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TECHNICAL MEMORANDUM
NO. DA-2

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

DOWNGRADED AT 12 YEAR INTERVALS;
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BY: E. KARIN

PICATINNY ARSENAL
TECHNICAL INFORMATION SECTION

DATE: MAY 1957

COPY NO. 18 OF 40

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

BY

B. KARIN

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SUBMITTED BY: B Karin
B. KARIN

REVIEWED BY: J.H. Robinson
J.H.ROBINSON

APPROVED BY: V Lindner
V. LINDNER

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

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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

V. LINDNER
Chief, Amm Dev Lab B

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ABSTRACT

The Phoenix, Claymore (T48 Mine), and improved Claymore (T48E1 Mine) are analysed for anti-personnel Lethality capability. It is found that the T48E1 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.

INTRODUCTION

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 Memoradnum to present comparative anti-personnel Lethality characteristics of the three weapons, utilizing the new casualty data issued by the BRL (Ref a).

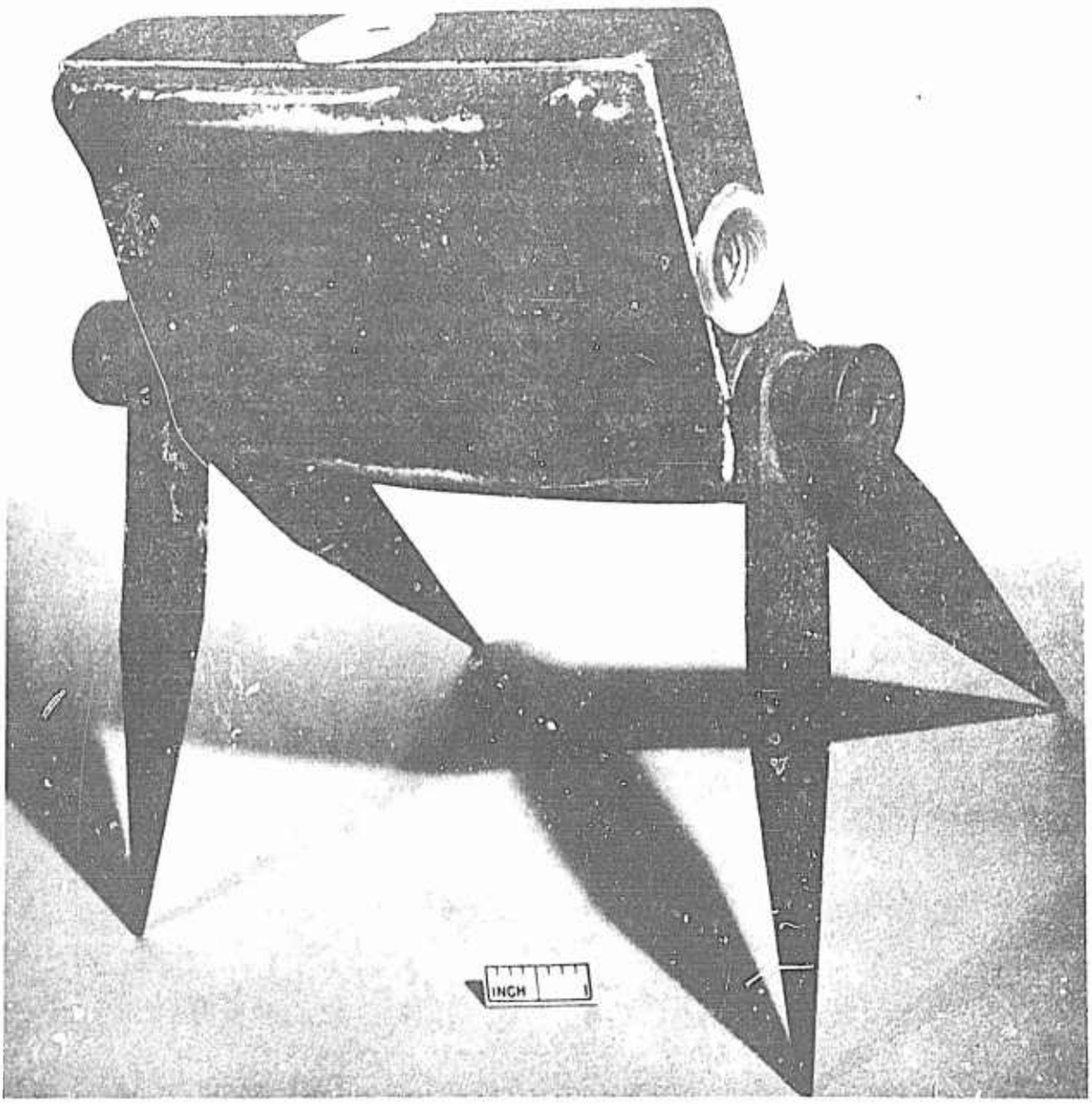

FIG. I

M-48152/1 July 1956 PICATINNY ARSENAL ORDNANCE CORPS

Canadian Phoenix Weapon, sample given to Picatinny Representative during June 26-28, 1956 trip to Camp Petawacva, Ontario.

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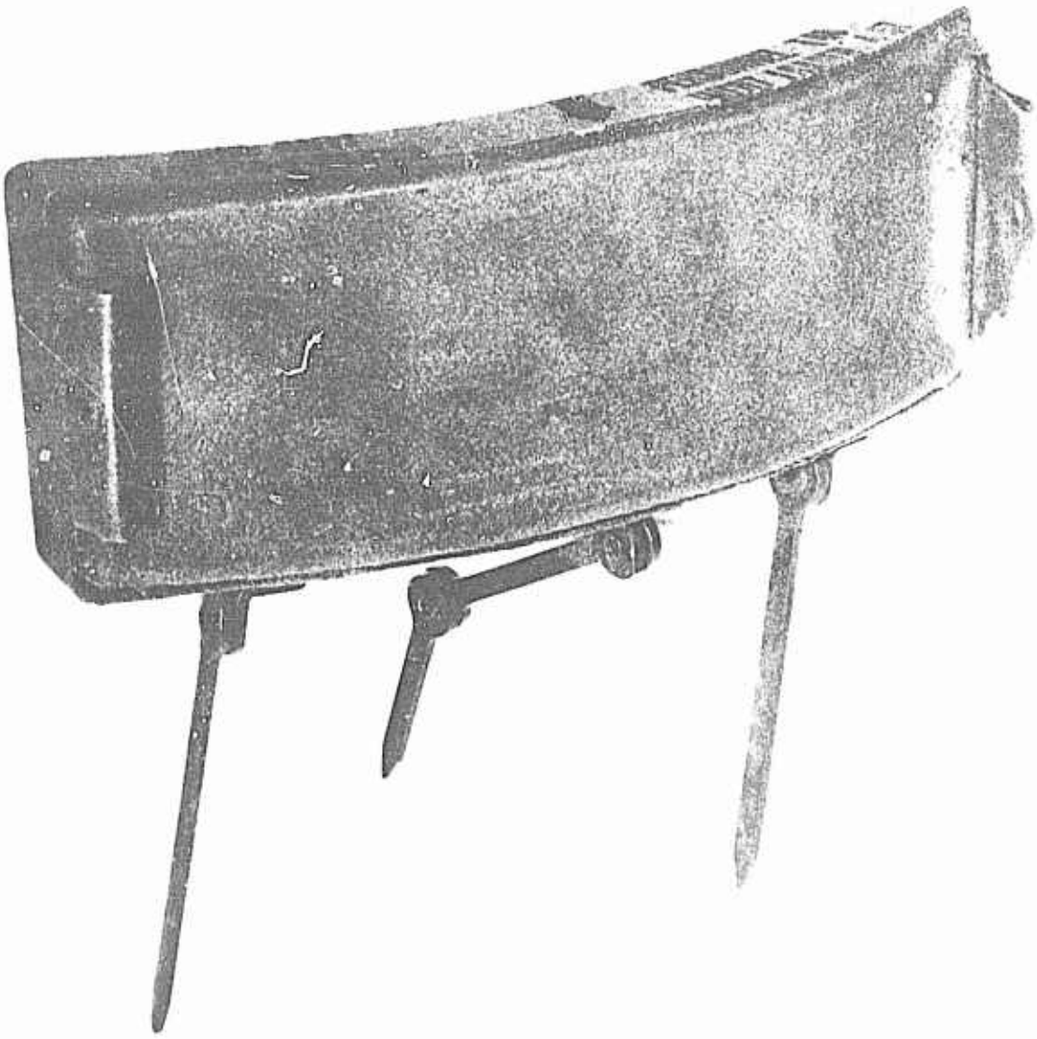


FIG. 2

M-50665	May 1957	PICATINNY ARSENAL	ORDNANCE CORPS
	T48	AntiPersonnel Mine ("Claymore")	CONFIDENTIAL

ANALYTICAL PROCEDURE

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

A. Probability of Disablement -Pk

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

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

1a. $E_k = P_{hk} \frac{NKA_t}{\theta x}$

1b. N = Number of fragments in the mine

1c. θ = 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,

$$K = \frac{.85}{7}$$

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 analagous 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

	Phoenix	T48	T48E1
Shape	Cubes	Cubes	Spheres
Numbers	250	675	684
Weight Grains	31	13	10.8

C. Weights - lbs

	Phoenix	T48	T48E1
Total	2.5	2.5	2.8(Estimated)
Frags	1.1	1.2	1.1
Expl	1.0	0.8	1.3

D. Initial-Velocities

Phoenix	T48	T48E1
4630 fps	3565 fps	4852 fps

The above velocities were computed from the Gurney Formula:

4. $$Vo = 8800 \sqrt{\frac{3C/M}{C/M + 5 + 4M/C}}$$

4a. C = Explosive Weight

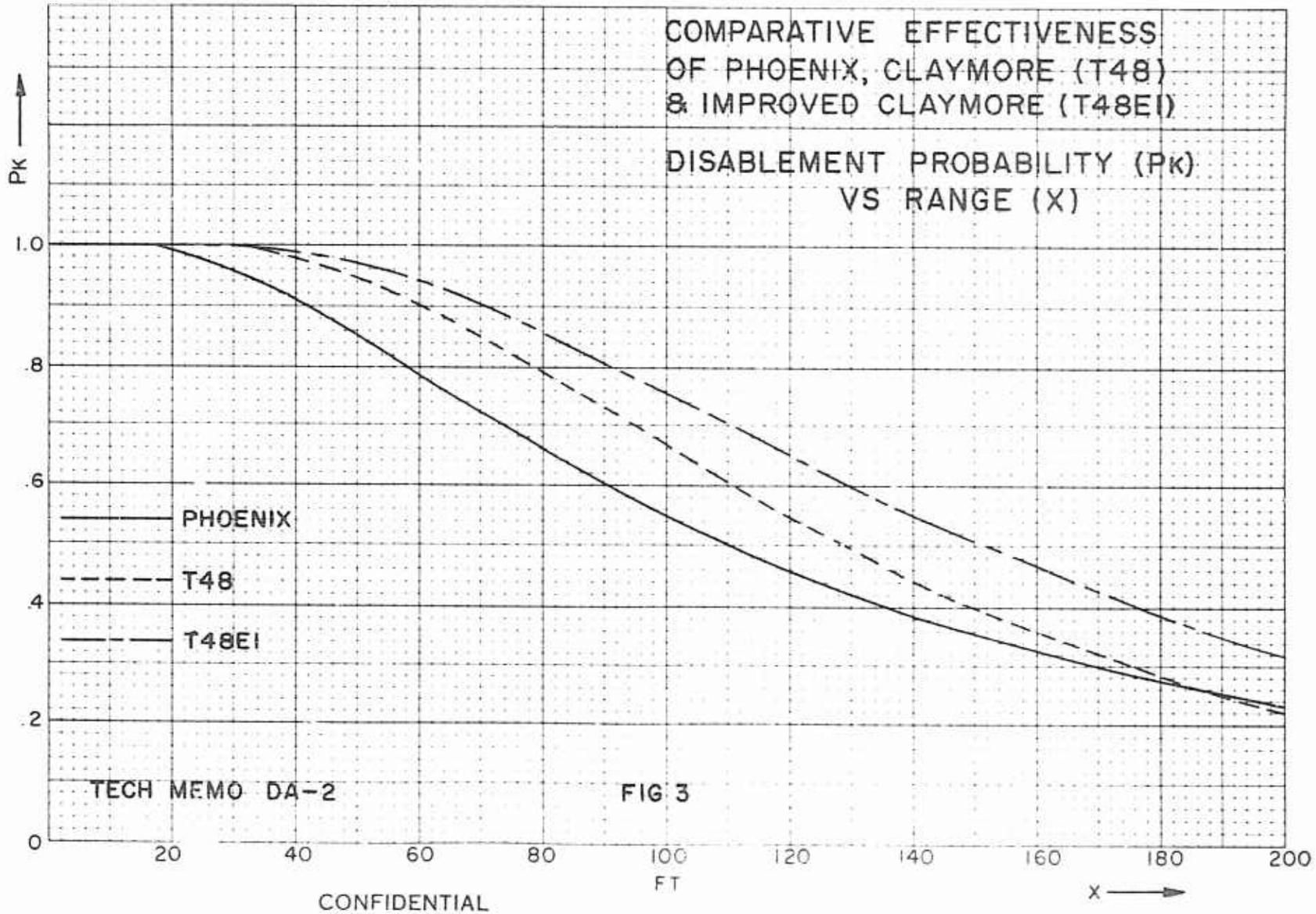
4b. M = Fragments Weight

The value thus obtained for the T48 Mine checks closely with experimental data reported in Ref h. In view of this, theoretical Gurney Velocities would appear reseaonable for the other two weapons, for which no experimental data

are available. For the case of the T48E1, 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 105 feet, whereas, the T48's is 122 feet, and the T48E1 7 foot high range is to be 150 feet.



TECH MEMO DA-2

FIG 3

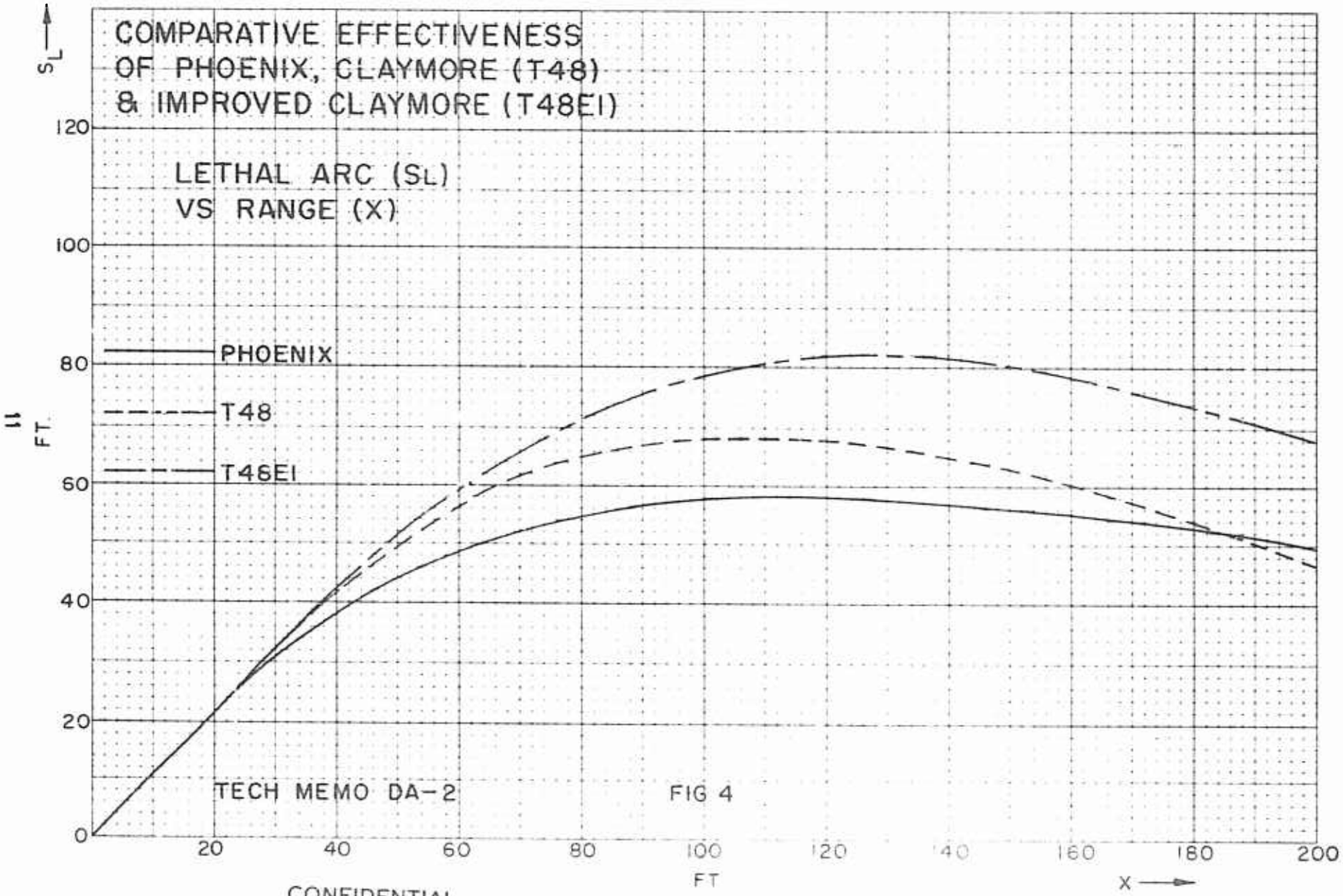


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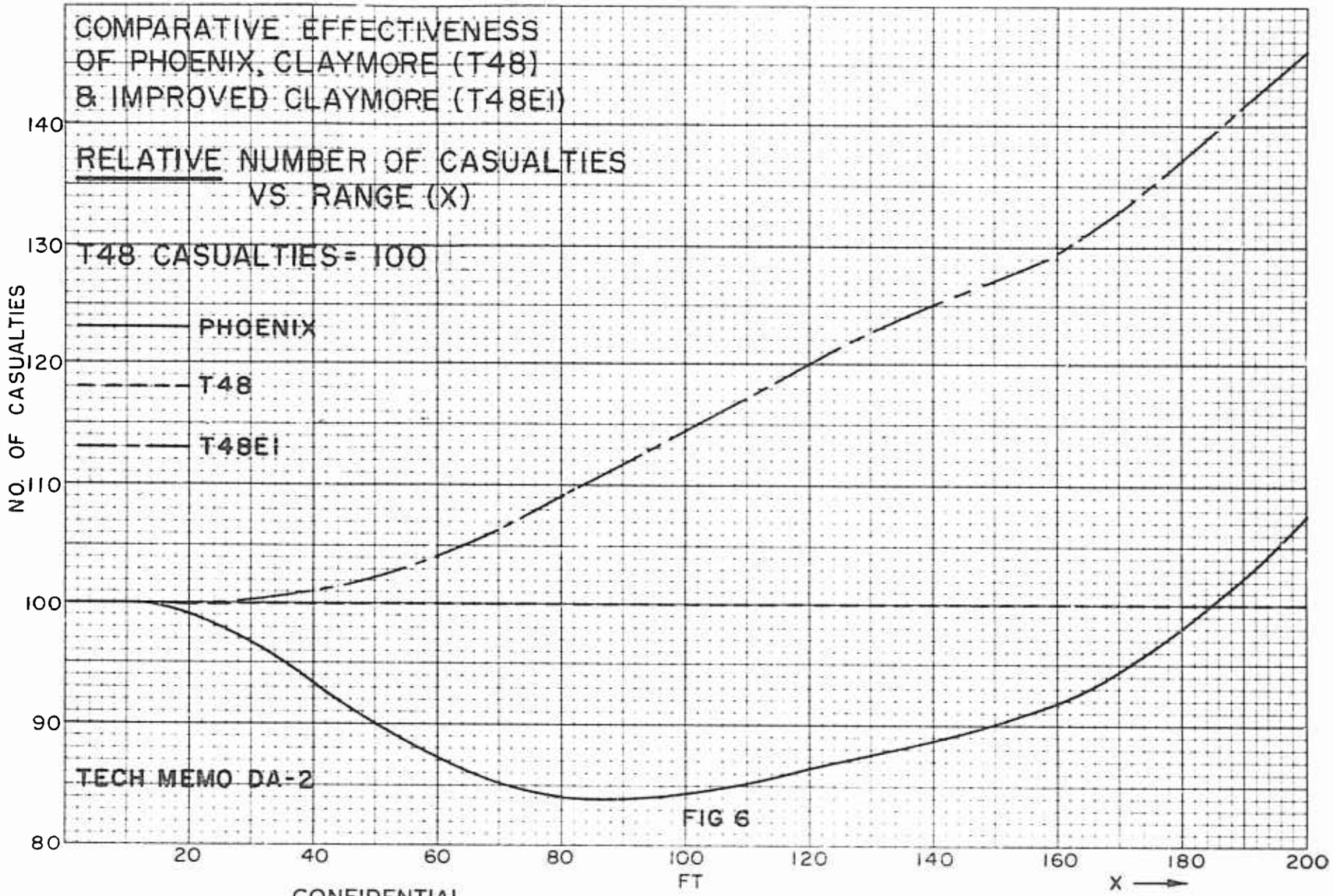
FIG 4


COMPARATIVE EFFECTIVENESS
OF PHOENIX, CLAYMORE (T48)
& IMPROVED CLAYMORE (T48E1)
RELATIVE NUMBER OF CASUALTIES
VS. RANGE (X)
T48 CASUALTIES = 100
PHOENIX
T48
T48E1
NO. OF CASUALTIES
140
130
120
110
100
90
80
20
40
60
80
100
120
140
160
180
200
FT
X
TECH MEMO DA-2
FIG 6

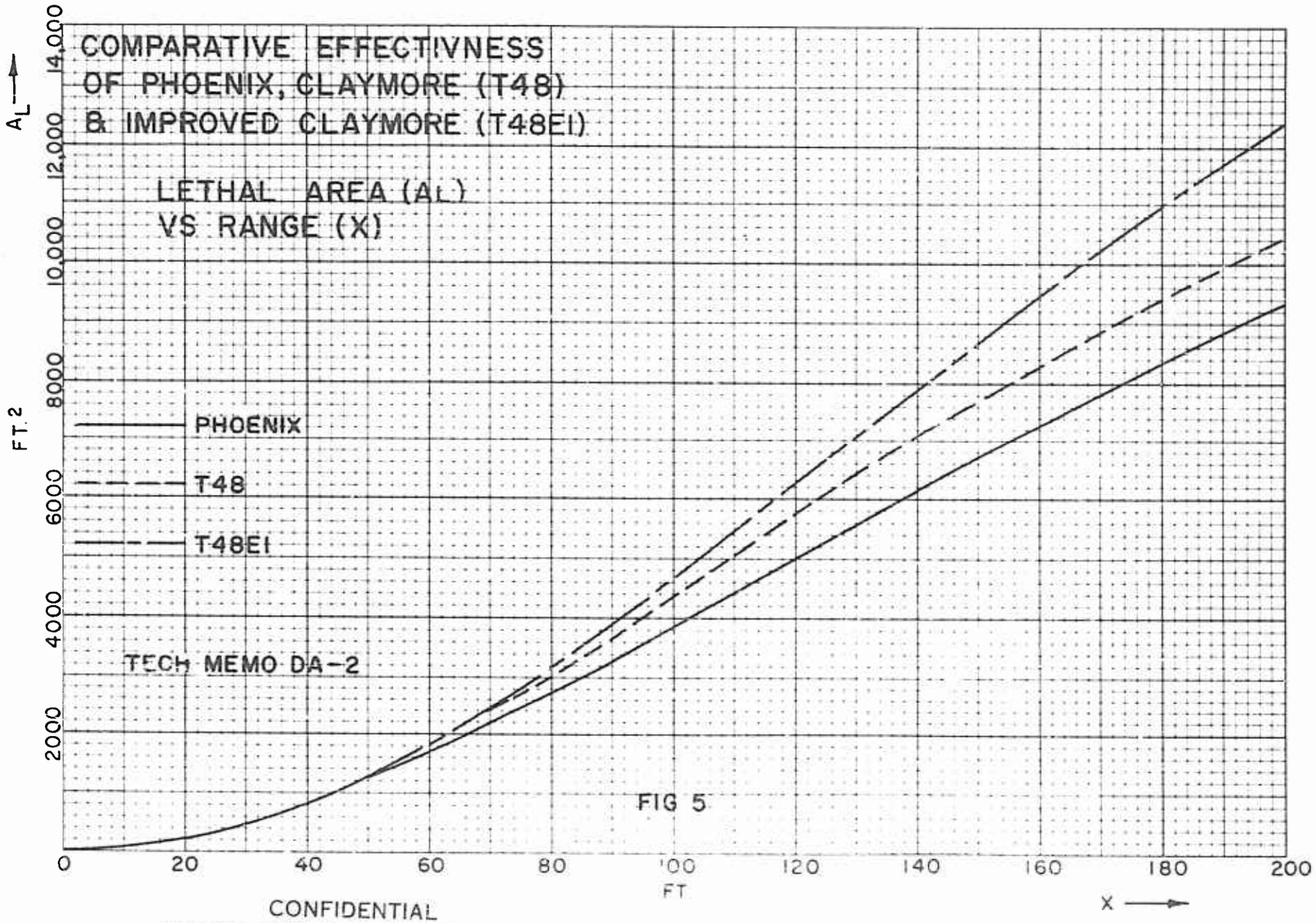

COMPARATIVE EFFECTIVNESS
OF PHOENIX, CLAYMORE (T48)
& IMPROVED CLAYMORE (T48E1)
LETHAL AREA (AL)
VS RANGE (X)
PHOENIX
T48
T48E1
TECH MEMO DA-2
A_L →
FT.2
2000
4000
6000
8000
10,000
12,000
14,000
0
20
40
60
80
100
120
140
160
180
200
FT
X →

FIG 5

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 T48E1, 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 undoubtly 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 efffectiveness.

It would be well to point out that Phoenix was orignally designed for anti-materiel use in addition to antipersonnel capability, thus the higher fragment weight. The anti-materiel 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 T48E1 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 T48E1. 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. inflict 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

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

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SUPPLEMENTARY

INFORMATION

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