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THIS PAGE IS UNCLASSIFIED
UNCLASSIFIED

ATI 205734

CLASSIFICATION CHANGED TO: UNCLASSIFIED
FROM: CONFIDENTIAL

AUTHORITY:

[Signature: Surface Wagner]
[Date: Nov 76]

UNCLASSIFIED
U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA
REPORT NO. 1035
WARHEADS FOR AIR TARGET GUIDED MISSILES;
TESTING OF
the Partial Report

TERRIER WARHEAD: MK 5 MOD 0;
FRAGMENTATION AND DROP TEST OF

NAVY DEPT.

NAVY REPORT
by No. 2

CLASSIFICATION CONFIDENTIAL
SECURITY INFORMATION

LIBRARY OF CONGRESS
REFERENCE DEPARTMENT
TECHNICAL INFORMATION DIVISION
FORMERLY (NAVY RESEARCH SECTION)

SEP 24 1952

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RLE COPY
PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation and drop characteristics of the Composition B loaded Terrier Warhead Mk 5 Mod 0 for guided missiles at -65°F and at ambient temperatures.

2. a. No significant differences were observed in the fragmentation characteristics of the Terrier Warhead Mk 5 Mod 0 when detonated at -65°F and ambient temperatures.

b. All five warheads that were dropped from 40 feet suffered some distortion. The central conduit tubes were not damaged.
TABLE OF CONTENTS

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<td>APPENDIX A - WARHEAD DRAWINGS, PHOTOGRAPHS</td>
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CONFIDENTIAL SECURITY INFORMATION 2
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(546) TF:RHS:mew Ser 0326 of 12 February 1952
b. BUORD Conf ltr NP9 Re3f-EJHL:edl Ser 25777 of 18 September 1951
c. NPG Conf Report No. 911 of 28 January 1952
d. NPG Conf Report No. 339 of 15 December 1951

3. BACKGROUND:

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

b. The standard construction and fragment characteristics of the Terrier Warhead Type F were reported in references (c) and (d). Fragmentation and drop tests of the Terrier Warhead Mk 5 Mod 0 (the production model of Terrier Warhead Type F) at both ambient and -65°F temperatures are reported herein.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation and drop characteristics of the Composition B loaded Terrier Warhead Mk 5 Mod 0 for guided missiles at -65°F and ambient temperatures.

5. PERIOD OF TEST:

a. Date of Project Letter 12 February 1952
b. Date Necessary Material Received 18 March 1952
c. Date Commenced Test 26 March 1952
d. Date Test Completed 14 May 1952

6. REPRESENTATIVES PRESENT:

This test was witnessed by Messrs. R. H. Suessle and D. W. Johnson representing the Naval Ordnance Laboratory.

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SECURITY INFORMATION
PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. Terrier Warhead Mk 5 Mod 0 is a production model of the Terrier Warhead Type F, reference (c). It is constructed according to Bureau of Ordnance Confidential Sk 316051; Figure 1, 21485 in length, tapered from 10412 O.D. at the nose to 134500 O.D. at the base, and 04109 wall thickness. The warhead contained a 119 diameter central conduit tube. The outer shell consisted of 54 notched rings which were copper-hydrogen brazed together.

b. For rings 1 through 12, the notches were spaced \( \pm 0.025 \) on centers entirely around each ring. For rings 13 through 54, the notches were spaced \( \pm 0.025 \) on centers entirely around each ring. The rings 1 through 12 were designed to produce 536 fragments weighing approximately 13.3 grams each and rings 13 through 54 were designed to produce 4056 fragments approximately 7.0 grams each. A sketch of ring details is shown in Figure 2. Each ring was 04375 thick and had a notch depth of 04213. Four rows of tack weld held the rings together during brazing.

c. The warheads were loaded with Composition B-1 at the Naval Mine Depot, Yorktown, Virginia. The weights and test conditions are as follows:

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<tr>
<th>Rd. Ser.</th>
<th>Temp.</th>
<th>Test</th>
<th>Empty Wt. (lbs.)</th>
<th>Hot Melt Wt. (lbs.)</th>
<th>Filler Wt. (lbs.)</th>
<th>Total Wt. (lbs.)</th>
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<td>1</td>
<td>-65°</td>
<td>Space</td>
<td>100.50</td>
<td>2.78</td>
<td>114.77</td>
<td>218.05</td>
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<td>2</td>
<td>-65°</td>
<td>Space</td>
<td>99.50</td>
<td>3.90</td>
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<td>*Ambient</td>
<td>Space</td>
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<td>Space</td>
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<td>114.08</td>
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<td>3</td>
<td>**Ambient</td>
<td>Space</td>
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<td>3.14</td>
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<td>Space</td>
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<td>3</td>
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<td>Drop</td>
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<td>3.26</td>
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<td>216.59</td>
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<td>4</td>
<td>44°</td>
<td>Drop</td>
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<td>3.22</td>
<td>113.47</td>
<td>217.64</td>
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*Ambient 49°

**Ambient 60°

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SECURITY INFORMATION
8. PROCEDURE:

a. Initiation was accomplished by using a 129 gram tetryl booster EX 2 Mod 0, \( \frac{3}{4} \) diameter by 4\( \frac{5}{8} \) long, and a special engineer's blasting cap. The booster was placed 7-3/8" from the forward end of the central conduit tube and initiated from the rear. The booster position for the warheads reported in reference (d) was 8-7/8" from the extreme front end of the warhead. The change in booster positions had some effect on the fragment space distribution.

b. Space distribution data were obtained in a 60° radius semicircular arena having 1/8" mild steel panels 5' high and marked off into 5° polar angle zones about the axis of the warhead with the nose end pointing toward 0°.

c. Velocity determinations were obtained by using three 35mm Fastax Cameras; Camera #1 covering the polar angle zone 55° to 120°, Camera #2 covering the zone from 0° to 55°, and Camera #3 covering the zone from 120° to 180°.

d. Sample fragment mass distribution determinations were made in a 4' x 8' cane fiberboard pack placed in the beamspray (80° to 87.1/2°) at a radius of 60°.

e. Drop damage assessment tests were conducted on five rounds of unfused warheads at ambient temperatures by dropping them from a forty (40) foot tower onto a two inch thick steel armor plate. The orientation of these drops was as follows: one nose up drop, one nose down drop, one side drop, one drop 45° from nose up, and one drop 45° from nose down.
Fragmenattion and Drop Test of

Approximately 1/4 of the fragments of design size (in groups of two rounds) or larger were double cubes bonded by the brazed joint. Sample beam spray fragments which were recovered in zone 80°-87° 1/2° are shown in Figures 3 and 4. One recovered fragment was of a double cube size with no visible notch. Radiographic data supplied by the Naval Ordnance Laboratory indicated that some notches were missing in rings Nos. 13 to 54. The average weights of the recovered fragments in the 5-10 gram group of the -65°F. and ambient temperature warheads were 6.9 and 7.0 grams respectively.

d. A drop test photograph is shown in Figure 5 and data are detailed in Appendix (E). In no case was there damage more serious than slight distortion of the shape of the warhead.

**PART D**

**CONCLUSIONS**

10. a. No significant differences were observed in the fragmentation characteristics of the Terrier Warhead Mk 5 Mod 0 when detonated at -65°F. and ambient temperatures.

b. All five warheads that were dropped from 40 feet suffered some distortion. The central conduit tubes were not damaged.
Terrier Warhead Mk 5 Mod 0; Fragmentation and Drop Test of

The tests upon which this report is based were conducted by:
A. N. HUGHES, Lieutenant, USN, Fragmentation Firing Officer
Fragmentation Division
Terminal Ballistics Department
K. A. BALLEW, GUN., USN, Assistant Ammunition Officer
Armament Department

This report was prepared by:
W. WRIGHT, JR., Ensign, USNR, Fragmentation Firing Officer
Fragmentation Division
Terminal Ballistics Department

This report was reviewed by:
V. PHILIPCHUK, Fragmentation Battery Officer
Fragmentation Division
Terminal Ballistics Department
R. H. LYDDANE, Director of Research
Terminal Ballistics Department
E. L. LEVSTIK, Lieutenant Commander, USNR
Terminal Ballistics Batteries Officer
Terminal Ballistics Department
W. B. ROBERTSON, Lieutenant Commander, USN
Terminal Ballistics Officer
Terminal Ballistics Department
H. K. ANDERSON, Lieutenant, USN, Ammunition Officer,
Armament Department
L. C. KLINGAMAN, Commander, USN, Armament Officer,
Armament Department
C. C. BRAMBLE, Director of Research, Ordnance Group

APPROVED: J. F. BYRNE
Captain, USN
Commander, Naval Proving Ground

E. A. RUCKNER
Captain, USN
Ordnance Officer
By direction
Forty-Ninth Partial Report
on
Warheads for Air Target Guided Missiles;
Testing of

Final Report
on
Terrier Warhead Mk 5 Mod 0;
Fragmentation and Drop Test of

Project No.: NPG-Re3f-607-1-52
Copy No.: 2
No. of Pages: 8

Date: SEP 15 1952
**TABLE 1**

**SPACE DISTRIBUTION DATA**

Terrier Warheads, Mk 5 Mod 0, Composition B loaded at -65°F,
60°F Radius Space Arena
1/8" MS panels 5' high

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<td>5-10</td>
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APPENDIX C
Terrier Warhead Mk 5 Mod 0; Fragmentation and Drop Test of

![Table II](image)

SPACE DISTRIBUTION DATA

Terrier Warheads, Mk 5 Mod 0, Composition B loaded at ambient temperature, 60° Radius Space Arena 1/8" MS panels 5' high

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APPENDIX C
**TABLE III**

**FRAGMENT VELOCITY DATA**

60° Arena Space Test

25mm Fastax Camera #2 2976 frames per sec.

Rd. 1, Terrier Warhead Mk 5 Mod 0 Comp. B

Serial No. 13 at -65°F.

Total Weight 218.05 Lbs.

Filler Weight 114.77 Lbs.

<table>
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<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
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<td>17,820</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>16,200</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>14,850</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>13,710</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>12,730</td>
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<tr>
<td>15</td>
<td>2</td>
<td>11,880</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>11,140</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>9,900</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>9,980</td>
</tr>
</tbody>
</table>

Median: 13,250

Average: 13,150
### Terrier Warhead Mk 5 Mod 0; Fragmentation and Drop Test of

#### TABLE III (Continued)

60° Arena Space Test

**35mm Fastax Camera #3**

- **Rd. I, Terrier Warhead Mk 5 Mod 0**
- **Serial No. 13 at -65°F.**
- **Total Weight 218.05 Lbs.**
- **Filler Weight 114.77 Lbs.**

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Base Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2</td>
<td>11,400</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>10,690</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>10,060</td>
</tr>
<tr>
<td>18</td>
<td>5</td>
<td>9,500</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>9,000</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>8,550</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>8,140</td>
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<td>22</td>
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<td>7,770</td>
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<td>1</td>
<td>6,580</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>6,110</td>
</tr>
<tr>
<td>29</td>
<td>2</td>
<td>5,900</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
<td>5,700</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>5,520</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>5,340</td>
</tr>
<tr>
<td>33</td>
<td>2</td>
<td>5,180</td>
</tr>
<tr>
<td>34</td>
<td>1</td>
<td>5,030</td>
</tr>
</tbody>
</table>

- **Median**: 8,200
- **Average**: 8,070

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SECURITY INFORMATION: 2

APPENDIX D
**TABLE IV**

**FRAGMENT VELOCITY DATA**

60° Arena Space Test

35mm Fastax Camera #2

3000 frames per sec.

Rd. 2, Terrier Warhead Mk 5 Mod 0

Serial No. 28 at -65°F.

Total Weight 216.06 Lbs.

Filler Weight 113.66 Lbs.

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1</td>
<td>20,000</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>16,360</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>15,000</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>13,850</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>12,860</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>12,060</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>11,250</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>10,590</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
<td>10,000</td>
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<td>19</td>
<td>7</td>
<td>9,470</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>9,090</td>
</tr>
<tr>
<td>21</td>
<td>3</td>
<td>8,570</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>8,180</td>
</tr>
</tbody>
</table>

Median

Average

10,350

11,100
60° Arena Space Test

35mm Fastax Camera #2 2820 frames per sec.

Serial No. 28 at -65°F.

Total Weight 216.06 Lbs.

Filler Weight 113.66 Lbs.

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Base Fragments</th>
<th>Velocity (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1</td>
<td>11,280</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>10,580</td>
</tr>
<tr>
<td>17</td>
<td>8</td>
<td>9,950</td>
</tr>
<tr>
<td>18</td>
<td>5</td>
<td>9,400</td>
</tr>
<tr>
<td>19</td>
<td>6</td>
<td>8,910</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>8,460</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>7,690</td>
</tr>
<tr>
<td>23</td>
<td>5</td>
<td>7,360</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>7,050</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>6,770</td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td>6,510</td>
</tr>
<tr>
<td>27</td>
<td>2</td>
<td>6,270</td>
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<tr>
<td>28</td>
<td>2</td>
<td>6,040</td>
</tr>
<tr>
<td>29</td>
<td>2</td>
<td>5,830</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>5,640</td>
</tr>
<tr>
<td>31</td>
<td>2</td>
<td>5,460</td>
</tr>
<tr>
<td>32</td>
<td>3</td>
<td>5,290</td>
</tr>
</tbody>
</table>

Median

Average 7,940

CONFIDENTIAL SECURITY INFORMATION 2 APPENDIX D
CONFIDENTIAL

Terrier Warhead Mk 5 Mod 0; Fragmentation and Drop Test of

TABLE V

FRAGMENT VELOCITY DATA

60° Arena Space Test
35mm Fastax Camera #1
Rd. 1, Terrier Warhead Mk 5 Mod 0
Serial No. 16 at Ambient Temp.
Total Weight 215.65 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Beam Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°-80°</td>
<td>28</td>
<td>6</td>
<td>6,110</td>
</tr>
<tr>
<td>80°-85°</td>
<td>28</td>
<td>3</td>
<td>6,110</td>
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<tr>
<td>75°-80°</td>
<td>29</td>
<td>7</td>
<td>5,900</td>
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<tr>
<td>80°-85°</td>
<td>29</td>
<td>3</td>
<td>5,900</td>
</tr>
<tr>
<td>85°-90°</td>
<td>29</td>
<td>3</td>
<td>5,900</td>
</tr>
<tr>
<td>75°-80°</td>
<td>30</td>
<td>2</td>
<td>5,700</td>
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<tr>
<td>90°-95°</td>
<td>30</td>
<td>2</td>
<td>5,700</td>
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<tr>
<td>90°-95°</td>
<td>31</td>
<td>2</td>
<td>5,520</td>
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<tr>
<td>75°-80°</td>
<td>32</td>
<td>1</td>
<td>5,340</td>
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<td>70°-75°</td>
<td>34</td>
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<td>75°-80°</td>
<td>34</td>
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<td>4,750</td>
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<td>65°-70°</td>
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</tr>
<tr>
<td>70°-75°</td>
<td>41</td>
<td>1</td>
<td>4,170</td>
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<td>60°-65°</td>
<td>43</td>
<td>1</td>
<td>3,980</td>
</tr>
<tr>
<td>65°-70°</td>
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</tr>
<tr>
<td>70°-75°</td>
<td>43</td>
<td>1</td>
<td>3,980</td>
</tr>
<tr>
<td>Median</td>
<td></td>
<td></td>
<td>5,900</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>5,550</td>
</tr>
</tbody>
</table>

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX D
60° Arena Space Test.

35mm Fastax Camera #2

Rd. 1, Terrier Warhead Mk 5 Mod 0
Serial No. 16 at Ambient Temp.

Total Weight 215.65 Lbs.
Filler Weight 113.67 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°-5°</td>
<td>16</td>
<td>2</td>
<td>10,580</td>
</tr>
<tr>
<td>0°-5°</td>
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<td>1</td>
<td>9,400</td>
</tr>
<tr>
<td>5°-10°</td>
<td>19</td>
<td>1</td>
<td>8,910</td>
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<tr>
<td>0°-5°</td>
<td>19</td>
<td>4</td>
<td>8,910</td>
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<tr>
<td>0°-5°</td>
<td>20</td>
<td>1</td>
<td>8,460</td>
</tr>
<tr>
<td>5°-10°</td>
<td>20</td>
<td>2</td>
<td>8,460</td>
</tr>
<tr>
<td>5°-10°</td>
<td>21</td>
<td>1</td>
<td>8,060</td>
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<tr>
<td>5°-10°</td>
<td>22</td>
<td>1</td>
<td>7,690</td>
</tr>
<tr>
<td>5°-10°</td>
<td>23</td>
<td>1</td>
<td>7,360</td>
</tr>
<tr>
<td>10°-15°</td>
<td>24</td>
<td>1</td>
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<td>7,050</td>
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<td>5°-10°</td>
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<td>6,510</td>
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<tr>
<td>0°-5°</td>
<td>26</td>
<td>1</td>
<td>6,510</td>
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<td>5°-10°</td>
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</tr>
<tr>
<td>0°-5°</td>
<td>30</td>
<td>2</td>
<td>5,640</td>
</tr>
</tbody>
</table>

Median 8,110
Average 7,850
TABLE V (Continued)

Terrier Warhead Mk 5 Mod 0; Fragmentation and Drop Test of

60° Arena Space Test

35mm Fastax Camera #3  2940 frames per sec.

Sample 1, Terrier Warhead Mk 5 Mod 0  Comp. B
Serial No. 16 a Ambient Temp.
Total Weight 215, 65 Lbs.  Filler Weight 113.67 Lbs.

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Base Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>6</td>
<td>9,800</td>
</tr>
<tr>
<td>19</td>
<td>4</td>
<td>9,280</td>
</tr>
<tr>
<td>20</td>
<td>9</td>
<td>8,820</td>
</tr>
<tr>
<td>21</td>
<td>6</td>
<td>8,400</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>8,020</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>7,670</td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>7,350</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>7,060</td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td>6,780</td>
</tr>
<tr>
<td>27</td>
<td>4</td>
<td>6,530</td>
</tr>
<tr>
<td>28</td>
<td>5</td>
<td>6,300</td>
</tr>
<tr>
<td>29</td>
<td>3</td>
<td>6,080</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>5,880</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>5,690</td>
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<tr>
<td>32</td>
<td>3</td>
<td>5,510</td>
</tr>
<tr>
<td>33</td>
<td>2</td>
<td>5,350</td>
</tr>
<tr>
<td>34</td>
<td>4</td>
<td>5,190</td>
</tr>
<tr>
<td>35</td>
<td>2</td>
<td>5,040</td>
</tr>
<tr>
<td>36</td>
<td>4</td>
<td>4,900</td>
</tr>
</tbody>
</table>

Median 7,170
Average 7,190

CONFIDENTIAL SECURITY INFORMATION 3  APPENDIX D
**TABLE VI (Continued)**

60° Arena Space Test  
35mm Fastax Camera #2  
2850 frames per sec.

**Rd. 2, Terrier Warhead Mk 5 Mod 0 Comp. B**  
Serial No. 35 at Ambient Temp.

Total Weight 217.56 Lbs.  
Filler Weight 114.08 Lbs.

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2</td>
<td>17,100</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>15,550</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>14,250</td>
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<tr>
<td>13</td>
<td>3</td>
<td>13,150</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>12,210</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>11,400</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>10,690</td>
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<tr>
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<td>4</td>
<td>10,060</td>
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<tr>
<td>18</td>
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<td>19</td>
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<td>9,000</td>
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<td>1</td>
<td>8,140</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>7,770</td>
</tr>
</tbody>
</table>

**Median**  
11,700  

**Average**  
11,850
**TABLE VI (Continued)**

60° Arena Space Test

35mm Fastax Camera #3 2970 frames per sec.

Rd. 2, Terrier Warhead Mk 5 Mod 0 Comp. B
Serial No. 35 at Ambient Temp.
Total Weight 217.56 Lbs. Filler Weight 114.08 Lbs.

<table>
<thead>
<tr>
<th>Frame in Which Hit Occurred</th>
<th>No. Base Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2</td>
<td>11,880</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>11,140</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>10,480</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>9,900</td>
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<td>19</td>
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<td>9,380</td>
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<td>8,100</td>
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<td>4</td>
<td>6,600</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>6,360</td>
</tr>
<tr>
<td>33</td>
<td>3</td>
<td>5,400</td>
</tr>
<tr>
<td>34</td>
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<td>5,240</td>
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<tr>
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<td>2</td>
<td>5,090</td>
</tr>
<tr>
<td>36</td>
<td>4</td>
<td>4,950</td>
</tr>
</tbody>
</table>

Median: 7,790
Average: 7,660

CONFIDENTIAL SECURITY INFORMATION 3 APPENDIX D
TABLE VII
FRAGMENT VELOCITY DATA

60° Arena Space Test
35mm Fastax Camera #1
No. 3, Terrier Warhead Mk 5 Mod 0
Serial No. 46 at Ambient Temp.
Total Weight 216.87 Lbs.
Filler Weight 113.67 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Beam Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80°-85°</td>
<td>25</td>
<td>1</td>
<td>6,120</td>
</tr>
<tr>
<td>75°-80°</td>
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<td>8</td>
<td>5,880</td>
</tr>
<tr>
<td>80°-85°</td>
<td>26</td>
<td>6</td>
<td>5,880</td>
</tr>
<tr>
<td>85°-90°</td>
<td>26</td>
<td>4</td>
<td>5,880</td>
</tr>
<tr>
<td>75°-80°</td>
<td>27</td>
<td>5</td>
<td>5,670</td>
</tr>
<tr>
<td>85°-90°</td>
<td>27</td>
<td>3</td>
<td>5,670</td>
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<tr>
<td>90°-95°</td>
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<td>5,670</td>
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<tr>
<td>75°-80°</td>
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<td>28</td>
<td>1</td>
<td>5,460</td>
</tr>
<tr>
<td>85°-90°</td>
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<tr>
<td>Median</td>
<td></td>
<td></td>
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<td>Average</td>
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SECURITY INFORMATION 1

APPENDIX D
TABLE VII (Continued)

60° Arena Space Test
35mm Fastax Camera #3

<table>
<thead>
<tr>
<th>Zone</th>
<th>No. Base Fragments</th>
<th>Frame in Which Hit Occurred</th>
<th>Velocity (f/s)</th>
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<tbody>
<tr>
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<td>10,600</td>
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<td>175°-180°</td>
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<tr>
<td>170°-175°</td>
<td>3</td>
<td>23</td>
<td>6,890</td>
</tr>
</tbody>
</table>

Median
Average

Total Weight 216.87 Lbs.
Filler Weight 113.67 Lbs.

Comp. B
2640 frames per sec.
TABLE VII (Continued)

60° Arena Space Test
35mm Fastax Camera #2  2550 frames per sec.
Rd. 3, Terrier Warhead Mk 5 Mod 0 Comp. B
Serial No. 46 at Ambient Temp.
Total Weight 216.37 Lbs.  Filler Weight 133.67 Lbs.

<table>
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<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
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<td>1</td>
<td>7,290</td>
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</table>

Median 8,450
Average 8,240
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TABLE VIII

FRAGMENT VELOCITY DATA

60° Arena Space Test

35mm Fastax Camera #1
2550 frames per sec.

Rd. 4, Terrier Warhead Mk 5 Mod 0
Comp. B
Serial No. 41 at Ambient Temp.

Total Weight 216.02 lbs.
Filler Weight 113.49 lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Beam Spray Fragments</th>
<th>Velocity (f/s)</th>
</tr>
</thead>
<tbody>
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<td>2</td>
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<tr>
<td>80°-85°</td>
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<tr>
<td>75°-80°</td>
<td>31</td>
<td>3</td>
<td>4,940</td>
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</table>

Median 5,860
Average 5,740

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SECURITY INFORMATION 1

APPENDIX D
## TABLE VIII (Continued)

**60° Arena Space Test**

**35mm Fastax Camera #3**

**Rd. 4, Terrier Warhead Mk 5 Mod 0**

**Serial No. 41 at Ambient Temp.**

**Total Weight 216.02 Lbs.**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Base Fragments</th>
<th>Velocity (fps)</th>
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<tbody>
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<td>10,600</td>
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<tr>
<td>165°-170°</td>
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<td>175°-180°</td>
<td>16</td>
<td>1</td>
<td>9,900</td>
</tr>
<tr>
<td>165°-170°</td>
<td>17</td>
<td>2</td>
<td>9,320</td>
</tr>
<tr>
<td>170°-175°</td>
<td>17</td>
<td>4</td>
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<td>165°-170°</td>
<td>20</td>
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<td>7,540</td>
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<tr>
<td>170°-175°</td>
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<td>2</td>
<td>7,540</td>
</tr>
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<td>175°-180°</td>
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<td>Median</td>
<td>8,180</td>
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</table>

**Average**

**CONFIDENTIAL SECURITY INFORMATION**
TABLE VIII (Continued)

60° Arena Space Test

35mm Fastax Camera #2 2560 frames per sec.

Rd. 4, Terrier Warhead Mk 5 Mod 0  Comp. B
Serial No. 41 at Ambient Temp.

Total Weight 216.02 Lbs.  Filler Weight 113.49 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
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</thead>
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<td>0°-5°</td>
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<td>7,040</td>
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</table>

Median
Average

8,860
8,520
**TABLE IX**

**FRAGMENT VELOCITY DATA**

60° Arena Space Test

35mm Fastax Camera #1  
2730 frames per sec.

Rd. 5, Terrier Warhead Mk 5 Mod 0  
Comp. B  
Serial No. 43 at Ambient Temp.

Total Weight 217.76 Lbs.  
Filler Weight 114.56 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Beam Spray Fragments</th>
<th>Velocity ( f/s )</th>
</tr>
</thead>
<tbody>
<tr>
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<td>6,300</td>
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<tr>
<td>80°-85°</td>
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</tr>
<tr>
<td>85°-90°</td>
<td>26</td>
<td>2</td>
<td>6,300</td>
</tr>
<tr>
<td>75°-80°</td>
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<td>6,070</td>
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<td>4</td>
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<td>6,100</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>5,920</td>
</tr>
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</table>
TABLE IX (Continued)

60° Arena Space Test

35mm Fastax Camera #2 2670 frames per sec.

Rd. 5, Terrier Warhead Mk 5 Mod 0 Comp. B
Serial No. 43 at Ambient Temp.

Total Weight 217.76 Lbs. Filler Weight 114.56 Lbs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Frame in Which Hit Occurred</th>
<th>No. Nose Fragments</th>
<th>Velocity (f/s)</th>
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</thead>
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<td>8,430</td>
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<td>8,010</td>
</tr>
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<td>0°-1°</td>
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<td>8,200</td>
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<tr>
<td>Average</td>
<td></td>
<td></td>
<td>7,960</td>
</tr>
</tbody>
</table>
Terrier Harrows No. 1,000, after being subjected to drops from 40 feet.
DROP TEST DATA

1. All warheads were dropped from a 40° tower onto a 2" thick steel plate. The detailed damage data are as follows:

   a. Side Drop, Serial No. 44 - The nose ring and side of the warhead was dented inward 1". The base was bulged and dented 1/4" from the normal circumference of the round. Two of the bolts securing the small loading plates were slightly bent. The central conduit was undamaged.

   b. Nose Up Drop, Serial No. 54 - The side was dented inward 1-1/4" and the base ring of the round was flattened at the impact area. The central conduit was not damaged.

   c. Nose Down Drop, Serial No. 47 - The nose ring was pushed into the central cone for 1/4 of its circumference and received a dent 1-1/4" deep. The base was dented slightly. The central conduit was not damaged.

   d. Drop 45° from Nose Up, Serial No. 56 - The base ring was dented 1-1/2" deep for 1/4 of the circumference of the round. In addition there was a small dent at the nose. The central conduit was not damaged.

   e. Drop 45° from Nose Down - The side was dented approximately 1-1/2" in depth and extended 7" around the warhead. The nose cone received a 1" deep dent. The central conduit was not damaged.
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Terrier Warhead Mk 5 Mod 03 Fragmentation and Drop Test of

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