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**AUTHORITY**

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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

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

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REGRADING DATA CANNOT BE PREDETERMINED
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
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. 1


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FIG. 2

T48 AntiPersonnel Mine
("Claymore")
ANALYTICAL PROCEDURE

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. \( E_k = P_{hk} \frac{N \tan \theta}{A_t} \)

1b. \( N = \) Number of fragments in the mine

1c. \( \theta = \) Horizontal spray angle - radians

1d. \( X = \) Range - distance from ground zero - ft

1e. \( A_t = \) Area of standing Human Target - 4.5 ft\(^2\)

1f. \( K = \) 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. \( P_{hk} = \) 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. $S_L = P_k \theta x$, 

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

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<th>T/8EL</th>
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<tbody>
<tr>
<td>Shape</td>
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<tr>
<td>Numbers</td>
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<td>675</td>
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<tr>
<td>Weight Grains</td>
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C. Weights - lbs

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<tr>
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<th>T/8EL</th>
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<tbody>
<tr>
<td>Total</td>
<td>2.5</td>
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<tr>
<td>Frags</td>
<td>1.1</td>
<td>1.2</td>
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<tr>
<td>Expl</td>
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<td>0.8</td>
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D. Initial Velocities

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<th>T/8EL</th>
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<tbody>
<tr>
<td>Phoenix</td>
<td>4630 fps</td>
<td>3565 fps</td>
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The above velocities were computed from the Gurney Formula:

4. \( V_0 = \frac{8800}{\\sqrt{C/M}} \sqrt{C/M + 5 + \frac{1}{2} M/V} \)

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 \( A_L \) 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 165 feet, whereas, the TA's is 122 feet, and the TA8E1 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

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

LETHAL ARC (SL) VS RANGE (X)

PHOENIX
T48
T48EI

TECH MEMO DA-2
FIG 4
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 T48E1 and Phoenix, used under identical conditions,

would yield 127 and 90 casualties, respectively. Thus one might say that
the T48E1 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. inflect the greatest number of casualties. The optimum
ranges are approximately 110, 115 and 130 feet for the T48, Phoenix and
T48E1 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 T48E1 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.
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CONCLUDING REMARKS

It should be noted that the design of the T48E1 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 T48E1 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 T48E1. These tests are scheduled for early in 1958. When the test data become available, the Lethality curves herein will be recomputed.
ACKNOWLEDGEMENT

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REFERENCES


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


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


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