out the lock end of the SPEC 2-T; and (4) the safety plug which redundantly prevents the source assembly from passing through the S-tube.

J. Structural closures of openings are not employed to contain the radioactive material within the package.

K. There are no valves, sampling ports, coolants or mechanisms for heat transfer or dissipation.

1.3.3 Operational Features ***(Excerpts from July 6, 1989 Supplement)***

A. The SPEC 2-T is a simple package and there are no operational considerations, beyond its use as an industrial radiography exposure device, which are required for its use as a transport package.

B. Iridium 192 wafers are contained in a sealed source capsule which can not be operationally opened.

C. The source assembly is contained in the SPEC 2-T by (1) the key operated lock engaging the locking ball and preventing movement through the S-tube; (2) the diameter of the locking ball which prevents movement of the source assembly out the lock end; (3) the redundant lock cap preventing loss of the pigtail out the lock end; and (4) the redundant source safety plug preventing loss of the pigtail through the outlet nipple end.

D. There are no valves, connections, piping, seals or similar containment mechanisms.

1.3.4 Contents of Packaging ***(Excerpts from July 6, 1989 Supplement)***

A. The SPEC 2-T has been approved by the Louisiana Nuclear Energy Division (agreement state radiation control agency) as a radiography exposure device with a maximum activity of 240 Ci of Iridium-192 as a sealed source.

B. The sealed source capsule meets the requirements of special form radioactive material pursuant to 10 CFR 71.75 as demonstrated by IAEA Certificate of Competent Authority Number USA/0095/S.

C. Iridium-192 solid metallic wafers are encapsulated in a stainless steel cylindrical capsule measuring approximately 3/4 inches by 1/4 inches diameter which is swaged onto a flexible cable approximately 7-1/8 or 7-7/8 inches long forming a source assembly.

D. The density of solid metallic iridium is approximately 22.5 grams per cubic centimeter. The weight of the Iridium-192 contents is negligible.

E. Iridium 192 is not fissile material, therefore moderator ratios and criticality configurations are not applicable.

F. The heat of decay for a maximum 240 Ci Iridium-192 is infinitesimal and the void space in the sealed source capsule is negligible, therefore pressure buildup is not a factor.

1.4 SPEC 2-T Commercial Overpack Configuration Package for Common Carrier Transport ***(Excerpts from July 10, 1991 Supplement)***

1.4.1 Gross weight: Maximum 80 pounds.

1.4.2 Description

The maximum gross weight of the SPEC 2-T commercial overpack configuration package has been increased to 80 pounds. The design of the commercial steel drum overpack remains unchanged from previously approved application dated March 13, 1989 and July 27, 1990 as supplemented. Drawing Number 53189-2 ~~Revision (0)~~ has been revised to provide additional dimensional detail without revising the overpack design. See Drawing Number 53189-2 ~~Revision (1)~~ *Revision (2).*

(Excerpts from August 21, 1989 Supplement)

A. Inner package: SPEC 2-T (See Section 1.3 above)

B. The overpack is a nominal 12 gallon open head 20 or 22 gauge steel drum with snap ring or bolt ring closure, and is manufactured in accordance with the National Motor Freight Classification 100-G, Item 260. The drum is partially filled with polyurethane foam to position the SPEC 2-T inner package in center of the overpack. A cavity liner and bottom support disk or bracing are optional. See Drawing No. 53189-2, ~~Revision 0~~ *Revision (2).*

C. Structural closures of openings are not employed to contain the radioactive material within the package.

D. There are no valves, sampling ports, coolants or mechanisms for heat transfer or dissipation.

1.4.3 Operational Features

A. The common carrier transport overpack is a simple package and there are no operational considerations.

B. Containment of the radioactive material within the SPEC 2-T inner package is described above.

C. There are no valves, connections, piping, seals or similar containment mechanisms.

1.4.4 Contents of Packaging ***(Excerpts from July 6, 1989 Supplement)***

A. The contents of the common carrier transport overpack is the SPEC 2-T inner package with a sealed source assembly which has been described above in Section 1.3.4.

B. Iridium 192 is not fissile material, therefore moderator ratios and criticality configurations are not applicable.

C. The heat of decay for a maximum 240 Ci Iridium-192 is infinitesimal and the void space in the sealed source capsule is negligible, therefore pressure buildup is not a factor.

2.0 STRUCTURAL EVALUATION

2.1 Structural Design

2.1.1 Discussion *(Excerpts from July 6, 1989 Supplement)*

A. The principal structural components of the SPEC 2-T are (1) the depleted uranium shield which provides the necessary radiation shielding and protects the sealed source capsule; (2) the depleted uranium supporting brackets and the "hot top" retaining ring; and (3) the stainless steel shell which firmly encased the depleted uranium shield and forms the outer package.

(Excerpts from November 4, 1991 Supplement)

B. The design of the depleted uranium shield of the package has been slightly revised as described in Drawing Number 788-1 ~~Revision (2)~~ *Revision (4)*, and the use of a tungsten or depleted uranium shielding pad in the side of the package has been incorporated as described in Drawing Number 12688-1 ~~Revision (1)~~ *Revision (2)*. The design change has resulted in an increase in the maximum weight and maximum exterior dimensions of the SPEC 2-T package and the maximum weight of the SPEC 2-T Commercial Overpack configuration package. The primary structural design concept of maintaining direct contact on all sides between the shielding material with the housing panels to create a strong package remains unchanged. The use of a side shielding pad and a revised depleted uranium shield does not reduce the structural strength of the package. There are no other changes from the previously approved SPEC 2-T packaging design.

The shield is cast from molten depleted uranium. Occasionally the shield develops minute porosity at the thickest section of the casting and in the hot top. The porosity does not affect the weight nor the strength of the shield, but may reduce the shielding characteristics at the location of the porosity. In instances when minor porosity exists, but does not result in radiation levels at the sides of the package in excess of 10 mrem/hr at one meter with 225 curies Ir-192, a shielding pad is installed to reduce the radiation level of the package to standard levels. It is not the intention for the use of the shielding pad to reduce the radiation levels below standard levels although minor reductions may occur. Depleted uranium shields with radiation levels in excess of 10 mrem/hr at one meter from either side of the package without a shielding pad is rejected. It should be noted that in the event of loss of the shielding pad due to a transportation accident, the maximum radiation level of 10 mrem/hr at one meter is greatly below the allowable 1000 mrem/hr hypothetical accident condition limits at one meter.

(Excerpts from July 6, 1989 Supplement)

C. The stainless steel capsule provides the primary containment vessel preventing the release of radioactive material and meets the requirements of 10 CFR 71.75 for special form radioactive material.

D. The source assembly, containing the sealed source capsule, is retained in the depleted uranium shield by (1) a key operated locking mechanism; (2) a locking ball on the source assembly which can not pass through the lock end of the SPEC 2-T; (3) a lock cap providing secondary protection and redundant retention of the source assembly; and (4) a redundant safety plug preventing movement of the source assembly through the outlet nipple end of the SPEC 2-T.

E. The commercial overpack and SPEC 2-T configuration for common carrier transport is designed to meet the conditions for normal conditions of transport and to provide the distances necessary to meet the required surface radiation levels for a package in common carrier transportation. Since the inner SPEC 2-T package will be shown to meet the hypothetical accident conditions, it is only necessary to demonstrate that the commercial overpack and SPEC 2-T configuration meets the normal conditions for transport for this configuration to satisfy the criteria for a Type B(U) package. If the overpack SPEC 2-T configuration were subjected to the hypothetical accident condition test, then it would pass since the inner SPEC 2-T package passed the test. The overpack can only provide additional structural protection for the SPEC 2-T package in the hypothetical accident condition tests.

2.1.2 Design Criteria *(Excerpts from July 6, 1989 Supplement)*

A. Primary consideration was given to protecting the depleted uranium shield by limiting its movement under typical working conditions, normal transportation and hypothetical accident conditions. Use was made of the casting "hot top" which is the cylindrical projection from the body of the casting and is the remains of the gate into which molten metal is poured to produce the casting. It is approximately 3 inches diameter by 5/16 inch high. A stainless steel ring is attached to the left side panel of the SPEC 2-T housing and the "hot top" is fitted into it to resist lateral movement. The depleted uranium shield rests on the bottom panel, and the sides and top panels are snug against the shield to prevent all vertical and side movement within the package. Shield brackets are attached to the top panel at the lock end of the shield and to the bottom panel on the other end of the shield to prevent rotational movement around the axis of the "hot top."

B. The direct contact of the shield with top, bottom and side panels is the primary means to prevent movement of the shield within the package. The shield is fitted against the lock insert which is fused to the end plate to

prevent shield movement toward the lock end, and the other end plate or shielding pad is fitted against the shield to prevent movement in the outlet direction. By preventing movement of the depleted uranium shield within the housing movement of the source assembly within the shield is also restrained such that the radiation levels after the hypothetical accident tests are within the established criteria. The principal area of concern is the thirty foot drop test.

C. Because the sealed source capsule qualifies as special form radioactive material, it is known that the sealed source capsule is not damaged by the thirty foot drop test nor the 1475°F thermal test. Located in the center of the depleted uranium shield within the SPEC 2-T case the sealed source capsule is adequately protected from any shear or crushing forces that could damage the capsule.

D. A commercially available steel drum commonly used in transport was selected to provide an outer package that would effectively transport the maximum ~~49 pound~~ *56 pound* inner SPEC 2-T package, and to adequately withstand substantial deformation from the normal condition of transport drop, penetration and compression tests. This overpack has been in use successfully for fifteen years. Foam is used to center the SPEC 2-T within the drum and to provide the necessary distance from the surfaces of the SPEC 2-T so the radiation levels on the surface of the drum do not exceed 200 mrem/hr.

2.1.3 Evaluation of Prior Production Variations ***(Excerpts from July 6, 1989 Supplement)***

Over a period of 14 years production variations in the SPEC 2-T have been made to improve the operation as an industrial radiography device and these improvements have withstood the test of time. No package operations nor significant structural changes were manifested by these modifications.

2.1.3.1 Foam Fill

A. The foam was eliminated because it provides no significant structural strength to the package, and there was evidence that foam retained moisture and caused corrosion under certain conditions of use as an exposure device.

B. The original SPEC 2-T package was tested with foam, which deteriorated during the thermal test. The current test package was tested without foam. Foam will be provided as an optional component of future packages.

2.1.3.2 Lock

1) Alternate 1

The original locking system consisted of a keyed plunger style lock with an end extension; one set screw installed through the end panel to secure the lock within the package; lock located on the side panel of the package; and cylindrical lock housing fused to the housing panel. See Drawing 788-2 Revision 0 Alternate 1.

2) Alternate 2

The carrying handle was relocated to panel "C", thus the side panel became the top panel and the lock was now located on the top of the device. See Drawing No. 788-2 Revision 0 Alternate 2.

3) Alternate 3

The lock and carrying handle were relocated to panel "B". The lock extension was eliminated, thus the larger diameter lock plunger secured the pigtail instead of the thinner, "needle type," lock plunger. A washer was fused to the top panel to provide a surface of equal elevation to the top of the lock. This was done for cosmetic purposes and provided no structural or operational changes. See Drawing 788-2 Revision 0 Alternate 3.

4) Alternate 4

See Drawing 788-2 Revision 0 Alternate 4. The lock plunger was slotted to allow it to straddle over the source assembly cable. The cosmetic washer was removed since the lock top was now flush with the top panel.

Note that the above modifications and the modification to slot the lock plunger are depicted in Drawing 1000 Revision 0 which is referenced in NRC Certificate of Compliance No. 9056, Revision 1, issued April 8, 1981. The SPEC 2-T which was involved in the January 1988 incident was sold on August 23, 1982 and was manufactured in accordance with Drawing 1000 Revision 0, except for the absence of the cosmetic washer, which performed no structural purpose.

5) Alternate 5

See Drawing 788-2 Revision 0 Alternate 5. The permanent lock housing was replaced with a removable housing. The revised design utilizes a lock ring to secure the lock within the SPEC 2-T. The lock ring is fastened to the top panel by three machine screws. The single set screw system was eliminated due to the more secure three screw design.

6) Alternate 6

See Drawing 788-2 Revision 0 Alternate 6. The lock housing is permanently fused to the top panel. The lock is secured within the lock housing by a lock ring which is fitted over the lock and fastened to the top panel by use of two allen head machine screws.

2.1.3.3 Housing

1) Alternate 1

See Drawing 788-2 Revision 0 Alternate 4. The bottom panel (Panel C) is 1/4" thick instead of the original 11 gauge thickness specified in Drawing 1000 Revision 0 referenced in NRC Certificate of Compliance Number 9056 Revision 1. The thicker panel provides greater strength to the package to resist damage in normal and accident conditions.

2) Alternate 2

See Drawing 788-2 Revision 0 Alternate 4 and Alternate 7. The length of the housing panels at the outlet end were increased to provide greater protection from impact to the outlet nipple and safety plug when transporting the device. The structural change is insignificant and has no operational impact.

2.1.3.4 Depleted Uranium Shield Brackets

See Drawing No. 1000, Drawing 788-2 Revision 0, and Drawing dated November 26, 1974 entitled Radiographic Exposure Device SPEC Model 2-T.

1) Alternate 1

The original shield bracket consisted of a 1/4 inch diameter carbon steel U-bolt. This was replaced by two 5/16 inch diameter machine

bolts and brackets. The bolt head provided a larger region to be fused to the housing panel. The increase in bolt diameter provides greater resistance to bending. The bracket and nuts are installed, tightened and fused after the bolt heads are fused to the panels thus providing greater shield movement resistance. See Drawing 1000 Revision 0 referenced in NRC Certificate of Compliance Number 9056 Revision 1.

2) Alternate 2

The carbon steel shield hold-down bolts were replaced with stainless steel bolts to eliminate fusion of dissimilar metals and to increase corrosion resistance.

3) Alternate 3

See Drawing 788-2 Revision 0 Cross Sectional View. Occasionally small tungsten or depleted uranium shielding pads are added to reduce low level radiation streaming through the S-tubes when radiation levels at six inches from the surface of the device are marginal. There are no adverse structural or package operational considerations to the addition of the optional pads.

2.2 Weights and Centers of Gravity ***(Excerpts from July 10, 1991 Supplement)***

2.2.1 SPEC 2-T

The SPEC 2-T package weighs a maximum of 56 pounds. The center of gravity is virtually the geometric center of the rectangular package.

2.2.2 SPEC 2-T Commercial Overpack

The SPEC 2-T commercial overpack configuration package for common carrier transport weighs a maximum of 80 pounds. The center of gravity is virtually the geometric center of the right circular cylinder defined by the steel drum overpack.

2.3 Mechanical Properties of Materials ***(Excerpts from July 6, 1989 Supplement)***

2.3.1 SPEC 2-T

A. Materials used in the SPEC 2-T are principally stainless steel, some carbon steel in past models, depleted uranium, titanium or zircalloy, aluminum in non structural parts, and brass. Optional materials are foam fill and tungsten.

B. All commercial grade materials are used in the construction of the SPEC 2-T and their mechanical properties are commonly established. There was no attempt nor necessity in the design or modifications of the SPEC 2-T to conduct theoretical engineering structural evaluations based on mechanical properties of materials, since it is a small light weight package whose simple design was based on extensive years of previous experience with similar packages and methods of construction, and which was proven by actual physical tests.

C. Series 300 stainless steel is used for the package panels, source assembly components, safety plug cap, brackets for the depleted uranium shield, hot top ring and components of the lock housing assembly. Brass is used in the outlet nipple, lock, and lock cap. The radiation shield is a depleted uranium casting with a titanium or zircalloy tube through the shield. The tungsten pads provide no structural or operational function. Aluminum is used for the carrying handle, but it is not a structural part of the package. The identification plate is stainless steel to withstand the thermal test.

2.3.2 Commercial Overpack for Common Carrier Transport

Commercially available 12 gallon, 20 or 22 steel gauge open head drum with snap ring or bolt ring closure and polyurethane foam. A plywood disc, metal bracing, and thin gauge metal or plastic cavity liner is optional. The mechanical properties of this material will meet general packaging requirements and normal conditions of transport, since it is not the purpose of the overpack to provide impact protection, a thermal barrier, or shielding material. Neither is it necessary that they withstand the hypothetical accident conditions for thermal, drop or puncture tests.

2.4 General Standards for All Packages ***(Excerpts from July 10, 1991 Supplement)***

The SPEC 2-T meets the general standards for all packages in accordance with the provisions of 10 CFR Sections 71.43, 71.45 and 71.47 as described in previous applications dated March 13, 1989 and July 27, 1990 as supplemented and described below for Normal Conditions of Transport and External Radiation Standards.

2.4.1 Minimum Dimension ***(Excerpts from July 6, 1989 Supplement)***

The smallest overall dimension of the package is nominally 4-1/4 inches plus or minus 1/4, and therefore never smaller than 4 inches.

2.4.2 Tamper Seal

A. The sealed radioactive source may only be released from the package by unlocking the camera with a key pursuant to the requirements of 10 CFR 34.22.

B. A tape identifying Source Production and Equipment Company, Inc. which is destroyed upon removal is affixed to the SPEC 2-T lock, and a redundant commercially available tamper seal affixed to the commercial overpack snap ring or bolt ring closure.

C. It is proposed that the radiography licensee transporting the SPEC 2-T as a private carrier be exempted from the tamper seal requirement, since the SPEC 2-T radiography device may be frequently used throughout the day and because the radiography company is required to secure the SPEC 2-T radiography exposure device to prevent tampering and unauthorized removal pursuant to 10 CFR 34.23.

2.4.3 Positive Closure

The primary containment system preventing the release of radioactive materials is the special form sealed source capsule which can only be opened destructively. In addition the sealed source assembly is retained in the depleted uranium shield by a key operated lock, a redundant safety plug and a redundant lock cap.

2.4.4 Chemical and Galvanic Reactions

The materials of construction are stable common metals which are known not to present chemical, galvanic or other reactions between the various metals. All the materials are inert to reaction with water, except for slow corrosion. As discussed below in Section 3.2 Thermal Properties of Materials an iron-uranium eutectic has been shown not to exist.

2.4.5 Package Operational Containment

No valves or other devices are present which would allow radioactive contents to escape from the primary containment of the sealed source capsule. The source assembly is retained in the shield by a key operated lock, a redundant safety plug, a restricting orifice through which the source assembly can not back out of the lock end, and a redundant lock cap.

2.4.6 Normal Conditions of Transport ***(Excerpts from July 10, 1991 Supplement)***

As described below in Section 2.6, Normal Conditions of Transport, the revised SPEC 2-T package and the revised SPEC 2-T commercial overpack configuration package were subjected to the applicable tests and demonstrated that there would be no loss or dispersal of radioactive contents, no significant increase in external radiation levels, and no reduction in the effectiveness of the packaging. The tests specified for normal conditions of transport had no significant effect on the packages.

2.4.7 Surface Temperature ***(Excerpts from July 6, 1989 Supplement)***

The maximum activity of 240 Ci in the SPEC 2-T has negligible heat of decay and the surface temperature of the package will be that of the ambient temperature.

2.4.8 Venting

Venting considerations are not applicable. Any pressure increase resulting from the decay of the maximum 240 Ci Iridium-192 in the sealed source capsule will be negligible and will be adequately contained by the sealed source capsule.

2.4.9 Lifting Devices

2.4.9.1 SPEC 2-T ***(Excerpts from August 28, 1989 Supplement)***

There are no lifting devices associated with the SPEC 2-T as a Type B package. A carrying handle is provided for use as a radiographic exposure device and is not considered a structural part of the Type B package. A SPEC 2-T was suspended from a single point at the center of the carrying handle while loaded with 150 pounds dead weight (50 pounds package weight times a safety margin of three) for a minimum of thirty minutes, which is considerably longer than any anticipated duration of normal use. In compliance with 10 CFR 71.45 (a) there was no deformation or damage to the handle, nor would failure of the handle under excessive load impair the ability of the package to meet the requirements of Subpart E of Part 71.

2.4.9.2 SPEC 2-T Commercial Overpack ***(Excerpts from November 4, 1991 Supplement)***

A. Commercially available carrying handles are provided as a convenience on the SPEC 2-T steel drum overpack configuration. They are not considered a structural part of the Type B package, and failure of the carrying handles would not prevent the package from meeting the normal or hypothetical accident condition test requirements. A SPEC 2-T steel drum overpack configuration was suspended from a single point approximately in the center of one of the carrying handles and loaded with 300 pounds dead weight (80 pound maximum package weight times a minimum safety factor of three) for a minimum of thirty minutes, which is considerably longer than any anticipated duration that the package will be carried. The handle supported the weight without any deformation or damage in compliance with 10 CFR 71.45(a).

B. Drawing Number ~~53189-1~~ *53189-2* of the Commercial Carriage Overpack has been revised per Revision (2) dated October 1, 1991 to specify the handles, the polyurethane fill material and density, and the National Motor Freight classification of the steel drum.

2.4.10 Tiedown Devices ***(Excerpts from July 6, 1989 Supplement)***

None.

2.4.11 External Radiation Standards ***(Excerpts from July 10, 1991 Supplement)***

A. External radiation levels for the SPEC 2-T package have previously been shown to meet the requirements for a radiography exposure device pursuant to 10 CFR 34.21. The increase in depleted uranium shield size and the use of a shielding pad increases the shielding capability of the SPEC 2-T packaging.

B. The SPEC 2-T containing no more than 45 Ci Iridium-192 does not exceed 200 mrem/hr at the surface of the package and 10 mrem/hr at one meter from the surface of the package.

C. The SPEC 2-T commercial overpack configuration package for common carrier transport does not exceed 200 mrem/hr at the surface of the drum overpack nor 10 mrem/hr at one meter from the surface of the overpack with 225 Ci of Iridium-192.

(Excerpts from July 6, 1989 Supplement)

D. Instructions are provided in Section 7 Operating Procedures for preparing the package for shipment to meet the requirements for transport.

2.5 Standards for Type B Packaging ***(Excerpts from July 10, 1991 Supplement)***

The revised SPEC 2-T meets the additional requirements for Type B packages in accordance with the provisions of 10 CFR 71.51.

2.5.1 Normal Condition of Transport Test Criteria

The results of tests described below in Section 2.8 for normal conditions of transport adequately demonstrate that there would be no loss or dispersal of radioactive contents, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the SPEC 2-T packaging.

2.5.2 Hypothetical Accident Conditions Test Criteria

The results of tests described below in Section 2.9 *and in Appendix 9.4, Test Report to Validate Previous 10 CFR Part 71 Puncture Tests*, for hypothetical accident conditions adequately demonstrate that there would be no possibility of 20 Ci Iridium-192 escaping from the package in one week nor would there be any radiation levels exceeding 1000 mrem per hour at one meter from the external surface of the package. The source capsule containing the radioactive material remained intact and was not released from the package.

2.5.3 Activity Release Limitations

Containment by filter or mechanical cooling systems are not applicable since there was no release of radioactive material. The source capsule remained intact after the applicable tests for normal conditions of transport and the hypothetical accident conditions.

2.6 Description of Test Packages

2.6.1 SPEC 2-T Test Packages ***(Excerpts from July 10, 1991 and January 5, 1992 Supplements)***

A typical prototype SPEC 2-T test package was used for the applicable normal conditions of transport tests. A substandard SPEC 2-T test package was used for the applicable hypothetical accident condition tests. Both test packages were fabricated in accordance with Drawing Number 12688-1, ~~Rev (1) dated May 25, 1991~~ *Revision (2)* with the exception that each joint of the substandard SPEC 2-T test package used for the hypothetical accident condition tests was fused intermittently along only 50% of its length. Past and current specifications require 100% fusion along each joint. No fused length of any joint of the test package exceeded one inch. In addition, no filler foam was used in the substandard SPEC 2-T test package to further establish a worst case design to subject to the hypothetical accident condition tests. Both test packages incorporated the revised depleted uranium shield described in Drawing Number 788-1 ~~Rev (1) dated February 2, 1991~~ *Revision (4).* Both test packages also incorporated a tungsten side shielding pad to subject packages of maximum weight to the applicable normal conditions of transport and hypothetical accident condition tests.

2.6.2 SPEC 2-T Commercial Overpack Configuration Test Package
(Excerpts from January 5, 1992 Supplement)
Free drop and compression tests for normal condition of transport were performed on a typical prototype SPEC 2-T commercial overpack configuration package. For the commercial steel drum overpack the optional ½" plywood interior bottom support disk and 1/4" steel exterior bottom support brace were not used in order to represent the worst case package design. The design of the commercial steel drum overpack

has been revised per Drawing Number 53189-2 Revision(2) dated October 1, 1991 to describe optional carrying handles, to specify the maximum thickness of the foam at the bottom of the drum, and to provide additional specifications for the foam material and the drum classification.

2.7 Drop Target Description ***(Excerpts from January 5, 1992 and July 10, 1991 Supplements)***

A. The target used for the Hypothetical Accident Condition Tests exceeds the requirements specified in IAEA Safety Series No. 37 "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material", Third Edition (1985 Edition).

B. The drop target consists of a solid carbon steel plate which measures 2'6" x 2'11" x 1-3-4" thick weighing 520 pounds. The thickness of the steel plate meets the minimum 4.0 cm IAEA requirement. The steel plate was wet floated onto the top surface of a flat horizontal concrete block which measures 4'6" x 4'6" x 4'6" thick weighing 13,668 pounds. The total weight of the drop target is 14,188 pounds thus greatly exceeds ten times the mass of an 80 pound package.

C. The concrete block is metal reinforced and is sunk to a depth of 4'2" into firm soil. See Drop Target Drawing No. 50890-1 ~~Revision (0) dated May 8, 1990~~ *Revision (1).*

D. A 35 foot tall tripod was erected over the drop target and used to raise and release the test package from a minimum height of 30 feet (9.2 m) above the top surface of the target. No damage nor separation of the steel plate from the concrete block occurred as a result of all free drop tests.

(Information from July 1, 1997 Supplement)

E. Additional drop target descriptions are provided in Appendix 9.4, Test Report to Validate Previous 10 CFR Part 71 Puncture Tests

2.8 Normal Conditions of Transport

2.8.1 SPEC Model 2-T Packages

2.8.1.1 Heat ***(Excerpts from July 6, 1989 Supplement)***

The packages were not tested at an ambient temperature of 100°F in still air and isolation, because the package was tested under the more extreme heat conditions 1475°F for thirty minutes in accordance with the hypothetical accident conditions tests. It satisfactorily passed the higher temperature test, and therefore it would have passed 100°F in still air and isolation criteria.

2.8.1.2 Cold ***(Excerpts from July 10, 1991 Supplement)***

Although it was not necessary to conduct this test because the design revisions to the SPEC 2-T package does not affect its ability to meet this requirement, and the SPEC 2-T has been shown to meet this requirement in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented, the substandard SPEC 2-T test package used for the hypothetical accident condition tests was surrounded on all sides, top and bottom with slabs of dry ice and enclosed within a standard commercial insulated ice chest for a period of 15 hours at an approximate temperature of -109 degrees F, which is greatly below the maximum allowable temperature of -40 degrees F. There were no observable effects to the SPEC 2-T package.

2.8.1.3 Reduced External Pressure ***(Excerpts from July 6, 1989 Supplement)***

This test was not performed because the SPEC 2-T is open to the atmosphere and there are no materials in the package which would be affected by a pressure reduction to 3.5 psi absolute. The special form sealed source capsule will withstand reduced pressures much greater than the 3.5 psi absolute. A pressure reduction to 3.5 psi absolute would have no affect on the effectiveness of the SPEC 2-T package.

2.8.1.4 Increased External Pressure ***(Excerpts from July 6, 1989 Supplement)***

The test was not performed because the SPEC 2-T is opened to the atmosphere and there are no materials in the package which would be affected by an increase of external pressure to 20 psi absolute. The special form sealed source capsule will withstand increased pressures much greater than the 20 psi absolute. An increase of external pressure to 20 psi absolute would have no affect on the effectiveness of the SPEC 2-T package.

2.8.1.5 Vibration ***(Excerpts from July 10, 1991 Supplement)***

As noted in previous applications the effects of vibration on the package and materials of constructions incident to normal transportation is negligible. Approximately 800 SPEC 2-T packages have been transported over a period of 16 years via all common modes of private and common transportation on water, highway and air without displaying damage or other noticeable effects. Vibration incident to normal transportation has not reduced the effectiveness of the package. The design revisions to the SPEC 2-T package does not reduce its ability to resist the effects of vibration.

2.8.1.6 Water Spray ***(Excerpts from July 6, 1989 Supplement)***

There are no materials of construction in the SPEC 2-T which would be affected by a water spray, and the production models do not easily permit water within the case. A water spray test was not conducted on the all metal package.

2.8.1.7 Free Drop ***(Excerpts from July 10, 1991 Supplement)***

A. A prototype SPEC 2-T test package was dropped from a distance of four (4) feet onto an essentially unyielding surface described in Section 2.7 above *and in Appendix 9.4, Test Report to Validate Previous 10 CFR Part 71 Puncture Tests*. The point of impact was the upper left corner at the outlet end. The center of gravity of the test package was oriented directly over the point of impact. The specific point of impact was selected upon evaluation that the most damage is likely to occur where the housing panels are the thinnest, and at the end of the package where the source assembly is most likely to escape in the event of damage.

B. The metal flange at the point of impact dented inward approximately ½ inch. 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, nor any increase in radiation levels, nor reduce the effectiveness of the package.

C. The same prototype SPEC 2-T test package was again dropped from a distance of four (4) feet onto the same drop target. The point of impact was the top edge of the lock end. Other points of impact were selected for the free drop tests described in previous applications. The flange dented inward approximately 1/8 inch at the maximum point. The lock continued to operate, there was no loss of radioactive contents, no increase in radiation levels, and no reduction in the effectiveness of the package.

2.8.1.8 Corner Drop ***(Excerpts from July 6, 1989 Supplement)***

This test is not applicable since the package is not constructed of wood or fiberboard.

2.8.1.9 Penetration ***(Excerpts from July 10, 1991 Supplement)***

The prototype SPEC 2-T test package was subjected to two impacts from a 1-1/4 inch diameter steel rod weighing 13 pounds falling a distance of 40 inches. The test package was placed on its left side on the essentially

unyielding surface previously described. The point of impact for both penetration tests was the geometric middle of the right side of the package directly on top of a shielding pad installed inside the package. This point of impact was selected as the worst case location to demonstrate the ability of the shielding pad to meet the requirements for normal condition of transport. Two tests were conducted to provide cumulative damage to the same point of impact to further demonstrate the structural integrity of the SPEC 2-T package. Other points of impact were selected for the penetration tests described in previous applications. The impact from both tests created only superficial marking of the surface of the package. There was no damage to the shielding pad. There was no loss of radioactive contents, no increase in radiation levels, and no reduction in the effectiveness of the package.

2.8.1.10 Compression ***(Excerpts from July 10, 1991 Supplement)***

Although it was not necessary to conduct this test because the design revisions to the SPEC 2-T packaging does not affect its ability to meet this requirement, and it has been shown to meet this requirement in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented, the prototype SPEC 2-T test package was subjected to a compressive load of 525 lbs for a period of 65 hours. The SPEC 2-T test package was placed vertically on a flat, horizontal surface with the outlet end of the 2-T downward. Twenty (20) 2"x 4"x 8" lead bricks were loaded onto a plywood platform which was placed upon the lock end of the 2-T. There were no observable effects of the compression test. The compression test did not result in loss of radioactive contents from the package, increase radiation levels nor reduce the effectiveness of the SPEC 2-T package.

2.8.1.11 Test Summary ***(Excerpts from July 10, 1991 Supplement)***

In compliance with 10 CFR Part 71.71, based upon the above tests and evaluations, it is determined that under normal conditions of transport:

1) There would be no loss or dispersal of radioactive contents.
2) There would be no significant increase in external radiation levels.
3) There would be no significant reduction in the effectiveness of the packaging.

2.8.2 SPEC 2-T Commercial Overpack Configuration Package for Common Carrier Transport

2.8.2.1 Heat ***(Excerpts from July 6, 1989 Supplement)***

The overpack was not tested at an ambient temperature of 100°F in still air and isolation, because the materials of construction of the overpack are stable at that temperature, and the inner SPEC 2-T has been shown to pass the more

stringent 1475°F thermal test for the hypothetical accident conditions. Therefore it is concluded that a temperature of 100°F in still air and isolation would have no effect on the effectiveness of the commercial overpack and SPEC 2-T configuration.

2.8.2.2 Cold ***(Excerpts from July 6, 1989 Supplement)***

The overpack was not tested at -40°F since the materials of construction are stable at that temperature, and the inner SPEC 2-T was satisfactorily tested at -109°F as described above. It is concluded that a temperature of -40 F would had no effect on the effectiveness of the overpack SPEC 2-T configuration.

2.8.2.3 Reduced External Pressure ***(Excerpts from July 6, 1989 Supplement)***

This test was not performed because the overpack and the SPEC 2-T are open to the atmosphere and there are no materials in the package which would be affected by a pressure reduction to 3.5 psi absolute. The special form sealed source capsule will withstand reduced pressures much greater than the 3.5 psi absolute. A pressure reduction to 3.5 psi absolute would have no affect on the effectiveness of the overpack and SPEC 2-T configuration.

2.8.2.4 Increased External Pressure ***(Excerpts from July 6, 1989 Supplement)***

The test was not performed because the overpack and SPEC 2-T are opened to the atmosphere and there are no materials in the package which would be affected by an increase of external pressure to 20 psi absolute. The special form sealed source capsule will withstand increased pressures much greater than the 20 psi absolute. An increase of external pressure to 20 psi absolute would have no affect on the effectiveness of the overpack and SPEC 2-T configuration.

2.8.2.5 Vibration ***(Excerpts from July 6, 1989 Supplement)***

The effects of vibration on the overpack and SPEC 2-T configuration and their materials of construction incident to normal transportation are negligible. The overpack and SPEC 2-T package configuration have been transported over a period of 14 years via all modes of common transportation on water, highway and air without displaying damage or other significant effects. Vibration incident to normal transportation has not reduced the effectiveness of the overpack and SPEC 2-T package configuration.

2.8.2.6 Water Spray ***(Excerpts from July 6, 1989 Supplement)***

A water spray test was not conducted. There are no materials of construction in the overpack which would be affected by a water spray and the SPEC 2-T would not be adversely affected by water.

2.8.2.7 Free Drop ***(Excerpts from July 10, 1991 Supplement)***

A. A prototype SPEC 2-T commercial overpack configuration test package was dropped a distance of four feet onto the previously described essentially unyielding surface described in section 2.7 of this application. The overpack consisted of an outer 22 gauge steel metal drum with a snap ring closure described in section 2.6.2 of this application. The center of gravity was positioned directly over the point of impact for each drop test. The prototype SPEC 2-T commercial overpack configuration test package was dropped a total of five times onto the following points of impact: bottom end, top (lid) end, side of drum corresponding to the location of the latch on the clamp closure ring, edge of the bottom end adjacent to the upper right hand corner of the outlet end of the prototype SPEC 2-T inner test package, and the edge of the top end on the closure ring latch adjacent to the upper left hand corner of the lock end of the prototype SPEC 2-T inner test package.

B. Damage at each point of impact consisted of superficial denting and scratches to the overpack. The drum closure ring and tamper seal remained intact. Damage to the SPEC 2-T inner package was limited to one slight dent at the tip end of the lock cap. The largest dent to the overpack occurred at the bottom edge and was approximately 1-1/2" deep. No rupture occurred. The free drop tests did not result in loss of radioactive contents, nor any increase in radiation levels, nor reduce the effectiveness of the SPEC 2-T commercial overpack configuration package.

2.8.2.8 Corner Drop ***(Excerpts from July 6, 1989 Supplement)***

This test is not applicable since the package is not constructed of wood or fiberboard

2.8.2.9 Penetration ***(Excerpts from July 6, 1989 Supplement)***

A. After the free drop tests the same two packages were subjected to the cumulative effects of ten successive penetration tests on each package. Both overpack configurations with an inner SPEC 2-T were

impacted by the hemispherical end of a steel rod 1-1/4 inch diameter and weighing 13 pounds which was dropped from a distance of 40 inches above the surface of the drum as they rested on the defined essentially unyielding surface. The steel rod was dropped normal to the axis of the drum cylinder when the drum was resting on its side and impacted the center between the two bungs, and twice impacted the latch of the closure ring. The steel rod was dropped parallel with the axis of the drum when it rested upright and impacted the center of the top (lid), impacted the center of the bottom, twice, impacted the latch of the closure ring, impacted the edge of the top (lid), and impacted twice the edge of the bottom. The steel rod was dropped directly onto the snap ring closure of the 22 gauge overpack with the drum resting at a 45° angle to produce maximum damage to the snap ring as depicted in Photographs M9-M10. Points of impact on the 22 gauge overpack are shown in Photographs M1-M10, and points of impact on the 20 gauge are shown in Photographs K1-K5.

B. Damage consisted exclusively of superficial dents and scratches to the surface of the overpacks. The largest dents on each package occurred at the center of the top and bottom ends, each approximately 5/8 inch deep. No ruptures or penetrations were produced. The latch of the closure ring was distorted and rendered unfit for reuse, but otherwise remained fully intact and functional. After all drop and penetration tests the packaging was suspended upside down and shaken. The lid and closure ring and contents remained fully intact. Cumulative damage to the 22 gauge overpack after all drop and penetration tests are shown in Photographs M11-M16, and damage to the 20 gauge overpack are in Photographs K6-K11.

C. The penetration test did not result in loss of radioactive contents from the package, a significant increase of radiation levels nor reduce the effectiveness of the overpack and SPEC 2-T configuration.

2.8.2.10 Compression ***(Excerpts from July 10, 1991 Supplement)***

A SPEC 2-T commercial overpack configuration package consisting of a 22 gauge steel drum with snap ring closure and prototype SPEC 2-T packaging was subjected to a compressive load of 525 pounds evenly distributed on the side of the package for a period of 60 hours. The side of the package was selected because previous tests were conducted with the load distributed on the top of the package as described in previous application. The test package was placed on its side on a flat, horizontal surface. A plywood board was placed on top of the overpack spanning the two bungs and 20 each 2" x 4" x 8" lead bricks were evenly placed on the board. The board was supported to prevent the load from toppling over, but the support did not reduce the weight

of the load on the overpack. There were no observable effects to the overpack of the compression test. The compression test did not result in loss of radioactive contents from the package, increased radiation levels nor reduce the effectiveness of the SPEC 2-T commercial steel drum overpack configuration package.

2.8.2.11 Summary ***(Excerpts from July 10, 1991 Supplement)***

In compliance with 10 CFR Part 71.71, based upon the above tests and evaluations, it is determined that under normal conditions of transport:

1) There would be no loss or dispersal of radioactive contents.
2) There would be no significant increase in external radiation levels.
3) There would be no substantial reduction in the effectiveness of the packaging.

2.9 Hypothetical Accident Conditions ***(Excerpts from July 10, 1991 Supplement)***

2.9.1 SPEC 2-T Package

2.9.1.1 Free Drops

A. A SPEC 2-T substandard test package was subjected to four successive free drops from a distance of 30 feet onto the essentially unyielding surface described in Section 2.7 of this application. Although only one free drop is required under the test criteria, four successive drops were conducted producing cumulative damage to more than adequately demonstrate the structural performance of the package and to obviate any questions concerning the proper selection of package orientation to produce maximum damage. See photographs P1 - P5.

B. Prior to the first test, the substandard SPEC 2-T test package was packed with dry ice and stored within a commercial ice chest for a period of 15 hours. After each test the package was returned to cold storage immediately after being inspected. The maximum duration from the moment the substandard SPEC 2-T test package was removed from dry ice storage until the drop test was accomplished was 90 seconds. Although no attempt was made to measure the temperature of the substandard test package at the moment of release, it is estimated that the temperature was closer to the -109F degree temperature of the dry ice than the required maximum of -20F degrees as specified in 10 CFR 71.73(b). The lower temperature was selected as the appropriate test condition since internal pressure of the containment system is not a factor. The lower temperature selection serves also to provide a worst case test of the package for the effects

of cold.

1) First Drop

A. The point of impact for this test was the bottom of the SPEC 2-T substandard test package. The package was suspended from the carrying handle to orient the center of gravity directly over the point of impact.

B. The exterior portion of the brass outlet nipple and the quick disconnect fitting of the safety plug broke off. The radiation level at the outlet end of the SPEC 2-T increased slightly but not significantly due to the secondary scattered radiation resulting from the loss of the safety plug fitting. There was no other significant increase in radiation levels in any direction from the SPEC 2-T package and there was no loss of radioactive content. All exterior TMJ joints remained intact and the source remained fully secured within the SPEC 2-T. An inspection of the interior TMJ joints connecting the hot top ring to the left side housing panel was not possible, but there was no indication of any damage to the hot top ring or the shield pad. Damage to the housing consisted of superficial scratches and denting to the bottom of the package. See Photographs P6 - P7.

2) Second Drop

A. The point of impact for this test was located at the top left corner at the lock end of the SPEC 2-T substandard test package. The package was suspended from a single wire attached to the diagonally opposite corresponding corner at the outlet end of the package to position the center of gravity directly over the point of impact.

B. The panels forming the corner joint at the point of impact distorted inward approximately 3/4 inch. Four (4) of the eight (8) TMJ joints connecting the end plate at the lock end to the housing panels separated as a result of the drop test. The seam connecting the top and side housing panels at the point of impact separated along a length of approximately four (4) inches, which included the

separation of two (2) of the seven (7) TMJ joints located along the seam. The brass lock cap sheared off from the lock insert of the SPEC 2-T leaving the connector end of the source pigtail exposed but undamaged. The male threaded portion of the lock cap remained lodged within the lock insert.

C. The lock was jammed in the locked position preventing the source assembly from moving in the shield. The tungsten shielding pad at the lock end remained undamaged. Interior damage was limited to slight deformation of the interior bracket at the lock end toward the point of impact. Also, the S-tube crimped at the point where it exits the shield and enters the lock insert. The six (6) TMJ joints connecting the hot top ring to the left side housing panel remained intact. No measurable displacement of the shield resulted. See Photographs P8 - P9.

D. The radiation level at the lock end of the SPEC 2-T increased slightly yet not significantly due to the secondary scattered radiation resulting from the loss of the lock cap.

3) Third Drop

A. The point of impact of the third drop test was the upper right edge of the SPEC 2-T. The damage to the seven (7) TMJ joints along the edge of impact consisted of the complete separation of two (2) joints and partial separation of one (1) joint. The housing of the package dented inward approximately 3/8" along the entire length of the edge of impact. Two (2) additional TMJ joints on the end plate at the lock end separated leaving only two (2) of the original eight (8) joints intact. Four (4) of the end plate joints were already separated as a result of the second drop test. The top housing panel at the lock end distorted upward approximately 3/4" and the interior shield brackets bent toward the left side of the SPEC 2-T approximately 3/8". All four (4) of the joints connecting the lock insert to the top panel and all three (3) of the joints connecting it to the lock end plate remained intact and continued to secure the pigtail. The six (6) TMJ joints connecting the hot top

ring to the left side housing panel were undamaged. The exterior portion of the S-tube at the lock end received additional distortion causing the locking ball of the source pigtail to remain jammed within the lock insert of the SPEC 2-T. Three (3) of the TMJ joints on the end plate at the outlet end separated completely. Much of the deformation to the housing of the package is a result of the absence of foam filler material, which was intentionally omitted to test a worst case package. See Photographs P10 - P11.

B. There was no loss of radioactive contents nor significant additional increase in radiation levels at one meter from the SPEC 2-T substandard test package after the third drop test.

4) Fourth Drop

A. The point of impact for the forth drop test was the bottom right corner at the outlet end of the SPEC 2-T. Two (2) of the seven (7) TMJ joints connecting the bottom and right side housing panels located closest to the outlet end separated completely. In addition, all of the remaining five (5) joints on the end plate at the outlet end separated causing the end plate and tungsten pad to separate completely from the package. The cable of the safety plug remained inside the outlet end of the S-tube due to the distortion to the end of the S-tube which was initially caused by the first drop test. All six (6) TMJ joints connecting the hot top ring to the left side housing panel remained intact yet the shield did not remain completely flush with the left side housing panel. The hot top and shielding pad were displaced approximately 1/4" from the interior surface of the left side panel yet remained within the hot top ring. The center of the right side housing panel was forced outward approximately 1/4" by the side of the shield opposite the hot top. The shield bracket at the outlet end bent toward the left side panel approximately 5/8" and the bracket at the lock end bent approximately 3/8" toward the right side panel. The shield shifted within the housing causing the lock end of the shield to be displaced toward the right side panel by approximately ½". This resulted in an increase in radiation level at the lock end of the

SPEC 2-T to 135 mrem/hr at one meter extrapolated to 225 curies of Ir-192 which remains greatly below the maximum allowable limit of 1000 mR/hr at one meter from the surface.

B. There was no loss of radioactive content and the package continued to meet the requirements specified in 10 CFR Part 71.51 after four successive drop tests using the same SPEC 2-T substandard test package.

2.9.1.2 Puncture

(Excerpts from July 10, 1991 Supplement)

No puncture tests were conducted on the SPEC 2-T substandard test package because it has been shown in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented that the puncture test produces such negligible damage to the package that a 14% increase in weight of the package would not have a significant effect. The damage caused by the three puncture tests described in previous application consisted of superficial surface scratches and denting, with no significant damage to the structural integrity nor substantial effectiveness of the packaging. The SPEC 2-T substandard test package was intentionally subjected to four successive 30 foot drop tests for this application to produce significantly greater cumulative damage than would be caused by the minimum requirements for only one 30 foot drop test followed by one puncture test.

(Excerpts from July 6, 1989 Supplement)

A. The SPEC 2-T substandard test package was dropped twice from a distance of 40 inches onto the center of a six inch diameter by eight inch high carbon steel cylindrical bar. The bar was located in the center of the drop test target specified in Section 2.7 Drop Target Description. The sealed source which was installed within the package for the series of drop tests was used also for the series of puncture tests.

B. The points of impact were those points that resulted in the greatest amount of damage to the same specimen during the drop tests. The point of impact of the first puncture test is the same as that of the first drop test, and the point of impact of the second puncture test is the same as that of the fourth drop test.

1) First Puncture Test Substandard Package

The point of impact for the test was located along the edge of the bottom panel at the outlet end of the SPEC 2-T. See

Drawing No. 22089-1 Rev (0). The package was suspended from the corners of the top panel at the lock end to orient the center of gravity directly over the point of impact.

There was no measurable additional structural distortion to the package. All exterior surfaces and fused joints surviving the previous drop test remained intact.

2) Second Puncture Test Substandard Package

The point of impact of the test was located at the top left corner at the lock end of the SPEC 2-T. See Drawing No. 22089-4. The package was suspended from a single thin wire attached to the bottom right corner at the outlet end to position the center of gravity directly over the point of impact.

There was no measurable additional structural distortion to the housing. All exterior surfaces and fused joints surviving the fourth drop test and first puncture test remained intact.

3) Third Puncture Test Second Test Package

The second SPEC 2-T test package was subjected to a puncture test after the thirty foot drop test. The package was dropped a distance of 40 inches onto the upper edge of a six inch diameter by an eight inch high solid, vertical, cylindrical, mild steel bar on an essentially unyielding, horizontal surface (Photograph I1). The package was oriented at a 45 degree angle to the horizontal plane of the target surface (Photograph I2). The point of impact was the bottom edge of the protruding end of the lock insert (Photograph I3-I4). The lock cap was removed to facilitate the selected point to be impacted. The lock insert was selected as the point of impact on the basis that it would be subject to the maximum damage from the puncture test, and its function as an important safety component of the package, and recommended by the U. S. Nuclear Regulatory Commission.

The bottom edge of the lock insert at the point of impact dented inward approximately 1/32 inch (Photograph I5). The joint connecting the lock insert to the end panel of the package remained fully intact and unflawed (Photograph I6-I8). The puncture test did not result in damage to the package or the radioactive source.

4) Results

The puncture tests did not produced any significant damage. The maximum radiation level at one meter measured after the second puncture test on the substandard test package was 82.1 mrem/hr, extrapolated to an activity of 240 Ci Iridium-192. The maximum radiation at one meter measured after the puncture test on the second test package was 12.0 mrem/hr, extrapolated to an activity of 240 Ci Iridium-192. Both maximum radiation levels remain well below the 1000 mrem/hr criteria for the hypothetical accident tests. The SPEC 2-T meets the criteria established for the hypothetical accident puncture test.

(Excerpts from July 1, 1997 Supplement)

2.9.1.2.1 Additional Puncture Tests

On June 12, 1997 the NRC informed SPEC that one of the hypothetical accident condition tests, the puncture tests, that was performed to qualify the SPEC 2-T as a Type B(U) package might not be valid. This concern was based on the puncture pin mounting information SPEC voluntarily provided to the NRC the previous week. An NRC 10 CFR Part 71 inspection was conducted the week of June 16th, 1997. The inspection confirmed that the six (6) inch diameter steel pin used for the one (1) meter puncture test was not rigidly mounted to the test target pad. The previous puncture tests used a pin that was mounted on the test target pad but the pin had not been mounted rigidly to prohibit toppling and vertical movement (i.e., bolted or welded). A review of a video tape of one of the numerous puncture tests conducted proved that the pin did not topple but that it did move laterally a few inches during the test. The NRC issued a Confirmatory Action Letter dated June 24, 1997 which describes SPEC's commitment to re-evaluate the SPEC 2-T to verify the validity of the previous puncture tests. In order to provide the highest level of directly reliable information we chose to retest the SPEC 2-T rather than extrapolate data from tests of other packages. The complete test report validating the previous 10 CFR Part 71 Puncture Tests is located in Appendix 9.4

2.9.1.3 Thermal ***(Excerpts from July 6, 1989 Supplement)***

2.9.1.3.1 Substandard Test Package

The SPEC 2-T substandard test package used for the thermal test was the same package used for all drop and puncture tests. The end plate at the lock end of the SPEC 2-T was removed and the sealed source used for the drop and puncture tests was replaced with a dummy (unloaded) source assembly. The end plate was reinstalled to the same position as existed after all previous tests. Neither the safety plug nor the lock cap was installed due to damage resulting from the series of drop tests.

2.9.1.3.2 Test Procedure

The substandard test package was placed in a commercial heat treating, thermostat controlled, furnace and subjected to a minimum temperature of 1475°F for a period of not less than 30 minutes. The substandard test package was allowed to remain within the opened furnace upon cessation of external heat for a period of 14 hours to cool without artificial influence.

2.9.1.3.3 Results

A. See Photographs D1, D2, D3, D4, E1, G1, G2, G3, and G4. As a direct result of the thermal temperature the springs inside the lock lost their temper and ceased to function, which rendered the lock inoperable. Due to damage inflicted by the drop tests, the lock was previously jammed in the locked position. If the lock had been operable prior to the thermal test, the damage to the springs as a result of the thermal test would have singularly rendered the lock inoperable and jammed in the locked position.

B. The aluminum portion of the carrying handle melted completely. The carrying handle is not considered a structural part of the SPEC 2-T package. It is provided as a convenience to field radiographers when the package is used as an industrial radiographic exposure device. The melting of the handle does not effect the qualification of the SPEC 2-T as a Type B package.

C. The baked enamel coating of the stainless steel name plate was incinerated, but the embossed lettering remained intact and completely legible. See Photograph G1.

D. The surface coating of the depleted uranium shield was completely incinerated and reduced to ashes. No eutectic formation between the depleted uranium and the stainless steel housing was observed.

E. The overall housing of the package assumed a predominantly copperish tint with portions along the exterior of the left and bottom panels also exhibiting a bluish tint mixed with the copper coloration.

F. The end plate at the lock end of the SPEC 2-T was again removed in order to assess the effects of the thermal test to the interior of the package. There was no physical observable effect on the shield resulting from the thermal test. The same sealed source used during the drop and puncture tests was reinstalled within the specimen to evaluate the effects of the thermal test on the radiation shielding of the package. The maximum radiation level at one meter from the surface of the package was 85.0 mrem/hr, extrapolated to an activity of 240 Ci Iridium-192. The difference between the maximum reading of 82.1 mrem/hr before the thermal test and 85.0 mrem/hr after the thermal test is not considered significant and independent of the test.

G. The hypothetical accident thermal test did not result in any further structural damage to the package.

2.9.1.4 Water Immersion ***(Excerpts from July 6, 1989 Supplement)***

The water immersion test was not performed since no fissionable materials are involved in the package, and since there are no materials of construction which would be damaged by water and water pressure equivalent to a 50 foot depth for a period of eight hours.

2.9.1.5 Summary of Structural Damage ***(Excerpts from July 10, 1991 Supplement)***

A. The above tests on the SPEC 2-T substandard test package more than adequately demonstrates that the revised SPEC 2-T packaging exceeds established standards for a Type B(U) package. First, the test package was deliberately constructed as substandard to represent a design which has significantly less structural integrity than the proposed production model SPEC 2-T. Second, the same substandard test package was subjected to four successive thirty foot drop tests to produce extremely severe cumulative damage. The above tests, which greatly exceeded those established for a Type

B(U) package, have been met by the substandard SPEC 2-T test package.

B. The significant TMJ joints of the SPEC 2-T packaging are those which are important to the structural integrity of the package. A production model SPEC 2-T consists of a total of 19 significant structural TMJ joints. For the SPEC 2-T substandard test package there were 44 joints connecting the housing panels, six (6) joints connecting the hot top ring to the left side panel, four (4) joints connecting the lock insert to the top panel, three (3) joints connecting the lock insert to the lock end plate, and eight (8) joints connecting the shield brackets to the top and bottom panels. Due to the 50% intermittently welded joint construction of the substandard SPEC 2-T test package there were a total of 65 significant TMJ joints on the SPEC 2-T substandard test package.

C. After the first drop test the package met the established criteria for normal conditions of transport. There was no structural damage to the package. The exterior portion of the brass outlet nipple and the safety plug fitting broke off. All TMJ joints, including the 65 significant joints, remained intact.

D. The second drop test resulted in minor distortion to the housing, separation of six (6) of the 44 TMJ joints connecting the housing panels, and the lock cap broke off. The interior damage consisted of minor deformation of the shield brackets.

E. The third drop test caused additional deformation of the housing along the edge of impact and the separation of an additional five (5) TMJ end plate joints and four (4) side panel joints. The interior shield brackets experienced further bending but remained intact, and the exterior portion of the S-tube at the lock end was distorted. After the first three drop tests the cumulative damage consisted of separation of 15 of the 44 housing panel TMJ joints.

F. The fourth drop test caused separation of seven (7) of the remaining 29 TMJ housing joints and the loss of the end plate at the outlet end. The six (6) TMJ joints connecting the hot top ring to the left side housing panel remained intact and the shielding pad remained in place. The shield brackets bent and the DU shield shifted approximately ½" inside the package.

G. After the entire series of four drop tests a total of 22 of the 65 significant TMJ joints were separated yet the package continued to meet the requirements for a Type B package specified in 10 CFR

71.51. It should be noted that if the package had been fabricated using 100% TMJ joints the structural damage would have been greatly reduced. The damage would also have been greatly reduced if the specified foam filler had not been omitted to create a worst case test package.

H. The cumulative damage resulted in an increase in radiation level at the lock end of the SPEC 2-T to 135 mR/hr at one meter extrapolated to 225 curies of Ir-192 which remains greatly below the maximum allowable limit of 1000 mR/hr at one meter from the surface, and there was no loss of radioactive content.

I. ***(Excerpts from January 5, 1992 Supplement)***
It should be noted that in January 1991 a SPEC 2-T was involved in a transportation incident which was very similar to a highly publicized incident in Texas in 1987. The most recent incident also subjected the package to damage that may have greatly exceeded the damage that could be caused by the hypothetical accident condition tests. A SPEC 2-T containing a radioactive source was dropped from a moving vehicle onto a paved highway. It was then struck by another vehicle causing damage to the 2-T and to the underside of the vehicle. Damage to the 2-T consisted of severe dents and abrasion. However, there was no increase in radiation level and no loss of radioactive content. Although superficially damaged, the 2-T was able to function as a radiographic exposure device without repairs required. Repairs were made to the damaged 2-T, and consisted of housing repair primarily. No structural work was needed. The SPEC 2-T involved in the incident was fabricated approximately five years ago.

2.9.1.6 Additional Structural Evaluation - Lock ***(Excerpts from January 5, 1992 Supplement)***

In response to a request from the NRC by letter dated November 27, 1991 the following information is provided.

A. Thirty foot free drop tests have been performed on the lock end of the package and have not resulted in an inadvertent unlocking of the lock mechanism nor jamming of the lock mechanism in the unlocked position. Of the nine (9) thirty foot free drop tests that have been described in previous applications three of the points of impact have been located at the lock end of the SPEC 2-T. The greatest amount of damage is expected to result from a free drop with the point of impact at the top left or top right corner at the lock end since this is where the package housing panels are the thinnest. The side and top

panels are approximately half as thick as the bottom panel.

B. Two free drop tests have been described in previous applications with the point of impact at the top left corner at the lock end of the package, and a third drop test was described with the point of impact at the bottom edge at the lock end. These tests, as well as every other sequence of free drop tests that have been performed on the SPEC 2-T, have resulted in damage to the locking mechanism. However, in all cases in which the lock has been jammed it has been jammed in the locked position.

C. The series of events that must exist in order for a free drop or puncture test to result in the lock being jammed in the open position is greatly beyond any reasonably foreseeable probability. Impact force, which is likely beyond that which is able to be generated in a thirty foot free drop test, must first compress the five internal lock tumbler springs. At the same instant a rotational force must be applied to the lock plunger body with sufficient torque to compress the lock pin spring and rotate the lock body 90 degrees in order to allow the lock to open. There is no reasonable likelihood that a 90 degree rotational force of any degree could be induced to the lock mechanism as a result of a thirty foot free drop or a puncture test on any point of impact on the SPEC 2-T.

D. In each of the hypothetical accident condition tests performed on the SPEC 2-T, including the many tests that were performed independent of the applications submitted to the NRC, the lock mechanism has never jammed in the unlocked position.

E. It should be noted that when the point of impact is the lock end of the SPEC 2-T the primary means to prevent loss of the source assembly is not the lock, it is the lock insert. The direction of forces imparted upon the source assembly as a result of a thirty foot free drop on the lock end of the SPEC 2-T are likely to cause the source assembly to be forced against the lock insert, not in the opposite direction against the lock.

2.9.1.7 Additional Structural Evaluation - Lock Cap
(Excerpts from January 5, 1992 Supplement)

In response to a request from the NRC by letter dated November 27, 1991 the following information is provided.

A. A 45 degree puncture test onto the bottom of the lock housing (lock insert) has been taken into account. The lock housing itself is located

inside the package housing, yet it is a portion of the same component which includes the lock insert. The lock insert is subject to damage as a result of thirty foot free drop and puncture tests at the point where it protrudes from the end panel of the SPEC 2-T. In response to a similar NRC request for additional information by letter dated May 3, 1989 a 45 degree puncture test was performed on the lock insert after the thirty foot drop tests. The damage was negligible. The damage consisted of a dent to the edge of the end of the lock insert.

B. The lock cap was damaged during each series of hypothetical accident condition tests performed on the SPEC 2-T yet without reducing the effectiveness of the package. The primary purpose of the lock cap is to prevent damage to the source assembly (pigtail) connector and to prevent the ingress of foreign material during transport. It can be stated that the lock cap also provides a redundant protection against loss of the source assembly through the lock end of the SPEC 2-T, but this not the primary function of the lock cap nor is there a demonstrated need for such a redundant safety feature.

C. The primary design feature to prevent loss of the source assembly is the lock insert. The inside diameter of the stainless steel lock insert is smaller than the diameter of the locking ball of the pigtail. This prevents loss of the source assembly even in the absence of the lock cap. The brass lock cap was either bent or sheared off during each hypothetical accident condition test. In the worst case of damage, when the lock cap body was sheared of, the threaded male end of the lock cap remained threaded within the lock insert. Therefore, the lock cap threaded end alone prevents loss of the source assembly since the inside diameter is smaller than the diameter of the pigtail locking ball.

2.9.2 SPEC 2-T Commercial Overpack Configuration Package

(Excerpts from January 5, 1992 Supplement)

The SPEC 2-T commercial overpack configuration package was not subjected to the hypothetical accident condition tests since the inner SPEC 2-T package has been shown to successfully pass those tests. Therefore, if any overpack and SPEC 2-T configuration package were subjected to the hypothetical accident condition tests the package would successfully pass the tests, because:

1. If the overpack were completely destroyed or ineffective the inner SPEC 2-T has been shown to pass the specified test.

2. The presence of the overpack could in no way adversely affect the ability of the inner SPEC 2-T to pass the test; conversely, the overpack could only

enhance the ability of the overpack and SPEC 2-T configuration package to pass the hypothetical accident condition tests.

2.10 Special Form *(Excerpts from July 6, 1989 Supplement)*

Iridium-192 wafers are encapsulated in a stainless capsule which meets the requirements of special form radioactive material pursuant to 49 CFR 173.403(z), 10 CFR 71.77 and Paras 142, 502-504 IAEA Safety Series No. 6 "Regulations for the Safety Transport of Radioactive Materiel" 1985 Edition. The individual iridium wafers could qualify as special form radioactive material, if it were not for the minimum dimension requirement; but the stainless steel capsule represents the primary containment vessel. The stainless steel capsule meets the requirements of special form radioactive material as demonstrated by IAEA Certificate of Competent Authority No. USA/0095/S. See Appendix 9.3 Documents.

2.10.1 Description

The stainless steel sealed source capsule in the SPEC 2-T package is approximately 3/4 inches long by 1/4 inches diameter. The sealed source capsule meets the minimum dimension requirement of 5 mm for special for special form radioactive material. Source assemblies ("pigtails") consist of the sealed source capsule swaged onto a flexible cable to which is swaged a stainless steel locking ball and a connector.

2.10.2 Free Drop

Since the stainless steel capsule is very light and ruggedly constructed it is apparent that effects of its impact onto a flat, horizontal, essentially surface would be negligible.

2.10.3 Percussion

The design and yield strength will permit the stainless steel 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.

2.10.4 Bending

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

2.10.5 Heating

The stainless steel capsule and the iridium wafers will withstand sustain temperatures greater than 1475°F for ten minutes without adverse effects.

2.10.6 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 2-T package, the stainless steel sealed source capsule, meets or exceeds the requirements for special form radioactive material as specified in 10 CFR 71.77.

3.0 THERMAL EVALUATION

3.1 Discussion *(Excerpts from July 6, 1989 Supplement)*

A. Due to the materials of construction of the SPEC 2-T which are known to have stable thermal properties and which will not be affected by the prescribed 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. Although not necessary to demonstrate compliance with the hypothetical accident thermal conditions the SPEC 2-T substandard test package, which had sustained the cumulative damage from four drop tests and the puncture test, was subjected to the prescribed 1475°F heat test for thirty minutes to alleviate any questions concerning the thermal assessment.

B. As discussed previously any overpack and inner SPEC 2-T configuration will successfully meet the prescribed 1475°F heat test since the inner package has been shown to meet the test. Even if an overpack were completely destroyed in the heat test the inner SPEC 2-T would still pass the test and the presence of the overpack would probably enhance its ability to pass the test by providing some thermal shielding.

C. The heat of decay from the maximum activity 240 Ci Iridium-192 source is negligible. There are no fluids in the SPEC 2-T 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 1475°F. Aluminum is the only material of construction which is affected by the 1475°F test temperature since it will melt at 1220 F, but aluminum is only used in the carrying handle which is not a structural part of the package. Brass has the next lowest melting point which is not lower than 1550°F. Brass is used in the lock, outlet nipple, and lock cap. The hypothetical accident temperature of 1475°F could only affect the temper of the springs in the lock plunger which may keep the lock from operating, but it would remain in locked position. A temperature of -40°F would have no effect on the critical 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, Incorporated.

The materials of construction are as follows:

Material	Melting Temperature
Aluminum	1220°F
Brass	1550°F
Depleted Uranium	2070°F
Stainless Steel	2550°F
Titanium 3-2.5	3000°F
Tungsten (alloy)	3000°F
Zircalloy 2	3270°F

From the above table it is readily apparent that a 1,475°F temperature would have no effect on the device.

There have been reports indicating a possibility of a iron-uranium eutectic formation at 1,340°F. Such eutetic formation has been associated with metallurgically clean surfaces and vacuum heat treatment. The depleted uranium casting used in the construction of the SPEC 2-T is not cleaned to obtain a metallurgically clean surface and the stainless steel plates are not chemically clean. No iron-eutetic formation has ever been observed or reported in the fabrication of radiography devices, and the supplier of the depleted uranium castings, Nuclear Metals, Inc., knows of no occurrences.

3.3 Technical Specification of Components

This section is not applicable. The only operating component in the SPEC 2-T package is the lock and the manufacturer does not report any temperature or pressure limitations other than that known for the common materials of construction in the lock which is basically brass and steel.

3.4 Thermal Evaluation for Normal Conditions of Transport

A. The SPEC 2-T package is manufactured from materials which are not affected by a temperature of 100°F. The SPEC 2-T substandard test package was subjected to a temperature of 1475°F in conjunction with the hypothetical accident thermal test and there were no observable detrimental effects. Before the first drop test the SPEC 2-T substandard test package was packed in dry ice. The cold test for normal transport was conducted by packing the unit in dry ice for 20 hours, reducing the temperature below -70°F and it satisfactorily passed the first hypothetical accident drop test in accordance with the normal conditions of transport criteria.

B. From the above it is conservatively concluded that within a temperature range between -40°F and 100°F the SPEC 2-T package will not release it contents, will not present increased radiation levels, and will not incur any reduction in the

effectiveness of the package.

3.5 Hypothetical Accident Thermal Evaluation

3.5.1 Summary of Thermal Effects

A. The springs inside the lock lost their temper and ceased to function, which rendered the lock inoperable. Due to damage inflicted by the drop tests, the lock was previously jammed in the locked position. If the lock had been operable prior to the thermal test, the damage to the springs as a result of the thermal test would have singularly rendered the lock inoperable and jammed in the locked position.

B. The aluminum portion of the carrying handle melted completely. The carrying handle is not a structural part of the package. It is a provided as a convenience to field radiographers when the package is used as an industrial radiographic exposure device. The melting of the handle does not effect the safety of the SPEC 2-T as a Type B package.

C. The baked enamel coating of the stainless steel name plate was incinerated, but the embossed lettering remained intact and completely legible. See Photograph G3.

D. The surface coating of the depleted uranium shield was completely incinerated and reduced to ashes. No eutectic formation between the depleted uranium and the stainless steel housing occurred.

E. The overall housing of the package assumed a predominantly copperish tint with portions along the exterior of the left and bottom panels also exhibiting a bluish tint mixed with the copper coloration.

F. The end plate at the lock end of the SPEC 2-T was again removed in order to assess the effects of the thermal test to the interior of the package. The slotted end of the lock plunger was inadvertently separated from the lock during removal of the end plate and lock insert. A sealed source was installed in the substandard test package to evaluate the effects of the thermal test on the radiation shielding of the package.

3.5.2 Conclusions from Hypothetical Accident Condition Thermal Test

A. The materials of construction of the SPEC 2-T package have been shown not to be affected by a temperature of 1475°F, therefore it can be concluded that such a temperature will have no effect on the package regardless of the time exposed to such a temperature. Nevertheless, the SPEC 2-T substandard test package with the cumulative damage of four drop tests and the puncture test

was placed into a furnace with a temperature at least 1475°F for 30 minutes. Except for discoloration and the melting of the non-structural aluminum handle there were no observable effects. A source assembly was reinstalled in the camera to evaluate the shielding. The maximum radiation level measured at one meter from the surface of the SPEC 2-T before the thermal test was 82.1 mrem/hr at one meter, extrapolated to an activity of 240 Ci Iridium-192, and the maximum radiation level after the thermal test was 85.0 mrem/hr, extrapolated to 240 Ci Iridium-192. The difference in the two readings is not significant.

B. The SPEC 2-T clearly did not release its radioactive contents as a result of the hypothetical accident thermal condition as evidenced by the above test and due to the fact that the primary containment is special form sealed source capsule which is manufactured from materials that are not affected by a temperature of 1475°F. The measured radiation levels after the hypothetical accident thermal test occurred as a result of the cumulative drop tests and not as a result of the thermal test. It can be conservatively concluded that the hypothetical accident thermal test did not have any effect on the resulting radiation levels.

4.0 CONTAINMENT

4.1 Containment Boundary *(Excerpts from March 13, 1989 Application)*

4.1.1 Containment Vessel

The sealed source capsule containing metallic Iridium-192 wafers described in Section 1.3.4 *and section 2.10* 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

Due to the size of the sealed source capsule and the location of the capsule within the SPEC Model 2-T there will be no penetrations of the primary containment vessel.

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 *(Excerpts from July 10, 1991 Supplement)*

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 was no release of radioactive material from the primary containment vessel.

4.2.2 Pressurization of Containment Vessel

The is negligible gas contained within the minute void of the sealed source capsule, therefore any pressurization due to temperature or reduced pressure at flight altitudes would not effect the integrity of the sealed source capsule.

4.2.3 Coolant Contamination

No coolants are used in the package.

4.2.4 Coolant Loss

No coolants are used in the package.

4.3 Containment Requirement for the Hypothetical Accident Conditions

4.3.1 Fission Gas Products

No fissionable radioactive material is used in the SPEC 2-T package.

4.3.2 Releases of Contents

Based on the results of the Type B performance tests described in Section 2.9 *and in Appendix 9.4, Test Report to Validate Previous 10 CFR Part 71 Puncture Tests,* 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.

5.0 SHIELDING EVALUATION

5.1 SPEC 2-T Package *(Excerpts from July 10, 1991 Supplement)*

The shielding performance of the SPEC 2-T packaging is established by actual measurements of randomly selected prototype SPEC 2-T packages and a substandard SPEC 2-T test package used for the hypothetical accident conditions tests. For surface radiation level measurements a distance correction factor was used to account for the distance from the center of the GM tube detector to the surface of the SPEC 2-T package. Theoretical calculations have not been used.

5.1.1 Typical Radiation Profile

The typical radiation profile of the SPEC 2-T package was established by actual measurements of two randomly selected prototype SPEC 2-T packages. One of the 2-T packages was fabricated with a shielding pad installed in the right side and the other SPEC 2-T did not contain a side shielding pad. Radiation level measurements were made for both packages with a 115 curie Ir-192 source are extrapolated to 45 curies and 225 curies. The highest radiation level for each location from either package is presented below to produce a worst case typical radiation profile.

Surface of SPEC 2-T Location of Plane	45 Ci Ir-192 Maximum mrem/hr	225 Ci Ir-192 Maximum mrem/hr
Parallel to Left Side	133	666
Parallel to Right Side	110	550
Parallel to Top	74	366
Parallel to Bottom	145	726
Parallel to Lock End	46	228
Parallel to Outlet End	56	270

One Meter from Surface Location of Plane	45 Ci Ir-192 Maximum mrem/hr	225 Ci Ir-192 Maximum mrem/hr
Parallel to Left Side	<1	4.7
Parallel to Right Side	<1	4.4
Parallel to Top	<1	2.8
Parallel to Bottom	<1	4.8
Parallel to Lock End	<1	2.8
Parallel to Outlet End	<1	2.7

5.1.2 Normal Conditions of Transport

Actual radiation level surveys were performed of a prototype SPEC 2-T test package, which was fabricated with a shielding pad in the right side, after the applicable tests were conducted for normal conditions of transport. Radiation levels were measured at a sufficient number of locations to determine if there were any significant changes compared to the radiation levels prior to the tests. There were no changes in radiation levels as a result of the normal condition of transport tests.

5.1.3 Hypothetical Accident Conditions

Actual radiation level measurements were also recorded from the substandard SPEC 2-T prototype test package, which was fabricated with a side shielding pad in the left side, after each of the hypothetical accident condition free drop tests. The tests were made with a 77 curie Ir-192 source. The measurements are extrapolated to 225 Ci Iridium-192, rounded to the nearest 0.5 mrem/hr, and presented below.

Radiation Levels (mrem/hr) at One Meter from Surface; 225 Ci Iridium-192

Package Surface	Initial	First Drop	Second Drop	Third Drop	Fourth Drop
Bottom	4.5	4.5	4.5	4.5	4.0
Top	3.0	3.0	3.0	3.0	4.0
Left Side	3.5	3.5	3.5	3.5	3.5
Right Side	4.5	4.5	4.5	4.5	5.0
Lock End	3.0	3.0	5.5	5.5	135.0
Nipple End	2.0	8.0	8.5	8.5	30.0

5.1.4 Source Specification

The source assembly used for the typical radiation profile measurements and for the normal condition of transport tests was a standard SPEC G-1F with an activity of 115 curies. The source assembly used for the hypothetical accident conditions tests was a standard SPEC G-1F with an activity of 77 curies.

5.1.5 Model Specification

Physical radiation measurements were performed on two randomly selected prototype SPEC 2-T packages, and radiation surveys were performed on a prototype SPEC 2-T test package after the applicable tests for normal conditions of transport, and on a substandard SPEC 2-T test package after each of the applicable hypothetical accident condition tests. Theoretical calculations or scale models were not used.

5.1.6 Shielding Evaluation

The radiation level measurements for a typical SPEC 2-T package presented above conservatively show that the it meets the requirements for all radioactive material packages specified in 10 CFR 71.47. Evaluation results verify that there is no significant increase in radiation levels, no loss or dispersal of radioactive contents, and no substantial reduction in the effectiveness of the SPEC 2-T packaging as a result of the applicable normal condition of transport tests specified in 10 CFR 71.71 in compliance with 10 CFR 71.51(a)(1). The maximum radiation level of 135 mrem/hr at one meter from the surface of the substandard SPEC 2-T test package at the conclusion of four 30 foot free drop tests, in addition to the evaluations presented in previously approved applications, shows that the SPEC 2-T package easily meets the maximum allowable 1000 mrem/hr at one meter hypothetical accident conditions criteria specified in 10 CFR 71.51(a)(2).

5.2 SPEC 2-T Commercial Overpack Configuration Package for Common Carrier Transport

5.2.1 Typical Radiation Profile

Radiation levels were measured at the surface and at one meter from the surface of a typical SPEC 2-T commercial overpack configuration package with a 114 curie Ir-192 source. The prototype SPEC 2-T inner package was fabricated without a side shielding pad to represent a worst case radiation profile. The maximum radiation level measured for each of the locations of the package was extrapolated to 225 curies of Ir-192 and is presented below. The location of the radiation level measurements for the overpack are represented in relation to the orientation of the prototype SPEC 2-T inner package. The results demonstrate that the maximum radiation levels of a typical SPEC 2-T commercial overpack package are greatly below the maximum allowable 200 mrem/hr at the surface and 10 mrem/hr at one meter from the surface of a Type B(U) package transported by common carrier.

Surface of Commercial Overpack:	225 Ci Ir-192
Location of Reading	mrem/hr
Adjacent to Left Side of 2-T	74
Adjacent to Right Side of 2-T	66
Adjacent to Top of 2-T	50
Adjacent to Bottom of 2-T	84
Adjacent to Lock End of 2-T (drum top)	42
Adjacent to Outlet End of 2-T (drum bottom)	64

One Meter from Surface of Commercial Overpack:	225 Ci Ir-192 mrem/hr
Location of Reading	
Adjacent to Left Side of 2-T	3.7
Adjacent to Right Side of 2-T	3.5
Adjacent to Top of 2-T	2.2
Adjacent to Bottom of 2-T	3.8
Adjacent to Lock End of 2-T (drum top)	2.5
Adjacent to Outlet End of 2-T (drum bottom)	2.4

5.2.2 Normal Conditions of Transport

A radiation survey was performed after each of the normal conditions of transport test performed on the prototype SPEC 2-T commercial overpack configuration package with 90 curies of Iridium-192. The prototype SPEC 2-T inner packaging was fabricated with a shielding pad in the right side to produce the maximum weight package for the normal condition tests. The surveys revealed absolutely no significant changes in radiation levels at the surface and at one meter from the surface of the package.

Surface of Commercial Overpack:	225 Ci Ir-192 Max mrem/hr	
Location of Reading	Before/After	
Adjacent to Left Side of 2-T	72	75
Adjacent to Right Side of 2-T	76	70
Adjacent to Top of 2-T	57	60
Adjacent to Bottom of 2-T	90	90
Adjacent to Lock End of 2-T (drum top)	32	40
Adjacent to Outlet End of 2-T (bottom)	64	60

One Meter from Surface of Commercial Overpack:	225 Ci Ir-192 mrem/hr	
Location of Reading	Before/After	
Adjacent to Left Side of 2-T	3.7	3.5
Adjacent to Right Side of 2-T	3.0	3.0
Adjacent to Top of 2-T	2.2	2.0
Adjacent to Bottom of 2-T	3.5	3.5
Adjacent to Lock End of 2-T (drum top)	2.2	2.5
Adjacent to Outlet End of 2-T (bottom)	2.4	2.0

5.2.3 Hypothetical Accident Conditions

As discussed in previous applications, any overpack and inner SPEC 2-T configuration package will successfully meet the prescribed maximum hypothetical accident conditions since the inner SPEC 2-T package alone has been shown to meet the tests. Even if the overpack were completely destroyed in the hypothetical accident condition tests the inner SPEC 2-T would still pass the tests and the presence of the overpack would only enhance its ability to pass the tests.

5.2.4 Shielding Evaluation

A. The typical radiation levels from a SPEC 2-T commercial overpack configuration package are within the radiation level limits for a package in common carrier transportation.

B. The above results and evaluations conservatively showed that there was no significant increase in radiation levels for the normal condition of transport tests for the commercial overpack. Since the SPEC 2-T package alone meets the shielding requirements for hypothetical accident conditions then the SPEC 2-T commercial overpack configuration package satisfies the conditions for a Type B(U) package.

5.3 Private Carriage Transport

It has been established in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented, that the SPEC 2-T with 225 curies of Iridium-192 meets the requirements for a radioactive material package in private carriage when transported in accordance with 49 CFR 173.441(b). Since the design revisions only increase the shielding performance of the SPEC 2-T package then it meets the shielding requirements for a Type B(U) package with more than 45 curies of Iridium-192 for transport in private carriage.

5.4 Common Carrier Transport

It has been established in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented, that the SPEC 2-T commercial overpack configuration package with 225 curies of Iridium-192 meets the requirements for a radioactive material package transported by common carrier. Since the design revisions only increase the shielding performance of the SPEC 2-T package then it meets the shielding requirements for a Type B(U) package with more than 45 curies of Iridium-192 for transport by common carrier.

6.0 CRITICALITY EVALUATION

(Excerpts from March 13, 1989 Application)

This section is not applicable since the SPEC 2-T does not contain and is not designed to transport fissile material.

7.0 OPERATING PROCEDURES

7.1 Procedures for Preparing and Loading the Package *(Excerpts from August 21, 1989 Supplement)*

A. Training of personnel who prepare and offer hazardous material shipments, including the SPEC 2-T, for transport is required pursuant to 49 CFR 173.1(b) and training of personnel transporting hazardous materials on public highways, including a SPEC 2-T loaded with Iridium-192, is required pursuant to 49 CFR 177.800(a).

B. The source assembly is initially loaded into the SPEC 2-T at the SPEC facilities under the provisions of Louisiana Radioactive Material License LA-2966-L01 in accordance with the procedures and radiation protection standards established under that license. Users of the SPEC 2-T may be authorized to install specified source assemblies in the SPEC 2-T in accordance with the provisions of their agreement state or NRC radioactive material license and in accordance with the instruction of the source exchanger authorized in their specific radioactive material license. As an example, the SPEC C-1 source changer is authorized for use with source assemblies used in the SPEC 2-T exposure device.

C. The SPEC 2-T should be prepared for shipment by a employee pursuant to the above requirements and may be a radiographer, radiation safety officer or similarly qualified employee of the licensee. A properly prepared package may be loaded onto a vehicle and transported by an individual who has been properly instructed pursuant to in the handling and transport of hazardous materials and who has been specifically instructed in securing radioactive material packages from movement during transport, separation distances, maximum transport index limitations and placarding requirements.

7.1.1 Package Preparation

7.1.1.1 Package Registration

The shipper, including users who transport the SPEC 2-T as a private carrier, must register as a user of the package by writing to:

Transportation Branch
Division of Safeguards and Transportation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

7.1.1.2 General Package Inspection

Visually inspect the SPEC 2-T to determine if it is in unimpaired condition for shipment. The SPEC 2-T should be inspected to determine that it is not

damaged, that the lock operates properly, that the source assembly (pigtail) 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 2-T and displays the package identification number USA/9056/B(U).

If any of the following required information is not present or legible the shipper may durably mark the required information on the SPEC 2-T package provided that he has determined that the package was fabricated in accordance with the approved design.

RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S., UN2974 USA/9056/B(U) TYPE B Model SPEC 2-T MAXIMUM GROSS WEIGHT: ~~49 POUNDS~~ *56 POUNDS* Contains Approximately 35 Pounds of Depleted Uranium Source Production & Equipment Company, Inc., St. Rose, Louisiana

7.1.1.3 Packaging

Verify that the lock plunger is fully depressed, and that the source assembly is properly locked and secured in the SPEC 2-T. The source safety plug and the lock cap must be firmly attached.

Although the SPEC 2-T package may be shipped and transported as a separate package when containing ~~110 Ci~~ *45 Ci* Iridium-192 or less, it is required that it be placed in the commercial overpack for transportation by common carrier when it contains more than ~~110 Ci~~ *45 Ci* Iridium-192 or if radiation levels exceed 200 mrem/hr on the surface of the SPEC 2-T.

Commercial overpacks are specified which consist of a 12 gallon steel drum and molded foam packing material, which prevents the movement of the SPEC 2-T within the barrel. Secure the top to the drum with the locking ring and tighten the locking ring bolt or secure the ring clamp. Although the SPEC 2-T lock functions as a security seal it is recommended that a lead or other shipping security seal be affixed to the locking ring on the barrel. Shielding may be incorporated into the commercial overpack to achieve any desired radiation levels for transportation.

7.1.1.4 Outer Package Surface Contamination

Regulations require 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^{-4} uCi/cm^2 (4 Bq/cm^2 or 220 dpm/cm^2) averaged over 300 cm^2 of any part of the surface. This may be determined by measuring the

activity on wipes taken from representative locations and the above criteria is assumed to be met if the activity on any sample averaged over the surface area wiped does not exceed 10^{-5} uCi/cm^2 (0.4 Bq/cm^2 or 22 dpm/cm^2). If the contamination on the surface of the outer package exceeds the above amount or if the source is known to be leaking or contaminated DO NOT SHIP, but contact Source Production & Equipment Company, Inc. for assistance.

7.1.1.5 Markings

When a SPEC 2-T is shipped or transported without an overpack the required markings as described above must be placed on the SPEC 2-T.

When a SPEC 2-T is shipped or transported in an overpack the outer package must be marked:

RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S., UN2974 INSIDE PACKAGE COMPLIES WITH PRESCRIBED SPECIFICATION

The overpack must also be marked with the name and address of the consignee or consignor unless it is an exclusive use or private carrier shipment.

7.1.1.6 Labels

No internal labels.

Survey the package and determine the maximum radiation levels at the surface and at one meter (39.37 inches) from the surface. Transport Index (TI) is the dimensionless number equivalent to the maximum radiation level measured in mR/hr (10 uSv/hr) at one meter (39.37 inches) from the surface of the package. Select the proper label from the chart below such that the specified radiation levels are not exceeded:

Radioactive Label	Surface mR/hr	Transport Index TI
Radioactive White I	0.5	Not Applicable
Radioactive Yellow II	50	1.0
Radioactive Yellow III	200	10.0

Complete the information on two labels:

Contents	Iridium-192 or Ir-192
Activity:	Determine the activity in Curies (Ci) or terabecquerel (TBq) by calculation from the original activity or from the decay chart
T.I.:	Enter the appropriate measured value rounded up to the next tenth.

Apply two radioactive labels to opposite sides of the outer package in such a manner that they do not obscure the required markings. The old radioactive labels must be removed or the new labels applied on top of the old labels. When any overpack is used additional labels on the inside package are not necessary.

U.S. regulations prohibit this package on any passenger carrying aircraft entering U.S. airspace and on U.S. flag carrier anywhere. Most other countries and airlines will permit this shipment on passenger carrying aircraft. Before entry into U.S. airspace by any carrier or before offering to a U.S. flag carrier one CARGO AIRCRAFT ONLY label must be affixed so that it does not obscure the radioactive labels or required markings.

7.1.1.7 Shipping Papers

U.S Department of Transportation Hazardous Material Regulations require the following shipping paper information when shipping or transporting the SPEC 2-T package:

(Excerpts from March 13, 1989 Application)

Radioactive Material, Special Form, N.O.S., UN2974 Iridium-192 _____ Ci Radioactive White I, Yellow II or Yellow III Label USA/9056/B(U)
Cargo Aircraft Only (if offered for air transportation)
For water transportation only enter the number of SPEC 2-T devices in each overpack, the number of overpacks; and the gross weight of each SPEC 2-T package (i.e ~~49 pounds~~ *56 pounds*) or the gross weight of each overpack.

The following certification statements must be added to the above shipping paper information except when the SPEC 2-T is being transported by a private carrier.

Shipper's Certifications (Not required for private carriers)
This is to certify that the above named materials are properly classified, described, packaged, marked, labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.
For air transportation only add: This shipment is within the limitation prescribed for ~~passenger aircraft~~ / cargo aircraft only (delete nonapplicable).
Signatures are required for the above certification statements. The signature must be legibly signed by a principal, officer, partner or employee of the shipper or his agent; and it may be legibly signed manually, by typewriter, or other mechanical means.

Although the U.S Department of Transportation or the ICAO Technical Instructions do not require a specified form for shipping papers or dangerous goods transport documents most international airlines are members of the International Air Transport Association and require use of the IATA Shipper's Declaration for Dangerous Goods "candy-stripe" form. Therefore, it is recommended that you use this form for international shipments to avoid possible delays. Consult the current edition of the IATA Dangerous Goods Regulations or Source Production & Equipment Company, Inc. for assistance in completing the IATA Shipper's Declaration for Dangerous Goods and other international shipping requirements.

7.1.1.8 Type B Quantity Consignee Notification

Prior to each shipment of a SPEC 2-T containing more than 20 Ci Iridium-192 the shipper shall notify the consignee of the dates of shipment and expected arrival.

7.1.1.9 Records and Documentation

A. The shipper, including users who transport the SPEC 2-T as a private carrier, are required to have a current copy of the NRC Certificate of Compliance No. 9056 in their possession and comply with the provisions in the certificate for shipment.

B. U. S. Department of Transportation Hazardous Material Regulations require that the shipper maintain on file for one year after the last shipment documentation of any test, demonstrating that special form material requirements have been met. A copy of the IAEA Certificate of Competent Authority USA/0095/S may be used to satisfy this requirement.

C. The NRC and most agreement state regulations require that the following records be maintained for at least two years after each shipment:

1) Identification of packaging by its model number: SPEC 2-T
2) Verification that the package was in satisfactory condition when shipped
3) Activity of Iridium-192 in each shipment
4) Date of each shipment, note that this includes transport by a user of the SPEC 2-T as a private carrier
5) Address to which shipment was made
6) Results that the package was properly prepared for shipment and evidence that surface contamination limits were met

D. In addition NRC licensees are required to maintain for the life of the SPEC 2-T package quality assurance records which establish the continuing integrity and safety of the package.

7.1.2 Transport

7.1.2.1 Placarding

A. When transporting one or more packages with a Radioactive Yellow III label four RADIOACTIVE placards must be displayed on the front, rear and two sides of the motor vehicle so that it is readily visible from the direction it faces and so that the wording is horizontal. The placard must be at least three inches away from any markings on the vehicle and must be securely affixed.

B. When offering a package with a Radioactive Yellow III label to a motor carrier for transport the shipper must offer to provide the motor carrier four RADIOACTIVE placards unless the vehicle is already displaying four RADIOACTIVE placards. The motor carrier does not have to accept the placards, and it is recommend that the shipper indicate on the bill of lading that placards were offered and acknowledged by the signature of the motor carrier driver on the bill of lading.

7.1.2.2 Shipping Paper Accessibility

A carrier, including a private carrier transporting a SPEC 2-T for his own use, is required to have the required shipping paper readily available to and recognizable by authorities in the event of an inspection or an accident. The shipping paper must be clearly distinguished from other papers by having it on top or distinctively tabbing it. When the driver is at the vehicle controls, while he is restrained by a seat belt, the shipping paper must be stored within his immediate reach, and readily visible to an individual entering the driver's compartment or in a holder mounted inside on the driver's door. When the driver is in the vehicle the shipping paper must be in a holder mounted inside on the driver's door or on the driver's seat.

7.1.2.3 Secure from Movement

Radioactive material packages must be blocked and braced so they can not change positions within the vehicle under conditions ordinarily encountered in transportation.

7.1.2.4 Separation Distances

A. The U. S. Department of Transportation Hazardous Material Regulations require that the following distances must be maintained from the closest radioactive material package to any area occupied by an individual:

Total Transport Index	Separation Distance Feet
0.1 - 1.0	1
1.1 - 5.0	2
5.1 - 10.0	3

The above separation distances do no apply when the outer package exceeds 200 mrem/hr at the surface of the package or the T.I. is greater than 10.0, and when the package is being transported under exclusive use conditions.

B. Although the above separation distances are specified by the U. S. Department of Transportation, each user should check their license application to determine if they are committed to a maximum of 2 mrem/hr or some other radiation level in any occupied area of the vehicle.

7.1.2.5 Route Selection

The U. S. Department of Transportation Hazardous Material Regulations require that when transporting one or more Radioactive Yellow III package that the vehicle is operated on routes that minimize radiological risk [See 49 CFR 177.825(a) for details].

7.1.2.6 Other Requirements

A carrier, including a private carrier, transporting at least one Radioactive Yellow III labeled package is subject to the Federal Motor Carrier Safety Requirements, 49 CFR Parts 390-397, pertaining to such items as driver qualifications, driving of motor vehicles, hours of service, vehicle inspections and maintenance, and specific precautions with hazardous materials, including radioactive materials.

7.2 Procedures for Receipt and Unloading the Package ***(Excerpts from August 21, 1989 Supplement)***

7.2.1 Handling and Unloading

A. The SPEC 2-T, either as the outside package or in an overpack, may be handled during transport and unloaded as an ordinary package by hand. No special equipment or procedures are required.

B. The consignee must establish written procedures for receiving and safely opening the SPEC 2-T outside package. The procedures should provide for inspection, monitoring, notification and records.

C. Users of the SPEC 2-T may be authorized to remove or exchange specified source assemblies in the SPEC 2-T in accordance with the provisions of their agreement state or NRC radioactive material license and in accordance with the instruction of the source exchanger authorized in their specific radioactive material license. As an example, the SPEC C-1 source changer is authorized for use with source assemblies used in the SPEC 2-T exposure device. The source assembly unloaded from the SPEC 2-T at the SPEC facilities under the provisions of Louisiana Radioactive Material License LA-2966-L01 in accordance with the procedures and radiation protection standards established under that license.

7.2.2 Receiving the SPEC 2-T

7.2.2.1 Delivery, Pick Up and Acceptance from Carrier

A. Regulations require that the consignee must make arrangements to receive the SPEC 2-T 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.

B. When the SPEC 2-T is offered for delivery by a carrier it must be received by the consignee.

C. The consignee must expeditiously pick up the SPEC 2-T upon receipt of notification from the carrier.

D. The package must be accepted by the consignee even if there is a damage claim against the carrier. A damage claim should be noted on the bill of lading and acknowledged by signature of a representative of the delivering carrier.

7.2.2.2 Receipt Survey and Inspection

A. Before the delivered package is opened and as soon as practicable after receiving the SPEC 2-T, but no later than three hours after it is received at the consignee's facility during normal working hours or eighteen hours if received after normal working hours the package must be monitored and inspected.

B. The outside package, as received, should be inspected for any indication of damage to the SPEC 2-T, and the maximum external radiation levels at the surface of the outside package and at one meter from the surface of the outside package must be measured and recorded. Dents and abrasions to the overpack normally encountered in handling, loading and unloading are not generally considered evidence of damage to the SPEC 2-T.

C. Since the sealed source in the SPEC 2-T is classified as special form radioactive material it is not required to monitor the external surfaces of the outside package for removable contamination.

7.2.2.3 Notification

If the measured maximum radiation levels at the surface of the outside package and at one meter from the surface of the outside package exceed either of the following limits:

Location	Maximum mrem/hr
Surface of Outside Package	200
One Meter from Surface of Outside Package	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, and that the stated accuracy of the survey meter be considered.

7.2.2.4 Records

Records of the receiving survey should be maintain 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 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 *(Excerpts from January 5, 1992 Supplement)*

7.3.1 Inspection

When preparing an empty SPEC 2-T for transport an inspection must be performed to verify that it does not contain a source assembly.

Step 1: With the safety plug installed, remove the lock cap to verify that there is no connecting cable (pigtail) protruding from the lock end of the SPEC 2-T. If a pigtail connector is present the package is NOT

empty and cannot be offered for transport as an empty package.

Note: If the SPEC 2-T contains a source assembly the source tag must be inspected to verify that the source model is authorized for use with the SPEC 2-T.

Step 2: If a pigtail connector is not present, place the SPEC 2-T vertically upright with the lock end down. Survey the lock end of the SPEC 2-T on all four sides. If the radiation intensity exceeds 10 millirem per hour at the surface of the SPEC 2-T it may contain a source assembly where the connecting cable (pigtail) has been removed or shortened. Immediately discontinue transport preparations, refer to Emergency Procedures, and notify the Radiation Safety Officer or Source Production and Equipment Co., Inc.

Note: An empty SPEC 2-T will produce radiation levels up to approximately 4 millirem per hour at the surface due to the depleted uranium shielding.

Step 3: If the radiation intensity exceeds 10 millirem per hour in Step 2 do not transport the SPEC 2-T until assured that it is empty. Verify by cranking the drive cable of a control assembly completely through the SPEC 2-T to remove any source assembly that may be inside. This should be performed by the Radiation Safety Officer.

7.3.2 Methods of Package Preparation

(Excerpts from August 21, 1989 Supplement)
When the SPEC 2-T is shipped or transported without an Iridium-192 sealed source it should be prepared in one of the two methods as described below, since it contains depleted uranium and it is not an empty package.

7.3.2.1 Limited Quantity of Radioactive Material

A. The SPEC 2-T can qualify as an excepted article containing depleted uranium pursuant 49 CFR 173.424, provided that the maximum radiation level on the external surface of the outside package does not exceed 0.5 mrem/hr at any point. Radiation levels on the surface of an empty SPEC 2-T exceed 0.5 mrem/hr, and therefore the SPEC 2-T as an outside package can not qualify as an excepted article containing depleted uranium. The SPEC 2-T must be placed in an outside package, such as the 12 gallon drum commercial overpack, to reduce the radiation levels on the surface of the outside package below 0.5 mrem/hr.

B. A manufactured article containing depleted uranium is excepted from specification packaging, marking, labeling, shipping paper, and certification requirements pursuant to 49 CFR 173.424. Shippers should consult with Source Production & Equipment Company, Inc. concerning variations in requirements for international shipment.

7.3.2.1.1 Packaging

A. Install, if available, the source safety plug and lock cap in the SPEC 2-T.

B. Verify that the SPEC 2-T identification plate is legible and present. If the identification plate is not present mark the SPEC 2-T "RADIOACTIVE."

C. Place the SPEC 2-T in a strong tight outside container, such as the 12 gallon drum commercial overpack in which it was received.

D. Verify that the maximum radiation level on the surface of the outside package does not exceed 0.5 mrem/hr.

7.3.2.1.2 Labeling

Labels are not required. Remove any RADIOACTIVE, White or Yellow labels, and any CARGO AIRCRAFT ONLY labels from the outside package. If the labels can not be removed they may be covered with an EMPTY label.

7.3.2.1.3 Marking

Markings are not required. The proper shipping name marking, RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S. UN 2974, and INSIDE PACKAGE COMPLIES WITH PRESCRIBED SPECIFICATION and other markings may remain if at least one EMPTY label is affixed, since the EMPTY label negates the meaning of any markings.

7.3.2.1.4 Shipping Papers and Certification

Shipping papers and certifications are not required for domestic shipments. The package may be returned by any mode of transport, including passenger aircraft.

The following notice must be enclosed in or on the package, included with the packing list, or other wise forwarded with the package:

This package conforms to the conditions and limitations specified in 49 CFR173.424 for excepted radioactive material, article manufactured from depleted uranium, UN2909.

It is recommended that the above notice be attached to the empty SPEC 2-T.

7.3.2.2 Labeled Radioactive Material Shipment ***(Excerpts from March 13, 1989 Application)***

A SPEC 2-T as the outside package without an Iridium-192 source may only be shipped or transported as a labeled radioactive material shipment.

7.3.2.2.1 Packaging

The thirty-five pounds of depleted uranium according to the regulations may be shipped in a Type B package, and the SPEC 2-T qualifies as a Type B package. The SPEC 2-T should be inspected to determine that it is in unimpaired condition. The source tag should be removed from the SPEC 2-T.

7.3.2.2.2 Marking

The proper shipping name and UN number, RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S., UN2974 should be covered over and changed to read RADIOACTIVE MATERIAL, N.O.S., UN2982. The USA/9056/B(U) TYPE B on the identification plate must be legible. The package must also be marked with the name and address of the consignee or consignor unless it is an exclusive use or private carrier shipment.

7.3.2.2.3 Labeling

The radiation levels on the surface of the SPEC 2-T will not exceed 50 mrem and the transport index will not exceed 1.0, therefore affix two Radioactive Yellow II labels on opposite sides of the SPEC 2-T in such a way that they do not obscure the required marking above.

Complete the information on two labels:

Contents: Depleted Uranium or U (depleted)	
Activity:	Determine the activity in Curies (Ci) or terabecquerel (Tbq). Thirty five pounds of depleted uranium is equivalent to approximately 7 mCi.
T.I.:	Enter the appropriate measured value rounded up to the next tenth. The TI should be 0.1

7.3.2.2.4 Shipping Paper

U.S Department of Transportation Hazardous Material Regulations require the following shipping paper information:

Radioactive Material, N.O.S., UN2982 Depleted Uranium 7 mCi Metallic Solid Radioactive Yellow II Label USA/9056/B(U)
Cargo Aircraft Only (if offered for air transportation)
For water transportation only enter the number of SPEC 2-T devices in each overpack, the number of overpacks; and the gross weight of each SPEC 2-T package (i.e. ~~49 pounds~~ *56 pounds*) or the gross weight of each overpack.

The following certification statements must be added to the above shipping paper information except when the SPEC 2-T is being transported by a private carrier.

Shipper's Certifications Not required for private carriers
This is to certify that the above named materials are properly classified, described, packaged, marked, labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.
For air transportation only add: This shipment is within the limitation prescribed for ~~passenger aircraft~~ / cargo aircraft only (delete nonapplicable).
Signatures are required for the above certification statements. The signature must be legibly signed by a principal, officer, partner or employee of the shipper or his agent; and it may be legibly signed manually, by typewriter, or other mechanical means.

Although the U.S Department of Transportation or the ICAO Technical Instructions do not require a specified form for shipping papers or dangerous goods transport documents most international airlines are members of the International Air Transport Association and require use of the IATA Shipper's Declaration for Dangerous Goods "candy-stripe" form. Therefore, it is recommended that you use this form for international shipments to avoid possible delays. Consult the current edition of the current edition of the IATA Dangerous Goods Regulations or Source Production & Equipment Company, Inc. for assistance in completing the IATA Shipper's Declaration for Dangerous Goods and other international shipping requirements.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

(Excerpts from January 5, 1992 Supplement)

There are no changes to the acceptance tests and maintenance program as described in previously approved applications dated March 13, 1989 and July 27, 1990 as supplemented, with the exception that in accordance with 10 CFR 71.85 nondestructive liquid penetrant inspection has been incorporated as the final inspection method for the structural joints of the SPEC 2-T packaging fabricated in accordance with the Source Production and Equipment Co., Inc. Thermal Metal Joining Procedures. Inspection procedures and inspection personnel qualification procedures are performed in accordance with Source Production and Equipment Co., Inc. Liquid Penetrant Inspection Procedures (Appendix 9.5).

(Excerpts from March 13, 1989 Application)

8.1 Acceptance Tests (Prior to First Use)

8.1.1 Visual Inspection

Upon receipt of a new SPEC 2-T the licensee should perform a general visual inspection of the package in accordance with the procedures and criteria approved pursuant to 10 CFR 34.28(b) or equivalent agreement state regulations.

8.1.2 Structural and Pressure Tests

Structural acceptance tests on the SPEC 2-T are not indicated because of the rugged design and durable materials of construction any structural failure would be apparent. 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.

8.1.3 Leak Tests

A. Pursuant to licensing provisions a leak test is not required upon initial receipt if there is documentation that a leak test has been performed within six months prior to the transfer of the sealed source. If there is no such documentation then the licensee should perform a leak test in accordance with the provisions of his license prior to placing the radiography device in use.

B. A leak test is not required upon receipt of special form material pursuant to 10 CFR 20.205(b)(1)(iii) and equivalent agreement state regulations.

8.1.4 Component Tests

Component acceptance tests on the SPEC 2-T are not indicated. Daily and quarterly inspection by the user pursuant to 10 CFR 34.28 and equivalent agreement state regulations are more than sufficient.

8.1.5 Tests for Shielding Integrity

A. Upon receipt of the SPEC 2-T the licensee is required to survey the package prior to opening it pursuant to 10 CFR 20.205(c) or equivalent agreement state regulations.

B. Upon initial receipt of the SPEC 2-T and whenever a source is exchanged a survey should be performed to show compliance with 10 CFR 34.21 or equivalent agreement state regulations that the maximum radiation level at six inches from the surface of the SPEC 2-T does not exceed 50 mrem/hr when the activity is extrapolated to 240 Ci of Iridium-192.

8.1.6 Thermal Acceptance Tests

Thermal acceptance tests for the SPEC 2-T is not indicated since heat of decay for the maximum permissible activity Iridium-192 source (240 Ci) is negligible.

8.2 Maintenance Program

8.2.1 Structural and Pressure Tests

Periodic structural acceptance tests on the SPEC 2-T are not indicated because of the rugged design and durable materials of construction any structural failure would be apparent. Periodic 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.

8.2.2 Leak Tests

Leak test for removable contamination are required to be performed at least every six months on the sealed source pursuant to 10 CFR 34.25 or equivalent agreement state regulations. A leak test should also be performed whenever there is indication of damage to the sealed source capsule. The leak test sample should be taken by inserting at least a six inch cotton tipped swab into the outlet nipple. If the tests indicate 0.005 microcurie 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 the applicable radiation control agency within five days. It is also recommended that Source Production & Equipment Company, Inc. be notified.

8.2.3 Subsystems Maintenance

The SPEC 2-T has no subsystems.

8.2.4 Valves, Rupture Discs, and Gaskets on Containment Vessel

Not applicable since 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 device performed pursuant to 10 CFR 34.43(b) or equivalent agreement state regulations are sufficient to establish the continuing integrity of the shield.

8.2.6 Thermal

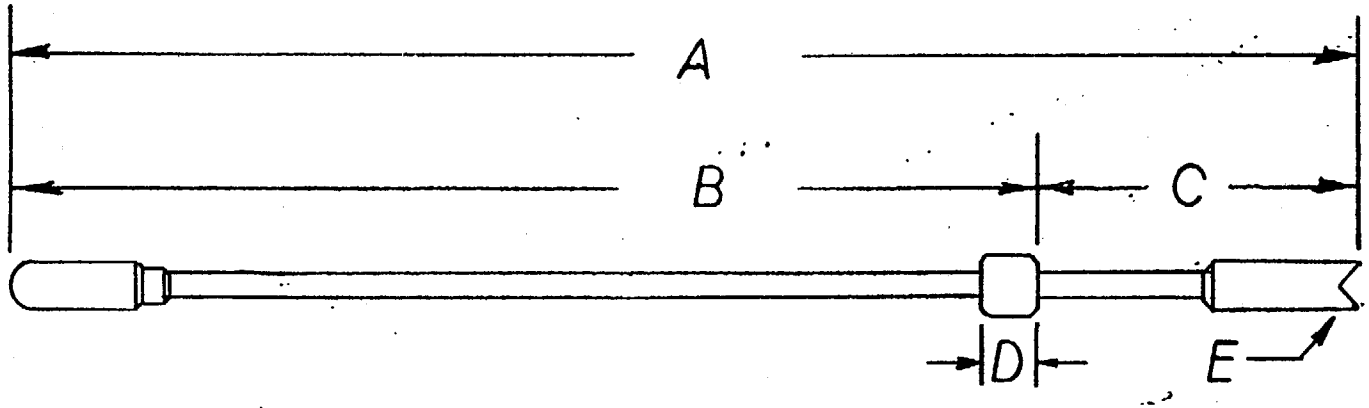
Periodic thermal tests on the SPEC 2-T is not indicated since heat of decay for the maximum permissible activity Iridium-192 source (240 Ci) is negligible. There are no components which be thermally degraded by typical use and transport.

8.2.7 Miscellaneous

The daily and quarterly inspection and maintenance program required of all licensed users of the SPEC 2-T is more than sufficient to assure the continuing integrity of the package.

APPENDIX 9.1
DRAWINGS

Drawing G-1, Rev. (0)	Source Assembly Model G-1
Drawing 53189-2, Rev. (2)	SPEC 2-T Commercial Carriage Overpack
Drawing 788-1, Rev. (4)	Model SPEC 2-T Depleted Uranium Shield
Drawing 12688-1, Rev. (2)	SPEC Model 2-T Exposure Device (Cross sectional View)
Drawing 788-2, Rev. (0)	SPEC 2-T Exposure Device, Alternate Designs
Drawing 1000, Rev.(0)	Model 2-T Exposure Device, Section and General Details
Drawing dated November 26, 1974	Model SPEC 2-T Radiographic Exposure Device
Drawing 50890-1, Rev. (1)	Drop Test Target
Drawing 22089-1, Rev. (0)	SPEC 2-T Drop Test Orientation
Drawing 22089-4, Rev. (0)	SPEC 2-T Drop Test Orientation



A	7 1/8"	± 1/16"
B	5 3/8"	± 1/16"
C	1 3/4"	± 1/16"
D	5/16" d x 5/16"	± 0 .015" / ± .010"
	DIMENSIONS	TOLERANCES

FOR USE IN
SPEC 2-T

E	CONNECTOR: SAF-T-KEY

SOURCE PRODUCTION & EQUIPMENT COMPANY, INC.
113 Teal Street St. Rose, Louisiana 70087

SCALE: N/A	APPROVED BY: RDD	DRAWN BY RDD
DATE: 7/18/88		REVISED

SOURCE ASSEMBLY MODEL: G-1

Effective Date: 7/18/88

DRAWING NUMBER G-1 Rev (0)

FIGURE WITHHELD UNDER 10 CFR 2.390

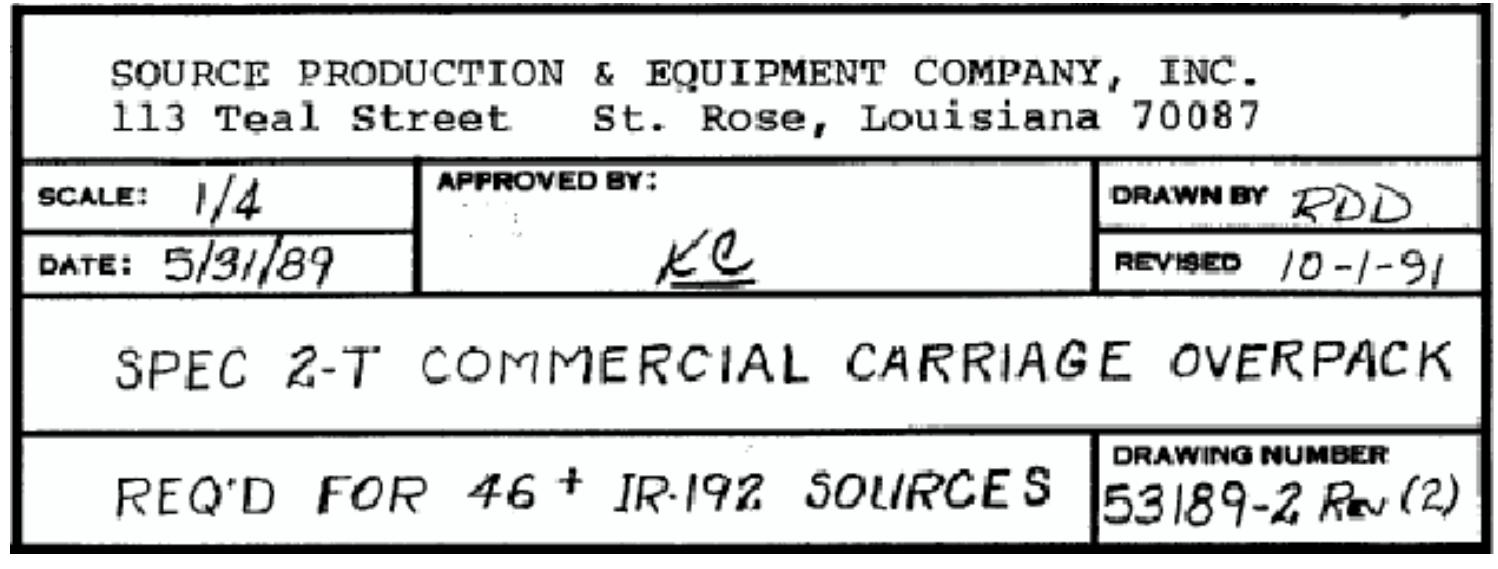
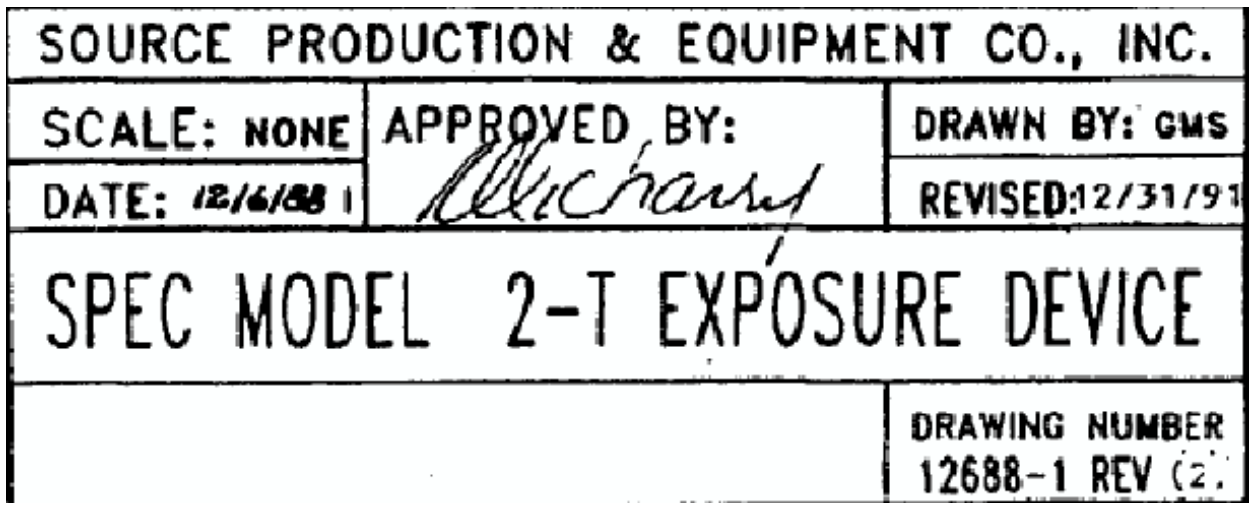


FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390



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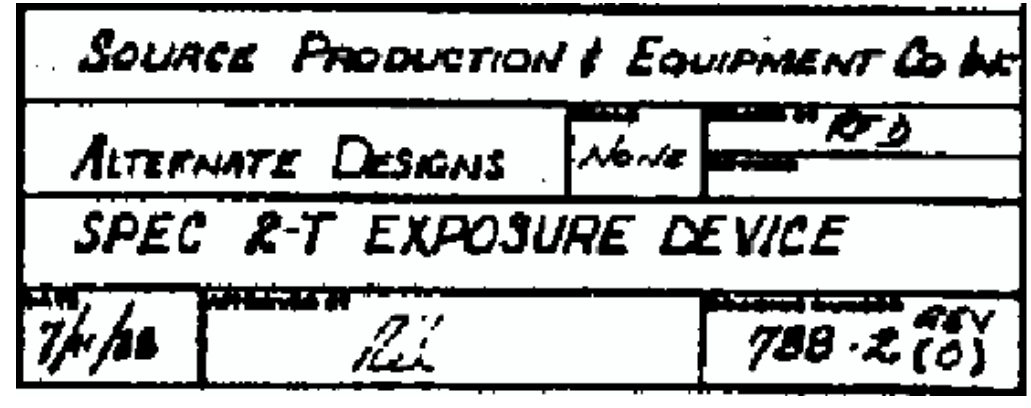

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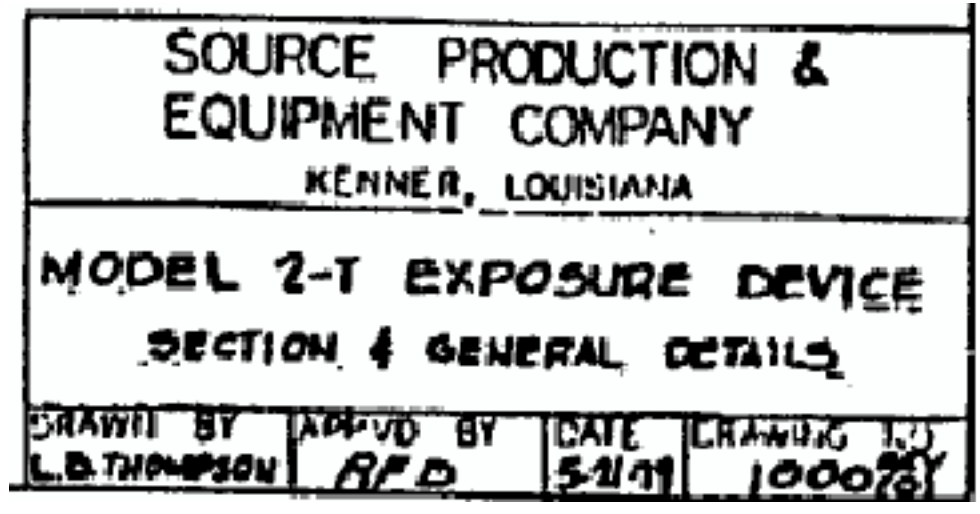

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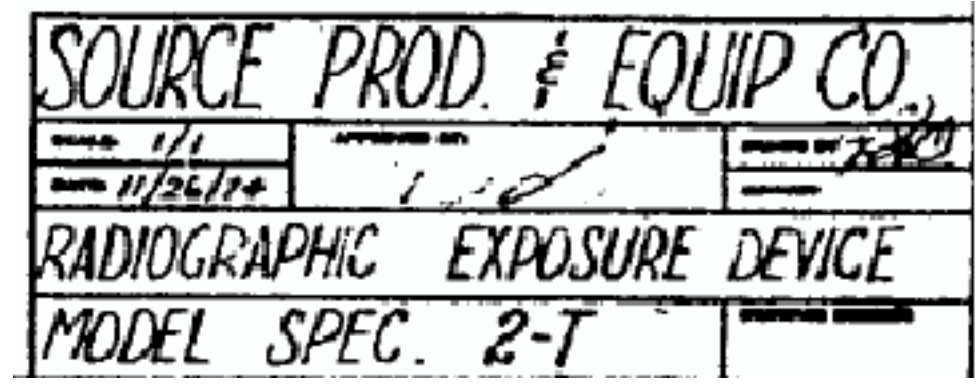

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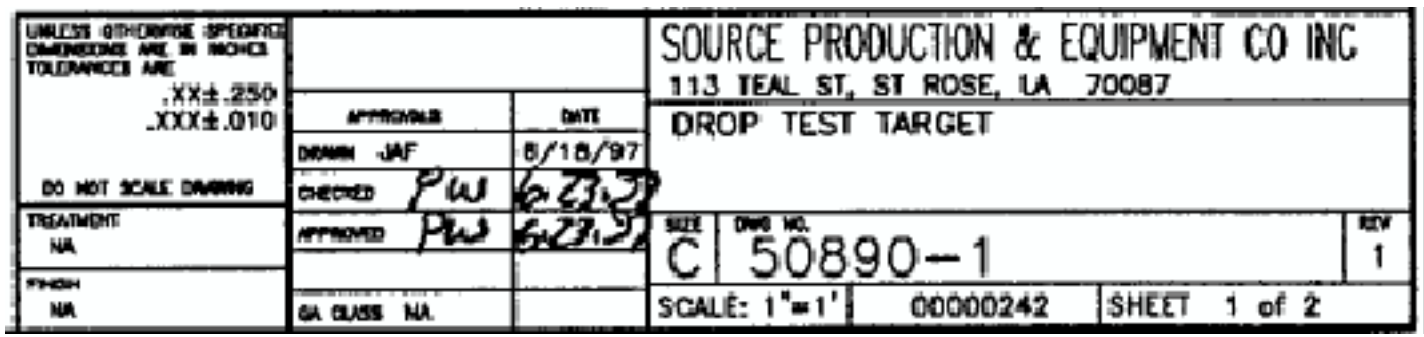
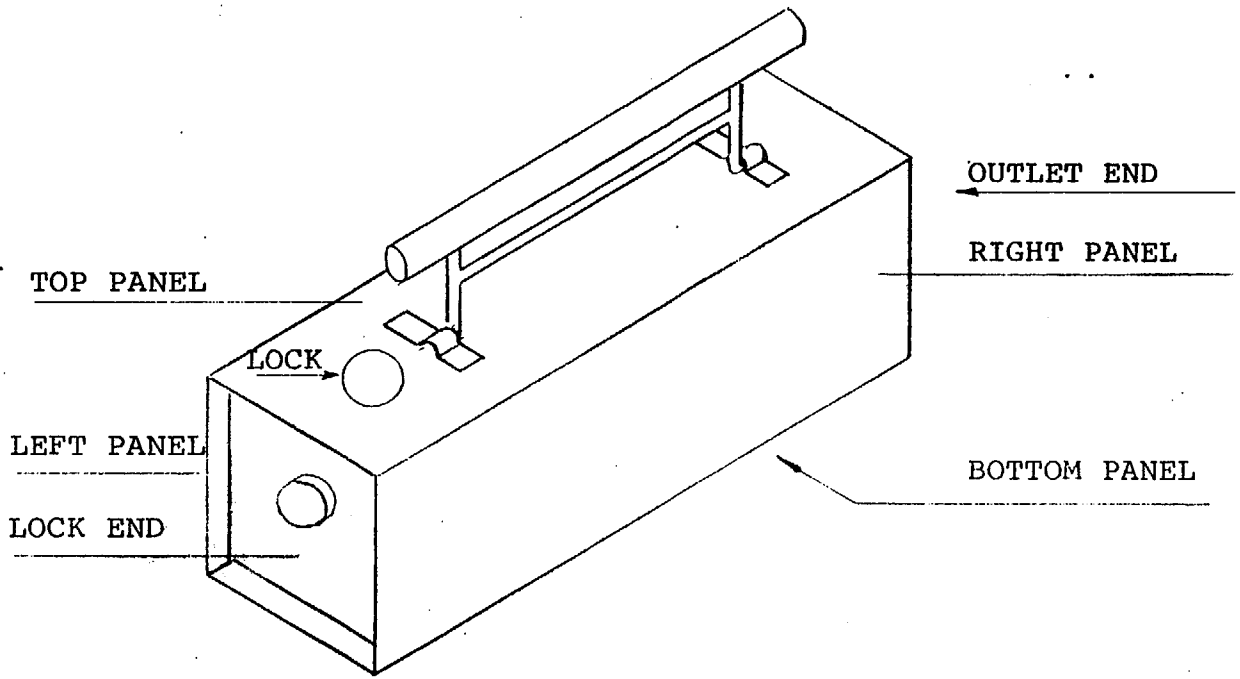
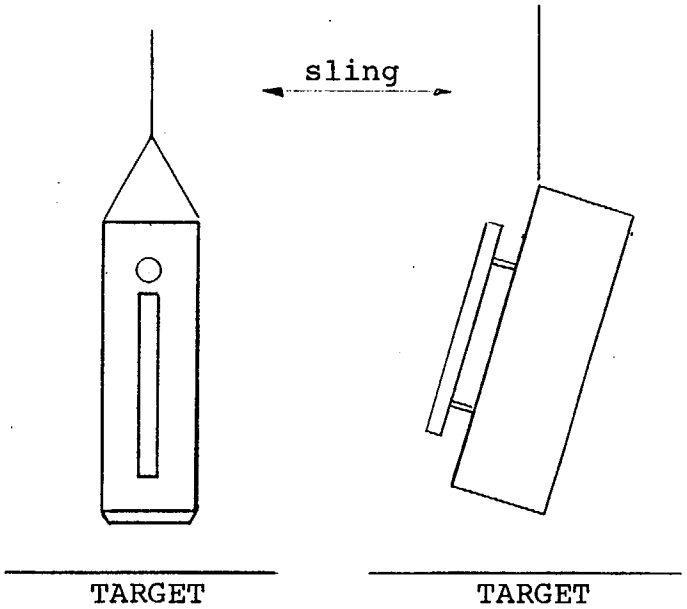


FIGURE WITHHELD UNDER 10 CFR 2.390

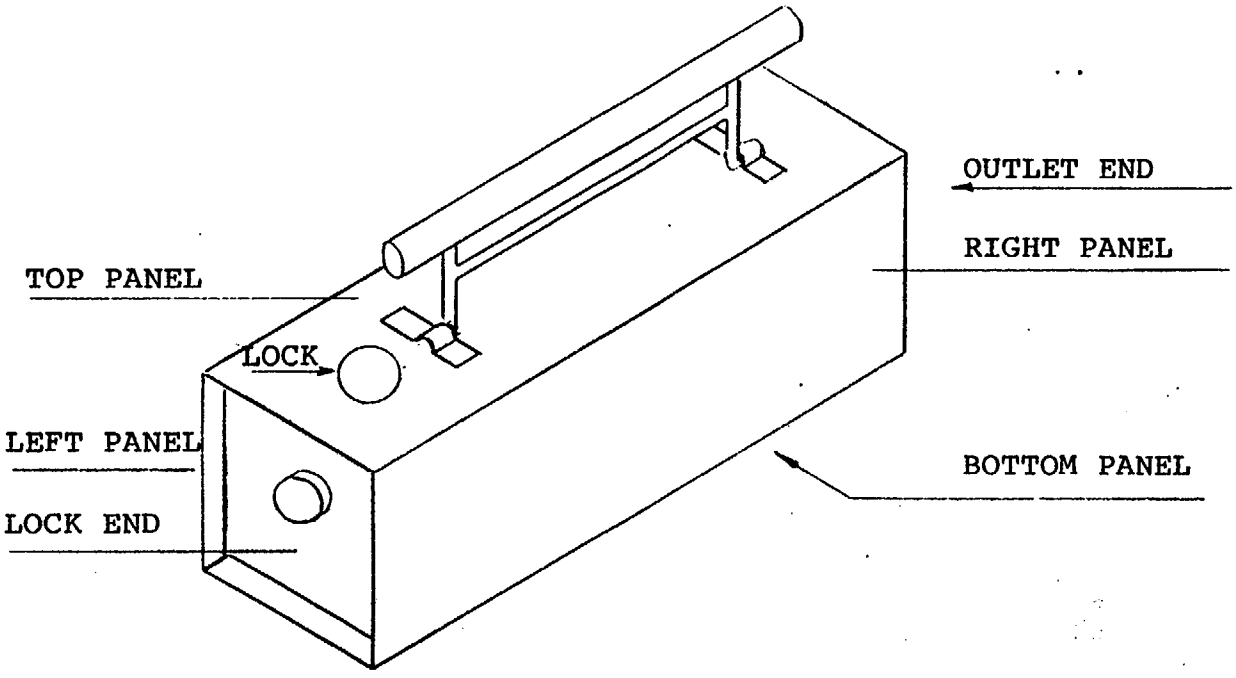
SOURCE PRODUCTION & EQUIPMENT CO INC 113 TEAL STREET BOSE LA 70087	SIZE C	DWG NO 50890–1		REV 1
ISSUED	SCALE: 1"=1'	00000243	SHEET 2 of 2	

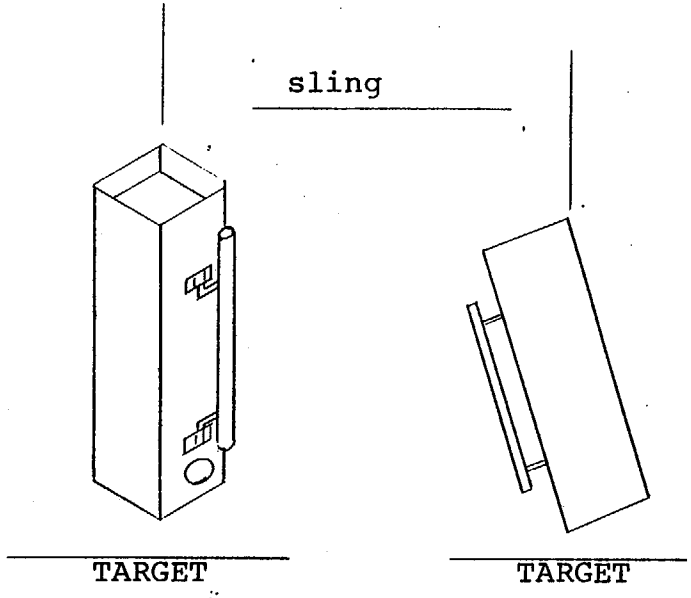




Point of Impact: End of bottom panel at the outlet end of specimen.

SOURCE PRODUCTION & EQUIPMENT COMPANY, INC 113 teal Street St. Rose, Louisiana 70087		
SCALE:	APPROVED BY:	DRAWN BY RDD
DATE: 2/20/89		REVISED
SPEC 2-T Drop Test Orientation		
SPEC 2-T S/N: Prototype 1 First Drop Test		DRAWING NUMBER 22089-1Rev(0)





SOURCE PRODUCTION & EQUIPMENT COMPANY, INC
113 teal Street St. Rose, Louisiana 70087

SCALE: N/A	APPROVED BY:	DRAWN BY RDD
DATE: 2/20/89		REVISED

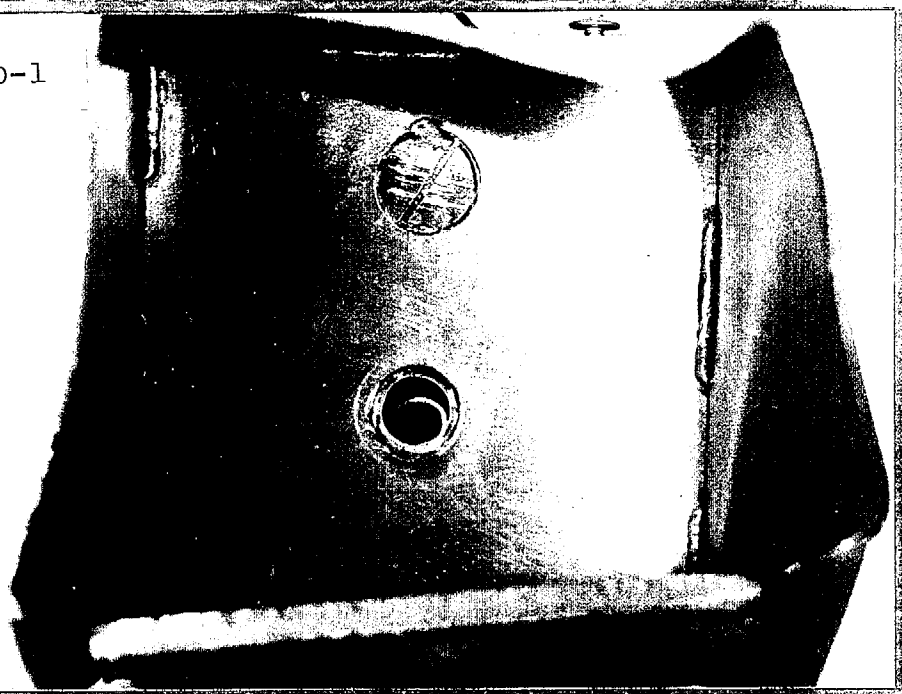
SPEC 2-T DROP TEST ORIENTATION

SPEC 2-T S/N: Prototype 1
Fourth Drop Test

DRAWING NUMBER
22089-4 Rev(0)

APPENDIX 9.2
PHOTOGRAPHS

D-1



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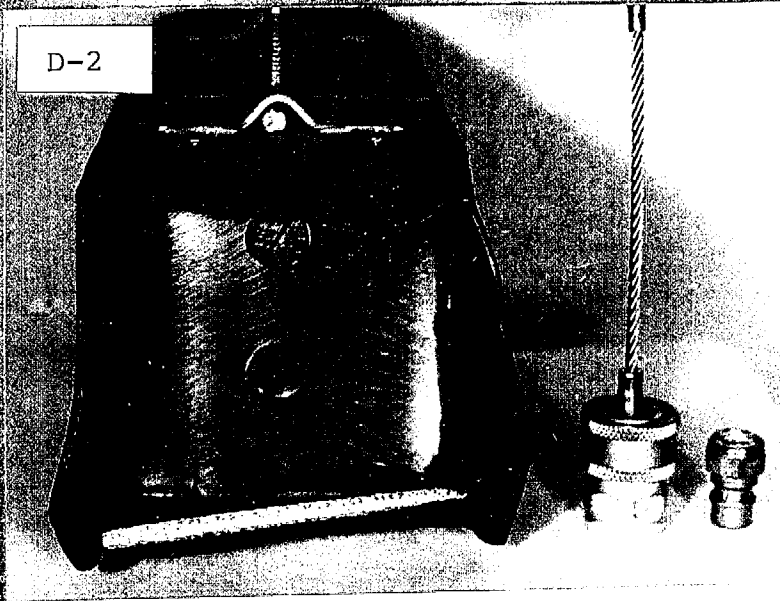

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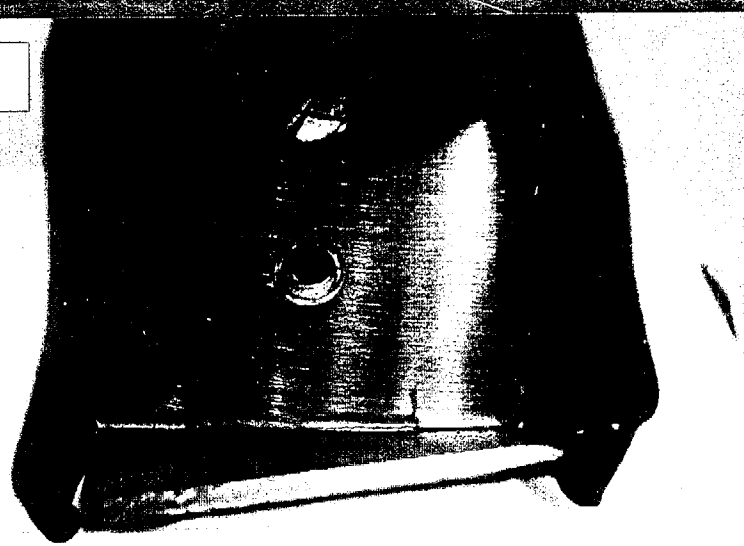
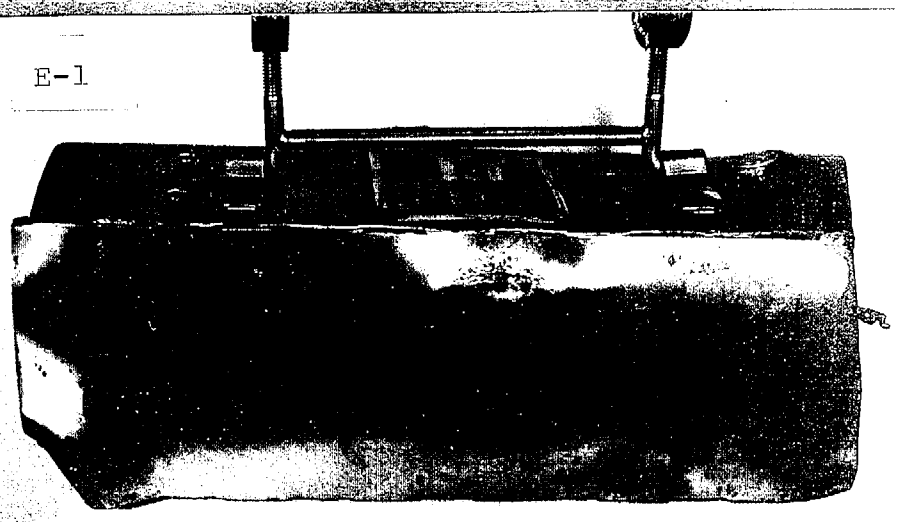


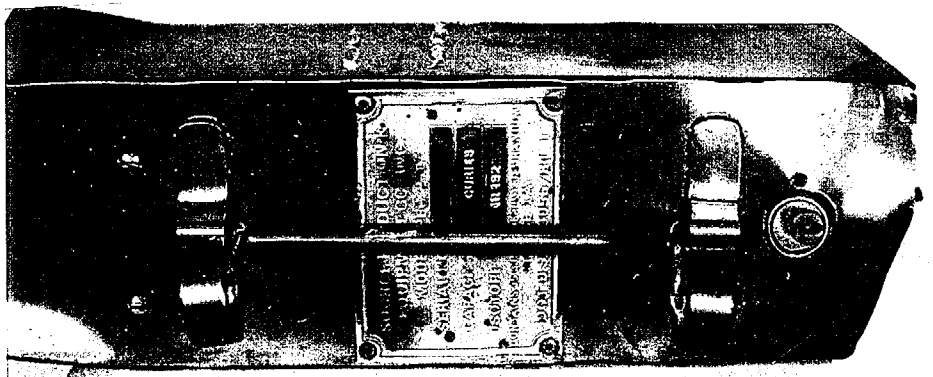
D-4

E-1



C-LINE #52584
35MM PRINTS

G-1



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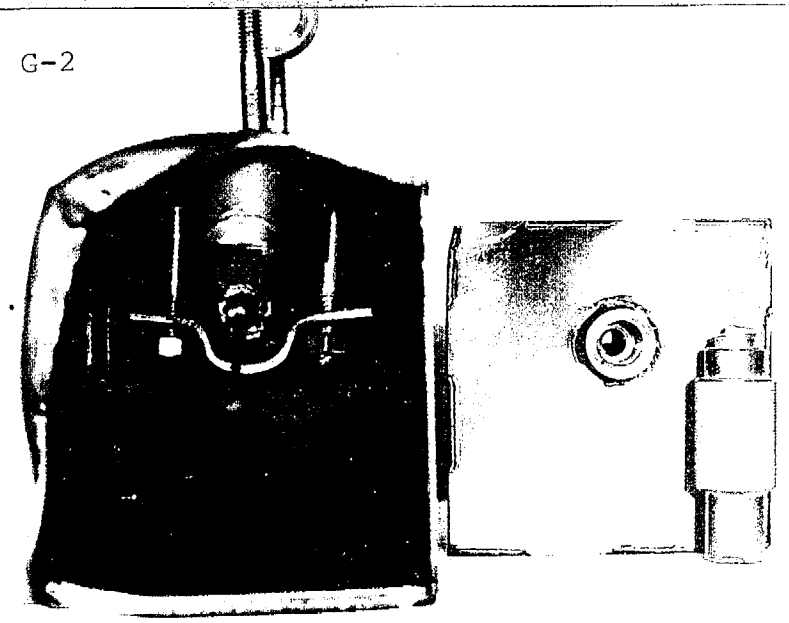
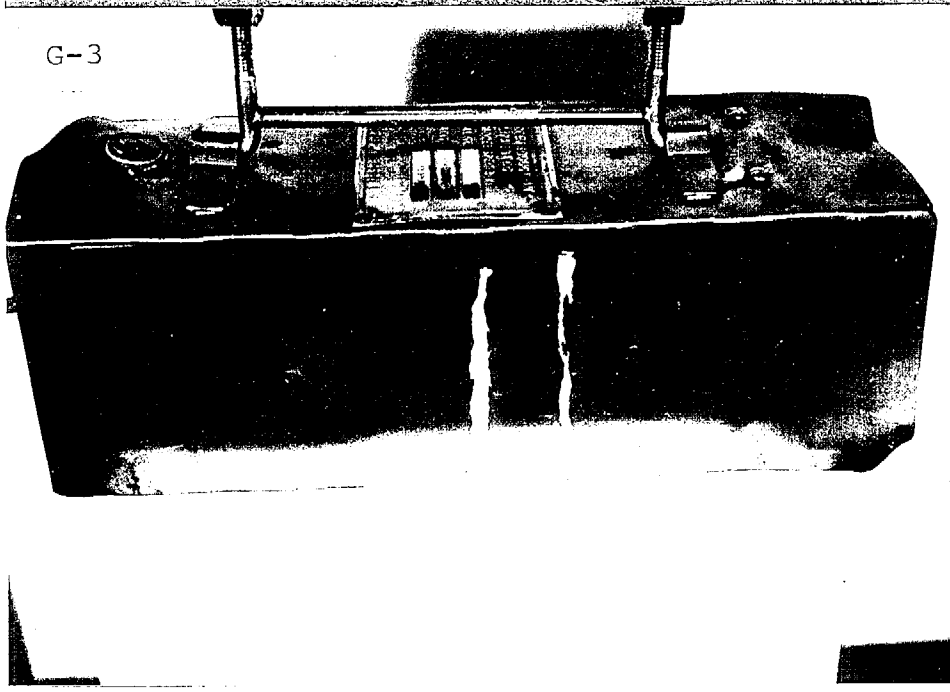


G-3



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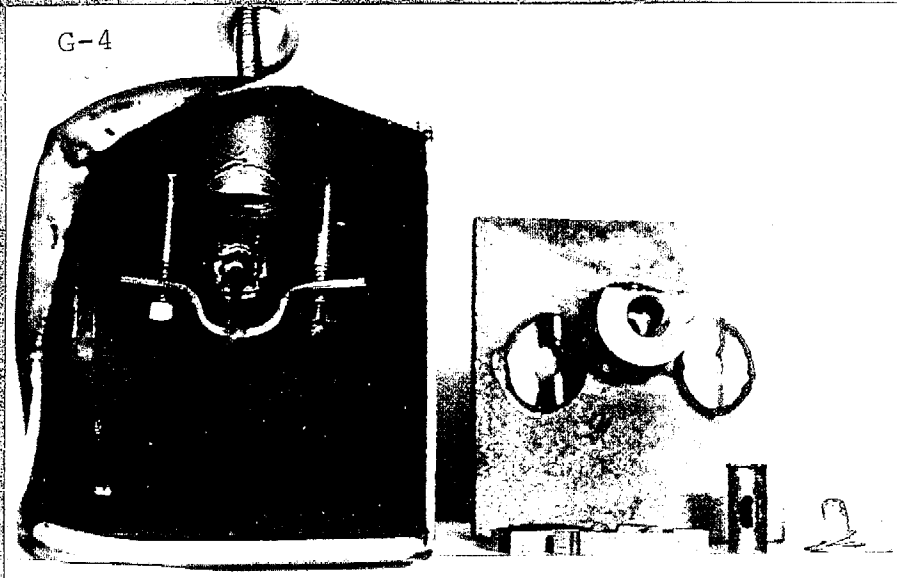

C-LINE #52384
35MM PRINTS

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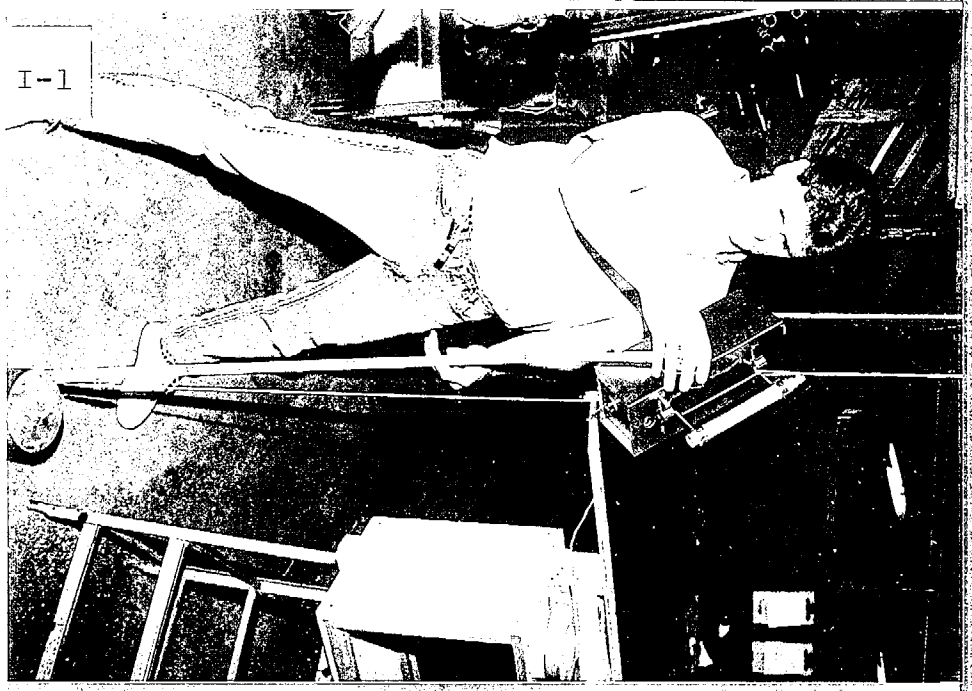

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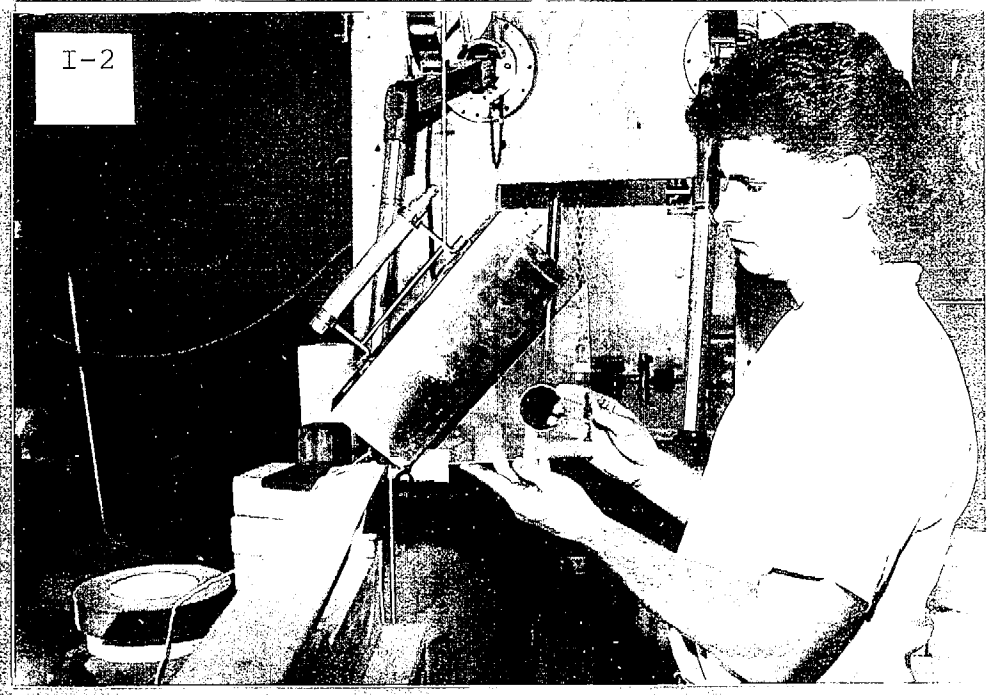

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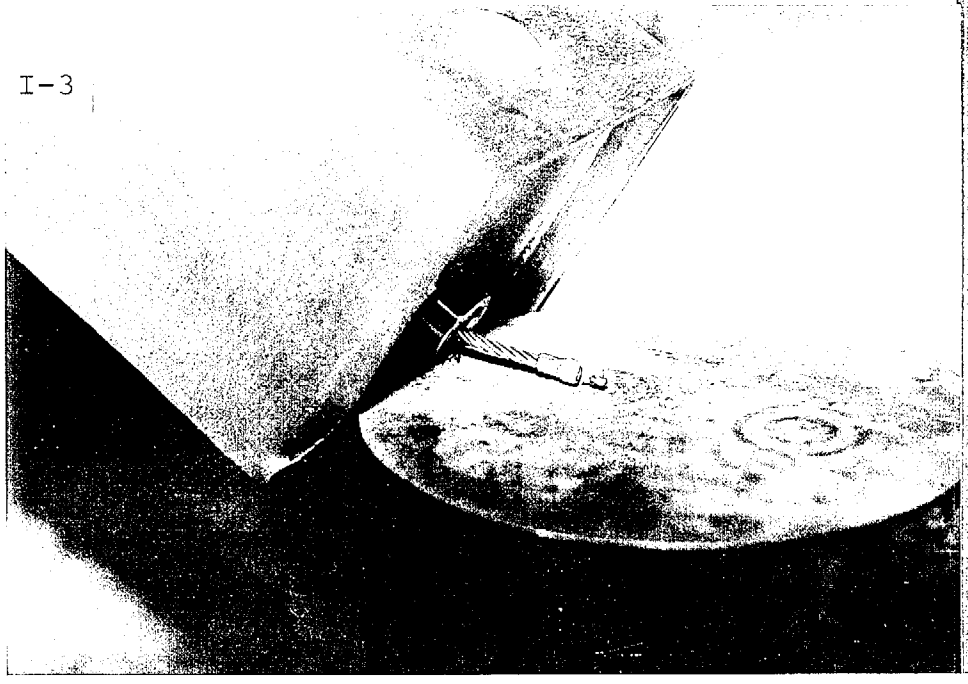

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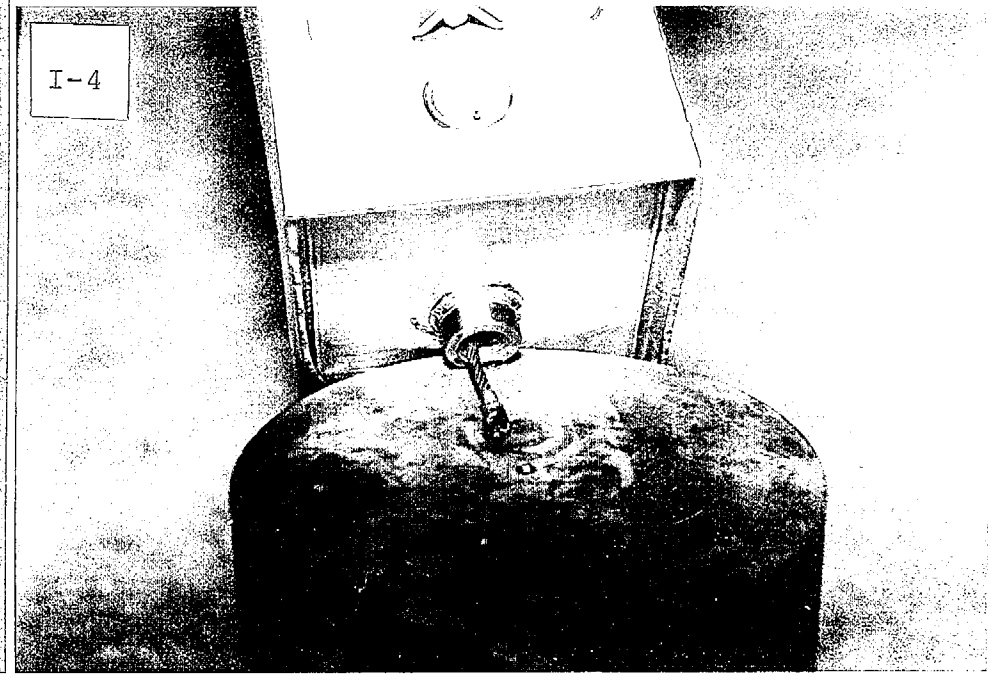

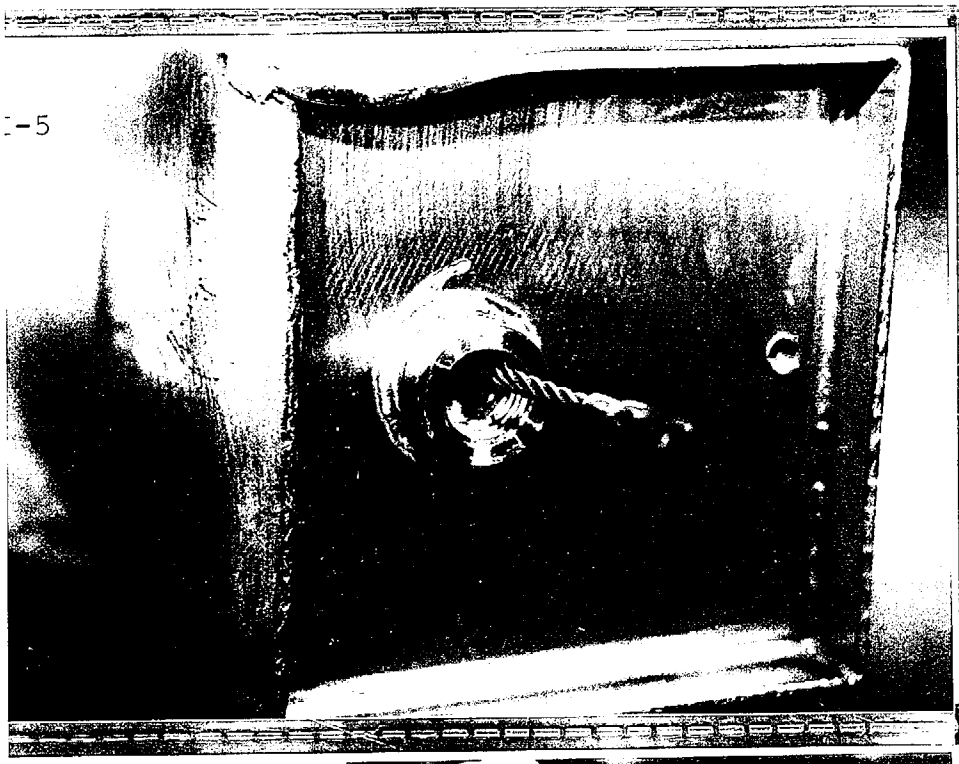

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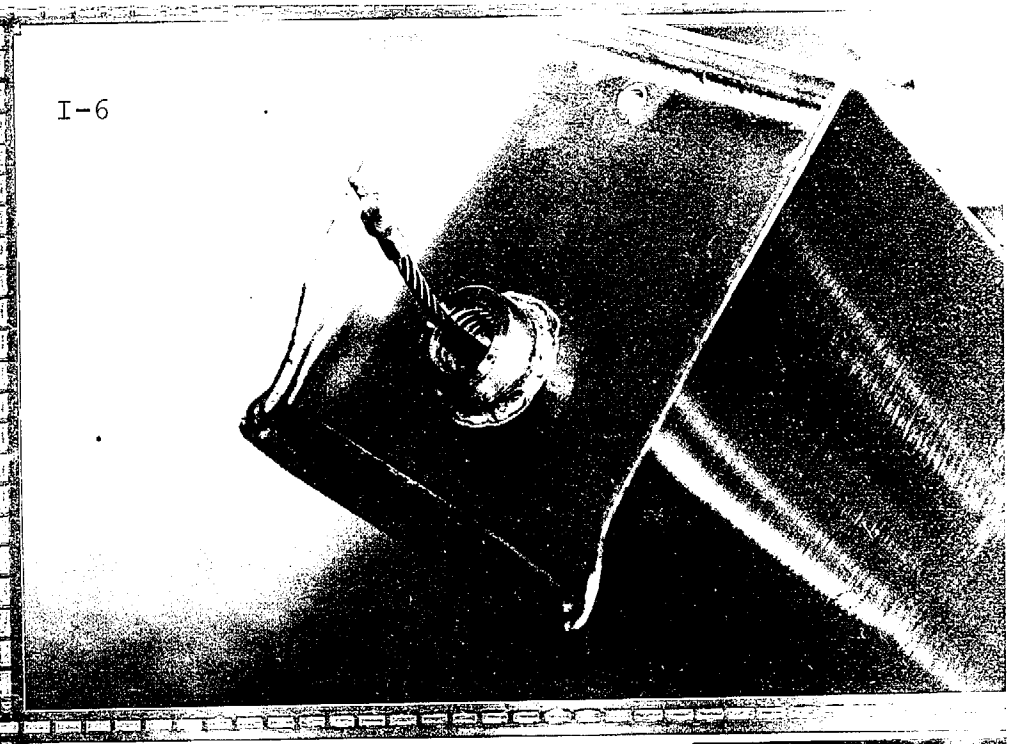

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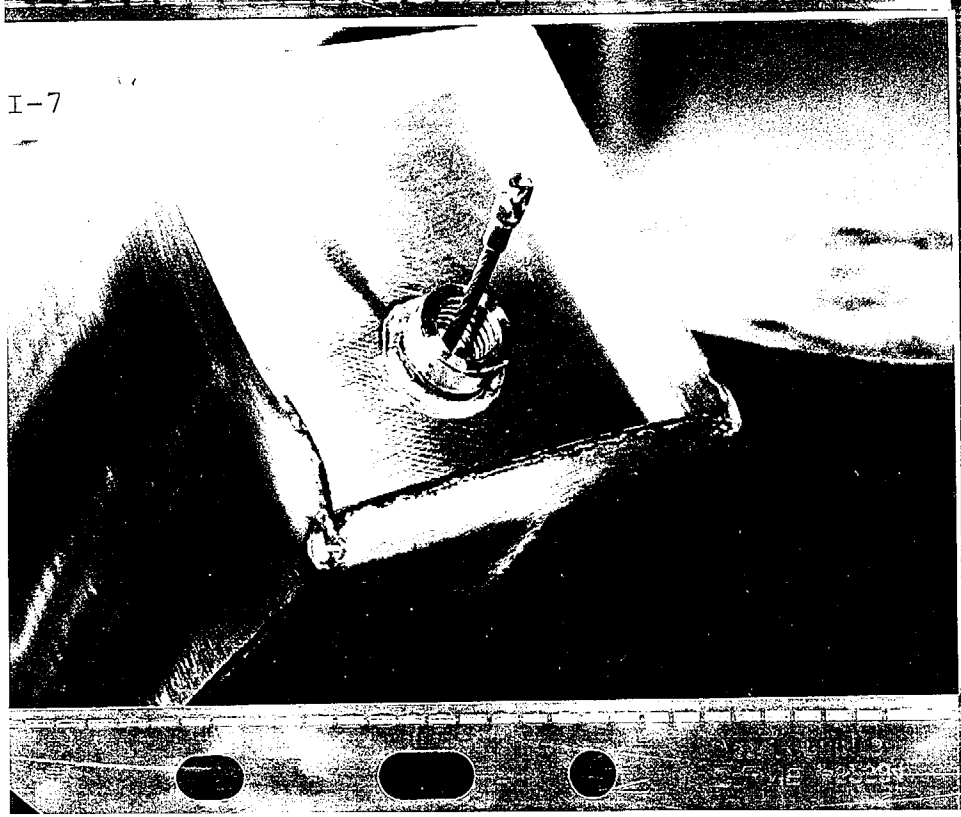

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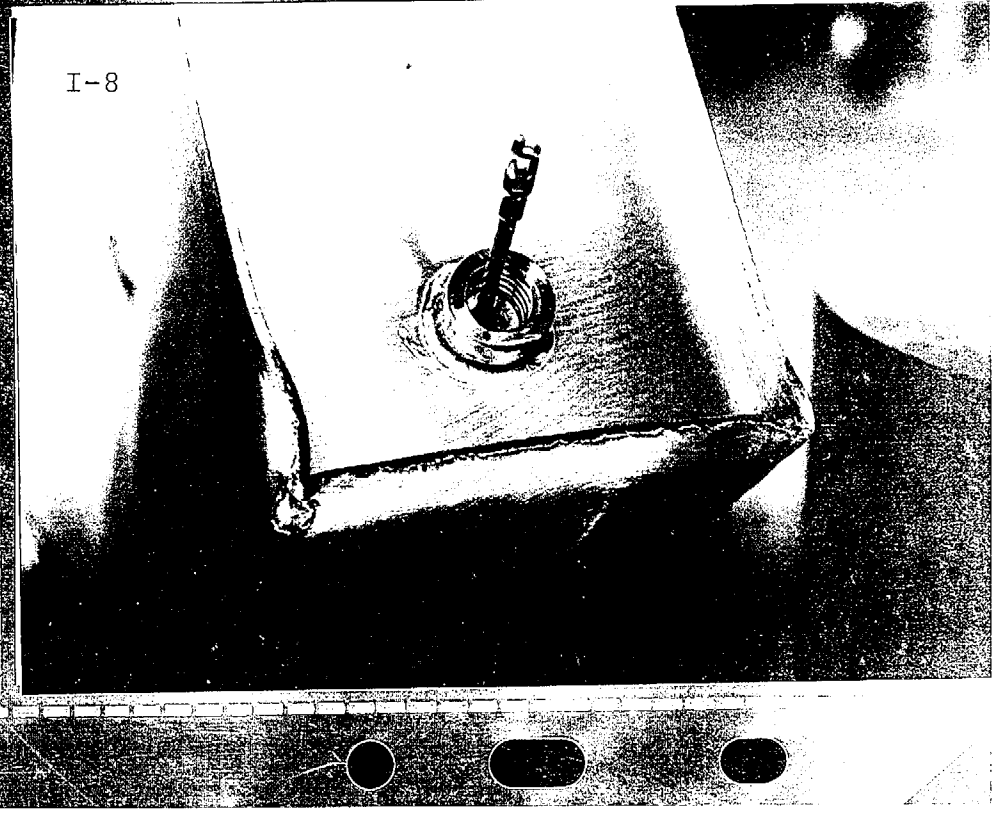

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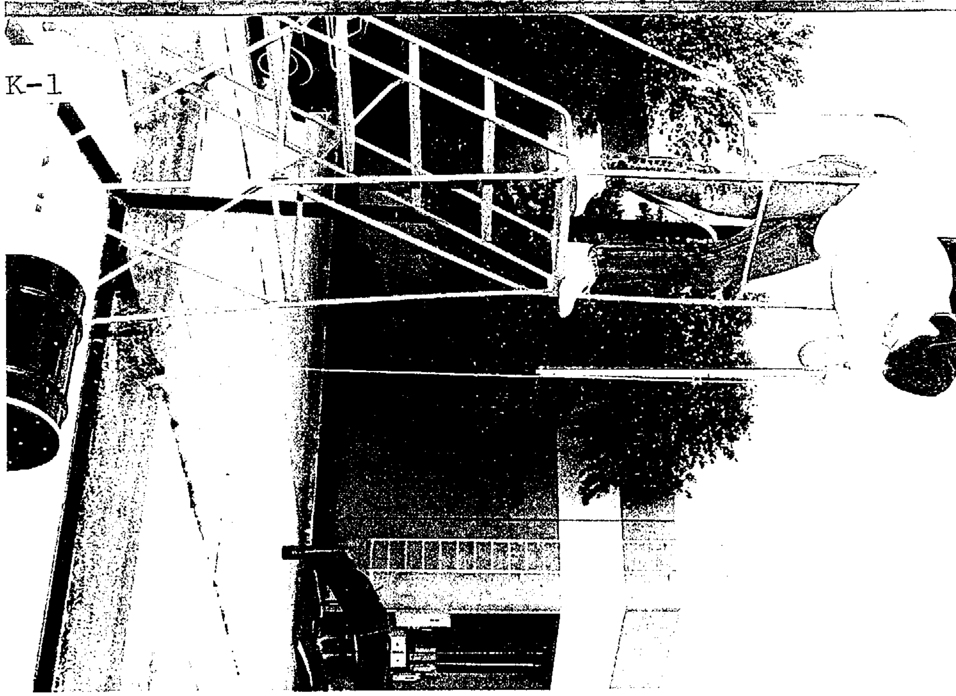
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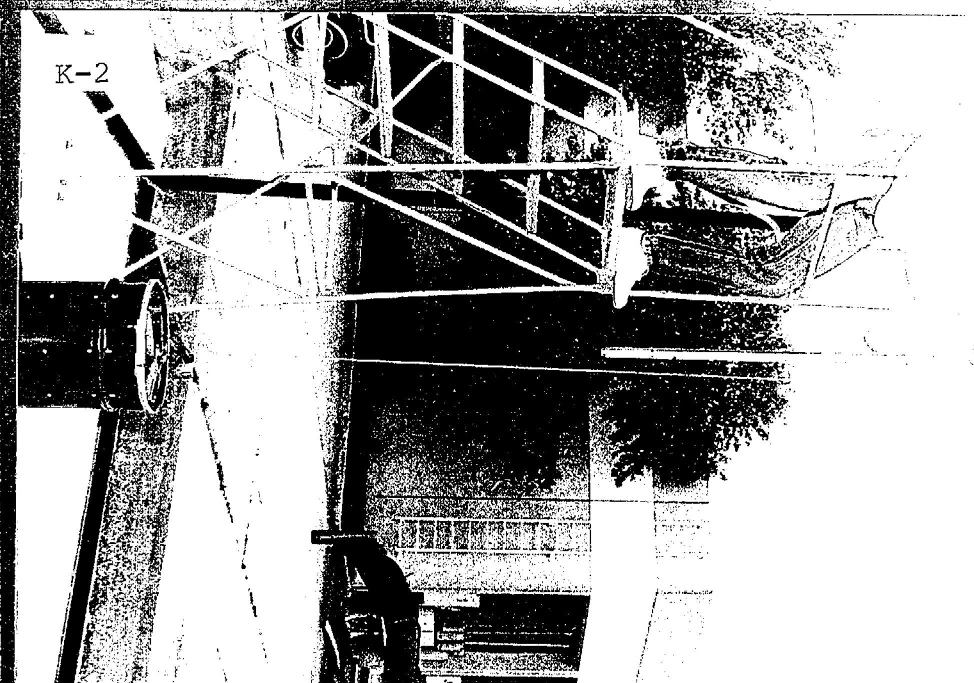
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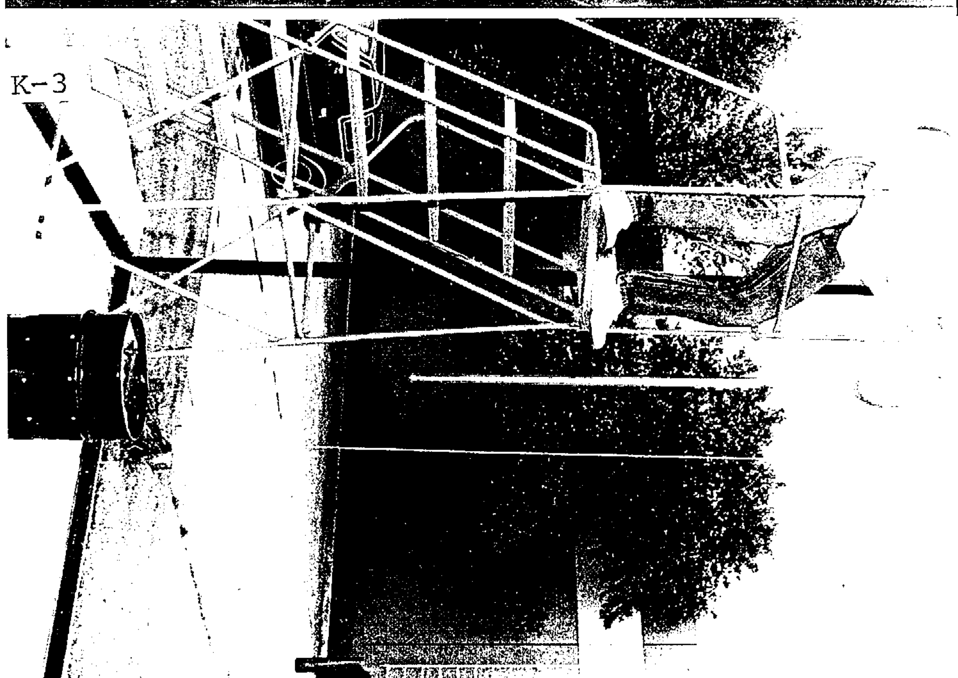
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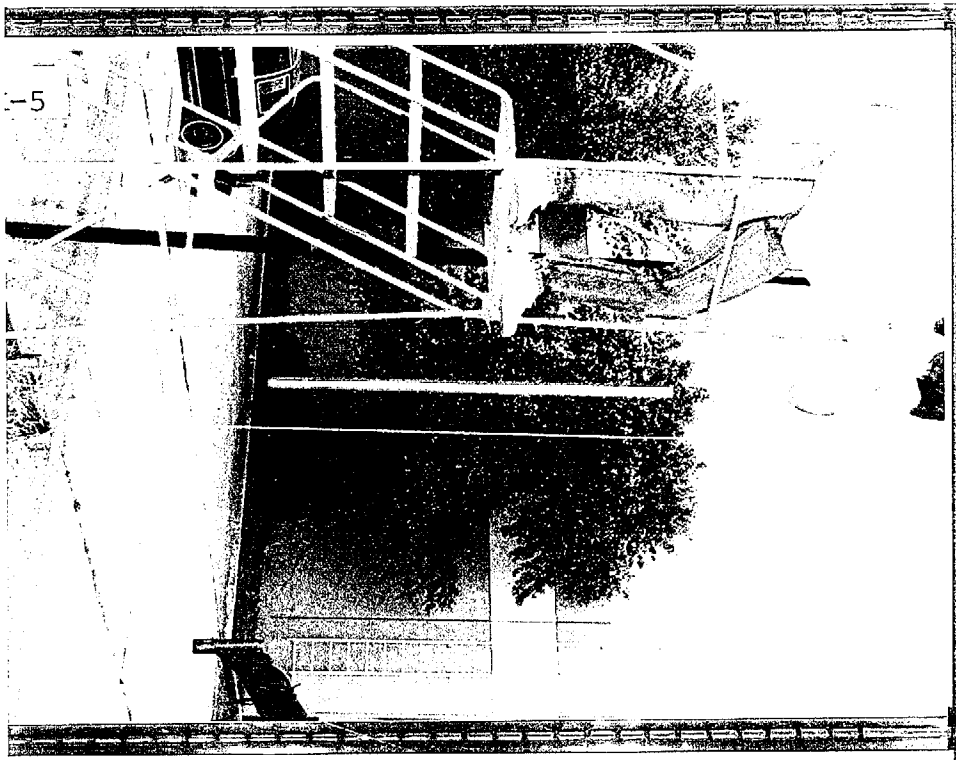
K-4



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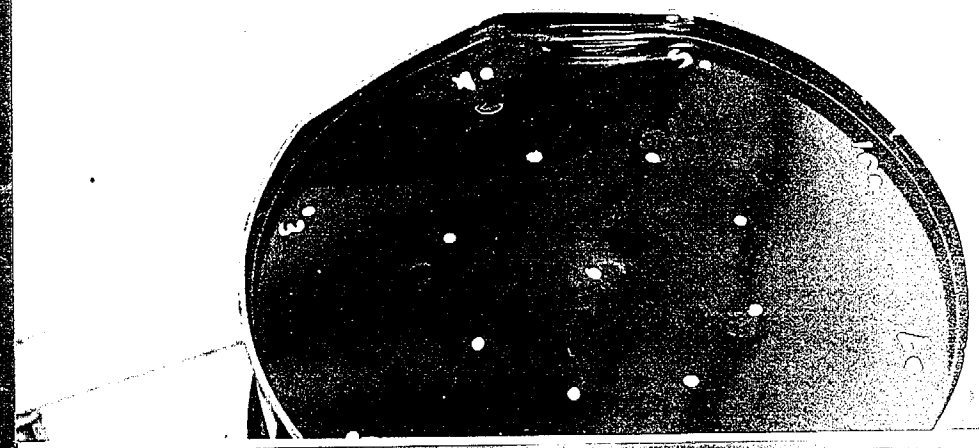

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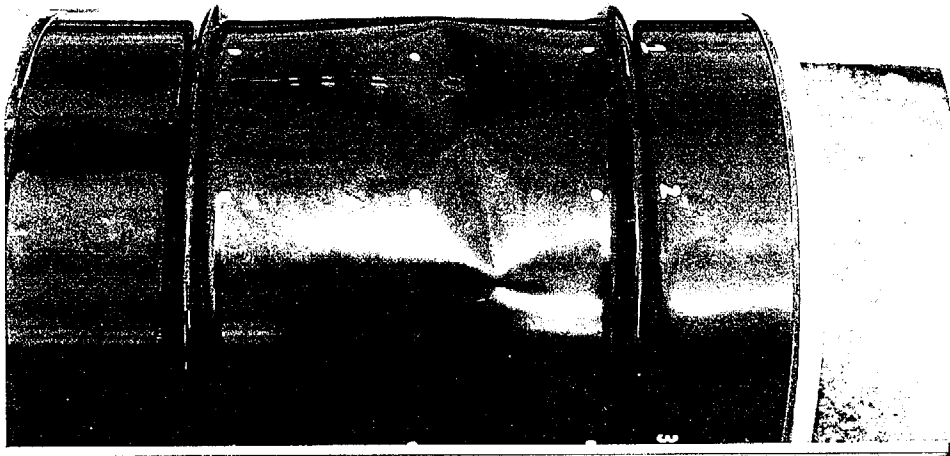

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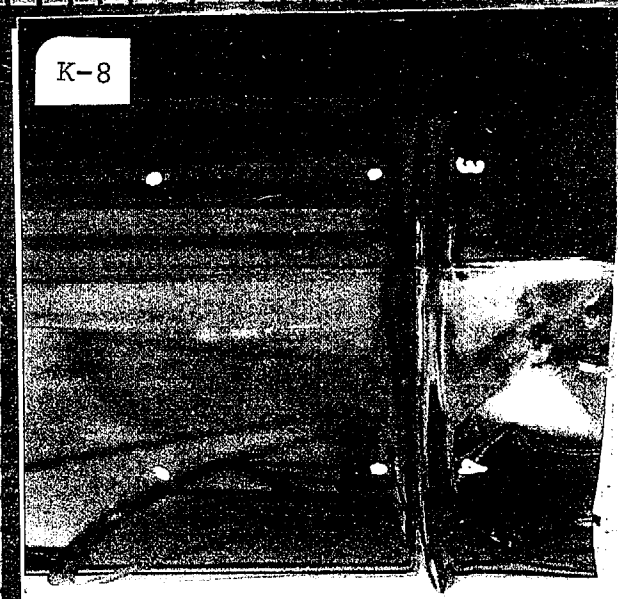

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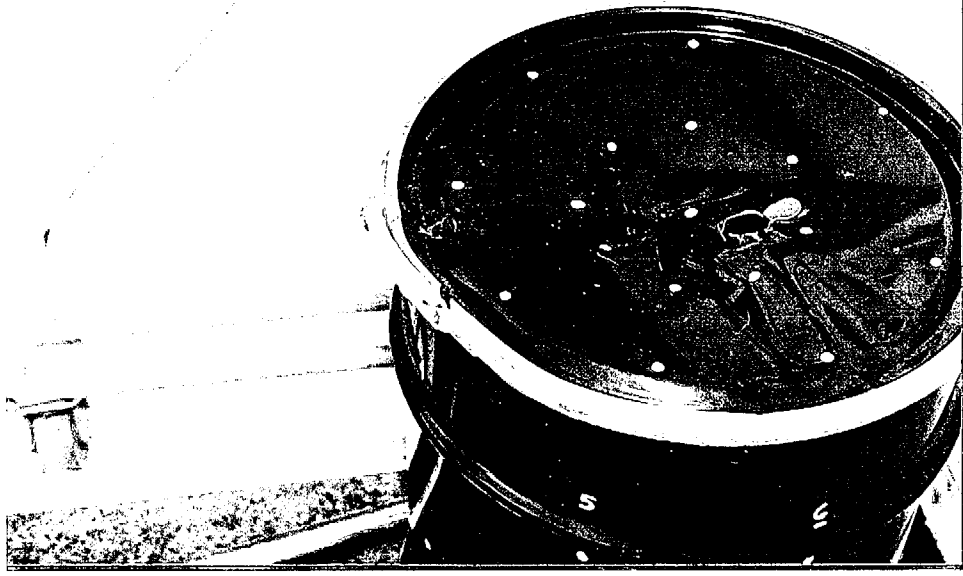
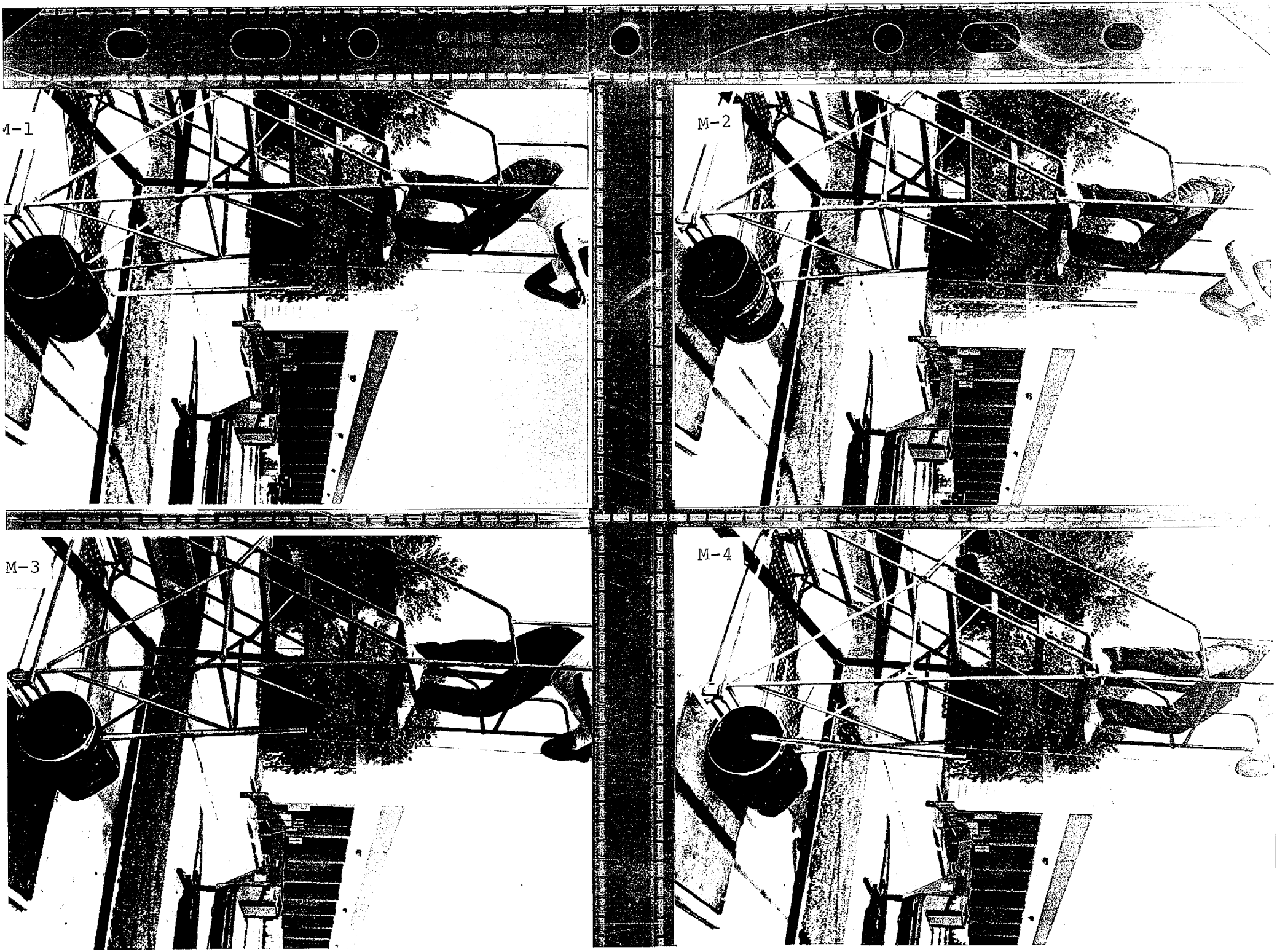
K-10

K-11

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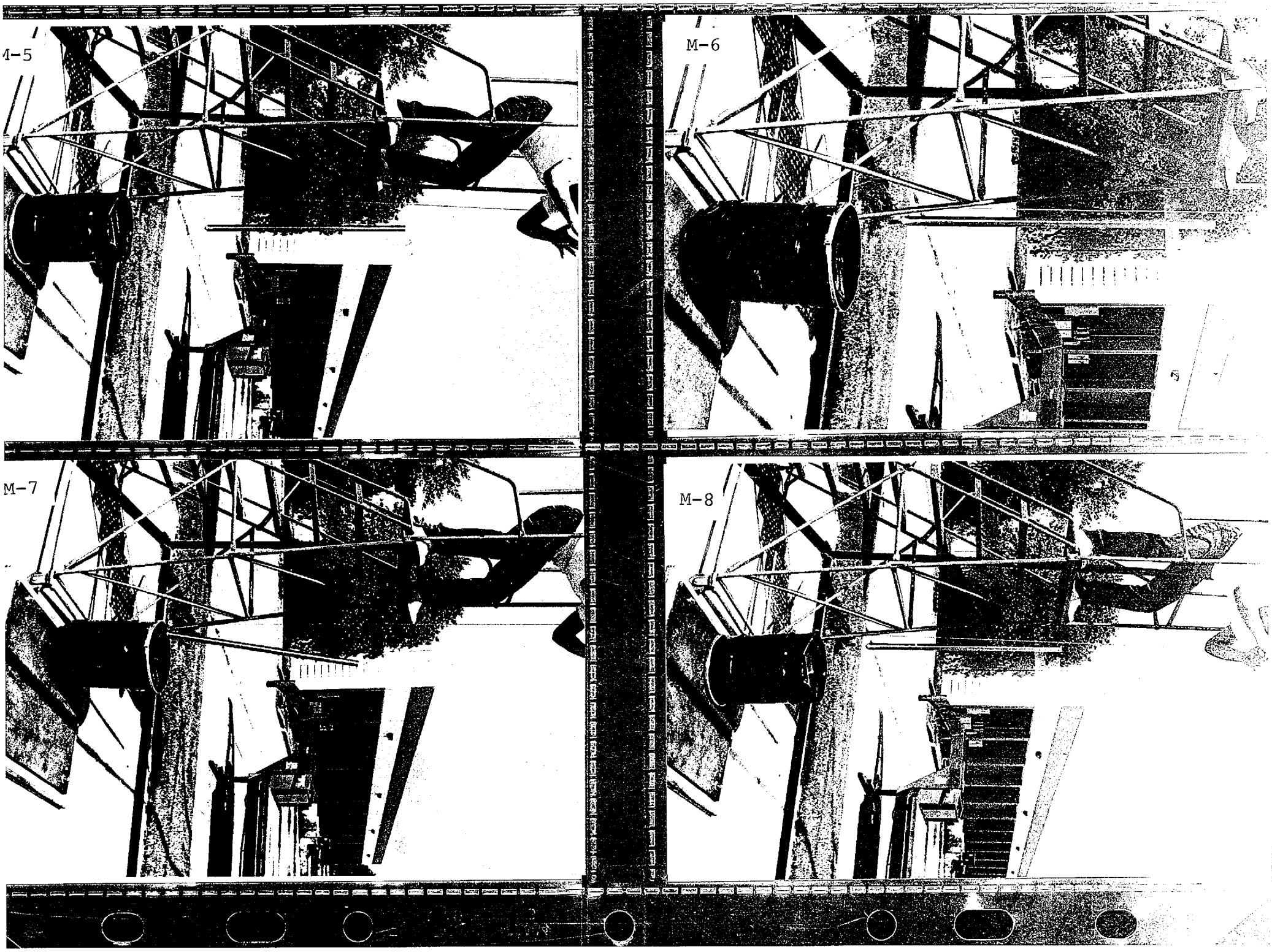
M-2
M-3
M-4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M-6
M-7
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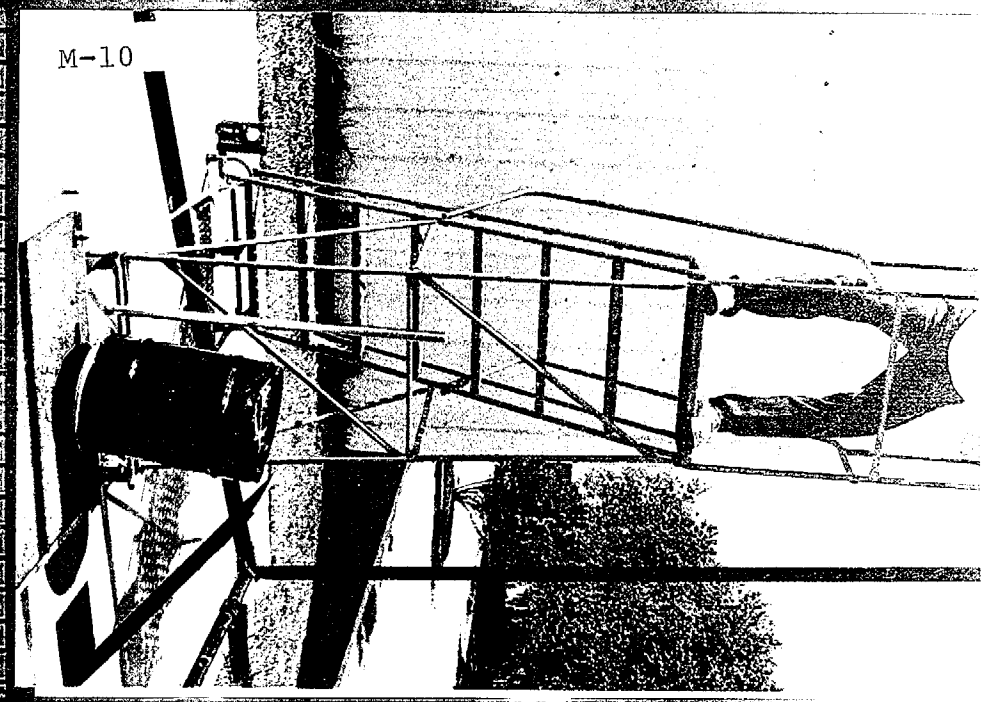
M-9

M-10



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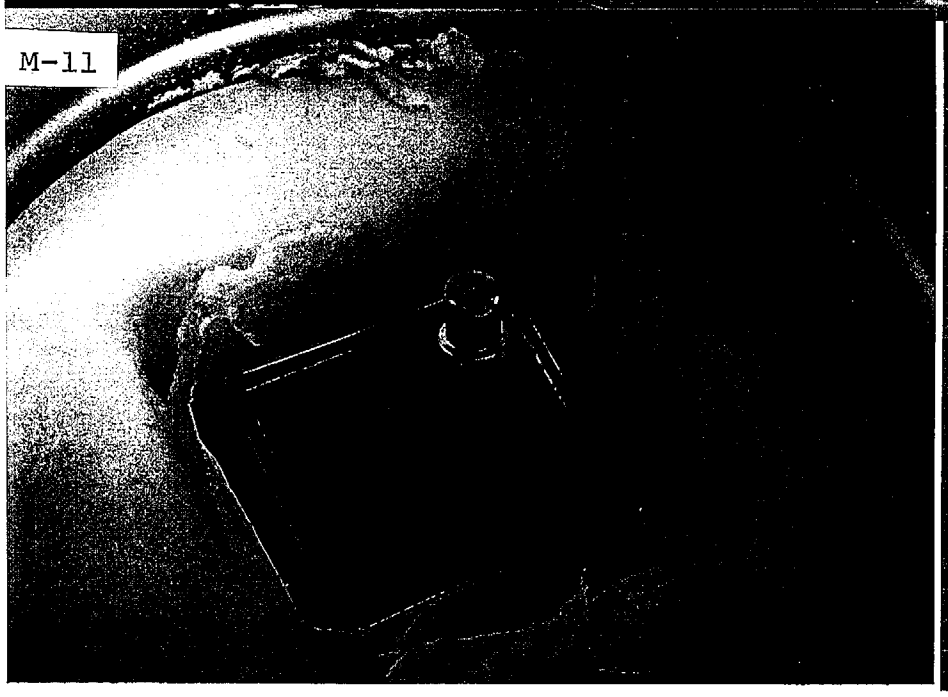

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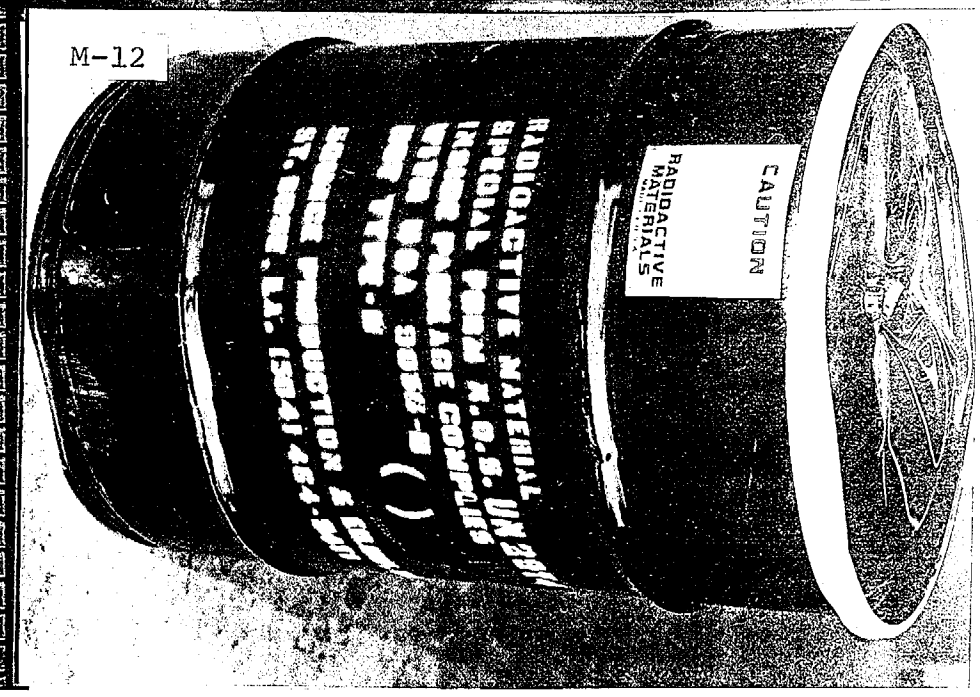

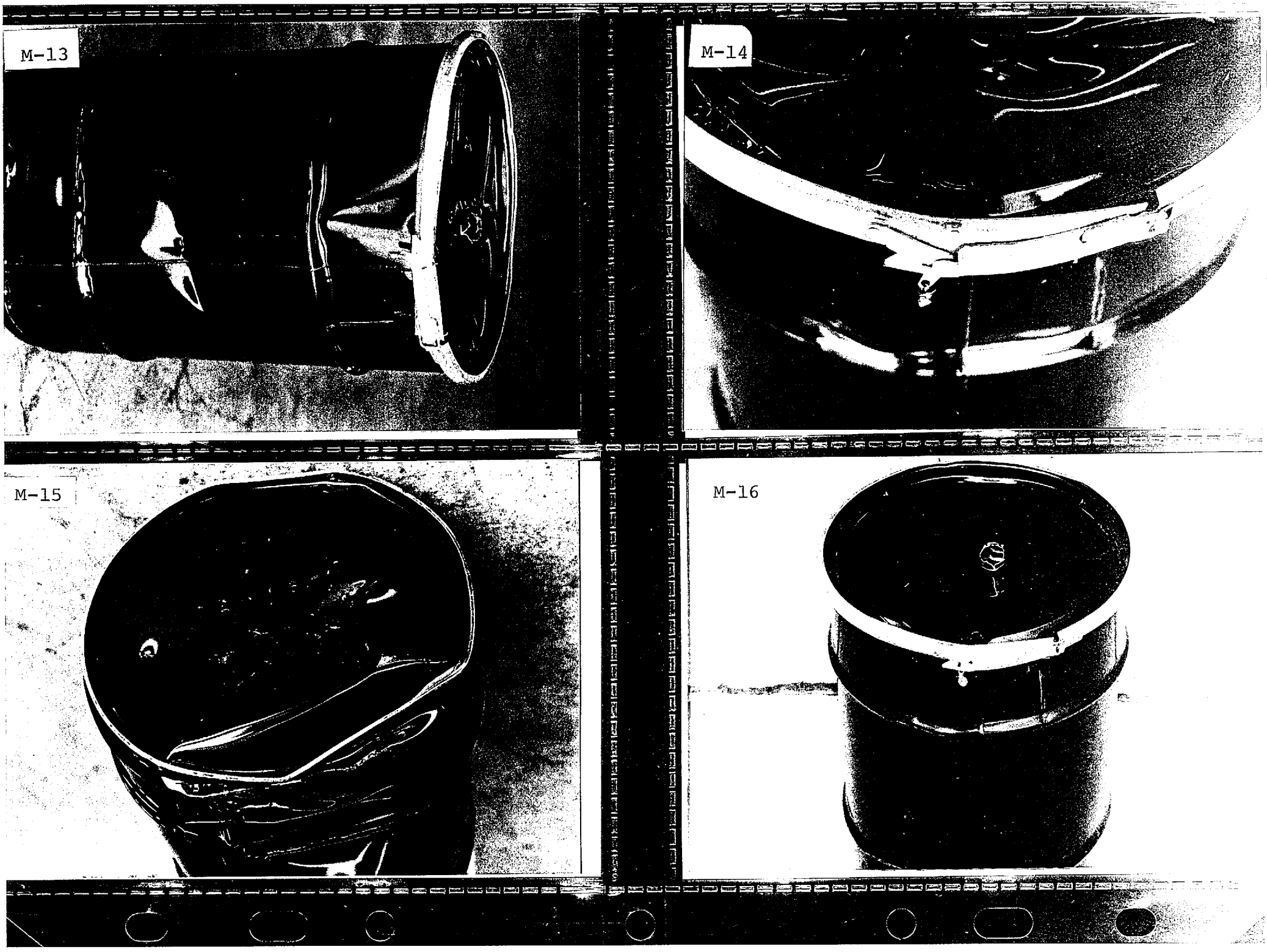
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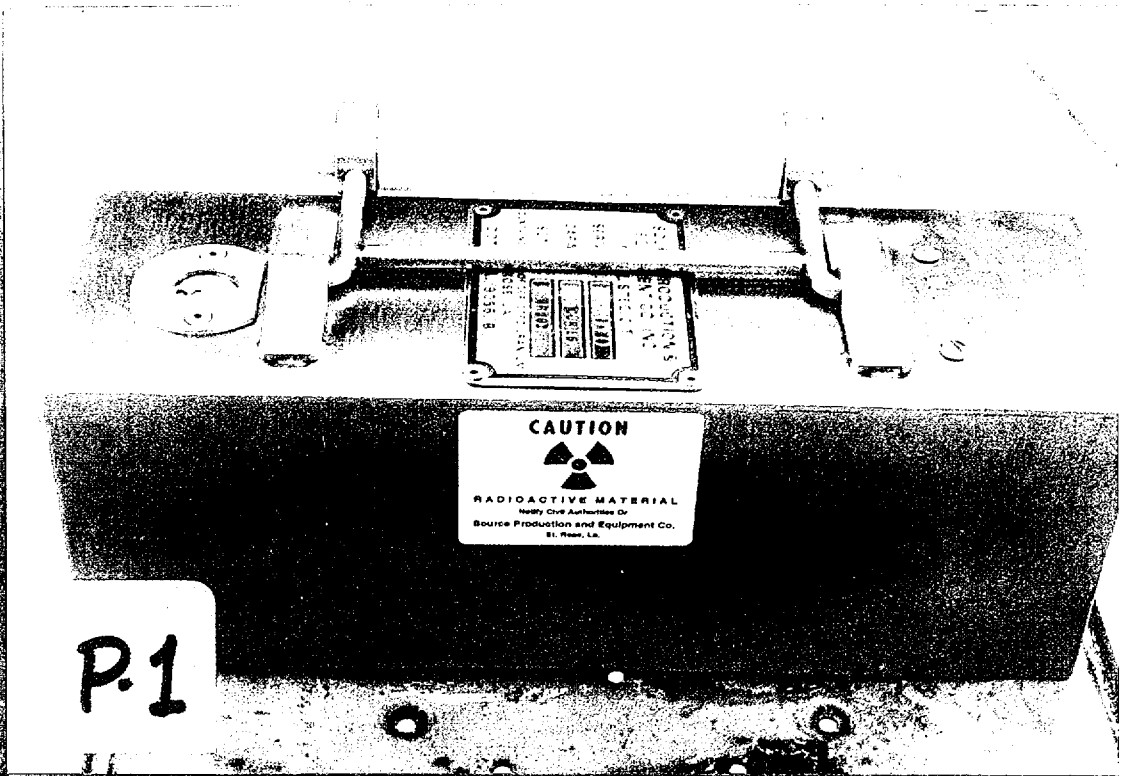
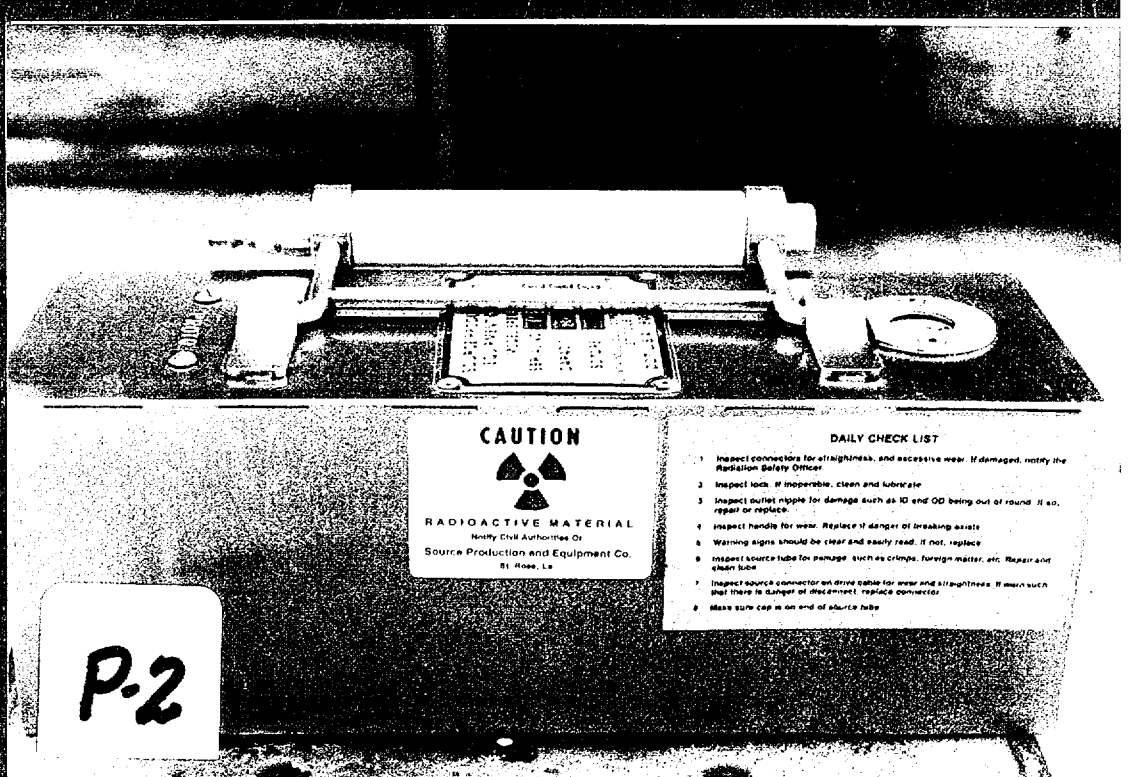
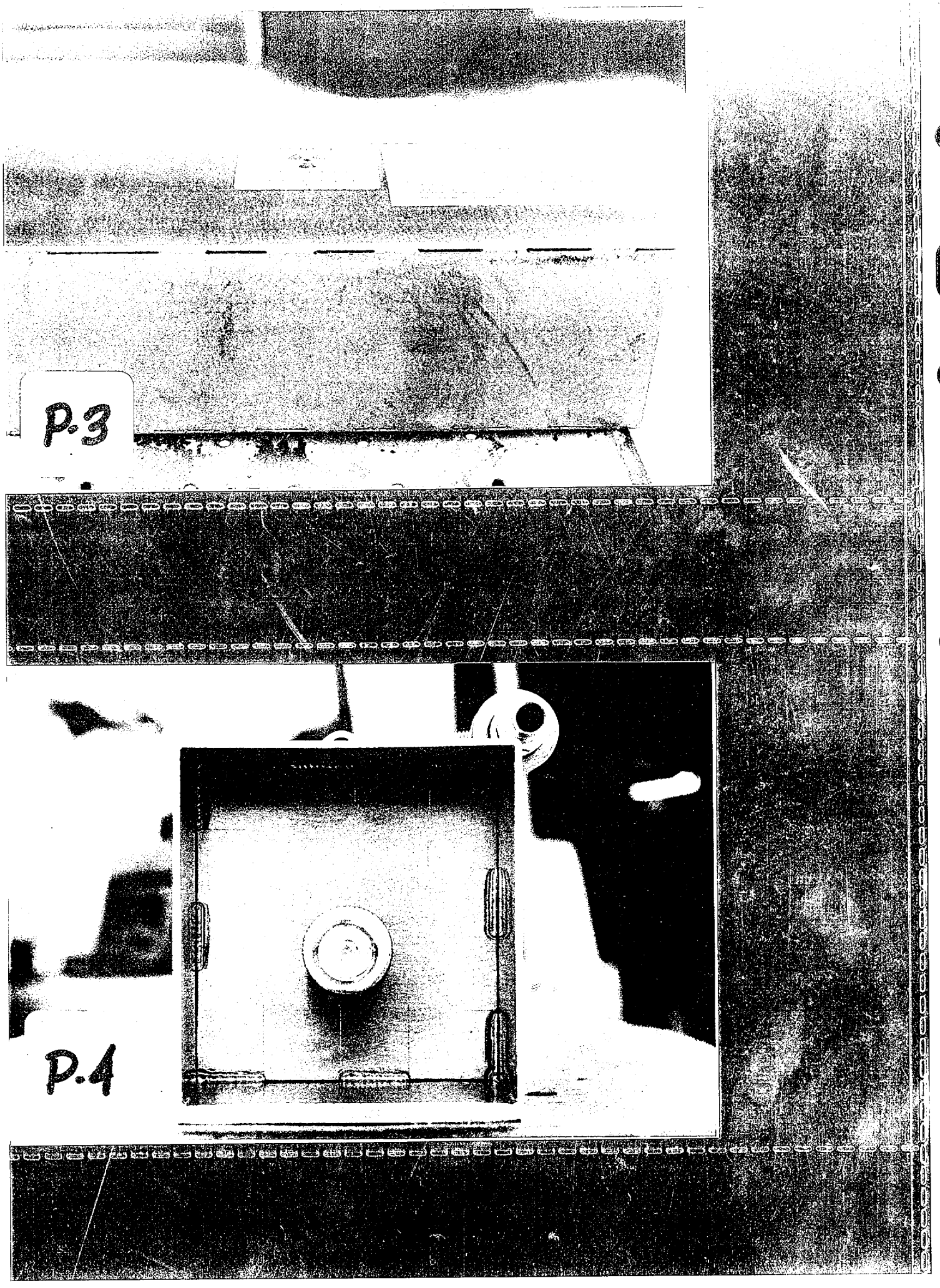
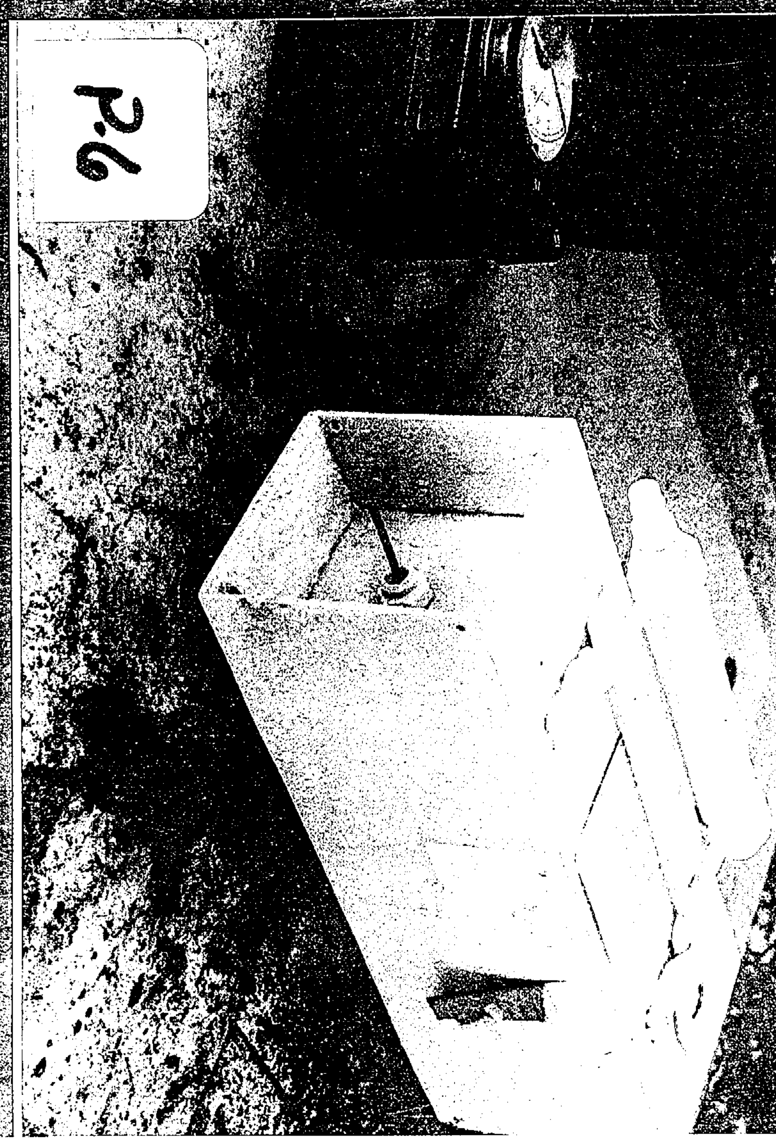
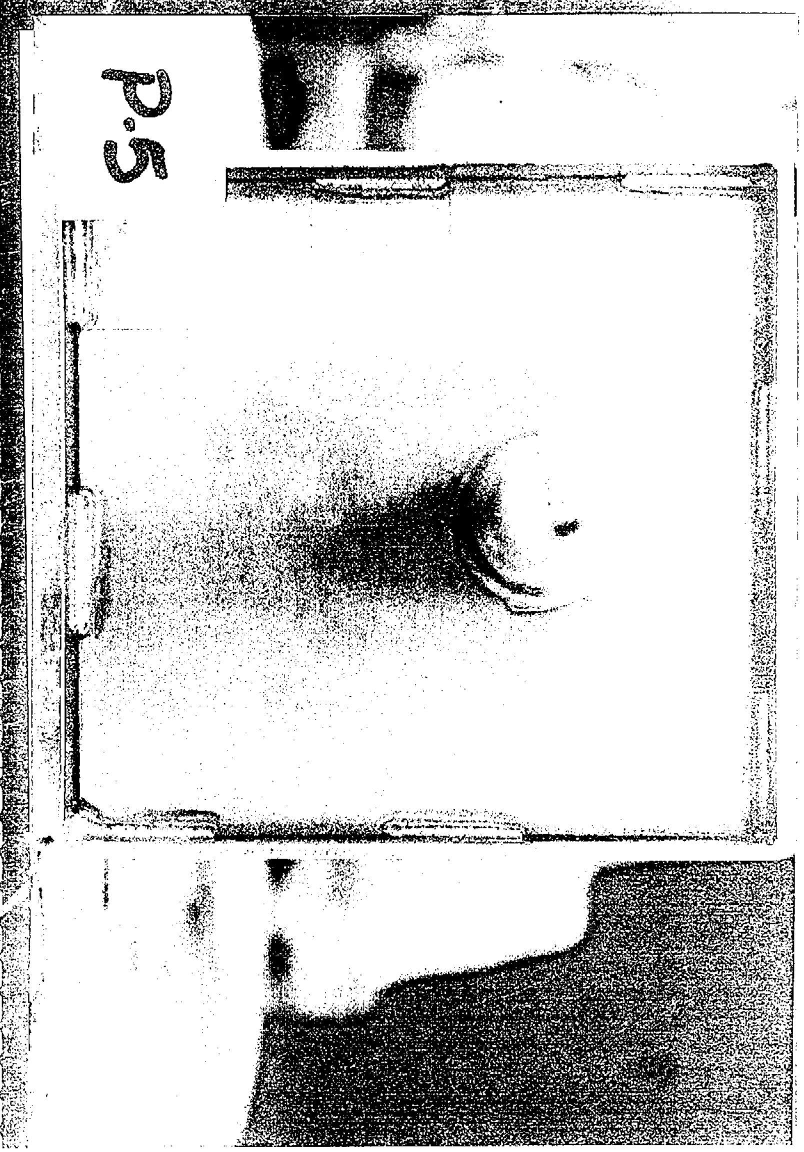
M-14
M-15
M-16

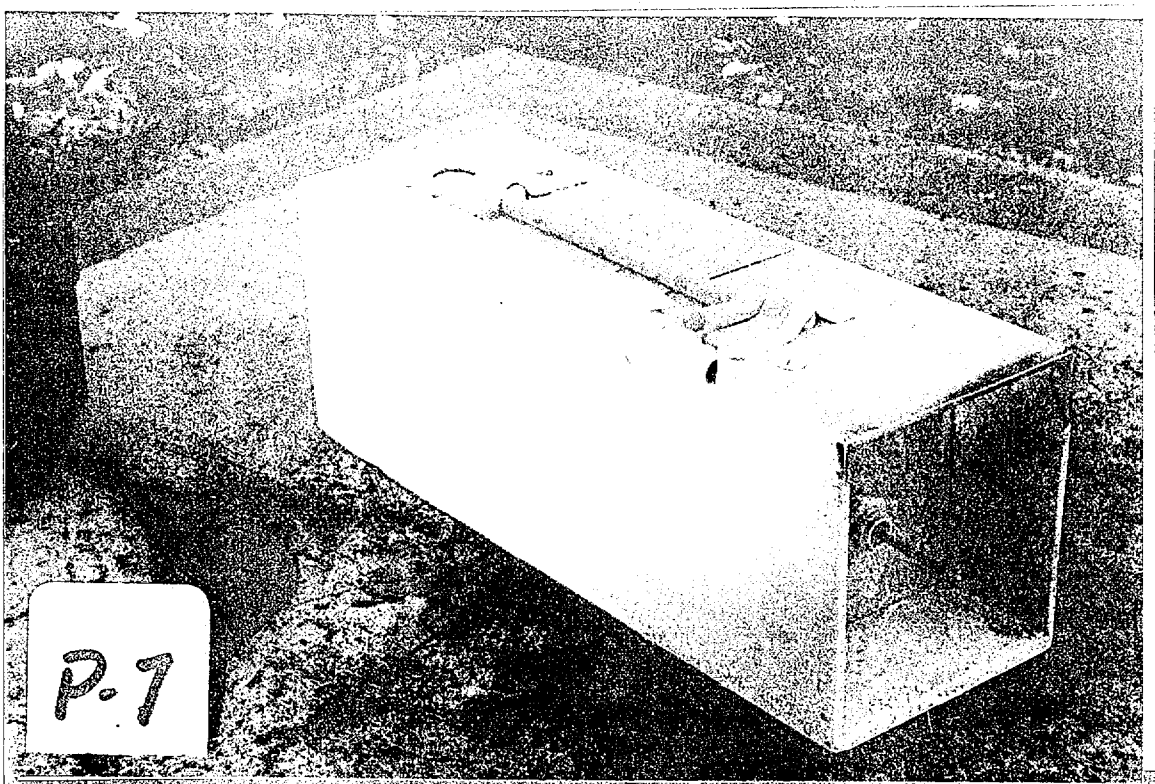





P.3
P.4



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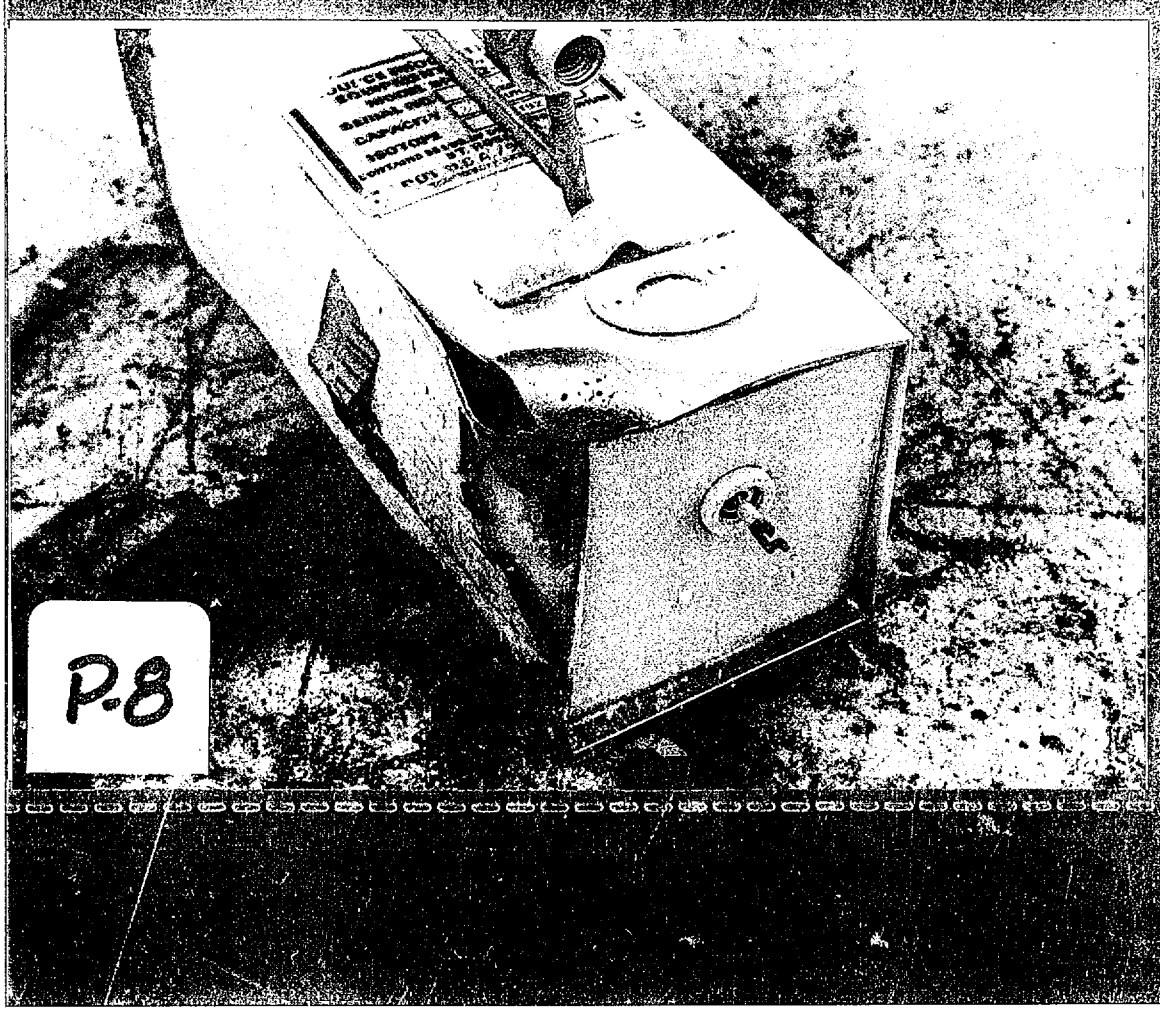
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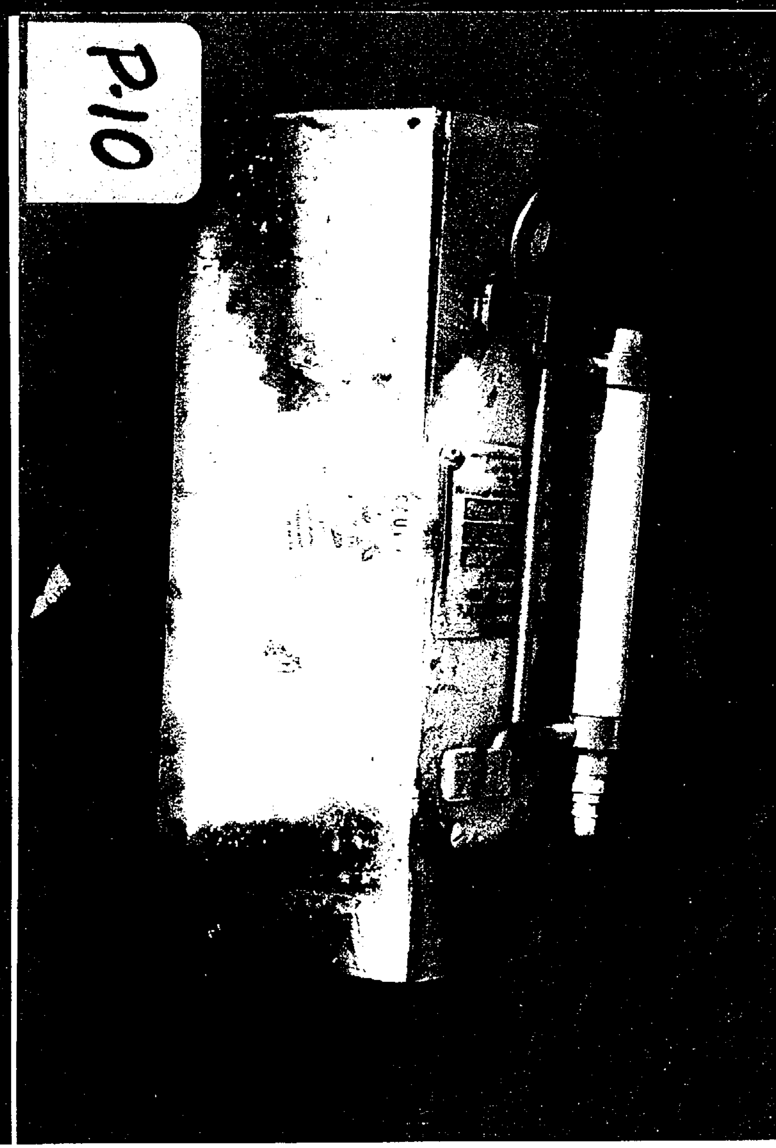
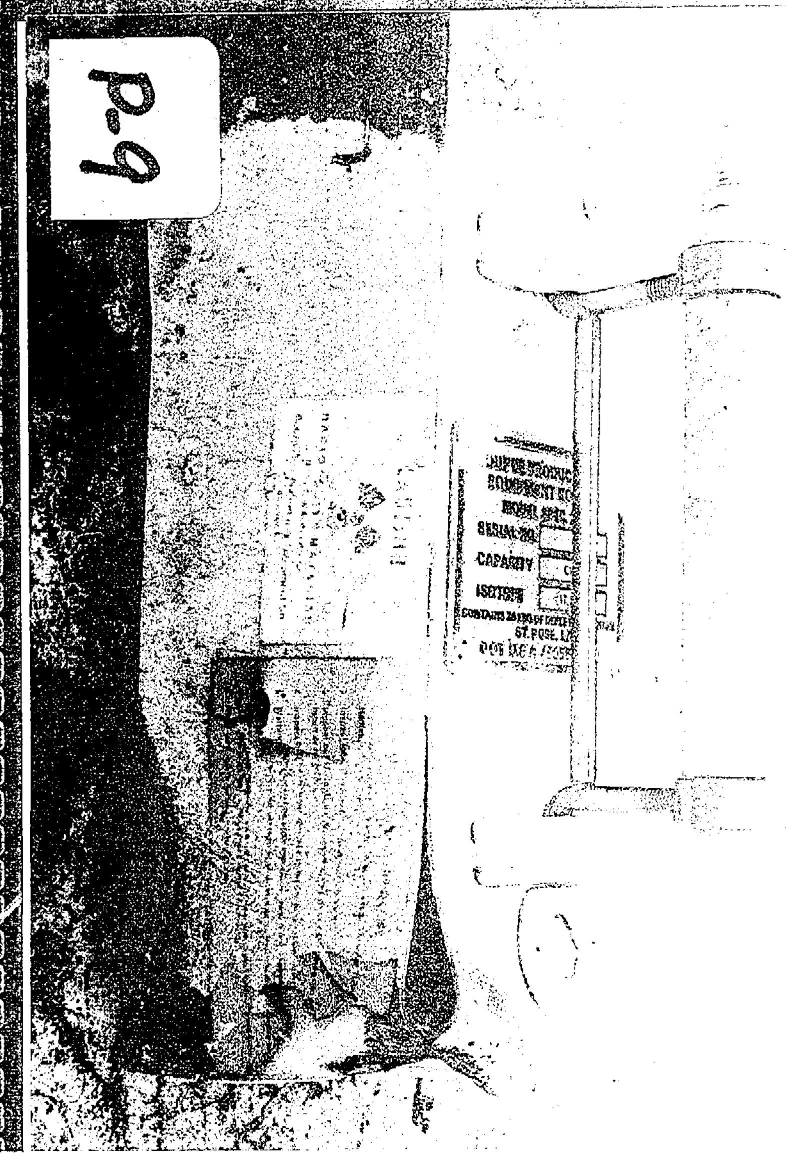
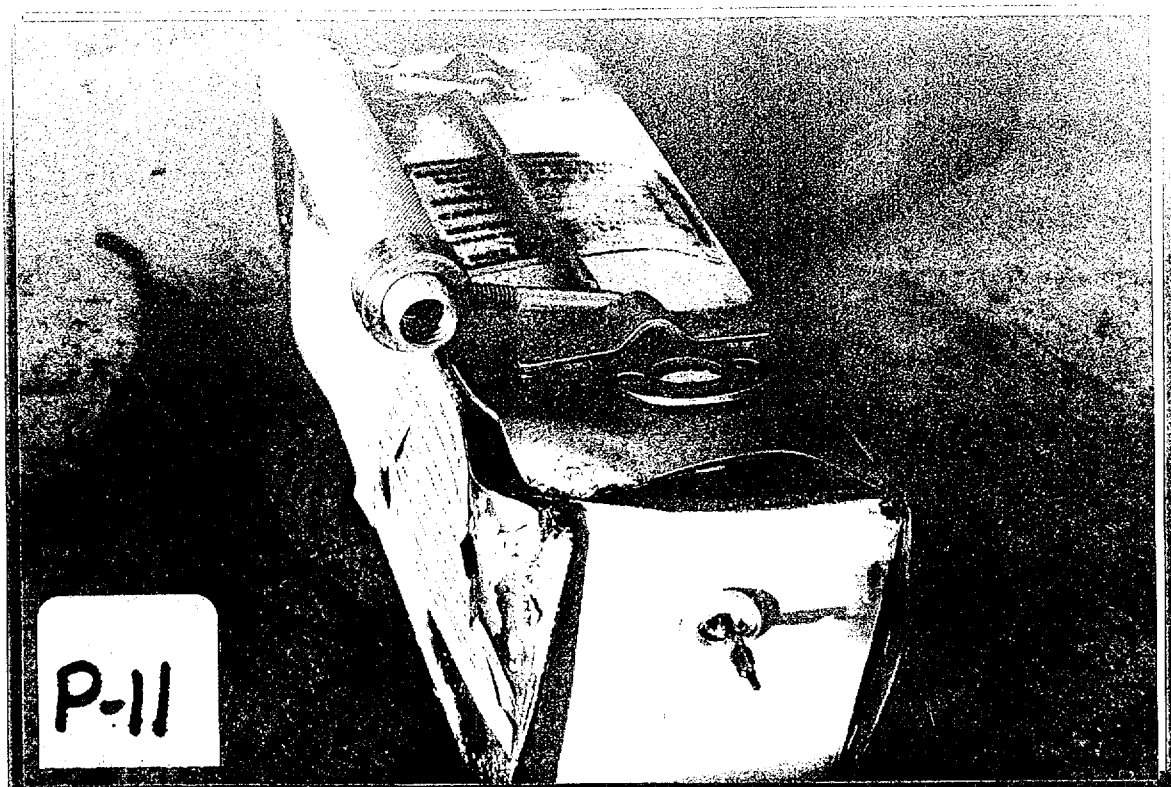
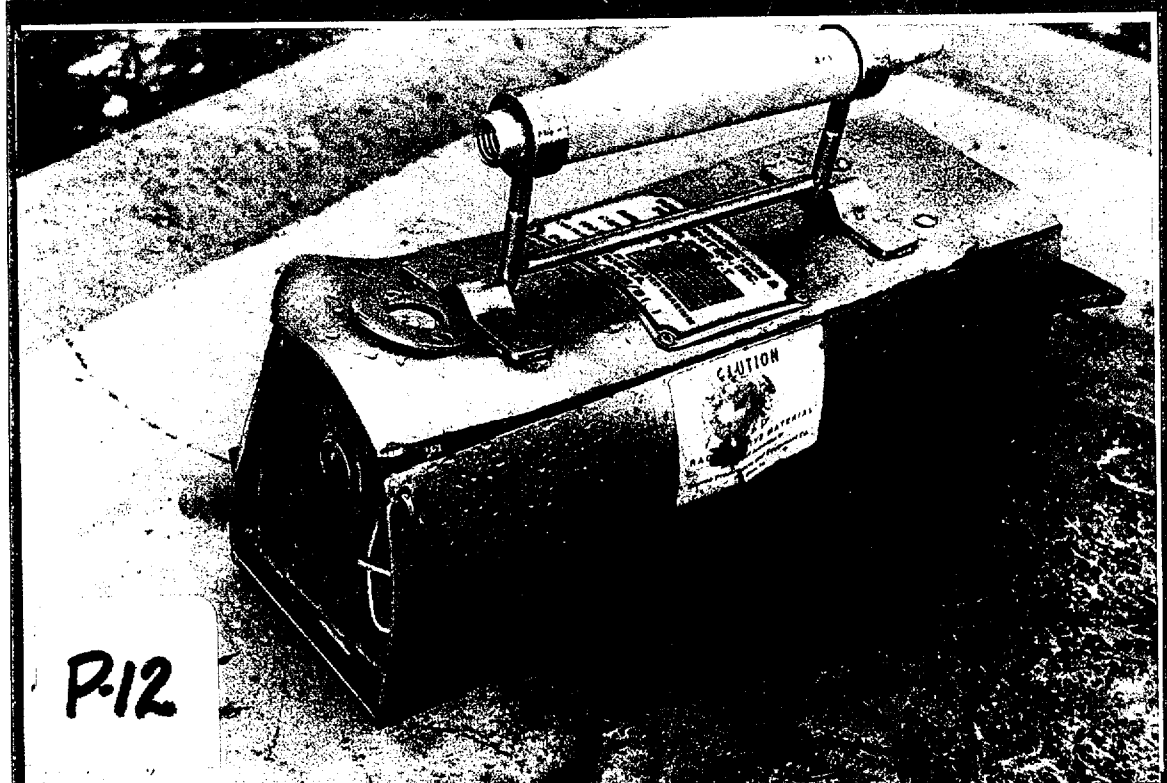
C-LINE #52564
4"x6" PRINTS







P-11



P-12

C-LINE #52564
4"x6" PRINTS

APPENDIX 9.3
DOCUMENTS

IAEA Certificate of Competent Authority Special Form Radioactive Materials Certificate Number USA/0095/S, Revision (7)
USNRC Quality Assurance Program Approval for Radioactive Material Packages Approval Numer 0102, Revision (6)

APPENDIX 9.3
DOCUMENTS

IAEA Certificate of Competent Authority
Special Form Radioactive Materials
Certificate Number USA/0095/S

USNRC Quality Assurance Program Approval for Radioactive Material Packages
Approval Numer 0102

U.S. Department
of Transportation

**Research and
Special Programs
Administration**

400 Seventh Street, S.W.
Washington, D.C. 20590

**IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS
CERTIFICATE NUMBER USA/0095/S, REVISION 7**

This certifies that the sources described have been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] for the transport of radioactive materials.

1. Source Identification - Source Production and Equipment Co. Series B, G, R and T Model Sources.

2. Source Description - The sources are encapsulations constructed of Type 316 stainless steel with welded closures which measure 5.84 mm (0.23") in diameter and 20.32 mm (0.8") long. Construction must be in accordance with the attached Source Production and Equipment Co. Drawing No. 101 dated 8/14/85.

3. Radioactive Contents - These sources consist of not more than 4.1 TBq (110 Ci) of Cobalt 60 or 8.9 TBq (240 Ci) of Iridium 192 as metal pellets.

4. Quality Assurance - Records of Quality Assurance activities required by Paragraph 209 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors and consignees in the United States exporting or importing shipments under this certificate shall satisfy the requirements of Subpart H of 10 CFR 71.

5. Expiration Date - This certificate expires September 30, 2000.

This certificate is issued in accordance with paragraph 703 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the petition and information dated July 31, 1995 submitted by Source Production and Equipment Company, St. Rose, LA, and in consideration of other information on file in this Office.

Certified by:

James K. O'Steen, Director
Office of Hazardous Materials
Technology

NOV - 3 1995
(DATE)

Revision 7 - Issued to incorporate the 1985 Edition of the IAEA regulations, and to extend the expiration date.

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1 "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1985 Edition, as amended 1990" , published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

2 Title 49, Code of Federal Regulations, Parts 100 - 199, United States of America.

NRC FORM 311
(12-95)

U. S. NUCLEAR REGULATORY COMMISSION

QUALITY ASSURANCE PROGRAM APPROVAL
FOR RADIOACTIVE MATERIAL PACKAGES

1. APPROVAL NUMBER: 0102
REVISION NUMBER: 6

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and Title 10, Code of Federal Regulations, Chapter 1, Part 71, and in reliance on statements and representations heretofore made in Item 5 by the person named in Item 2, the Quality Assurance Program identified in Item 5 is hereby approved. This approval is issued to satisfy the requirements of Section 71.101 of 10 CFR Part 71. This approval is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

2. NAME
Source Production and Equipment Company, Inc.

STREET ADDRESS
113 Teal Street

CITY: St. Rose | STATE: LA | ZIP CODE: 70087-9691

3. EXPIRATION DATE
July 31, 2001

4. DOCKET NUMBER
71-0102

5. QUALITY ASSURANCE PROGRAM APPLICATION DATE(S)
November 16, 1988 and May 13, 1996

6. CONDITIONS

1. Activities conducted under applicable criteria of Subpart H of 10 CFR Part 71 to be executed with regard to transportation packagings.

2. Records shall be maintained in accordance with the provisions of 10 CFR Part 71. Specifically:

   a. Records of each shipment of licensed material shall be maintained for three years after that shipment [10 CFR § 71.91(a)].

   b. Records providing evidence of packaging quality shall be maintained for three years after the life of the packaging [10 CFR § 71.91(c)].

   c. Records describing activities affecting packaging quality shall be maintained for three years after this Quality Assurance Program Approval is terminated (10 CFR § 71.135).

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

John P Jankovich

JOHN P. JANKOVICH, SECTION LEADER
TRANSPORTATION AND STORAGE INSPECTION SECTION
SPENT FUEL PROJECT OFFICE, NMSS

July 2, 1996
DATE

APPENDIX 9.4
TEST REPORT TO VALIDATE PREVIOUS 10 CFR PART 71
PUNCTURE TESTS

SOURCE PRODUCTION AND EQUIPMENT COMPANY, INC.
113 Teal Street, St. Rose, Louisiana 70087

Test Report to Validate Previous 10 CFR Part 71 Puncture Tests

Model SPEC 2-T Type B(U) Package
Docket Number 71-9056

2T-SUPP4.(0)

SOURCE PRODUCTION AND EQUIPMENT COMPANY, INC.
Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
Model SPEC 2-T Type B(U) Package
Docket Number 71-9056

Table of Contents Page

2T-SUPP4.(0)

SOURCE PRODUCTION AND EQUIPMENT COMPANY, INC.
Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
Model SPEC 2-T Type B(U) Package
Docket Number 71-9056

1. GENERAL INFORMATION

1.1 Introduction and Background.

On June 12, 1997 the NRC informed SPEC that one of the hypothetical accident condition tests, the puncture tests, that was performed to qualify the SPEC 2-T as a Type B(U) package might not be valid. This concern was based on the puncture pin mounting information SPEC voluntarily provided to the NRC the previous week. An NRC 10 CFR Part 71 inspection was conducted the week of June 16th, 1997. The inspection confirmed that the six (6) inch diameter steel pin used for the one (1) meter puncture test was not rigidly mounted to the test target pad. The previous puncture tests used a pin that was mounted on the test target pad but the pin had not been mounted rigidly to prohibit toppling and vertical movement (i.e., bolted or welded). A review of a video tape of one of the numerous puncture tests conducted proved that the pin did not topple but that it did move laterally a few inches during the test. The NRC issued a Confirmatory Action Letter dated June 24, 1997 which describes SPEC's commitment to re-evaluate the SPEC 2-T to verify the validity of the previous puncture tests. In order to provide the highest level of directly reliable information we chose to retest the SPEC 2-T rather than extrapolate data from tests of other packages.

The drop test and puncture tests were conducted on June 26, 1997 in accordance with SPEC Test Plan, Rev (1) dated June 24, 1997 which were witnessed by Mr. Cass R. Chappell and Mr. Andrew Gaunt from the NRC, and Mr. Sami Aouad and Ms. Ann Troxler from the Louisiana Division of Radiation Protection. The puncture test must be conducted in sequence following the 9 meter free drop test. The damage from the additional puncture tests was extremely slight, insignificant in terms of structural and shielding, and virtually identical to the damage from the previous tests. The tests successfully verified the validity of all the previously performed puncture tests.

1.2 Test Report Format.

This report provides the test information that is specified in the Test Plan, Rev (1) dated June 24, 1997 which includes data from tests of other packages (SPEC-150 and SPEC C-1). That data is not relevant for purposes of this report. An edited copy of the Test Plan, which includes some of the test data, is located in Appendix 4. 2. The Test Plan document with original signatures is maintained as a QA record.

1.3 Radioactive Contents of Test Package.

A production source was installed in the test package to perform the accident condition tests. This is the most direct and reliable means to evaluate the displacement of the source relative to the shield and to evaluate the integrity of the shield after the tests. Experience has shown that for packages similar to radiography devices and source changers it is usually impossible to remove and replace a dummy source assembly with a live source after the hypothetical accident condition tests due to the structural damage, particularly for radiography cameras. In many cases the package must be partially dismantled. We believe it is not possible to reliably position the live source in exactly the same location as the dummy source used for the test. The adequacy of the shielding design for the package was verified by actual measurements of radiation profiles of the test sample before and after the tests, and the readings are extrapolated to the maximum authorized activity for the package.

1.4 Survey Method.

The surveys of the test packagings were performed in accordance with SPEC Survey Procedure 7.04, Rev (3) (See Appendix 4. 3). No distance correction factor from the package surface to the detector was applied to surface radiation levels because the surface readings are not required to determine if a packaging meets the shielding requirements following the hypothetical accident condition free drop and puncture tests. Background radiation was

not factored out of survey readings because it does not have significant impact on the actual readings at 1 meter for the purposes of this test, which is to verify that no radiation level exceeds 1 R/hr at 1 meter when extrapolated to the maximum authorized activity of the packaging. The background radiation levels at the location in the facility where the surveys were conducted ranged from approximately 0.2 mR/hr to 0.4 mR/hr depending on the quantity of packages being prepared for transport in the adjacent shipping area of the shop.

The purpose for recording surface radiation readings before and after the tests is twofold. First, it provides additional data that either supports or refutes the structural evaluation of a package. Secondly, it is used to locate the spot on each side where the radiation level is highest from which to take the reading at 1 meter. It should be noted that even for a package with flat surfaces at 1 meter away the detector might not be located perpendicular to the highest surface reading. The highest reading at 1 meter will be located on a direct line formed by the source capsule and the highest reading spot on the surface. Unless the highest surface reading is located adjacent to the center of the DU shield, the beam of highest radiation will not be perpendicular to the package at 1 meter. Using a survey method that requires perpendicular positioning of the detector from the highest surface reading will not produce the highest actual readings at 1 meter. SPEC's survey method assures that the highest readings at 1 meter are taken.

1.5 Drop Target Description.

The drop target at SPEC greatly exceeds the requirements specified in IAEA Safety Series No. 37 "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material," 1985 Edition as amended 1990. The drop target consists of a solid carbon steel plate which measures 35-1/4 inches x 30-1/4 inches x 1-3/4 inches thick weighing 528 pounds (See Drawing Nos. 50890-1, Rev (1) in Appendix 4. 1). The thickness of the steel plate meets the minimum 4.0 cm IAEA requirement. The steel plate was wet floated onto a 1 inch thick layer of high strength grout to keep the plate level and prevent air pockets from forming while curing. Both conditions are more common when floating directly onto wet cement. The grout is a commercial product with a minimum compressive strength of 7,250 psi which is approximately twice the compressive strength of concrete. The grout firmly attaches the steel plate to the top surface of a flat horizontal concrete block which measures 46 inches x 46 inches x 56 inches thick weighing approximately 9900 pounds. The total weight of the drop target is approximately 10,500 pounds which greatly exceeds ten times the mass of a 100 pound package. The concrete block is sunk to a depth of 52 inches into firm soil. (A detailed inspection of the drop target prior to the tests identified variations from the target description provided in previous applications.) A sturdy 40 foot tall structure was erected over the drop target and used to raise and release the test package from a minimum height of 30 feet (9.2 meters) above the top surface of the target. No damage nor separation of the steel plate, grout and the concrete block has occurred from any previous tests.

1.6 Puncture Pin Description.

The puncture pin is a 6 inch diameter x approximately 8-1/4 inch long solid mild steel rod. It is rigidly mounted to the center of the drop target pad (See Drawing No. 990001, Rev (0) in Appendix 4. 1). This is essentially the same design that was used for the previous puncture tests. However, for the previous tests the pin was not mounted in a manner to assure that it would not topple over or move laterally. The pin used for these tests is welded to a steel holder which was bolted to the steel drop target pad. The pin is inspected after each puncture test to verify that it did not topple over nor move laterally.

The length of the puncture pin was selected to be a minimum of 8 inches, in accordance with 10 CFR 71.73(c)(2), and a maximum of 8.3 inches. This is based on an analysis of each package design and previous test experience to determine which pin length will cause maximum damage to the package. The deformation resulting from previous 30 foot free drop and puncture tests has been relatively minor; far less than eight inches. The package contain no deep recesses or pockets that could be accessed better by a bar longer than 8 inches. These package will not be housed in a drum or overpack during testing. It is clear that there is no length greater than 8 inches that will cause more damage to the package than the required 8 inch pin length. Based on these factors the length of the puncture test bar will be 8 inches min, 8.3 inches max.

1.7 Selection of Test Package Orientation.

The orientation of a package must be selected to strike the package surface in a position for which maximum damage is expected. The term "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 1 meter from the external surface of the package. For purposes of orientation analysis, maximum damage will be considered as the condition that provides maximum movement, or chance of movement, of the sealed radioactive source away from the fully shielded position within the depleted uranium (DU) shield. This is the condition most likely to result in increased radiation levels outside of the package. The history of testing packages has provided extensive comparative information regarding the orientations that have caused the most damage in previous tests. It should be noted that there has never been an instance in which an accident condition test has fractured, deformed or otherwise reduced the shielding capability of the DU shield, even at temperatures near minus (-) 100 degrees Fahrenheit. Therefore, orientations to promote shield and source separation is considered far more likely to cause the maximum damage. The orientation selection and supporting rational was recorded prior to the start of the tests and are included in this report. After the 9 meter free drop test the orientation for the puncture test was re-evaluated based on the damage from the 9 meter free drop. (See sketches of orientations in Appendix 4.4.)

2. STRUCTURAL EVALUATION

2.1 Structural Design - SPEC 2-T

The structural design information remains unchanged from the information that is provided in the current application for Certificate of Compliance No. 9056 (See Package Drawings, Appendix 4. 5).

2.1.2 Description of Test Packaging.

The test package is a Model SPEC 2-T, s/n 1152, which is a used production package that was constructed in standard production fashion pursuant to applicable quality assurance procedures specified in NRC Certificate of Compliance No. 0102. For each of the tests an actual production model G-3 Iridium-192 source assembly, which was constructed in standard production fashion pursuant to applicable quality assurance programs, was contained within the test package. The test packaging specimen meets the design specified in Certificate of Compliance No. 9056. It represents the current production model design. See Drawings 12688-1, Rev (2), 788-1, Rev (4), and 53189-2, Rev (2) in Appendix 4. 5. Note that Drawing Numbers 788-2, Rev (0) and 1000, Rev (0) are referenced in Certificateof Compliance No. 9056 but are included in the appendix. They are drawings of older design revisions that are still in use but have been discontinued as production designs and do not reflect the design of the test package used.

2.2 Hypothetical Accident Condition - 9 Meter Free Drop Test.

2.2.1 Discussion.

The 2-T packaging was not chilled prior to this test because it had been chilled for previous tests, including when tested as a stand-alone package without the steel drum overpack, without noticeable affect from the chilling as reported in previous applications to the NRC for the 2-T. It has been tested as a stand alone package without the steel drum overpack package with numerous orientations. It has successfully passed all previous tests.

2.2.2 Selection of orientation.

The SPEC 2-T is similar in construction to the SPEC-150. Essentially, the SPEC-2-T is a depleted Uranium shield weighing approximately 35 lb. enclosed in a rectangular GTAW welded corrosion-resisting steel enclosure. The shield is retained in the enclosure by tabs or "ears" cast integrally with the shield. One of these tabs is attached to the top of the enclosure, near the lock end. The other is attached to the bottom of the enclosure, near the outlet end. A cylindrical feature of the shield ("hot top") also fits into a ring welded to the left side of the enclosure, providing restraint in the front-rear and top-bottom directions. The mechanism securing the radioactive source assembly in the center of the depleted Uranium shield is also attached to the lock end of the enclosure. An impact causing the shield to shift toward the outlet end of the camera, while preserving the integrity of the securing mechanism, would result in the source capsule being displaced from the fully shielded position within the depleted Uranium shield. This would result in maximum damage.

Dropping the package with the impact flat on the outlet end of the package would be expected to maximize the chances of significant relative displacement of the shield, except that the safety plug extends almost to the end of the package. This would limit the deformation of the end plate to approximately 0.25 inch, resulting in less than maximum damage. Therefore this orientation was not selected.

Dropping the package with the impact point at the bottom right corner at the outlet end, as viewed from the lock end of the package, allows for a larger potential displacement of the shield, especially if the center of gravity of the package is located approximately over the impact point to reduce package rotation at impact. Additionally, this orientation allows the reaction from the shield to be transferred through a tungsten shim and bear on the end plate near the weld joint. Prototype packages have been dropped repeatedly and demonstrate greatest damage when dropped on one of the bottom outlet end corners.

Based on these factors the package was oriented so as to fall with the center of gravity over the outlet end bottom right corner, as viewed from the lock end of the package (See Photographs B1 & B2).

2.2.3 Drop Test Description.

A model SPEC 2-T, s/n 1152, was subjected to a free drop from a distance of 9 meters (30 feet) onto the previously described drop target (See Photograph B3). The point of impact was the bottom right corner at the outlet end of the package as planned (See Photograph B4). The package retained the planned orientation throughout the free fall and impact.

2.2.4 Damage Assessment.

Outlet End: The ring on the safety plug (quick disconnect) stuck in retracted position (See Photograph B5). Safety plug and outlet nipple bent upward 1/4 inch (See Photograph B6). The damage created a partial misalignment between outlet nipple and S-tube, which prevented the safety plug from being completely withdrawn from the package. The center of the outlet end panel bowed outward as expected approximately 0.200 inch (See Photograph B6). The weld joint at bottom right corner of the protective flange separated 1-½ inches (See Photograph B7). There was no damage to any other welded joint. Approximately 2 inches of the bottom edge dented outward a maximum amount of 1/4 inch. The bottom left corner dented out 1/16 inch (See Photograph B4).

Left Side: The center of the left side of the package bowed outward 1/8 inch, which was caused by the force of the DU shield hot top. The location of damage is 5-3/4 inch from outlet end (See Photograph B8).

Right Side: No damage, other than what has been described on outlet end.

Bottom: The edge at the outlet end dented 1/4 inches upward (See Photograph B9).

Top: The top surface and carrying handle were undamaged.

Lock End: No damage.

2.2.5 Damage Summary.

The structural damage was very minor. The most significant damage was the outward deformation of the outlet end panel which was caused by the momentum of the DU shield. The damage did not relocate the source relative to the shield to reduce the shielding capacity significantly. All the structural weld joints at the end panel remained completely intact.

2.3 Hypothetical Accident Condition - Puncture Test.

2.3.1 Selection of Orientation.

Relative to the size of the package being tested, the puncture test pin is very large. It is unlikely that the puncture test pin will penetrate the package. Past puncture tests have not penetrated the exterior of the package at all or caused significant damage to this or other SPEC packages. Based on these factors the puncture test orientation was selected based on the probability of elevating radiation levels.

The most likely scenario for maximum damage and elevating radiation levels as a result of this test would involve breaking the outlet nipple off of the outlet end plate. This component is relatively fragile when compared with the rest of the package and could possibly be broken off by an impact against the edge of the puncture pin. There is no guidance to require or prohibit selecting the edge of the pin rather than the center. If the outlet nipple was broken off the safety plug could come out, causing elevated radiation levels at the outlet end.

Based on these factors the package was prepared to be oriented so as to impact the edge of the puncture test pin with the center of gravity essentially over the safety plug (See Photograph B10). The puncture test orientation was reconsidered after the 30-foot free drop damage assessment. The basic theory of inducing the largest increase in radiation levels remains unchanged. Breaking off the outlet nipple remains the intended goal. In order to accomplish this, the puncture test orientation for this package remained unchanged from the original selected orientation.

2.3.2 Drop Test Description.

The package was dropped from a height of 40 inches (See Photograph B11). The point of impact was the safety plug at the outlet end of the package as planned (See Photograph B12). The puncture pin was marked by the impact of the safety plug (See Photograph B13).

2.3.3 Damage Assessment.

Outlet End: The outlet nipple broke off from the end panel causing the safety plug to disengage from the package. The edge of the quick disconnect fitting of the safety plug was dented approximately 7/16 inch long x 3/32 inch deep.

Top: The top plate edge at the left side of the package was pushed upward approximately 1/4 inch by the edge of the puncture pin (See Photograph B14).

Right Side: The right plate edge was pushed inward approximately 5/16 inch by the edge of the puncture pin (See Photograph B14).

2.3.4 Puncture Test Damage Summary.

The impact separated the outlet nipple from the package as expected but the damage did not affect the structural reliability of the package. There was no additional movement of the DU shield toward the outlet end nor any damage to structural features or weld joints. There was no puncturing of the package.

2.4 Summary of Structural Evaluation.

The only structural damage caused by the accident condition 9 meter free drop and puncture tests was limited to the deformation of the protective flange at the outlet end and the slight outward bowing of the outlet end panel. The package housing, DU shield, and all primary structural features designed to maintain the radioactive source in the shielded position under hypothetical accident conditions remained intact and performed fully as designed. No design revisions are needed. The SPEC 2-T remained safe and structurally sound after the drop test and puncture tests which demonstrates that the design meets the accident condition structural requirements for a Type-B package by a large margin.

3. SHIELDING EVALUATION

3.1 Package Shielding Discussion.
The shield that was fabricated into the test package is the current production shield design which is referenced in Certificate of Compliance No. 9056.

3.2 Shielding Evaluation.
Although a pretest survey is not required for the accident condition tests, a pretest survey was made at the surface and 1 meter from the 2-T. The pre-test and post-test surface reference readings in Table 2 were made to supplement the structural evaluation. See Sketches of survey locations in Appendix 4. 7.

TABLE 1 Shielding Evaluation SPEC 2-T

SPEC 2-T S/N 1152 - Highest Radiation Readings in mR/hr - (Model G-3 source, 17 Curies - Ir-192 on 6/25/97)						
Point	Location	Pre-Test Surface Reading 6/25/97	Post-Test Surface Readings 6/27/97	Pre-Test 1 Meter Readings 6/25/97	Post-Test 1 Meter Readings 6/27/97	Post-Test 1 Meter Readings Extrapolated to 150 Curies (background included) EF = 13.489
A	Left Side	26	18	0.6	1.1	14.8
B	Right Side	18	14	0.4	0.8	10.8
C	Top	12	12	0.5	0.6	8.1
D	Bottom	22	26	0.7	0.6	8.1
E	Lock End	12	12	0.6	0.6	8.1
F	Outlet End	10	480	0.8	3.6	48.6 (Safety Plug Broken Off)

LE 2 Shielding Evaluation SPEC 2-T

SPEC 2-T, S/N 1152 - Surface Reference Radiation Readings in mR/hr - (Model G-3 source, 16.68 Curies - Ir-192 on 6/2797)			
Point	Location	Pre-Test Surface Readings 6/25/97	Post-Test Surface Readings 6/27/97
G	Left Side @ Outlet End	6	5.2
H	Left Side @ Lock End	4	6.0
I	Bottom @ Outlet End	6	3.0
J	Bottom @ Lock End	3	4.4
K	Right Side @ Lock End	6	8.0
L	Right Side @ Outlet End	5	3.4
M	Top @ Lock End	3	4.0
N	Top @ Outlet End	2	2.0

3.3 Shielding Evaluation Summary.

The survey data for the 2-T conservatively shows that the packaging meets the allowable limit of 1 R/hr at 1 Meter by a large margin. The highest extrapolated reading is less than 5% of the allowable limit. The surface reference readings in Table 2 supports the conclusions derived from the structural evaluation of the packaging. The design of the SPEC 2-T meets the shielding requirements of a Type B(U) packaging.

4. APPENDICES

Appendix 4.1 Drop Target and Puncture Pin Drawings

Target: Drawing 50890-1 Rev (1)
Pin: Drawing 990001, Rev (0)

Appendix 4.2 Test Procedure

Test Plan, Rev (1), June 24, 1997

Appendix 4.3 Survey procedure 7.04, Rev (3)

Appendix 4.4 Sketches of Orientations - Free Drop and Puncture

SPEC 2-T, Free Drop
SPEC 2-T, Puncture

Appendix 4.5 SPEC 2-T Package Drawings

12688-1, Rev (2)
788-1, Rev (4)
53189-2, Rev (2)

Appendix 4.6 Photographs

(See List)

Appendix 4.7 Sketches of SPEC 2-T Survey Locations.

Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
July 1, 1997

Appendix 4.1
Drop Target and Puncture Pin Drawings

FIGURE WITHHELD UNDER 10 CFR 2.390

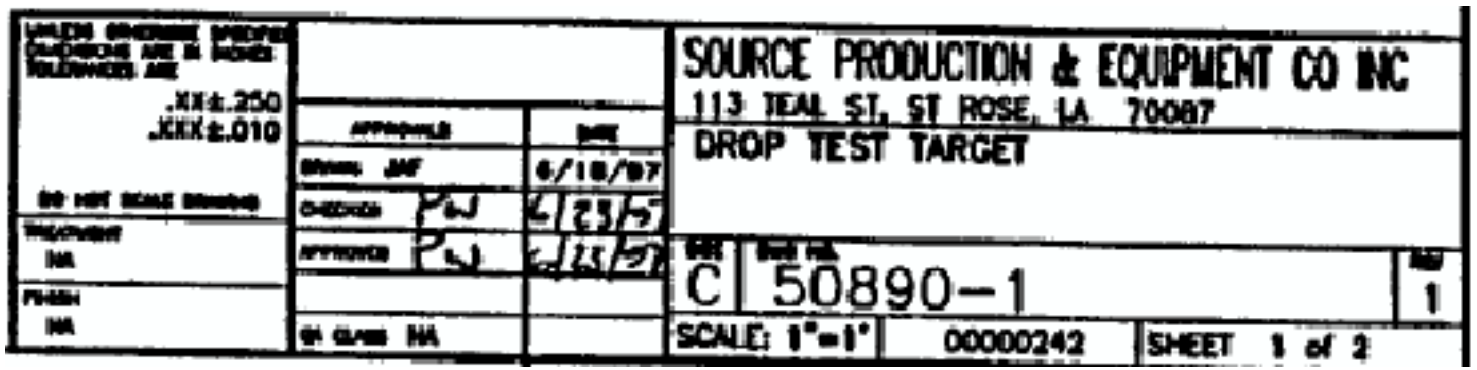
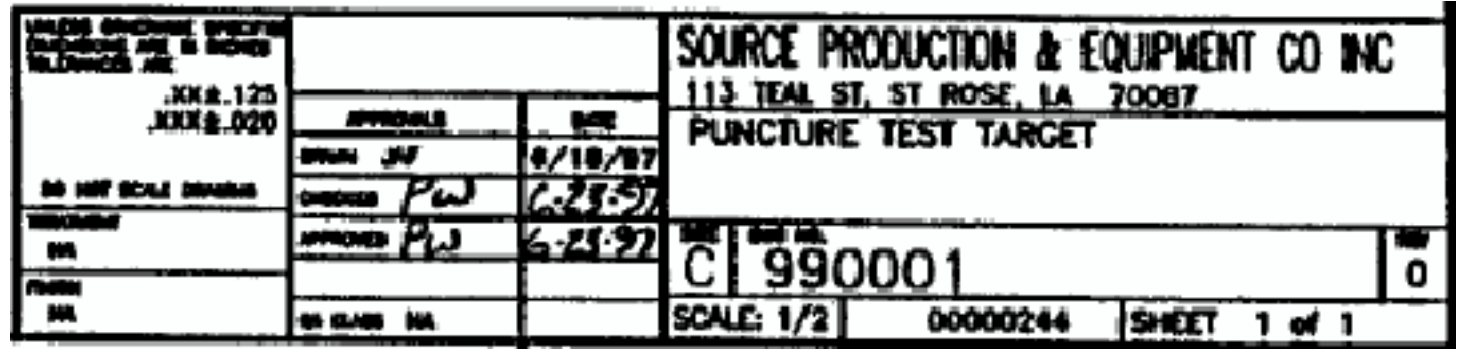


FIGURE WITHHELD UNDER 10 CFR 2.390

SOURCE PRODUCTION & EQUIPMENT CO INC	SIZE C	50890-1	REV 1
	SCALE: 1"=1'	0000243	SHEET 2 of 2

FIGURE WITHHELD UNDER 10 CFR 2.390



Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
July 1, 1997

Appendix 4.2
Test Procedure

Source Production and Equipment Co., Inc.

10 CFR 71.73 Hypothetical Accident Conditions Tests

Test Data Revision (0)

June 29, 1997

1.0 Test Purpose:

To verify past Hypothetical Accident Conditions Puncture Tests on the Models SPEC-150, SPEC-2T and C-1 Type B (U) Shipping Packages.

2.0 Scope: Type B (U) Packages to be Tested:

2.1 Model SPEC-150, C.O.C. #USA/9263/B(U)

2.2. SPEC Model 2-T, C.O.C. #USA/9056/B(U)

2.3. SPEC Model C-1 and Overpack, C.O.C. #USA/9036/B(U)

2.1.1 Test Sequence:

All three of the 30' drop tests will be performed first, followed by the three Puncture Tests. The order is as follows:

<u>30 ft Drop Test:</u>

2.1.1.1 SPEC-150

2.1.1.2 SPEC 2-T

2.1.1.3 SPEC C-1

<u>Puncture Test:</u>

2.1.1.4 SPEC 2-T

2.1.4.5 SPEC C-1

2.1.4.6 SPEC-150

3.0 References:

3.1 10 CFR 71.73; Hypothetical Accident Conditions; Section (c) Tests. Tests for Hypothetical Accident Conditions must be conducted as follows:

(1) Free Drop

(2) Puncture

3.2 10 CFR 71.51; Additional requirements for Type B packages; Section (a)(2)

3.3 IAEA Safety Series No.6, Mechanical Test, Sections (a) and (b)

4.0 Precautions/Limitations:

4.1 Ensure that emergency procedures, equipment and response are in place.

4.2 Less than 20 curie sources will be used for the tests.

Note: It was necessary to increase the curie activity due to availability of sources to 30 curies maximum single source strength.

4.3 Safety glasses must be worn by all personnel in the test area.

4.4 All personnel must be monitored.

5.0 Test and Recording Equipment Required:

5.1 Drop test tower with test targets

5.2 Release mechanism

5.3 Tape measures (50' and 6' minimum)

5.4 Sufficient extension cords for required electrical usage

5.5 Stopwatch

5.6 Freezer with dry ice

5.7 Thermometers (ambient and freezer)

5.8 Lifting wires

5.9 Video cameras

5.10 Photo cameras

6.0 Testing Procedures:

6.1 SPEC-150 9 Meter Pre-test

6.1.1 Install the source into the device.

6.1.2 Record Device and Sealed Source Data: Take photos.

SPEC-150 Serial Number: 500 Weight: 52 lbs.

Source Serial Number: DA2410 Model Number: G-60 Activity/Date: 26 curies 6/25/97

6.1.3 Record radiation levels at the surface of the device and at 1 meter from the device surface in accordance with procedure 7.04 Rev (3).

Radiation levels at the surface of the device:

Top: 16 mR/hr Bottom: 12 mR/hr Left Side: 20 mR/hr Right Side: 14 mR/hr

Outlet End: 10 mR/hr Lock End: 12 mR/hr

Radiation levels at 1 meter from the surface of the device:

Top: .5 mR/hr Bottom: .6 mR/hr Left Side: .7 mR/hr Right Side: .7 mR/hr

Outlet End: .4 mR/hr Lock End: .7 mR/hr

Note: Readings are highest radiation levels at each side for both the surface and 1 meter.

6.1.4 Determine orientation of sample and provide written justification. (See Justification of Package Orientation for 30-foot Drop and Puncture Tests). Attach the drop wire to the device. Verify the orientation at ground level (bottom/right corner at outlet end).

6.1.5 Chill the device:

Put dry ice on bottom (floor) of the freezer.

Place device on top of ice.

Install thermometer inside the device.

Place ice around (in contact with) the device.

Close the freezer and record time.

Date/Time placed in freezer: 6/25/97 9:30 pm (Note: at 9:25 pm, the device temperature was 76.4 F)

Verified by: [signature] Mike Frizell

6.1.6 Verify emergency procedure preparations.

6.2 SPEC-150 9 Meter Drop Test

6.2.1 Record ambient temperature and conditions:

Temperature: 77 F Conditions: Partly cloudy; No wind

Verified by: [signature] Mike Frizell Date/Time: 6/26/97 10:10 am

Note: The test was initially set up at 9:06 am. At 9:20 am it began to rain and the test was postponed. The temperature and conditions of the initial set up was: 88 F Partly cloudy; No wind.

6.2.2 Post surveillance personnel.

6.2.3 Start the video.

6.2.4 Remove the frozen SPEC-150 from the freezer. Take photos.

Record device temperature: -85.6 F Record date/time: 6/26/97 10:12 am

Verified by: [signature] Mike Frizell Date: 6/26/97

Note: The test was initially set up at 9:06 am. The device was taken from the freezer at 9:14 am. At 9:20 am it began to rain. Test was postponed and the device was returned to the freezer. The initial temperature of the device (before postponement of the test) was -103 F.

6.2.5 Record time elapsed from the removal of the device from the freezer to the time of impact.

6.2.6 Attach the device (drop wire) to the release mechanism.

6.2.7 Verify the orientation at ground level (bottom/right corner at outlet end). Take photos.

Orientation verified by: [signature] Mike Frizell Date: 6/26/97

6.2.8 Lift the device to 30 feet (minimum).

6.2.9 Verify the height from the top of the target (steel plate surface) to the lowest point on the device. Take photos.

Height verified by: 30' 4" [signature] Mike Frizell Date: 6/26/97

6.2.10 Drop the device.

6.2.11 Record time elapsed from Step 6.2.5 (above)

Time elapsed: 5 minutes 18 seconds Verified by: [signature] Pete Weber

6.2.12 Perform the safety survey.

6.2.13 Perform preliminary Part 71 survey.

6.3 SPEC-150 9 Meter Post Test

6.3.1 Record the damage.

There was no damage to the drop test target. Verified by: [signature] Mike Frizell

See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the SPEC-150 device.

6.3.2 Weigh the device after the drop test.

Weight: 52 lbs. Verified by: Mike Frizell Date: 6/26/97

6.3.3 Assess the damage to re-evaluate the orientation for the Puncture Test.

Damage Assessed by: Pete Weber Pete Weber Date: 6/26/97

Determine the orientation for the Puncture Test with rational based on damage of the 30' drop test.

Orientation: (See Justification of Package Orientation for 30-foot Drop and Puncture Tests)

Concurrence by: Donny Dicharry Donny Dicharry Date: 6/26/97

6.3.4 Attach the drop wire to the device so that when the device is suspended (hanging) the orientation for the Puncture Test will be on the safety plug at the outlet end of the device.

6.3.5 Verify the orientation at ground level.

6.3.6 Install thermometer inside the device and return the device to the freezer.

Time/Date placed in freezer: 11:00 am 6/26/97 Verified by: Mike Frizell Mike Frizell

Note: The device was placed back in the freezer (after the 30' drop) begin its re-chilling. It was removed from the freezer at 11:50 for damage assessment and returned at 12:23 pm. It was then removed again at 1:00 pm for "rigging" the orientation harness and returned again at 1:15 pm.

6.4 SPEC-2T 9 Meter Pre-test

6.4.1 Install the source into the device.

6.4.2 Record Device and Sealed Source Data:

SPEC-2T Serial Number: 1152 Weight: 53.5 lbs. Take photos.

Source Serial Number: DF2501 Model Number G-3 Activity/Date: 17 curies 6/25/97

6.4.3 Record radiation levels at the surface of the device and at 1 meter in accordance with procedure 7.04 Rev (3).

Radiation levels at the surface of the device:

Top: 12 mR/hr Bottom: 22 mR/hr Left Side: 26 mR/hr Right Side: 18 mR/hr

Outlet End: 10 mR/hr Lock End: 12 mR/hr

Radiation levels at 1 meter from the surface of the device:

Top: .5 mR/hr Bottom: .7 mR/hr Left Side: .6 mR/hr Right Side: .4 mR/hr

Outlet End: .8 mR/hr Lock End: .6 mR/hr

Note: Readings are highest radiation levels at each side for both the surface and 1 meter.

6.4.4 Determine orientation of sample and provide written justification. (See Justification of Package Orientation for 30-foot Drop and Puncture Tests). Attach the drop wire to the device. Verify the orientation at ground level (bottom/right corner at the outlet end).

6.5 SPEC-2T 9 Meter Drop Test

6.5.1 Record ambient temperature and conditions:

Temperature: 78 F Conditions: Cloudy and clearing.

Verified by: Mike Frizell Mike Frizell Date/Time: 6/26/97 10:25 am

6.5.2 Post surveillance personnel.

6.5.3 Ensure that the video is running.

6.5.4 Attach the device (drop wire) to the release mechanism.

6.5.5 Verify the orientation at ground level (bottom/right corner at the outlet end). Take photos.

Orientation verified by: Mike Frizell Date: 6/26/97

6.5.6 Lift the device to 30 feet (minimum).

6.5.7 Verify the height from the top of the target (steel plate surface) to the lowest point on the device. Take photos.

Height verified by: 30' 3" Mike Frizell Date: 6/26/97

6.5.8 Drop the device.

6.5.9 Perform the safety survey.

6.5.10 Perform preliminary Part 71 survey.

6.6 SPEC-2T 9 Meter Post Test

6.6.1 Record the damage.

There was no damage to the drop test target. Verified by: Mike Frizell

See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the SPEC-2T device.

6.6.2 Weigh the device after the drop test.

Weight: 53.5 lbs. Verified by: Mike Frizell Date: 6/26/97

6.6.3 Assess the damage to determine orientation for the puncture test.

Damage Assessed by: Pete Weber Date: 6/26/97

Determine the orientation for the Puncture Test with rational based on damage of the 30' drop test.

Orientation: (See Justification of Package Orientation for 30-foot Drop and Puncture Tests).

Concurrence by: Donny Dicharry Date: 6/26/97

6.6.4 Go to SPEC-2T Puncture Pre-test to begin preparations.

6.7 SPEC C-1 9 Meter Pre-Test

6.7.1 Install the sources into the device.

6.7.2 Record Device and Sealed Sources Data: Take photos.

SPEC-C-1 Serial Number: 283 Weight: C-1 69 lbs. Total with drum: 89 lbs.

Source Serial Number: CL1002 Model Number: T-5 Activity/Date: 19 curies 6/25/97

Source Serial Number: DA0202 Model Number: G-40T Activity/Date: 22 curies 6/25/97

6.7.3 Put the device into the drum.

6.7.4 Install the lid, ring and bolt.

6.7.5 Weigh the total package (C-1 and drum) and take photos.

6.7.6 Total Package Weight: 89 lbs. Verified by: Tommy Ruiz Date: 6/26/97

Note: Scale s/n 2688; Calibrated on 3/26/97; Next due on 9/26/97.

6.7.7 Record radiation levels at the surface of the package (C-1 and drum) and at 1 meter in accordance with procedure 7.04 Rev (3).

Radiation levels at drum surface:

Top 7 mR/hr Bottom 4 mR/hr Side: Quadrant A 10 mR/hr Quadrant B 7.2 mR/hr
Quadrant C 6 mR/hr Quadrant D 7.8 mR/hr

Radiation levels at 1 meter from the surface of the drum:

Top .4 mR/hr Bottom .2 mR/hr Side: Quadrant A .6 mR/hr Quadrant B .4 mR/hr
Quadrant C .6 mR/hr Quadrant D .6 mR/hr

Note: Readings are highest radiation levels at each side for both the surface and 1 meter.

6.7.8 Determine orientation of sample and provide written justification. . (See Justification of Package Orientation for 30-foot Drop and Puncture Tests). Attach the drop wire to the device. Verify the orientation at ground level (flat on top of drum).

6.8 SPEC C-1 9 Meter Drop Test

6.8.1 Record ambient temperature and conditions:

Temperature: 80 F Conditions: Partly cloudy and clearing. No wind.

Verified by: Mike Frizell Date/Time: 6/26/97 10:42 am

6.8.2 Post surveillance personnel

6.8.3 Ensure that the video is running.

6.8.4 Attach the package (drop wire) to the release mechanism.

6.8.5 Verify the orientation at ground level (flat on top of drum). Take photos.

Orientation verified by: Mike Frizell Date: 6/26/97

6.8.6 Lift the package to 30 feet (minimum).

6.8.7 Verify the height from the top of the target (steel plate surface) to the lowest point on the device. Take photos.

Height verified by: 30' 7" Mike Frizell Date: 6/26/97

6.8.8 Drop the package.

6.8.9 Perform the safety survey.

6.8.10 Perform the preliminary Part 71 survey.

6.9 SPEC C-1 9 Meter Post Test

6.9.1 Record the damage.

There was no damage to the drop test target. Verified by: Mike Frizell

See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the package (C-1 and drum).

6.9.2 Weigh the package after the drop test.

Weight: 88.5 lbs. Verified by: Mike Frizell Date: 6/26/97

6.9.3 Assess the damage to re-evaluate the orientation for the puncture test.

Damage Assessed by: Pete Weber Date: 6/26/97

Determine the orientation for the Puncture Test with rational based on damage of the 30' drop test.

Orientation: (See Justification of Package Orientation for 30-foot Drop and Puncture Tests). (Impact on plunger knobs).

Concurrence by: Donny Dicharry Date: 6/26/97

6.9.4 Go to SPEC C-1 Puncture Pre-test to begin preparations.

6.10 SPEC-2T Puncture Pre-test

6.10.1 Attach the drop wire to the package and confirm the orientation at ground level.

Verified by: Not needed. This is only the pre-test step. Verification of orientation is required at the drop test step. Date: 6/26/97

6.10.2 Install Puncture Test pin to the steel test pad.

6.10.3 Verify that the pin is rigidly mounted to prevent lateral movement or tipping of the pin caused by the device dropping on the pin.

Verified by: Mike Frizell Mike Frizell Date: 6/26/97 11:35 am

6.11 SPEC-2T Puncture Test

6.11.1 Record ambient temperature and conditions:

Temperature: 86 F Conditions: Cloudy

Verified by: Mike Frizell Mike Frizell Date/Time: 2:00 pm (est.) 6/26/97

6.11.2 Ensure that the video is running.

6.11.3 Attach the device (drop wire) to the release mechanism.

6.11.4 Verify the orientation at pin level (impact on safety plug). Take photos.

Orientation verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.11.5 Lift the device to 1 meter (minimum).

6.11.6 Verify height from the top surface of the pin to the lowest point on the device. Take photos.

Height verified by: 40.5" Mike Frizell Mike Frizell Date: 6/26/97

6.11.7 Drop the device.

6.11.8 Perform the safety survey.

6.11.9 Perform preliminary Part 71 survey.

6.11.10 Perform the wipe test.

Wipe CPM: 47 Background: 52 CPM uci. < .0002 uci.

Wipe test performed by: Steve Punch Steve Punch Date: 6/26/97

6.12 SPEC 2-T Puncture Post Test

6.12.1 Record the damage.

See Post Test Damage Assessment Report, Form OA 11.4, Rev (0) for damage assessment of the device.

Verified by: Mike Frizell Mike Frizell

6.12.2 Weigh the device after the Puncture Test.

Weight (Puncture Test #1 53 lbs., Verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.12.3 Test performed by: Kenneth D. Lamm Jr. Steve Punch Joseph A. Tiger

6.12.4 Test Assessment: Describe damage, weight , dose rate and all other pertinent descriptions and information.

Comments: See Post Test Damage Assessment Report, Form OA 11.4, Rev (0) for damage assessment of the device.

6.12.5 Assessment by: Kenny Carrington Kenny Carrington Date: 6/26/97

6.12.6 Test Approval:

President _____ Date: 6/26/97

QA Manager _____ Date: 6/26/97

6.13 SPEC C-1 Puncture Pre-test

6.13.1 Attach the drop wire to the device (C-1 without drum) and confirm the orientation at ground level. (Note: The C-1 container must remain placed inside the overpack (drum) for the Puncture Test).

This was revised after the 30' drop damage assessment. The C-1 was Puncture Tested as a stand alone package without the overpack drum. The point of impact determined was on the impact on plunger knobs.

Note: The information in 6.14U is relative to the Unplanned Test of the SPEC C-1 where setup procedures for the test were established. 6.14U was not included in the initial test procedure. The "U" designates "Unplanned"

6.14U UNPLANNED TEST SPEC C-1 Puncture Test

Description: C-1 serial number 88; Stand alone; No drum overpack
Weight: 67 lbs. (plus added 5 3/4 lb. lead weight; Total 72 3/4 lbs.
Point of Impact: On the Plunger Knobs

6.14u.1 Record ambient temperature and conditions:

Temperature: n/a Conditions: n/a

Verified by: n/a Mike Frizell Date/Time: n/a

6.14u.2 Inspect pin and drop target. Verify that the drop target and pin have not moved as a result of the previous test.

(Note: There was no previous Puncture Test in which to verify that the target and pin did not move as a result of a previous test. The pin was inspected prior to the Puncture Test of C-1 #88. This purpose of this test (puncture of #88) was to determine the setup and procedure for the test (since this point of impact had never been selected or performed in previous tests). This pre-determination was prompted by the damage assessment of the 30' drop test. The pin was then re-inspected prior to the following Puncture Test for C-1 serial number 283.

Verified by: n/a Mike Frizell Date: n/a

6.14u.3 Ensure that the video is running.

n/a. Unplanned test.

6.14u.4 Attach the package (drop wire) to the release mechanism.

6.14u.5 Verify the orientation at pin level (impact on plunger knobs). Take photos.

Orientation verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.14u.6 Lift the package to 1 meter (minimum).

6.14u.7 Verify height from the top surface of the pin to the lowest point on the package. Take photos.

Height verified by: 40.250" Mike Frizell Date: 6/26/97

Note: Measurement was taken from the lowest part of the package, not from the plunger knobs.

6.14u.8 Drop the package.

6.14u.9 Perform the safety survey.

N/A. Dummy sources were installed in the C-1 #88

6.14u.10 Perform the preliminary part 71 survey.

N/A. Dummy sources were installed in the C-1 #88

6.14u.11 Perform the wipe test.

Wipe CPM: n/a Background: n/a uci: n/a

Leak test performed by: N/A. Steve Punch Date: n/a

KC STEVE PUNCH INADVERTENTLY SIGNED THIS BLANK. 8/18/97 KC

6.14 SPEC-C-1 Puncture Test (Planned Test C-1 #283)

6.14.1 Record ambient temperature and conditions:

Temperature: 86 F Conditions: Cloudy; Winds at approximately 5 mph

Verified by: Mike Frizell Date/Time: 1:45 pm (est.) 6/26/97

6.14.2 Inspect pin and drop target. Verify that the drop target and pin have not moved as a result of the previous test.

Verified by: Mike Frizell Date: 6/26/97 1:35 pm

6.14.3 Ensure that the video is running.

6.14.4 Attach the package (drop wire) to the release mechanism.

6.14.5 Verify the orientation at pin level (impact on plunger knobs). Take photos.

Orientation verified by: Mike Frizell Date: 6/26/97

6.14.6 Lift the package to 1 meter (minimum).

6.14.7 Verify height from the top surface of the pin to the lowest point on the package. Take photos.

Height verified by: 40.250" Mike Frizell Date: 6/26/97

Note: Measurement was taken from the lowest part of the package, not from the plunger knobs.

6.14.8 Drop the package.

6.14.9 Perform the safety survey.

6.14.10 Perform the preliminary part 71 survey.

6.14.11 Perform the wipe test.

Wipe CPM: 48 Background: 52 CPM uci: <.0002 uci.

Leak test performed by: Steve Punch Date: 6/26/97

6.15 SPEC C-1 Puncture Post Test

6.15.1 Record the damage.

See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the device (C-1, stand alone; No drum).

Verified by: Mike Frizell

6.15.2 Weigh the device after the Puncture Test.

Weight: 68.5 lbs (C-1 container only: No drum). Verified by: Mike Frizell Date: 6/26/97

6.15.3 Test performed by:

6.15.4 Test Assessment: Describe damage, weight , dose rate and all other pertinent descriptions and information.

Comments: See Post Test Damage Assessment Report. Form QA 11.4. Rev (0) for damage assessment of the device (C-1, stand alone: No drum)

6.15.5 Assessment by: Kenny Carrington Date: 6/26/97

6.15.6 Test Approval:

President Date: 6/26/97

QA Manager Date: 6/26/97

6.16 SPEC-150 Puncture Pre-test

6.16.1 None. All Pre-test arrangements were performed at the 9 meter post test to allow the device to be re-installed into the freezer.

6.17 SPEC 150 Puncture Test Number One (Planned Test)

6.17.1 Record ambient temperature and conditions:

Temperature: 82 F Conditions: Cloudy: No wind.

Verified by: Mike Frizell Date/Time: 2:30 pm (est.) 6/26/97

6.17.2 Inspect pin and drop target. Verify that the drop target and pin have not moved as a result of the previous test.

Verified by: Mike Frizell Date: 6/26/97

6.17.3 Ensure that video is running.

6.17.4 Remove the device from the freezer.

Record device temperature: -32.8 F Record date/time: 6/26/97 2:12 pm

Verified by: Mike Frizell Date: 6/26/97

6.17.5 Record time elapsed from the removal of the device from the freezer to the time of impact.

6.17.6 Attach the device (drop wire) to the release mechanism.

6.17.7 Verify the orientation at pin level (impact on safety plug). Take photos.

Orientation verified by: Mike Frizell Date: 6/26/97

6.17.8 Lift the device to 1 meter (minimum).

6.18.9 Verify height from the top surface of the pin to the lowest point on the device. Take photos.

Height verified by: 40.250" Mike Frizell Date: 6/26/97

6.17.10 Drop the device.

6.17.11 Record elapsed time from step 6.17.5 (above)

Time elapsed: 11 minutes 11 seconds Verified by: Pete Weber

6.17.12 Perform the safety survey.

6.17.13 Perform the preliminary Part 71 survey.

6.17.14 Perform the wipe test.

Wipe CPM: 52 Background: 52 CPM uci. <.0002 uci.

Leak test performed by: Steve Punch Steve Punch Date: 6/26/97

UNPLANNED TEST SPEC 150 Puncture Test Number Two

6.17.15 Inspect pin and drop target. Verify that the drop target and pin have not moved as a result of the previous test.

Verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.16 Ensure that video is running.

6.17.17 Attach the device (drop wire) to the release mechanism.

6.17.18 Verify the orientation at pin level (right side). Take photos.

Orientation verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.19 Lift the device to 1 meter (minimum).

6.17.20 Verify height from the top surface of the pin to the lowest point on the device. Take photos.

Height verified by: 40.250" Mike Frizell Mike Frizell Date: 6/26/97

6.17.21 Drop the device.

6.17.22 Perform the safety survey.

6.17.23 Weigh the device after the drop.

Weight: 52 lbs. Verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.24 Perform the wipe test.

Wipe CPM: 64 Background: 52 CPM uci. <.0002 uci.

Leak test performed by: Steve Punch Steve Punch Date: 6/26/97

UNPLANNED TEST SPEC 150 Puncture Test Number Three

6.17.25 Inspect pin and drop target. Verify that the drop target and pin have not moved as a result of the previous test.

Verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.26 Ensure that video is running.

6.17.27 Attach the device (drop wire) to the release mechanism.

6.17.28 Verify the orientation at pin level (directly on lock cap). Take photos.

Orientation verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.29 Lift the device to 1 meter (minimum).

6.17.30 Verify height from the top surface of the pin to the lowest point on the device. Take photos.

Height verified by: 40.250" Mike Frizell Mike Frizell Date: 6/26/97

6.17.31 Drop the device.

6.17.32 Perform the safety survey.

6.17.33 Weigh the device after the second Puncture Test drop.

Puncture #2 Weight: 52 lbs. Verified by: Mike Frizell Mike Frizell Date: 6/26/97

6.17.34 Perform the wipe test.

Wipe CPM: 52 Background: 52 CPM uci. <.0002 uci.

Leak test performed by: Steve Punch Steve Punch Date: 6/26/97

6.18 SPEC-150 Puncture Post Test

6.18.1 Record the damage.

See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the device.

Verified by: Mike Frizell

6.18.2 Weigh the device after the third Puncture Test drop.

Puncture #3 Weight: 52 lbs. Verified by: Mike Frizell Date: 6/26/97

Scale serial number: 2697

6.18.3 Test performed by:

6.18.4 Test Assessment: Describe damage, weight, dose rate and all other pertinent descriptions and information.

Comments: See Post Test Damage Assessment Report, Form QA 11.4, Rev (0) for damage assessment of the device.

6.18.5 Assessment by: Kenny Carrington Date: 6/27/97

6.18.6 Test Approval:

President Date: 6/27/97

QA Manager Date: 6/27/97

6.19 Package Test Certification

6.19.1 This is to certify that the preparations and tests for both the 30' Drop Test and the Puncture Test were performed in accordance with this procedure.

SPEC-150:	President		Date 6/27/97
	QA Manager		Date 6/27/97
SPEC-2T:	President		Date 6/27/97
	QA Manager		Date 6/27/97
SPEC C-1:	President		Date 6/27/97
	QA Manager		Date 6/27/97

6.20 Prepare Test Report

H:\PROJECTS\RETEST\PUNCDATA.WPD

Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
July 1, 1997

Appendix 4.3
Survey Procedure 7.04, Rev (3)

PROCEDURE

7.04 TESTING SURVEY PROCEDURE

Prepared By: Joe Fryer

APPROVAL

Kenny Carrington, Test Coordinator 6/25/97

Pete Weber, General Manager 6/25/97

Steve Punch, Asst. Radiation Safety Officer 6-25-97

Mike Frizell, Quality Assurance Manager 6/25/97

Revision: (3) 06/25/97

Source Production & Equipment Company, Inc.
113 Teal Street, St. Rose, LA 70087

Rev No.	Revision	Revised By/Date	Checked By/Date
0	Initial Procedure	JF 06/23/97	KC 06/25/97

QUALITY ASSURANCE PROGRAM
PROCEDURE, INSTRUCTION AND SPECIAL PROCESS
DOCUMENT CHANGE EVALUATION RECORD

Document Name: TESTING SURVEY PROCEDURE

QA Document 7.04 Prepared By: J. FRYER

Description of Change Requested: INITIAL RELEASE.

Reason for Change Requested: CREATED FOR PACKAGE TESTING

Review Conducted By K. CARRINGTON / M. FRIZELL Date: 6 25 97

Does this change conflict with the QA Program?

Yes_____ No ✓ QA Manager C. Ken Fryer Date _____

Document Review Recommendation: [✓] Approve [ ] Reject [ ] Amend

Comments: _____

Change Authorization Signature: _____ Date: _____

Document Revision Number: _____ DOcument Effective Date: _____

Docuemnt Approval Signature: _____ Date: _____

Distribution: Form QA 6.1 Revised: _____ Date: _____

Dept: _____ Initials: _____ Date: _____

Dept: _____ Initials: _____ Date: _____

Dept: _____ Initials: _____ Date: _____

NOTE: Initial to verify receipt, indoctrination and understanding of the revised document. As applicable, the document must remain available for use at the appropiate work station(s).

Distribution Complete: _____ Date: _____

PROCEDURE
7.04 TESTING SURVEY PROCEDURE
Revision (3)

1.0 Purpose:

To define the radiation survey of packages and safety procedures for use during testing of Type B packages for Normal Conditions of Transport (10CFR71.71) and Hypothetical Accident Conditions (10CFR71.73) tests.

2.0 Scope

This procedure applies to all potentially destructive tests performed during the testing of existing Type B packages or prototype packages for Type B status. These tests may include:

2.1 10CFR71.71(c)(7) Free Drop (1.2 m)
2.2 10CFR71.71(c)(8) Corner Drop (wood or fiberboard packages)
2.3 10CFR71.71(c)(9) Compression
2.4 10CFR71.71(c)(10) Penetration
2.5 10CFR71.73(c)(1) Free drop (30 m)
2.6 10CFR71.73(c)(2) Puncture

3.0 References

3.1 SPEC Procedure 6.09 Radiation Emergency Procedure
3.2 SPEC Procedure 6.10 Survey Meter Calibration
3.3 10 CFR Part 71 sections .51, .71, .73

4.0 Definitions/Acronyms

4.1 CFR Code of Federal Regulations
4.2 RSO Radiation Safety Officer

5.0 Requirements

5.1 Equipment

5.1.1 Calibrated and properly operating survey meter (with remote probe)
5.1.2 One meter stick, QA controlled
5.1.5 Permanent marker
5.1.6 Safety Glasses

5.2 Documentation

5.2.1 QA 12.1.1 Survey Instrument Calibration Certificate
5.2.2 Test Package Radiation Survey Report (Attachment #1)
5.2.3 Procedure 6.09; Radiation Emergency Response

6.0 Safety

6.1 Potential Hazards

6.1.1 High Radiation

Since these tests are potentially destructive and designed to verify package integrity,

6.1.1.1 The area shall be considered as a high radiation area after each test until otherwise demonstrated.
6.1.1.2 All non-essential personnel shall be removed from the area prior to executing each test.
6.1.1.3 All essential personnel must be monitored with a dosimeter and a TLD or film badge.
6.1.1.4 Procedure #6.09, Radiation Emergency Procedure, with all requirements (i.e. handling equipment, survey meters, response, etc) must be in effect.
6.1.1.5 The RSO or his assistant or designate will be responsible for implementation of the procedure, if necessary. All individuals with responsibility in the emergency response will be familiar with the procedure commensurate with their involvement in the action.

6.1.2 Flying Debris

6.1.2.1 All personnel must stand clear during impacts because of the potential of flying debris.
6.1.2.2 Safety glasses must be worn by all personnel in the test area during the drop tests.

7.0 Procedure

7.1 Pretest:

7.1.1 Record the following data on the Test Package Survey Report in the appropriate sections:

Date
Test Performed

Package Description
Package Model & Serial Number(s)
Radionuclide
Source Model & Serial Number
Source Activity
Survey Meter Mfg, Model & Serial Number(s)
Time test was executed (for calculation purposes if needed)

7.1.2 Locate the highest radiation level at the surface for each side of the test package using the sealed source assembly that will be installed for the test. Make a written note if the probe was flush against the surface of the device or if it was necessary to position the probe (detector) away from the surface due to the configuration of the detector holder.

7.1.3 Mark each surface of the package at the EXACT location of the highest reading. Trace the outline of the probe on the package in order to relocate its exact location after the test is performed.

7.1.4 For cylindrical packages, mark each quadrant at the location of the highest reading. Trace the outline of the probe on the package in order to relocate its exact location after the test is performed

7.1.5 Assign each reference mark a unique alphabetical designation.

7.1.6 Record the highest radiation level found for each reference mark in the "Initial" column for Surface Survey on the Test Package Radiation Survey Report Form (Attachment# 1). The levels recorded will be the actual (uncorrected) radiation readings.

7.1.7 Once the highest radiation level is located (and recorded) at the surface of the package, determine the highest radiation level at one meter extending outward from THAT SURFACE POINT by projecting the radiation "beam" from the point on the surface to the sealed source inside the package. (The one meter stick will facilitate easier survey method).

7.1.8 Record the one meter readings in the "Initial" column for One Meter Survey on the Test Package Radiation Survey Report Form (Attachment# 1). The levels recorded will be the actual (uncorrected) radiation readings.

7.1.9 For recessed areas of the packages (i.e. SPEC-2T and SPEC-150 outlet and lock ends), record surface and one meter readings using the end of the flanges as the surface. Mark the end plate (inside the flange) as the reference point.

7.1.10 In addition to the highest radiation level measured at the surface of the package, select two random points, uniformly spaced, and measure the radiation level at these randomly selected points. Mark and record their locations and levels as described in section 7.1.3, 7.1.5 7.1.6. (Note: it is not intended to locate any particular range of levels, only what the level is. This will be used after the drop test to determine if any changes in shield or source location has occurred).

7.1.11 Photograph each surface of the marked up package.

7.2 Post test:

7.2.1 Designate one individual of the test team to be responsible for performing the safety survey after each drop test. The individual shall be trained in the operation of survey meters and survey procedures. After each destructive test is performed, only the survey meter operator may approach the test package until the safety survey of the test site is completed.

7.2.2 Immediately (or within seconds) after the test package impacts the target, the survey meter operator is to begin a safety survey of the test site. No other personnel are to advance toward the test package until the area safety survey is complete. After a preliminary determination of the site radiation level, the survey meter operator may request assistance (if necessary) in rotating the package from its resting position in order to survey the surface in contact with the ground. The assistant shall leave the immediate area after the package has been rotated. The survey meter operator will then re-survey the test site. If the radiation levels in the test site area are below 100 mR/hr up to a distance of 1 meter from the package the area is determined to be "all clear".

7.2.4 If the radiation level exceeds 100 mR/hr within 32' of the package, a radiation emergency response shall be implemented and controlled by the RSO. All tests will be discontinued until all radiation levels are deemed safe by the RSO. (Note: an unshielded 20 curie source at 32' provides a dose rate of 100 mR/hr).

7.2.5 When the "all clear" signal is given the package may be moved for damage assessments, photographs, etc. and final survey profiles.

7.2.6 The survey meter operator will resurvey the package at each of the reference marks identified in steps 7.1.3 and 7.1.4 and record in the "Final" column on the Surface Survey section on the Test Package Radiation Survey Report Form (Attachment# 1). . The survey meter must be held on each point in the same orientation as the initial survey. Enter the actual (uncorrected) radiation levels found for each reference mark on the survey report for the surface locations.

7.2.7 Record the highest radiation levels of each side of the package at one meter and record in the "Final" column on the One Meter Survey section on the Test Package Radiation Survey Report Form (Attachment# 1). Readings are the actual (uncorrected) radiation levels.

8.0 Documentation

8.1 Test Package Radiation Survey Report (Attachment #1)

SOURCE PRODUCTION & EQUIPMENT

TEST PACKAGE SURVEY REPORT

TEST PERFORMED: _____ DATE: _____

PACKAGE: _____ MODEL# _____ SERIAL # _____

SOURCE: _____ ACTIVITY: _____ MODEL# _____ SERIAL # _____

SURVEY METER(1): _____ MODEL# _____ SERIAL # _____

SURVEY METER(2): _____ MODEL# _____ SERIAL # _____

METER(1) CALIBRATION(Q/A): _____ METER(2) CALIBRATION(Q/A): _____

SURVEY METER OPERATOR: _____ TRAINING VERIFIED(Q/A): _____

HIGH RADIATION AREA: _____ (FT RADIUS FROM TARGET) VERIFICATION OF ABOVE(Q/A): _____

TIME OF EXECUTION: _____ TIME AREA SURVEY COMPLETE: _____

NOTE: READINGS ARE ACTUAL (UNCORRECTED) RADIATION LEVELS.

SURFACE SURVEY			
LOCATION	INITIAL(MR/HR)	FINAL(MR/HR)	CHANGE
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
K			
L			
M			

1 METER SURVEY			
LOCATION	INITIAL(MR/HR)	FINAL(MR/HR))	CHANGE
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
K			
L			
M			

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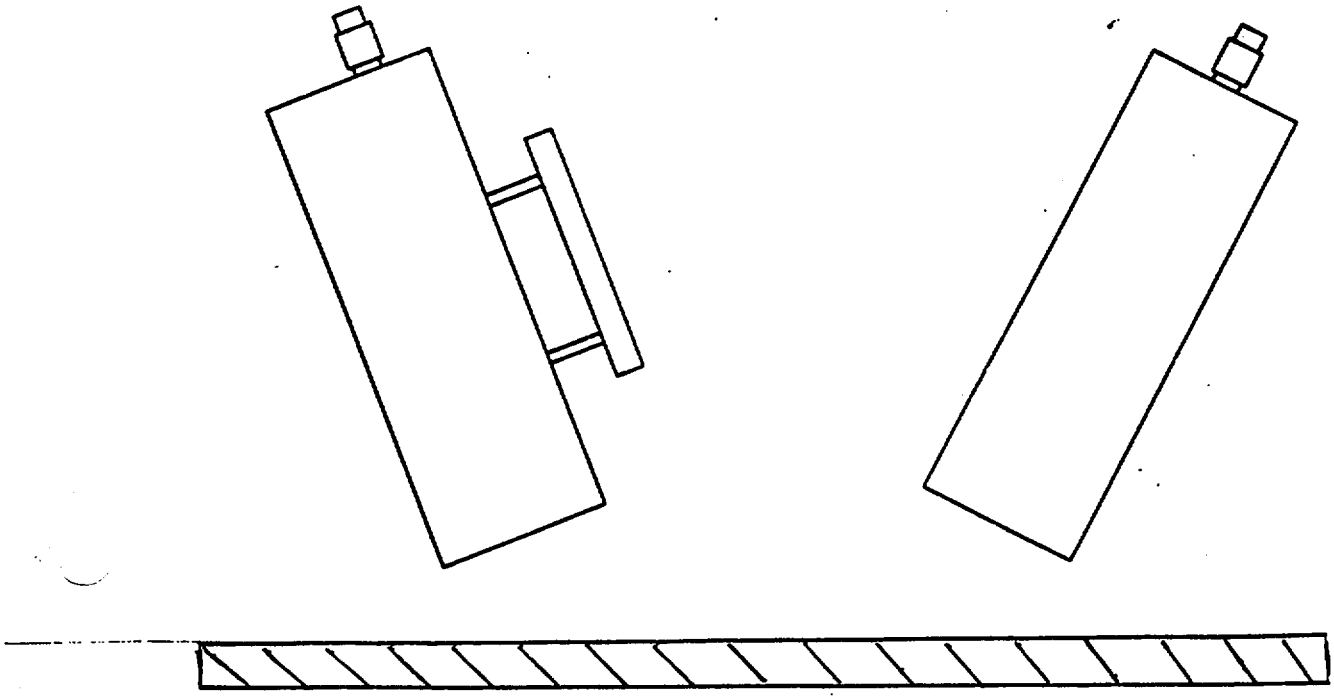
July 1, 1997

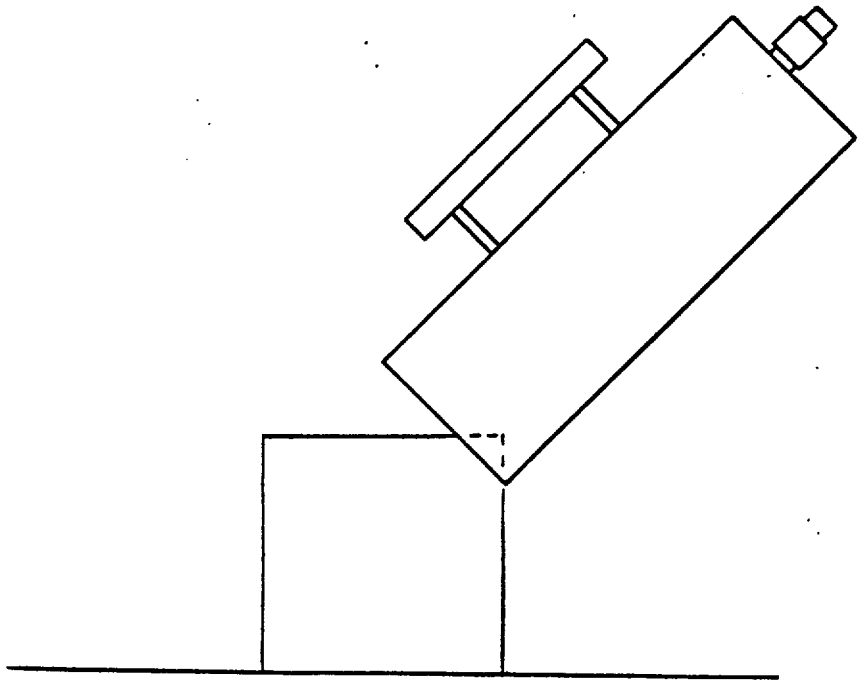
Appendix 4.4
Sketches of Orientations

Free Drop and Puncture

SPEC 2T Serial Number 1152
30' Drop Test 6/26/97
Point of Impact: Right/Bottom Corner at Outlet End



SPEC 2-T Serial Number 1152
Puncture Test 6/26/97
Point of Impact: Safety Plug



Test Report to Validate Previous 10 CFR Part 71 Puncture Tests
July 1, 1997

Appendix 4.5
SPEC 2-T Package Drawings

FIGURE WITHHELD UNDER 10 CFR 2.390

'A

SOURCE PRODUCTION & EQUIPMENT CO., INC.		
SCALE: NONE	APPROVED BY:	DRAWN BY: GMS
DATE: 12/6/88		REVISED: 12/31/91
SPEC MODEL 2-T EXPOSURE DEVICE		
		DRAWING NUMBER 12688-1 REV (2)

FIGURE WITHHELD UNDER 10 CFR 2.390

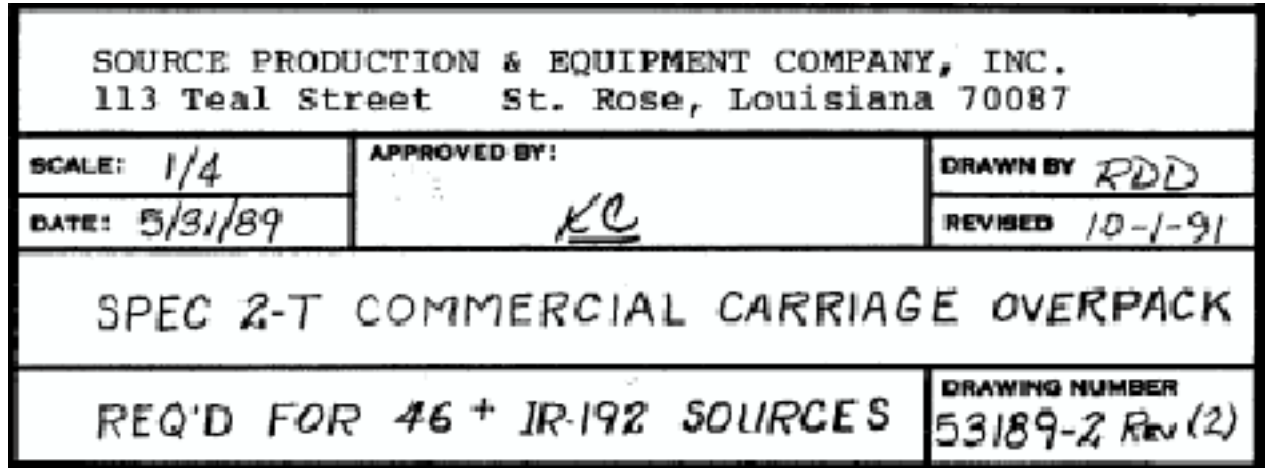


FIGURE WITHHELD UNDER 10 CFR 2.390

SOURCE PRODUCTION & EQUIPMENT CO., INC.		
SCALE: NONE	APPROVED BY:	DRAWN BY: GMS
DATE: 2-2-91		REVISED: 4/5/94
MODEL SPEC 2-T		
DEPLETED URANIUM SHIELD		DRAWING NUMBER 788-1 REV (4)

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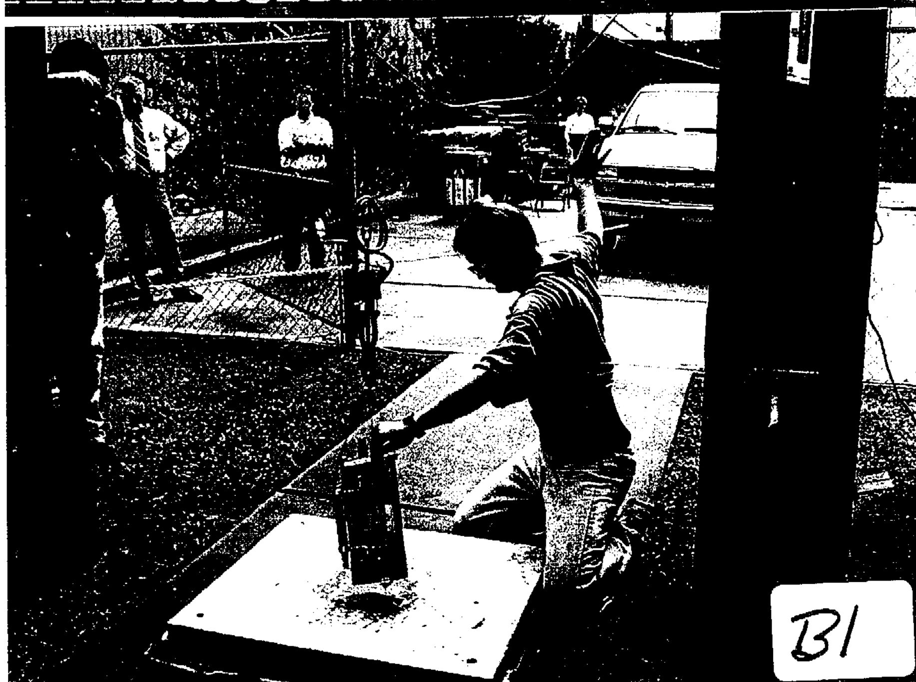
July 1, 1997

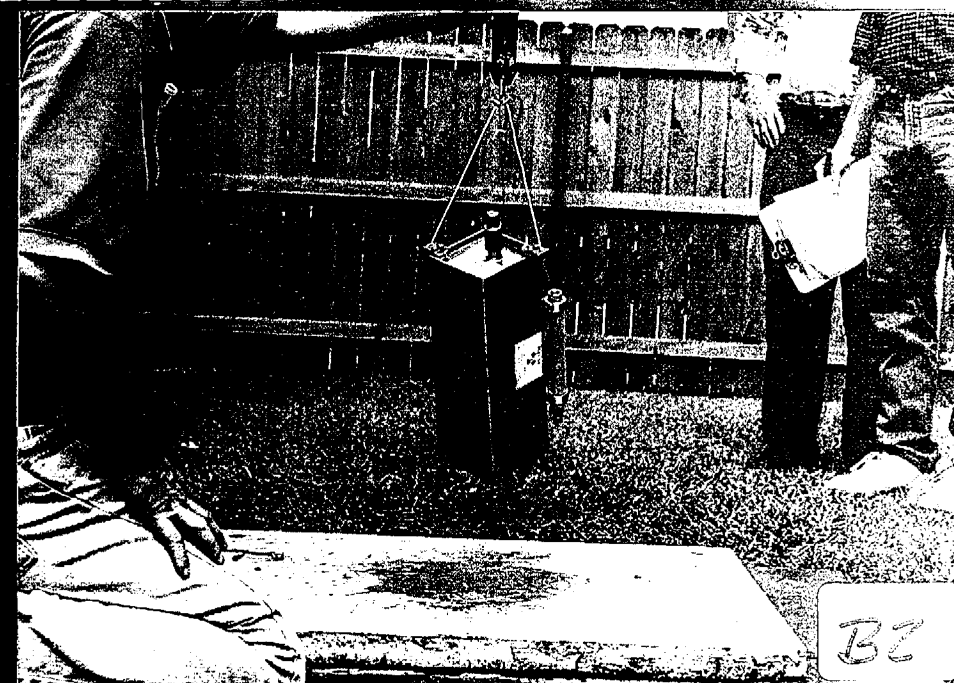
Appendix 4.6
Photographs

Appendix 4.6 - Photos

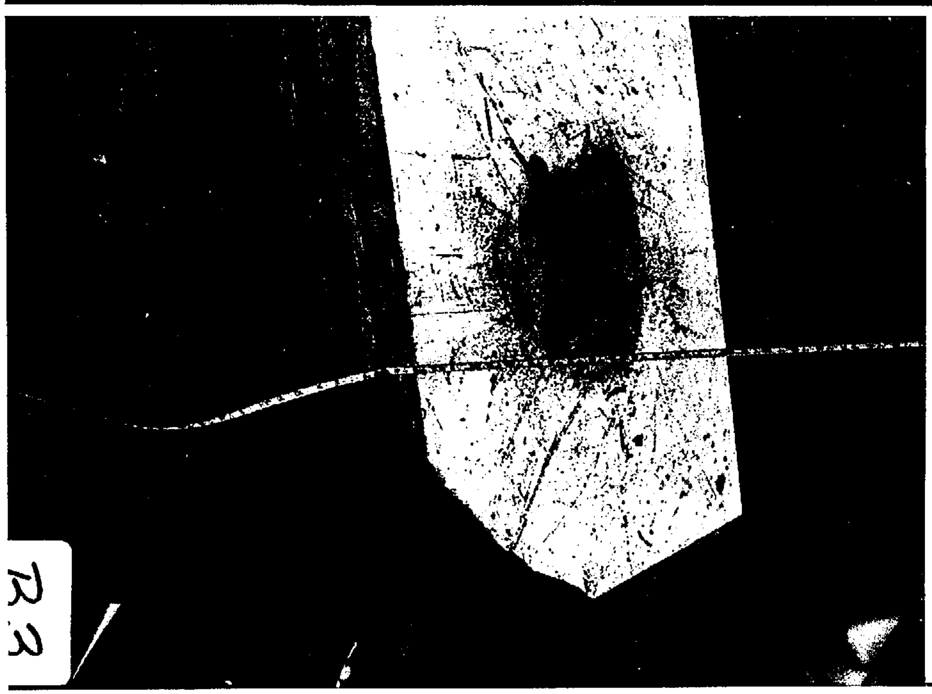
Photo	Description
	SPEC 2-T Tests
B1	Before 30-foot drop, Height Check
B2	Before 30-foot drop, Orientation
B3	Before 30-foot drop, Orientation
B4	After 30-foot drop, Damage
B5	After 30-foot drop, Damage, Safety plug
B6	After 30-foot drop, Damage, Outlet Nipple
B7	After 30-foot drop, Damage, Corner Flange
B8	After 30-foot drop, Damage, Right Side
B9	After 30-foot drop, Damage, Bottom
B10	Before Puncture Test - Orientation, Safety Plug
B11	Before Puncture Test - Height Check
B12	Puncture Test - Instant of Impact
B13	After Puncture Test - Damage, Puncture Pin
B14	After Puncture Test - Safety Plug



B1



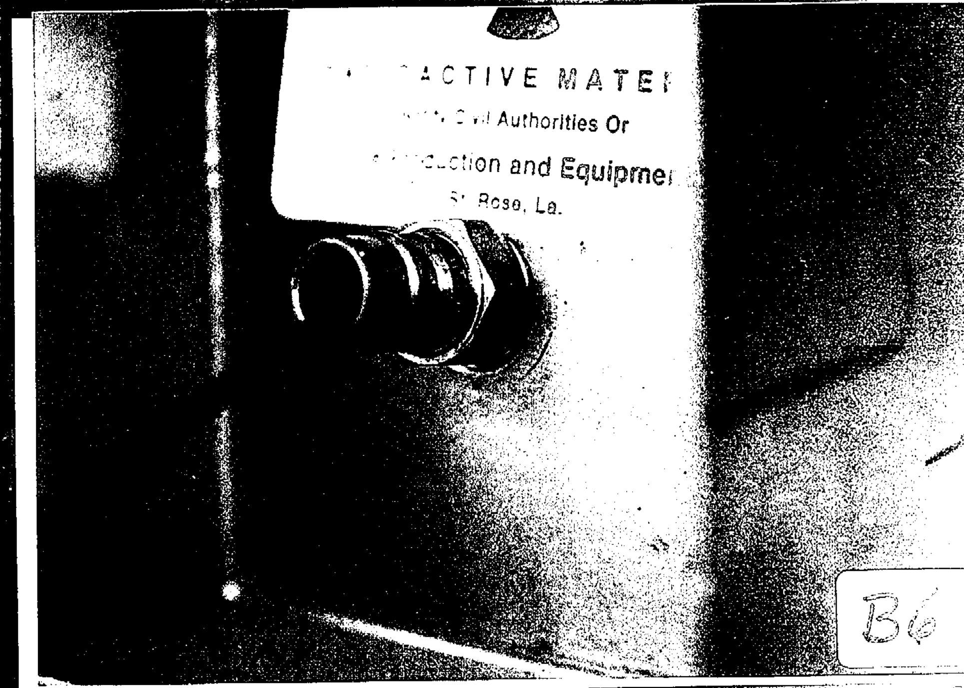
B2



B3

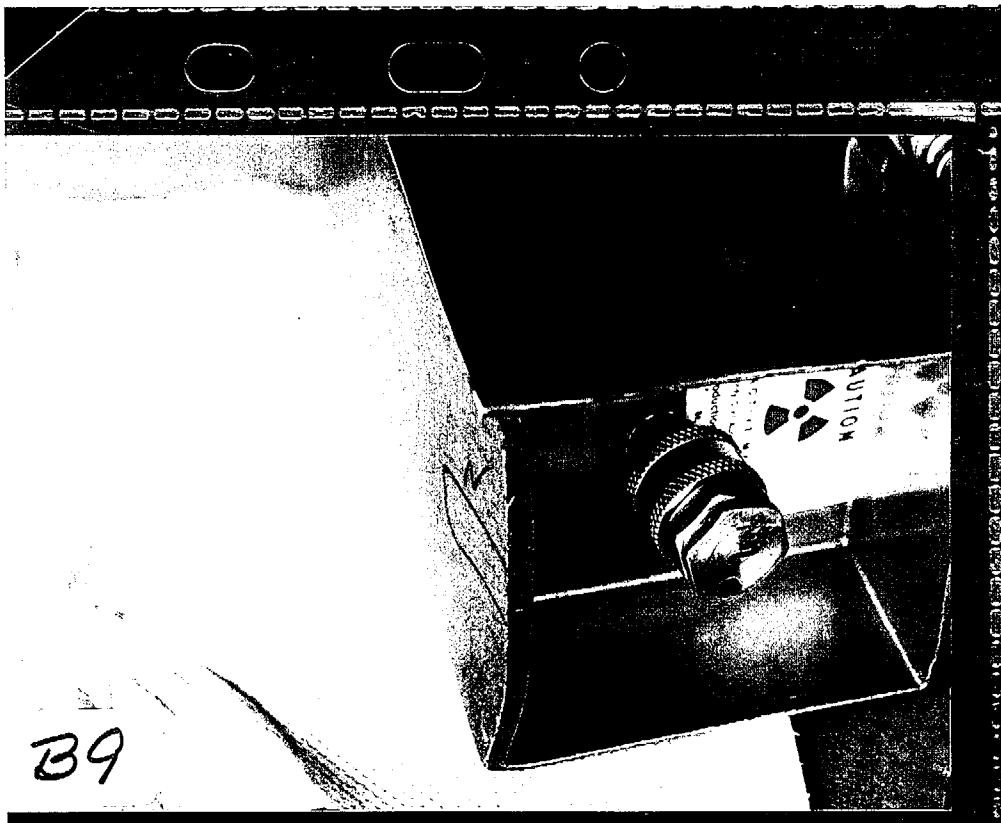
B4

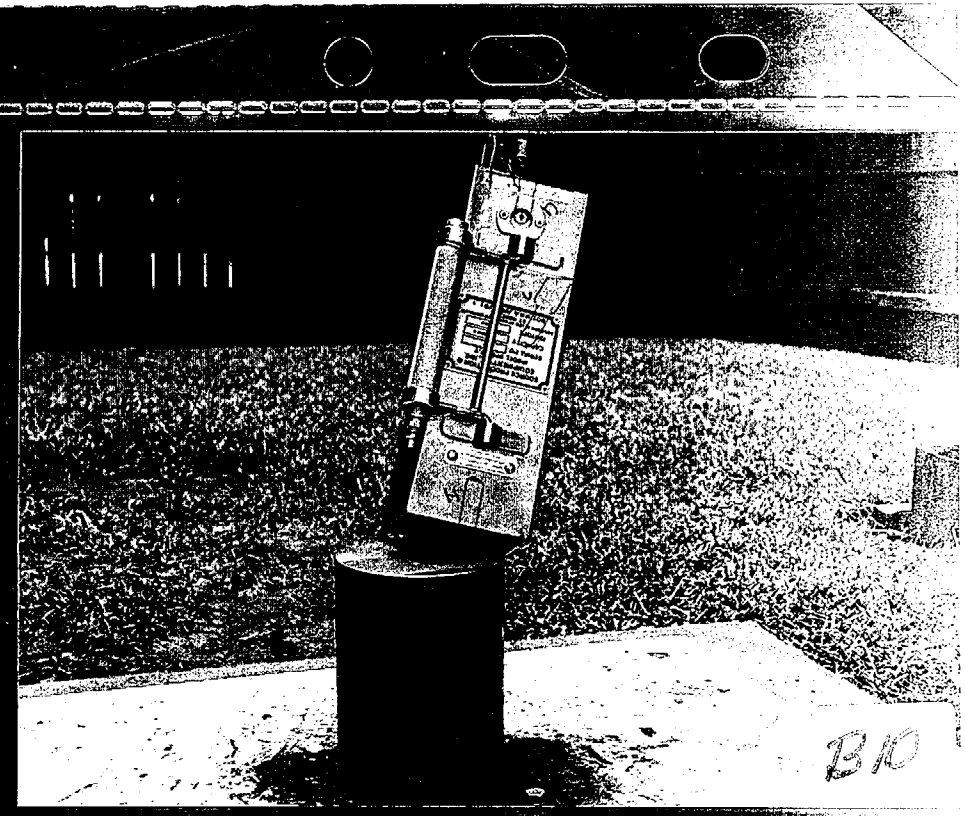

B5


ACTIVE MATE
Authorities Or
and Equipme
Rose, La.
B6


B7

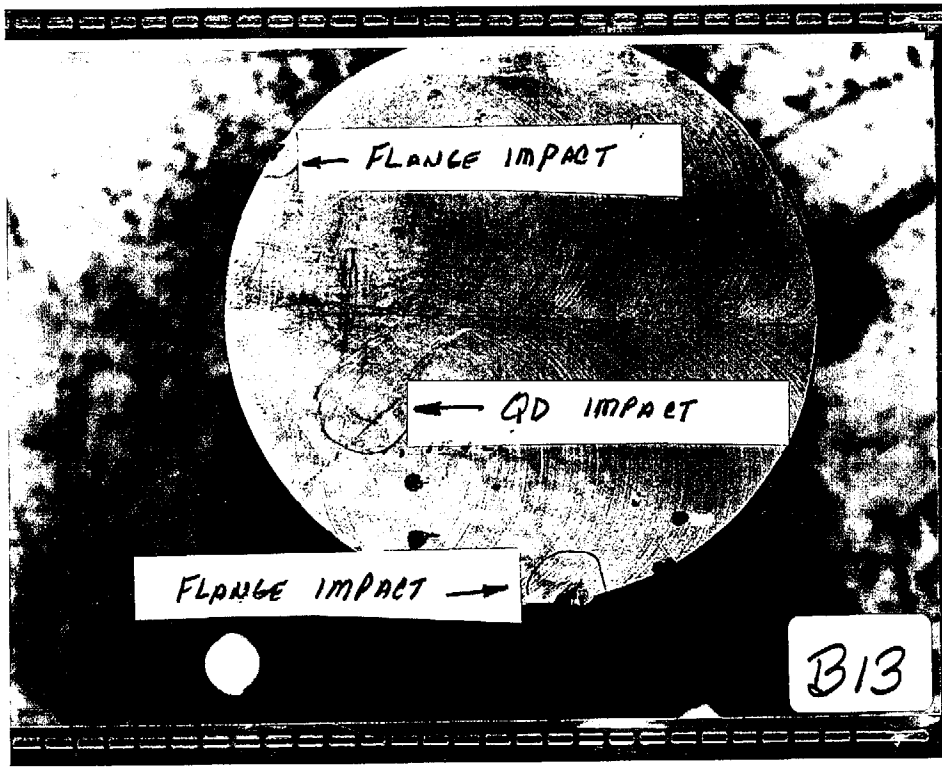

SOURCE PRO
EQUIPMENT
MODEL
SERIAL NO.
CAPACITY
ISOTOPE
ST. ROSE
DOT/U.S.A./
B8

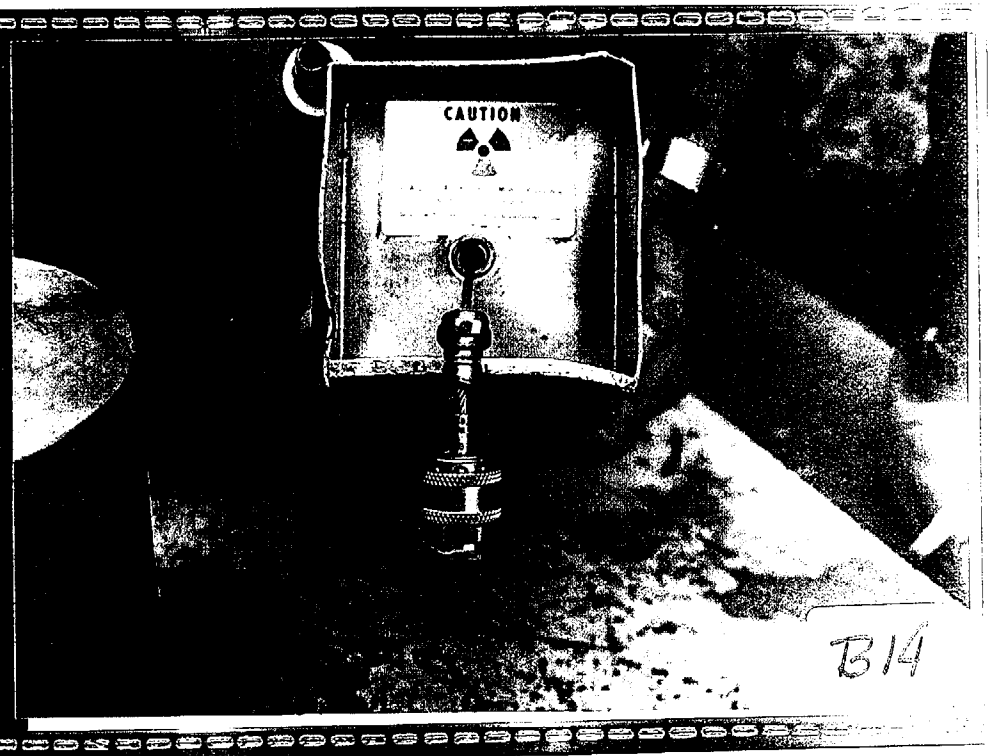

B9


B10


B11


B12


FLANGE IMPACT
QD IMPACT
FLANGE IMPACT
B13


CAUTION
B14

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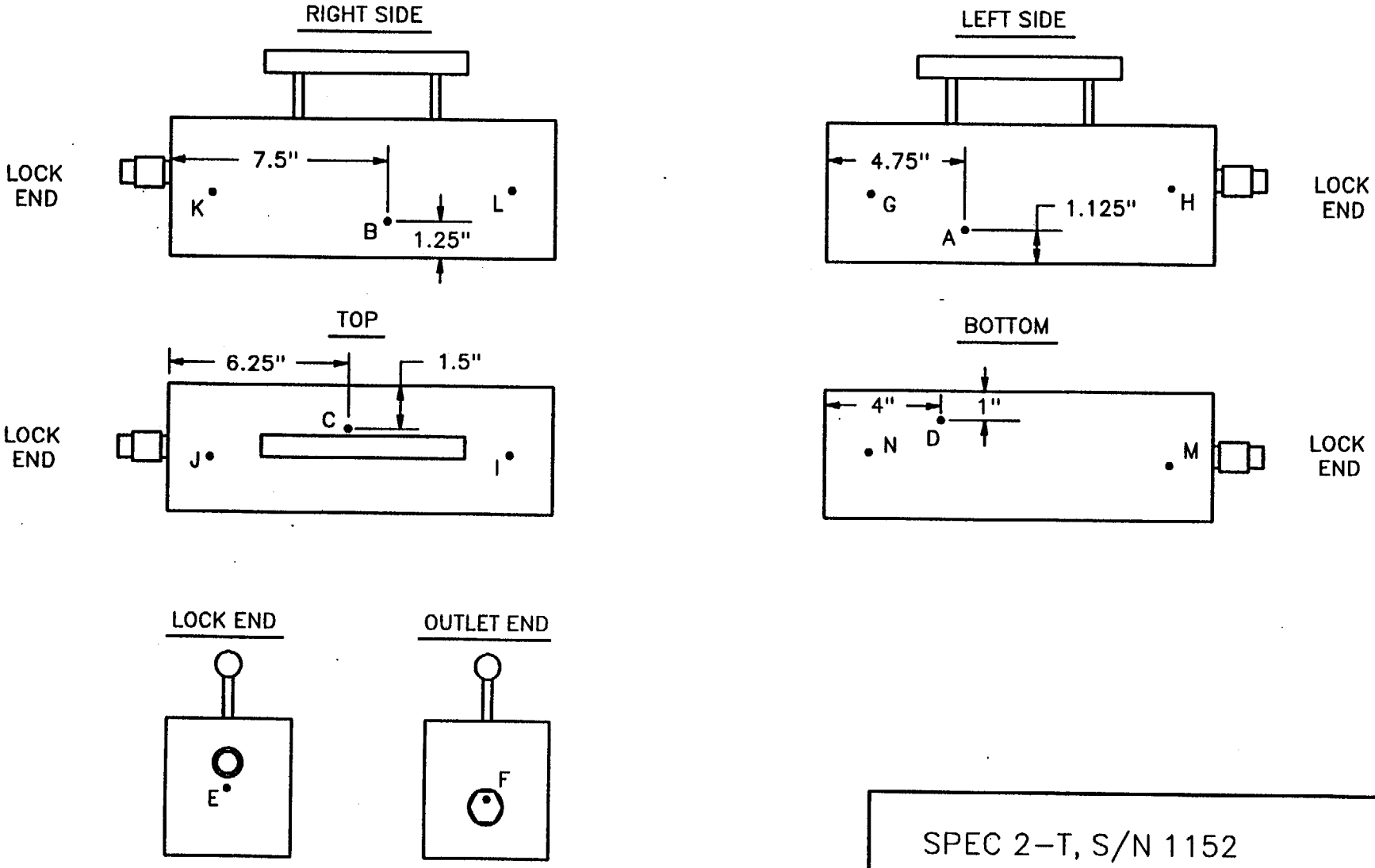
Appendix 4.7
Sketches of SPEC 2-T Survey Locations



SPEC 2–T, S/N 1152

LOCATIONS OF SURFACE RADIATION READINGS.
LOCATIONS ARE MARKED ON PACKAGE SURFACE.

FILENAME: H:\DC\SPEC\63097DT2 S. BYRD 6-30-97 SCALE: 3/16

APPENDIX 9.5
LIQUID PENETRANT INSPECTION INSTRUCTIONS

WORK INSTRUCTION

NO: QA28 **TITLE : Liquid Penetrant Inspection**

Prepared By: Mike Frizell

APPROVAL

Pete Weber, General Manager

Kelley Richardt , Quality Assurance Manager

Revision: (1)

Effective Date: 11/10/99

Work Instruction No: QA28
Title: Liquid Penetrant Inspection

Rev No.	Revision	Revised By/Date	Checked By/Date

Work Instruction No.: QA28
Title: Liquid Penetrant Inspection

0	Initial Release. Work Instruction # QA28 supercedes Procedure # 7.56.	CMF 04/07/98	
1	Add reference to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix 8. Change the maximum allowable surface temperature from 125F to 100F.	KDR 11/04/99	

1.0 PURPOSE:

To specify the liquid penetrant nondestructive testing technique and the accept/reject criteria to be applied to the inspection of metal joints fabricated in accordance with Source Production and Equipment Company, Inc., Thermal Metal Joining, Gas Tungsten Arc and Shielded Metal Arc Work Instructions.

Requirements contained within are for the control of the reliability, quality, and repeatability of the liquid penetrant inspection.

2.0 SCOPE

This procedure applies to all liquid penetrant inspection of in-process and final welds, performed by SPEC on Radioactive Material Packages, and other items manufactured by SPEC.

3.0 REFERENCES

3.1 ASTM-E 165 "Standard Practice for Liquid Penetrant Inspection Method".

3.2 ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix 8

4.0 DEFINITIONS/ACRONYMS:

4.1 SPEC: Source Production and Equipment Company, Inc.

4.2 TMJ: Thermal Metal Joining

4.3 GTAW: Gas Tungsten Arc

4.4 SMAW: Shielded Metal Arc

4.5 INDICATION: An indication is the evidence of a mechanical imperfection. Only indications with major dimensions greater then 1/16" shall be considered relevant.

4.5.1 A linear indication is one having a length greater than three times the width.

4.5.2 A rounded indication is one of circular or elliptical shape with the length equal

to or less than three times the width.

4.5.3 Any questionable or doubtful indications shall be re-examined to determine whether or not they are relevant. This re-examination may be by a complete repeated liquid penetrant inspection or by examination with a 10X magnifying glass.

5.0 REQUIREMENTS:

5.1 Tools: 10X Magnifying Glass

5.2 Materials: Penetrants, developers, and cleaners shall meet the requirements of MIL-I-25135. The same brand name of dye, developer and cleaner must be used in conjunction with each other.

5.2.1 Penetrant Test Materials

5.2.1.1 Magnaflux Corporation Spot-check, SKL-HF, SKC-NF, SKD-NF (Group I)

5.2.1.2 Equivalent Manufacturer of MIL-I-25135 Liquid Penetrant Materials.

5.3 Documentation:

5.3.1 Visual and Dye Penetrant Weld Inspection, Form QA27F1

5.4 Qualifications:

5.4.1 Personnel performing Liquid Penetrant Inspection shall have sufficient instruction and experience to perform the inspection properly and apply the Accept/Reject criteria to indications.

5.4.2 Formal training is administered by the Quality Assurance Manager or an individual qualified in the specified method with a minimum of six months of experience and designated as a training instructor by the Quality Assurance Manager. Training is documented separately for each individual.

5.4.3 Qualification testing is a documented practical examination administered by the Quality Assurance manager or an appropriately qualified instructor designated by the Quality Assurance Manager.

5.4.4 The practical examination must verify that the individual has appropriately evaluated the indications obtained with respect to type, size and location of indications considered acceptable and those considered unacceptable.

6.0 SAFETY:

6.1 Hazards:

6.1.1 Liquid penetrant inspection shall be handled in such a manner that repeated or prolonged contact of materials with the skin shall be avoided.

6.1.2 Solutions used in penetrant inspection are highly volatile, and shall be used only in well ventilated areas.

6.1.3 Penetrant materials have low flash points and shall not be heated, exposed to hot surfaces, or open flames.

6.2 Warnings:

6.2.1 All personnel must have read the Material Safety Data Sheets before using liquid penetrant materials.

7.0 PROCEDURE:

7.1 SURFACE PREPARATION

7.1.1 Inspection surfaces shall be free of any foreign materials that would cause false indications or interfere with interpretation of results. If a weld surface has been painted, the paint shall be removed by liquid paint stripper, or grinder. Powerwire brushing is prohibited as it tends to close over defects.

7.2 LIQUID PENETRANT PROCEDURE

7.2.1 After the surface has been prepared in accordance with Section 7.1, a uniform

coating of cleaner shall be sprayed on the test surface. Excessive cleaner shall be wiped or blotted with a clean cloth. Complete drying of the test object shall be accomplished by normal evaporation for a minimum of five minutes.

7.2.2 All surfaces to be tested shall be throughly and uniformly coated with penetrant by brushing or spraying. The surface temperature shall be between 50° F and 100° F.

7.2.3 The surface shall remain wet with the penetrant for a minimum of 5 minutes and a maximum of 20 minutes. Any complete drying of the surface during the penetration time shall require re-cleaning and re-application of the penetrant as described in paragraph 8.2.

7.2.4 After the penetration time has expired excessive penetrant shall be removed by wiping all excess penetrant with a clean dry cloth and then a cloth dampened with cleaner. Flushing of the excess penetrant with cleaner is prohibited.

7.2.5 Drying of the surface after penetrant removal shall be accomplished by normal evaporation. i.e. no fans or heaters shall be used.

7.2.6 Within 10 minutes after penetrant removal, the developer shall be throughly agitated and applied to the test surface by spraying on a thin uniform coating.

7.2.7 The inspection shall be made a minimum of 7 minutes and a maximum of 30 minutes after the developer has dried.

7.2.8 Upon completion of the inspection the penetrant materials shall be removed as soon as possible.

NOTE: Wiping off the indication and applying more developer invalidates the liquid penetrant inspection and is not a valid re-examination.

8.0 INSPECTION:

8.1 Accept Criteria:

8.1.1 Welds shall be free of relevant linear indication.

8.1.2 Welds shall be free of relevant rounded indications greater than 3/16".

8.1.3 Welds shall be free of four or more relevant rounded indications in a line separated by 1/16" or less (edge to edge).

NOTE: An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for the acceptance. i.e. The red spot is measured, not the imperfection that caused it.

8.2 Reporting:

8.2.1 Inspection results shall be documented on SPEC Inspection Form QA27F1.

8.2.2 Inspection results shall be maintained for the life of the package.

8.3 Non-Conforming Material: All nonconformances shall be documented on a "Nonconforming Material Report" per section 15.0 of the Quality System Procedure Manual, Control of Nonconforming Product.

9.0 FORMS/FIGURES/TABLES:

9.1 Visual and Dye Penetrant Weld Inspection, Form QA27F1