UNCLASSIFIED

AD NUMBER
AD007452
CLASSIFICATION CHANGES
TO: **unclassified**
FROM: **restricted**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to DoD only; Administrative/Operational Use; 09 MAR 1953. Other requests shall be referred to Naval Air Systems Command, Washington, DC 20362. Pre-dates formal DoD distribution statements. Treat as DoD only.**
AUTHORITY
E.O. 10501 dtd 5 Nov 1953; NSWC notice dtd 9 Sep 1977

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

AD _____

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION ALEXANDRIA, VIRGINIA

DOWNGRADED AT 3 YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS
DOD DIR 5200.10

UNCLASSIFIED

THIS REPORT HAS BEEN DECLASSIFIED
AND CLEARED FOR PUBLIC RELEASE.

DISTRIBUTION A
APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

AD No. 24452
ASTIA FILE COPY

[redacted]

SECURITY INFORMATION

U. S NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1097

GUNFIRE QUALIFICATION TEST OF MODEL HRS-2 AND -3 HELICOPTER SELF SEALING FUEL CELL INSTALLATION

FINAL Report

Copy No. _____

Task Assignment TED NO. NPG AE6603

Classification RESTRICTED SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

PART A

SYNOPSIS

1. This is the final report on the gunfire qualification test of the Model HRS-2 and -3 Helicopter self sealing fuel cell installation conducted under TED No. NPG AE6603, initiated and authorized by Bureau of Aeronautics ltr Aer-AE-664 of 30 October 1952.

2. This test was conducted for the purpose of determining the following factors relating to the subject fuel cell installation:

a. Whether the self sealing performance of the fuel cells and the integrity of the cell plies, seams, and joints could satisfactorily conform to the requirements established by paragraph 4.3.2.2.3.6 of Military Specification MIL-T-5578A when subjected to an attack with .30 caliber ball and .50 caliber armor piercing projectiles and fragments from a detonated 40mm HEP projectile.

b. Whether the supporting structure for the fuel cells could satisfactorily resist excessive structural damage in accordance with the requirements established by paragraph D-12(b) of Navy Aeronautical Specification SR-112A as a result of the hydraulic surge of fuel incident to projectile and fragment impacts.

3 Seven (7) .30 caliber ball and two (2) .50 caliber armor piercing projectiles were fired into the installation producing a total of twenty-three (23) wounds, one (1) of which was above the fuel level and was discounted. Twenty-one (21) of the twenty-two (22) qualifying wounds sealed satisfactorily.

As an additional phase of the test, the purpose of which was to obtain fragmentation data, one (1) 40mm HEP projectile was statically detonated 24 inches from the outside of the installation. Upon impact of the fragments, the installation caught fire and suffered extensive damage before the fire fighting crews could extinguish the fire.

When the installation was disassembled for inspection, the damage was of such a severe nature that it was impossible to identify the total number of fragment wounds in the fuel cells.

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

The hydraulic surge of fuel incident to projectile and fragment impacts resulted in minor damage to the surrounding and supporting structure. The damage inflicted would not in any way endanger the airworthiness or structural integrity of the helicopter.

4. It is concluded that:

a. Twenty-one (21) of the twenty-two (22) qualifying wounds sealed satisfactorily in accordance with the requirements established by paragraph 4.3.2.2.3.6 of Military Specification MIL-T-5578A.

b. The structural performance of the Model HRS-2 and -3 helicopter self sealing fuel cell installation satisfactorily conformed to the requirements established by paragraph D-12(b) of Navy Aeronautical Specification SR-112A.

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

TABLE OF CONTENTS

	Page
SYNOPSIS	1
TABLE OF CONTENTS	3
AUTHORITY	4
REFERENCES	4
BACKGROUND	4
OBJECT OF TEST	4
PERIOD OF TEST	5
REPRESENTATIVES PRESENT	5
DESCRIPTION OF ITEM UNDER TEST	5
DESCRIPTION OF TEST EQUIPMENT	7
PROCEDURE	7
RESULTS AND DISCUSSION	7
CONCLUSIONS	8
DISPOSITION OF MATERIAL	8
APPENDIX A - NPG PHOTOGRAPHS	FIGURES 1-7 (Incl)
APPENDIX B - PRELIMINARY NOTES	1 (Only)
TABULATED RESULTS OF GUNFIRE TEST	1-4 (Incl)
APPENDIX C - DISTRIBUTION	1-2 (Incl)

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

PART B

INTRODUCTION

1. AUTHORITY:

This test was conducted under TED No. NPG AE6603, initiated and authorized by reference (a) which directed the gunfire test of the Model HRS-2 and -3 helicopter self sealing fuel cell installation.

2. REFERENCES:

a. Bureau of Aeronautics ltr Aer-AE-664 of 30 Oct 1952
b. Military Specification MIL-T-5578A
c. Navy Aeronautical Specification SR-112A

3. BACKGROUND:

The Sikorsky Aircraft Division of United Aircraft Corporation submitted to the Naval Proving Ground for final qualification gunfire test, the forward section of the Model HRS-2 and -3 helicopter self sealing fuel cell installation incorporating five (5) Goodyear Tire and Rubber Company fuel cells.

4. OBJECT OF TEST:

As requested by reference (a), this test was conducted for the purpose of determining the following factors relating to the subject fuel cell installation:

a. Whether the self sealing performance of the fuel cells and the integrity of the cell plies, seams, and joints could satisfactorily conform to the requirements established by paragraph 4.3.2.2.3.6 of reference (b) when subjected to an attack with .30 caliber ball and .50 caliber armor piercing projectiles and fragments from a detonated 40mm HEP projectile.

b. Whether the supporting structure for the fuel cells could satisfactorily resist excessive structural damage in accordance with the requirements established by paragraph D-12(b) of reference (c) as a result of the hydraulic surge of fuel incident to projectile and fragment impacts.

5. PERIOD OF TEST:

a.	Date of Project Letter	30 Oct 1952
b.	Date Necessary Material Received	12 Dec 1952
c.	Date Commenced Test	9 Jan 1953
d.	Date Completed Test	9 Jan 1953

6. REPRESENTATIVES PRESENT:

Mr. W. C. Grannis	Bureau of Aeronautics
Mr. R. Jespersen	Sikorsky Aircraft Corp.
Mr. J. C. Rasmussen	Goodyear T & R Company
Mr. T. A. Underwood	Goodyear T & R Company
Mr. C. W. Wheeler	Goodyear T & R Company

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

The subject test specimen incorporates that section of the helicopter fuselage which extends from station #84 to station #155. The shell enclosing the five (5) interconnected Goodyear self sealing fuel cells is constructed of 24 SO and 24 S aluminum alloy and is supported from within by metal stringers, channels, reinforcing strips, and bulkheads. Access to the fuel cells is through the cabin's metalite floorboard which forms the upper surface of the shell. Backing material is employed in the cavities to provide additional support for the fuel cells.

The following pertinent data appears on the nameplate of the fuel cells:

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

- -

Center Forward

Reorder by Part No. S14-30-6260
Sikorsky Aircraft
Model HRS-2 - Center Fwd.
Date Mf'd. - Aug 1952
Construction No. FTL-11-6
Mf'd. by - Goodyear T & R Co.
Serial No. - 28374
Wt. Empty - 21 lbs.
Spec. MIL-T-5578A Tanks
Type 1, Class A, Style 1
Contract NOA-S-51-650
Suitable for Aromatic Fuels

L. H. Forward

Reorder by Part No. S14-30-6261
Sikorsky Aircraft
Model HRS-2 - L. H. Fwd.
Date Mf'd. - Aug 1952
Construction No. FTL-11-6
Mf'd. by - Goodyear T & R Co.
Serial No. - 28375
Wt. Empty - 15 lbs.
Spec. MIL-T-5578A Tanks
Type 1, Class A, Style 1
Contract NOA-S-51-650
Suitable for Aromatic Fuels

R. H. Forward

Reorder by Part No. S14-30-6262
Sikorsky Aircraft
Model HRS-2 - R. H. Fwd.
Date Mf'd. - Aug 1952
Construction No. FTL-11-6
Mf'd. by - Goodyear T & T Co.
Serial No. - 28376
Wt. Empty - 15 lbs.
Spec. MIL-T-5578A Tanks
Type 1, Class A, Style 1
Contract NOA-S-51-650
Suitable for Aromatic Fuels

L. H. Center

Reorder by Part No. S14-30-6263
Sikorsky Aircraft
Model HRS-2 - L. H. Center
Date Mf'd. - Aug 1952
Construction No. FTL-11-6
Mf'd. by - Goodyear T & R Co.
Serial No. - 28377
Wt. Empty - 26 lbs.
Spec. MIL-T-5578A Tanks
Type 1, Class A, Style 1
Contract NOA-S-51-650
Suitable for Aromatic Fuels

R. H. Center

Reorder by Part No. S14-30-6264
Sikorsky Aircraft
Model HRS-2 - R. H. Center
Date Mf'd. - Aug 1952
Construction No. FTL-11-6
Mf'd. by - Goodyear T & R Co.
Serial No. - 28387
Wt. Empty - 27 lbs.
Spec. MIL-T-5578A Tanks
Type 1, Class A, Style 1
Contract NOA-S-51-650
Suitable for Aromatic Fuels

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

8. DESCRIPTION OF TEST EQUIPMENT:

The following equipment was employed in conducting this test:

a. .30 caliber, M-2, aircraft machine gun.
b. .50 caliber accuracy gun.
c. .30 caliber, M-2, ball ammunition.
d. .50 caliber, M-2, armor piercing ammunition.
e. Iso-octane fuel.
f. One (1) 40mm HEP projectile, M-2, assembled with tracer and Mk 27 nose fuze modified for static detonation.

9. PROCEDURE:

As requested by reference (a), this test was conducted in general accordance with the requirements established by reference (b). The ambient temperature during the gunfire test was +40°F.

10. RESULTS AND DISCUSSION:

From a range of 75 feet, seven (7) .30 caliber ball and two (2) .50 caliber armor piercing projectiles were fired into the installation producing a total of twenty-three (23) wounds, one (1) of which was above the fuel level and was discounted. Twenty-one (21) of the twenty-two (22) qualifying wounds sealed satisfactorily in accordance with the requirements established by paragraph 4.3.2.2.3.6 of reference (b). The wound failing to exhibit a satisfactory sealing performance was leaking heavily at the end of the allotted two (2) minutes. The failure of the wound to seal was attributed to metal flowering into the wound.

As an additional phase of the test, the purpose of which was to obtain fragmentation data, one (1) 40mm HEP projectile was statically detonated 24 inches from the outside of the installation. Upon impact of the fragments the installation caught fire and suffered extensive damage before the fire fighting crews were able to extinguish the fire.

When the installation was disassembled for inspection, the damage was of such a severe nature that it was impossible to identify the total number of fragment wounds in the fuel cells, only three (3) wounds being positively attributed to the 40mm fragments.

Figures 2 through 5, inclusive, are views showing the fuel cells at the conclusion of the gunfire test and fire.

The hydraulic surge of fuel incident to projectile impacts resulted in the following damage to the supporting and surrounding structure: The bottom skin was slightly torn and the cabin floor buckled over the L. H. forward cell. The damage inflicted would not in any way endanger the airworthiness or structural integrity of the helicopter.

Figures 6 and 7 are views showing the structural damage at the conclusion of the gunfire test and fire.

Tabulated results of the gunfire test are contained in Appendix (B).

PART D

CONCLUSIONS

11. It is concluded that:

a. Twenty-one (21) of the twenty-two (22) qualifying wounds sealed satisfactorily in accordance with the requirements established by paragraph 4.3.2.2.3.6 of reference (b).

b. The structural performance of the Model HRS-2 and -3 helicopter self sealing fuel cell installation satisfactorily conformed to the requirements established by paragraph D-12(b) of reference (c).

PART E

DISPOSITION OF MATERIAL

12. The material used in this test will be disposed of as directed by reference (a).

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

---

The test upon which this report is based was conducted by:
E. E. WIGINGTON, Lieutenant, USN
Aircraft Damage Assessment Officer
Aviation Ordnance Department

This report was prepared by:
H. P. BRANSCOME, Aircraft Damage Assessment Division,
Aviation Ordnance Department

This report was reviewed by:
J. C. TALLEY, Director of Research,
Aviation Ordnance Department
E. E. WIGINGTON, Lieutenant, USN
Aircraft Damage Assessment Officer
Aviation Ordnance Department
F. A. NUSOM, Captain, USN
Aviation Ordnance Officer
Aviation Ordnance Department
C. C. BRAMBLE, Director of Research
Ordnance Group

APPROVED: J. F. BYRNE
Captain, USN
Commander, Naval Proving Ground

E. A. Ruckner
E. A. RUCKNER
Captain, USN
Ordnance Officer
By direction

RESTRICTED

NPG REPORT NO. 1097

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Final Report

on

Gunfire Qualification Test of

Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

Project No.: TED No. NPG AE6603
No. of Pages: 9

Date: MAR 9 1953

RESTRICTED
SECURITY INFORMATION

NPO 51918 9 January 1953 SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing test specimen mounted for gunfire test with .30 caliber ball, .50 caliber armor piercing projectiles and the fragments from a detonated 40mm projectile.

Figure 1

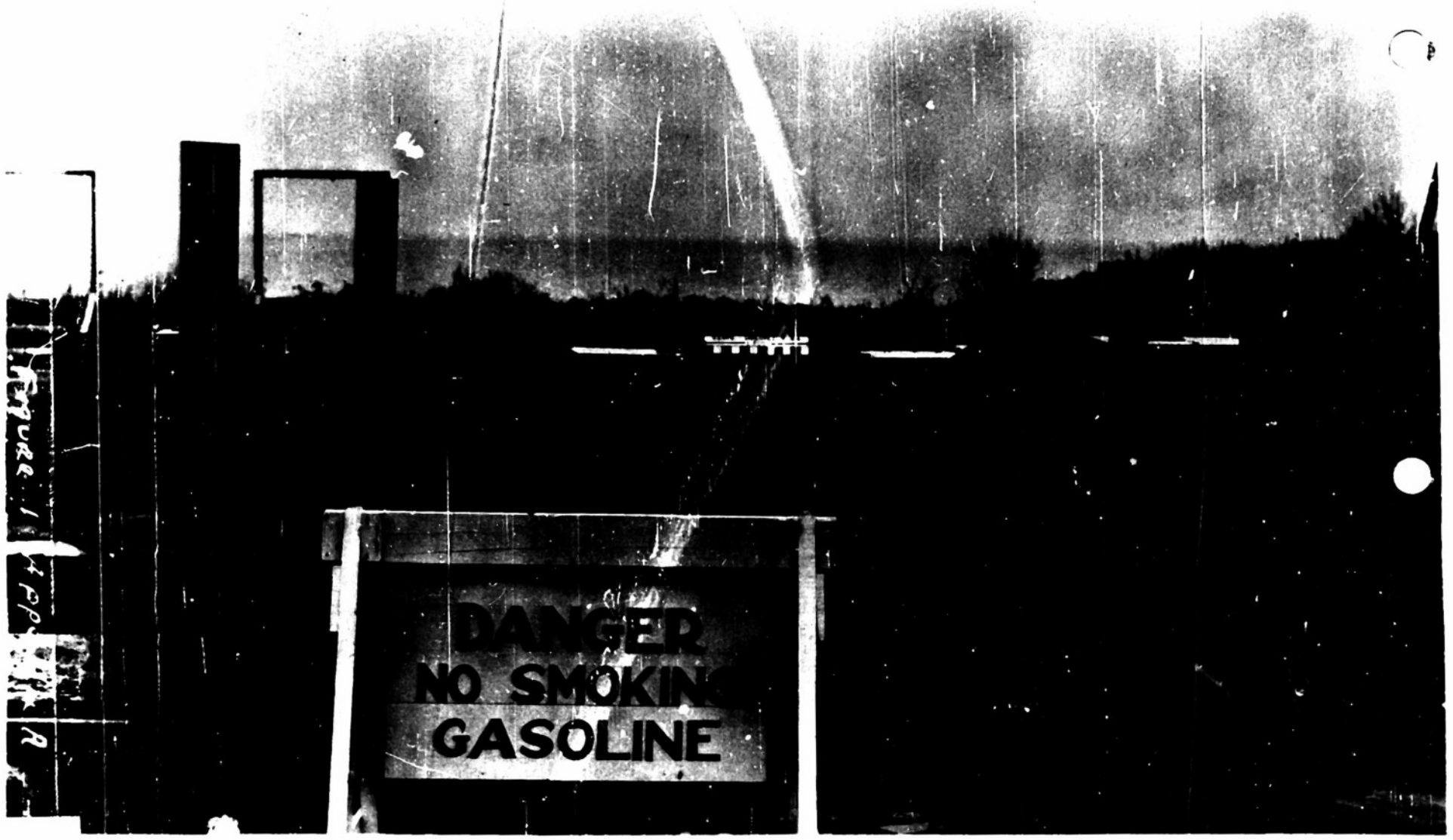
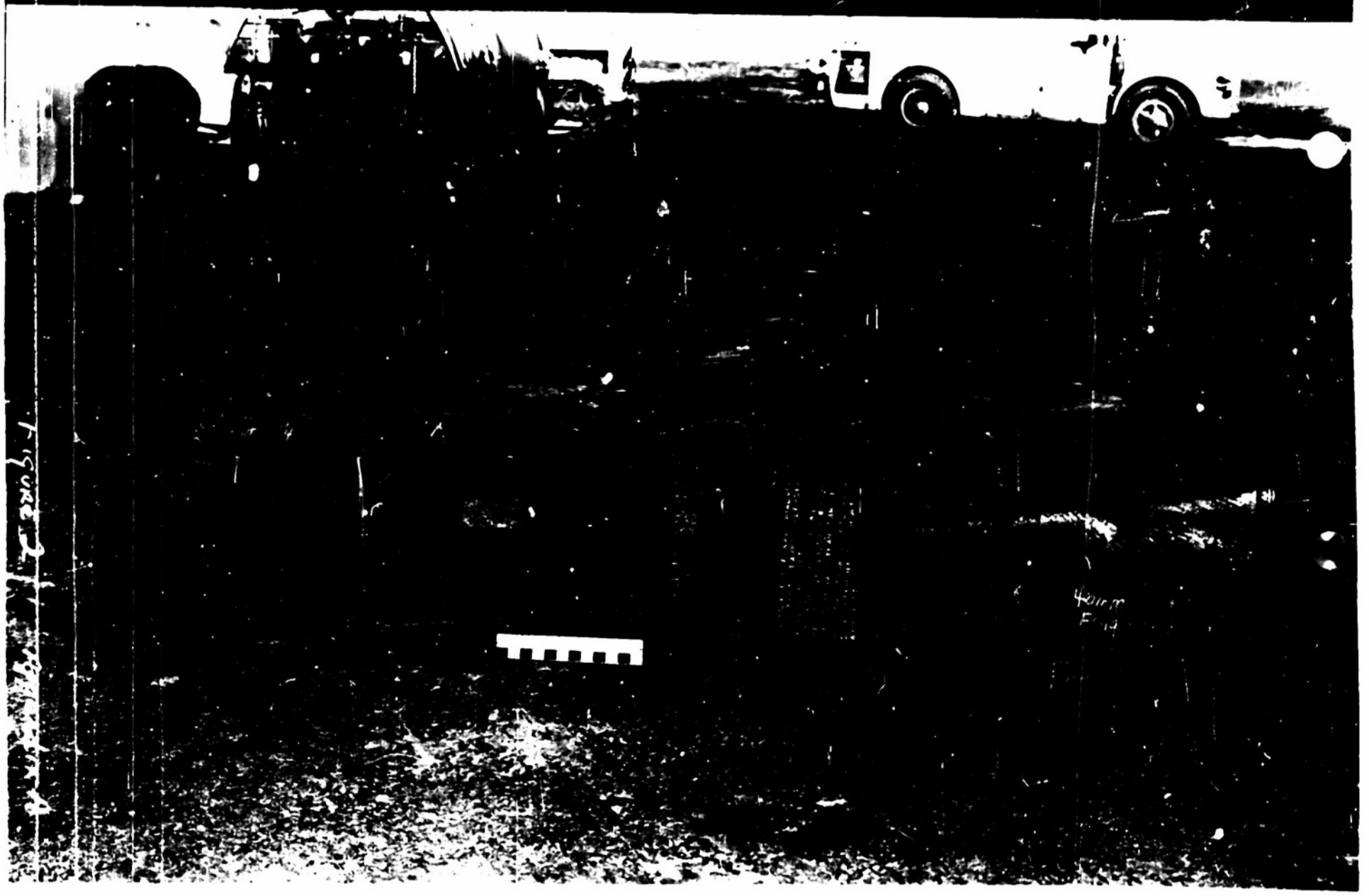


Figure 1 App. A

NP9 51919 9 January 1953 RESTRICTED SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing entrance wounds in RH and LH center fuel cells inflicted by .30 caliber ball projectiles and fragments from a detonated 40mm projectile. The extensive damage to the RH center cell is the results of a fire.

Figure 2



NP9 51920

9 January 1953

RESTRICTED
SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing entrance and exit wounds in RH and LH center fuel cells inflicted by .30 caliber ball projectiles and a fragment from a detonated 40mm projectile.

Figure 3

Figure 3 Appendix A

NP9 51921 9 January 1953 RESTRICTED SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing entrance and exit wounds in RH, LH and center forward fuel cells inflicted by .30 caliber ball and .50 caliber armor piercing projectile impacts.

Figure 4

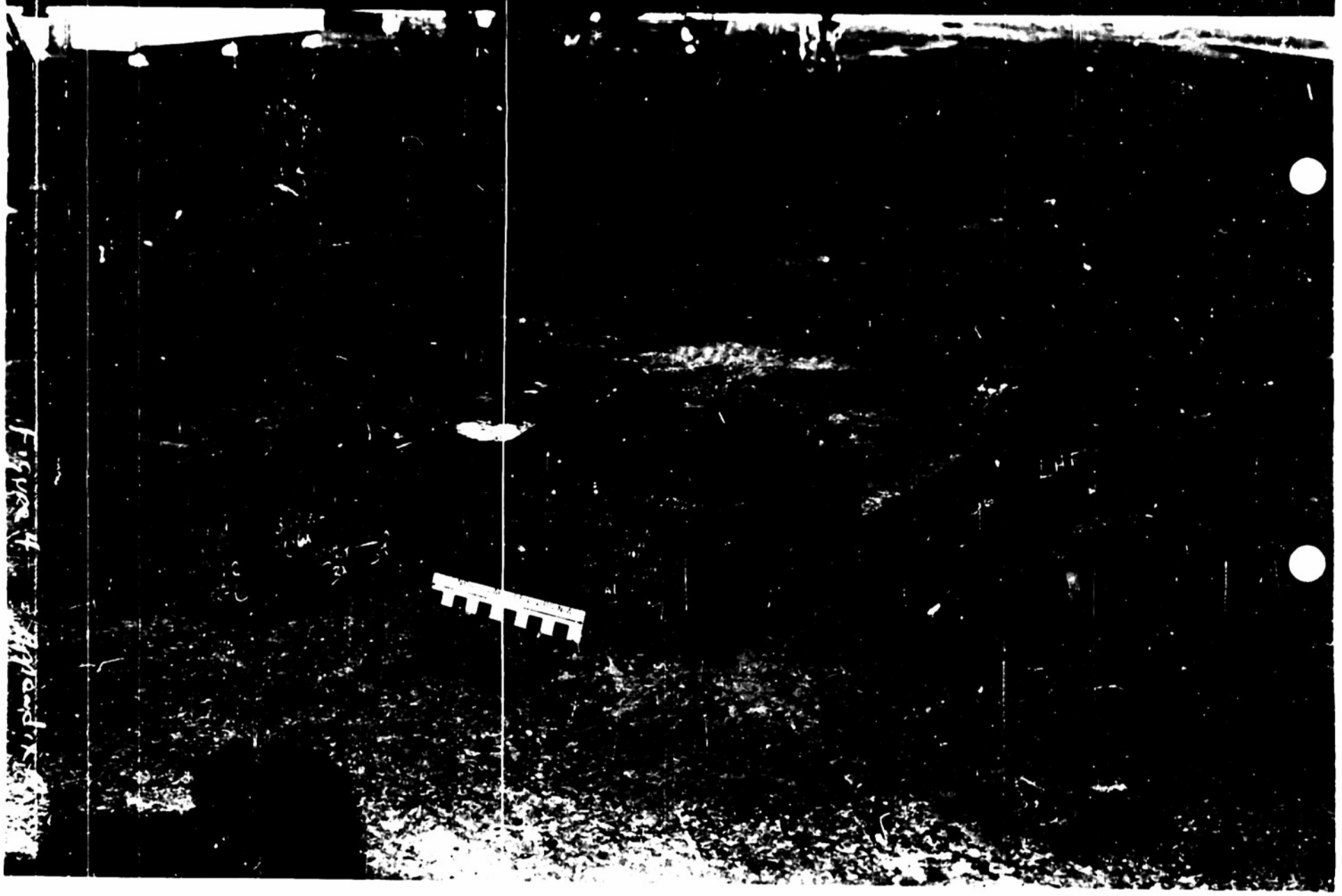


Figure 4 Attached

RESTRICTED
SECURITY INFORMATION

NP9 51922 9 January 1953

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing entrance and exit wounds in RH, LH and center forward fuel cells inflicted by .30 caliber ball and .50 caliber armor piercing projectile impacts.

Figure 5

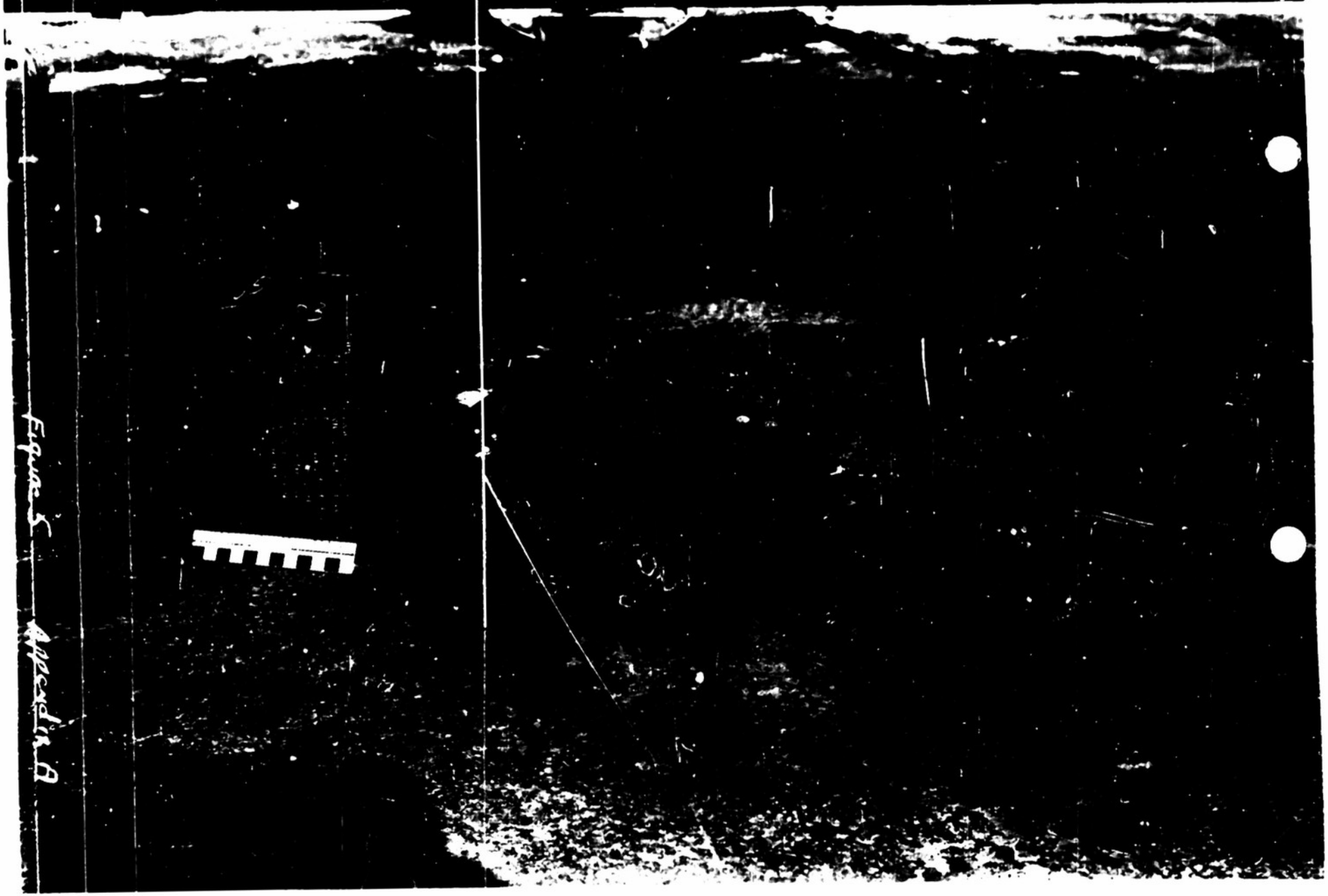


Figure 5 Appendix A

NP9 51923 9 January 1953 RESTRICTED SECURITY INFORMATION

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing the top of the test structure at the conclusion of the gunfire test and fire.

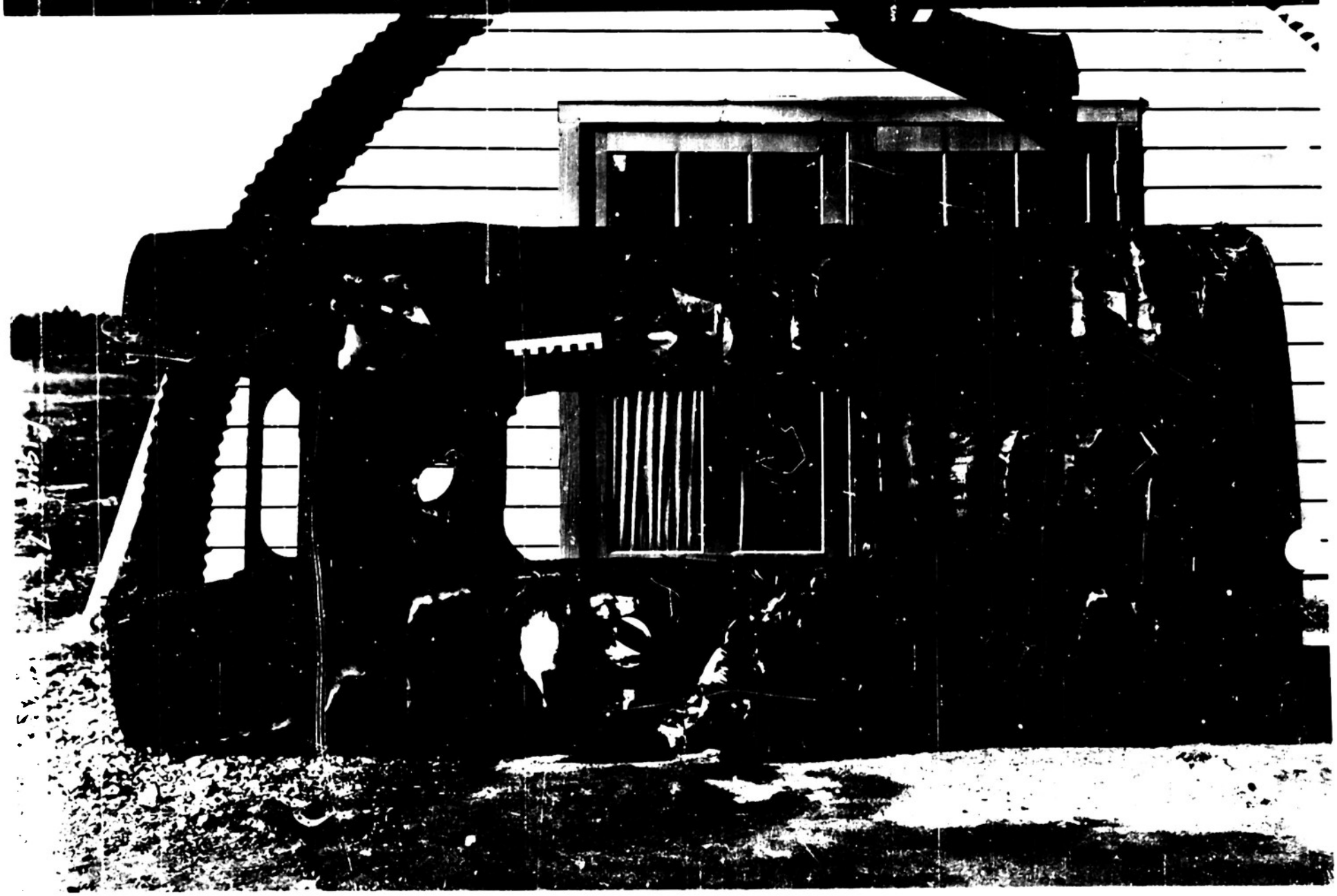
Figure 6

RESTRICTED
SECURITY INFORMATION

NP9 51924 9 January 1953

Gunfire Qualification Test of Model HRS-3 Helicopter Self Sealing Fuel Cell Installation. View showing the bottom of the test structure at the conclusion of the gunfire test and fire.

Figure 7



Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

TABULATED RESULTS OF GUNFIRE TEST

Preliminary Notes:

1. In the following table, the number with "x" after them refer to the exit wounds made by the subject round.

2. The following abbreviations are used:

SRH	Small round hole
LH	Leaking heavily

TABULATED RESULTS OF GUNFIRE TEST

Weather: Raining
Temp.: 40°F

Humidity 98%
Wind N-NW 7K

Specimen Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation Date 1-9-53

Entrance Round No.	1	1A	2	3	3A
Leakage, Impact	Dry	Dry	Dry	Dry	Dry
(2 min.)	-	-	-	-	-
(5 min.)	-	-	-	-	-
Size of Wound	SRH	2"	SRH	SRH	5/8"
Head of Fuel				3-1/2"	4-1/2"
Location of Impact	R.H Center Cell - L.H. Center Cell		R.H. Center Cell	R.H. Fwd. Cell - Center Fwd. Cell	
Obliquity Angle	90°	90°	90°	90°	90°
Type Fuel	Iso-octane		Iso-octane	Iso-octane	
Type Ammunition	.30 caliber ball		.30 caliber ball	.30 caliber ball	
Type of Impact	Normal - Full Tumble		Normal	Normal - Normal	
Remarks					

Exit Data-Round	1x	1Ax	2x	-	-
Size Hole (in.)					
Head of Fuel					
Leakage, Impact	Dry	Dry	Dry		
(2 min.)	-	-	-		
(5 min.)	-	-	-		
Remarks					

TABULATED RESULTS OF GUNFIRE TEST (Continued)

Specimen Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation Date 1-9-53

Entrance Round No.	4	4A	5	5A
Leakage, Impact	Dry - Above Fuel Level		Dry	Dry
(2 min.)	-	-	-	-
(5 min.)	-	-	-	-
Size of wound	SRH	3/4"	SRH	1/2"
Head of Fuel		-	3"	4"
Location of Impact	R.H. Center Cell - L.H. Center Cell		R.H. Fwd Cell - Center Fwd. Cell	
Obliquity Angle	90°	90°	90°	90°
Type Fuel	Iso-octane		Iso-octane	
Type Ammunition	.30 caliber ball		.30 caliber ball	
Type of Impact	Normal	Normal	Normal	Normal
Remarks				

Exit Data-Round	4x	5x	-
Size Hole (in.)		1/2"	
Head of Fuel		4"	
Leakage, Impact	Dry	Dry	
(2 min.)	-	-	
(5 min.)	-	-	
Remarks			

TABULATED RESULTS OF GUNFIRE TEST (Continued)

Specimen Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation				Date 1-9-53
Entrance Round No.	6	6A	7	8
Leakage, Impact	Dry	Dry	Dry	Dry
(2 min.)	-	-	-	-
(5 min.)	-	-	-	-
Size of Wound	SRH	SRH	SRH	SRH
Head of Fuel	3"	2-1/2"	3-1/2"	4"
Location of Impact	R.H. Fwd. Cell - Center Fwd. Cell		Center Fwd. Cell	L.H. Fwd. Cell
Obliquity Angle	80°	80°	80°	90°
Type Fuel	Iso-octane		Iso-octane	Iso-octane
Type Ammunition	.30 caliber ball		.30 caliber ball	.50 caliber AP
Type of Impact	Normal	Normal	Normal	Normal
Remarks				Cabin floor buckled over LH forward fuel cell.
Exit Data-Round	6x	-	-	8x
Size Hole	3/4"			1-3/4"
Head of Fuel	3"			4-1/2"
Leakage, Impact	Dry			Damp
(2 min.)	-			-
(5 min.)	-			-
Remarks				

TABULATED RESULTS OF GUNFIRE TEST (Continued)

Specimen Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation Date 1-9-53

Entrance Round No.	9	9A	Detonation		
Leakage, Impact	Damp	L.H.	Unobserved due to fire.		
(2 min.)	-	L.H.	-		
(5 min.)	-	L.H.	-		
Size of Wound	SRH	1-3/4"	1-1/4"	- 1-3/4"	- 1/2"
Head of Fuel	6"	3-1/2"	-	-	-
Location of Impact	L.H. Fwd. Cell	- Center Fwd. Cell	L.H. Center	- R.H. Center	- L.H. Center Cells
Obliquity Angle	90°	90°	-	-	-
Type Fuel	Iso-octane		Iso-octane		
Type Ammunition	.50 caliber AP		40mm HEP projectile		
Type of Impact	Normal	Full tumble	Static detonation (Fragments)		
Remarks	Bottom skin torn - Metal flowered into wound.		Specimen caught fire and burned extensively.		

Exit Data-Round	9x	-
Size Hole (in.)	1-3/4"	
Head of Fuel	4"	
Leakage, Impact	Damp	
(2 min.)	-	
(5 min.)	-	
Remarks	Projectile tumbled	

Gunfire Qualification Test of
Model HRS-2 and -3 Helicopter Self Sealing Fuel Cell Installation

DISTRIBUTION

Bureau of Ordnance:	
Ad3	1
Re3	1
Re8	1
Bureau of Aeronautics	
Attn: AE-664	5
Attn: TD-4	2
Navy Research Section, Library of Congress Washington 25, D. C. (via BUAER TD-410)	2
Commanding General Aberdeen Proving Ground Aberdeen, Maryland Attn: Technical Information Section Development and Proof Services	1
Naval Gun Factory Attn: Aircraft Armament Section	1
NATC, Patuxent River, Maryland	1
Naval Liaison Officer USAFPGC, Eglin Field, Florida	1
Commander, Operational Development Force U. S. Atlantic Fleet, U. S. Naval Base Norfolk 11, Virginia	1
NAOTS, Chincoteague, Va.	1
NADS, Johnsville, Pa.	1
Air Materiel Command Liaison Officer Wing 3 Headquarters Aberdeen Proving Ground, Aberdeen, Maryland	2

DISTRIBUTION (Continued)

U. S. Air Force AMC Engineering Field Office Room 1833, Main Navy Building Washington 25, D. C.		2
Local:	OV	1
	OVT	1
	File	[illegible]