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THIS REPORT HAS BEEN DECLASSIFIED AND CLEARED FOR PUBLIC RELEASE.

DISTRIBUTION A
APPROVED FOR PUBLIC RELEASE;
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U.S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1083

TESTING OF
WARHEADS FOR AIR TARGET GUIDED MISSILES

60th Partial Report

FRAGMENTATION OF DOUBLE SLEEVE
WARHEAD NO. 141

Task Assignment MPG-Re3f-607-1-53

Copy No. 12 Classification CONFIDENTIAL

SECURITY INFORMATION
SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of double sleeve Warhead No. 141 and ascertain the effect of a OV208 air gap between sleeves on fragment velocity.

2. a. Warhead No. 141 produced:

   (1) 1547 fragments weighing over 5/8 grams.

   (2) 516 effective fragments in polar zone 75° - 100°.

   (3) An average median fragment velocity of 3200 ft/sec.

b. The OV208 air gap between the warhead sleeves was responsible for a fragment velocity loss of about 600 ft/sec.
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<td>APPENDIX D - FRAGMENT VELOCITY DATA</td>
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<td>APPENDIX E - DISTRIBUTION</td>
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**APPENDIX A - WARHEAD DRAWING, PHOTOGRAPH**

**APPENDIX B - FRAGMENT MASS DISTRIBUTION,**

**PHOTOGRAPHS**

**APPENDIX C - FRAGMENT SPACE DISTRIBUTION**

**TABLE I**

**APPENDIX D - FRAGMENT VELOCITY DATA**

**TABLE II 1-2** *(Incl)*

**APPENDIX E - DISTRIBUTION**

**1-2** *(Incl)*
INTRODUCTION

1. AUTHORITY:
   This test was authorized by reference (a) and conducted under Task Assignment NPG-Ref-607-1-53, reference (b).

2. REFERENCES:
   a. NOL Conf Work Request No. WG/25/53 of 3 Nov 1952
   b. BUORD Conf ltr NP9 Re3f:EKJ:gg Ser 42699 of 29 Jul 1952
   c. NPG Conf Report No. 904 of 21 Jan 1952
   d. NPG Conf Report No. 815 of 14 Jul 1951

3. BACKGROUND:
   The Warhead for the Angled Arrow Projectile has a double sleeve construction with the air gap between sleeves containing rocket propellant. A model of this type of warhead was constructed, No. 141, to obtain data on the effect of the air gap on fragmentation. Reference (c) reported double sleeve warhead data in which the sleeves were of thin aluminum and the air gap was filled with water.

4. OBJECT OF TEST:
   This test was conducted to determine the fragmentation characteristics of double sleeve warhead No. 141 and ascertain the effect of a 0V208 air gap between sleeves on fragment velocity.

5. PERIOD OF TEST:
   a. Date Project Letter 3 November 1952
   b. Date Necessary Material Received 18 November 1952
   c. Date Commenced Test 24 November 1952
   d. Date Test Completed 11 December 1952
6. DESCRIPTION OF ITEM UNDER TEST:

Warhead No. 141, Figure 1, 8V00 long, 3V75 outside diameter, had a double concentric sleeve construction with a 0V200 thick inner sleeve, a 0V192 thick outer sleeve, and a 0V208 air gap separating the sleeves. The inside 2V55 diameter was fully loaded with Composition C-3 explosive at the Naval Proving Ground. One end of the warhead had a 1/8" thick end plate secured by screws to the warhead and the other end was open. The warhead and explosive weights are as follows:

<table>
<thead>
<tr>
<th>Warhead No.</th>
<th>Empty Wt. (lbs)</th>
<th>Comp C-3 Wt (lbs)</th>
<th>Total Wt (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>141-1</td>
<td>9.38</td>
<td>2.34</td>
<td>11.72</td>
</tr>
<tr>
<td>141-2</td>
<td>9.32</td>
<td>2.36</td>
<td>11.68</td>
</tr>
<tr>
<td>141-3</td>
<td>9.32</td>
<td>2.36</td>
<td>11.68</td>
</tr>
<tr>
<td>141-4</td>
<td>9.38</td>
<td>2.35</td>
<td>11.73</td>
</tr>
</tbody>
</table>

? PROCEDURE:

a. Warheads Nos. 141-1 and 141-2 were detonated in a sawdust filled chamber for fragment mass distribution determinations. After each detonation, the sawdust was sifted and the fragments recovered by the use of sieves and a magnetic separator.

b. Warheads Nos. 141-3 and 141-4 were detonated, for space and velocity data, in a horizontal position in the center of a 30 foot radius semi-circular space arena which consisted of 5' high panels of 1/8" thick mild steel. The arena was marked off in 5° polar angle zones with the open end of the warhead pointed toward 0°. Opposite the arena were 10' high velocity plates, covering the polar angle zone from 80° to 120°, at 30° from the detonation. One 35mm Fastax camera, viewing these plates, recorded the detonation and fragment flashes on the plates from which the fragment velocities were computed.
8. RESULTS AND DISCUSSION:

a. Fragment Mass Distribution:

Since Warhead No. 141-1 detonated low order in the chamber, the test was repeated with Warhead No. 141-2. Detailed data and fragments are shown in Figures 2 and 3. The fragment numbers and weights for Warhead No. 141-2 are as follows:

<table>
<thead>
<tr>
<th>Fragment Wt Group (grams)</th>
<th>No. Fragments</th>
<th>Total Wt (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5/8</td>
<td>--</td>
<td>752</td>
</tr>
<tr>
<td>5/8 - 1-1/4</td>
<td>663</td>
<td>575</td>
</tr>
<tr>
<td>1-1/4 - 2-1/2</td>
<td>488</td>
<td>835</td>
</tr>
<tr>
<td>2-1/2 - 5</td>
<td>286</td>
<td>986</td>
</tr>
<tr>
<td>5 - 10</td>
<td>100</td>
<td>670</td>
</tr>
<tr>
<td>10 - 20</td>
<td>10</td>
<td>120</td>
</tr>
</tbody>
</table>

b. Fragment Space Distribution:

The average number of effective fragment hits, those capable of penetrating 1/8" mild steel, obtained from two warheads are as follows:

<table>
<thead>
<tr>
<th>Polar Angle Zone</th>
<th>Average hits per total zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 75°</td>
<td>0</td>
</tr>
<tr>
<td>75° - 100°</td>
<td>516</td>
</tr>
<tr>
<td>100° - 170°</td>
<td>0</td>
</tr>
<tr>
<td>170° - 180°</td>
<td>*14</td>
</tr>
</tbody>
</table>

* End plate fragments

Detailed data by 5° zones are listed in Table I.

c. Fragment Velocity Data:

Although the velocity plates were in zone 80° - 120°, the only hits recorded were in zone 80° - 100° and the average median fragment velocity was 3200 feet per second. Detailed velocity data are listed in Table II. In order to determine the effect of the air gap between sleeves on fragment velocity, data in references (c) and (d) were used in obtaining a Gurney constant for
Fragmentation of Double Sleeve Warhead No. 141

Composition C-3 loaded plain sleeve cylinders. The velocities used were average median velocities measured over standard base lines. A Gurney constant of 7600 was obtained and using this value, a single sleeve warhead having a wall thickness equal to that of the double sleeve Warhead No. 141 would produce an average median fragment velocity of 3800 ft./sec. Therefore, the air gap in Warhead No. 141 was responsible for a velocity loss of about 600 ft./sec.

PART D

CONCLUSIONS

9. a. Warhead No. 141 produced:

(1) 1547 fragments weighing over 5/8 grams.

(2) 516 effective fragments in polar zone 75° - 100°.

(3) An average median fragment velocity of 3200 ft./sec.

b. The OY208 air gap between the warhead sleeves was responsible for a fragment velocity loss of about 600 ft./sec.
Fragmentation of Double Sleeve Warhead No. 141

The tests upon which this report is based were conducted by:
A. N. HUGHES, Lieutenant,
Fragmentation Firing 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:
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Terminal Ballistics Department
E. L. LEVSTIK, Lieutenant Commander, USNR
Terminal Ballistics Batteries Officer
Terminal Ballistics Department
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Terminal Ballistics Officer
Terminal Ballistics Department
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APPROVED:  J. F. BRYNE
Captain, USN
Commander, Naval Proving Ground
E. A. RUCKNER
Captain, USN
Ordnance Officer
By direction
Sixtieth Partial Report

on

Testing of

Warheads for Air Target Guided Missiles

Final Report

on

Fragmentation of Double Sleeve

Warhead No. 141

Project No.: NPG-Re3f-607-1-53
Copy No.: 12
No. of Pages: 7

Date: FEB 10 1953

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SECURITY INFORMATION
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<th>PCS.</th>
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<td>0 - 9g</td>
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<td>1</td>
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<tr>
<td>1 - 1.5g</td>
<td>5.7</td>
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<tr>
<td>1.5 - 2g</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>2g - 5g</td>
<td></td>
<td>9.2</td>
</tr>
<tr>
<td>5g - 10g</td>
<td>41.5</td>
<td></td>
</tr>
<tr>
<td>10g - 20g</td>
<td></td>
<td>2.7</td>
</tr>
<tr>
<td>20g - 40g</td>
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<td>25.6</td>
</tr>
<tr>
<td>40g - 80g</td>
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<tr>
<td>80g - 160g</td>
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<td>284</td>
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<tr>
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<td>640g -</td>
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**END PLATE**

8 PCS.

197 Gms.

Mass Distribution of warhead No. 141-1 is warhead detonated low order.
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Scale: 1"
Fragmentation of Double Sleeve Warhead No. 141

TABLE I

FRAGMENT SPACE DISTRIBUTION

NOL Warheads Nos. 141-3 and 141-4

30° Radius Space Arena. (Semi-circular)
1/8" M.S. panels 5' high

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<th>Total on Panel</th>
<th>Per 5° Zone</th>
<th>Per Total 5°</th>
<th>Per Unit Solid</th>
<th>Angle</th>
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CONFIDENTIAL SECURITY INFORMATION

APPENDIX C
Fragmentation of Double Sleeve Warhead No. 141

<table>
<thead>
<tr>
<th>Zones 80° - 100°</th>
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<tbody>
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<td>Frame in Which Hit Occurred</td>
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</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>21</td>
</tr>
<tr>
<td>22</td>
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</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>26</td>
</tr>
</tbody>
</table>

Median: 3170
Average: 3080
Table II (Continued)

30 Ft. Radius Arena  
35mm Fastax Camera  
Rd. 4 - 3V75 Warhead #141-4  
Total Weight: 11.73 lbs.  
Filler: Comp. C-3  
Filler Weight: 2.35 lbs.

Zones 80° - 100°

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Fragments</th>
<th>Velocity (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
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<td>3550</td>
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<td>6</td>
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<tr>
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</table>

Median Velocity: 3220 fps  
Average Velocity: 3150 fps
Fragmentation of Double Sleeve Warhead No. 141

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Fragmentation of Double Sleeve Warhead No. 141

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