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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 948

WARHEADS FOR AIR TARGET GUIDED MISSILES;
TESTING OF

40th Partial Report

AAP ROD-PRODUCING WARHEAD AND
ROCKET MOTOR; FRAGMENTATION OF

FINAL Report

Copy No. 11

Task

Assignment NPG-Re3f-607-1-52

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AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of AAP rod-producing warheads. These warheads were made from NE 8737 steel tubing, internally grooved, heat treated to Rockwell "C" 40-44, and Composition C-3 loaded.
2. The AAP warhead expelled rod-like fragments up to 8" in length evenly about the warhead circumference at an average velocity of 4160 ft./sec.

AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

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AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

PART II

INTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3f-607-1-52, reference (b).

2. REFERENCES:

- a. NOL Conf ltr NP/NOL/X11(270) WG:SW:mbw Ser 01569 of 6 September 1951
- b. BUORD Conf ltr NP9 Re3f-EJHL:edb Ser 25777 of 18 September 1951
- c. NPG Conf Report No. 858 of 13 October 1951
- d. NPG Conf Report No. 854 of 1 September 1951

3. BACKGROUND:

a. Reference (b) authorized the Naval Ordnance Laboratory to work directly with the Naval Proving Ground in the development and testing of guided missile warheads.

b. Reference (d) reported the fragmentation characteristics of the notched ring AAP warhead. Reference (c) reported the fragment mass distribution of two types of AAP rod-producing warheads, Type 4. Four additional AAP rod-producing warheads, were delivered to the Proving Ground for fragmentation tests.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of AAP rod-producing warheads. These warheads were made from NE 8737 steel tubing, internally grooved, heat treated to Rockwell "C" 40-44, and Composition C-3 loaded.

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AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

5. PERIOD OF TEST:

a. Date Project Letter	6 September 1951
b. Date Necessary Material Received	27 September 1951
c. Date Commenced Test	5 December 1951
d. Date Test Completed	7 December 1951

6. REPRESENTATIVES PRESENT:

This test was witnessed by Messrs. S. Wolf and J. R. Burton representing the Naval Ordnance Laboratory.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

Four rounds of AAP rod-producing warheads were assembled with inert AAP rocket motors. Detailed assemblies are shown in Figures 1, 2, and 3. The warheads were made from NE 8737 steel tubing, internally grooved to produce 24 rod-like fragments and heat treated to Rockwell "C" 40-44. The warheads were assembled with mock-up VT fuzes modified for static detonation and then loaded with Composition C-3 at the Proving Ground. The weights of the components were as follows:

<u>Rd.</u> <u>No.</u>	<u>Serial</u> <u>No.</u>	<u>Motor Wt.</u> <u>lbs.</u>	<u>Head Wt.</u> <u>with Fuze</u> <u>lbs.</u>	<u>Filler</u> <u>Wt. lbs.</u>	<u>Total Wt.</u> <u>lbs.</u>
1	505-1	38.85	17.10	4.60	60.55
2	505-2	38.75	17.10	4.61	60.46
3	505-3	38.80	17.32	4.46	60.58
4	505-4	38.80	17.15	4.50	60.45

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AAF Rod-Producing Warhead and Rocket Motor, Fragmentation of

8. PROCEDURE:

a. Round No. 1, Serial No. 505-1, was detonated in a sawdust filled chamber for mass distribution data. After the detonation, the sawdust was sifted and the fragments recovered by the use of sieves and a magnetic separator.

b. Rounds Nos. 2, 3, and 4, Serials Nos. 505-2, 505-3, and 505-4, were detonated in a 30.6 foot radius velocity arena. The arena consisted of 15 foot high 1" thick steel panels in longitude zones 350°-55° and 125°-190°. A cane fiberboard pack 4' high 8' wide, and 4' thick was placed with its center 5 feet off the ground, in the 90° longitudinal plane, and 30.6 feet from the center of the arena for recovery of sample rod-like fragments. The velocity determinations were obtained by high speed photographic technique. Angular fragment distribution and fragment lengths were recorded from impacts on the panels. All rounds were placed vertically with the warhead up on a wooden stand in the center of the arena and detonated statically.

9. RESULTS AND DISCUSSION:

a. Mass Distribution

Detailed mass distribution data of Round No. 1, Serial No. 505-1 are listed in Table IV and shown in Figure 4. The number and lengths of the rod-like fragments are as follows:

<u>No.</u>	<u>Approx. Size</u>	<u>No.</u>	<u>Approx. Size</u>
10	8"	6	4 1/2"
2	6"	27	2" - 4"

The motor fragmented satisfactorily, considering that it contained no propellant.

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b. Fragment Space Distribution

One of the three warheads detonated for space distribution and velocity detonated low order. The warhead is shown in Figure 6. The other two detonated high order producing rod-like fragments. The fragments were distributed evenly, approximately 15° apart about the circumference of the warhead at approximately 93° of latitude measured from the forward end of the missile. The rocket motor is the forward end of this missile with the warhead the base end. The rod-like fragments had a tendency to remain about 6" to 8" in length with some breaking into two lengths. Detailed fragment length and angular distribution data are listed in Table I. Sample warhead and motor fragments recovered are shown in Figures 5 and 7.

c. Fragment Velocities

The rod-like fragment velocity from the warheads 505-2 and 505-3 averaged 4160 ft./sec. The motor fragments which hit in latitude zone 75°-78° averaged 2500 ft./sec. These fragments were from the rear section of the motor nearest the warhead. The major portion of the motor fragments were found within 400 feet of the arena center and their velocity is estimated to be 200-500 ft./sec. Detailed fragment velocity data are listed in Tables II and III.

PART D

CONCLUSIONS

10. The AAP warhead expelled rod-like fragments up to 8" in length evenly about the warhead circumference at an average velocity of 4160 ft./sec.

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AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

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

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This report was prepared by:

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By direction**

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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fortieth Partial Report
on
Warheads for Air Target Guided Missiles;
Testing of

Final Report
on
AAP Rod-Producing Warhead and
Rocket Motor; Fragmentation of

Project No.: NPG-Re3f-607-1-52
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Date: MAR 27 1952

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17-32000-8-1

MP-4/487

December 1951

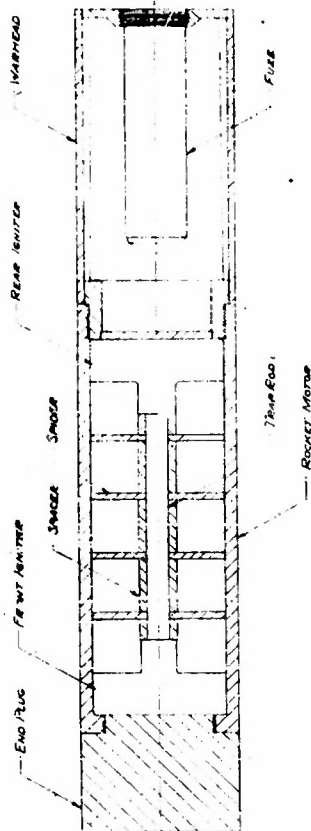
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Board Drawing SK 315165

Outline Drawing of Air Warhead and Rocket Motor

Figure 1

REVISION	DATE	BY	CHKD



SK 315165

NAME: SK 315165 DATE: 12/1/51 BY: [Signature] CHECKED: [Signature] DO NOT SCALE THIS DRAWING MATERIAL:		APPROVED: [Signature] TITLE: AIR-TRIAL WARHEAD TYPE No. 1 TEST ASSEMBLY		SCALE: 1/2 UNIT: IN. JOB NO.: SK 315165	
SPECIAL INSTRUCTIONS: THIS DRAWING IS TO BE USED FOR THE PURPOSE OF THE TEST ASSEMBLY ONLY. IT IS NOT TO BE USED FOR THE PURPOSE OF THE PRODUCTION OF THE WARHEAD.		SPECIAL INSTRUCTIONS: THIS DRAWING IS TO BE USED FOR THE PURPOSE OF THE TEST ASSEMBLY ONLY. IT IS NOT TO BE USED FOR THE PURPOSE OF THE PRODUCTION OF THE WARHEAD.		SPECIAL INSTRUCTIONS: THIS DRAWING IS TO BE USED FOR THE PURPOSE OF THE TEST ASSEMBLY ONLY. IT IS NOT TO BE USED FOR THE PURPOSE OF THE PRODUCTION OF THE WARHEAD.	

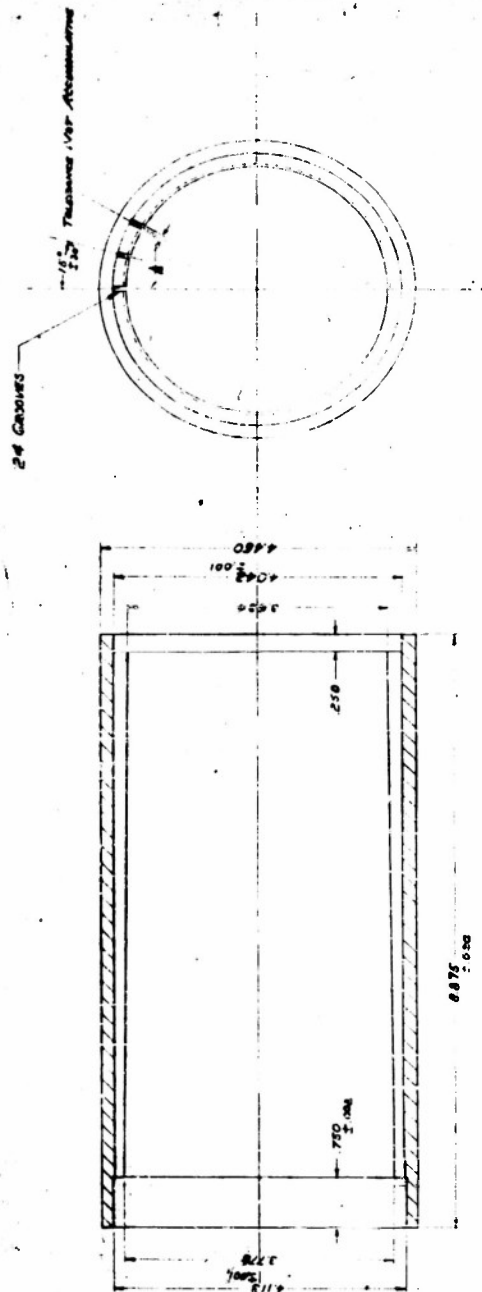
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65 December 1951.

Buord Drawing SK 31753! ABE god-producing

88767-6dN

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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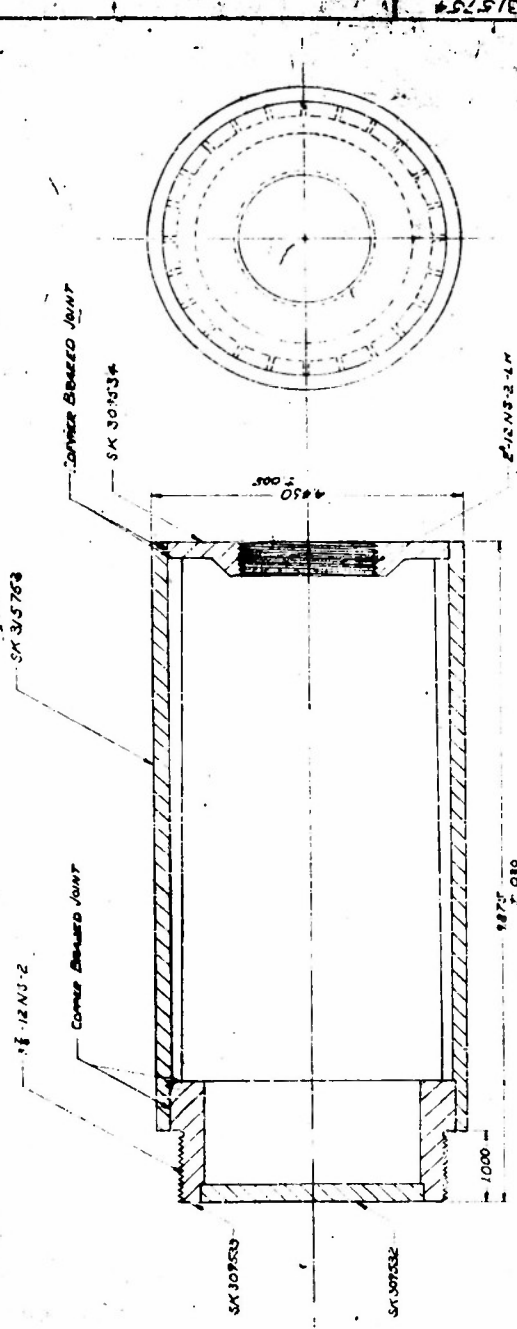


5K 3/5 753

[illegible]



REV	DESCRIPTION	DATE	BY



WARMED 1/8 TO BE CORNER PLATED

- HEAT TREATMENT**
1. QUENCH IN OIL FROM 1640-1565°F; DRAW TO ROOMTEMP C 40-44
 2. HEAT AND QUENCH WITH CYLINDRICAL AXIS IN VERTICAL POSITION TO MINIMIZE DISTORTION.
 3. HEAT IN CONTROLLED ATMOSPHERE OR SALT BATH FURNACE TO PRODUCE SOME FREE SURFACE.

NAME SKETCHED BY DATE CHECKED BY DATE APPROVED BY DATE		AAP TRIAL WARMHEAD TYPE NO. 9 ASSEMBLY	
MATERIAL: 309530 PART NO.: 309530		SK 309534 SK 309536	

AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

TABLE I

ANGULAR DISTRIBUTION DATA

AAP Rod-Producing Warhead and Rocket Motor
30.5 Foot Radius Arena, 15' High Panels

Rd. No. 2 Serial No. 505-2		Rd. No. 3 Serial No. 505-3		Rd. No. 4 Serial No. 505-4	
Longitude	Fragment	Longitude	Fragment	Longitude	Fragment
Angle		Angle		Angle	
(Degrees)	Length (Inches)	(Degrees)	Length (Inches)	(Degrees)	Length (Inches)
2	8 1/4	This round detonated Low Order. Sec Figure 6.		6	3 *
18	3 1/4			25	8 1/4
19	3 3/4			39	7 3/4
34	7			56	8
51	8			92	8
132	3			137	5
132	4			153	5 1/4
148	4 *			169	4 *
164	3 *			185	6
180	3 1/2 *				

* These fragment lengths were probably greater. They penetrated the 1" thick STS panels and the impact openings were recorded as the fragment lengths.

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AAP Rod-Producing Warhead and Rocket Motor, Fragmentation of

TABLE II

FRAGMENT VELOCITY DATA

35mm Fastax Camera
Rd. 2 NOL 505-2 AAP
30.6 foot Radius Arena
Total Weight 60.46 lbs.

3150 frames per sec.
Comp. C-3

Filler Weight 4.61 lbs.

<u>Longitude Zone</u>	<u>No.</u>	<u>Frame in Which Hit Occurred</u>	<u>No. Rod-like Fragments</u>	<u>Velocity (f/s)</u>
350°-55°	5	22	5	4380
125°-190°	4	23	4	4190
350°-55°	1	24	1	4020
Median				4380
Average				4270

Motor Hits

<u>Longitude Zone</u>	<u>No.</u>	<u>No. Motor Fragments</u>	<u>Velocity (f/s)</u>
350°-55°	1		
125°-190°	1	38	2
350°-55°	2		
125°-190°	1	39	3
			2540
			2470

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APPENDIX C

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ALP Rod-Producing Warheads and Rocket Motor, Fragmentation of

TABLE III

FRAGMENT VELOCITY DATA

35mm Fastax Camera
Rd. 4 NOL ALP Warhead 505-4
30.6 foot Radius Arena
Total Weight 60.45 lbs.

3180 frames per sec.
Comp. C-3

Filler Weight 4.50 lbs.

<u>Longitude Zone</u>	<u>No.</u>	<u>Frame in which Hit Occurred</u>	<u>No. Rod-like Fragments</u>	<u>Velocity (f/s)</u>
350°-55°	4			
125°-190°	4	24	8	4050
Average				4050

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APPENDIX C

N.P. 46967

Motor		Motor	
0-5	Gms.		
593	Pcs.		
	Gms.		
1/4-1 1/4	Gms.	47	
234	Pcs.	40	
173	Gms.		
1 1/4-2 1/4	Gms.	46	
109	Pcs.	81	
178	Gms.		
2 1/4-5	Gms.	35	
73	Pcs.	127	
266	Gms.		
5-10	Gms.	17	
52	Pcs.	109	
364	Gms.		
10-20	Gms.	22	
28	Pcs.	310	
383	Gms.		
20-40	Gms.	18	
20	Pcs.	479	
576	Gms.		
40-80	Gms.	1	
23	Pcs.	60	
1149	Gms.		
80-160	Gms.	4	
11	Pcs.	458	
1303	Gms.		
160-320	Gms.	2	
7	Pcs.	412	
1144	Gms.		
320-640	Gms.	3	
	Pcs.	1513	
	Gms.		
640+	Gms.	8	
	Pcs.	14056	
	Gms.		

FUZE - FRAGS

82 PCS.
1029 Gms.

SCALE

NPC-45062

7 December 1951

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~~Mass Distribution of AAF Rod-producing Warhead and Rocket Motor Serial~~

No. 505-1.

Figure 4

FRAG NO. 1617

AAP MOTOR FRAGMENTS

NOL 505-2

3 Gms.

8 Gms.

4 Gms.

4 Gms.

11 Gms.

13 Gms.

51 Gms.

99 Gms.

102 Gms.

107 Gms.

135 Gms.

344 Gms.

388 Gms.

1054 Gms.

1129 Gms.

1246 Gms.

1475 Gms.

4569 Gms.

SCALE 1"

Sample Rocket Motor Fragments from AAP Serial No. 505-2 recovered in the field.

Figure 5

NP9-47490

5 December 1991

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AAP Rod-producing Warhead and Rocket Motor Serial No. 505-3 after low order
detonation. Exp. plate, fuze and some Composition C-3 were blown out.
Figure 6



AAP FRAGMENTS
NOL 505-4

NP9-46856

HEAD

168 Gms.

MOTOR

27 Gms.

106 Gms.

243 Gms.

357 Gms.

562 Gms.

738 Gms.

11804 Gms.

SCALE 1"

NP9-46856

5 December 1951

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Sample Warhead and Rocket Motor Fragments from AAP Serial No. 505-4
recovered in cane fiberboard and in the field.

Figure 7

AAP Rod-Producing Warheads and Rocket Motor, Fragmentation of

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