

UNCLASSIFIED

AD NUMBER

AD121957

CLASSIFICATION CHANGES

TO: unclassified

FROM: confidential

LIMITATION CHANGES

TO:

Approved for public release, distribution unlimited

FROM:

Distribution: Further dissemination only as directed by Naval Proving Ground, Dahlgren VA.; Nov 1952 or higher DoD authority.

AUTHORITY

Nov 1964, DoDD 5200.10, 26 July 1962;
USNSWC ltr 3 Feb 1976

THIS PAGE IS UNCLASSIFIED

AD 121957

Armed Services Technical Information Agency

Reproduced by

DOCUMENT SERVICE CENTER

KNOTT BUILDING, DAYTON, 2, OHIO

This document is the property of the United States Government. It is furnished for the duration of the contract and shall be returned when no longer required, or upon recall by ASTIA to the following address: **Armed Services Technical Information Agency, Document Service Center, Knott Building, Dayton 2, Ohio.**

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

REPRODUCTION QUALITY NOTICE

This document is the best quality available. The copy furnished to DTIC contained pages that may have the following quality problems:

- **Pages smaller or larger than normal.**
- **Pages with background color or light colored printing.**
- **Pages with small type or poor printing; and or**
- **Pages with continuous tone material or color photographs.**

Due to various output media available these conditions may or may not cause poor legibility in the microfiche or hardcopy output you receive.

If this block is checked, the copy furnished to DTIC contained pages with color printing, that when reproduced in Black and White, may change detail of the original copy.

AD No. 121 957

ASTIA FILE COPY



CONFIDENTIAL

SECURITY INFORMATION

FC

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1063

FRAGMENTATION OF PROJECTILES AND WARHEADS

22nd Partial Report

COMPARISON OF LETHAL FRAGMENTS FROM
BRANDT 120mm MORTAR AND 4"2 MORTAR SHELL M329

FINAL Report

Task

Assignment NPG-Re2c-35-1-52

Copy No. _____

Classification CONFIDENTIAL
SECURITY INFORMATION

FEB 26 1957

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

PART A

SYNOPSIS

1. This analysis was undertaken to determine the relative lethal effectiveness of three types of mortar projectiles: (1) the 120mm Light Brandt, TNT loaded; (2) the 120mm Heavy Brandt, TNT loaded; and (3) the 4.2 M329, Composition B loaded.

2. Of the three types of mortar projectile evaluated, assuming similar fragment space distribution patterns, the order of lethal effectiveness is as follows:

a. From point of burst to 55 yards range:

(1) 120mm Heavy Brandt

(2) 4.2 M329

(3) 120mm Light Brandt

b. From 55 yards range to 250 yards range:

(1) 120mm Heavy Brandt

(2) 120mm Light Brandt

(3) 4.2 M329

3. It is understood that the Aberdeen Proving Ground will conduct fragmentation tests of the 4.2 M329 mortar projectile, TNT loaded, and will make lethality studies of all three types of mortars at various burst heights.

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4W2 Mortar Shell M329

TABLE OF CONTENTS

	<u>Page</u>
SYNOPSIS	1
TABLE OF CONTENTS.	2
AUTHORITY.	3
REFERENCES	3
BACKGROUND	3
OBJECT OF ANALYSIS	3
PERIOD OF ANALYSIS	3
DESCRIPTION OF ITEMS UNDER ANALYSIS.	4
PROCEDURE.	4
ANALYSIS	5
CONCLUSIONS.	6
APPENDIX A - 120mm MORTARS, PHOTOGRAPH	FIGURE 1
APPENDIX B - NO. FRAGMENTS VERSUS RANGE.	TABLE I
NO. FRAGMENTS VERSUS RANGE, GRAPH	FIGURE 2
APPENDIX C - NO. FRAGMENTS IN WEIGHT GROUPS.	TABLE II
APPENDIX D - FRAGMENT WEIGHT VERSUS VELOCITY	TABLE III
APPENDIX E - DISTRIBUTION.	1-2 (Incl)

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4#2 Mortar Shell M329

PART B

INTRODUCTION

1. AUTHORITY:

This analysis was authorized by reference (a) and conducted under Task Assignment NPG-Re2c-35-1-52, reference (b).

2. REFERENCES:

- a. BUORD Conf ltr NP9 Re2c-JSM:rjb Ser 37970 of 18 Apr 1952
- b. BUORD Conf ltr NP9 Re2c-HRK:saw Ser 23964 of 4 Aug 1951
- c. NPG Conf Report No. 968 of 6 May 1952
- d. BRL Restr Report No. 758 of May 1951
- e. BRL Restr Report No. 697 of 3 Feb 1949

3. BACKGROUND:

Reference (a) requested that the fragmentation results for the two types of 120mm Brandt mortar projectile and for the 4#2 mortar projectile M329 be evaluated and compared for lethal effectiveness. The 120mm Brandt fragmentation data were reported in reference (c) and the 4#2 M329 fragmentation data were given in enclosure (1) of reference (a).

4. OBJECT OF ANALYSIS:

This analysis was undertaken to determine the relative lethal effectiveness of three types of mortar projectile: (1) the 120mm light Brandt, TNT loaded; (2) the 120mm heavy Brandt, TNT loaded; and (3) the 4#2 M329, Composition B loaded.

5. PERIOD OF ANALYSIS:

- | | |
|---------------------------------|-------------------|
| a. Date Project Letter | 18 April 1952 |
| b. Date Necessary Data Received | 22 April 1952 |
| c. Date Commenced Analysis | 21 May 1952 |
| d. Date Analysis Completed | 15 September 1952 |

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4#2 Mortar Shell M329

PART C

DETAILS OF ANALYSIS

6. DESCRIPTION OF ITEMS UNDER ANALYSIS:

a. Detailed descriptions of the light and heavy 120mm Brandt mortar projectiles given in reference (c) are summarized as follows:

(1) 120mm light Brandt, 5.9 lbs. explosive charge weight (mainly TNT), 28.4 lbs. total weight, 16#15 length, 0#478 wall thickness at forward bourrelet, and 0#329 wall thickness at 1" forward of base cavity. The assembled projectile is shown in Figure 1.

(2) 120mm heavy Brandt, 9.7 lbs. explosive charge weight (mainly TNT), 37.3 lbs. total weight, 21#91 length, 0#381 wall thickness at forward bourrelet, and 0#244 wall thickness at 1" forward of base cavity. The assembled projectile is shown in Figure 1.

b. The 4#2 mortar projectile M329, Composition B loaded, 7.8 lbs. explosive weight, 26.0 lbs. total weight, cylindrical in shape, with wall thicknesses of 0#20 and 0#233.

7. PROCEDURE:

a. The fragment weight group 0-0.625 grams of the 120mm light and heavy Brandt projectiles reported in reference (c) was separated into two groups, 0-0.3 grams and 0.3-0.625 grams, and recounted in order to obtain information comparable with Aberdeen data reported in enclosure (1) of reference (a).

b. The initial fragment velocities of the Brandt projectiles were estimated from the measured average velocity of the faster fragments at 15 feet range, correcting to zero range by the use of the formula employed below for calculating lethal ranges. A fragment weight of 40 grams was used for both types in making this small correction. The initial velocity for the 4#2 M329 mortar projectile, Composition B loaded, was obtained from enclosure (1) of reference (a).

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

c. The cumulative fragment mass distribution shows the total number of fragments from each projectile with mass greater than m , where m assumes the values of the several boundaries between the fragment mass groups. If the range is such that a fragment of mass m is barely lethal, all fragments with a greater mass will be effective, and all with a smaller mass ineffective. The usual lethality criterion for personnel, that the fragment must have a kinetic energy of at least 58 foot pounds, was employed. The minimum lethal velocity for a fragment of mass m was computed, and the range at which the fragment would have this velocity derived from the equation (reference (e))

$$\log \frac{V_x}{V_0} = - \frac{.0178X}{M^{1/3}}$$

where

V_x = velocity at 58 ft./lb. energy (ft./sec.)

V_0 = initial velocity (ft./sec.)

M = fragment mass (gm.)

X = lethal range (yd.)

The initial fragment velocities of the three types of projectiles are as follows:

120mm Heavy Brandt - 5680 ft./sec.

120mm Light Brandt - 4900 ft./sec.

4.2 M329 - 5900 ft./sec.

8. ANALYSIS:

a. The cumulative number of fragments versus lethal range are listed in Table I and are plotted in graph form, Figure 2. The 120mm heavy Brandt produced more lethal fragments than both the 4.2 M329 and 120mm light Brandt mortar projectiles. The 4.2 M329 produced more lethal fragments than the 120mm light Brandt at ranges up to 55 yards. At ranges greater than 55 yards, the converse is true.

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

b. The numbers of fragments in weight groups are listed in Table II and the fragment velocity-weight-lethal range values for 58 foot-pounds energy are listed in Table III.

c. The 4.2 mortar projectile, being Composition B loaded, can be expected to produce a greater number of fragments at the shorter lethal ranges and a higher initial fragment velocity than if it were TNT loaded.

PART D

CONCLUSIONS

9. a. Of the three types of mortar projectiles evaluated, assuming similar fragment space distribution patterns, the order of lethal effectiveness is as follows:

- (1) From point of burst to 55 yards range:
 - (a) 120mm heavy Brandt
 - (b) 4.2 M329
 - (c) 120mm light Brandt
- (2) From 55 yards range to 250 yards range:
 - (a) 120mm heavy Brandt
 - (b) 120mm light Brandt
 - (c) 4.2 M329

b. It is understood that Aberdeen Proving Ground will conduct fragmentation tests of the 4.2 M329 Mortar, TNT loaded, and will make lethality studies of all three types of mortars at various burst heights.

CONFIDENTIAL

NPG REPORT NO. 1063

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

The computations upon which this report is based were made by:

V. PHILIPCHUK, Fragmentation Battery 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:

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
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

CONFIDENTIAL

NPG REPORT NO. 1063

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twenty-Second Partial Report

on

Fragmentation of Projectiles and Warheads

Final Report

on

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

Project No.: NPG-Re2c-35-1-52
Copy No.: 33
No. of Pages: 7

Date:

NOV 19 1952

CONFIDENTIAL
SECURITY INFORMATION

57AA-13717

IR-475

8 JAN 1952

Left and right 12 mm mortar ammunition
cases

ORIGINAL
COPY



USNPG DAHLGREN, VIRGINIA
1 FOOT



Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4W2 Mortar Shell M329

TABLE I

Cumulative No. of Mortar Fragments versus Lethal Range

(5 ROUND AVERAGES)

<u>4W2 M329</u>		<u>120mm Light Brandt</u>		<u>120mm Heavy Brandt</u>	
<u>No.</u>	<u>Range (Yards)</u>	<u>No.</u>	<u>Range (Yards)</u>	<u>No.</u>	<u>Range (Yards)</u>
2457	16	2147	12	3052	14
1948	27	1576	23	2169	26
1547	36	1169	38	1511	40
1033	50	808	59	933	64
375	76	495	90	502	95
177	94	244	130	218	138
94	111	78	178	77	196
31	137	7	265	30	276
11	212			10	385
6	307			1	531

NP9-49326

CONFIDENTIAL
Security Information

NUMBER OF FRAGMENTS
VERSUS
LETHAL RANGE
15 SEPTEMBER 1952

EUGENE DIETZGEN CO.
MADE IN U.S.A.

EUGENE DIETZGEN GRAPH PAPER
10 X 10 PER INCH

3200
2900
2600
2300
2000
1700
1400
1100
800
500

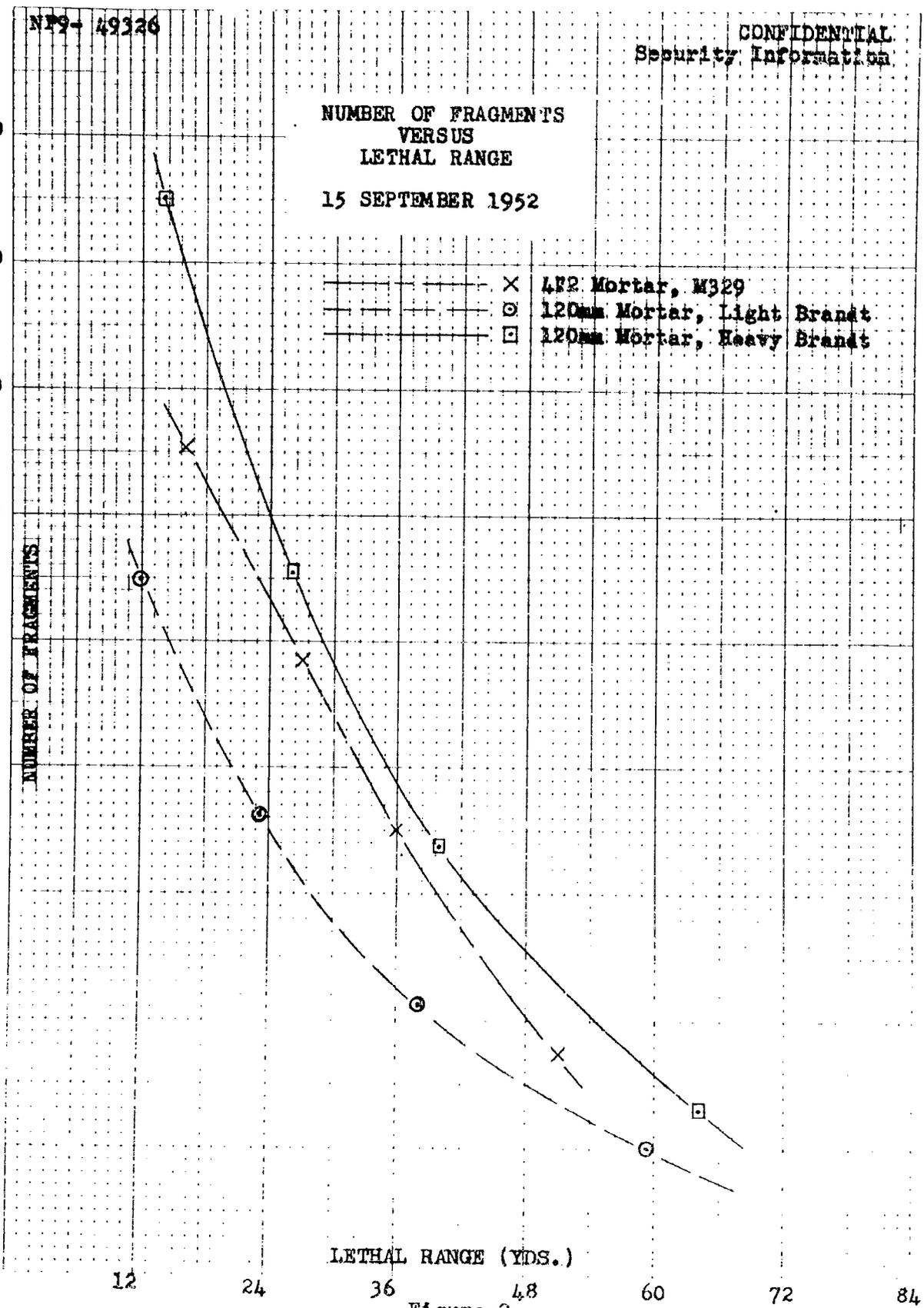
NUMBER OF FRAGMENTS

- × 4.2 Mortar, M329
- 120mm Mortar, Light Brand
- 120mm Mortar, Heavy Brand

12 24 36 48 60 72 84

LETHAL RANGE (YDS.)

Figure 2



Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

TABLE II

No. of Mortar Fragments in Various Weight Groups

(5 ROUND AVERAGES)

<u>4.2 M329</u>		<u>120mm Light Brandt</u>		<u>120mm Heavy Brandt</u>	
<u>Wt. Group</u> <u>(grams)</u>	<u>No.</u>	<u>Wt. Group</u> <u>(grams)</u>	<u>No.</u>	<u>Wt. Group</u> <u>(grams)</u>	<u>No.</u>
0.324-0.648	509	0.3-0.625	571	0.3-0.625	883
0.648-0.972	401	0.625-1.25	407	0.625-1.25	658
0.972-1.62	514	1.25-2.50	361	1.25-2.50	578
1.62-3.24	658	2.50-5.0	313	2.50-5.0	431
3.24-4.86	198	5.0-10	251	5.0-10	284
4.86-6.48	83	10-20	166	10-20	141
6.48-9.72	63	20-40	71	20-40	47
9.72-22.7	20	40-80	7	40-80	20
22.7-48.5	5			80-160	9
48.5+	6			160+	1

CONFIDENTIAL

NPG REPORT NO. 1063

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4"2 Mortar Shell M329

TABLE III

Fragment Weight-Velocity-Lethal Range Values
for 58 Foot-Pounds Energy

<u>4"2 M329</u>			<u>120mm Light Brandt</u>			<u>120mm Heavy Brandt.</u>		
<u>I.V. - 5900 ft./sec.</u>			<u>I.V. - 4900 ft./sec.</u>			<u>I.V. - 5680 ft./sec.</u>		
<u>Frag.</u>	<u>Vel.</u>	<u>Range</u>	<u>Frag.</u>	<u>Vel.</u>	<u>Range</u>	<u>Frag.</u>	<u>Vel.</u>	<u>Range</u>
<u>Wt.</u>	<u>(ft./sec.)</u>	<u>(Yds.)</u>	<u>Wt.</u>	<u>(ft./sec.)</u>	<u>(Yds.)</u>	<u>Wt.</u>	<u>(ft./sec.)</u>	<u>(Yds.)</u>
<u>(grams)</u>			<u>(grams)</u>			<u>(grams)</u>		
0.324	2280	16	0.30	2375	12	0.30	2375	14
0.648	1620	27	0.625	1647	23	0.625	1647	26
0.972	1320	36	1.25	1152	38	1.25	1152	40
1.62	1020	50	2.50	822	59	2.50	822	64
3.24	723	76	5.0	581	90	5.0	581	95
4.86	593	94	10	411	130	10	411	138
6.48	512	111	20	291	178	20	291	196
9.72	418	137	40	206	265	40	206	276
22.7	274	212				80	145	385
48.5	187	307				160	103	531

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX D

CONFIDENTIAL

NPG REPORT NO. 1063

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

DISTRIBUTION

Bureau of Ordnance:

Ad3	1
Re2	1
Re3	2
Re2c	5
Chief of Ordnance Department of the Army Attn: ORDTX-AR	2
Navy Research Section Library of Congress Washington 25, D. C. (Via BUORD Re2)	2
Commanding General Aberdeen Proving Ground Aberdeen, Maryland Attn: Technical Information Section Development and Proof Services	1
Commander, Operational Development Force U. S. Atlantic Fleet, U. S. Naval Base Norfolk 11, Virginia	1
Naval Ordnance Laboratory	1
Naval Ordnance Laboratory Attn: Explosives Division	1
Picatinny Arsenal, Dover, N. J. Attn: Technical Division	1
Reports Office APL/JHU, Silver Spring, Maryland	1
APL/JHU, Silver Spring, Maryland Attn: Mr. H. S. Morton (Via INSORD, Silver Spring, Md.)	1

CONFIDENTIAL
SECURITY INFORMATION

CONFIDENTIAL

NPG REPORT NO. 1063

Comparison of Lethal Fragments from
Brandt 120mm Mortar and 4.2 Mortar Shell M329

DISTRIBUTION (Continued)

Inst. for Cooperative Research JHU/1315 St. Paul St. Via: (District Chief, Phila. Ord District 1500 Chestnut St., Phila. 2, Pa. Attn: Mr. Edward R. C. Niles)	1
Commanding Officer Frankford Arsenal Phila. 37, Pa.	1
Commandant of the Marine Corps Headquarters, USMC Washington 25, D. C.	2
President, Marine Corps Equipment Board Quantico, Va.	2
Local:	
OT	1
OTZ	1
OT-1	1
File	1

CONFIDENTIAL
SECURITY INFORMATION