UNCLASSIFIED

AD NUMBER

AD385060

CLASSIFICATION CHANGES

TO: UNCLASSIFIED
FROM: CONFIDENTIAL

LIMITATION CHANGES

TO: Approved for public release; distribution is unlimited.
FROM: Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; MAY 1957. Other requests shall be referred to Picatinny Arsenal, Dover, NJ.

AUTHORITY

ARRADCOM ltr 13 feb 1980 ; ARRADCOM ltr 13 feb 1980

THIS PAGE IS UNCLASSIFIED
AD- 385060

SECURITY REMARKING REQUIREMENTS

DCU 8206.1-0, DEC 76

REVIEW ON 30 APR 77
THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE,

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.
SECURITY MARKING

The classified or limited status of this report applies to each page, unless otherwise marked. Separate page printouts MUST be marked accordingly.

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.

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.
A COMPARISON OF PHOENIX, CLAYMORE, AND IMPROVED CLAYMORE ANTI-PERSONNEL EFFECTIVENESS

DATE: MAY 1957

ORDNANCE PROJECT NO. TA3-5920
A COMPARISON OF
PHOENIX, CLAYMORE
AND
IMPROVED CLAYMORE
ANTI-PERSONNEL
EFFECTIVENESS
BY
B. KARIN

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C. § 793. The transmission or disclosure of this document to any unauthorized person is prohibited by law.

Picatinny Arsenal, Dover, N.J
Samuel Feltman Laboratories
Ammunition Development Lab B
Technical Memorandum DA-2
May 1957

In addition to security reasons, this document and must be held in strict confidence of the U.S. Government.

CONFIDENTIAL
REGRADING DATA CANNOT BE PREDETERMINED

SUBMITTED BY:
B. KARIN

REVIEWED BY:
J. H. ROBINSON

APPROVED BY:
V. LINDNER

CONFIDENTIAL
FOREWORD

This report is a comparison of three different systems for providing anti-personnel firepower to the troops in the field. The conclusion that one of the systems, namely the T48E1, is superior, is based on an analytical approach and requires experimental verification.

V. Lindner
Chief, Amm Dev Lab B

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.
The Phoenix, Claymore (T48 Mine), and improved Claymore (T48EL Mine) are analysed for anti-personnel Lethality capability. It is found that the T48EL is best, with the T48 and Phoenix following in that order.

Performance of the three weapons at various ranges up to 200 ft is determined and discussed.
The Claymore (T48 Mine), the Improved Claymore (T48E1 Mine), and the Phoenix are directional anti-personnel mines (or fougasses) designed primarily for defense against mass human wave infantry attack. Each of the three devices comprises a doubly curved surface of preformed fragments backed up with a layer of high explosive. The weapons are usually emplaced several inches above ground with the fragmenting surface facing the direction from which an attack is expected. Upon detonation of the HE, the fragments are propelled out in a fan shaped pattern of about 60° angle and almost parallel with the ground.

The T48 Mine and its successor, the T48E1, are US developments; the Phoenix is a similar Canadian device. Figs. 1 and 2 show photographs of the Phoenix and the T48 Mines respectively. At this writing the T48E1 is still under development, hence no photographs are available. However, the T48E1 is of the same general configuration as the other two, differing only in specific design details.

It is the purpose of this Memorandum to present comparative anti-personnel Lethality characteristics of the three weapons, utilizing the new casualty data issued by the BRL (Ref a).
FIG. I

M-48152/1 July 1956 PICATINNY ARSENAL


CONFIDENTIAL
All 3 mines were analyzed in a similar manner, utilizing the basic Lethality analysis procedures given in Refs. b, c, and d.

A. Probability of Disablement - $P_k$

The values of $P_k$ were computed between 0 and 200 feet range in 10 foot increments in the following manner:

1. $P_k = 1 - e^{-E_k}$

1a. $E_k = P_{hk} \frac{NH^2}{A_t}$

1b. $N = \text{Number of fragments in the mine}$

1c. $\theta = \text{Horizontal spray angle - radians}$

1d. $X = \text{Range - distance from ground zero - ft}$

1e. $A_t = \text{Area of standing Human Target} = 4.5 \text{ ft}^2$

1f. $K = \text{Fragment per unit area factor}$

For purposes of calculation, it was assumed that 85% of the fragments were randomly distributed in a 7 foot high band at all ranges. (The 85% figure is based upon data on the Phoenix given in Ref. g.). Therefore,

$$K = \frac{0.85}{7}$$

1g. $P_{hk} = \text{single hit disablement probability per the 30 sec. assault casualty criterion given in Ref a.}$ The Lethality Chart, revised 6 Feb 57 (Ref e.), which incorporate data of Ref a, was utilized for all $P_{hk}$
determinations.

B. Lethal Arc

In addition to \( P_k \), values of \( S_L \), Lethal Arc, were also determined at ranges from 0 to 200 ft. The term "Lethal Arc" is an index of the number of casualties inflicted by the weapon at a given range. This term is analogous to the more usual casualty index, "Lethal Area". Lethal Area is proportional to the number of casualties inflicted on targets in an area; Lethal Arc is proportional to the number of casualties inflicted on targets along an arc centered at ground zero. This latter case more closely approximates the actual condition in a human wave attack. (For a more detailed discussion of Lethal Arc vs. Lethal Area, the reader is referred to Tech Memo BD-2, Ref b).

2. \( S_L = P_k \times x \)

C. Lethal Area

While curves of Lethal Arc are believed to be more valid bases for comparison of anti-human wave munitions, Lethal Area data have been computed as well:

3. \( A_L = \int_{0}^{x} S_L dx \)
CALCULATION PARAMETERS AND ASSUMPTIONS

A. Spray Angle
   All mines were assumed to yield a 60° horizontal spray angle.

B. Fragments

<table>
<thead>
<tr>
<th>Shape</th>
<th>TJF</th>
<th>TAFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix</td>
<td>Cubes</td>
<td>Cubes</td>
</tr>
<tr>
<td>Numbers</td>
<td>250</td>
<td>675</td>
</tr>
<tr>
<td>Weight</td>
<td>31</td>
<td>13</td>
</tr>
<tr>
<td>Grains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Weights - lbs

<table>
<thead>
<tr>
<th>Shape</th>
<th>TJF</th>
<th>TAFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Frags</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Expl</td>
<td>1.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>

D. Initial-Velocities

<table>
<thead>
<tr>
<th>Shape</th>
<th>TJF</th>
<th>TAFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4630 fps</td>
<td>3565 fps</td>
<td>4852 fps</td>
</tr>
</tbody>
</table>

The above velocities were computed from the Gurney Formula:

\[ V_0 = 8800 \sqrt{\frac{C/M}{C/M + 5 + 2M/C}} \]

4a. \( C \) = Explosive Weight
4b. \( M \) = Fragments Weight

The value thus obtained for the TAF Mine checks closely with experimental data reported in Ref h. In view of this, theoretical Gurney Velocities would appear reasonable for the other two weapons, for which no experimental data...
are available. For the case of the T4E1, where voids occur between spheres, this was considered in computing velocity i.e. only the column of explosive actually backing each sphere was considered effective. The scheme of this calculation was devised by Dr. J. Bledsoe of Aerojet-General and is covered in Ref f.
RESULTS

Comparison curves of kill probabilities, Lethal Arc and Lethal Area for all three mines are given on figures 3, 4 and 5 respectively. It should be noted that the assumption of a single pattern height (7 feet) at all ranges results in somewhat optimistic data for distances greater than design range for this pattern height. Inasmuch as the fragments fan out vertically as well as horizontally, strictly speaking a specific height of pattern would only apply at one range. At greater ranges the fragment density is actually lower than that calculated and \( P_k \), \( S_L \) and \( H_L \) would be correspondingly lower. This 7 foot high pattern assumption, however, is believed to have little effect for comparative purpose. If anything, the curves err in favor of the Phoenix. Its design range for a 7 foot pattern is 105 feet, whereas, the T48's is 122 feet, and the T48EL 7 foot high range is to be 150 feet.
COMPARATIVE EFFECTIVENESS
OF PHOENIX, CLAYMORE (T48)
& IMPROVED CLAYMORE (T48EI)
DISABLEMENT PROBABILITY (P_k)
VS RANGE (X)

TECH MEMO DA-2
FIG 3

CONFIDENTIAL

REMARK: DATA CANNOT BE PREDETERMINED
COMPARATIVE EFFECTIVENESS
OF PHOENIX, CLAYMORE (T48)
& IMPROVED CLAYMORE (T48EI)

RELATIVE NUMBER OF CASUALTIES
VS. RANGE (X)

T48 CASUALTIES = 100

PHOENIX
T48
T48EI

TECH MEMO DA-2

FIG 6
COMPARATIVE EFFECTIVENESS
OF PHOENIX, CLAYMORE (T48)
& IMPROVED CLAYMORE (T48EI)

LETHAL AREA (AL)
VS RANGE (X)

PHOENIX
T48
T48EI
TECH MEMO DA-2

FIG 5

CONFIDENTIAL
NEGATING DATA CANNOT BE PREDETERMINED
DISCUSSION OF RESULTS

A review of Fig. 3, 4, and 5 indicates that all three weapons have some effectiveness against personnel out to 200 feet and beyond. As expected each suffers a decrease of $P_k$ with increasing range.

It should be noted that by any of the three measures of effectiveness, \( P_k \), \( S_L \), or \( A_L \), the order of effectiveness is T48EL, T48, and Phoenix.

An interesting sidelight is the fact that the T48 performs better than the Phoenix, despite a significantly lower initial velocity. This is undoubtedly due to the relative number of fragments. While the Phoenix fragments are each individually more effective than the lighter T48 fragments, the relatively small number makes for very low density out at the longer ranges, this seriously compromising overall effectiveness.

It would be well to point out that Phoenix was originally designed for anti-material use in addition to antipersonnel capability, thus the higher fragment weight. The anti-material requirement has since been dropped.

Fig. 4, Lethal Arc vs. Range, probably gives the most realistic measure of effectiveness of the three weapons, inasmuch as Lethal Arc is a direct measure of the number of casualties inflicted by the mine. A review of the curves indicates that the T48EL is markedly superior at longer ranges.

To give a better picture of relative effectiveness, the data of Fig. 4 have been replotted on Fig. 6. Utilizing the T48 Mine as a base, the number of casualties inflicted by the T48 at any range is referred to as 100. The other two curves indicate the relative number of casualties inflicted by the Phoenix and T48EL. For example, if under some condition of
target density at 150 foot range, the T48 Mine were to yield 100 casualties, then the T48El and Phoenix, used under identical conditions, would yield 127 and 90 casualties, respectively. Thus one might say that the T48El has 27% greater casualty inflicting potential than the T48, and the Phoenix is 10% less effective, at 150 feet. Similar conclusions could be drawn about relative effectiveness at other ranges.

Referring again to Fig. 4, Lethal Arc vs Range, it is probably these data which would most interest the using service. Among other things, these curves indicate the ranges at which the weapons can be used most effectively, i.e. inflict the greatest number of casualties. The optimum ranges are approximately 110, 115 and 130 feet for the T48, Phoenix and T48El respectively. It would be well to note, however, that all three curves are quite flat in the peak region, indicating that the weapons could be used over a wide range spread without compromising Lethality. For example, if the T48El were used against a human wave at 180 foot range, the number of casualties inflicted at that range would be only 10% less than the maximum possible number of casualties (at 130 feet). The flat peaking characteristic thus allows for use under a wide variety of field conditions, while still realizing almost full casualty inflicting potential of the weapon.
CONCLUDING REMARKS

It should be noted that the design of the T4RE1 Mine is still tentative. The analysis herein concerns itself with the design which evolved from an Aerojet-General Corp. analysis of various possible configurations to optimize effectiveness at 50 yards. (Ref f) Testing of this design has not been completed, as yet. The calculations on the T4RE1 are thus based upon predicted performance, and may require revision at some later date. In this connection, it is planned to perform comparative fragmentation pattern and velocity tests of all three weapons during the Final Engineering Tests of the T4RE1. These tests are scheduled for early in 1982. When the test data become available, the Lethality curves herein will be recomputed.
ACKNOWLEDGMENT

The Author wishes to express his appreciation to Mr. J. E. Clausen and Mr. L.P. Nichols for their assistance during the preparation of this Memorandum.
REFERENCES


b. Karin, B. Some notes on a Lethality Criterion for Anti-Human Wave Ammunition, SFAL Tech Memo BD-2, January 1957


d. Karin, B. Fundamentals of Lethality of Antipersonnel Weapons, PA R&D Lecture No. 73, April 1955

e. Karin, B. Lethality Chart, SFAL Revised 6 Feb 1957


"RELEASE OR COMMUNICATION TO FOREIGN GOVERNMENTS OR THEIR NATIONALS IS NOT AUTHORIZED", AUTHORITY: FCO 3IR 5720.20 dated 26 MARCH 1965.