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NPG REPORT NO. 1217

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1217

RESEARCH, DEVELOPMENT, AND TESTS OF
AIR DEFENSE WEAPON PROJECTILE FUZES

98th Partial Report

FRAGMENTATION TESTS OF 3"/50 PROJECTILES
MK 33, COMPOSITION A-3 LOADED, AND
ASSEMBLED WITH BASE VT FUZES D-170

FINAL Report

Task
Assignment NPG-Re2b-1-1-53

Copy No. 11

Classification CONFIDENTIAL
SECURITY INFORMATION

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Fragmentation Tests of 3"/50 Projectiles Mk 33,
 Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of modified 3"/50 Projectiles Mk 33, Composition A-3 loaded, and assembled with base VT fuzes D-170.

2. a. The base VT fuze projectile differed from the nose VT fuze standard projectile in that it had a more concentrated beam of fragments in polar zone 65°-110° and had a 10% higher fragment velocity. However, the standard nose VT fuze projectile has a slightly wider beam spray.

b. The fragmentation data are summarized as follows:

	3"/50 AA Projectiles Mk 33, Comp. A-3 Loaded		
	Nose VT	Short base VT	Long base VT
No. hits in zone 65°-110°	269	514	436
No. hits in zone 45°-120°	318	514	436
Medium fragment velocity (ft/sec)	3300	3670	3510
No. fragments 1.25 - 205 grams	510	519	491

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

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Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

PART B

INTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re2b-1-1-53.

2. REFERENCES:

- a. BUORD Conf ltr S78-1(54) Re2c-JSM:rjb Ser 45192 of 24 September 1952
- b. NPG Conf Report No. 1123 of 7 May 1953
- c. NPG Conf Report No. 468 of 31 January 1950

3. BACKGROUND:

a. Reference (b) reported the fragmentation results for the 5"/38 AAC projectile assembled with base VT fuze. Nose VT fuze projectile fragmentation data were included.

b. In the development of base VT fuzes for medium caliber projectiles, the Naval Proving Ground was requested by reference (a) to fragment and evaluate the base VT fuze in the 3"/50 projectile.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of modified 3"/50 Projectiles Mk 33, Composition A-3 loaded, and assembled with base VT fuzes D-170.

5. PERIOD OF TEST:

- | | |
|---|-------------------|
| a. Date Project Letter | 24 September 1952 |
| b. Date all Necessary Material Received | 6 August 1953 |
| c. Date Commenced Test | 27 August 1953 |
| d. Date Test Completed | 21 September 1953 |

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

Twelve rounds of 3"/50 Projectiles Mk 33 were used, modified according to BUORD Drawing No. 1370699, Figure 1. The nose portion of the projectile is integral with the projectile body, and there is a 2.00 diameter hole in the base for the accommodation of the base VT fuze. All projectiles were loaded with Composition A-3 having a density of $1.63 \pm .01$. Six projectiles were cavitized for the short VT fuze and six for the long VT fuze. The intrusion depths of the fuzes, measured from the projectile base, were 6.02 and 7.02 for the short and long fuze respectively, Figure 2. The average weight data in pounds of the projectiles are as follows:

<u>VT Fuze Type</u>	<u>Empty Proj.</u>	<u>Comp. A-3</u>	<u>Fuze</u>	<u>Total</u>
Short Base	9.45	0.92	3.20	13.57
Long Base	9.37	0.85	3.52	13.74
*Standard Nose	9.43	0.81	2.50	12.74

* Reference (c) data.

7. PROCEDURE:

a. Fragment Mass Distribution:

Three rounds of each fuze type were tested for fragment mass distribution. Each projectile was placed in a cane fiberboard box which was located in the center of a sawdust filled chamber. After each detonation, the sawdust was sifted and the fragments collected by the use of a screen mesh and a magnetic separator.

b. Fragment Space Distribution:

Three rounds of each type were tested in a 20 foot radius circular space distribution arena having 1/8" mild steel panels 5 feet high, marked off in 5° polar angle zones about the axis of the projectile with the nose pointed toward 0°. Complete penetrations of the panels were recorded.

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

c. Fragment Velocity:

Since only a small number of projectiles was available, 6 of each type, fragment velocity and space distribution determinations were combined. Additional 1/8" mild steel panels were added to the space arena in order to obtain a larger fragment sample for the velocity data. A 16mm Fastax camera viewed 10 feet high panels at 20 feet from the projectile in the zone 0°-100°. The normal procedure for obtaining fragment velocities of 3" projectiles requires a 30 foot base line; the velocities obtained on these tests are slightly higher since a 20 foot base line was used.

8. RESULTS AND DISCUSSION:

a. Fragment Mass Distribution:

(1) The two types of base VT fuzed 3"/50 projectile produced similar numbers of projectile fragments in weight group 1.25 to 205 grams. The detailed data, listed in Table I and shown in Figures 3 to 8, are summarized as follows:

<u>VT Fuze Type</u>	<u>No. Proj. Fragments 1.25 to 205 grams</u>
Short Base VT	519
Long Base	491
*Standard Nose	510

* Reference (c) data.

The differences in numbers are not considered significant. The base VT fuzed projectiles did produce over twice the number of fuze fragments, but these are not considered to be very effective, since their median size is quite small.

(2) Since the base VT fuzed projectile weighed about one pound more than the nose VT fuzed projectile, the standard nose VT projectile is considered superior to the base VT projectile in mass characteristics on a weight for weight basis.

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

b. Fragment Space Distribution:

The base VT fuzed projectile produced many more effective fragments, those capable of penetrating 1/8" mild steel plate at 20 feet, than the nose VT fuzed projectile. The data detailed in Table II are summarized as follows:

<u>VT Fuze Type</u>	<u>No. Hits per total zone</u>		
	<u>65° - 110°</u>	<u>45° - 120°</u>	<u>0° - 180°</u>
Short Base	514	514	514
Long Base	436	436	436
*Standard Nose	269	318	324

* Reference (c) data.

The beam of effective fragment hits is narrower and more concentrated on the base VT fuzed projectile than on the nose VT fuzed projectile.

c. Fragment Velocity:

Detailed fragment velocity data listed in Table III are summarized as follows:

<u>VT Fuze Type</u>	<u>Average Median Beam Spray Fragment Velocity</u>
Short Base	3670 f.s.
Long Base	3510 f.s.
*Standard Nose	3300 f.s.

* In reference (c), measured velocity over a 30 foot base line was given as 3140 f/s. This value has been approximately corrected to a 20 foot base line to give the entry in the table.

Fragmentation Tests of 3"/50 Projectiles Mk 33,
 Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

PART D

CONCLUSIONS

9. a. The base VT fuze projectile differed from the nose VT fuze standard projectile in that it had a more concentrated beam of fragments in polar zone 65°-110° and had a 10% higher fragment velocity. However, the standard nose VT fuze projectile has a slightly wider beam spray.

b. The fragmentation data are summarized as follows:

	3"/50 AA Projectiles Mk 33, Comp. A-3 Loaded		
	<u>Nose VT</u>	<u>Short base VT</u>	<u>Long base VT</u>
No. hits in zone 65°-110°	269	514	436
No. hits in zone 45°-120°	318	514	436
Medium fragment velocity (ft/sec)	3300	3670	3510
No. fragments 1.25 - 205 grams	510	519	491

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

The tests upon which this report is based were conducted by:

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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Ninety-eighth Partial Report

on

Research, Development, and Tests of
Air Defense Weapon Projectile Fuzes

Final Report

on

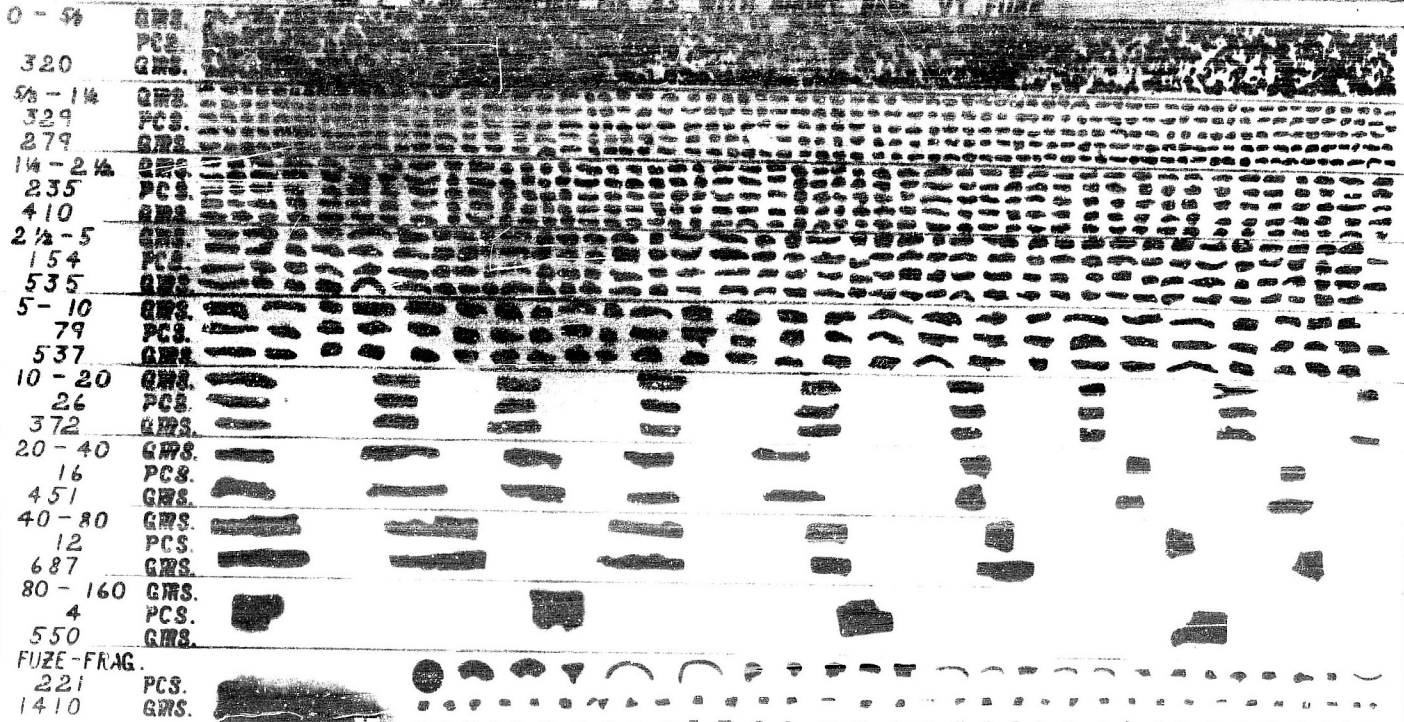
Fragmentation Tests of 3"/50 Projectiles
Mk 33, Composition A-3 Loaded, and
Assembled with Base VT Fuzes D-170

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NOV 25 1953

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SCALE 1

FRAG NO. 1774

RD-2 J 50 MODIFIED MK 33 WITH SHORT BASE VT FUZE

NP9 NO 164119

0 - 5/8	GMS.	
261	PCS.	
	GMS.	

5/8 - 1 1/4	GMS.	
242	PCS.	
205	GMS.	

1 1/4 - 2 1/2	GMS.	
202	PCS.	
351	GMS.	

2 1/2 - 5	GMS.	
152	PCS.	
522	GMS.	

5 - 10	GMS.	
87	PCS.	
611	GMS.	

10 - 20	GMS.	
40	PCS.	
539	GMS.	

20 - 40	GMS.	
18	PCS.	
522	GMS.	

40 - 80	GMS.	
12	PCS.	
612	GMS.	

80 - 160	GMS.	
4	PCS.	
517	GMS.	

FUZE-FRAG.	GMS.	
265	PCS.	
1410	GMS.	

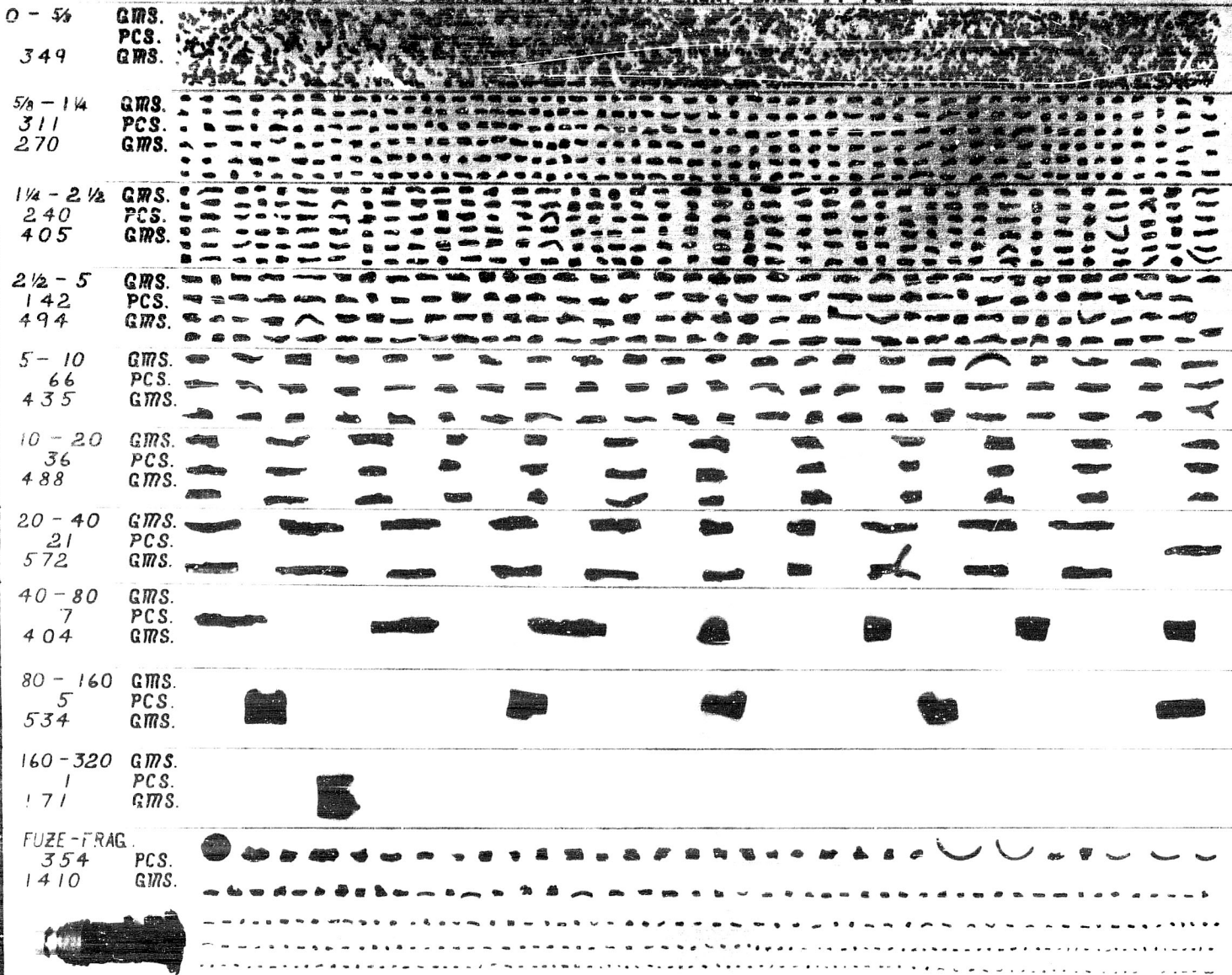


SCALE 1"

FRAG NO. 1777

MP9 NO. 64136

RD-3 3"/50 MODIFIED MK 63 WITH SHORT BASE VT FUZE



SCALE 1"

MP9-64136

8 September 1953

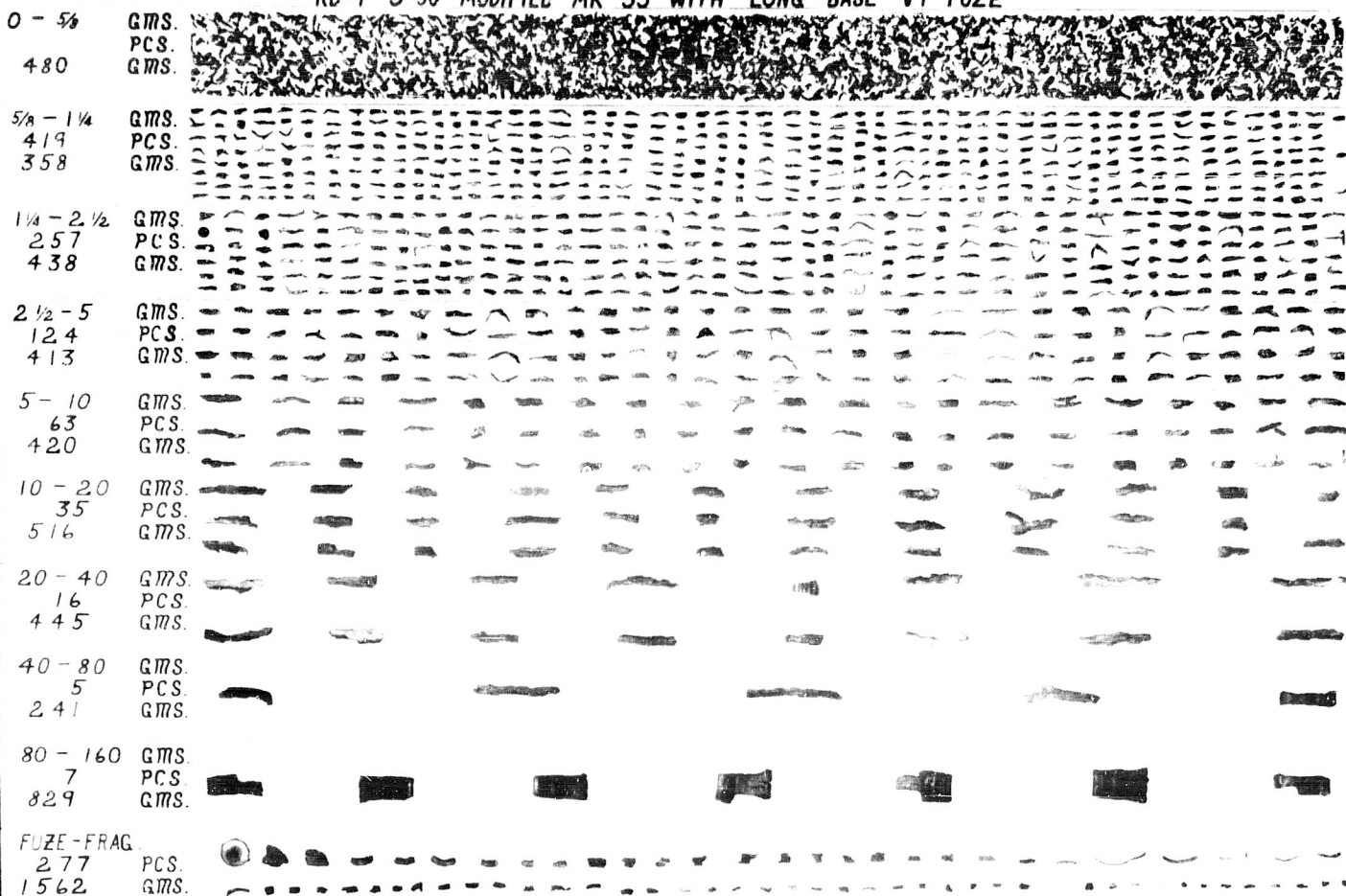
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Rd. 3 Fragment Mass distribution 3"/50 Projectile, Composition A-3 loaded, and assembled with short base VT fuze.

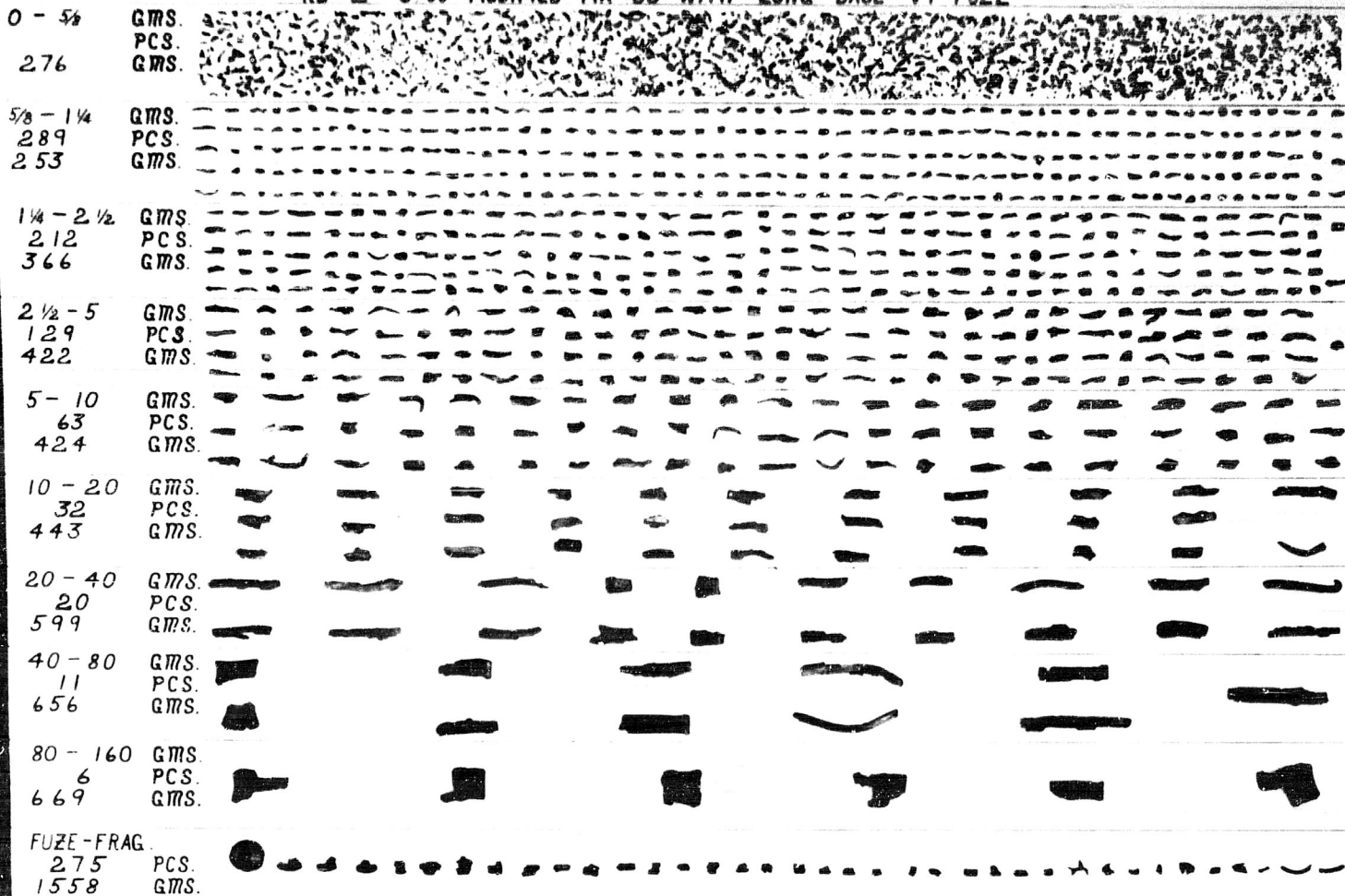
FIGURE 5

RD-1 3 50 MODIFIED MK 33 WITH LONG BASE VT FUZE



SCALE 1

RD-2 3.50 MODIFIED MK 33 WITH LONG BASE VT FUZE

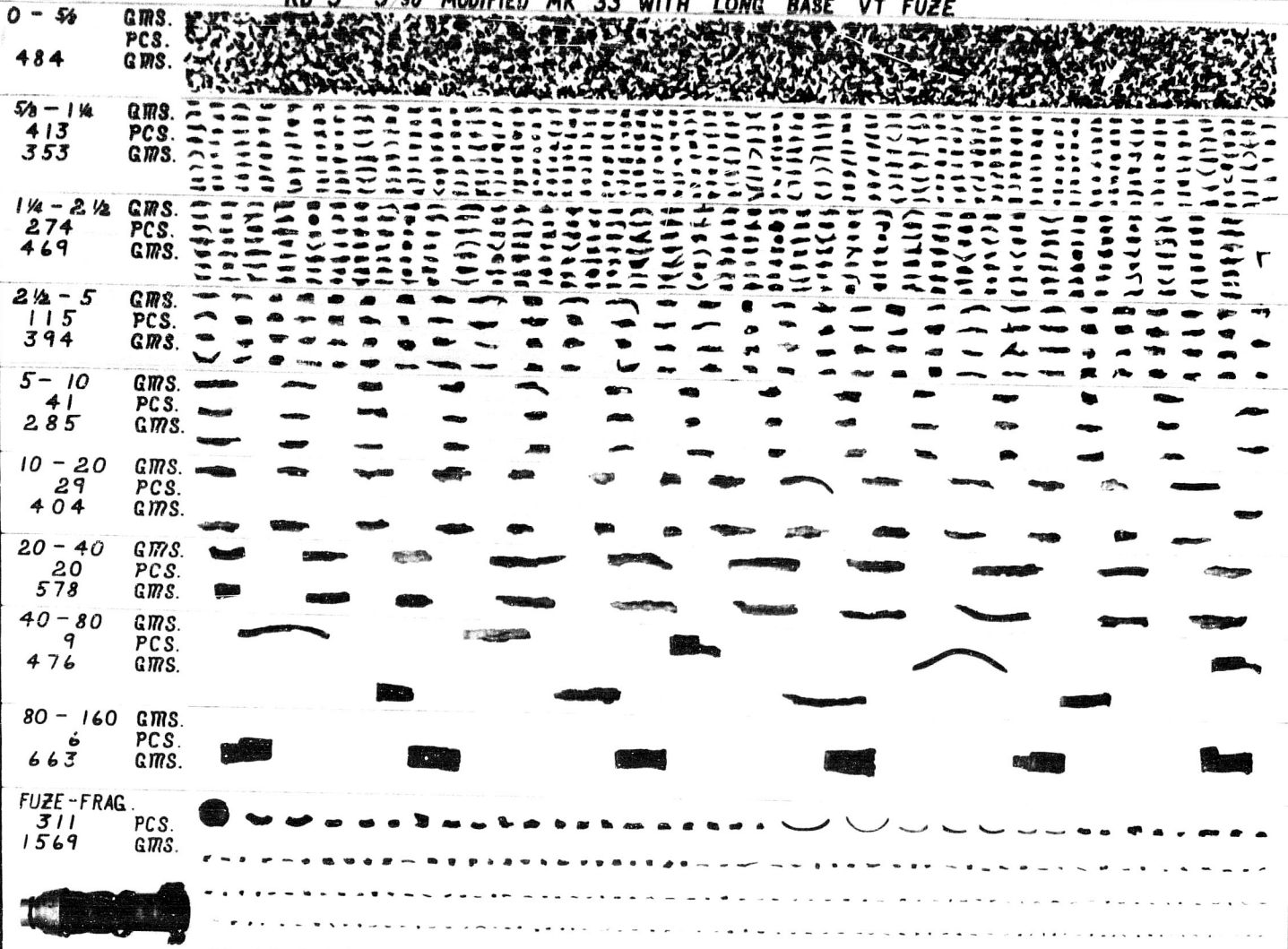


SCALE 1

FRAG NO. 1778

RD-3 3.50 MODIFIED MK 33 WITH LONG BASE VT FUZE

NP9 NO. 64182



SCALE 1

NP9-64182

October 1944

QUALITY DIVISION

Rd. 3 Fragment Mass distribution of 3.50 Projectile, Composition A-3 Loaded, and assembled with long base VT fuze.

FIGURE 8

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Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

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TABLE I

MASS DISTRIBUTION DATA

Base VT Fuze	Rd. No.	Comp. Wt. lb.	Comp. A-3 Filler Wt. lb.	3"/50 PROJECTILES, MODIFIED MK 33, COMP. A-3 LOADED AND ASSEMBLED WITH BASE VT FUZES (D-170)												Total No.	Photo. No. NP9									
				NUMBER AND WEIGHT OF RECOVERED FRAGMENTS																						
				0-0.625	0.625-1.25	1.25-2.5	2.5-5	5-10	10-20	20-40	40-80	80-205	Fuze													
				grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	grams Wt.	No.	Gms.										
Short	1	13.58	.92	320	279	329	410	235	535	154	537	79	372	26	451	16	687	12	550	4	550	1410	221	1076	5551	64117
"	2	13.58	.92	261	205	242	351	202	522	152	611	87	539	40	522	18	612	12	517	4	517	1410	265	1022	5550	64119
"	3	13.48	.92	349	270	311	405	240	494	142	435	66	488	36	572	21	404	7	705	6	705	1410	354	1183	5532	64136
Long	1	13.82	.85	480	358	419	438	257	413	124	420	63	516	35	445	16	241	5	829	7	829	1562	277	1203	5702	64122
"	2	13.73	.85	276	253	289	366	212	422	129	424	63	443	32	599	20	656	11	669	6	669	1558	275	1037	5666	64129
"	3	13.70	.85	484	353	413	469	274	394	115	285	41	404	29	578	20	476	9	663	6	663	1569	311	1218	5675	64182
Short Avg.		13.55	0.92	310	251	294	389	226	517	149	528	77	466	34	515	18	568	10	591	5	591	1410	280	1094	5544	---
Long Avg.		13.75	0.85	413	321	374	424	248	410	123	376	56	454	32	541	19	458	8	720	6	720	1563	288	1153	5681	---
VT* Avg.		12.74	0.81	Not Available	327	183	540	154	617	90	739	55	386	15	254	5	989	8	989	8	989	1025	114	624	4877	

NOTE:

* NPG Conf Report No. 468 of 31 January 1950, totals are for 1.25 - 205 grams and fuze fragments.

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APPENDIX B

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Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE II

SPACE DISTRIBUTION DATA

20 Ft. Radius Circular Space Arena
1/8" MS panels 5' high

3"/50 Proj. with Short base VT fuze
Date: 16 September 1953

Zone Degrees	Proj. #10 Fuze #4 Rd. 1			Proj. #11 Fuze #5 Rd. 2			Proj. #12 Fuze #6 Rd. 3			Avg. Impacts Per 5° zone on panel	Avg. Impacts Per total 5° zone on panel	Avg. Impacts Per Unit Solid Angle
	<u>R</u>	<u>L</u>	<u>Avg.</u>	<u>R</u>	<u>L</u>	<u>Avg.</u>	<u>R</u>	<u>L</u>	<u>Avg.</u>			
C-5												
5-10												
10-15												
15-20												
20-25												
25-30												
30-35												
35-40												
40-45												
45-50												
50-55												
55-60												
60-65												
65-70	1	2	1.5	1		0.5	2		1.0	1.0	23	50
70-75	4	2	3.0	6	3	4.5	3	6	4.5	4.0	96	184
75-80	6	7	6.5	4	6	5.0	6	4	5.0	5.5	136	250
80-85	4	2	3.0	2	3	2.5	4	2	3.0	2.8	70	129
85-90	1	3	2.0	6	6	6.0	2	3	2.5	3.5	88	161
90-95	2		1.0	3	3	3.0	3	2	2.5	2.2	56	101
95-100		1	0.5	2	2	2.0	1	2	1.5	1.3	33	60
100-105				1		0.5	1		0.5	0.3	7	14
105-110	1		0.5							0.2	5	9
110-115												
115-120												
120-125												
125-130												
130-135												
135-140												
140-145												
145-150												
150-155												
155-160												
160-165												
165-170												
170-175												
175-180												

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Fragmentation Tests of 3"/50 Projectile Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE II (Continued)

20 Ft. Radius Circular Space Arena
1/8" MS panels 5' high

3"/50 Proj. with Long base VT fuze
Date: 16 September 1953

Zone Degrees	Proj. #4 Fuze #10 Rd. 1			Proj. #5 Fuze #11 Rd. 2			Proj. #6 Fuze #12 Rd. 3			Avg. Impacts Per 5° zone on panel	Avg. Impacts Per total 5° zone on panel	Avg. Impacts Per Unit Solid Angle
	R	L	AVG.	R	L	AVG.	R	L	AVG.			
0-5												
5-10												
10-15												
15-20												
20-25												
25-30												
30-35												
35-40												
40-45												
45-50												
50-55												
55-60												
60-65												
65-70		1	0.5	1	1	1.0	1	1	1.0	0.8	19	40
70-75	4	2	3.0	6	4	5.0	5	3	4.0	4.0	96	184
75-80	4	4	4.0	4	5	4.5	5	4	4.5	4.3	106	198
80-85	1	1	1.0	3	3	3.0	2	3	2.5	2.2	55	101
85-90	2	1	1.5	1	1	1.0	3	2	2.5	1.7	43	78
90-95	1	3	2.0	2	3	2.5	2	1	1.5	2.0	50	92
95-100	1	2	1.5	2	2	2.0	2	4	3.0	2.2	55	101
100-105	1		0.5	1		0.5	1		0.5	0.5	12	20
105-110												
110-115												
115-120												
120-125												
125-130												
130-135												
135-140												
140-145												
145-150												
150-155												
155-160												
160-165												
165-170												
170-175												
175-180												

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III

FRAGMENT VELOCITY DATA

20 Ft. Radius Arena,	6300 Frames per second
10' high panels in zone 65°-110°	Fuze (Short) D-170 Base VT Fuze
16mm Fastax Camera	Filler Weight 0.92 lbs.
Rd. No. 1 - 3"/50 AA with short	Total Weight 13.62 lbs.
VT Base Fuze	Date: 16 September 1953
Filler Comp. A-3	

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	4	3820
34	4	3710
35	4	3600
36	3	3500
37	1	3410
38	2	3320
39	1	3230
40	1	3150
Median		3620
Average		3520

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III (Continued)

20 Ft. Radius Arena,	6300 Frames per second
10' high panels in zone 65°-110°	Fuze (Short) D-170 Base VT Fuze
16mm Fastax Camera	Filler Weight 0.92 lbs.
Rd. No. 2 - 3"/50 AA with short	Total Weight 13.52 lbs.
VT Base Fuze	Date: 16 September 1953
Filler Comp. A-3	

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
32	4	3940
33	3	3820
34	7	3710
35	2	3600
36	3	3500
37	2	3410
40	2	3150
Median		3730
Average		3650

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III (Continued)

20 Ft. Radius Arena,	6250 Frames per second
10' high panels in zone 65°-110°	Fuze (Short) D-170 Base VT Fuze
16mm Fastax Camera	Filler Weight 0.92 lbs.
Rd. No. 3 - 3"/50 AA with short	Total Weight 13.62 lbs.
VT Base Fuze	Date: 16 September 1953
Filler Comp. A-3	

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
32	1	3910
33	3	3790
34	5	3680
35	2	3570
36	2	3470
37	3	3380
Median		3670
Average		3620

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III (Continued)

20 Ft. Radius Arena, 10' high panels in zone 65°-110° 16mm Fastax Camera Rd. No. 1 - 3"/50 AA with long VT Base Fuze Filler Comp. A-3	6000 Frames per second Fuze (Long) D-170 Base VT Fuze Filler Weight 0.85 lbs. Total Weight 13.76 lbs. Date: 16 September 1953
--	---

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
31	1	3870
32	7	3750
34	2	3530
36	1	3330
37	3	3240
38	1	3160
45	1	2670
Median		3580
Average		3500

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III (Continued)

20 Ft. Radius Arena,	6200 Frames per second
10' high panels in zone 65°-110°	Fuze (Long) D-170 Base VT Fuze
16mm Fastax Camera	Filler Weight 0.85 lbs.
Rd. No. 2 - 3"/50 AA with long	Total Weight 13.72 lbs.
VT Base Fuze	Date: 16 September 1953
Filler Comp. A-3	

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
35	4	3540
36	2	3440
37	3	3350
38	2	3260
39	1	3180
42	1	2950
Median		3450
Average		3360

Fragmentation Tests of 3"/50 Projectiles Mk 33,
Composition A-3 Loaded, and Assembled with Base VT Fuzes D-170

TABLE III (Continued)

20 Ft. Radius Arena, 10' high panels in zone 65°-110° 16mm Fastax Camera Rd. No. 3 - 3"/50 AA with long VT Base Fuze Filler Comp. A-3	6150 Frames per second Fuze (Long) D-170 Base VT Fuze Filler Weight 0.85 lbs. Total Weight 13.72 lbs. Date: 16 September 1953
--	---

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	1	3730
34	2	3620
35	3	3510
36	1	3420
37	2	3320
38	2	3240
Median		3500
Average		3460