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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1137

COMBAT AIR OPERATIONS GUIDED MISSILE FUZES:
RESEARCH, DEVELOPMENT, TESTS AND REPORTS OF

8th Partial Report

FUZING SYSTEM FOR XSAM-N-4, GUIDED MISSILE DOVE:
STEEL PLATE IMPACT TESTS

Task Assignment NPG-Re2b-34-1-53
Copy No. 8 Classification CONFIDENTIAL

SECURITY INFORMATION
Fusing System for XSAM-N-4, Guided Missile Dove; Steel Plate Impact Tests

PART A

SYNOPSIS

1. The XB-44A is the tail fuzing system for the warhead used on guided missile Dove. Dove is an air-to-ground, glide type of missile with stubby wings and no self-propulsion. It is approximately 24 inches in diameter and five (5) feet in length. Air scoops in the nose and stabilizing fins on the tail control the flight.

2. These initial tests of the XB-44A fuze during its evaluation phase were conducted to determine the functioning ability and delay interval after steel plate impacts.

3. The limited number of rounds fired in this test and the inconsistency of some of the results precludes the possibility of drawing any definite conclusions about the functioning ability of the fuze. The results listed below are probably indicative of the fuze sensitivity and functioning delay to be expected with the present models of the XB-44A fuze:

<table>
<thead>
<tr>
<th>No.</th>
<th>Impact Velocity</th>
<th>Target Thickness</th>
<th>Target Obl.</th>
<th>Fuze Action</th>
<th>Delay After Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ft./Sec.</td>
<td>Inches</td>
<td>Deg.</td>
<td></td>
<td>Distance</td>
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<tr>
<td>2</td>
<td>375</td>
<td>1/4&quot; M.S.</td>
<td>0</td>
<td>1 Dud, 1 H0</td>
<td>240</td>
</tr>
<tr>
<td>2</td>
<td>900</td>
<td>1/4&quot; M.S.</td>
<td>0</td>
<td>1 Dud, 1 H0</td>
<td>295</td>
</tr>
<tr>
<td>1</td>
<td>391</td>
<td>1/2&quot; M.S.</td>
<td>0</td>
<td>H0</td>
<td>165</td>
</tr>
<tr>
<td>1</td>
<td>862</td>
<td>1/2&quot; STS</td>
<td>0</td>
<td>H0</td>
<td>125</td>
</tr>
<tr>
<td>1</td>
<td>900</td>
<td>1&quot; STS</td>
<td>0</td>
<td>H0</td>
<td>220</td>
</tr>
<tr>
<td>3</td>
<td>900</td>
<td>1-1/4&quot; STS</td>
<td>0</td>
<td>2 Duds, 1 H0</td>
<td>215</td>
</tr>
</tbody>
</table>

4. It is recommended that:

A stronger container be provided for the spotting charge used to indicate fuze action in future heavy plate penetration tests. Breakage of the container and the consequent loss of a large portion of the spotting charge resulted in the production of such small amounts of flame and smoke when the fuse detonated that observation of the action was questionable in many cases.
FUZZING SYSTEM FOR XSALS-N-4, GUIDED MISSILE DANCE; STEEL PLATE IMPACT TESTS

TABLE OF CONTENTS

SYNOPSIS .................................................. 1
TABLE OF CONTENTS ......................................... 2
AUTHORITY .................................................. 3
REFERENCES ................................................ 3
BACKGROUND ................................................ 3
OBJECT OF TEST ............................................. 3
PERIOD OF TEST ............................................. 4
REPRESENTATIVES PRESENT .................................. 4
DESCRIPTION OF ITEM UNDER TEST ......................... 5
DESCRIPTION OF TEST EQUIPMENT ......................... 5
PROCEDURE ................................................ 6
RESULTS AND DISCUSSION .................................. 6
CONCLUSIONS ................................................ 8
RECOMMENDATIONS .......................................... 8

APPENDIX A - FIRING RECORD .............................. TABLE I
APPENDIX B - NPG PHOTOGRAPHS ........................... FIGURES 1-8 (Incl)
APPENDIX C - DISTRIBUTION .............................. 1-2 (Incl)
Fuzing System for XB-44A, Guided Missile Dove;
Steel Plate Impact Tests

PART B

INTRODUCTION

1. AUTHORITY:

Reference (a) authorized the Naval Ordnance Laboratory to deal directly with the Naval Proving Ground in conducting tests of the XB-44A fuze for the Dove missile. Reference (b) outlined the overall evaluation program for this fuze, and reference (c) those tests desired on the Naval Proving Ground's 500 ft. rocket launcher. Tests were conducted under task assignment NPG-Re2b-
34-1-53, reference (d). Reference (e) requested that field testing of the fuze be suspended as a result of the unsatisfactory arming times encountered during the program.

2. REFERENCES:

a. BUORD ltr NP9 (Re2b-286-2) FLY of 4 Apr 1949
b. NOL ltr NP51/671-8(3-615) TSHLD Ser 01641 of 19 Dec 1950
c. NPG Work Request from NOL, TSS 6125 of 31 Oct 1951
d. BUORD Conf ltr Re2b-DBLaPlbijn Ser 42694 of 29 Jul 1952
e. NOL ltr NP/NOL/X11 (649) Ser 0751 of 31 Mar 1952
f. NPG Report No. 933 of 20 Mar 1952

3. BACKGROUND:

The XB-44A is the tail fuzing system for the warhead used on guided missile Dove. Dove is an air-to-ground, glide type of missile with stubby wings and no self-propulsion. It is approximately 24 inches in diameter and five (5) feet in length. Air scoops in the nose and stabilizing fins on the tail control the flight. Reference (f) describes the relatively unsatisfactory performance of the fuze during its functioning tests while in the development stage.

4. OBJECT OF TEST:

These initial tests of the XB-44A fuze during its evaluation phase were conducted to determine the functioning ability and delay interval after steel plate impacts.
Fusing System for XSAM-N-4, Guided Missile Dove; Steel Plate Impact Tests

5. PERIOD OF TEST:
   a. Date Project Letter 31 Oct 1951
   b. Date Necessary Material Received 3 Jan 1952
   c. Date Commenced Test 29 Jan 1952
   d. Date Firing Stopped 6 Feb 1952
   e. Date Test Suspended 31 Mar 1952

6. REPRESENTATIVES PRESENT:
   H. L. Davis  
   Naval Ordnance Laboratory
   R. Happick  
   Naval Ordnance Laboratory
PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

The XB-44A is a vane arming tail fuze completely described and illustrated in reference (f). Dual primers, detonated upon impact by firing pins, initiate a pyrotechnic delay train which provides approximately one-quarter second delay before detonation of the fuze.

8. DESCRIPTION OF TEST EQUIPMENT:


Launcher: NPG 500 ft.

Targets: 1/4" and 1/2" mild steel; 1/2", 1/16 and 1-1/4" STS.

Propulsion: Low Velocity Impacts - one (1) 5" HVAR motor with 3/25 retro motor Mk 7

High Velocity Impacts - three (3) HVAR motors in carriage with either 3/25 or 5/10 HVAR retro-motor to separate carriage from bomb. Round 8 utilized 3 Model 38 propulsion motors.

Camera: Bowen acceleration at 180 frames/second.

Pre-arming of fuze: 100% Compressed Air Supply.
Fuzing System for XSAM-N-4, Guided Missile Dove; Steel Plate Impact Tests

9. PROCEDURES:

a. The XB-44A fuzes and black powder spotting charges were installed in 250 lb. G.P. Bombs in the manner described in reference (f). The fuzes were pre-armed while on the launcher, immediately prior to firing.

b. Round 8 was propelled by three (3) 5"0 rocket motors Model 38, installed parallel in a carrier. All other high velocity impacts utilized three (3) 5"0 HVAR motors for propulsion of the round. Separation of the propulsion carriage and bomb was obtained by the use of either a 3"25 or 5"0 "retro" motor (motor installed in carriage in reverse direction to propulsion motors). The "Retro" motor was ignited after 360 ft. of launcher travel so that the bomb and carriage would not be in contact when they left the launcher. Low velocity impacts (350-400 ft/sec.) were obtained with a single 5" HVAR motor as the propulsion vehicle and a 3"25 "retro" motor Mk 7 providing the separation force.

c. The distance from the launcher muzzle to the target was varied between 50 and 200 ft. in an attempt to establish the optimum distance for adequate separation and minimum yaw of the rounds.

d. The time and distance of fuze delay after target impact was measured with a Bowen Acceleration camera stationed normal to the line of flight on rounds 3 thru 10.

10. RESULTS AND DISCUSSION:

a. A detailed record of the test results is presented as Table I. Excerpts from the Bowen film records of target impacts and delayed fuze functioning are shown as Figures 1 thru 8.

b. A 3"25 rocket motor Mk 7 proved to be unsatisfactory as a "retro" force when used with the three (3) motor carriage on the 500 ft. launcher. If a longer launcher had been available, permitting the propulsion motors to burn out before ignition of the "retro" motor, it is possible that a 3"25 motor might have had sufficient thrust to effect sufficient separation of the round before impact. Motors having a higher acceleration and shorter burning distance (the 5"25 motors Mk 1 used with the Weapon A round have been considered) would have been more desirable than the 5" HVAR motors for propulsion. A 5" HVAR motor was used as a "retro"
motor on the last two (2) rounds with good results. Separation was necessary to prevent damage to the tail fuze and eliminate any extra forces on the bomb during target penetration. A 3*/25 "retro" motor was satisfactory for separation when a single 5" HVAR motor was used for propulsion.

c. Six (6) of the ten (10) fuzes tested functioned after target impact with delay times ranging from 0.29 to 0.75 seconds. The fuze is designed to have a delay time of 0.25 seconds. All rounds flighted into the river so that the dud fuzes could not be recovered to determine the cause of malfunctioning.

d. The sensitivity of the fuze cannot be established from the results obtained inasmuch as consistent functioning was not obtained on any of the targets employed. Two (2) of the four (4) rounds fired at the lightest target, 1/4" mild steel, resulted in high order fuze detonation; the other two (2) were duds. All three (3) rounds fired against the heaviest target, 1-1/4" STS, lost the greater part of their spotting charge upon target impact when the black powder container ruptured. Consequently, the two (2) apparent duds in these three (3) shots may have actually had satisfactory fuze functioning which could not be observed because of the lack of sufficient spotting charge material.
CONCLUSIONS

11. a. The limited number of rounds fired in this test and the inconsistency of some of the results preclude the possibility of drawing any definite conclusions about the functioning ability of the fuze. The results listed below are probably indicative of the fuze sensitivity and functioning delay to be expected with the present models of the XB-44 fuze:

<table>
<thead>
<tr>
<th>No.</th>
<th>Impact Velocity</th>
<th>Target Thickness</th>
<th>Col.</th>
<th>Fuze Action</th>
<th>Delay After Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>375 Ft./Sec.</td>
<td>1/4&quot; M.S.</td>
<td>0</td>
<td>1 Dud, 1 HO</td>
<td>240 Ft. 0.75 Sec.</td>
</tr>
<tr>
<td>2</td>
<td>900 Ft./Sec.</td>
<td>1/4&quot; W.S.</td>
<td>0</td>
<td>1 Dud, 1 HO</td>
<td>295 Ft. 0.36 Sec.</td>
</tr>
<tr>
<td>1</td>
<td>391 Ft./Sec.</td>
<td>1/2&quot; M.S.</td>
<td>0</td>
<td>HO</td>
<td>165 Ft. 0.50 Sec.</td>
</tr>
<tr>
<td>1</td>
<td>862 Ft./Sec.</td>
<td>1/2&quot; STS</td>
<td>0</td>
<td>HO</td>
<td>125 Ft. 0.29 Sec.</td>
</tr>
<tr>
<td>1</td>
<td>900 Ft./Sec.</td>
<td>1&quot; STS</td>
<td>0</td>
<td>HO</td>
<td>220 Ft. 0.40 Sec.</td>
</tr>
<tr>
<td>3</td>
<td>900 Ft./Sec.</td>
<td>1-1/4&quot; STS</td>
<td>0</td>
<td>2 Duds, 1 HO</td>
<td>215 Ft. 0.39 Sec.</td>
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PART E

RECOMMENDATIONS

12. It is recommended that:

A stronger container be provided for the spotting charge used to indicate fuze action in future heavy plate penetration tests. Breakage of the container and the consequent loss of a large portion of the spotting charge resulted in the production of such small amounts of flame and smoke when the fuze detonated that observation of the action was sometimes questionable.
Fuzing System for XSAM-N-4, Guided Missile Dove; Steel Plate Impact Tests

The tests upon which this report is based were conducted by:
F. W. KASDORF, Rocket Battery Officer
Terminal Ballistics Department

This report was prepared by:
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This report was reviewed by:
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Terminal Ballistics Department
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Terminal Ballistics Officer
Terminal Ballistics 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
Eighth Partial Report
on
Combat Air Operations Guided Missile Fuzes;
Research, Development, Tests and Reports of

Final Report
on
Fuzing System for XSAM-N-4, Guided Missile Dove;
Steel Plate Impact Tests

Project No.: NPG-Ro2b-34-1-53
Copy No.: 8
No. of Pages: 9

CONFIDENTIAL
SECURITY INFORMATION

Date: JUN 9 - 1953
Fusing System for XSAM-N-4, Guided Missile Dove;
Steel Plate Impact Tests

TABLE I

<table>
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<th>Date Fired</th>
<th>Rd. No.</th>
<th>No.</th>
<th>Target Thickness</th>
<th>Target M.S.</th>
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<th>Propulsion</th>
<th>1-5&quot; HVAR</th>
<th>365</th>
<th>DUD</th>
<th>165</th>
<th>0.50</th>
<th>90° Yaw At Impact</th>
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<td>160</td>
<td>1/4&quot; M.S.</td>
<td>0°</td>
<td></td>
<td>1-5&quot; HVAR</td>
<td>365</td>
<td>DUD</td>
<td>165</td>
<td>0.50</td>
<td>Good</td>
<td></td>
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<tr>
<td>1-29-52</td>
<td>2</td>
<td>154</td>
<td>1/2&quot; M.S.</td>
<td>0°</td>
<td></td>
<td>1-5&quot; HVAR</td>
<td>391</td>
<td>HO</td>
<td>165</td>
<td>0.50</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>1-30-52</td>
<td>3</td>
<td>151</td>
<td>1-1/4&quot; STS</td>
<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>840</td>
<td>DUD</td>
<td>125</td>
<td>0.29</td>
<td>Slight Yaw At Impact</td>
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<td>4</td>
<td>152</td>
<td>1/2&quot; STS</td>
<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>862</td>
<td>HO</td>
<td>240</td>
<td>0.76</td>
<td>Good</td>
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<td>155</td>
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<td>0°</td>
<td></td>
<td>1-5&quot; HVAR</td>
<td>379</td>
<td>HO</td>
<td>295</td>
<td>0.36</td>
<td>Good</td>
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<td>156</td>
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<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>879</td>
<td>HO</td>
<td>295</td>
<td>0.36</td>
<td>Good</td>
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<td>7</td>
<td>157</td>
<td>1/4&quot; M.S.</td>
<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>950</td>
<td>DUD</td>
<td>215</td>
<td>0.59</td>
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<td>2-4-52</td>
<td>8</td>
<td>158</td>
<td>1-1/4&quot; STS</td>
<td>0°</td>
<td></td>
<td>3-5&quot; Model 58</td>
<td>988</td>
<td>DUD</td>
<td>220</td>
<td>0.40</td>
<td>Good</td>
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</tr>
<tr>
<td>2-5-52</td>
<td>9</td>
<td>160</td>
<td>1-1/4&quot; STS</td>
<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>881</td>
<td>HO</td>
<td>215</td>
<td>0.59</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>2-6-52</td>
<td>10</td>
<td>153</td>
<td>1&quot; STS</td>
<td>0°</td>
<td></td>
<td>3-5&quot; HVAR</td>
<td>900</td>
<td>HO</td>
<td>220</td>
<td>0.40</td>
<td>Good</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:
Rd. 1  No Camera
Rd. 2  No Camera
Rd. 3  Black Powder Spilled from Bomb after Impact
Rd. 4  Black Powder Spilled from Bomb on target impact may have been ignited by Retro Motor - Bomb hit ground 125 ft. beyond target - Fuse action uncertain but appeared probable at this point.
Rd. 5  Fuse Action out of camera field but was observed visually
Rd. 6  Fuse Action out of camera field but was observed visually
Rd. 7  No separation motor used
Rd. 8  Most of black powder appeared to spill from head after impact - may account for non-observation of fuse action
Rd. 9  5" HVAR Retro Motor used for separation - some Black Powder lost from bomb after impact
Rd. 10  5" HVAR Retro Motor used for separation - Good flight and separation on rounds 9 and 10 - Some Black Powder lost from Bomb after impact.

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Test of Xb-24A Davis Fuze. View: Roll 3 - Dud operation of fuze #151 after penetration of 1-1/4" SST target, C° obl. at 940 ft/sec. Fuze is mounted in tail of 2504 C.P. boat. Smoke at target results from deflagration of unburned propellant upon impact and spillage of black powder spotting charge.

Figure 1
Figure 2 - Functioning Test of XB-44A Dowm Fuze. View: Rd & - Fuze #152 operation 125 ft. (C.29 sec.) after penetration of 1/2" STS target, C° obl., at 662 ft/sec. Flash immediately behind target originates from unburned propellant in "retro" rocket. Fuze spotting charge is circled.
Functioning Test of XP-11A Dive Fuze. - Fuzes: No. 2, Fuse #1, operation 240 ft. 75 sec. after penetration of 1/4" mild steel target, exit obliquity at 379 ft/sec. Make puff detonated by fuze mounted in tail of 236" C.P. bomb.

Figure 1
Date Fired: 31 January 1953

Functioning Test of XB-44A Dove Fuze. View: Rd 6 - Fuze #156 fired from NPG 560 ft launcher in 25# G.P. bomb vs 1/4" mild steel target at 30° obl. Impact velocity 879 ft/sec. Fuze functioned HO with 295 ft, (0.36 sec.) delay after impact, out of field of view of camera. Figure 4.

Figure 5
Date Fired: 4 February 1959

Functioning test of XB-25A drive from Vier. 12.8 - Fuse #1/8 fired from NPC 500 ft. launcher in 2/4 4.5, bomb ve 1-1/4 s 880 feet at 200 ft. Interm velocity 385 ft/s.

Black powder in the charge containe apparently ruptured spilling black powder after target impact, possibly preventing fuse action from being visible.

Figure 6
NPG-6315C. Date Fired: 5 February 1953
Functioning Test of XB-44A dove Fuze. View: No 9 - Fuze #160 fired from NPG 500 ft. launcher in 2½° G.P. bomb ve. 1-1/2" STS target at 6° obt. Impact velocity 981 ft/sec. Fuze functioned HO with 213 ft. (0.39 Sec.) delay after impact. Note fuze detonation at after end of sand pile. Figure 7