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U S NAVAL PROVING GROUND	
DAHLGREN, VIRGINIA	
REPORT NO 946	
WARHEADS FOR AIR TARGET GUIDED MISSILES:	
TESTING OF	
<u>39th</u> Partial Report	

ROD-EXPELLING WARHEADS,	
TEST OF NOL MODELS 119 AND 121	
<u>FINAL</u> Report	Task Assignment <u>NPG-Re3f-677-1-52</u>
Copy No. <u>32</u>	Classification <u>CONFIDENTIAL</u> <u>SECURITY INFORMATION</u>

JUN 16 1952

Rod-Expelling Warheads, Test of NOL Models 119 and 121

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of rod-expelling warheads Nos. 119a, 119c, and 121.
2. a. Rod-expelling warheads Nos. 119a, 119c, and 121 produced rod-like fragments varying in length from 2" to 9" with warhead No. 121 having the longest fragments.

b. Fragments were distributed fairly evenly about the circumference except on warhead No. 119c which expelled the entire flat side (11 rods) into 15° of longitude zone.

c. The median fragment velocities ranged from 4100 ft/sec to 4850 ft/sec. The flat portion of warhead No. 119c produced the highest fragment velocities. The off centering of the booster in warheads Nos. 119a and 121 caused an 8% variation in fragment velocity with the highest velocity fragments being expelled from the warhead side furthest away from the booster.

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PART B

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(253) Ser 01501 of 27 Aug 1951
- b. BUORD Conf ltr NP9-Re3f-EJHL:edb Ser 25777 of 18 Sep 1951

3. BACKGROUND:

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

b. In the development of the warhead for the Meteor guided missile, the Naval Ordnance Laboratory sent three warheads, Nos. 119a, 119c, and 121, to the Proving Ground for fragmentation tests to determine the extent to which passageways through the warhead may produce asymmetry in the rod pattern. Passageways are frequently required to allow electrical leads to pass through or around the warhead.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of rod-expelling warheads Nos. 119a, 119c, and 121.

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5. PERIOD OF TEST:

a. Date Project Letter	27 August 1951
b. Date Necessary Material Received	13 August 1951
c. Date Commenced Test	3 December 1951
d. Test Completed	3 December 1951

6. REPRESENTATIVE PRESENT:

This test was witnessed by Mr. G. T. Boswell representing the Naval Ordnance Laboratory.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. Warheads Nos. 119a and 121: 8" diameter, 12"25 long, cylindrical, SAE 1010-1015 steel, .7500 wall thickness as rolled, with longitudinal grooves .375 deep, .062 wide, spaced .531 on centers entirely around the body, designed to produce 45 rods 1/2" x 1/2" x 12", central conduit tube 2" inside diameter through the warhead. The longitudinal axis of the tube for warhead 119a coincided with that of the warhead, while the axis of the conduit through warhead 121 was displaced 0"250 from the warhead axis. The tubes were welded to one of the 1/8" thick end plates. The other end plate was screwed on after loading. Photographs are shown in Figures 1, 2, and 3.

b. Warhead 119c:

This warhead was identical to the two described above except:

- (1) 1"593 inside diameter central conduit tube.
- (2) One side of the warhead was flat'ened to allow leads to go around the warhead. The chord length of this flat portion was 6"25.
- (3) Designed to produce 42 rods.
- (4) Axis of the conduit coincided with the axis of the curved portion of the warhead.

Photographs are shown in Figures 1 and 4.

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The weights of the warheads were as follows:

<u>Rd.</u> <u>No.</u>	<u>Warhead</u> <u>No.</u>	<u>Empty Wt.</u> <u>(lbs)</u>	<u>Comp C-3</u> <u>Filler</u> <u>Wt.(lbs)</u>	<u>* Booster</u> <u>Wt.(lbs)</u>	<u>Total</u> <u>Wt.(lbs)</u>
1	119c	40.62	20.13	.18	60.93
2	119a	42.82	22.33	.18	65.33
3	121	39.90	24.02	.18	64.10

* Tetryl, 1" diameter and 4" long

8. DESCRIPTION OF TEST EQUIPMENT:

a. Arenas: 30.6 foot radius velocity arena consisting of 15 foot high 1" thick steel panels from 350° to 55° and 125° to 190° longitude with a 4' high x 8' wide x 4' thick cane fiberboard pack having its center at 90° longitude (reference zone). A sketch of this arena is shown in Figure 5. The fragment impacts on the panels are used to determine angular distribution and fragment length. The cane fiberboard packs were set to trap sample fragments. Another pack of cane fiberboard was placed in zone 125° to 140° to trap additional fragments on Round No. 1, Warhead No. 119c.

b. Camera: One 35mm Fastax camera was placed at 250 feet from the arena to record fragment velocities by the usual high speed photographic technique.

9. PROCEDURE:

Each warhead was placed vertically in the center of the arena with its center 6 feet above ground level, and initiated from the top by a special engineers blasting cap. The top face of the booster was 3" from the top end plate of each warhead. The position of the booster axis with that of the conduit varied for each round. The exact positions were as follows:

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Rod-Expelling Warheads, Test of NOL Models 119 and 121

a. Round No. 1, Warhead No. 119c.

The flat side of the warhead was placed parallel to the 90° longitudinal plane with the booster axis coinciding with the conduit axis. Flat side fragments were recorded from 165° to 190° and curved side fragments recorded from 2° to 127°.

b. Round No. 2, Warhead No. 119a.

The booster was placed on the side on the central conduit toward the 180° line on the panels which made the center of the booster 1/2" off center relative to the warhead and conduit axes.

c. Round No. 3, Warhead No. 121.

The conduit was displaced from its center 1/4" toward the 180° line on the panels. The booster was placed on the side of the conduit toward the 0° line on the panels which made the center of the booster 1/4" off center relative to the warhead axis and 1/2" off center relative to the conduit axis.

10. RESULTS AND DISCUSSION:

a. Fragment Lengths and Distribution.

Detailed fragment lengths and distribution are listed in Tables I, II, and III. The design rod of all three warheads fractured into 2 to 3 rod-like fragments ranging in length from 2" to 9" with the longest fragments recorded being from Warhead 121. Warhead 119a, 121 and the curved portion of 119c distributed their rod-like fragments fairly evenly about the circumference of the warheads. All of the rod-like fragments from the flat portion (11 rods) of warhead 119c were expelled in longitude zone 165° to 190°. There was a zone, 135° to 165°, which had no fragments. No clumping, adjoining rods not breaking at the groove, was recorded. Sample rod-like fragments recovered from the cane fiberboard packs are shown in Figure 6.

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b. Fragment Velocities:

Detailed fragment velocities are listed in Tables IV, V, and VI and the median velocities in foot per second are summarized as follows:

Rd. No.	Warhead No.	Zone 350-55°	Zone 125-190°	Zone 165-190°
1	119c	4300	----	*4850
2	119a	4450	4100	
3	121	4300	4660	

* Flat side of warhead.

The results of Rounds Nos. 1 and 2 indicate that the fragments from the side of the warhead which was furthest away from the booster had approximately 8% higher velocities than the side closest to the booster.

PART D

CONCLUSIONS

11. a. Rod-expelling warheads Nos. 119a, 119c, and 121 produced rod-like fragments varying in length from 2" to 9" with warhead No. 121 having the longest fragments.

b. Fragments were distributed fairly evenly about the circumference except on warhead No. 119c which expelled the entire flat side (11 rods) into 15° of longitude zone.

c. The median fragment velocities ranged from 4100 ft/sec to 4850 ft/sec. The flat portion of warhead No. 119c produced the highest fragment velocities. The off centering of the booster in warheads Nos. 119a and 121 caused an 8% variation in fragment velocity with the highest velocity fragments being expelled from the warhead side furthest away from the booster.

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

V. PHILIPCHUK, Fragmentation Battery Officer,
Fragmentation Division,
Terminal Ballistics Department

This report was prepared by:

V. PHILIPCHUK, Fragmentation Battery Officer,
Fragmentation Division,
Terminal Ballistics Department

This report was reviewed by:

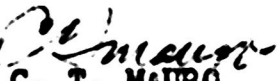
R. H. LYDDANE, Director of Research,
Terminal Ballistics Department

W. B. ROBERTSON, Lieutenant Commander, USN,
Terminal Ballistics Batteries Officer,
Terminal Ballistics Department

R. T. RUBLE, Lieutenant Commander, USN,
Terminal Ballistics Officer,
Terminal Ballistics Department

C. C. BRAMBLE, Director of Research, Ordnance Group

APPROVED: IRVING T. DUKE
Rear Admiral, USN
Commander, Naval Proving Ground


C. T. MAURO
Captain, USN
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**U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA**

Thirty-ninth Partial Report

on

Warheads for Air Target Guided Missiles;

Testing of

Final Report

on

Rod-Expelling Warheads,

Test of NOL Models 119 and 121

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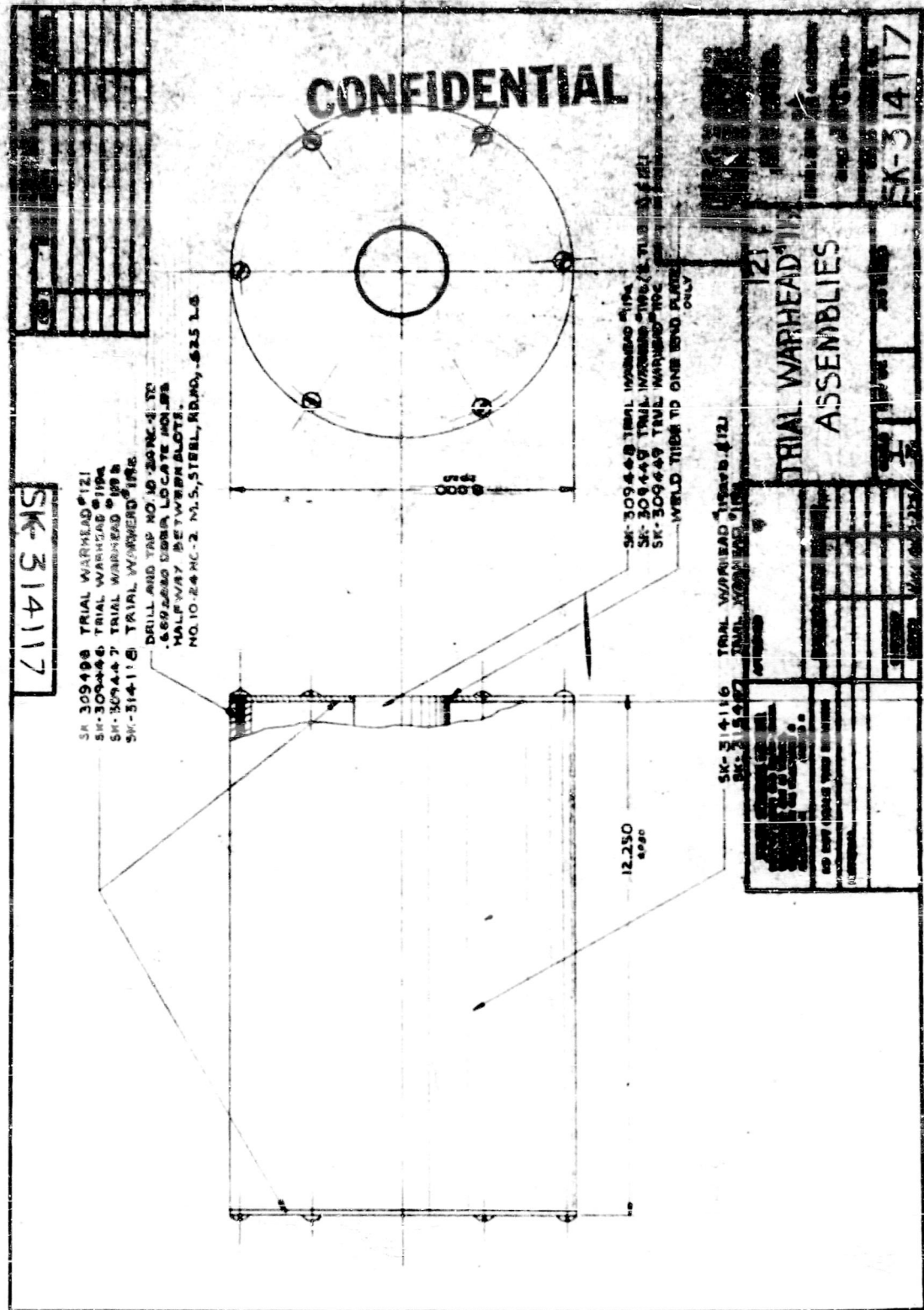
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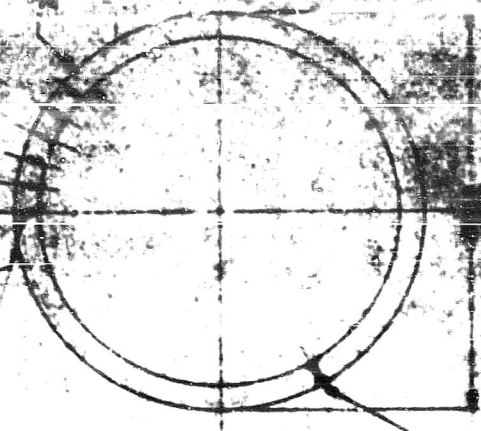
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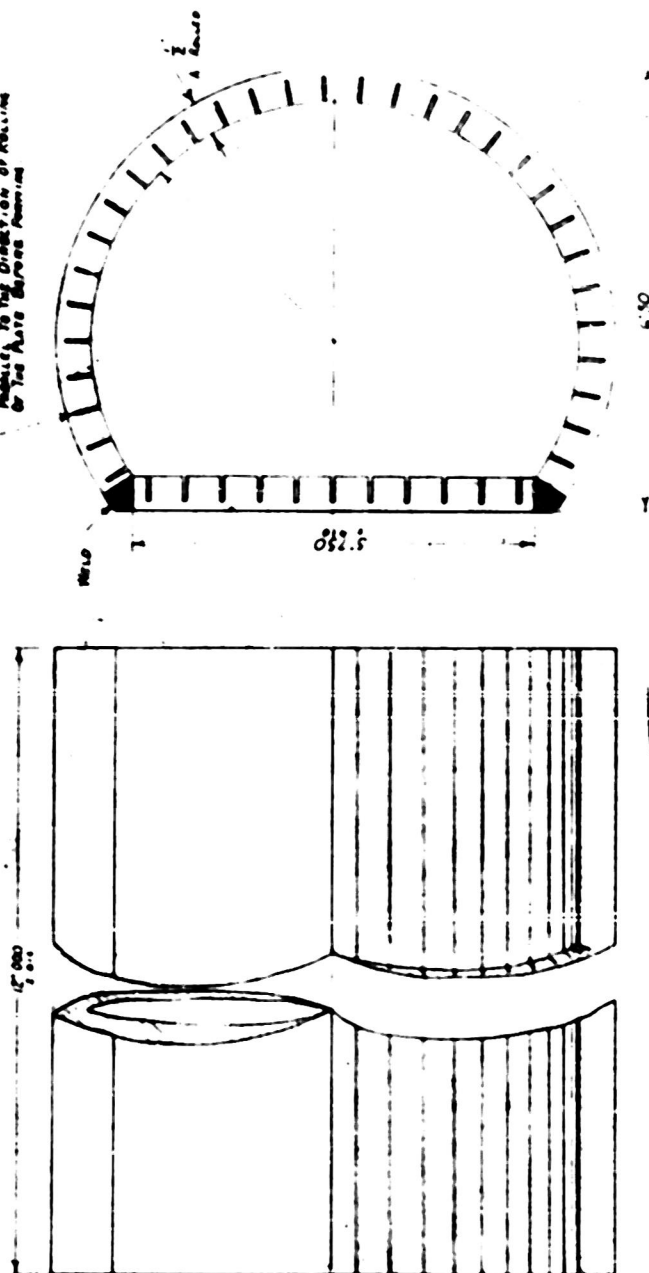
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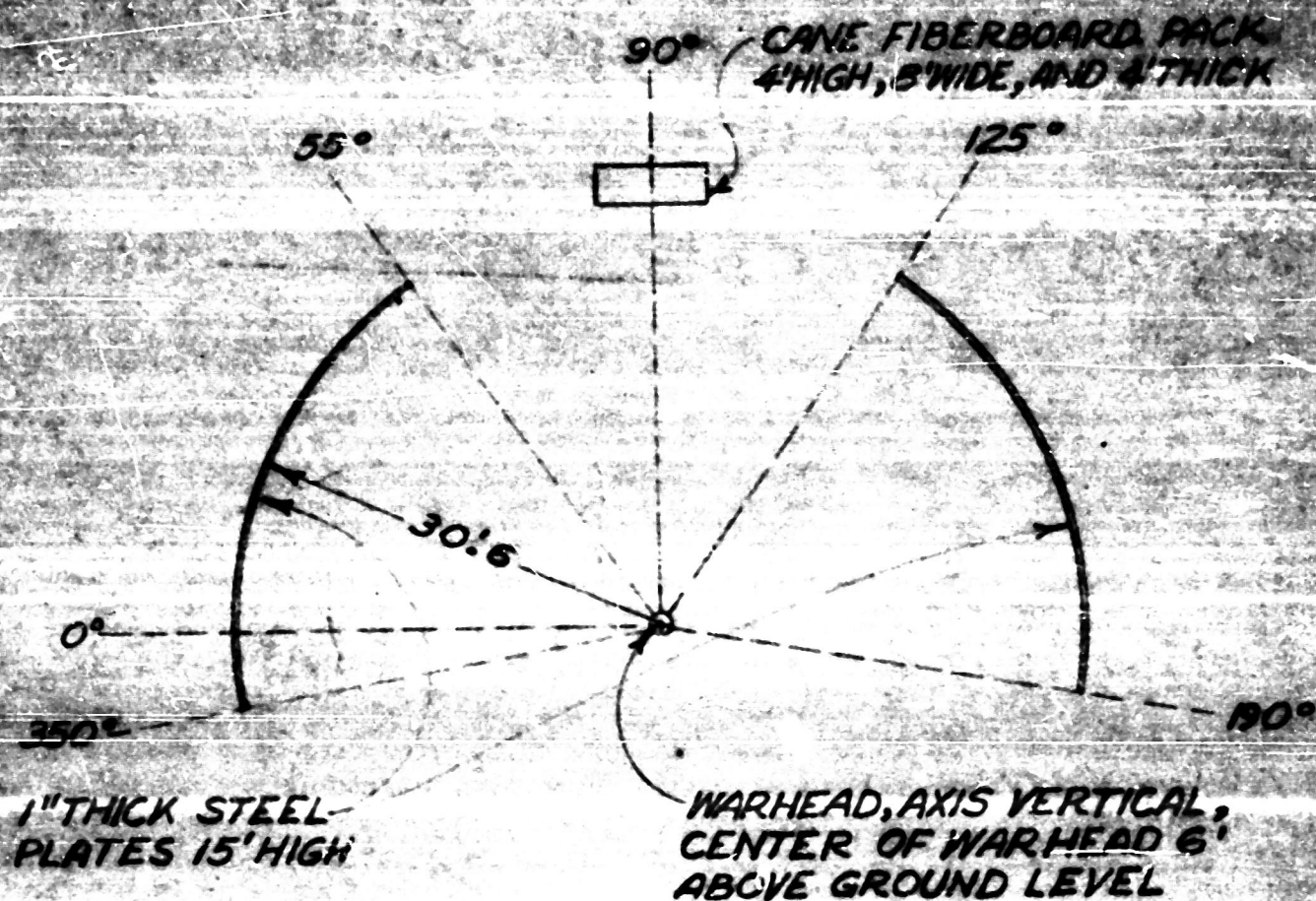
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WARHEAD NO. 119.
CENTER SECTION

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TOP VIEW OF 30.6 FOOT RADIUS
VELOCITY ARENA

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FIGURE 5

APPENDIX B

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Rod-Expelling Warheads, Test of NOL Models 119 and 121

TABLE I

FRAGMENT LENGTHS AND ANGULAR DISTRIBUTION

Rd. 1. Warhead No. 119c

<u>Longitude (Degree)</u>	<u>Fragment Length (Inches)</u>	<u>Longitude (Degree)</u>	<u>Fragment Length (Inches)</u>
2	4	127	5 1/2
3	4	165	4
3	3	165	3 1/2
11	3	167	3
12	3	169	2
19	6	172	3
19	5	173	3
19	1	176	6
28	6	176	7 1/2
28	5	177	1
28	1	179	1
37	5	179	3
37	4 1/2	179	3
45	3	179	3
45	6 1/2	178	5
53	4	180	2
53	5	180	2
87	6 1/2	180	3
93	5	181	4
93	6	181	2
		181	1
		183	5 1/2
		183	6
		183	6 1/2
		185	5
		185	3
		187	7 1/2
		187	4
		190	5 1/2
		190	3

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APPENDIX C

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Red-Expelling Warheads, Test of NOL Models 119 and 121

TABLE II

FRAGMENT LENGTHS AND ANGULAR DISTRIBUTION

Rd. 2, Warhead No. 119a

<u>Longitude</u> <u>(Degree)</u>	<u>Fragment</u> <u>Length (Inches)</u>	<u>Longitude</u> <u>(Degree)</u>	<u>Fragment</u> <u>Length (Inches)</u>
1	3	129	5
1	2	130	6
3	1	137	4 1/2
11	4 1/2	137	7
11	4	146	4
11	4	146	4
19	4 1/2	156	5
19	1	156	4
19	4 1/2	165	6
26	4	165	3
26	3 1/2	172	6
27	2 1/2	172	3 1/2
36	5 1/2	179	4 1/2
36	3	179	4 1/2
43	5	179	3
43	4	189	3
43	2	189	7
50	3		
52	3		
52	4		
54	4		
58	4 1/2		
85	5		
90	4		
90	4		

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Red-Expelling Warheads, Test of WOL Models 119 and 121

TABLE III

FRAGMENT LENGTHS AND ANGULAR DISTRIBUTION

Rd. 3. Warhead No. 121

<u>Longitude (Degree)</u>	<u>Fragment Length (Inches)</u>	<u>Longitude (Degree)</u>	<u>Fragment Length (Inches)</u>
359	5	130	9
0	3	130	2
8	4	137	5
8	4	137	3
15	5	145	5
15	3	145	3
24	4	145	3
24	5	154	5
32	7	154	4
32	3	162	5
42	9	162	5
42	3	172	6
50	8	172	3
52	4	180	5
85	7	180	3
92	4	188	5
		188	3

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TABLE IV

FRAGMENT VELOCITY DATA

35mm Fastax Camera
Rd. 1 - NOL 119c
Total Weight - 60.93 lbs.

3180 frames per sec.
Comp. C-3
Filler Weight - 20.13 lbs.

<u>Frame in Which Hit Occurred</u>	<u>350°-55° No. Fragments</u>	<u>Velocity (f/s)</u>
22	6	4420
23	7	4230
24	3	4050
25	1	3890
26	1	3740
Median		4300
Average		4220

<u>Frame in Which Hit Occurred</u>	<u>165°-190° No. Fragments</u>	<u>Velocity (f/s)</u>
18	2	5400
19	4	5120
20	3	4870
21	3	4630
22	1	4420
23	2	4230
Median		4850
Average		4840

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APPENDIX D

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Rod-Expelling Warheads, Test of NOL Models 119 and 121

TABLE V

FRAGMENT VELOCITY DATA

35mm Fastax Camera
Rd. 2 - NOL 119a
Total Weight - 65.33 lbs.

3150 frames per sec.
Comp. C-3
Filler Weight - 22.33 lbs.

<u>Frame in Which Hit Occured</u>	<u>350°-55° No. Fragments</u>	<u>Velocity (f/s)</u>
21	6	4590
22	6	4380
23	5	4190
24	2	4020
Median		4450
Average		4360

<u>Frame in Which Hit Occurred</u>	<u>125°-190° No. Fragments</u>	<u>Velocity (f/s)</u>
23	4	4190
24	8	4020
25	2	3860
Median		4100
Average		4050

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APPENDIX D

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Rod-Expelling Warheads, Test of NOL Models 119 and 121

TABLE VI

FRAGMENT VELOCITY DATA

35mm Fastax Camera
Rd. 3 - NOL 121
Total Weight - 64.10 lbs.

3135 frames per sec.
Comp. C-3
Filler Weight - 24.02 lbs.

<u>Frame in Which Hit Occurred</u>	<u>350°-55° No. Fragments</u>	<u>Velocity (f/s)</u>
21	2	4520
22	8	4320
23	4	4130
24	3	3960
Median		4300
Average		4240

<u>Frame in Which Hit Occurred</u>	<u>125°-190° No. Fragments</u>	<u>Velocity (f/s)</u>
20	5	4750
21	7	4520
22	2	4320
Median		4660
Average		4570

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APPENDIX D

FILE NO 1416

NOL MODEL 119A

ZONE 85-95

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NOL MODEL 119C

ZONE 85-95

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ZONE 125-140

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N.P. 46823

NOL MODEL 121

ZONE 85-95

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SCALE 1"

Rod-like fragments from Model Nos. 119A, 119C, and 121 recovered in cane fiberboard packs.

Figure 6

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