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SECURITY INFORMATION

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1164

TERMINAL BALLISTICS

3rd Partial Report

- - - - - - - - - - - -

FRAGMENTATION TESTS OF 2.75 DACR ROCKETS T131

FINAL Report

Copy No. 11

Task Assignment NPG-Re3d-445-1-53

Classification CONFIDENTIAL
SECURITY INFORMATION

Fragmentation Tests of 2"75 DACR Rockets T131

PART A

SYNOPSIS

1 This test was conducted to determine the fragmentation characteristics of the Composition B loaded 2"75 DACR Rocket T131E2. This rocket was designed to penetrate 1/4" aluminum and damage a target mainly by blast.

2. The 2"75 DACR Rocket T131E2 when detonated statically produced:

a. very fine fragments,

b. an average median fragment velocity of 5990 ft./sec., and

c. an average of 458 fragment hits in total polar zone 55°-115° with the heaviest concentration in zone 90°-100°.

Fragmentation Tests of 2"75 DACR Rockets T131

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PART B

INTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3d-445-1-53, reference (b).

2. REFERENCES:

a. BUORD Conf ltr S78-1(119) Re3d-ANB:bc Ser 50941 of 27 January 1953
b. BUORD Conf ltr NP9 Re3d ANB:bc Ser 43441 of 12 August 1952
c. Picatinny Conf ltr ORDBB 471.94/1-337 to NAVPROV of 26 June 1953
d. Armour Research Conf Project No. 90-396D Report of 31 July 1950
e. NPG Conf Report No. 964 of 30 April 1952

3. BACKGROUND:

The Armour Research Foundation started the development of a 2"75 spin stabilized high explosive rocket to be launched at high velocity and at a high cyclic rate for air-to-air warfare in June 1946. The results of their investigation and development were reported in July 1950, reference (d). Further development of this rocket was undertaken by Picatinny Arsenal. The latest design of this rocket, the 2"75 DACR T131E2, was shipped to the Naval Proving Ground for fragmentation and plate penetration tests. This report deals with the fragmentation tests, while the plate penetration tests will be made the subject of a future report.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of the Composition B loaded 2"75 DACR Rocket T131E2. This rocket was designed to penetrate 1/4" aluminum and damage a target mainly by blast.

5. PERIOD OF TEST:

a.	Date Project Letter	27 January 1953
b.	Date All Necessary Material Received	29 June 1953
c.	Date Commenced Test	17 April 1953
d.	Test Completed	15 June 1953

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

The 2"75 Rocket T131E2 is a Direct Action Close Range (DACR) missile, Figures 1 and 2. Twenty (20) rounds were fragmented in this test. The cartridge cases of all rounds were removed and the propellant burned out prior to test. The rounds were assembled with nose fuzes T2021 modified for static detonation by Picatinny Arsenal. The nominal weights furnished by Picatinny in reference (c) are as follows:

Component	Pounds
Fuze	0.16
Empty head	0.70
Explosive, Composition B	1.00
Motor	1.39
Motor nozzle plate	0.41
Unburnt propellant	0.10
Total	3.76

The actual average total weights of the twenty rounds tested was 3.78 lbs. The excess, 0.02 lbs., is attributed to the modified fuze.

7. 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, cleaned, classified, and photographed.

b. Fragment velocity measurements were obtained by the usual high-speed photographic technique using an 8mm Fastax camera. Fragment velocities obtained are the mean velocities over the first 30 feet of travel. The 30' radius velocity plates cover 1/3 of the total solid angle in polar zone 80°-108°.

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 off in 5° polar angle zones about the axis of the rocket with the nose pointed toward 0°. The center of gravity of the rocket head coincided with the arena center. Complete fragment penetrations of the panels were counted.

8. RESULTS AND DISCUSSION:

For comparative purposes the 2"75 AAFFR Mk 2 Rocket fragmentation data, reported in reference (e), will be included in this report. The Mk 2 is longer and heavier, has a thicker wall, and contains more explosive than the T131E2.

a. Mass Distribution

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

5 *Round Averages
No. Fragments in Various Weight Groups

Rocket	0.3-5/8 grams	5/8-2-1/2 grams	2-1/2-5 grams	5-10 grams	10-20 grams	20-40 grams	greater than 40 grams
T131E2	261	102	11	5	5.4	2	2.8
Mk 2	**	819	139	59	14	10	1

*Figures are motor and head totals
**Not available

b. Space Distribution

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

Polar Zone	Average No. Hits on total zone T131E2	* Mk 2
0°- 55°	0	0
55°-115°	458	745
115°-155°	0	0
155°-180°	25	8
Total	483	753

*Nine round average; the T131E2 column is a ten round average.

Comparison of the T131E1 space distribution data with the mass distribution data, indicates that many of the fragments under 5/8 grams, and a few under 0.3 grams, are capable of penetrating 1/8" thick mild steel plate at 30 feet.

c. Fragment Velocity

Detailed fragment velocity data are listed in Table III. The average beam spray fragment velocity follows:

	Beam Spray Velocities (ft./sec.) T131E2	Mk 2
Median	5990	3780
*Highest	7100	4350

*The highest individual velocity recorded.

PART D

CONCLUSIONS

9. The 2"75 DACR Rocket T131E2 when detonated statically produced:

a. very fine fragments,

b. an average median fragment velocity of 5990 ft./sec., and

c. an average of 458 fragment hits in total polar zone 55°-115° with the heaviest concentration in zone 90°-100°.

Fragmentation Tests of 2"75 DACR Rockets T131

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By direction

CONFIDENTIAL

NPG REPORT NO. 1164

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Third Partial Report

on

Terminal Ballistics

Final Report

on

Fragmentation Tests of 2"75 DACR Rockets T131

Project No.: NPG-Re3d-445-1-53
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No. of pages: 7

Date: AUG 20 1953

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17 April 1953

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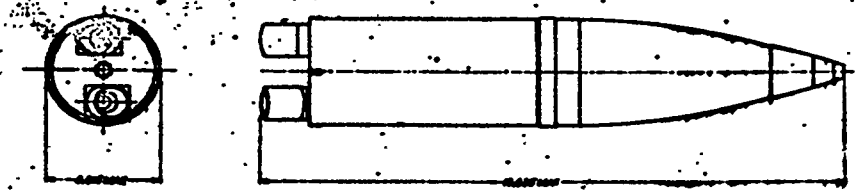
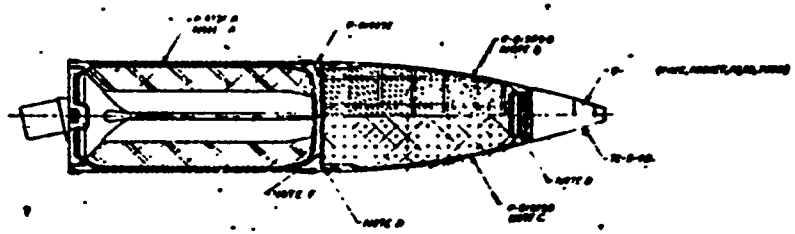
2.75 DAGR Rocket Head T131
FIGURE 1



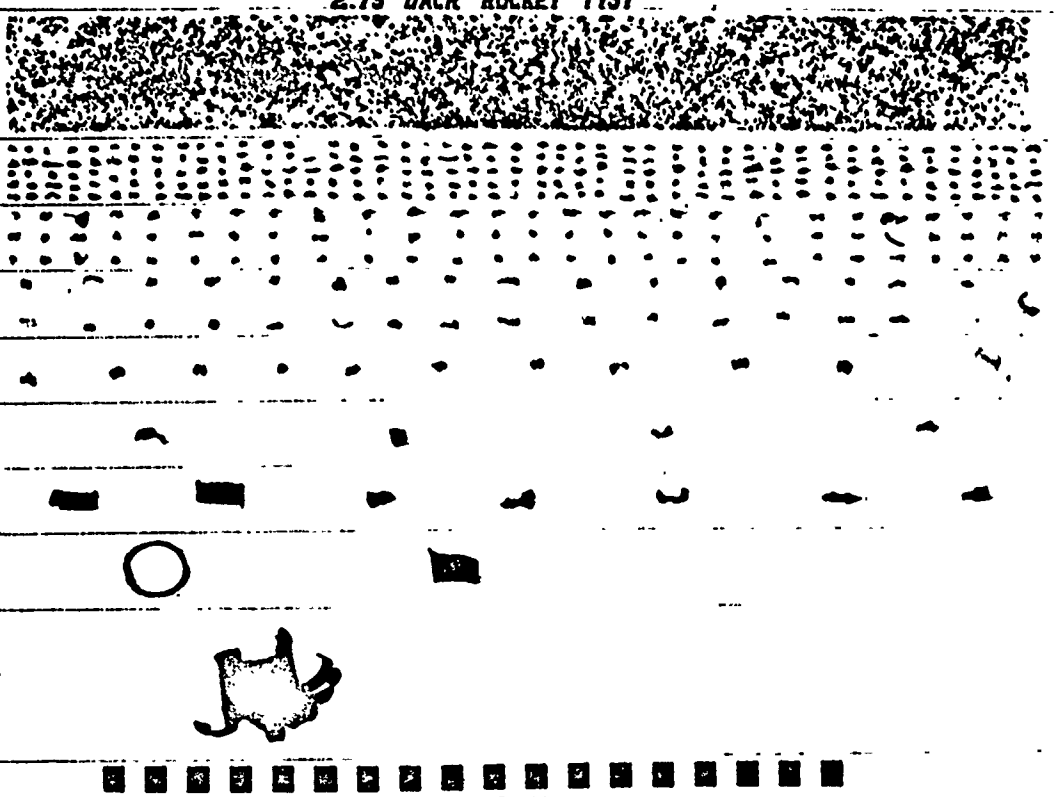


LIST OF DRAWINGS

FRAG NO. 1734 [redacted] N.P.9 NO. 63130

2.75 DACR ROCKET T131

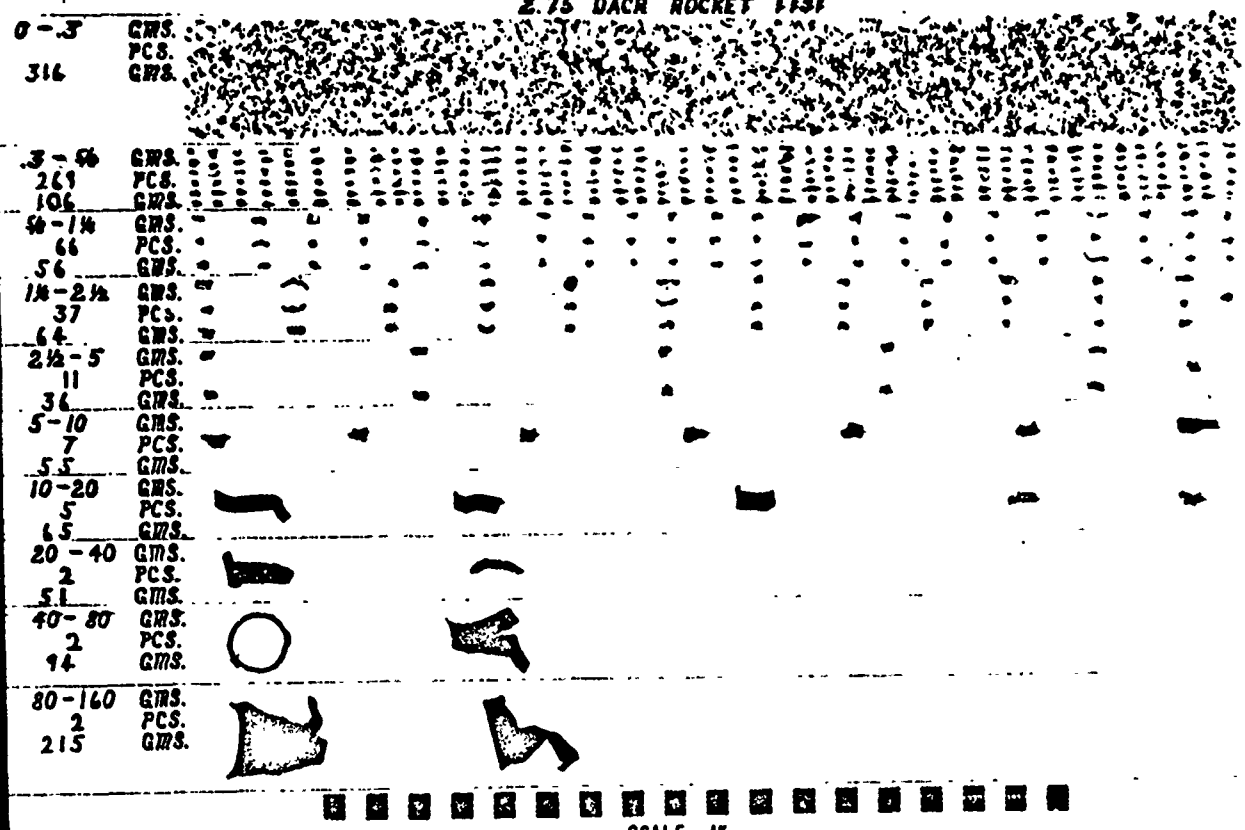
0 - .3	GMS.
	PCS.
327	GMS.
.3 - 5/8	GMS.
230	PCS.
94	GMS.
5/8 - 1 1/4	GMS.
81	PCS.
66	GMS.
1 1/4 - 2 1/2	GMS.
33	PCS.
53	GMS.
2 1/2 - 5	GMS.
11	PCS.
39	GMS.
5 - 10	GMS.
4	PCS.
31	GMS.
10 - 20	GMS.
7	PCS.
90	GMS.
20 - 40	GMS.
2	PCS.
63	GMS.
160 - 320	GMS.
1	PCS.
298	GMS.



SCALE 1"

FRAG NO. 1735 [redacted] N.P.9 NO. 63172

2.75 DACR ROCKET T131



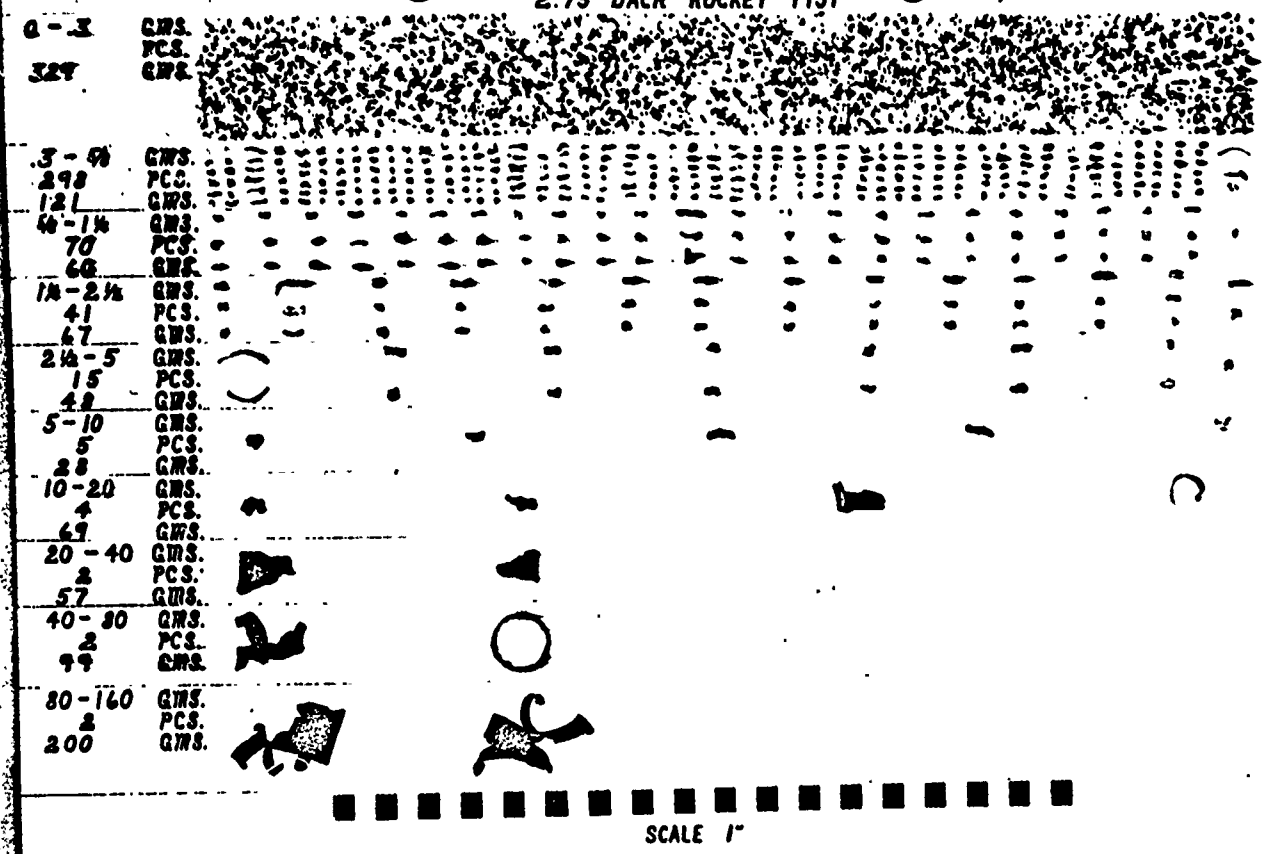
[illegible] April 19[illegible] [illegible]

[illegible] Distribution of 2.75 [illegible] Rocket [illegible], Composition B loaded.

FIGURE 4

FRAG NO: 1736. [redacted] N.P.9 NO. 63182

2.75 DACR ROCKET T131



NP9-63182 24 April 1953 CONFIDENTIAL SECURITY INFORMATION

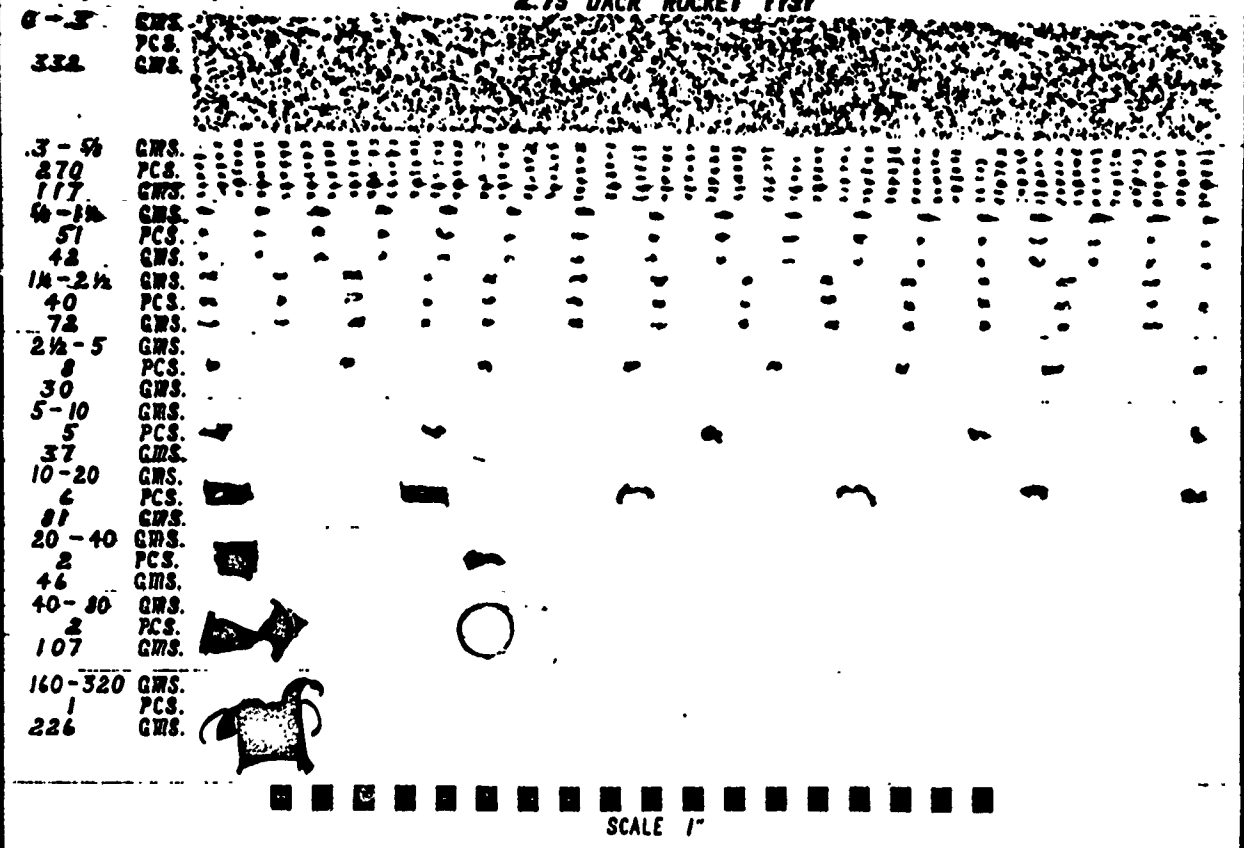
Ed. No. 3 Mass Distribution of 2.75 DACR Rocket T131E2, Composition

Blended.

FIGURE 5

FRAG. NO. 1737 [redacted] M.P.9 NO. 63241

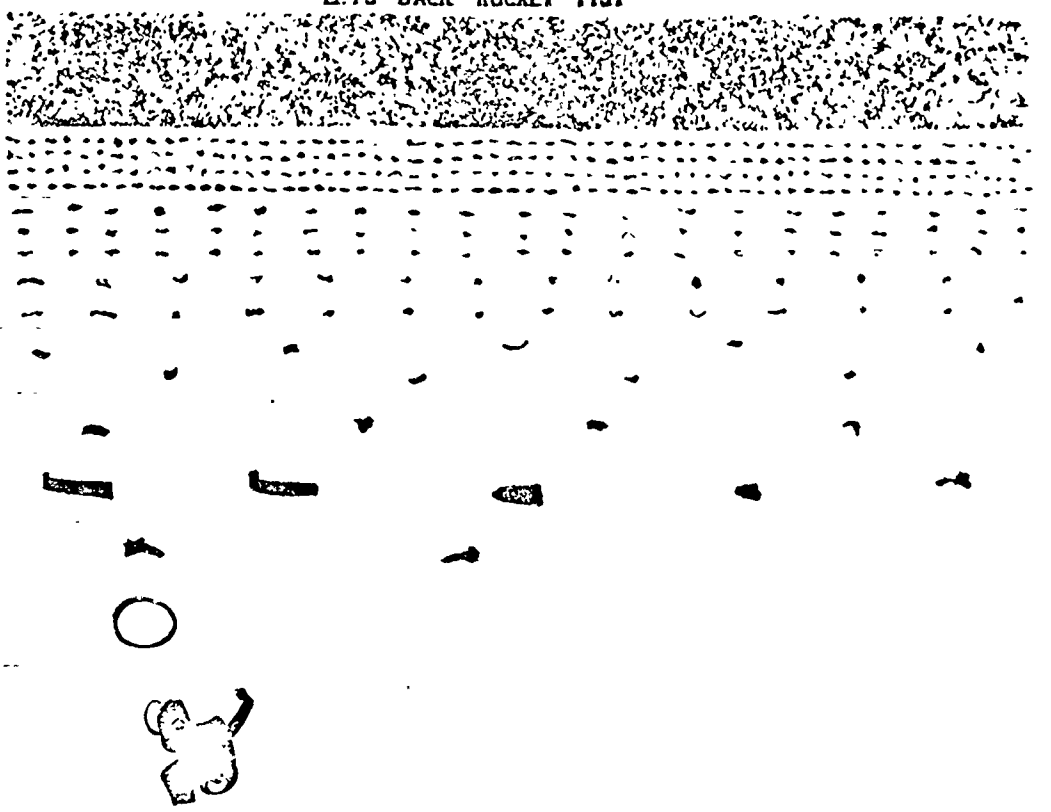
2.75 DACR ROCKET T131



FRAG NO. 1735 [redacted] H.P.9 NO. 63274

2.75 DACR ROCKET T131

0 - .3	GMS.
	PCS.
356	GMS.
.3 - 5/8	GMS.
239	PCS.
96	GMS.
5/8 - 1 1/8	GMS.
63	PCS.
53	GMS.
1 1/8 - 2 1/2	GMS.
27	PCS.
46	GMS.
2 1/2 - 5	GMS.
9	PCS.
30	GMS.
5 - 10	GMS.
4	PCS.
30	GMS.
10 - 20	GMS.
5	PCS.
87	GMS.
20 - 40	GMS.
2	PCS.
42	GMS.
40 - 80	GMS.
1	PCS.
41	GMS.
[illegible] - 320	GMS.
1	PCS.
293	GMS.



SCALE 1"

TA

MASS DISTR

FRAGMENTATION OF 2"75 DACR ROCKETS T131E2, CO
NUMBER AND WEIGHT OF RECOVERED FRAGMENTS

Rd. No.	*Comp. Wt. lb.	Filler Wt. lb.	0-.3 grams Wt. Gms.	.3-0.625 grams Wt. Gms.	.3-0.625 grams No.	0.625-1.25 grams Wt. Gms.	0.625-1.25 grams No.	1.25-2.5 grams Wt. Gms.	1.25-2.5 grams No.	2.5-5 grams Wt. Gms.	2.5-5 grams No
1	3.78	1.00	327	94	230	66	81	53	33	39	1
2	3.75	1.00	316	106	269	56	66	64	37	36	1
3	3.78	1.00	329	121	298	60	70	67	41	48	1
4	3.78	1.00	332	117	270	42	51	72	40	30	
5	3.75	1.00	356	96	239	53	63	46	27	30	
Avg.	3.77	1.00	332	107	261	55	66	60	36	37	1

*These complete weights are NPG weights. Picatinny Arsenal repo
plate, head, and explosive respectivily and in addition 0.10 lb o

TABLE I

MASS DISTRIBUTION DATA

TS T131E2, COMPOSITION B LOADED
RAGMENTS

5-2.5 grams		2.5-5 grams		5-10 grams		10-20 grams		20-40 grams		40-80 grams		80-160 grams		160-320 grams		Total		Photo. No.
.	No.	Wt. Gms.	No.	Wt. Gms.	No.	Wt. Gms.	No.	Wt. Gms.	No.	Wt. Gms.	No.	Wt. Gms.	No.	Wt. Gms.	No.	No.	Gms.	NP9
	33	39	11	31	4	90	7	63	2	-	-	-	-	298	1	369	1061	63130
	37	36	11	55	7	65	5	51	2	94	2	215	2	-	-	401	1058	63172
	41	48	15	28	5	69	4	57	2	99	2	200	2	-	-	439	1078	63182
	40	30	8	37	5	81	6	46	2	107	2	-	-	226	1	385	1090	63241
	27	30	9	30	4	87	5	42	2	41	1	-	-	293	1	351	1074	63274
	36	37	11	36	5	78	5.4	52	2	68	1.4	83	0.8	163	0.6	389	1072	-

y Arsenal reported nominal weights of 1.39, 0.41, 0.70, and 1.00 lb. for the motor, nozzle tion 0.10 lb of unburnt propellant. The T2021 nose fuze weighed 0.16 lb.

TABLE II

SPACE DISTRIBUTION DATA

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

2"75 DACR Rockets T131E2
21 April 1953

Zone Degrees	Rd. 1 R.	Rd. 1 L.	Rd. 1 Avg.	Rd. 2 R.	Rd. 2 L.	Rd. 2 Avg.	Rd. 3 R.	Rd. 3 L.	Rd. 3 Avg.	Rd. 4 R.	Rd. 4 L.	Rd. 4 Avg.	Rd. 5 R.	Rd. 5 L.	Rd. 5 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															
70-75															
75-80		2	1												
80-85	2	1	1.5		3	1.5		1	0.5	1	1	1.0	4	1	2.5
85-90	1	3	2.0	3	4	3.5	4	1	2.5	3	2	2.5	2	1	1.5
90-95	8	4	6.0	3	5	4.0	2	7	4.5	6	5	5.5	7	6	6.5
95-100	6	7	6.5	5	2	3.5	6	5	5.5	4	2	3.0	6	2	4.0
100-105	1	6	3.5	3	2	2.5	3	3	3.0	4	3	3.5	1	4	2.5
105-110				1		0.5		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		1	0.5	2	3	2.5	2	2	2.0
170-175	4	1	2.5	3	7	5.0	1	3	2.0	4	4	4.0	4	4	4.0
175-180	4	2	3.0	2	8	5.0	5	8	6.5	8	4	6.0	9	7	8.0

Fragmentation Tests of 2.75 DACR Rockets T131

TABLE II (Continued)

Zone	Rd. 6			Rd. 7			Rd. 8			Rd. 9			Rd. 10		
Degrees	R.	L.	Avg.	R.	L.	Avg.	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															
70-75													1		0.5
75-80							3	1	2.0	1		0.5		1	0.5
80-85	7	1	4.0	5	1	3.0	3		1.5	2	2	2.0	2		1.0
85-90	4	3	3.5	3	1	2.0	2	4	3.0	2	2	2.0	4	4	4.0
90-95	6	2	4.0	11	2	6.5	4	5	4.5	6	8	7.0	5	5	5.0
95-100	9	6	7.5	4	4	4.0	7	2	4.5	6	3	4.5	4	5	4.5
100-105	2	2	2.0	1	5	3.0	3	5	4.0		3	1.5	2	1	1.5
105-110					1	0.5				1		0.5	1	1	1.0
110-115															
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	0.5	2		1.0	1	1	1.0		1	0.5	1		0.5
170-175	4	6	5.0	4	4	4.0	3	2	2.5	3	1	2.0	7	1	4.0
175-180	7	5	6.0	6	1	3.5	2	3	2.5	5	1	3.0	7	3	5.0

Fragmentation Tests of 2.75 HACR Rockets T13E

TABLE II (Continued)

Zone Degrees	Avg. Impacts Per 5° Zone on Panel	Avg. Impacts Per Total 5° Zone on Panel	Avg. Impacts Per Unit Solid Angle
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			
70-75	0.05	1.2	2
75-80	0.4	10	18
80-85	1.9	48	88
85-90	2.7	68	124
90-95	5.4	136	250
95-100	4.8	120	220
100-105	2.7	67	124
105-110	0.3	7	14
110-115	0.05	1.2	2
115-120			
120-125			
125-130			
130-135			
135-140			
140-145			
145-150			
150-155			
155-160	0.05	0.5	2
160-165	0.1	0.7	4
165-170	0.9	5	40
170-175	3.5	9	126
175-180	4.9	9.8	410

Fragmentation Tests of 2"75 DACR Rockets T132

TABLE III

FRAGMENT VELOCITY DATA

30 Ft. Radius Velocity Arena
8mm Fastax Camera No. 1
Rd. No. 1-2"75 T131E2 Rocket Assembly
Filler Comp. B Filler weight 1.00 lbs.

6650 frames per second
Fuze P.D. T2021
Total weight 3.81 lbs.
8 June 1953

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
29	4	6880
30	6	6650
31	3	6440
32	6	6230
33	4	6050
34	2	5870
35	3	5700
36	3	5540
37	3	5390
38	9	5250
39	1	5100
40	2	4990
41	2	4870
Median		5950
Average		5880

Fragmentation Tests of 2"75 DACR Rockets T131

TABLE III (Continued)

30 Ft. Radius Velocity Arena
8mm Fastax Camera No. 1
Rd. No. 2 - 2"75 T131E2 Rocket Assembly
Filler Comp. B Filler weight 1.00 lbs.

7100 frames per second
Fuze P.D. T2021
Total weight 3.73 lbs.
8 June 1953

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
30	2	7100
31	4	6870
32	7	6660
33	6	6450
34	8	6260
35	3	6090
36	7	5920
37	6	5760
38	4	5610
39	8	5460
40	4	5330
41	5	5200
42	7	5070
43	1	4950
44	3	4840
45	1	4730
Median		5890
Average		5850

Fragmentation Tests of 2.75 DACR Rocket T131

TABLE III (Continued)

30 Ft. Radius Velocity Arena
8mm Fastax Camera No. 1
Rd. No. 3 - 2.75 T131E2 Rocket Assembly
Filler Comp. B Filler weight 1.00 lbs.

6650 frames per second
Fuze P.D. T2021
Total weight 3.85 lbs.
8 June 1953

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
29	2	6830
30	3	6650
31	7	6440
32	7	6230
33	6	6050
34	8	5870
35	4	5700
36	2	5540
37	2	5390
38	1	5250
39	2	5120
42	2	4750
44	1	4530
Median		6110
Average		5950

Fragmentation Tests of 2.75 DACR Rocket T131

TABLE III (Continued)

30 Ft. Radius Velocity Arena
8mm Fastax Camera No. 1
Rd. No. 4 - 2.75 T131E2 Rocket Assembly
Filler Comp. B Filler weight 1.00 lbs.

6500 frames per second
Fuze P.D. T202I
Total weight 3.77 lbs.
8 June 1953

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
28	2	6960
29	1	6720
30	5	6500
31	7	6290
32	2	6090
33	6	5910
34	5	5740
35	2	5570
36	2	5420
37	3	5270
38	5	5130
40	1	4880
41	2	4760
42	1	4640
43	1	4530
Median		5920
Average		5790

Fragmentation Tests of 2"75 DACH Rocket T131

TABLE III (Continued)

30 Ft. Radius Velocity Arena
8mm Fastax Camera No. 1
Rd. No. 5 - 2"75 T131E2 Rocket Assembly
Filler Comp. B Filler weight 1.00 lbs.

6500 frames per second
Fuze P.D. T2021
Total weight 3.77 lbs.
8 June 1953

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
28	3	6960
29	7	6720
30	10	6500
31	2	6290
32	3	6090
33	4	5910
34	3	5740
35	3	5570
36	3	5420
37	7	5270
38	2	5130
39	3	5000
41	1	4760
Median		6100
Average		5970

Fragmentation Tests of 2.75 DACR Rockets T131

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