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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1124

FRAGMENTATION CHARACTERISTICS

22nd Partial Report

- -

FRAGMENTATION TEST OF 5"/38 HC AND VT (FCL) PROJECTILES MK 49, EXPLOSIVE "D" AND COMPOSITION A-3 LOADED

FINAL Report

Task Assignment NPG-Re3d-418-1-53

Copy No. 12

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Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of standard 5"/38 HC and VT (FCL) projectiles Mk 49, Explosive "D" and Composition A-3 loaded, respectively.

2. The fragmentation characteristics are as follows:

	HC Expl. "D"	VT (FCL) Comp. A-3
Median fragment velocity (80°-110° zone) ft./sec.	3400	4080
Hits in total zone		
0°-65°	23	40
65°-115°	692	1072
115°-180°	37	105
Totals 0°-180°	752	1217
No. fragments in weight group 5/8 - 350 grams	1218	2113
Mean fragment mass (grams)	11.8	5.78

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

TABLE OF CONTENTS

	Page
SYNOPSIS	1
TABLE OF CONTENTS	2
AUTHORITY	3
REFERENCES	3
BACKGROUND	3
OBJECT OF TEST	3
PERIOD OF TEST	3
DESCRIPTION OF ITEM UNDER TEST	4
PROCEDURE	4
RESULTS AND DISCUSSION	5
CONCLUSIONS	6
APPENDIX A - PROJECTILE DRAWING	FIGURE 1
APPENDIX B - SPACE DISTRIBUTION DATA	TABLE I 1-2 (Incl)
APPENDIX C - FRAGMENT VELOCITY DATA	TABLE II 1-6 (Incl)
APPENDIX D - MASS DISTRIBUTION	TABLE III 1 (Only) FIGURES 2-11 (Incl)
APPENDIX E - DISTRIBUTION	1-2 (Incl)

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

PART B

INTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3d-418-1-53, reference (b).

2. REFERENCES:

a. BUORD Restr ltr NP9 Re3d-ANB:bc of 6 October 1952
b. BUORD ltr NP9 Re3d-ANB:bc of 29 July 1952

3. BACKGROUND:

Since little static fragmentation data on 5"/38 projectiles with standard loading and fuzing were available, and in view of the widespread usage of the 5"/38 and its employment as a standard in evaluating new designs, the Bureau of Ordnance requested in reference (a) that fragmentation tests of the 5"/38 projectiles be conducted.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of standard 5"/38 HC and VT (FCL) projectiles Mk 49, Explosive "D" and Composition A-3 loaded, respectively.

5. PERIOD OF TEST:

a.	Date Project Letter	6 October 1952
b.	Date Necessary Material Received	7 November 1952
c.	Date Commenced Test	13 January 1953
d.	Test Completed	20 March 1953

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

5"/38 Projectile Mk 49 Mod 1, Manufactured by National Tube Co., Ammunition Lot E/08074 C-52. The assembly and weights are as follows:

Proj.	Proj. Lot	Filler	Nose Fuze	AD Fuze	Base Fuze	Average wts. (lbs.) Empty	Fuze	Filler	Total
HC	293	Exp."D"	Mk 29	Mk 55	Mk 28	41.95	3.9	7.25	53.1
VT(FCL)	294	A-3	Mk 71	--	plug	41.2	4.5	7.60	53.3

Both types were initiated with the nose fuzes modified for static detonation by the Naval Proving Ground. A photograph of the Mk 49 Mod 0 projectile is shown in Figure 1. The Mk 49 Mod 1 projectile is identical to this except for a minor change in the band scoring.

7. PROCEDURE:

a. Space distribution data were obtained in a 30 foot radius semi-circular space distribution arena having 1/8" mild steel panels 5' high and marked off into 5° polar angle zones about the axis of the projectile. The projectiles were placed horizontally on a wooden stand with the nose pointed toward 0°. Complete penetrations of the panels were recorded. Seven (7) rounds of each type were tested in this arena.

b. Fragment velocity determinations were obtained by the usual high speed photographic technique in a 30 foot radius arena. The camera used was a 35mm Fastax. Fragment velocities obtained are the mean velocities over the first thirty (30) feet of travel of beam spray (polar angle 80°-110°) fragments. The projectiles were placed nose up in the center of the arena on a 6 foot stand. Three (3) rounds of each type were tested in this arena.

c. Fragment mass distribution tests were conducted in a sawdust filled chamber. Each of the five (5) projectiles tested was supported on its side in a cane fiberboard box. After each detonation, the sawdust was sifted and the fragments collected by the use of a screen mesh and a magnetic separator.

8. RESULTS AND DISCUSSION:

a. Space Distribution:

Detailed space distribution data are listed in Table I. The 7 round average data are summarized as follows:

Polar Zone	Average Fragment Hits per Total Zone HC Expl. "D"	VT (FCL) Comp. A-3
0°-15°	7	10
15°-40°	0	0
40°-65°	16	30
65°-115°	692	1072
115°-165°	26	95
165°-180°	11	10
Totals	752	1217

b. Fragment Velocity:

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

Proj.	Filler	3 Rd. Average Median Fragment Velocity (zone 80°-110°)
HC	Expl. "D"	3400 ft./sec.
VT (FCL)	Comp. A-3	4080 ft./sec.

c. Fragment Mass Distribution:

Detailed fragment mass distribution data are listed in Table III. Photographs of the fragments are shown in Figures 2-11, inclusive. Rd No. 4 data of the VT (FCL) projectiles was not used in averaging the data due to a malfunctioning fuze. This round was later initiated with a 50 gram Composition C-3 booster and a special engineers blasting cap. The mass data are summarized as follows:

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

Average No. Fragments in Weight Groups

Weight Group (Grams)	HC Expl. "D" (5 rd. aver.)	VT (FCL) Comp. A-3 (4 rd. aver.)
5/8 - 1-1/4	185	407
1-1/4 - 2-1/2	197	479
2-1/2 - 5	187	415
5 - 10	153	303
10 - 20	209	270
20 - 40	169	176
40 - 80	85	47
80 - 160	28	13
160 - 320	5	2
320 - 350	0	1
Totals	1218	2113

d. The finer fragmentation and higher fragment velocity of the VT (FCL) projectile, Composition A-3 loaded, when compared to the HC projectile, Explosive "D" loaded, is attributed to the explosive characteristics. The mean fragment masses for the HC and VT (FCL) projectiles, computed from the best fit to a Mott law, were 11.8 and 5.78 grams, respectively.

PART D

CONCLUSIONS

9. The fragmentation characteristics are as follows:

	HC Expl. "D"	VT (FCL) Comp. A-3
Median fragment velocity (80°-110° zone) ft./sec.	3400	4080
Hits in total zone		
0°-65°	23	40
65°-115°	692	1072
115°-180°	37	105
Totals 0°-180°	752	1217
No. fragments in weight group 5/8 - 350 grams	1218	2113
Mean fragment mass (grams)	11.8	5.78

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

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NPG REPORT NO. 1124

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twenty-second Partial Report

on

Fragmentation Characteristics

- -

Final Report

on

Fragmentation Test of 5"/38 HC and VT (FCL)

Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

Project No.: NPG-Re3d-418-1-53
Copy No.: 12
No. of Pages: 7

Date: APR 30 1953

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13 January 1953

5"/38 Projectile Mk 49 Mod 0. BUORD Drawing No. 563196.
FIGURE 1

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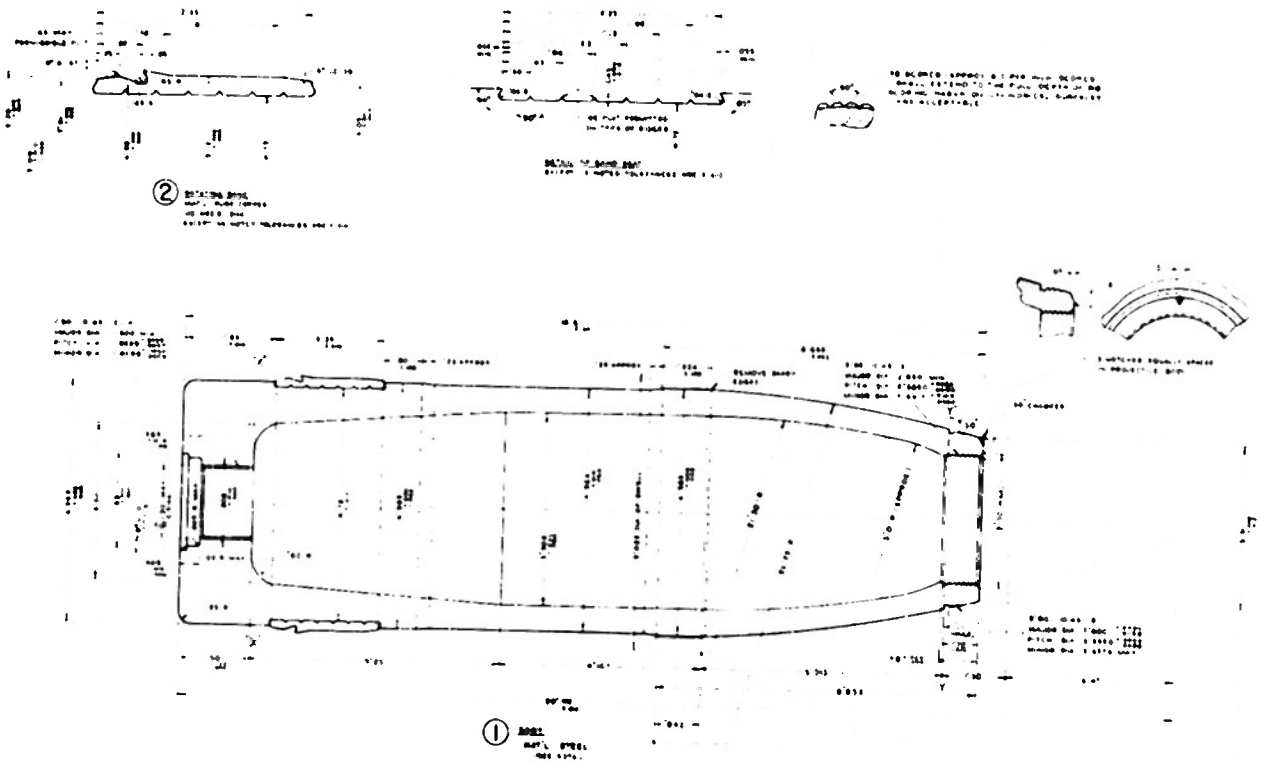
563196



5" PROJECTILE (HC) MK49 MOD 0
(FOR 5"/38 CAL GUN)

REQUISITION SHEET

BUREAU OF ORDNANCE

AMMUNITION 563196

WARNING

RESTRICTED

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

TABLE I

SPACE DISTRIBUTION DATA

Date: 1-14-53

30' Radius Space Arena
1/8" MS panels 5' high

5"/38 VT (FCL) Projectiles Mk 49-1
Composition A-3 Loaded

Zone Degrees	Rd. 1	Rd. 2	Rd. 3	Rd. 4	Rd. 5	Rd. 6	Rd. 7	Avg. impacts per 5° zone on panel	Avg. impacts per total 5° zone on panel	Avg. impacts per unit Solid angle
0-5	2	3	4	3	5	2	5	3.4	7	290
5-10		2		1	1			0.6	3	40
10-15										
15-20										
20-25										
25-30										
30-35										
35-40										
40-45		1						0.1	3	7
45-50	1		1		1			0.4	11	30
50-55						1		0.1	3	7
55-60		1			1			0.3	10	20
60-65						1		0.1	3	7
65-70					2			0.3	10	20
70-75	1	3	1	1		1	1	1.1	40	76
75-80	3	3	1	3	1	4	2	2.4	89	165
80-85	3	2	4		7	1		2.4	90	165
85-90	4	5	6	5	3	5	3	4.4	166	300
90-95	3	6	9	6	7	6	9	6.6	250	450
95-100	9	13	10	7	7	10	8	9.1	340	630
100-105	1	1		3	2			1.0	37	69
105-110	1	1			1		1	0.6	20	40
110-115		1			2	2	1	0.9	30	60
115-120	1	2			1	1	2	1.0	33	69
120-125	1							0.1	3	7
125-130			1		1			0.3	9	20
130-135				1	1			0.3	8	20
135-140		1		1		1	1	0.6	15	40
140-145	2		3	1				0.9	20	60
145-150										
150-155		1		2				0.4	7	30
155-160										
160-165										
165-170										
170-175	2	1	2	1	1	1	1	1.3	5.8	81
175-180	2	2	2	1	2	2	2	1.9	3.8	160

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

TABLE I (Continued)

SPACE DISTRIBUTION DATA

Date: 1-14-53

30' Radius Space Arena
1/8" MS panels 5' high

5"/38 HC Projectiles Mk 49-1
Explosive "D" Loaded

Zone Degrees	Rd. 1	Rd. 2	Rd. 3	Rd. 4	Rd. 5	Rd. 6	Rd. 7	Avg. impacts per 5° zone on panel	Avg. impacts per total 5° zone on panel	Avg. impacts per unit Solid angle
0-5	2	1	1	1	1	1	1	1.1	22	93
5-10	1				1	3		0.7	3	40
10-15	1			1				0.3	2	20
15-20										
20-25										
25-30										
30-35										
35-40										
40-45										
45-50										
50-55			1					0.1	3	7
55-60		2						0.3	10	20
60-65		1						0.1	3	7
65-70	1			1				0.3	10	20
70-75		1		1	1		1	0.6	20	40
75-80	2	1		1		3	3	1.4	52	96
80-85	1	1	3	4	2	1	2	2.0	75	138
85-90	1	1	2	1		2	4	1.6	60	110
90-95	5	1	4	5	6	5	3	4.1	155	280
95-100	5	6	10	5	11	7	10	7.7	290	530
100-105					1	3	1	0.7	30	50
105-110										
110-115										
115-120										
120-125			1		1			0.3	10	20
125-130										
130-135										
135-140										
140-145				1				0.1	2	7
145-150				1		1		0.3	6	20
150-155	1				1		1	0.4	7	30
155-160			1					0.1	1.4	7
160-165										
165-170		2	1					0.4	3	30
170-175			1	1		2	1	0.7	3	40
175-180	2	4	3	1	2	2	4	2.6	5.2	220

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

TABLE II

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 1, 5"/38 Mk 49-1 Projectile VT (FCL)
Total Weight: 53.85 lbs.

2450 Frames per sec.
Filler: Composition A-3
Filler Weight: 7.60 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
16	2	4590
17	32	4320
18	33	4080
19	17	3870
20	10	3680
21	7	3500
22	6	3340
23	1	3200
24	2	3060
25	2	2940
Median		4110
Average		3970

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

TABLE II (Continued)

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 2, 5"/38 Mk 49-1 Projectile VT (FCL)
Total Weight: 53.30 lbs.

2450 Frames per sec.
Filler: Composition A-3
Filler Weight: 7.60 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
17	14	4320
18	35	4080
19	24	3870
20	16	3680
21	7	3500
22	4	3340
23	6	3200
24	1	3060
25	1	2940
Median		4000
Average		3870

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

TABLE II (Continued)

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 3, 5"/38 Mk 49-1 Projectile VT (FCL)
Total Weight: 53.37 lbs.

2450 Frames per sec.
Filler: Composition A-3
Filler Weight: 7.60 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
16	3	4590
17	32	4320
18	27	4080
19	26	3870
20	12	3680
21	6	3500
22	4	3340
23	3	3200
24	1	3060
Median		4120
Average		3980

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

TABLE II (Continued)

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 1, 5"/38 Mk 49-1 Projectile HC
Total Weight: 53.30 lbs.

2450 Frames per sec.
Filler: Explosive "D"
Filler Weight: 7.25 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
20	1	3680
21	21	3500
22	29	3340
23	15	3200
24	4	3060
25	6	2940
26	3	2830
27	3	2720
28	4	2630
29	3	2530
30	1	2450
Median		3320
Average		3210

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

TABLE II (Continued)

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 2, 5"/38 Mk 49-1 Projectile HC
Total Weight: 53.20 lbs.

2500 Frames per sec.
Filler: Explosive "D"
Filler Weight: 7.25 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
20	4	3750
21	24	3570
22	25	3410
23	16	3260
24	7	3130
25	3	3000
26	5	2880
27	4	2780
28	3	2680
29	2	2590
Median		3420
Average		3310

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

- -

TABLE II (Continued)

FRAGMENT VELOCITY DATA

Date: 1-13-53

30 Ft. Radius Arena
35mm Fastax Camera
Rd. 3, 5"/38 Mk 49-1 Projectile HC
Total Weight: 53.21 lbs.

2450 Frames per sec.
Filler: Explosive "D"
Filler Weight: 7.25 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
20	8	3680
21	32	3500
22	18	3340
23	15	3200
24	4	3200
25	1	2940
26	2	2830
27	4	2720
28	3	2630
29	1	2530
Median		3450
Average		3310

TABLE III

MASS DISTRIBUTION DATA

FRAGMENTATION OF VT (FCL) 5"/38 MK 49-1 PROJECTILES COMP A-3 LOADED, MK 71 NOSE FUZES

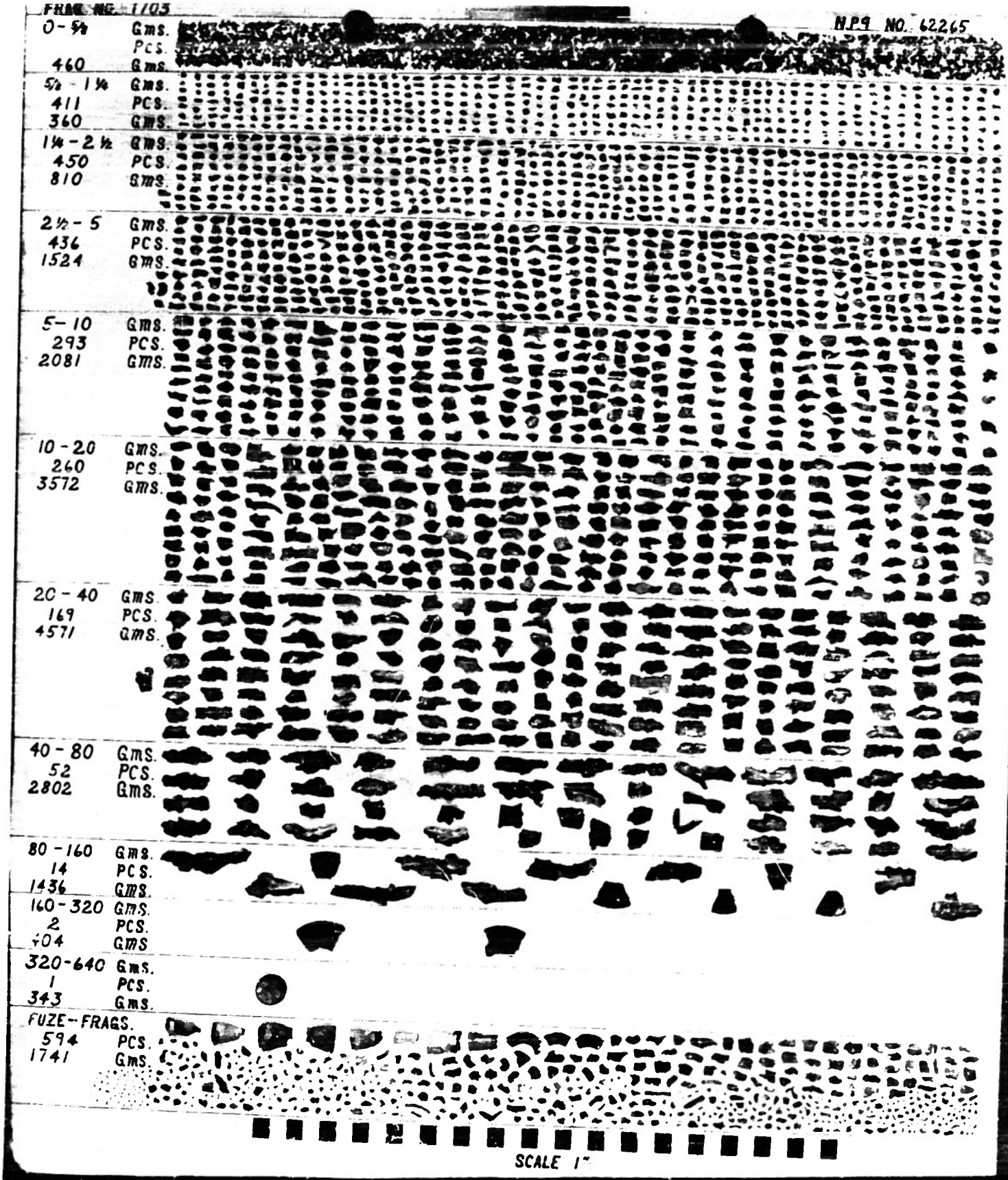
NUMBER AND WEIGHT OF RECOVERED FRAGMENTS

Rd. No.	Comp. Wt. lb.	Filler Wt. lb.	0-0.625 grams Wt. Gms.	0.625-1.25 grams Wt. Gms.	No.	1.25-2.5 grams Wt. Gms.	No.	2.5-5 grams Wt. Gms.	No.	5-10 grams Wt. Gms.	No.	10-20 grams Wt. Gms.	No.	20-40 grams Wt. Gms.	No.	40-80 grams Wt. Gms.	No.	80-160 grams Wt. Gms.	No.	160-320 grams Wt. Gms.	No.	320-640 grams Wt. Gms.	No.	Fuze Frags Wt. Gms.	No.	Total No.	Total Gms.	Photo. No. NP9
1	53.57	7.60	460	360	411	810	450	1524	436	2081	293	3572	260	4571	169	2802	52	1436	14	404	2	343	1	1741	594	2682	20104	62265
2	53.06	7.60	358	327	365	747	417	1278	359	2003	284	3632	259	4456	165	3086	57	1500	15	706	3	342	1	1791	575	2500	20226	62284
3	53.16	7.60	444	351	395	957	528	1623	464	2178	313	3968	276	5278	195	2120	41	578	5	582	3	339	1	1821	580	2801	20239	62323
*4	53.67	7.60	374	284	324	506	286	892	253	1562	221	3163	230	4701	166	4179	74	2055	19	612	3	337	1	1840	442	2019	20505	62377
5	53.50	7.60	470	406	458	937	520	1436	401	2274	321	3916	283	4667	176	1920	37	1881	18	173	1	339	1	1704	928	3144	20123	62383
Avg	53.32	7.60	433	361	407	863	479	1465	415	2134	303	3772	270	4743	176	2482	47	1349	13	466	2	341	1	1764	669	2782	20175	---

* Rd No. 4 was not used in averaging. Projectile was detonated with a 50 gram Comp C-3 booster.

FRAGMENTATION OF 5"/38 MK 49-1 HC PROJECTILES EXPLOSIVE "D" LOADED, MK 29 PDF AND MK 28 BDF

1	52.96	7.25	239	143	168	300	162	551	153	1021	145	2776	187	4782	168	5241	93	2556	22	1255	6	---	-	1645	457	1561	20509	62538
2	53.19	7.25	276	183	215	445	250	896	251	1184	164	3263	226	4342	157	4408	82	3457	30	430	3	---	-	1653	451	1829	20542	62554
3	52.92	7.25	205	153	176	298	169	569	163	946	134	2814	193	4461	158	4769	86	3184	30	1458	8	---	-	1663	476	1593	20520	62568
4	53.18	7.25	233	142	161	351	192	540	152	1084	149	2874	203	4905	172	4403	82	3201	30	1245	6	---	-	1651	506	1653	20629	62588
5	53.29	7.25	261	180	203	384	211	750	214	1232	172	3316	236	5232	189	4418	80	2939	27	358	2	---	-	1657	376	1710	20727	62596
Avg	53.11	7.25	243	161	185	356	197	661	187	1093	153	3009	209	4744	169	4648	85	3067	28	949	5	---	-	1654	453	1669	20585	---



NPG-62265 23 January 1953 CONFIDENTIAL
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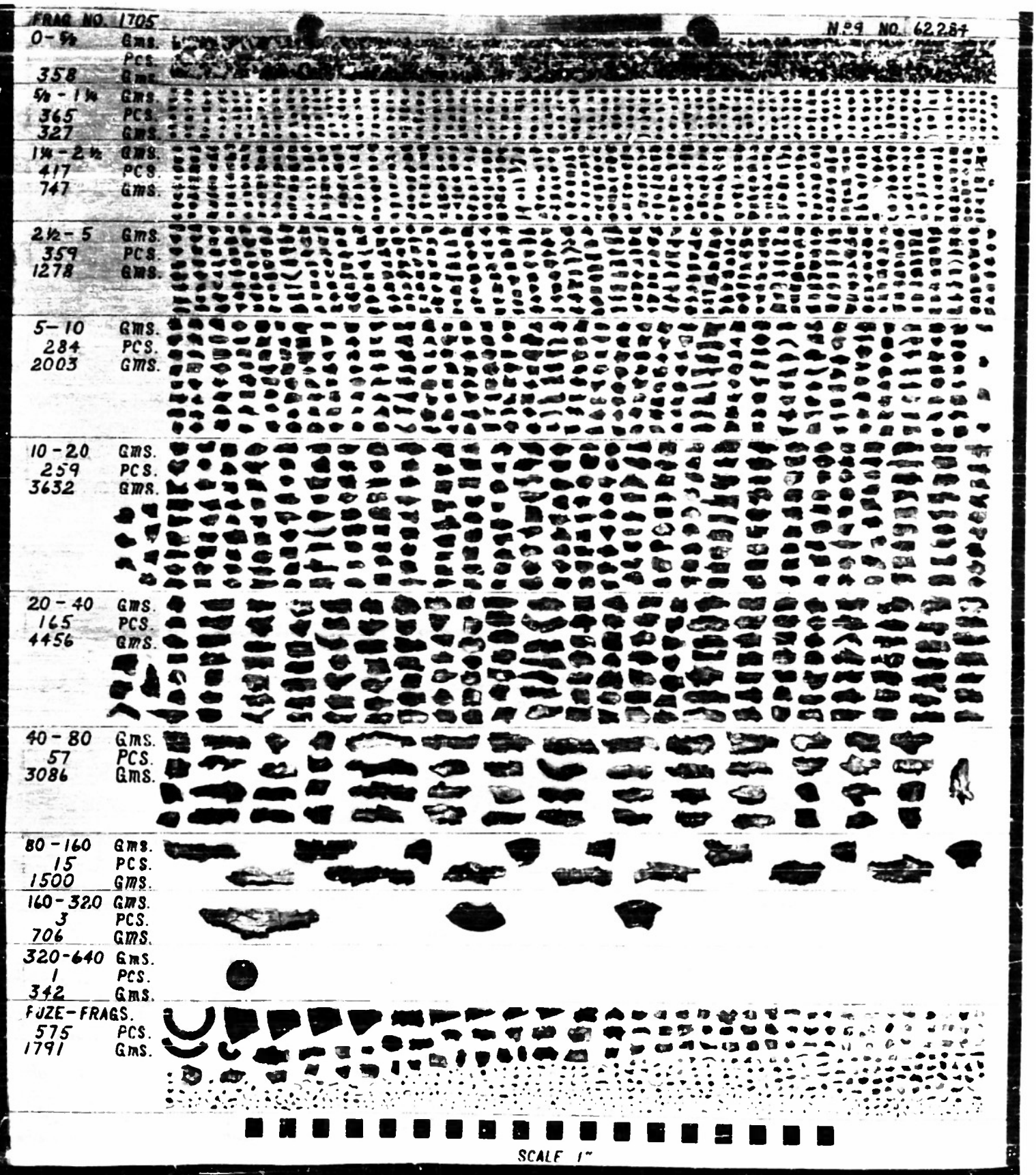
Mass Distribution of 5"/38 VT(PCL) Projectile Mk 49 Mod 1 Composition A-3 loaded, assembled with VTF Mk 71.

Rd. 1

FIGURE 2



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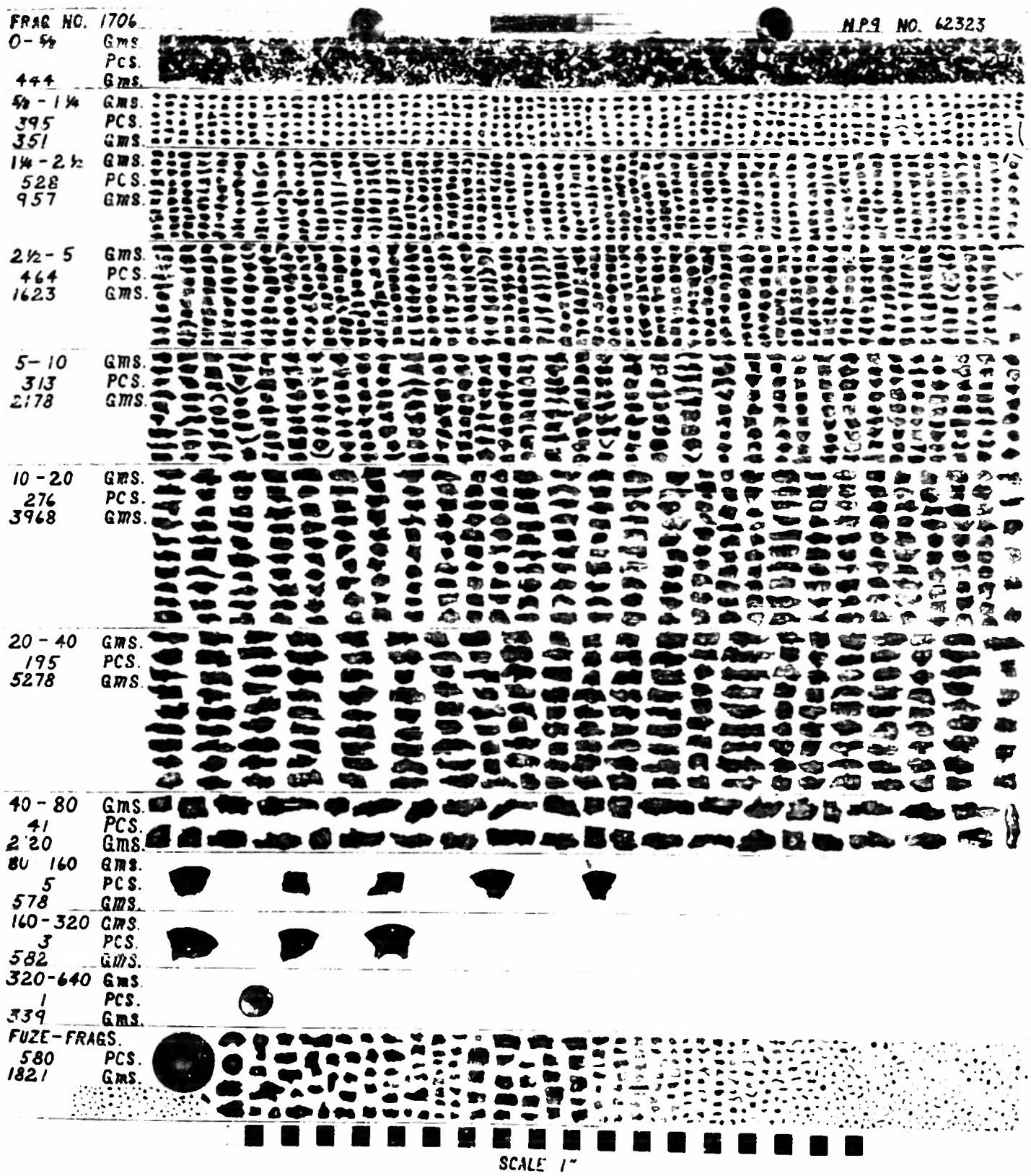
[illegible] 28 January 1953 SECURITY INFORMATION

[illegible] Distribution of [illegible] VT(FOL) Projectile [illegible] Composition [illegible] loaded, assembled with VTF [illegible] 71.

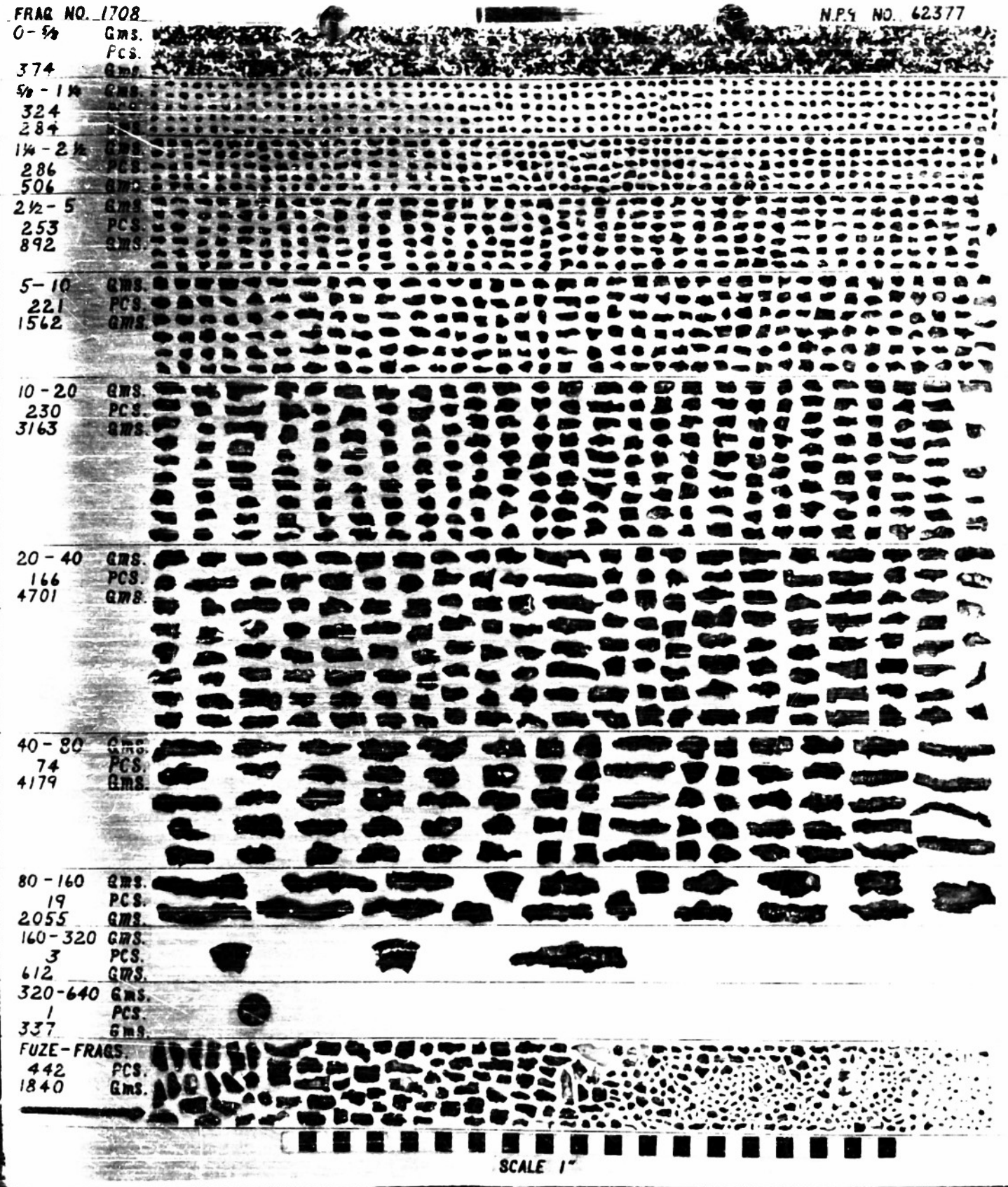
[illegible] 2 FIGURE [illegible]



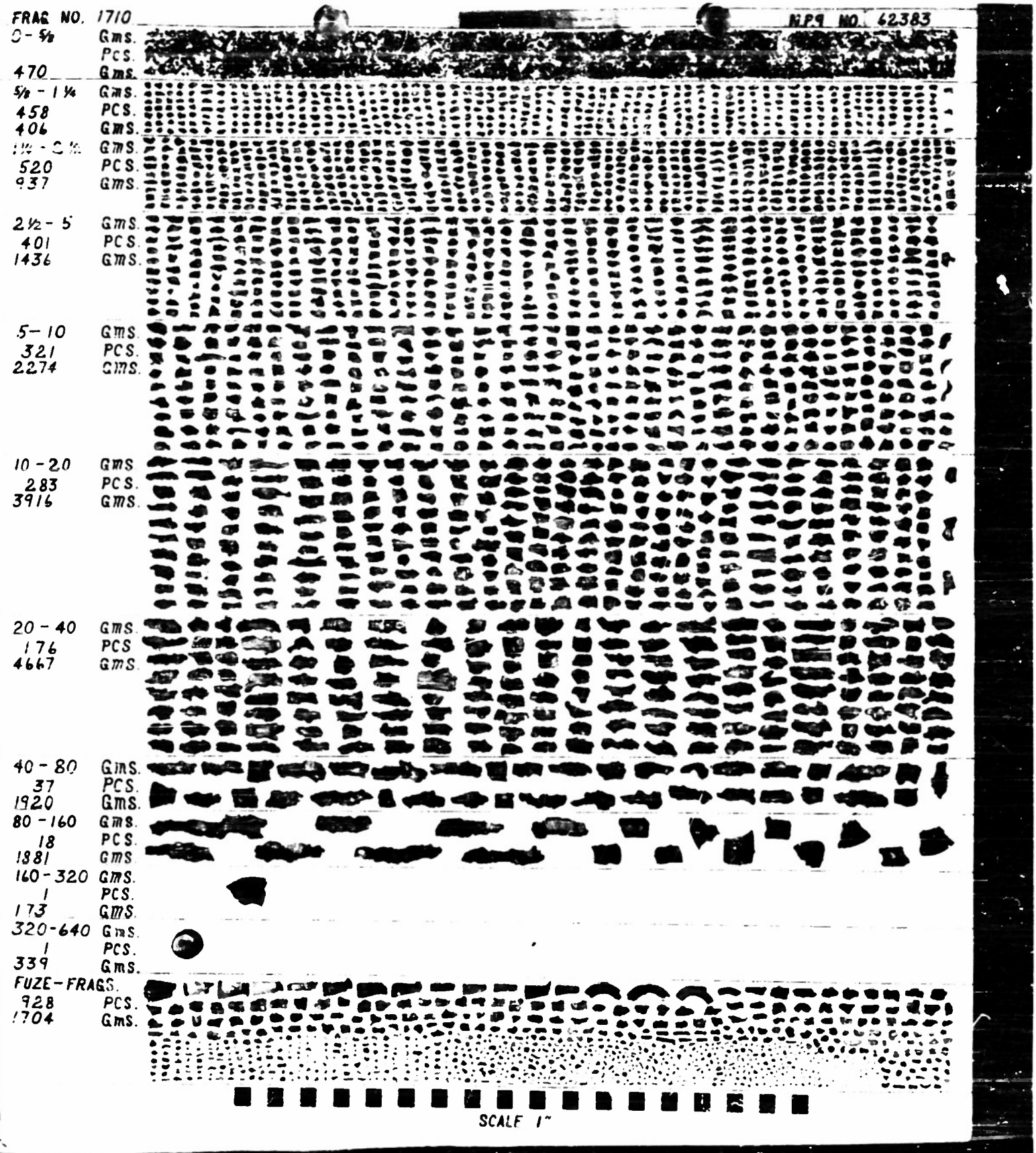
NP9-62323 2 February 1953 CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of 5"/38 VT(FCL) Projectile Mk 49 Mod 1 Composition A-3 loaded, assembled with VTF Mk 71.

Rd. 3 FIGURE 4



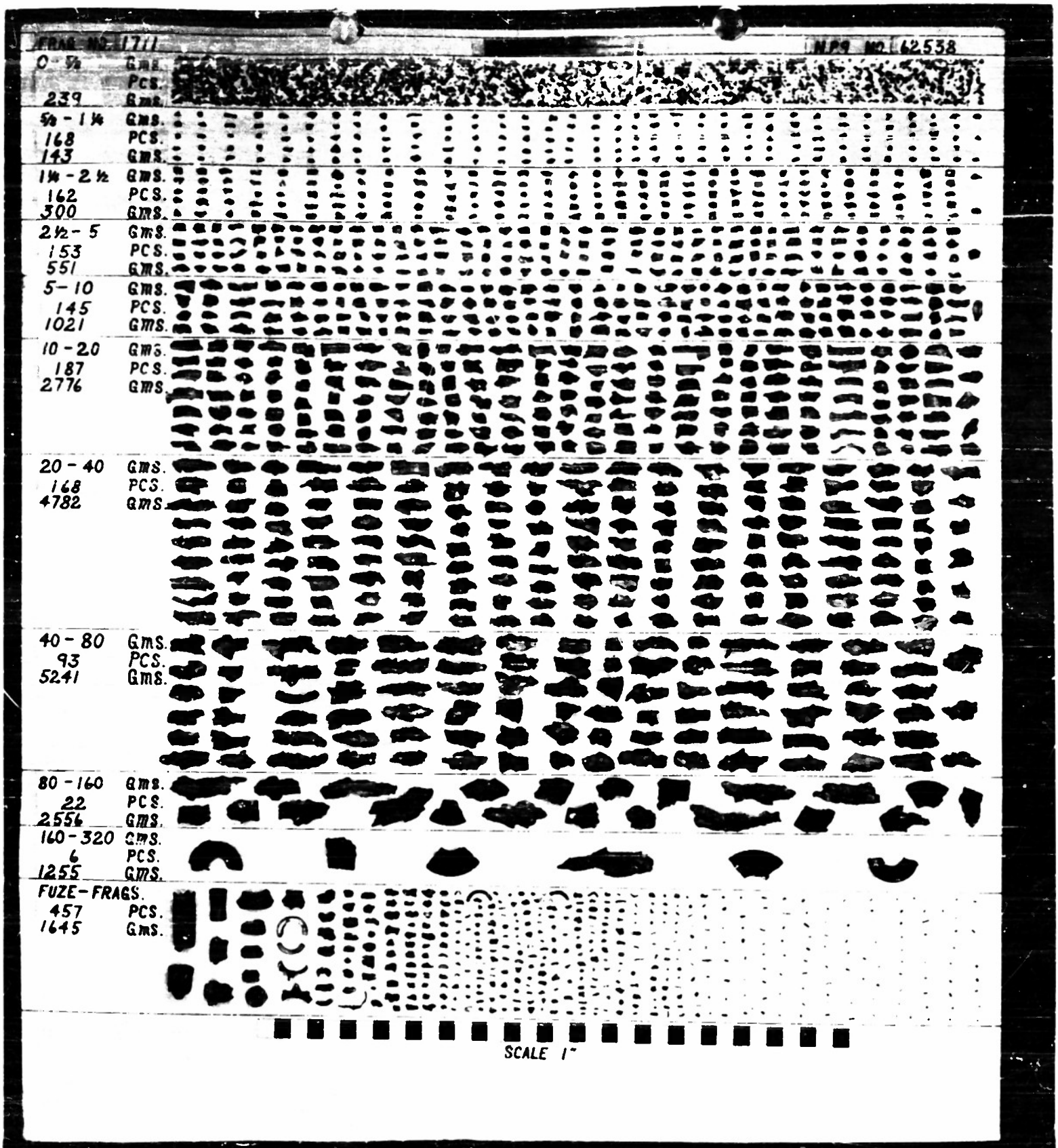
NPG-62377 5 February 1953 CONFIDENTIAL
Mass Distribution of 5"/38 VT(FCL) Projectile Mk 49 Mod 1 Composition A-3 loaded, Assembled with VTF Mk 71. These data were not used in the averaging due to malfunction of fuze.



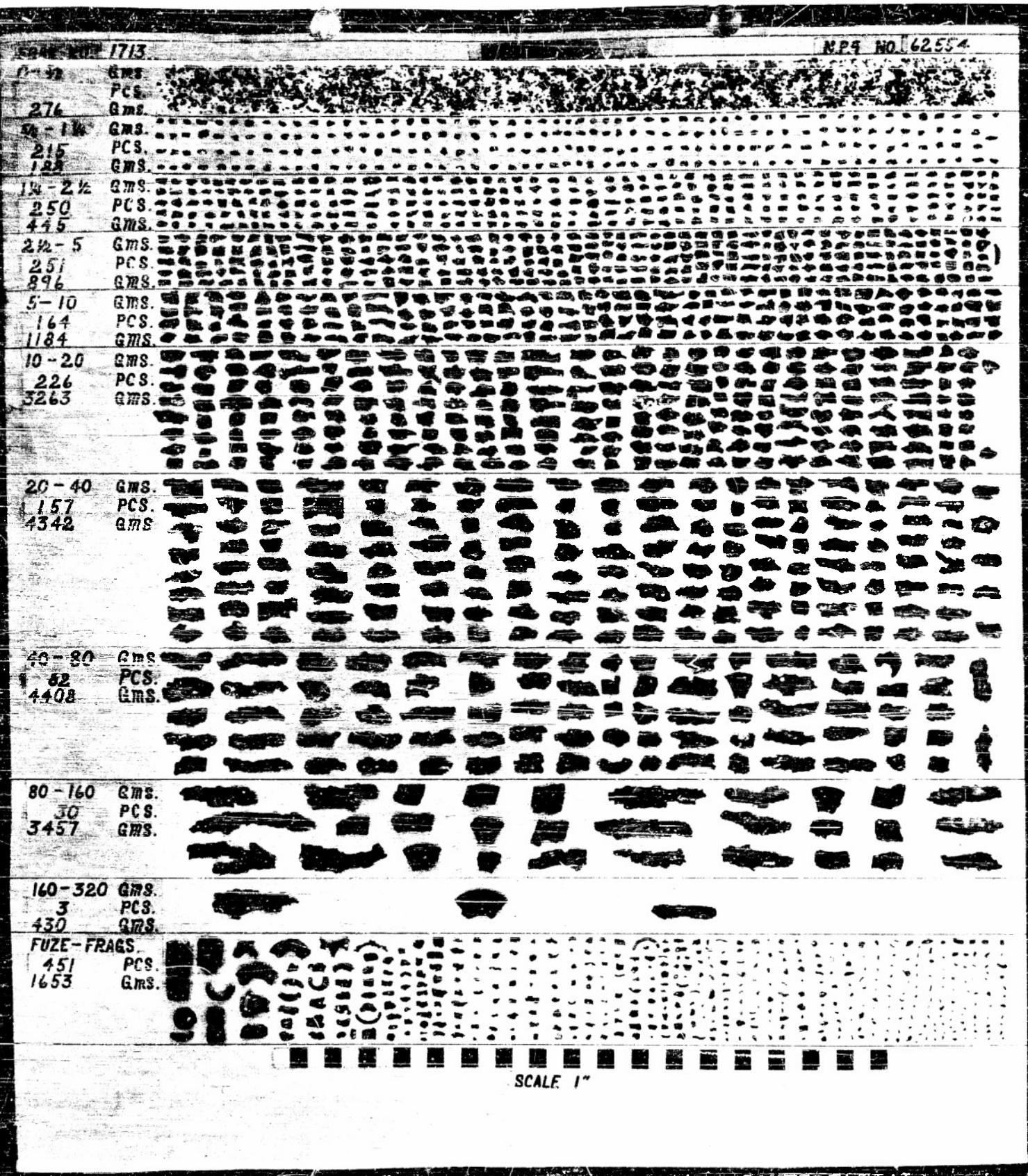
CONFIDENTIAL
SECURITY INFORMATION

NP9-62383 10 February 1953
Mass Distribution of .5"/38 VT(FCL) Projectile Mk 49 Mod 1 Composition A-3 loaded; assembled with VTF Mk 71.
Rd. 5

FIGURE 6



[illegible]
[illegible]ed, assembl[illegible]
Initiated.
Rd. 1

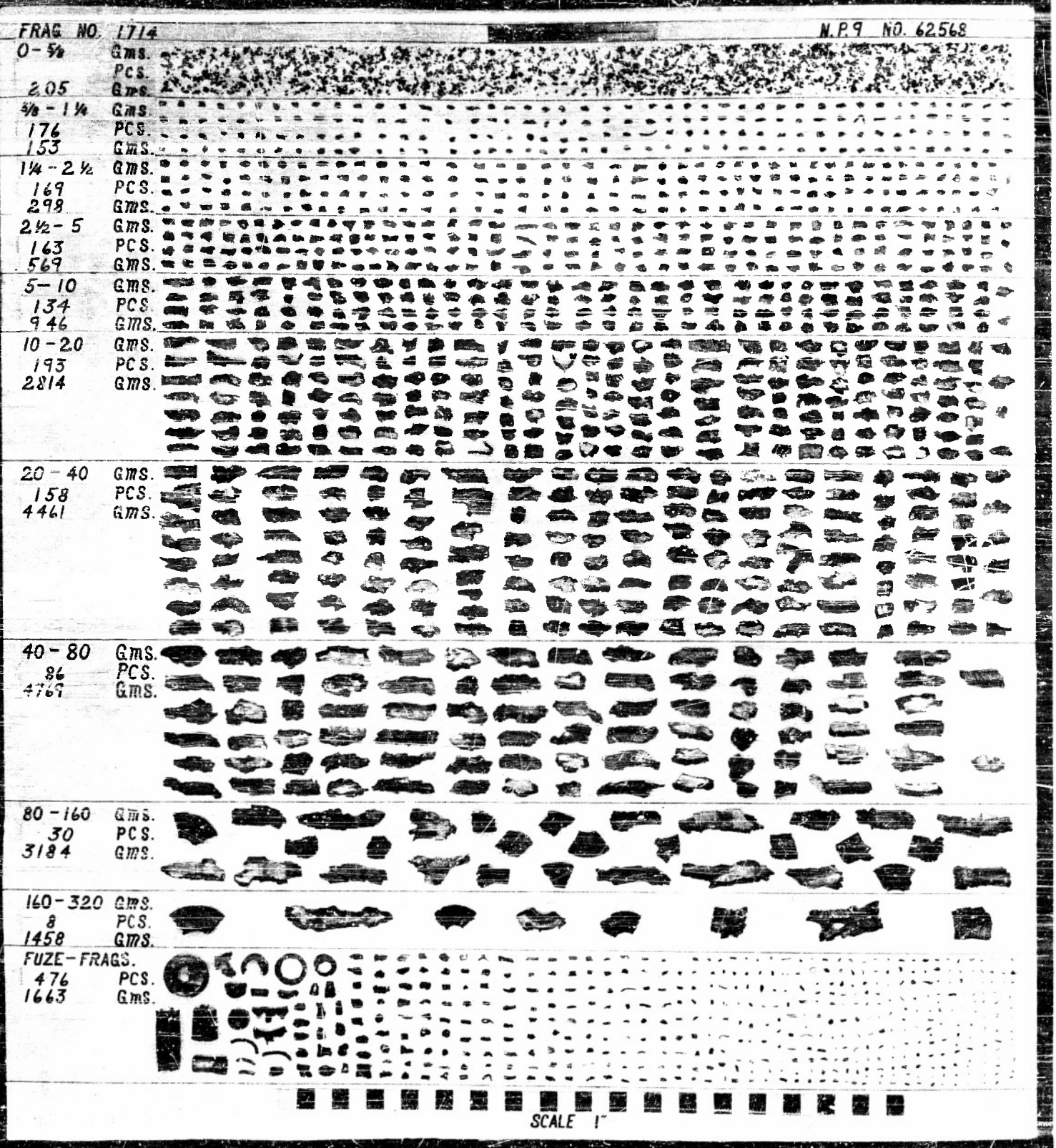


NP9-62554 16 February 1953 CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of 5"/38 HC Projectile Mk 49 Mod 1 Explosive "D" loaded, assembled with Mk 28 BDF, Mk 55 ADF, and Mk 29 PDF. Nose Initiated.

Rd. 2.

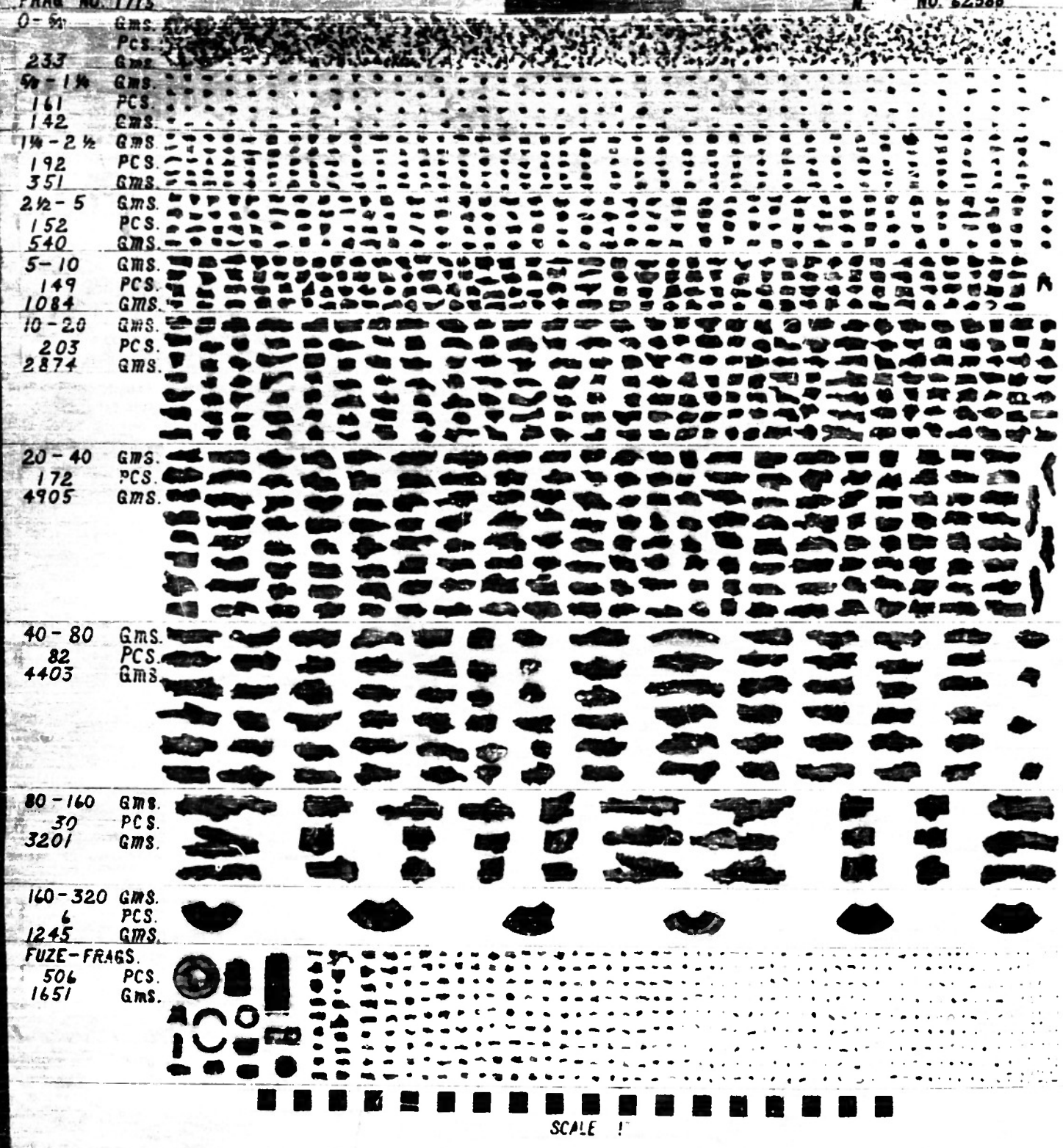
FIGURE 8



NP9-62568 24 February 1953 CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of 5"/38 HC Projectile Mk 49 Mod 1 Explosive "D" loaded, assembled with Mk 28 EDF, Mk 55 ABF, and Mk 29 PLF. Nose Initiated.

Rd. 3 FIGURE 9



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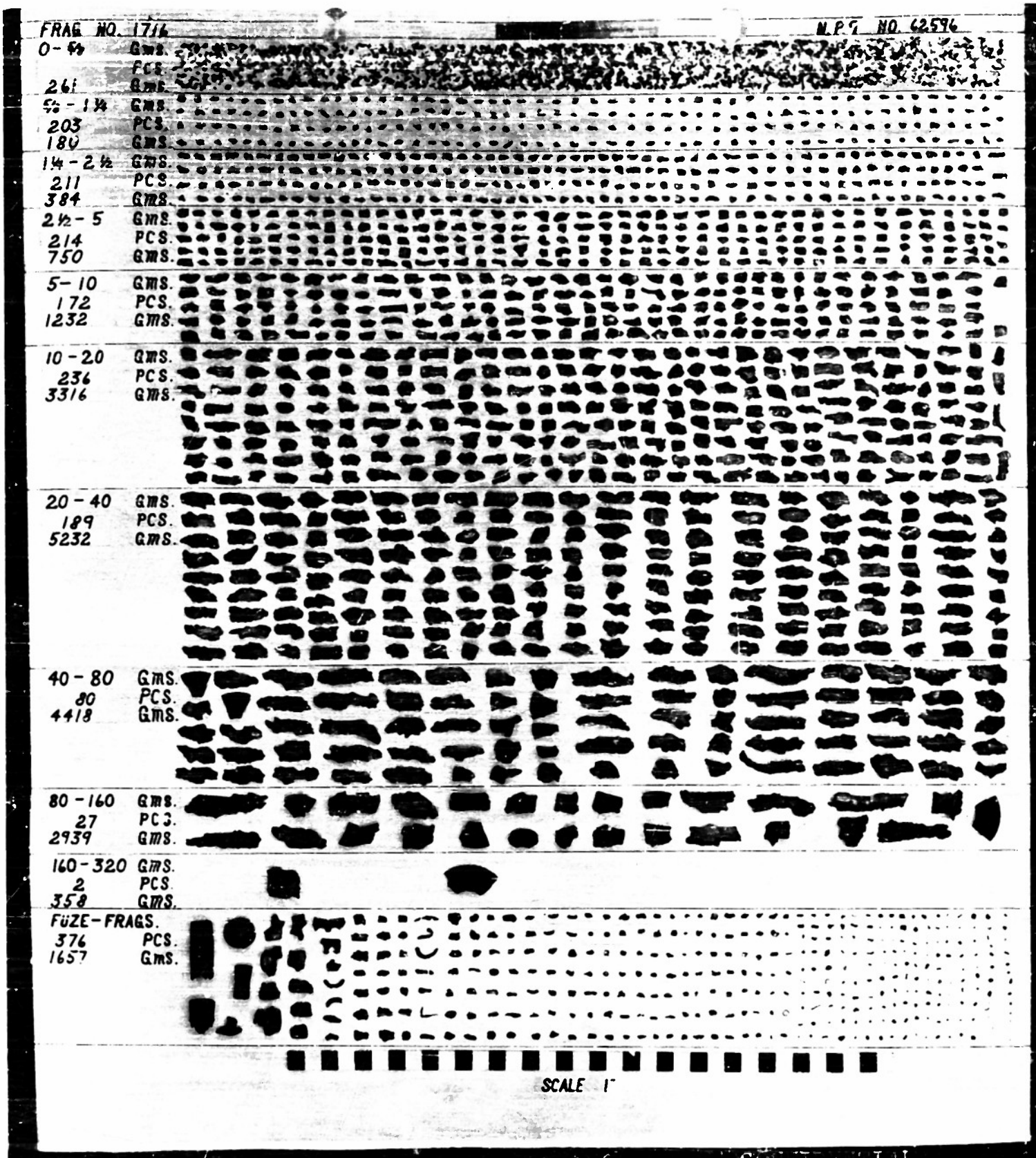
SECURITY INFORMATION

NP9-62588 27 February 1953
Mass Distribution of 5"/38 HC Projectile Mk 49 Mod 1 Explosive "D" loaded, assembled with Mk 28 BDF, Mk 55 ADF, and Mk 29 PDF. Nose Initiated.
No. 4 FIGURE 10



CONFIDENTIAL
SECURITY INFORMATION

NPG-62596 4 March 1953
Mass Distribution of 5"/38 HC Projectile [illegible] 49 Mod 1 Explosive "D" loaded, assembled with [illegible] 20 [illegible] 55 ADF, and Mk 29 PDF. Nose Initiated.
Rd. 5

FIGURE 11

Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

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Fragmentation Test of 5"/38 HC and VT (FCL)
Projectiles Mk 49, Explosive "D" and Composition A-3 Loaded

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