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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 911

WARHEADS FOR AIR TARGET GUIDED MISSILES
TESTING OF

GUIDED MISSILE WARHEAD FRAGMENTATION
TEST OF

35th Partial Report

Task Assignment NPG-Re3f-607-1-52

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NPG REPORT NO. 911

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

(10) V. J. Philipchuk
a. N. Hughes

(9)

Thirty-fifth Partial Report. no. 35,

on

(6)

Warheads for Air Target Guided Missiles,

Testing of.

- -

Guided Missile Warhead Fragmentation,

Test of.

(12) 17p.

(11) 28 Jan 52

(16)

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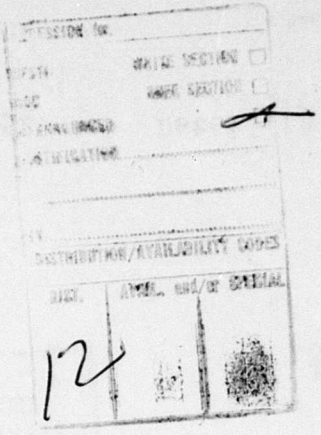
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Terrier Warhead Type F, BUORD Confidential Sketch 318051.
Figure 1

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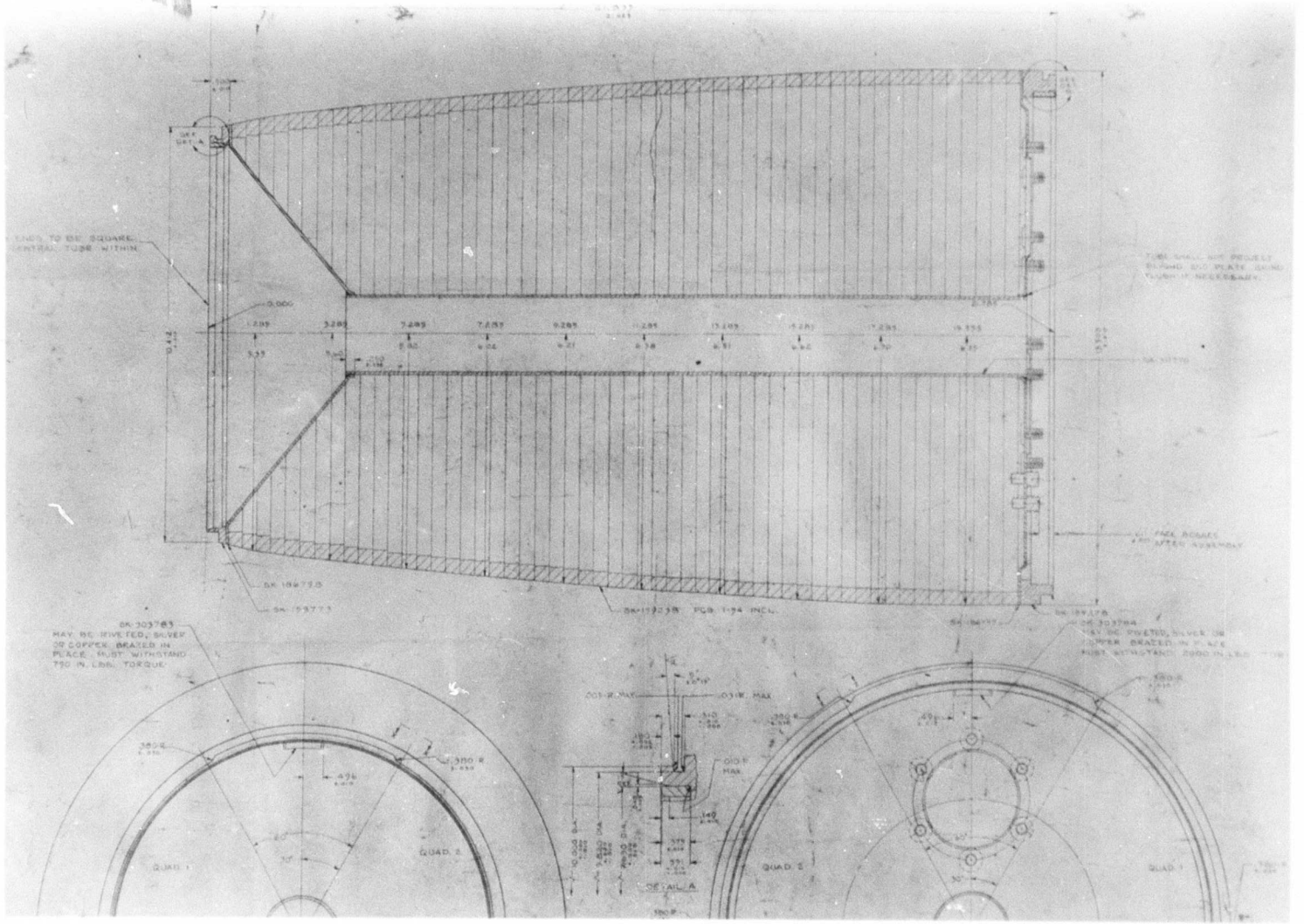

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A

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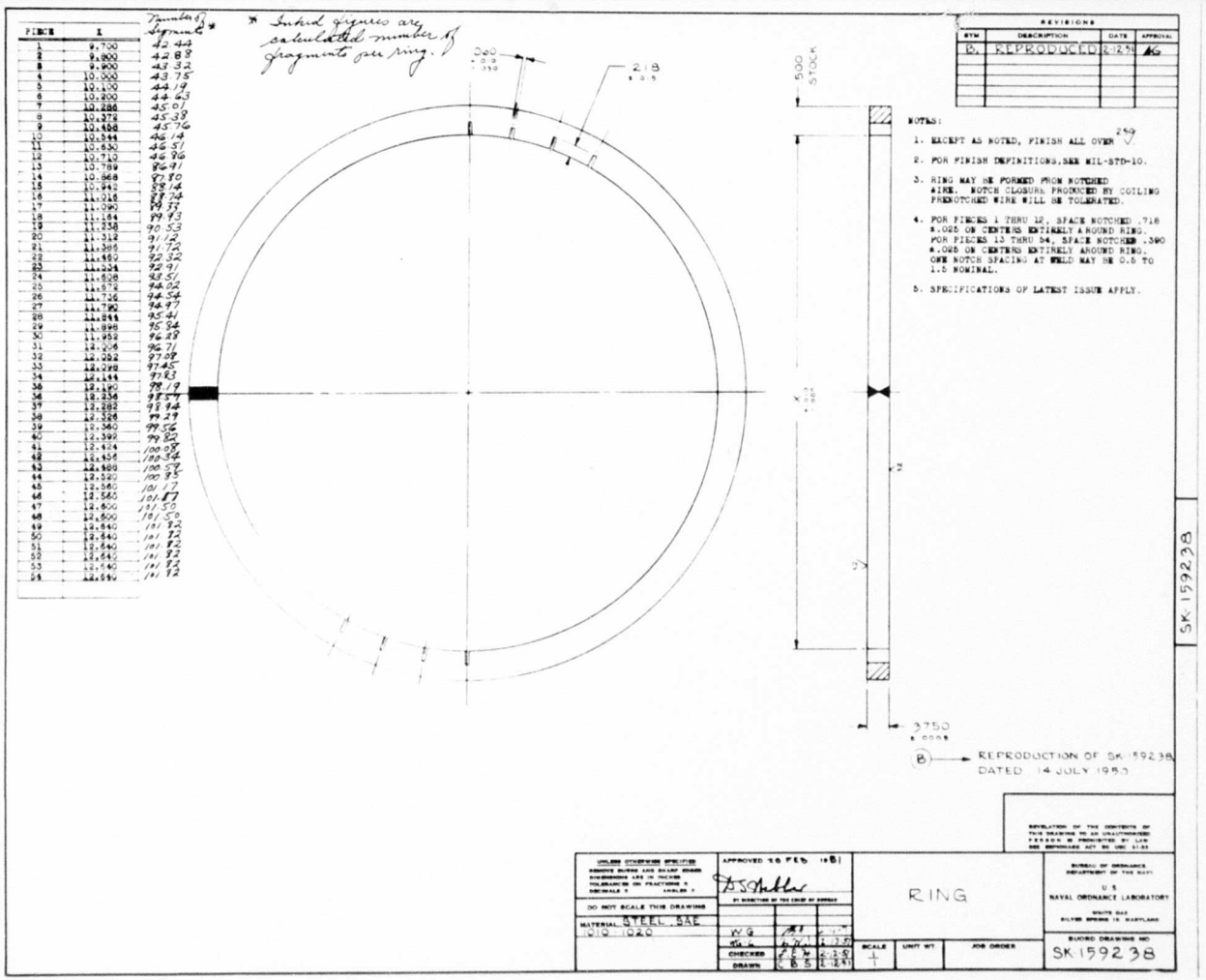
Ring for Terrier Warhead Type F, BUORD Confidential Drawing No. 159238.
Figure 2



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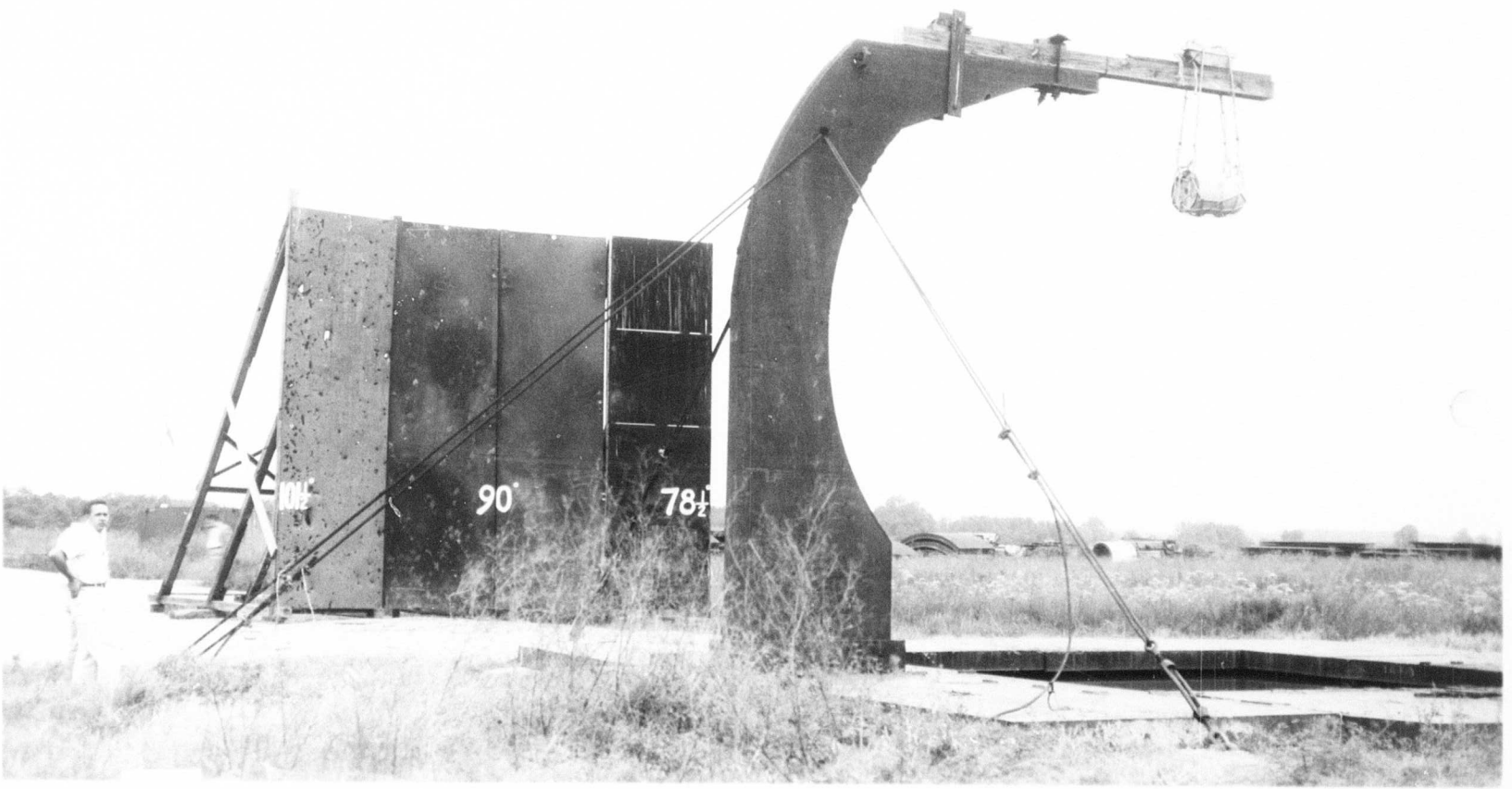
Field set up before firing of Terrier Warhead Type F over NPG Waterpit.
Figure 3



B

Guided Missile Warhead Fragmentation, Test of

TABLE I

FRAGMENT VELOCITY DATA

35mm Fastax Camera 1 — 1770 frames per sec.

Rd. 1 - Terrier — Comp. B-1

Total Weight 217.56 lbs. — Filler Weight 114.53 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
17	6	6250
18	45	5900
19	22	5590
20	10	5310
21	2	5060
Median		5860
Average		5760

C

Guided Missile Warhead Fragmentation, Test of

- -

TABLE I (Continued)

35mm Fastax Camera 2 — 1830 frames per sec.

Rd. 1 - Terrier — Comp. B-1

Total Weight 217.56 lbs. — Filler Weight 114.53 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
18	12	6100
19	42	5780
20	19	5490
21	9	5230
22	2	4990
Median		5800
Average		5680

Guided Missile Warhead Fragmentation, Test of

- -

TABLE II

FRAGMENT VELOCITY DATA

35mm Fastex Camera 1 — 1770 frames per sec.

Rd. 1 - Terrier 3 x 3 Plate — Comp. B-1

Total Weight 217.56 lbs. — Filler Weight 114.53 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
8	10	6640

Median

Average

Guided Missile Warhead Fragmentation, Test of

TABLE II (Continued)

35mm Fastax Camera 2 — 1830 frames per sec.

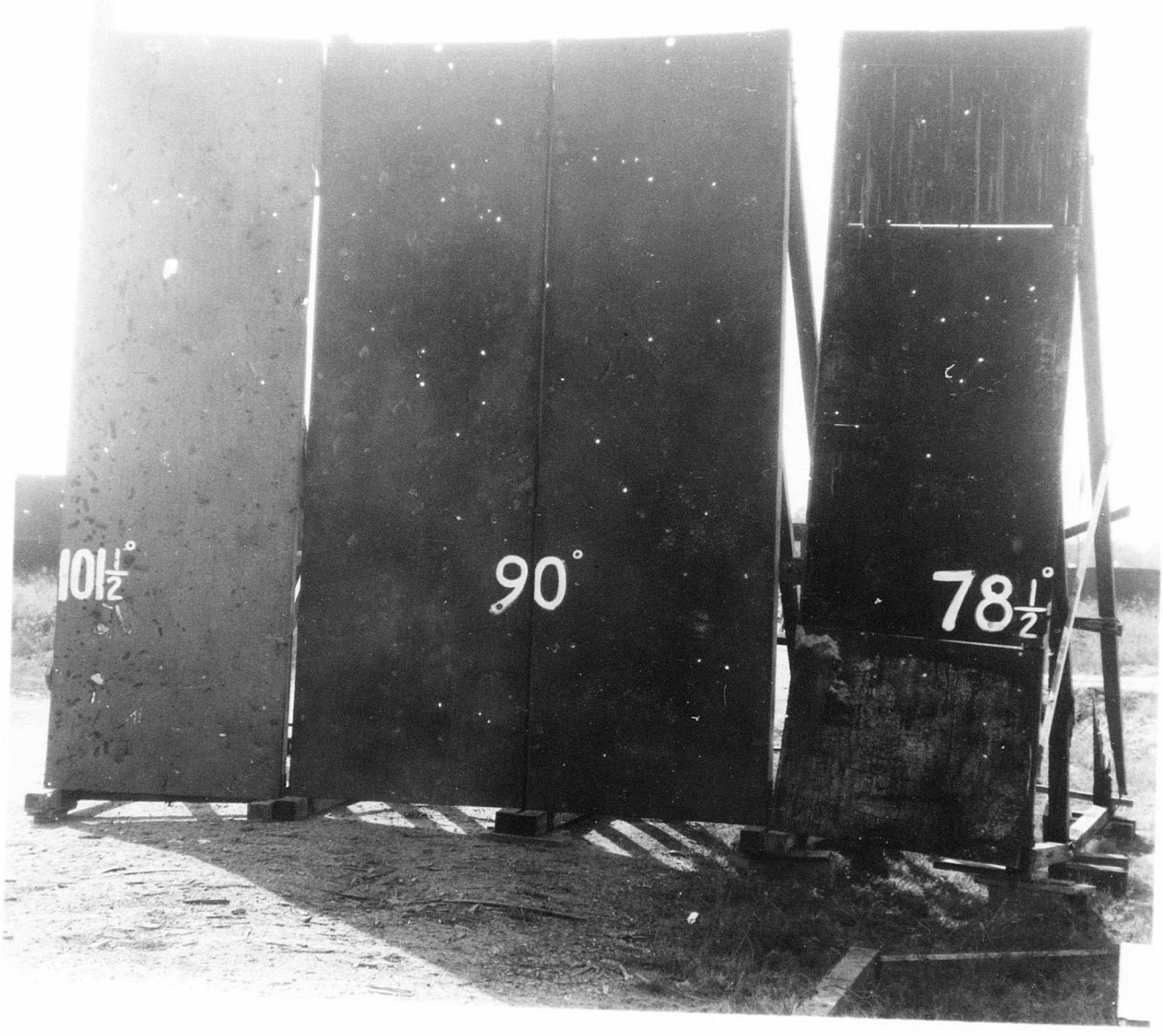
Rd. 1 - Terrier 3 x 3 Plate — Comp. B-1

Total Weight 217.56 lbs. — Filler Weight 114.53 lbs.

Frame in Which Hit Occurred	No. Fragments	Velocity (f/s)
9	10	6100

Median

Average



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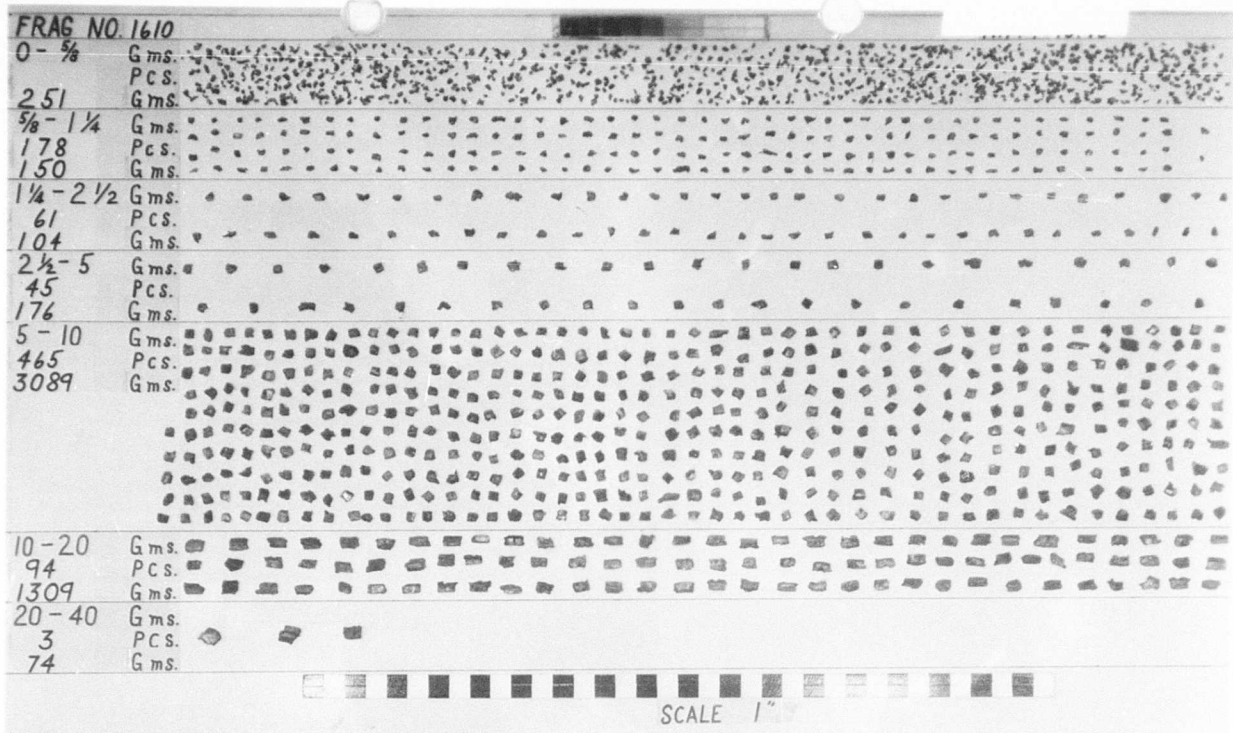
Steel panels after firing of Terrier Warhead Type F. Panels were at 60 feet from warhead.

Figure 4



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Beam spray (60°-120°) fragments from Terrier Warhead Type F, Composition B-1 loaded. Fragments were recovered from NPG waterpit.

Figure 5

E

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NPG REPORT NO. 911

Guided Missile Warhead Fragmentation, Test of

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of the Composition B loaded Terrier Type F guided missile warhead which was modified for production purposes by the addition of four rows of tack weld.

2. The addition of four rows of tack weld to the guided missile warhead Terrier Type F had no adverse effects on its fragmentation characteristics.

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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(259) WG:HWS:br Ser 01536 of 30 Aug 1951 to NAVPROV
b. BUORD Conf ltr NP9 Re3f-EJHL:edb Ser 25777 of 18 Sep 1951 to NAVPROV
c. NPG Conf Report No. 889 of 15 Dec 1951
d. NPG Conf Report No. 203 of 25 Jan 1949

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 Type F warhead were reported in reference (c). The standard construction had to be modified for production manufacturing by tack welding the rings together in four locations in order to facilitate the ring brazing. The fragmentation results of this modified Terrier Type F warhead are reported herein.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of the Composition B loaded Terrier Type F guided missile warhead which was modified for production purposes by the addition of four rows of tack weld.

5. PERIOD OF TEST:

a.	Date of Project Letter	30 Aug 1951
b.	Date Necessary Material Received	6 Aug 1951
c.	Date Commenced Test	11 Sep 1951
d.	Test Completed	11 Sep 1951

6. REPRESENTATIVES PRESENT:

This test was witnessed by Mr. L. E. Hightower and Mr. T. C. McGreen representing the Naval Ordnance Laboratory.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. Terrier Warhead Type F, Serial No. 34; one round constructed according to Bureau of Ordnance Conf Sk 318051, Figure 1, Appendix (A), 21".835 in length, tapered from 10".412 O.D. at the nose to 13".500 O.D. at the base, and ".409 wall thickness. The warhead contained a 1".9 diameter central conduit tube and the outer shell consisted of 54 notched rings which were copper hydrogen brazed together.

b. The rings were formed from notched wire. For rings 1 through 12, the notches were spaced ".718 ±".025 on centers entirely around each ring. For rings 13 through 54, the notches were spaced ".390 ±".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 weighing approximately 7.0 grams each. A sketch of ring details is shown in Figure 2, Appendix (A).

Each ring was ".375 thick and had a notch depth of ".218. Four rows of tack weld held the rings together during brazing. The warhead was loaded with Composition B-1 at Naval Mine Depot Yorktown, Virginia.

The weights are as follows:

Rd. No.	Empty Wt. (lbs)	Hot Melt. (lbs)	*Filler Wt. (lbs)	Complete Wt. (lbs)
1	100.00	3.03	114.53	217.56

*Composition B-1 at 1.66 density.

8. PROCEDURE:

a. The mass distribution collection was conducted by the general method described in reference (d). The warhead was placed horizontally over a water pit so that 1/6 of the beam spray (60° - 120°) fragments would be recovered in the water pit. The white stripe which was painted over one of the four welds was on the bottom side of the warhead as it hung in the horizontal position. A photograph of the field set up before firing is shown in Figure 3, Appendix (B).

b. Fragment velocities were measured by the usual photographic technique. Mean velocities of beam spray fragments were obtained for 30' and 60' of fragment travel from the warhead. Steel panels 20' high and 6' wide were placed in the beam spray at 60' from the warhead. The width of the panels covered 23° of the beam spray (from 78-1/2° to 101-1/2°) at the 60' radius, Figure 4, Appendix (D). In addition, 3/8" mild steel panels 3' high and 3' wide were placed in the beam spray at 30' from the warhead. The width of these panels covered 6° of the beam spray (from 87° to 93°).

c. Initiation was accomplished by using a 167 gram tetryl booster, 1".423 diameter by 4".50 long, and a special engineers blasting cap. The booster was placed in the central tube with its front end at 8-7/8" from the extreme front end of the warhead.

9. RESULTS AND DISCUSSION:

a. A total of 510 fragments of approximately design size for rings 13 through 54 (465 weighing between 5 and 10 grams, 45 weighing between 2-1/2 and 5 grams) and a total of 94 fragments of approximately design size for rings 1 through 12 (weighing between 10 and 20 grams) were recovered in the water pit. Since these figures represent 1/6 of the total fragments in the beam spray, there should be 3060 fragments weighing between 2-1/2 and 10 grams and 564 fragments weighing between 10 and 20 grams in the total beam spray (60° to 120° measured from the nose relative to the longitudinal axis of the warhead). The fragments collected in the water pit are shown in Figure 5, Appendix (E).

b. The mean beam spray fragment velocities for the first 30' and 60' of travel are tabulated in Tables I and II, Appendix (C). The median fragment velocity obtained when viewing the 60' radius panels was 5830 ft./sec., with the fastest fragments having a mean velocity of 6250 ft./sec.

c. The 20' high steel panels at the 60' radius were placed at various polar angle zones and had the following numbers of fragment hits:

Panel Thickness (inches)	Zone	No. Fragment Hits	No. Complete Penetrations	No. Incomplete Penetrations
.125	78-1/2°-84-1/4°	36	36	0
.485	84-1/4°-90°	36	32	4
.493	90°-95-3/4°	49	41	8
.610	95-3/4°-101-1/2°	27	8	19

A photograph of the steel panels after firing is shown in Figure 4, Appendix (D).

PART D

CONCLUSIONS

10. It is concluded that:

The addition of four rows of tack weld to the guided missile warhead Terrier Type F had no adverse effects on its fragmentation characteristics.

Guided Missile Warhead Fragmentation, Test of

The tests upon which this report is based were conducted by:
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Title GUIDED MISSILE WARHEAD FRAGMENTATION

Author(s) V. PHILIPCHUK AND A.E. HUGHES

Date PARTIAL REPT. 38 on WARHEADS FOR AIR TARGET GUIDED MISSILES 30 Jan 58

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