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USNSWC ltr dtd 14 Aug 1975; USNSWC ltr dtd 14 Aug 1975

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| DAHLGREN, VIRGINIA          |
| REPORT NO 956               |
| WARHEADS FOR AIR TARGET GUIDED MISSILES; |
| TESTING OF                 |
| 41st Partial Report        |
| INVESTMENT CAST STEEL TUBE  |
| FOR AIR TARGET GUIDED MISSILES; |
| FRAGMENTATION TEST OF       |
| Task Assignment NPG-Re3f-607-1-52 |
| FINAL Report               |
| Copy No. 72                |
| Classification INDUSTRY    |
Forty-first Partial Report

on

Warheads for Air Target Guided Missiles; Testing of

Final Report

on

Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of
Investment Cast Steel Tube for Air Target Guided Missile, 2 1/2" x 2 1/2"
section of tube removed for Tensile Tests.

Figure 1
**TABLE I**

**MASS DISTRIBUTION DATA**

**FRAGMENTATION OF INVESTMENT CAST STEEL TUBE WARHEAD:** 4.56 O.D.; .145 WALL, 9.25 LONG, COMP C-3 LOADED

**FUZE:** SPECIAL ENGINEERS BLASTING CAP AND TETRYL BOOSTER FROM MK 44 AUX. DET.

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>20.48</td>
<td>5.63</td>
<td>385</td>
<td>308</td>
<td>356</td>
<td>596</td>
<td>341</td>
<td>732</td>
<td>217</td>
<td>1185</td>
<td>174</td>
<td>1506 124 1562 57 330 7</td>
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APPENDIX B
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

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Re2 1
Re3 2
Re3f 3

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APL/JLU, Silver Spring, Maryland 1

APL/JLU, Silver Spring, Md.
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(Via HSOHD, Silver Spring, Md.) 1

APPENDIX C
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

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Via: (District Chief, Phila. Ord District
1500 Chestnut St., Phila. 2, Pa.
Attn: Mr. Edward R. C. Niles)

Director, Research and Development Division
New Mexico Institute of Mining and Technology
Socorro, New Mexico
Via: Development Contract Officer
New Mexico Institute of Mining and Technology
Socorro, New Mexico

Boeing Airplane Company
Seattle Division
Seattle, Washington

Local:

<p>| | |</p>
<table>
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<th></th>
</tr>
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<tbody>
<tr>
<td>OT</td>
<td>1</td>
</tr>
<tr>
<td>OTZ</td>
<td>1</td>
</tr>
<tr>
<td>OT-1</td>
<td>1</td>
</tr>
<tr>
<td>File</td>
<td>1</td>
</tr>
</tbody>
</table>
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

PART A

SYNOPSIS

1. This test was conducted to determine the fragment mass distribution of a Composition C-3 loaded investment cast steel tube.

2. a. Approximately 70% of the total weight of the warhead fragmented into fragments weighing more than 5 grams each.

    b. The fragment mass distribution compared favorably with that obtained from similar steel tubes manufactured by other processes.
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

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<td>RESULTS AND DISCUSSION</td>
<td>5</td>
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<tr>
<td>CONCLUSIONS</td>
<td>6</td>
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**APPENDIX A** - WARHEAD, PHOTOGRAPH  
FIGURE 1

**APPENDIX B** - MASS DISTRIBUTION DATA  
FIGURE 2  
TABLE 1

**APPENDIX C** - DISTRIBUTION  
1-2 (Incl)
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. BUORD Conf ltr NP9 Re3f-6JHL:eddb Ser 12896 of 26 Sep 1951
   b. BUORD Conf ltr NP9 Re3f-6JHL:eddb Ser 25777 of 18 Sep 1951
   c. NPG Conf Report No. 705 of 16 Jan 1951
   d. NPG Conf Report No. 681 of 15 Nov 1950

3. BACKGROUND:

   In the development of warhead cases for air target guided missiles, an investment cast steel tube was manufactured. The casting of steel tubes is a simple and expeditious method of manufacturing warhead cases.

4. OBJECT OF TEST:

   This test was conducted to determine the fragment mass distribution of a Composition C-3 loaded investment cast steel tube.

5. PERIOD OF TEST:

   a. Date Project Letter
   b. Date Necessary Material Received
   c. Date Commenced Test
   d. Test Completed

   26 September 1951
   24 September 1951
   4 December 1951
   4 December 1951
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

From an investment cast steel tube, cylindrical, 4½ outside diameter, 4/16 wall thickness, 9/16 long, manufactured by S. D. Hicks and Son Co., a 2 1/2" x 2 1/2" section from one end was removed for physical tests. The physical properties and chemical analysis of this tube were as follows:

Physical Properties: (Tests conducted at NPG)

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Yield Strength at 0.2% offset (psi)</th>
<th>Tensile Strength (psi)</th>
<th>Elongation (% in 4d)</th>
<th>Reduction of Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28,000</td>
<td>35,800</td>
<td>2.7</td>
<td>5.4</td>
</tr>
<tr>
<td>2</td>
<td>24,000</td>
<td>33,100</td>
<td>2.7</td>
<td>6.5</td>
</tr>
<tr>
<td>3</td>
<td>22,500</td>
<td>32,400</td>
<td>4.0</td>
<td>10.4</td>
</tr>
<tr>
<td>Average</td>
<td>24,800</td>
<td>33,800</td>
<td>3.1</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Chemical Properties: (reported in reference (a))

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.10</td>
<td>.39</td>
<td>.69</td>
</tr>
</tbody>
</table>

The warhead was loaded with Composition C-3, and the weights were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Empty</th>
<th>Comp. C-3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds</td>
<td>14.85</td>
<td>5.63</td>
<td>20.48</td>
</tr>
</tbody>
</table>

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Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

7. PROCEDURES:

The warhead was initiated by a MK 44 auxiliary detonating fuze tetryl pellet and a special engineers blasting cap in a sawdust-filled chamber. After the detonation, the sawdust was sifted and the fragments recovered by the use of sieves and a magnetic separator.

8. RESULTS AND DISCUSSION:

The detailed mass distribution data are listed in Table I and the fragments are shown in Figure 2. The number of fragments in the various weight groups are summarized as follows:

<table>
<thead>
<tr>
<th>Wt. Group (grams)</th>
<th>No. Fragments</th>
<th>Wt. of Fragments (gm.)</th>
<th>% of Total Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-80</td>
<td>7</td>
<td>330</td>
<td>5</td>
</tr>
<tr>
<td>20-40</td>
<td>57</td>
<td>1582</td>
<td>24</td>
</tr>
<tr>
<td>10-20</td>
<td>124</td>
<td>1506</td>
<td>23</td>
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<tr>
<td>5-10</td>
<td>174</td>
<td>1185</td>
<td>18</td>
</tr>
<tr>
<td>2 1/2 - 5</td>
<td>217</td>
<td>732</td>
<td>11</td>
</tr>
<tr>
<td>1 1/4 - 2 1/2</td>
<td>341</td>
<td>596</td>
<td>9</td>
</tr>
<tr>
<td>5/8 - 1 1/4</td>
<td>356</td>
<td>308</td>
<td>4</td>
</tr>
<tr>
<td>0 - 5/8</td>
<td>---</td>
<td>385</td>
<td>6</td>
</tr>
</tbody>
</table>

Approximately 70% of the total warhead weight fragmented into fragments which were greater than 5 grams in weight. Comparing the fragment sizes with those recovered from similar size warheads manufactured by processes other than casting, references (c) and (d), indicates that the casting of cases may be a satisfactory method for producing warheads. It should be noted, however, that the results reported in references (c) and (d) are for warheads with substantially thinner walls, so that no exact comparison can be made.
PART D

CONCLUSIONS

9. a. Approximately 70% of the total weight of the warhead fragmented into fragments weighing more than 5 grams each.

b. The fragment mass distribution compared favorably with that obtained from similar steel tubes manufactured by other processes.
Investment Cast Steel Tube for Air Target Guided Missiles; Fragmentation Test of

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