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U S NAVAL PROVING GROUND  
 DAHLGREN, VIRGINIA

REPORT NO 964

FRAGMENTATION CHARACTERISTICS  
 18th Partial Report

FRAGMENTATION TEST OF  
 2"75 ROCKET HEADS

Task Assignment NPG-Re3d-418-1-52

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NPG REPORT NO. 964

U. S. NAVAL PROVING GROUND  
DAHLGREN, VIRGINIA

Eighteenth Partial Report  
on  
Fragmentation Characteristics

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Final Report  
on  
Fragmentation Test of  
2V75 Rocket Heads

NAVY RESEARCH SECTION  
SCIENCE DIVISION  
REFERENCE DEPARTMENT

MAY 12 1952

Project No.: NPG-Re3d-418-1-52  
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Fragmentation Test of 2V75 Rocket Heads  
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PART A

SYNOPSIS

1. This test was conducted to obtain the fragmentation characteristics of the 2V75 Air to Air Folding-Fin Rocket (AAFPR).
2. The HBX-1 loaded 2V75 AAFPR when detonated statically produced:
  - a. relatively fine fragments
  - b. an average median fragment velocity of 3780 ft./sec. and
  - c. an average of 745 fragment hits in total polar angle zone 55°-115°, with the heaviest concentration in zone 95°-100°.

Fragmentation Test of 2V75 Rocket Heads

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Fragmentation Test of 2W75 Rocket Heads  
-----PART BINTRODUCTION

## 1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3d-418-1-52, reference (b).

## 2. REFERENCES:

- a. BUORD Conf ltr S78-1(119) Re3d-ANB:hm Ser 25820 of 18 Sep 1951
- b. BUORD Restr ltr NP9 Re3d-ANB:hm of 4 Aug 1951
- c. NOTS Conf NAVORD Report 1263, NOTS 329 of 6 Oct 1950

## 3. BACKGROUND:

Reference (c) reported on the details of the 2W75 Air to Air Folding-Fin Rocket (AAFFR) which has a high explosive head and is intended to be used by fighter and interceptor aircrafts in attacks against other aircraft. Reference (a) requested the Proving Ground to obtain fragmentation data for this rocket. The results are reported herein.

## 4. OBJECT OF TEST:

This test was conducted to obtain the fragmentation characteristics of the 2W75 Air to Air Folding-Fin Rocket (AAFFR).

## 5. PERIOD OF TEST:

- |                                     |                   |
|-------------------------------------|-------------------|
| a. Date Project Letter              | 18 September 1951 |
| b. Date Necessary Material Received | 19 November 1951  |
| c. Date Commenced Test              | 11 December 1951  |
| d. Date Test Completed              | 4 January 1951    |

## 6. REPRESENTATIVE PRESENT:

This test was witnessed in part by Mr. F. R. Donoghue representing the Bureau of Ordnance.

Fragmentation Test of 2875 Rocket Heads  
-----PART CDETAILS OF TEST

## 7. DESCRIPTION OF ITEM UNDER TEST:

2875 AAFRR Rockets having HBX-1 loaded MK 2 Rocket Heads and empty Mod 103XE-SF Rocket Motors. The heads were assembled with EX 100 Mod 0 point detonating fuzes which were modified by the Proving Ground for static detonation. The loaded heads with the fuze weighed  $6.30 \pm .05$  lbs. and the empty motors weighed  $4.0 \pm .05$  lbs. totaling  $10.3 \pm .1$  lbs. for the rounds assembled for static detonations. The filler (HBX-1) for the heads weighed 1.4 lbs.

## 8. PROCEDURE:

The twenty (20) rockets were detonated for the following information:

- 5 rounds for fragment mass distribution data,
- 5 rounds for fragment velocity data, and
- 10 rounds for fragment space distribution data.

a. The determination of fragment mass distribution was conducted in a sawdust-filled chamber. Each rocket was supported on its side in a cane fiberboard box. After each detonation, the sawdust was sifted and the fragments collected with the head fragments and the motor fragments separated and classified separately.

b. Fragment velocity measurements were obtained by the usual high speed photographic technique, using a 35mm Fastax camera. Fragment velocities obtained are the mean velocities over the first 30.6 feet of travel of beam spray (polar angle  $75^\circ$  to  $105^\circ$ ) fragments.

c. Fragment space distribution measurements were made in an arena consisting of a complete circle twenty (20) feet in radius. The arena panels were  $1/8$ " mild steel plate, five (5) feet high and marked in  $5^\circ$  zones about the axis of the rocket with the nose pointed toward  $0^\circ$ . The center of gravity of the rocket head coincided with the arena center. Complete fragment penetrations of the panels were counted.

Fragmentation Test of 2V75 Rocket Heads

9. RESULTS AND DISCUSSION:

a. Mass Distribution

Photographs of the fragment mass distribution data are shown in Figures 3 to 7 inclusive and are tabulated in Table III. The data are summarized as follows:

5 ROUND AVERAGES

Rocket	NO. FRAGMENTS IN VARIOUS WEIGHT GROUPS					
	<u>5/8-2 1/2</u> grams	<u>2 1/2-5</u> grams	<u>5-10</u> grams	<u>10-20</u> grams	<u>20-30</u> grams	<u>320-640</u> grams
Head	773	125	44	4	0	0
Motor	46	14	15	10	10	1*

\* The largest motor fragment averaged 503 grams.

The fine fragmentation of the rocket head can be attributed to the large explosive charge weight (1.4 lbs.) for a 2V75 diameter head.

b. Fragment Velocity

Detailed fragment velocity data are listed in Table II. The average median beam spray velocity of four rounds was 3780 ft./sec. The fifth round was oriented before detonation in such a way to obtain the velocity of the largest motor fragment by camera. This fragment could not be distinguished on the film but from the location of this fragment on the rounds fired in the field, its velocity is estimated to be in the order of 200 ft./sec.

c. Space Distribution

Detailed space distribution data are listed in Table I and the average fragment hits are summarized as follows:

\* 9 ROUND AVERAGES

<u>Polar Zone</u>	<u>Hits on Panels</u>	<u>Hits on Sphere</u>
0°-55°	0	0
55°-115°	30	745
115°-155°	0	0
155°-180°	3	8
Total	33	753

\* Ten (10) rounds were detonated, one of which detonated low order. The other nine (9) rounds detonated high order.

Fragmentation Test of 2V75 Rocket Heads  
-----

As noted from the above data, practically all hits were in zone 55°-115° with the heaviest concentration in zone 95°-100°. Many of the motor fragments struck the 1/8" mild steel panels causing silvery splashes on the steel without even denting the panels.

PART DCONCLUSIONS

10. The HBX-1 loaded 2V75 AAFRR when detonated statically produced:
- a. relatively fine fragments
  - b. an average median fragment velocity of 3780 ft./sec. and
  - c. an average of 745 fragment hits in total polar zone 55°-115° with the heaviest concentration in zone 95°-100°.

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NPG REPORT NO. 964

Fragmentation Test of 2U75 Rocket Heads  
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The tests upon which this report is based were conducted by:

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Fragmentation Division,  
Terminal Ballistics Department

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Commander, Naval Proving Ground

*C. T. Mauro*  
C. T. MAURO  
Captain, USN  
Ordnance Officer  
By direction

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2	1/10/52	WJH	WJH

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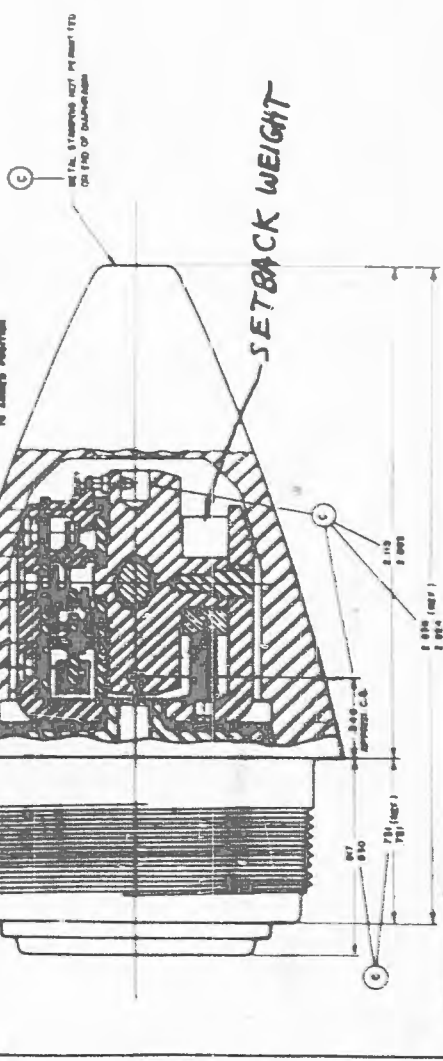
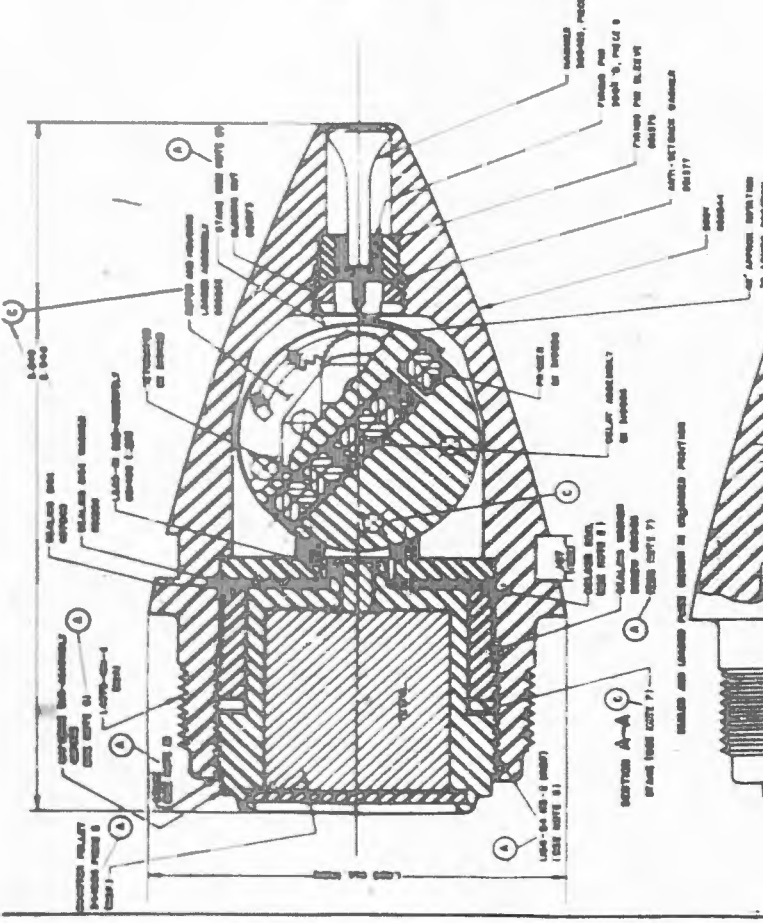
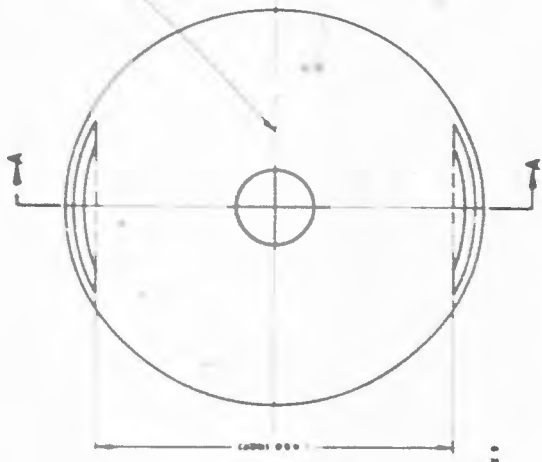
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Fragmentation Test of 2V75 Rocket Heads

TABLE I

SPACE DISTRIBUTION DATA

20' Radius Space Arena      12 December 1951, 2V75 Rockets (Rd. 1)  
 1/8" MS panels 5" high      2 January 1952, 2V75 Rockets (Rds. 2-9)  
 9 Rounds Fired

Zone, Degrees	Rd. 1			Rd. 2			Rd. 3		
	R <sub>e</sub>	L <sub>e</sub>	AVG <sub>e</sub>	R <sub>e</sub>	L <sub>e</sub>	AVG <sub>e</sub>	R <sub>e</sub>	L <sub>e</sub>	AVG <sub>e</sub>
0-5									
5-10									
10-15									
15-20									
20-25									
25-30									
30-35									
35-40									
40-45									
45-50									
50-55									
55-60		1	0.5						
60-65							1		0.5
65-70							1		0.5
70-75	1		0.5				1	1	1
75-80	2	5	3.5	1	2	1.5	1	2	1.5
80-85	4	1	2.5	4	3	3.5	2	1	1.5
85-90	5	3	4	2	3	2.5	1	2	1.5
90-95	6	8	7	7	4	5.5	1	3	2
95-100	10	6	8	12	9	10.5	6	5	5.5
100-105	3	3	3	3	2	2.5	3	1	2
105-110	1		0.5						
110-115									
115-120									
120-125									
125-130									
130-135									
135-140									
140-145									
145-150									
150-155									
155-160									
160-165					1	0.5			
165-170	2	1	1.5	1		0.5			
170-175	1		0.5	2	1	1.5	1		0.5
175-180	1		0.5	2		1	1		0.5

Fragmentation Test of 2V75 Rocket Heads

TABLE I (Continued)

20' Radius Space Arena 12 December 1951, 2V75 Rockets (Rd. 1)  
 1/8" MS panels 5" high 2 January 1952, 2V75 Rockets (Rds.2-9)  
 9 Rounds Fired

Zone, Degrees	Rd. 4			Rd. 5			Rd. 6		
	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	1		0.5						
60-65		1	0.5				1		0.5
65-70									
70-75	1		0.5	1		0.5			
75-80	3	2	2.5		1	0.5	2	2	2.
80-85	1	1	1	6	3	4.5	3	1	2
85-90	8	6	7	3	7	5	8	1	4.5
90-95	10	3	6.5	7	3	5	7	7	7
95-100	13	10	11.5	10	10	10	9	6	7.5
100-105	1	2	1.5	6	5	5.5	5	4	4.5
105-110					1	0.5			
110-115		1	0.5						
115-120									
120-125									
125-130									
130-135									
135-140									
140-145									
145-150									
150-155									
155-160									
160-165					1	0.5			
165-170					1	0.5			
170-175					2	1			
175-180		2	1				1		0.5

Fragmentation Test of 2V75 Rocket Heads

TABLE I (Continued)

20' Radius Space Arena      12 December 1951, 2V75 Rockets (Rd. 1)  
 1/8" MS panels 5" high      2 January 1952, 2V75 Rockets (Rds. 2-9)  
 9 Rounds Fired

Zone, Degrees	Rd. 7			Rd. 8			Rd. 9		
	R <sub>a</sub>	L <sub>a</sub>	AVG <sub>a</sub>	R <sub>a</sub>	L <sub>a</sub>	AVG <sub>a</sub>	R <sub>a</sub>	L <sub>a</sub>	AVG <sub>a</sub>
0-5									
5-10									
10-15									
15-20									
20-25									
25-30									
30-35									
35-40									
40-45									
45-50									
50-55									
55-60		1	0.5				1	1	1
60-65	1		0.5					1	0.5
65-70				2		1			
70-75	1	1	1	1	2	1.5	1	1	1
75-80	2	1	1.5	2	2	2	5		2.5
80-85	4	2	3	5	3	4	5	2	3.5
85-90	2	4	3	9	9	9	4	2	3
90-95	7	9	8	10	5	7.5	11	6	8.5
95-100	10	11	10.5	11	9	10	12	12	12
100-105	8		4	4	1	2.5	5	3	4
105-110									
110-115		1	0.5						
115-120									
120-125									
125-130									
130-135									
135-140									
140-145									
145-150									
150-155									
155-160								1	0.5
160-165					1	0.5			
165-170				1	2	1.5			
170-175		1	0.5	4	3	3.5			
175-180	1		0.5	1		1.5		1	0.5

Fragmentation Test of 2V75 Rocket Heads

TABLE I (Continued)

20° Radius Space Arena      12 December 1951, 2V75 Rockets (Rd. 1)  
 1/8" MS panels 5" high      2 January 1952, 2V75 Rockets (Rds. 2-9)

9 ROUND AVERAGES

<u>Zone, Degrees</u>	<u>Average Impacts Per 5° Zone on Panels</u>	<u>Average Impacts Per Total 5° Zone</u>	<u>Average Impacts Per Unit Solid Angle</u>
0-5			
5-10			
10-15			
15-20			
20-25			
25-30			
30-35			
35-40			
40-45			
45-50			
50-55			
55-60	0.2	4	9
60-65	0.3	7	14
65-70	0.2	5	9
70-75	0.7	17	30
75-80	1.9	47	88
80-85	2.8	70	130
85-90	4.4	111	200
90-95	6.3	159	290
95-100	9.5	240	440
100-105	3.3	81	152
105-110	0.1	2	5
110-115	0.1	2	5
115-120			
120-125			
125-130			
130-135			
135-140			
140-145			
145-150			
150-155			
155-160	.06	.6	3
160-165	0.2	1.5	9
165-170	0.4	2	17
170-175	0.8	2	29
175-180	0.7	1.4	60

## Fragmentation Test of 2875 Rocket Heads

TABLE IIFRAGMENT VELOCITY DATA

35mm Fastax Camera 3300 frames per sec.  
 30.6 foot Radius Arena  
 Rd. 1, 2875 AAFF Rocket HBX-1 loaded  
 Total Head Weight 6.30 lbs. Filler Weight 1.4 lbs.  
 Total Head and empty motor weight 10.30 lbs.

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
24	10	4210
25	9	4040
26	9	3880
27	10	3740
28	9	3610
29	5	3480
30	2	3370
31	2	3260
32	1	3160
33	2	3060
37	3	2730
38	2	2660
39	3	2590
40	2	2520
Median		3800
Average		3620

Fragmentation Test of 2U75 Rocket Heads

TABLE II (Continued)

35mm Fastax Camera 3210 frames per sec.  
 30.6 foot Radius Arena  
 Rd. 2, 2U75 AAFP Rocket HBX-1 loaded  
 Total Head Weight 6.30 lbs. Filler Weight 1.4 lbs.  
 Total Head and empty motor weight. 10.30 lbs.

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
23	6	4270
24	14	4090
25	10	3930
26	13	3780
27	16	3640
28	6	3510
29	8	3390
30	5	3270
31	3	3170
34	1	2890
35	1	2810
36	1	2730
37	2	2650
38	2	2580
39	2	2520
41	1	2400
Median		3750
Average		3630
CONFIDENTIAL SECURITY INFORMATION	2	APPENDIX C

Fragmentation Test of 2V75 Rocket Heads

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TABLE II (Continued)

35mm Fastax Camera 3240 frames per sec.  
 30.6 foot Radius Arena  
 Rd. 3, 2V75 AAFP Rocket HBX-1 loaded  
 Total Head Weight 6.30 lbs. Filler Weight 1.4 lbs.  
 Total Head and empty motor weight 10.30 lbs.

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
23	7	4310
24	6	4130
25	3	3970
26	12	3810
27	11	3670
28	8	3540
29	6	3420
30	4	3300
31	1	3200
32	3	3100
33	1	3000
34	1	2920
36	2	2750
37	1	2680
38	2	2610
39	1	2540
Median		3780
Average		3610
CONFIDENTIAL SECURITY INFORMATION	3	APPENDIX C

Fragmentation Test of 2V75 Rocket Heads

TABLE II (Continued)

35mm Pastax Camera 3270 frames per sec.  
 30.6 foot Radius Arena  
 Rd. 4, 2V75 AAFF Rocket HBX-1 loaded  
 Total Head Weight 6.35 lbs. Filler Weight 1.4 lbs.  
 Total Head and empty motor weight 10.35 lbs.

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
23	1	4350
24	5	4170
25	7	4000
26	11	3850
27	15	3710
28	5	3570
29	5	3450
30	3	3340
31	2	3230
32	1	3130
36	2	2780
37	1	2700
42	2	2380
Median		3800
Average		3650

TABLE III

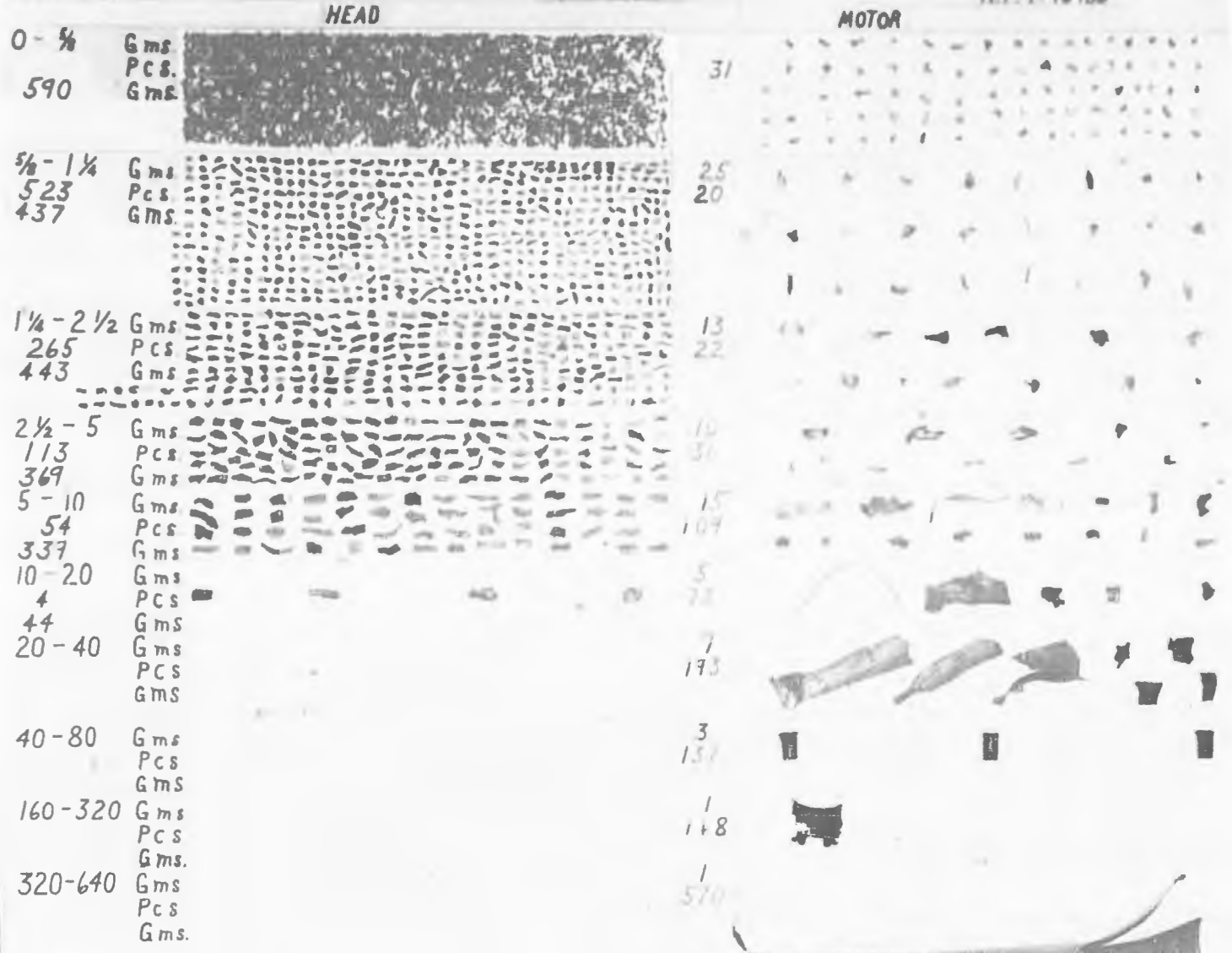
MASS DISTRIBUTION DATA

FRAGMENTATION OF 2775 LAFF ROCKET; HEAD MK 2 BK-1 LOADED AND MOTOR F00 1038-87 (MOTOR EMPTY)

HEAD	Comp. or Rd. No.	Wt. lb.	0.25-1.25		1.26-2.5		2.6-5		5-10		10-20		20-40		40-80		80-160		160-320		320-640		Fuse Frag- ments No.	Photo No. NP9			
			Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.	Grams Wt.			Grams Wt.	Total Wt.	Total Frag- ments No.
1	6.25	1.4	590	437	523	443	265	369	113	339	54	44	4	--	--	--	--	--	--	--	--	2458	1004	233	45	46986	
2	6.30	1.4	633	423	517	419	256	409	120	251	39	96	8	--	--	--	--	--	--	--	--	2486	1007	256	68	47021	
3	6.30	1.4	649	445	536	433	256	451	132	238	38	20	2	--	--	--	--	--	--	--	--	2507	1038	271	74	47051	
4	6.30	1.4	656	438	515	494	298	421	128	190	33	11	1	--	--	--	--	--	--	--	--	2483	1072	273	97	47156	
5	6.30	1.4	480	379	450	429	252	449	133	342	55	46	4	--	--	--	--	--	--	--	--	2397	978	272	84	47156	
<b>MOTOR</b>																											
1	4.01	--	31	20	25	22	13	31	10	109	15	73	5	193	7	137	3	--	--	168	1	570	1	1354	60	--	46986
2	4.00	--	20	32	41	37	22	51	14	110	17	149	10	136	4	294	6	83	1	--	--	421	1	1332	116	--	47021
3	3.95	--	20	22	28	33	18	76	23	118	17	247	18	140	6	163	3	--	--	--	--	493	1	1312	114	--	47051
4	4.00	--	27	21	26	27	15	38	11	59	10	61	5	146	5	434	8	--	--	--	--	537	1	1350	81	--	47156
5	4.04	--	34	17	21	40	23	51	14	104	16	162	11	134	4	326	6	--	--	--	--	494	1	1362	96	--	47156
<b>AVERAGE HEAD</b>																											
6.29	1.4	602	424	508	444	265	420	125	272	44	43	4	--	--	--	--	--	--	--	--	--	--	2466	1020	261	74	---
<b>AVERAGE MOTOR</b>																											
4.00	--	26	22	28	32	18	49	14	100	15	138	10	150	5	271	5	16.8	.2	33.6	.2	503	1	1342	97	--	--	---

FRAG NO. 1620

NP9 46986



FUZE - FRAGS

45 Pcs  
233 Gms

SCALE 1"

NP9-46986

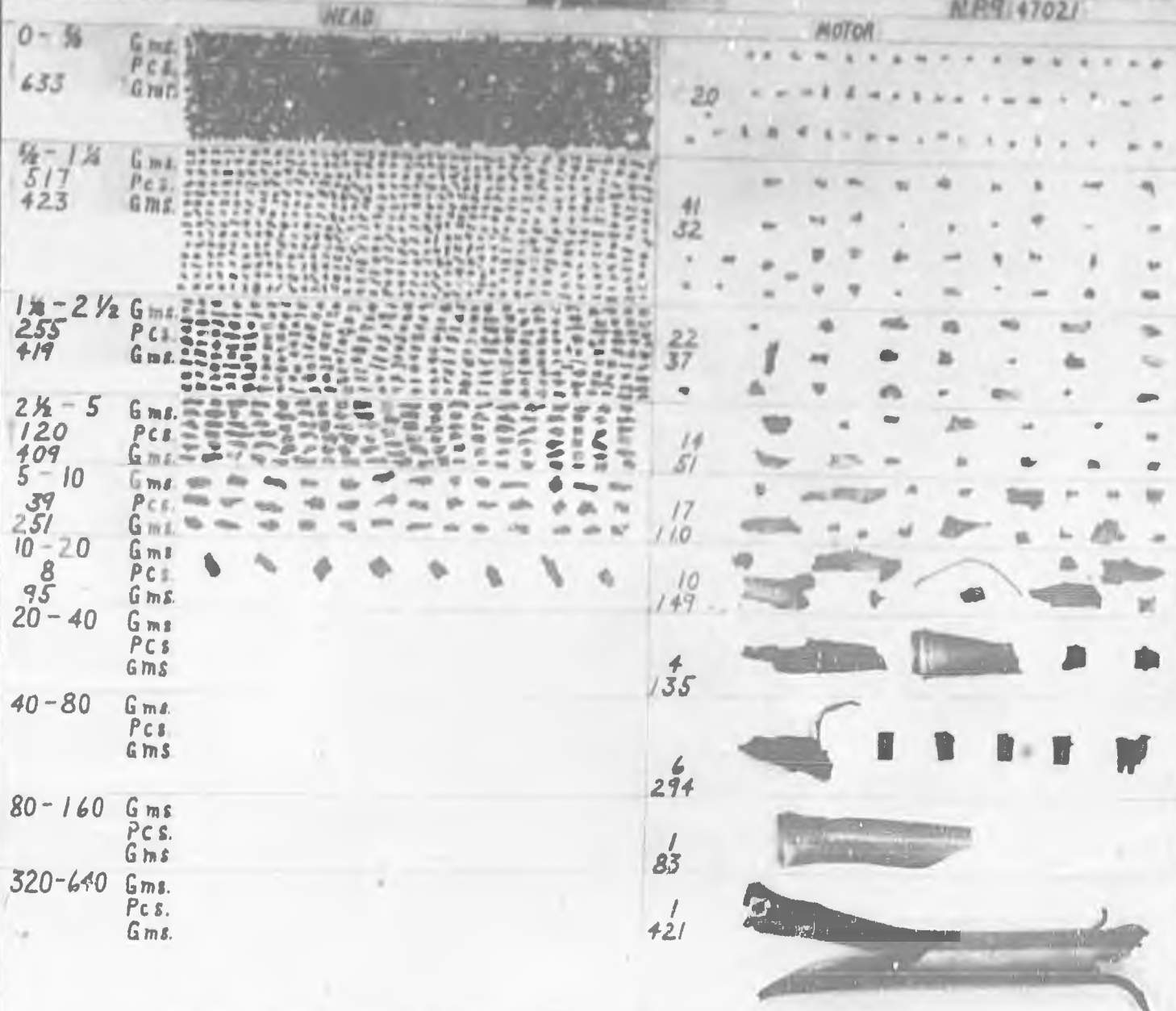
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SECURITY INFORMATION

Round No. 1. Fragment Mass Distribution of HBX-1 loaded 2.75 AAFP Rocket.  
Figure 3

FRAG NO. 1421

NP9-47021



FUZE - FRAGS  
 68 PCS  
 256 Gms.

SCALE 1"

NP9-47021

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 SECURITY INFORMATION

Round No. 2. Fragment Mass Distribution of HBX-1 loaded 2.75 AAFV Rocket.  
 Figure 4

FRAG. NO. 122

NP9-47051

Size Range	Units	Weight	Motor
0-5	20		
449			
1/8-1/4	25		
536	22		
445			
1/4-2 1/2	10		
256	33		
433			
2 1/2-5	23		
132	76		
451			
5-10	17		
38	118		
238			
10-20	18		
2	247		
20			
20-40	6		
	140		
40-80	3		
	163		
320-640	1		
	493		

FUZE - FRAGS  
 74 Pcs.  
 271 Gms.



NP9-47051

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SECURITY INFORMATION

Round No. 3. Fragment Mass Distribution of HBX-1 loaded 2.75 AAFP Rocket.  
Figure 5

FRAG NO: 1423

HEAD

NP9-47153

0- 1/2 Gms.  
456 Pcs.  
Gms.

27

1/2 - 1 1/4 Gms.  
515 Pcs.  
438 Gms.

26  
21

1 1/2 - 2 1/2 Gms.  
298 Pcs.  
494 Gms.

15  
27

2 1/2 - 5 Gms.  
128 Pcs.  
421 Gms.

11  
38

5 - 10 Gms.  
33 Pcs.  
190 Gms.

10  
59

10 - 20 Gms.  
1 Pcs.  
11 Gms.

5  
61

20 - 40 Gms.  
Pcs.  
Gms.

5  
146

40 - 80 Gms.  
Pcs.  
Gms.

8  
434

320-640 Gms.  
Pcs.  
Gms.

1  
537

FUZE - FRAGS  
97 Pcs.  
273 Gms.



SCALE 1"

NP9-47153

28 DECEMBER 1951

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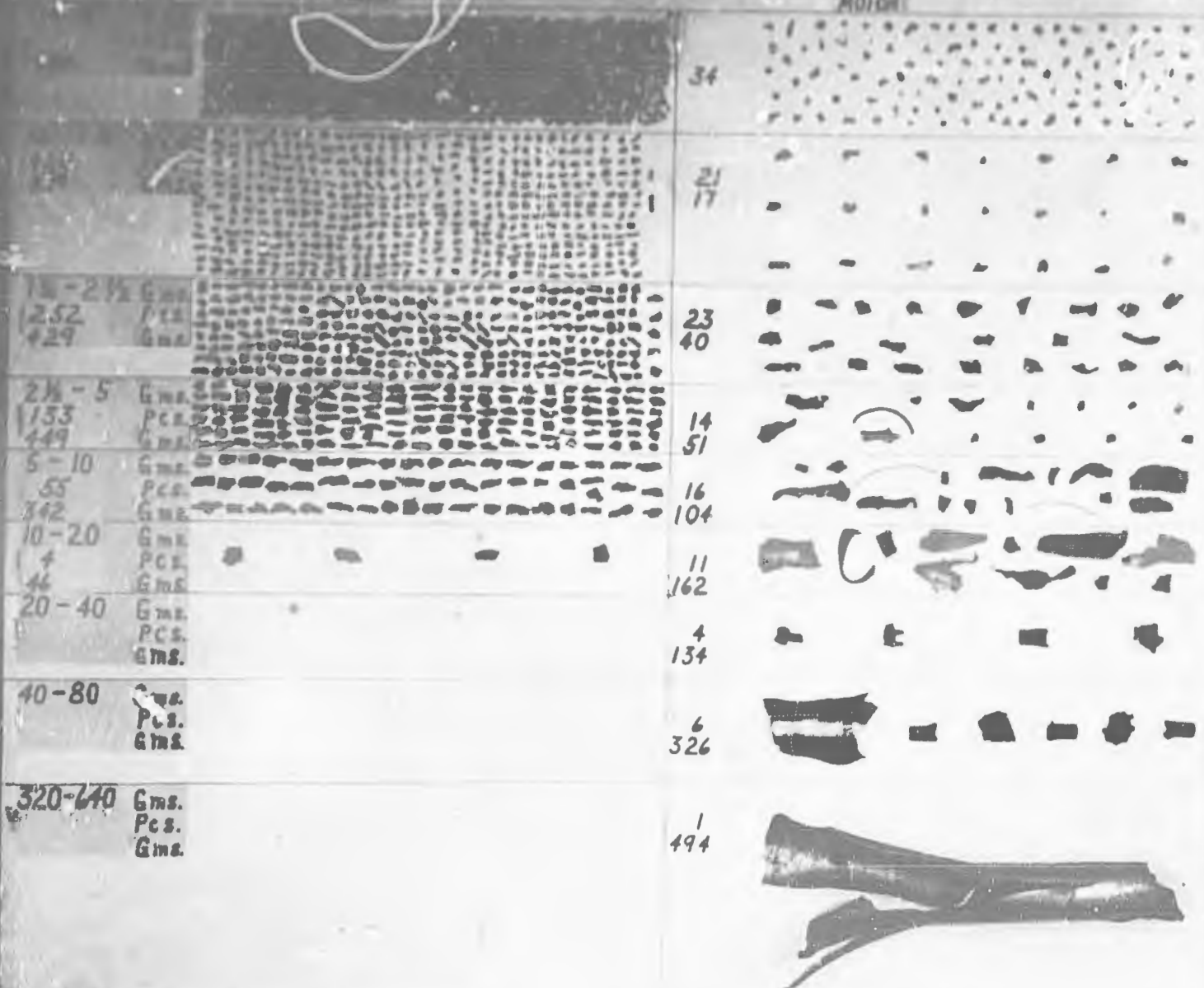
SECURITY INFORMATION

Round No. 4. Fragment Mass Distribution of HBX-1 loaded 2775 AAFP Rocket.

Figure 6

MRP 47156

MOTOR



FBZE - Thrust  
84 Pcs.  
272 Gms.



SCALE 1"

Round No. 5. Fragment Mass Distribution of HW-1 Loaded 2.75 AAPP Rocket.  
Figure 7

Fragmentation Test of 2V75 Rocket Heads

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Fragmentation Test of 2075 Rocket Heads

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