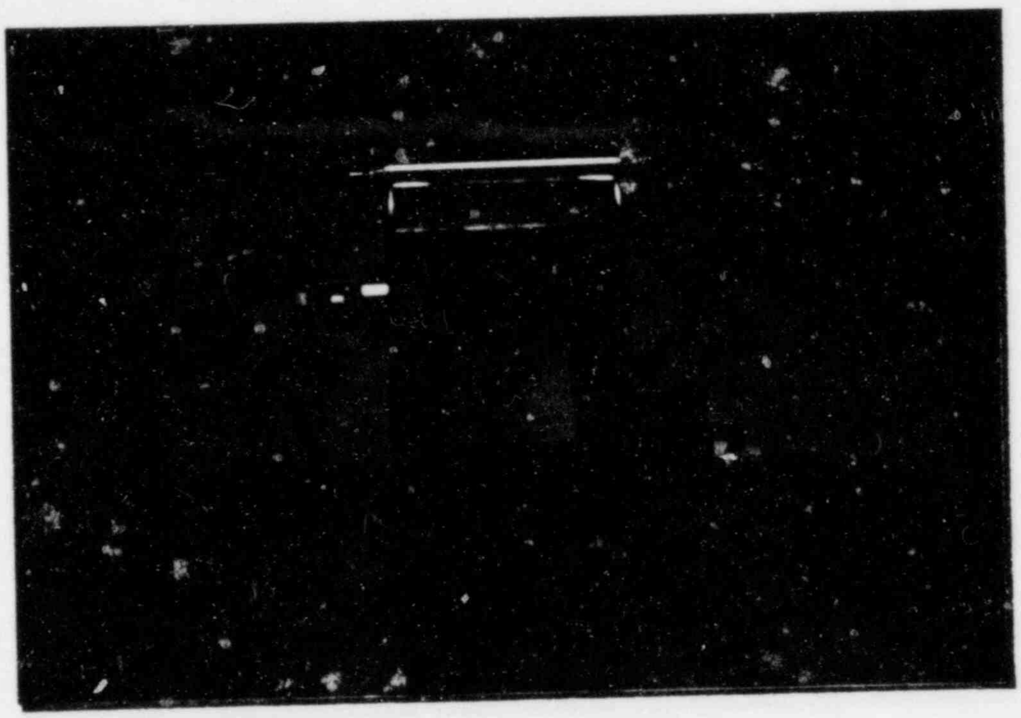
71-9160

MODELS 20-VS & 40-VS



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22842

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1 GENERAL INFORMATION

The enclosed information concerns a metal container which weighs forty-two (42) pounds and contains thirty-four (34) pounds of depleted uranium. The container is a device used to perform operations in the field of radiography and also is used as a transport vehicle for Iridium-192 sealed sources.

1.1 INTRODUCTION

The containers, Gulf Nuclear, Inc. Models 20-VS and 40-VS will be used to transport 100.0 curie and 200.0 curie Iridium-192 sealed sources. The container is approximately six (6) inches wide, eight (8) inches long and twelve (12) inches high. The upper portion includes a handle for carrying purposes. The outer case and all external parts of the container are fabricated from stainless steel. The two containers, 20-VS and 40-VS, are identical in construction. The two model numbers reflect a slight difference in the internal shield.

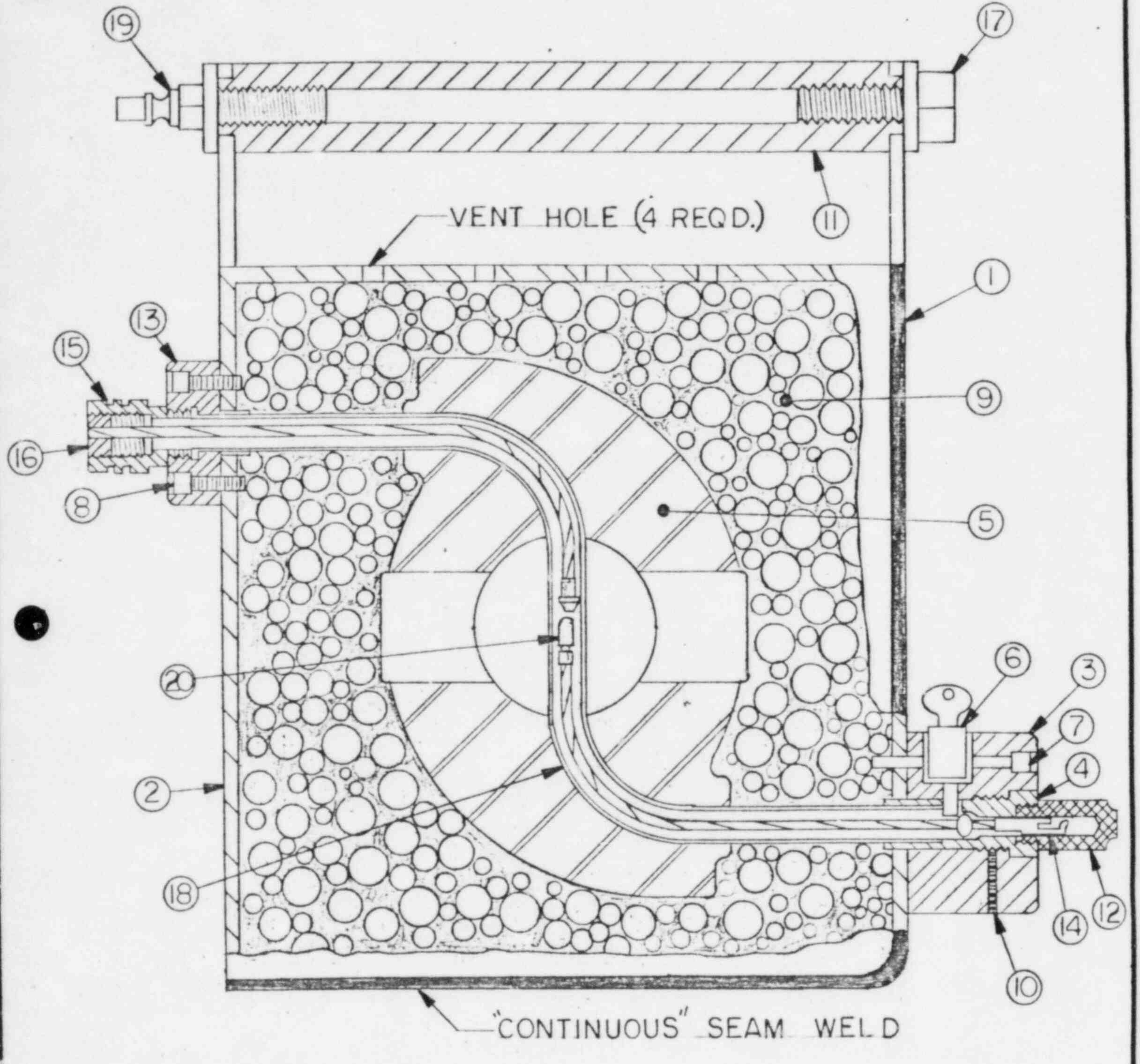
1.2 PACKAGE DESCRIPTION

1.2.1 Packaging

The package contains a depleted uranium shield which is designed to shield a 100.0 or a 200.0 curie Iridium-192 sealed source. The sources, Gulf Nuclear, Inc. Model RG-13 and RGSA-13, meet special form requirements (See Appendix 6). The shield is contained in a stainless steel case. The void between the shield and the case is filled with epoxy (See Appendix 1.3).

1.2.2 Contents of Package

The container is used to transport quantities up to 200 curies of Iridium-192. The radioactive material is contained in a sealed source configuration that meets special form requirements.



REVISIONS		
NO.	DATE	BY
1	7-12-82	C.P.H.
2		
3		
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5		

GULF NUCLEAR, INC.		
20-VS, 40-VS CAMERA ASSEMBLY		
DRAWN BY M.P.A	SCALE NONE	MATERIAL
CHK'D	DATE 11-10-82	DRAWING NO.
TRACED	APP'D C.P.H.	BS-12-0

Revision 1
September 14, 1983

PART NO.	PART NAME	MATERIAL	QUA. REQD.
1	BACK SHELL HALF	STAINLESS ST.	1
2	FRONT SHELL HALF	STAINLESS ST.	1
3	LOCK BLOCK	STAINLESS ST.	1
4	LOCKBLOCK INSERT	STAINLESS ST.	1
5	CASTING	DEPL. URANIUM	1
6	CORBIN LOCK	STAINLESS ST.	1
7	SOCKET HEAD CAP SCREW	STAINLESS ST.	4
8	SOCKET HEAD CAP SCREW	STAINLESS ST.	4
9	POTTING EPOXY	EPOXY	3 LBS.
10	SET SCREW	STAINLESS ST.	1
11	CARRYING & STORAGE HANDLE	STAINLESS ST.	1
12	LOCK BLOCK DUST COVER	STAINLESS ST	1
13	CAMERA NOSE	STAINLESS ST.	1
14	PIGTAIL	304 STAINLESS	1
15	SAFETY PLUG	STAINLESS ST.	1
16	INSERT	STAINLESS ST.	1
17	DUST COVER STORAGE BOLT	STAINLESS ST.	1
18	"S" TUBE	TITANIUM	1
19	OUTLET NIPPLE	STAINLESS ST.	1
20	SOURCE CAPSULE	STAINLESS ST.	1

REVISIONS		
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GULF NUCLEAR, INC.

20-VS, 40-VS PARTS LIST

DRAWN BY MPA	SCALE	MATERIAL
CHK'D	DATE 11-11-82	DRAWING NO. BS-12-1
TRACED	APP'D C.P.H.	

Revision 1
September 14, 1983

2 STRUCTURAL EVALUATION

2.1 Structural Design

2.1.1 Discussion

The outer shell of the container is constructed of stainless steel which is 0.076 inches thick. With the exception of the top lid, all seams are welded. The lock block, nose piece, etc., are either stainless steel or plated steel. The epoxy filler adds strength to the assembly as well as being a fire shield for the depleted uranium.

2.1.2 Design Criteria

The package is designed to function as a radiography device as well as a transport container. Radiation consideration are such that the package has a radiation level of less than 200 mRem/hr on the surface and less than 50 mRem/hr at six inches. The package is also designed to meet Yellow III Label criteria.

2.2 Weight

The weight of the package is forty-two (42) pounds.

2.3 Mechanical Properties of Material

All exterior metal parts are fabricated from 17-4 PH (AISI 630; UNS S 17400) stainless steel. The shielding material is depleted uranium. The S-tube is titanium. The internal space between the shield and the housing is filled with epoxy. 17-4 stainless steel is a chromium-nickel grade of stainless steel that may be hardened by a single low-temperature precipitation-hardening heat treatment. Excellent mechanical properties at a high strength level may be obtained by such treatment. The strength and corrosion resistance properties of 17-4 hold up well in service temperatures up to 800°F. The following may be considered as average or typical room-temperature properties:

Tensile strength	:	150,000 psi
Yield strength	:	110,000 psi
Rockwell "C" Hardness	:	34

(Reference: Earl M. Jorgensen Co., Section I, pp 29, 1981)

The mechanical properties of titanium are:

Tensile strength	:	100,000 - 125,000 psi
Yield strength	:	75,000 - 110,000 psi

(Reference: Machinery's Handbook, 21st Edition, pp 2261)

2.4 GENERAL STANDARDS FOR ALL PACKAGES

2.4.1 Chemical and Galvanic Reactions

The radioactive materials are contained in a capsule constructed from 17-4 stainless steel and meets special form requirements (10 CFR Part 71, Appendix D). There is no chemical or galvanic reactions between the depleted uranium, the epoxy, the stainless steel and the titanium alloy.

2.4.2 Positive Closure

The source assembly in the Models 20-VS and 40-VS cannot be exposed without opening a key operated lock. (See Appendix 1.3, Drawing #BS-12-0). As a safety feature, in the event of a lock failure, the safety plug prevents the radioactive material from movement. The camera is so constructed that the sealed source has only one exit. When transported on a sole use vehicle and the package is considered the transportation device, a tamper proof seal wire is threaded through the hole provided in the safety plug to prevent unauthorized removal of the source. When transported on a common carrier, the package will be contained in an overpack which has a tamper-proof seal on the locking ring.

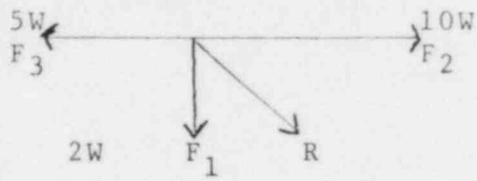
2.4.3 Lifting Device

There is a handle on the top of the container that is designed for lifting. This handle meets the specifications as required in 10 CFR 71.31(c)(1); i.e. it can support more than three times it weight without generating stress in any materials. (See Figure 2.4.3). The handle is so designed that failure of this part under an excessive load would not impair the containment nor shielding properties of the package (10 CFR 71.31(c)(4)).

2.4.4 Tie-Down Device

There is no part of the package designed primarily as a tie-down device. Generally the camera is transported in a lock-box on a radiographer's vehicle. However, if the container needed to be tied down, a strap, chain or rope could be passed between the handle and the body of the container to tie the package down.

This material is 17-4PH stainless steel which has a tensile strength of 90 to 100,000 pounds/in.^{2}. (Reference: Machinery's Handbook, Twenty-First Edition, pp 2126). Refering to the reference, pp 291, Case II



$$R = \sqrt{(F_2 - F_3)^2 + (F_1)^2} \quad \text{where } F_1 = 2W = 84\#$$

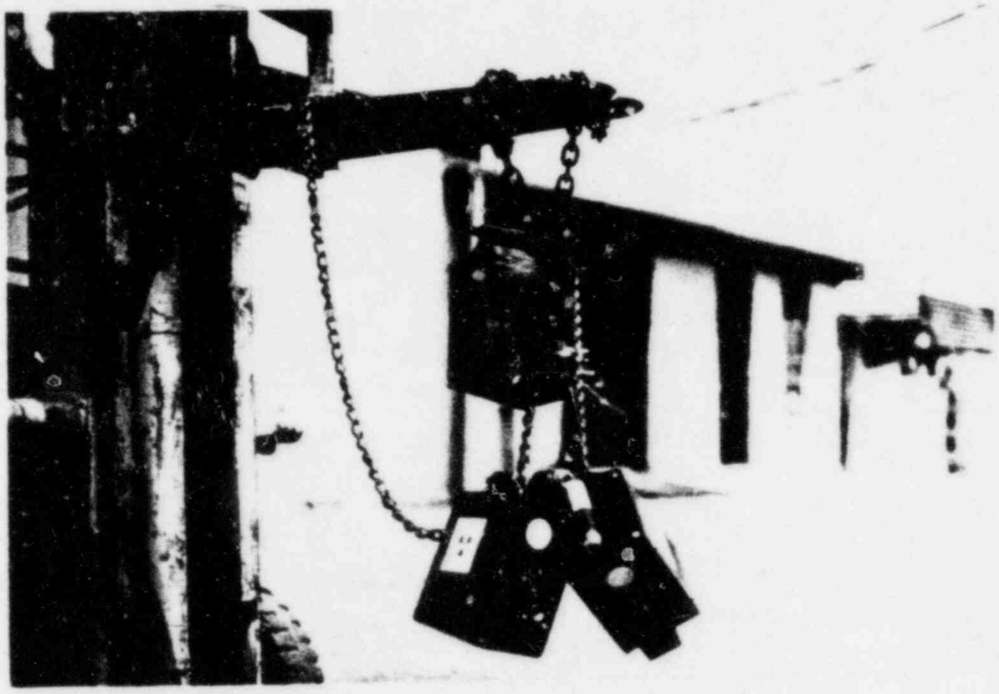
$$R = \sqrt{(420-210)^2 + (84)^2} \quad \text{where } F_2 = 10W = 420\#$$

$$R = 226.1\# \qquad F_3 = 5W = 210$$

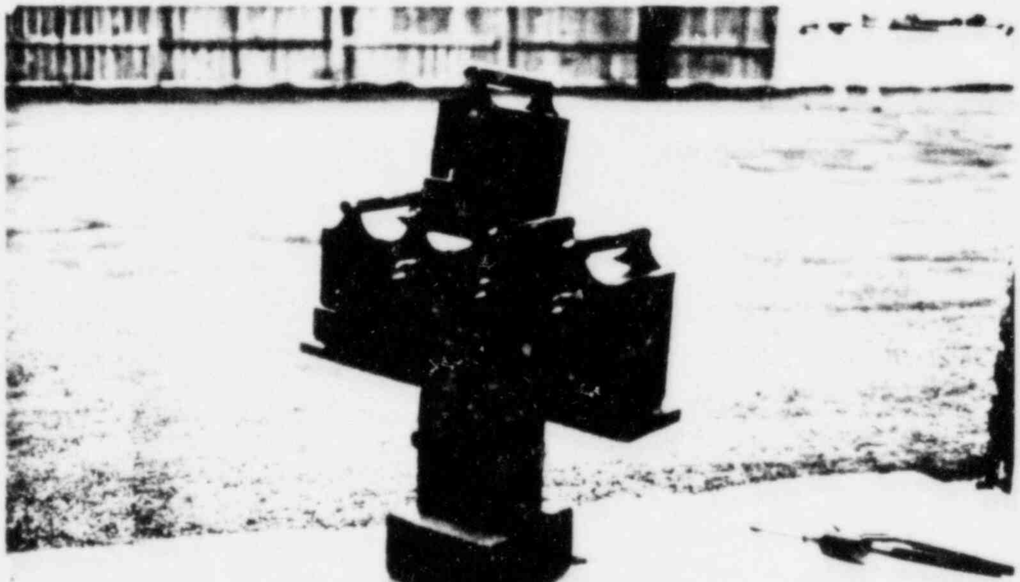
$$W = 42$$

The resulting force (R) equals to 226.1 pounds, far below the shear strength of stainless steel.

If the package were to be tied down, the breaking strength of the tie-down would be more critical than the possibility of the shearing of the container. In the event the handle was used as a part of a tie-down, and the handle did shear, there would be no change in the shielding properties of the package.



2.4.3 Device supporting three times the weight of package



2.5.1 Device supporting five times its weight

2.5 STRUCTURAL STANDARDS FOR TYPE B AND LARGE QUANTITY PACKAGING

2.5.1 Load Resistance

The container, regarded as a simple beam, supported at its ends along the major horizontal axis is capable of supporting five (5) times its weight without generating stress in any material of the packaging in excess of its yield strength. (10 CFR 71.32(a). See Figure 2.5.1.

2.5.2 External Pressure

The Models 20-VS and 40-VS are open to the air, therefore, there will be no differential pressure to act upon the package. The following analysis shows that the source capsule will not fail under a pressure of 25 psi. The capsule is assumed to be a thin walled tube. The collapsing pressure is calculated from:

$$P = 86{,}670 \frac{t}{d} - 1386$$

where P = collapsing pressure in psi

t = wall thickness (0.0545 inches)

d = outside diameter (0.225 inches)

$$P = 19{,}607\#/in^2$$

The collapsing pressure is computed to be 19,607 pounds/in^2. Therefore, the source capsule can withstand an external pressure of 25 psi without adverse effect.

(Reference: MACHINERY'S HANDBOOK, 21st Edition, pp 440)

2.6 NORMAL CONDITIONS OF TRANSPORT

2.6.1 Heat

The thermal evaluation of the Model 20-VS and 40-VS is presented in Section 2.7.3. From this evaluation, it can be concluded that these packages can withstand the normal heat conditions of transport.

2.6.2 Cold

The metals used in the manufacture of the Model 20-VS and 40-VS can all withstand a temperature of -40°F. The lower limit of the resin is -40°F. Therefore, the Model 20-VS and 40-VS can withstand the normal transport cold condition.

2.6.3 Pressure

The Model 20-VS and 40-VS are open to the atmosphere, therefore, there will be no pressure differential on them. The source capsules are glycol tested during manufacture in which they are subjected to a vacuum of at least a ½ atmosphere.

2.6.4 Vibration

The lock device of the Model 20-VS and 40-VS is the same as that used in the 20-V and 40-V, which have been in use for approximately 9 years. The entire body is welded, except for the top. The shield is held in place by hardened resin. There has never been a failure of one of these devices due to vibration. Therefore, it is concluded the Model 20-VS and 40-VS can withstand vibration normally associated to transport.

2.6.5 Water Spray

All materials used in construction of the Model 20-Vs and 40-VS are highly water resistant. Exposure to water will not affect the structural integrity or reduce the shielding effectiveness of the package. Therefore, the water spray test was not performed.

2.6.6 Free Drop

The drop test as presented in Section 2.7.1, Hypothetical Accident Conditions-Free Drop show that the Model 20-VS and 40-VS can withstand the normal transport free drop conditions without loss of shielding effectiveness or loss of structural integrity.

2.6.7 Corner Drop

Not applicable.

2.6.8 Penetration

The hemispherical end of a 1¼" diameter steel rod weighing 15 pounds was dropped from a height of 40 inches onto one side. The top, the lock block and the camera nose had no physical damage or damage to the shielding effectiveness. The container withstood the puncture test for the Hypothetical Accident Conditions (See Section 4.2.).

2.6.9 Compression

The Model 20-VS and 40-VS was subjected to five (5) times its own weight with no physical damage or damage to the shielding effectiveness of the container. (See Figure 2.5.1) The load of five (5) times the container weight was greater than 2 pounds per square inch times the cross sectional area.

2.7 HYPOTHETICAL ACCIDENT CONDITIONS

PART 71, APPENDIX B

2.7.1 Free Drop

Prior to the hypothetical accident conditions test a radiation profile was made on the 20-VS. The results are shown in Figure 2.7.1.0.

The package was dropped a total of three times from a height of thirty (30) feet onto a one-half inch steel plate centered on an eight inch thick concrete pad. Physical damage occured, but shielding and containment characteristics were not altered. Two controlled drops were made, causing the lock block to strike the plate. Damage was done to the lock block, but remained bolted to the camera and was functional. Throughout the drop tests, at no time was the radioactive materials positioned so that a potential exposure could happen to personnel in contact with the package. See Figures 2.7.1 - 2.7.1.8.

2.7.2 Puncture

The package was dropped two times onto a six inch diameter bar eight inches long. The first drop, the package struck on a corner, doing no appreciable damage. The second drop results were the same, some bending of the outer shell, but no change in position of the shielding material. The package was dropped again, causing it to land on the lock block. Again there was a minor surface damage, but the lock block was functional and as in the other drops, the shielding material remained intact. (See Figure 2.7.2.1 - 2.7.2.4)

2.7.3 Thermal

The package was suspended over a six foot diameter tank with diesel fuel floating on the water. The diesel fuel was ignited and a fire maintained for a thirty minute interval. The temperature was monitored by a potentiometer to insure a temperature of at least fourteen hundred seventy five degrees (1475°F) Fahrenheit. Diesel fuel burns at approximately twenty-eight hundred degrees Fahrenheit (2800°F). After the thirty minute interval, the pumping of the fuel was stopped and the fire was allowed to extinguish itself, and the package to cool naturally. Flammable gases were emitted through the vent holes in the top of the package during the burn test and for approximately three minutes after the fire was extinguished. The package was allowed to cool naturally. See Figure 2.7.3.1- 2.7.3.4.

2.7.4 Water Immersion

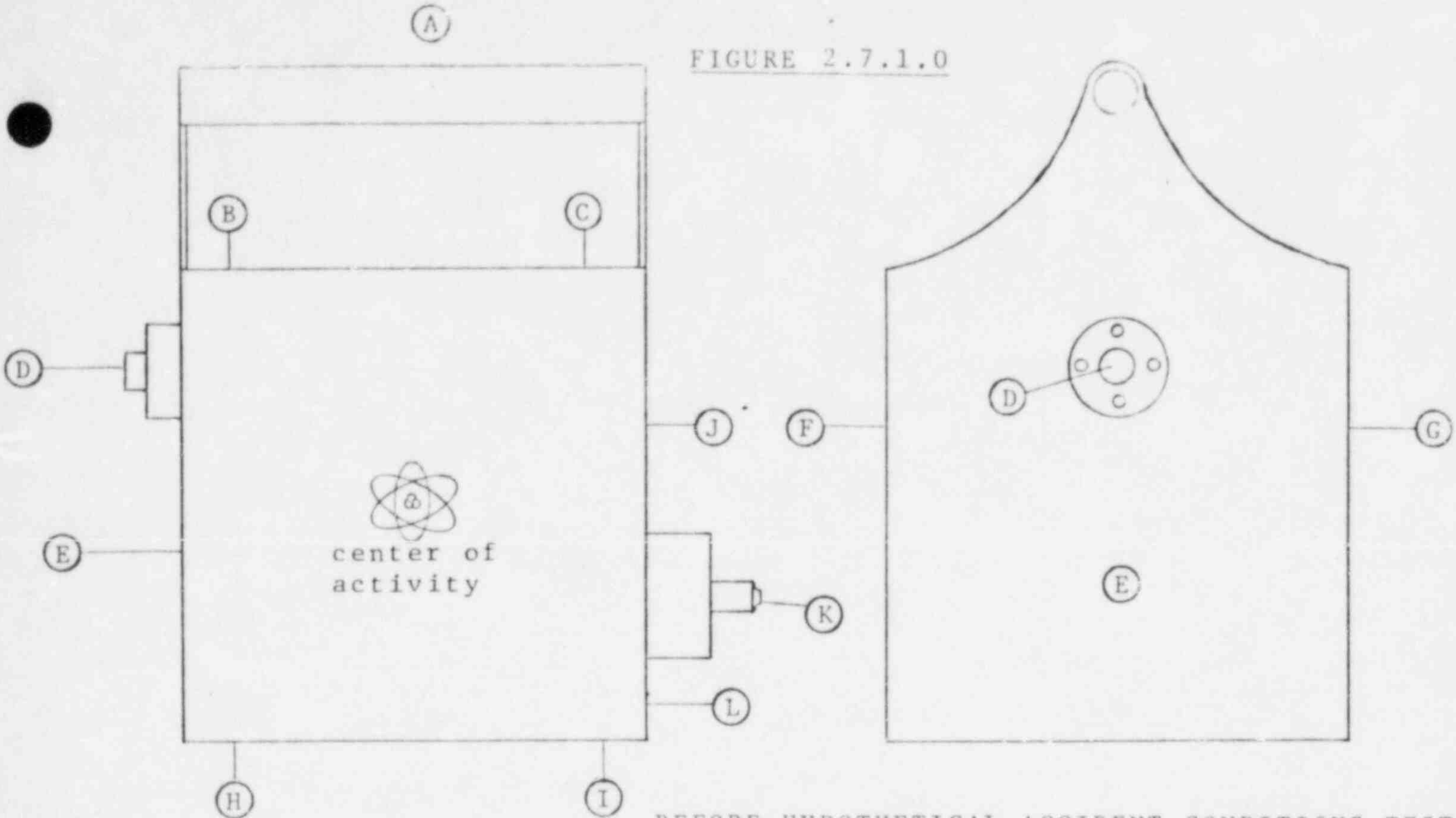
Not applicable.

2.7.5 Summary of Damage

There was visible damage done to the package by the drop tests. But the shielding and containment properties were not altered. There was deformation to the aluminum radiation sign on the top of the package due to the thermal test. Removing the top of the package revealed that part of the epoxy was charred and burned, but the shield was intact and in place. A radiation profile measured after all tests were completed indicates that the package still conforms to 49 CFR 173.393(i). See Figure 2.7.5.1 - 2.7.5.5.

ALL READINGS TAKEN AT SURFACE OF CAMERA

FIGURE 2.7.1.0



BEFORE HYPOTHETICAL ACCIDENT CONDITIONS TEST

Serial Number: #53 Date: 12/4/81

Model Number: 20-VS Signature:
(Prototype Stainless Steel)

Position	Reading	Notes
A	40	Source 702S (114 Ci) Iridium-192
B	25mr/hr	Calibration Date, Victoreen Model 492 S/N 3945
C	40	
D	35	
E	70	
F	100	
G	70	
H	40	
I	25	
J	45	
K	35	
L	35	

APPENDIX 2.7

2.7.1 FREE DROP TEST

Figure 2.7.1.1 Device before the test

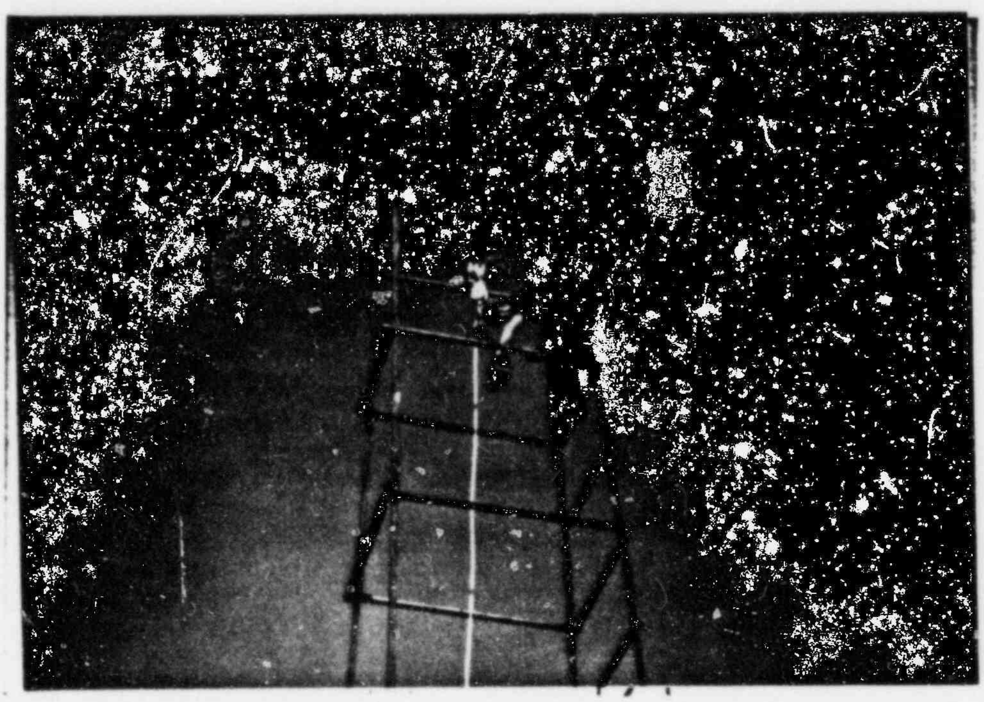


Figure 2.7.1.2 Device being prepared for drop

FREE DROP TEST

Figure 2.7.1.3 Device striking pad

Figure 2.7.1.4 Device after striking pad

FREE DROP TEST

Figure 2.7.1.5 Device after striking pad

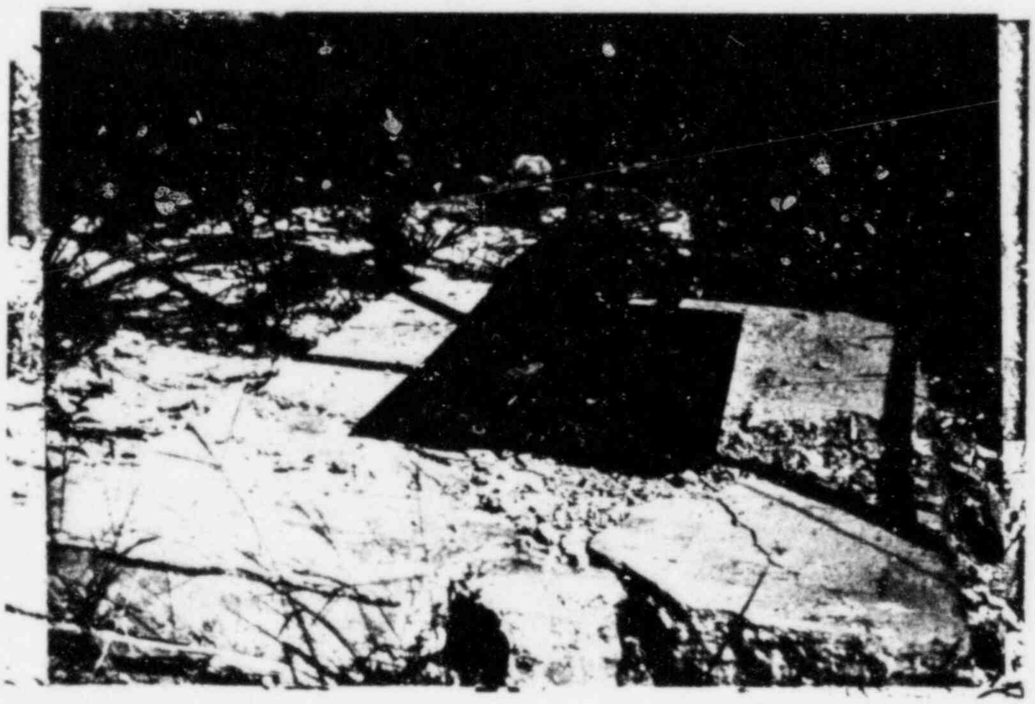


Figure 2.7.1.6 Device striking lock block

FREE DROP TEST

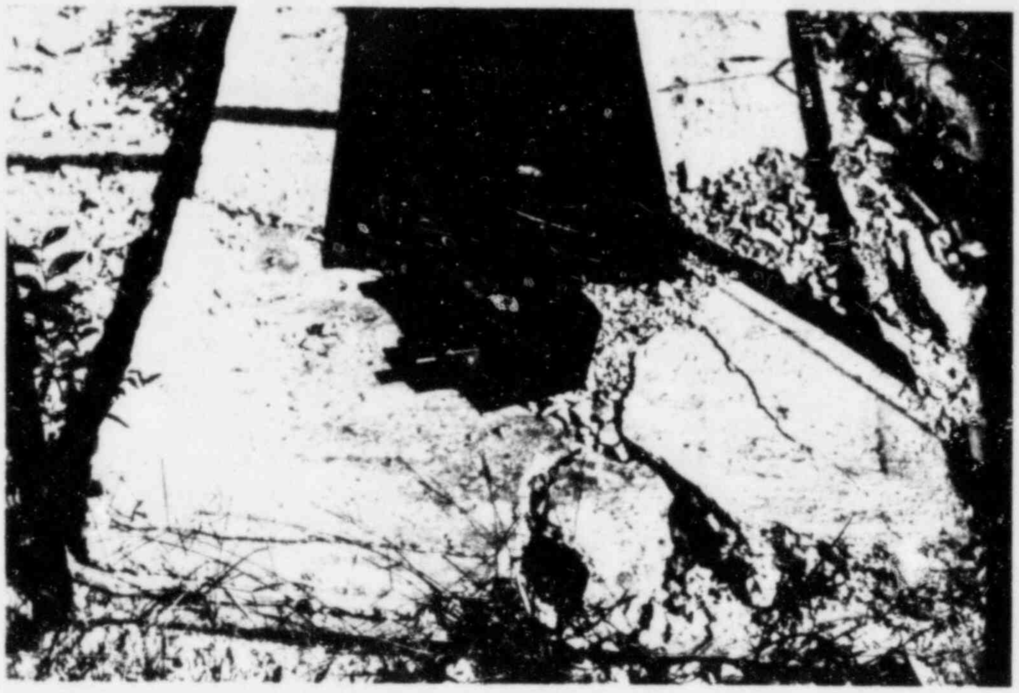


Figure 2.7.1.7 After striking lock block

Figure 2.7.1.8 After striking lock block

APPENDIX 3

2.7.2 PUNCTURE TEST

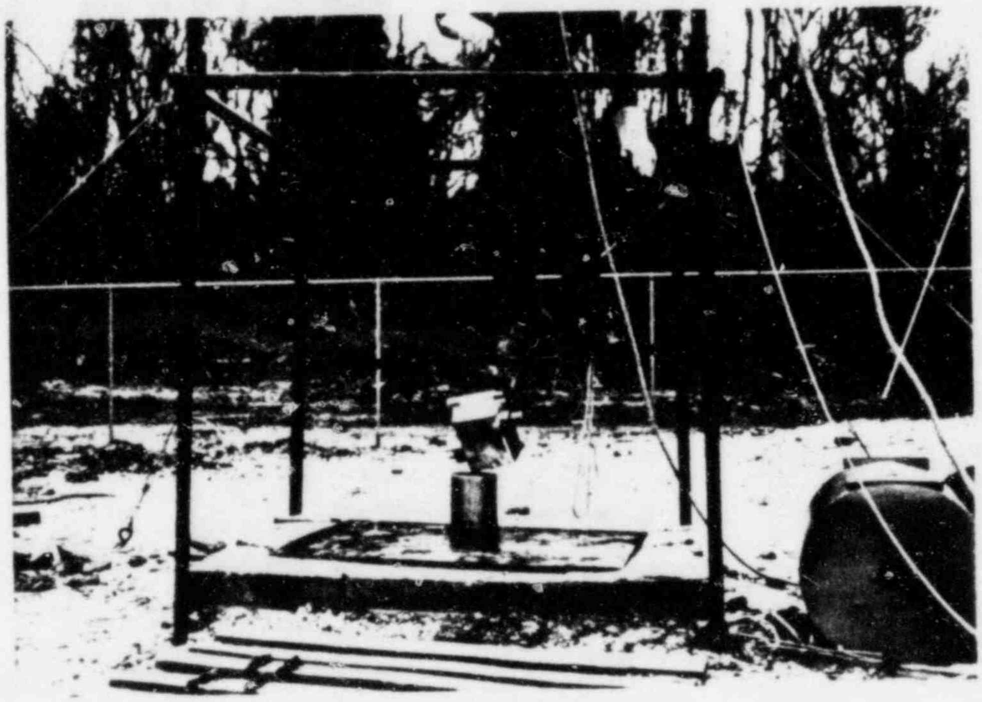


Figure 2.7.2.1 Device striking pin

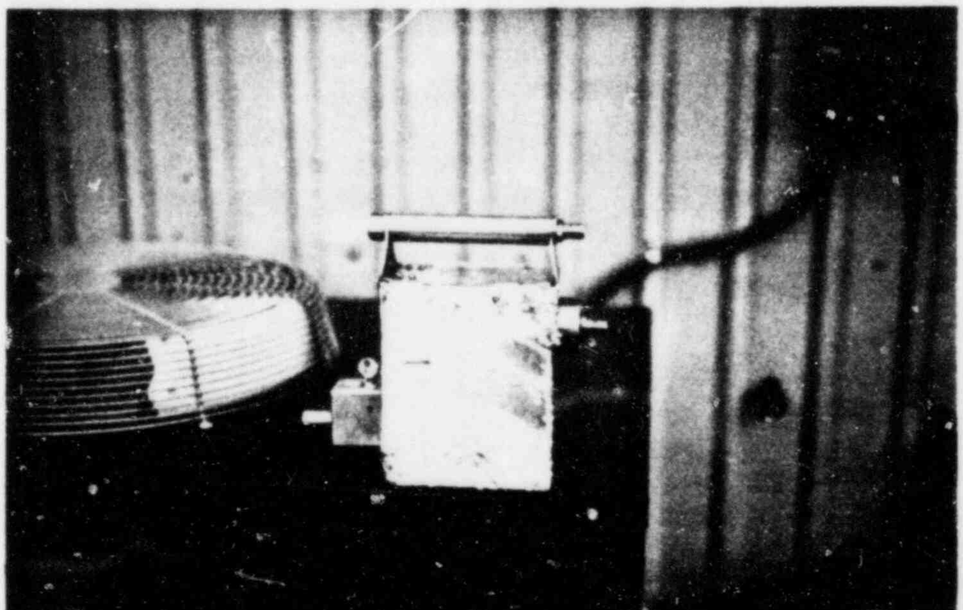


Figure 2.7.2.2 Device after striking pin

2.7.2 PUNCTURE TEST

Figure 2.7.2.3 Striking lock block on pin

Figure 2.7.2.4 After striking lock block on pin

2.7.3 THERMAL TEST

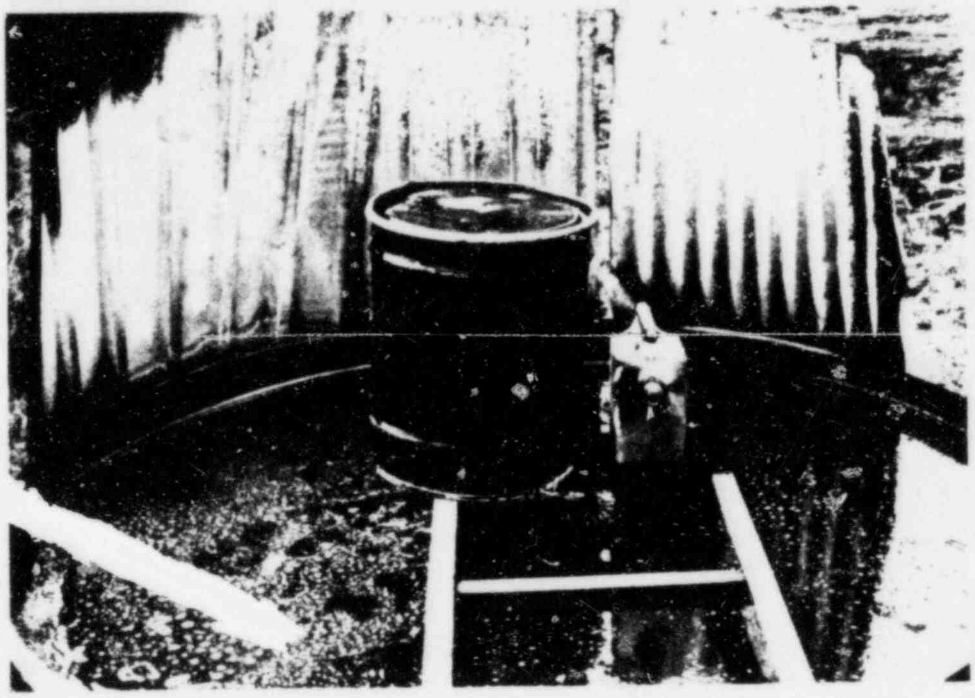


Figure 2.7.3.1 Device before test

Figure 2.7.3.2 Device during test

THERMAL TEST

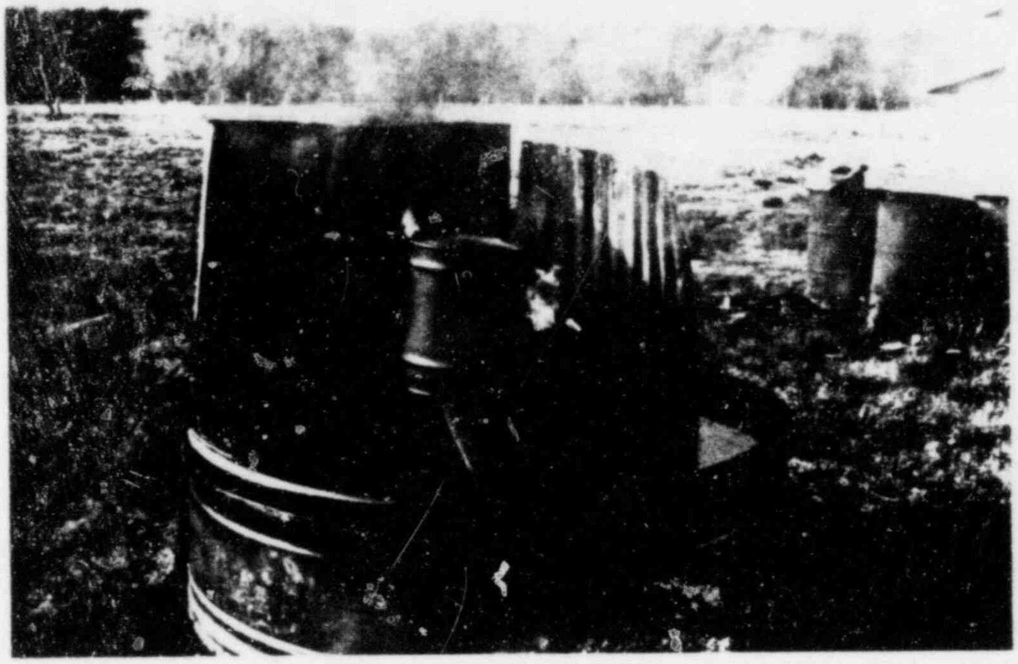


Figure 2.7.3.3 Device immediately after test

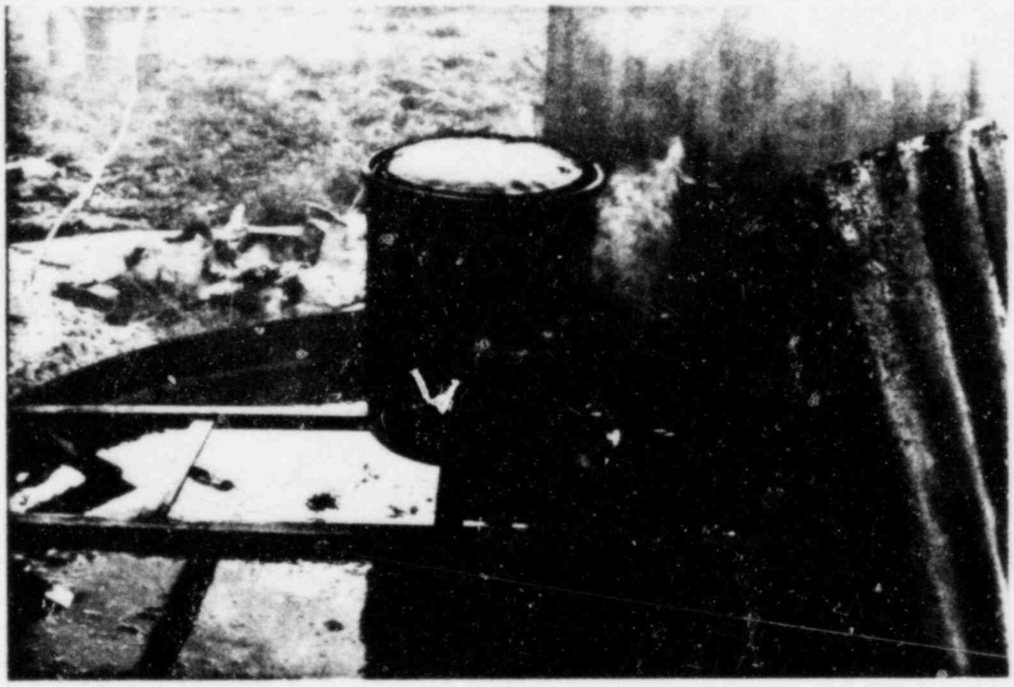


Figure 2.7.3.4 Device three minutes after test

SUMMARY

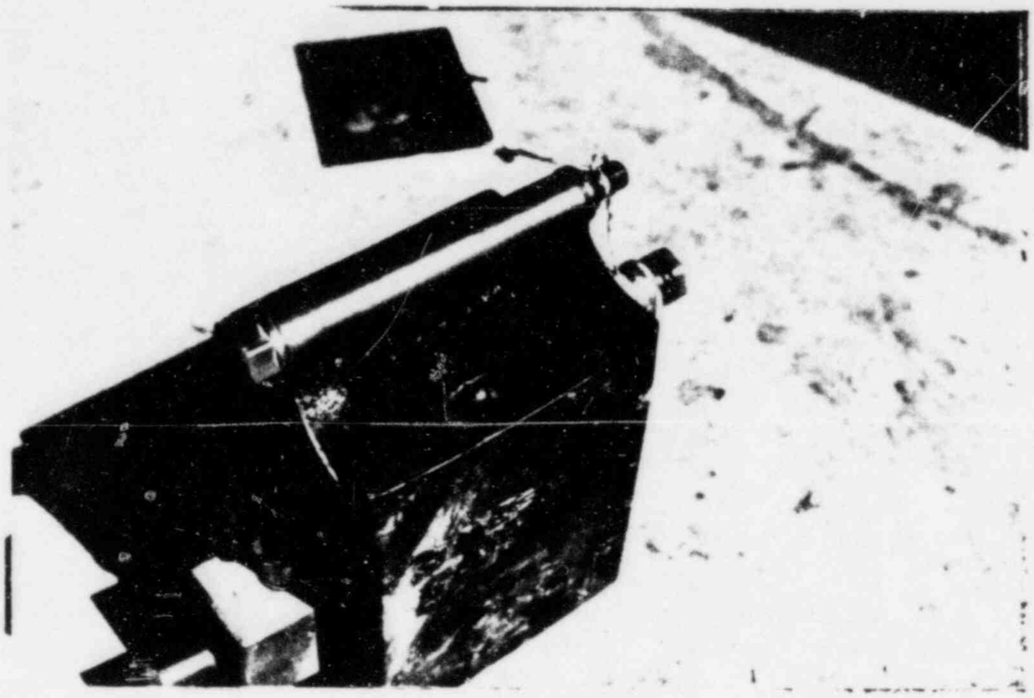


Figure 2.7.5.1

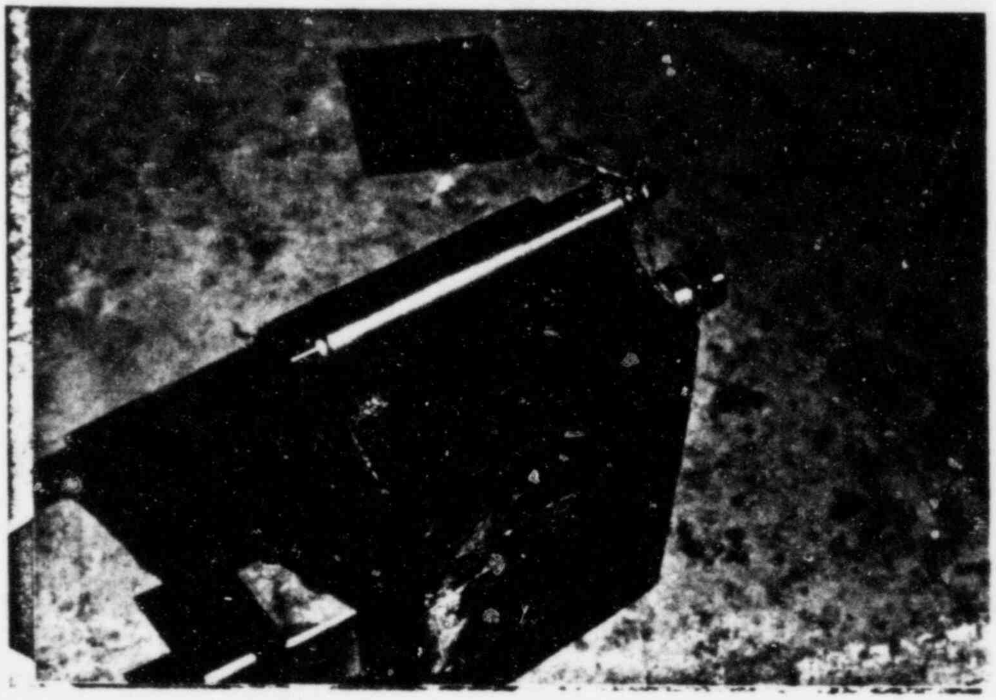


Figure 2.7.5.2

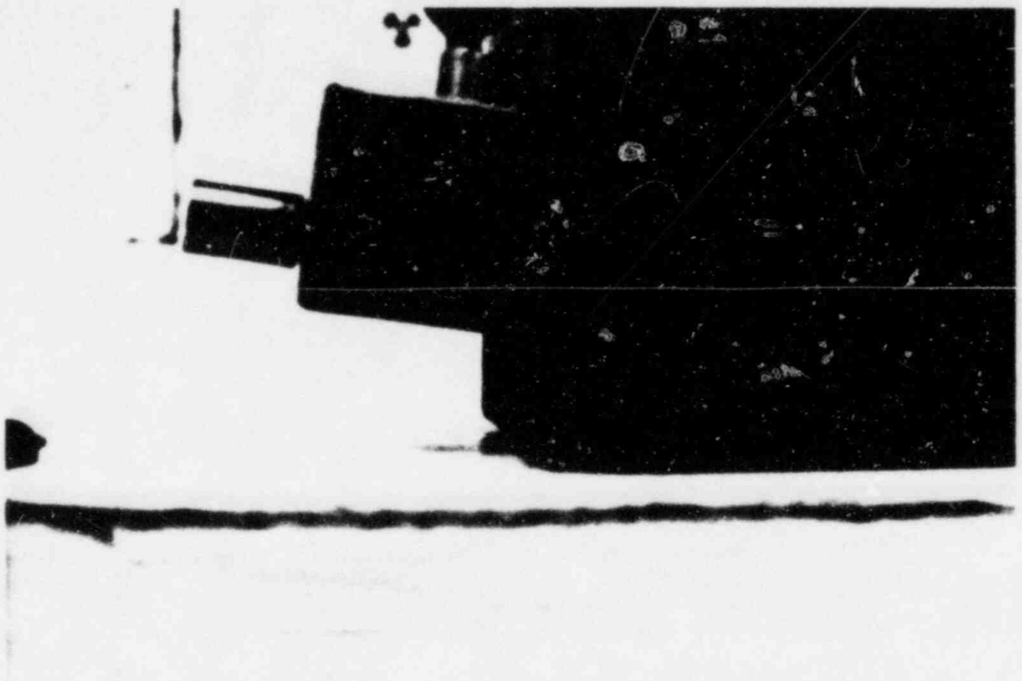


Figure 2.7.5.3

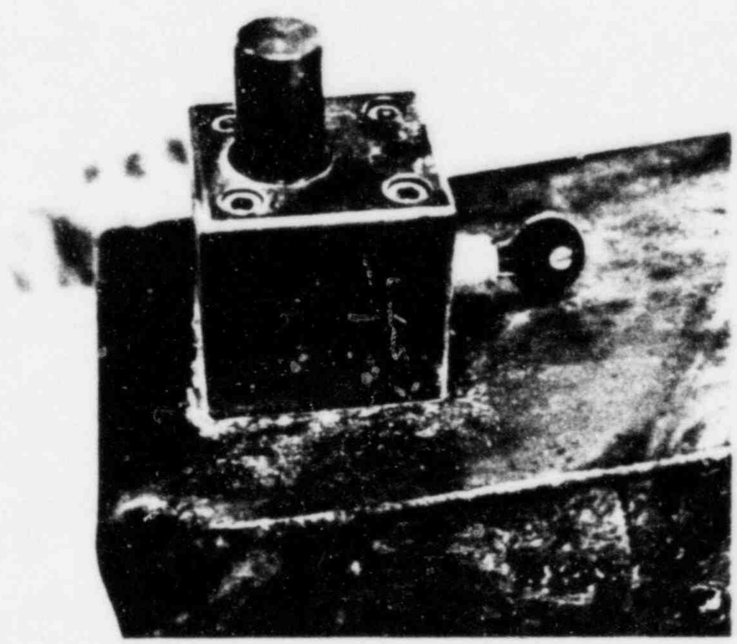
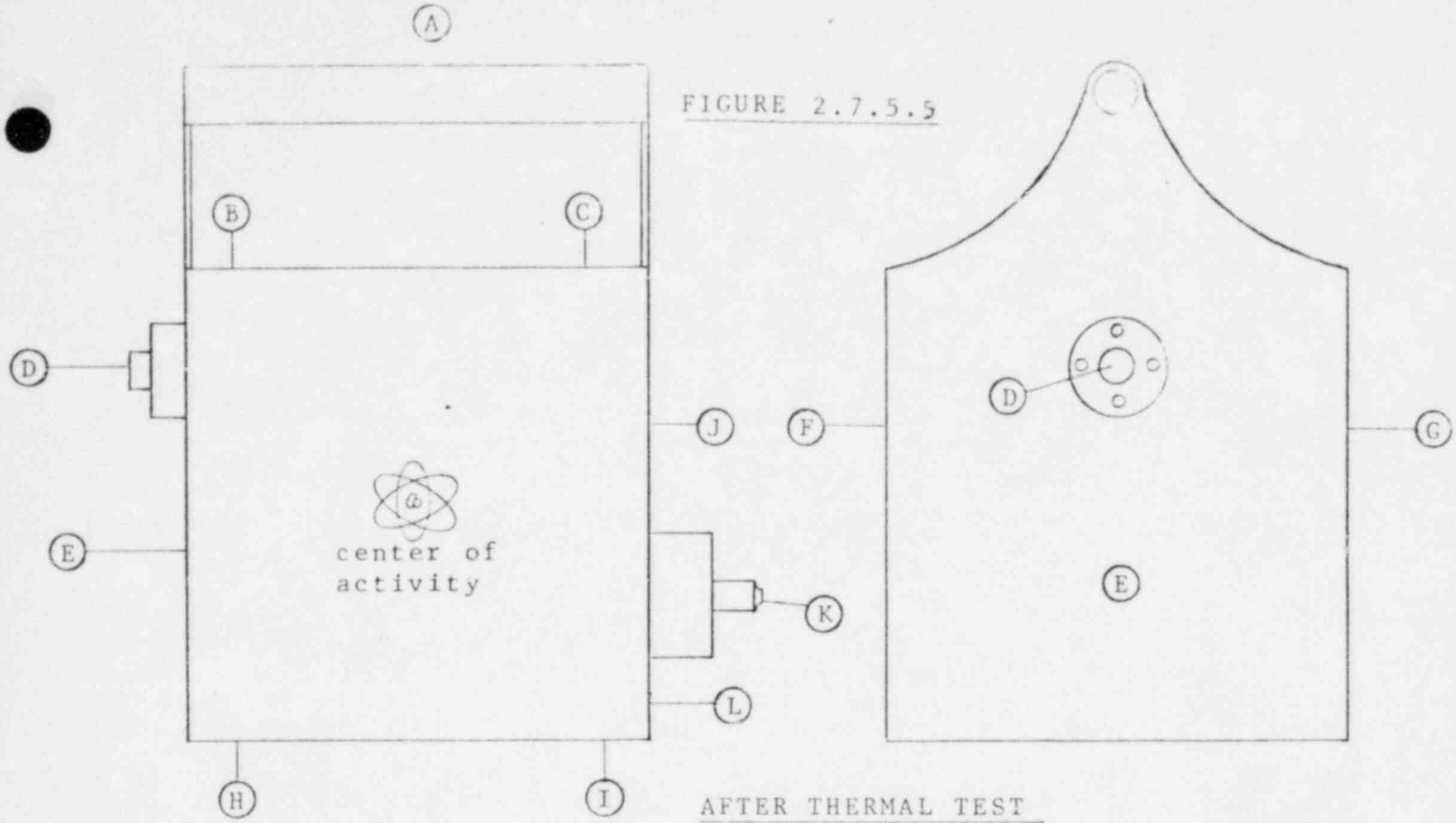


Figure 2.7.5.4

ALL READINGS TAKEN 6" FROM CAMERA SURFACE

FIGURE 2.7.5.5



AFTER THERMAL TEST

AFTER HYPOTHETICAL ACCIDENT CONDITIONS TEST

Serial Number: #53 Date: 5/26/83

Model Number: 20-VS Signature:
(Prototype Stainless Steel)

Position	Mr/Hr Reading	Notes
A	42	Source #7025 114 Ci, Iridium-192
B	25	Bicron Radiographer S/N A016A
C	39	
D	35	
E	70	
F	105	
G	72	
H	40	
I	26	
J	46	
K	35	
L	35	

2.8 SPECIAL FORM

2.8.1 Description

The radioactive materials used in these packages are all special form licensed material. These sources are Models RG-13 and RGSA-13. They are encapsulated in stainless steel and measure .240" in diameter and a .400" in length.

2.8.2 Free Drop

These sources, RG-13 and RGSA-13 were dropped through a distance of 30 feet striking a one-half inch thick steel plate supported by an eight inch concrete pad with no damage done.

2.8.3 Percussion

A one-inch diameter steel rod weighing at least three pounds was dropped through a distance of forty inches onto the sources which were supported by a one inch sheet of lead on a concrete base. The sources were damaged, but not to the degree there could be a leak. The sources were then leak tested, using the glycol test with no indication of a leak.

2.8.4 Heating

The sources were heated to a temperature of 1475°F and held at that temperature for 10 minutes. The sources were then glycol tested, with no indications of a leak.

2.8.5 Immersion

The sources were placed in a container of water for a period of 24 hours. The sources were glycol tested, with no indications of a leak.

3 THERMAL CONDITION

3.1 Discussion

The thermal evaluation is covered in Section 2.7.3 Hypothetical Accident Conditions-Thermal. It is concluded that the melting temperatures of the materials used in the construction of the Model 20-VS and 40-VS are all in the excess of 1475°F with the exception of the resin which will char and burn. But, since this material is used only as a binder between the depleted Uranium and the steel case, there is no change in the shielding properties or the containment capabilities of the package.

4 OPERATING PROCEDURES

4.1 Procedures for Loading the Package.

All sources are fabricated in hot cells designed for maximum shielding, keeping exposures to technicians as low as reasonably achievable as required by 10 CFR Part 20. All operations pertaining to the manufacturing of these sources such as welding, leak testing, and special form testing are performed in this enclosure. When the source has been found to meet all specifications, using the manipulators, the source is placed in a source changer and locked in place. The source changer is removed from the hot cell and placed in the designated area for source exchange. The following is the standard procedure for source changing:

(1) Connect source changer tube to nose of camera
(2) Connect crank out conduit to lock block.
(3) Make sure lock is in up position.
(4) Turn crank handle clock-wise and crank out enough cable to make connection on pigtail (approximately 3 inches).
(5) Make connection between the disconnect and the connection on the pigtail.
(6) Connect source changer tube to the changer.
(7) Clear the area of all personnel.
(8) Place a survey meter close to camera, in the on position, so that the meter movement can be seen.
(9) Standing as far away as possible from the camera, rotate the crank handle counter-clockwise rapidly. The survey meter should go from a low reading to a high reading and back to the low reading.
(10) Lock the camera.
(11) Disconnect changer tube from camera and replace with safety plug.
(12) Disconnect crankout conduit and replace with dust cover.
(13) Monitor package with survey meter to ensure that radiation levels do not exceed 200 mRem/hr on surface and 10 mRem/hr one meter from surface.
(14) Attach serial number and identification tag to package.

4.2 Procedure for Unloading the Package

When a package is received, it must be checked for contamination and radiation level as required in 10 CFR 20.205. If contamination or radiation levels are in excess of the specified limits, the required notification (per 10 CFR 20.205) will be made. If the contamination or radiation levels are within the specified limits, the following procedure will be followed for unloading the package.

(1) Remove safety plug and attach changer tube to camera and changer.
(2) Remove dust cover and connect drive cable to connector on pigtail.
(3) Connect drive cable conduit to camera.
(4) Using appropriate key, unlock camera.
(5) Place a survey meter, in the on position, so that the meter movement can be seen.
(6) Standing as far away as possible from the camera, rotate the crank handle, clockwise rapidly. The survey meter should go from a low reading to a high reading and back to a low reading.
(7) Lock the changer.
(8) Disconnect the changer tube from the changer.
(9) Uncouple disconnect from the connector on the pigtail.
(10) The radioactive material is now ready for removable to storage.
(11) Remove the changer tube from the camera.
(12) Check the changer tube and camera for contamination. They must have no contamination as provided in 49 CFR. 173.397(a).

5 ACCEPTANCE TESTS AND MAINTENANCE PROGRAMS

5.1 Acceptance Tests

All 20-VS and 40-VS containers will be manufactured and used in accordance with Gulf Nuclear, Inc.'s Quality Assurance Program. Approval number 0210, Revision 2, Expiration Date, July 31, 1988.

5.1.1 Visual Inspection

The package is visually examined to insure proper assembly and that the package is properly marked.

5.1.2 Structural and Pressure Tests

Prototypes of the 20-VS and 40-VS were tested to a minimum of 210 pounds external pressure.

5.1.3 Leak Tests

All radioactive sources used in the Model 20-VS and 40-VS cameras are subject to leak tests as prescribed for special form materials (49 CFR 173.398) and IAEA Safety Series No. 6 1973 Revised Edition. Failure of any of these tests prevent the use of the source capsule.

5.1.4 Component Tests

The lock block assembly is tested for locking the radioactive materials securely inside the package. The shielding materials are checked for shielding integrity during manufacture and upon completion. The S-tube is checked for obstructions during preliminary construction and upon completion.

5.1.5 Tests for Shielding Integrity

Shielding tests are conducted as component tests (6.1.4) and during manufacture. Surface readings and at one meter are conducted using a source designed for the camera. Surface readings must not exceed 200 mRem/hr and one meter reading must not exceed 10 mRem/hr. Failure of this test, will prevent the use of the package.

5.1.6 Thermal Acceptance Test

Not applicable.

5.2 MAINTENANCE PROGRAM

5.2.1 Structural and Pressure Tests

Not applicable.

5.2.2 Leak Tests

Described in section 5.1.3. The radioactive source capsule is leak tested at manufacture and at six month intervals.

5.2.3 Subsystem Maintenance

The lock assembly is tested as described in section 5.1.4 prior to the use of the package. The S-tube is checked for ease of movement every time the source is cranked in and out.

5.2.4 Valves, Rupture Disks and Gaskets

Not applicable.

5.2.5 Shielding

Before the shipping of a package and when replacing a spent source, the radiation levels on the surface and at one meter are checked. If surface readings exceed 200 mRem/hr or one meter reading exceeds 10 mRem/hr, the package is rejected and taken out of use.

5.2.6 Thermal

Not applicable.

5.2.7 Miscellaneous

Not applicable.