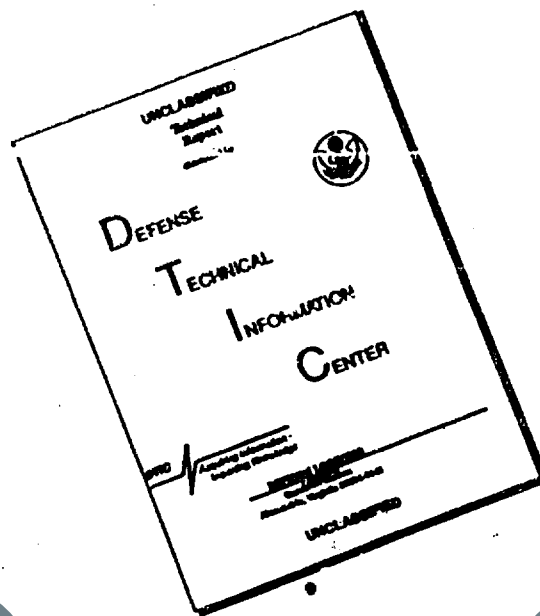


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BALLISTIC RESEARCH LABORATORIES HANDBOOK OF ENGINEERING DATA

Preface

For a number of years, the Ballistic Research Laboratories of Aberdeen Proving Ground have been making measurements of the characteristics of projectiles, propelling charges, etc. While these data are available in various Ballistic Research Laboratories reports, there is no single document which contains a concise tabulation of all the available information concerning the respective articles which have been subject to measurement. It was pointed out by Colonel H. H. Zornig that the utility of the information would be considerably enhanced if all acquired data were collected in a single document. Following Colonel Zornig's suggestion, the preparation of a handbook of such engineering data as are available at the Ballistic Research Laboratories has been initiated.

The first numbers written by Mr. H. P. Hitchcock deal with projectiles. Later additional series pertaining to propelling charges, guns, etc., will be prepared.

The number of an item in the handbook consists of three parts. The first part indicates the caliber, e.g., 6 in. or 155mm; the second indicates whether the item is a projectile, a propelling charge, or a gun; 1 denoting a projectile, 2, a propelling charge, and 3, a gun. The third part indicates the model (Arabic) or mark number (Roman numerals). Thus 155-1-III refers to the 155mm projectile MK III while 3-1-42 refers to the 3" shell M42.

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Ballistic Research Laboratories
Handbook of Ballistic and
Engineering Data for Ammunition,
No. 20-1-95

Ballistic Research Lab.
Aberdeen Proving Ground,
Maryland.
15 February 1949

BALLISTIC AND ENGINEERING DATA

for
Shot, AP, 20-mm, M95
with
Tracer

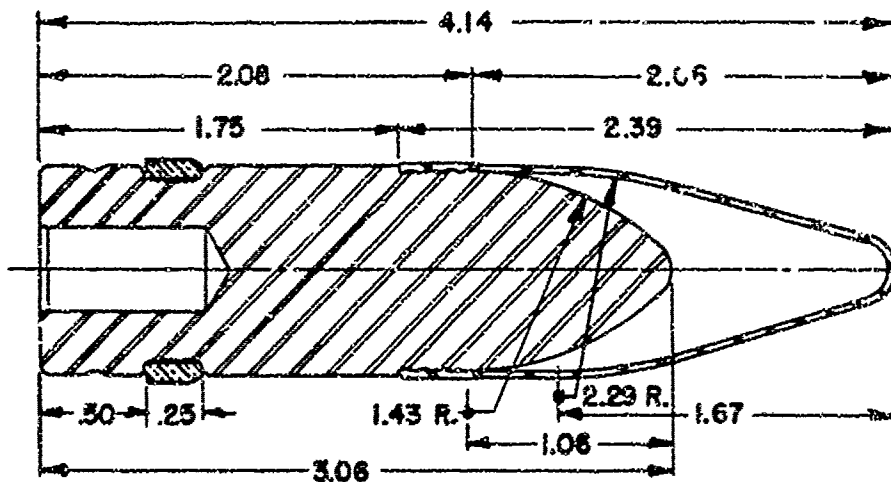
<u>Section</u>		<u>Paragraphs</u>
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II	Description -----	2 - 4
III	Interior ballistic data -----	5
IV	Exterior ballistic data -----	6 - 7
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SECTION I
GENERAL

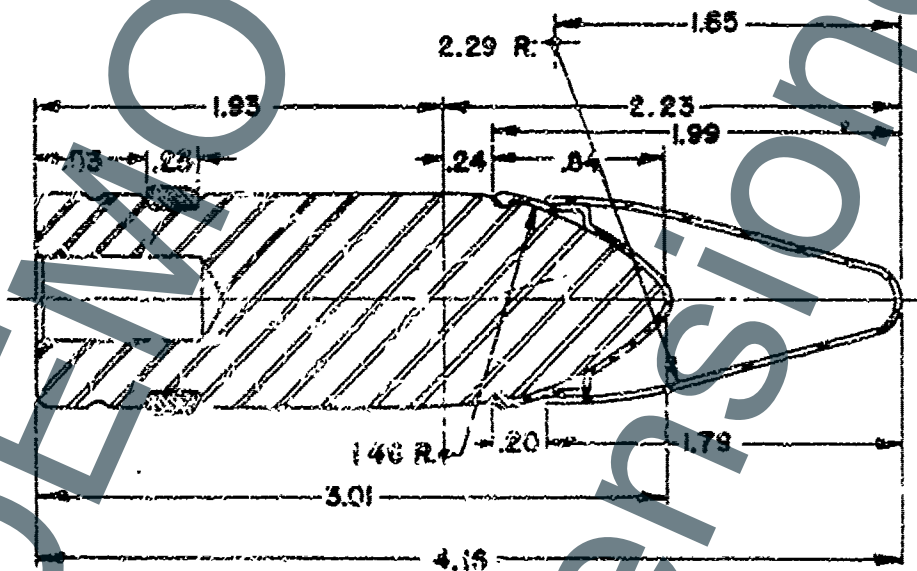
	<u>Paragraph</u>
Purpose -----	1

1. Purpose. The purpose of this number of the handbook is to furnish a concise collection of information regarding the shape, dynamics, ballistics and effects of the 20-mm armor-piercing Shot M95, which contains a tracer composition. Some data are also given for the experimental armor-piercing Shot T9E4 with Tracer, which is slightly different from the M95 (T9E5). This information is collected from the drawings, reports, and technical manuals pertaining to this ammunition.

ALL DIMENSIONS IN CALIBERS



SHOT, AP, 20-MM, M95



SHOT, AP, 20-MM, T9E4

SECTION III
INTERIOR BALLISTIC DATA

Theoretical yaw in bore - - - - -	<u>Paragraph</u> 5
-----------------------------------	-----------------------

5. Theoretical yaw in bore. For the AP Shot M95:

Minimum	18 min
Maximum	22 min

SECTION IV
EXTERIOR BALLISTIC DATA

Aerodynamic data - - - - -	<u>Paragraph</u> 6
Firing table data - - - - -	7

5. Aerodynamic data.

a. Drag. The drag coefficient plotted on page 5 was determined from resistance firings of the AP Shot T9E4 with Tracer at Mach numbers from 0.75 to 2.75. The data listed below were determined from time-of-flight firings of the AP Shot M95 with and without Tracer.

<u>AP Shot M95</u>	<u>With tr</u>	<u>w/o tr</u>
Velocity (fps)	3000	3000
Form factor (Projectile Type 5) i_5	1.12	1.15
Ballistic coefficient (Projectile Type 5) C_5	.413	.401
Drag coefficient K_D	.149	.153

b. Stability. A letter from the director of the Ballistic Research Laboratories to the Chief of Ordnance (APG 472.5/317-1821) gives data on the stability of the AP Shot M95 without Tracer. BRL Report No. 15, "Aerodynamics of 20-mm Projectiles", gives data on the stability of the AP Shot T9E4 with Tracer.

<u>AP Shot</u>	<u>M95 w/o tr</u>	<u>T9E4 with tr</u>
Velocity (fps)	2700	2750
Moment coefficient K_M	1.68	1.47
Twist of rifling $1/n$	1/25.586	1/25.586
Stability factor s	2.28	2.78

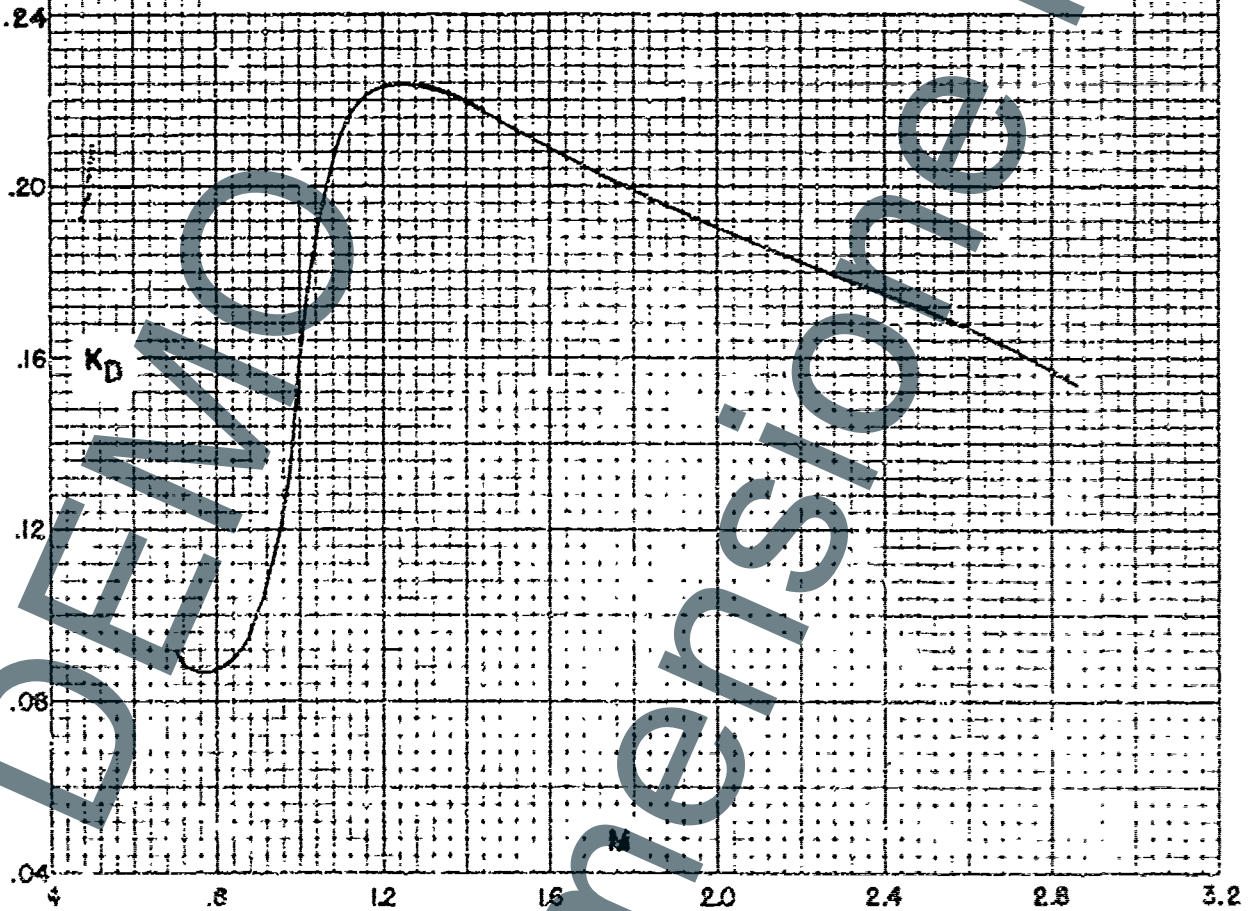
DRAG COEFFICIENT VS MACH NUMBER
SHOT, AP, 20-MM, T9E4

$$K_D = 0.1564 + 0.0670 \sin \theta$$

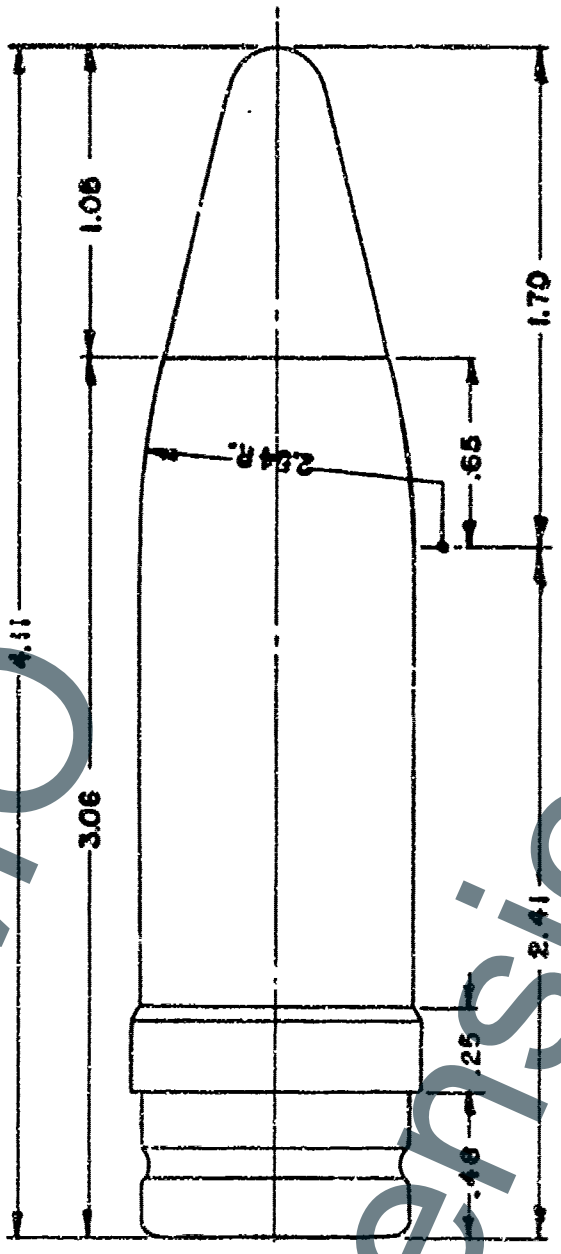
$$\theta = \frac{X}{0.04013 + \frac{10X^2}{\sqrt{1+1000X^2 + 360X^4}}} - \frac{100X^2}{10+882X^2} \text{ (RADI)}$$

$$X = 0.0005V - 0.555$$

$$V = 1120.27 M \text{ (FPS)}$$



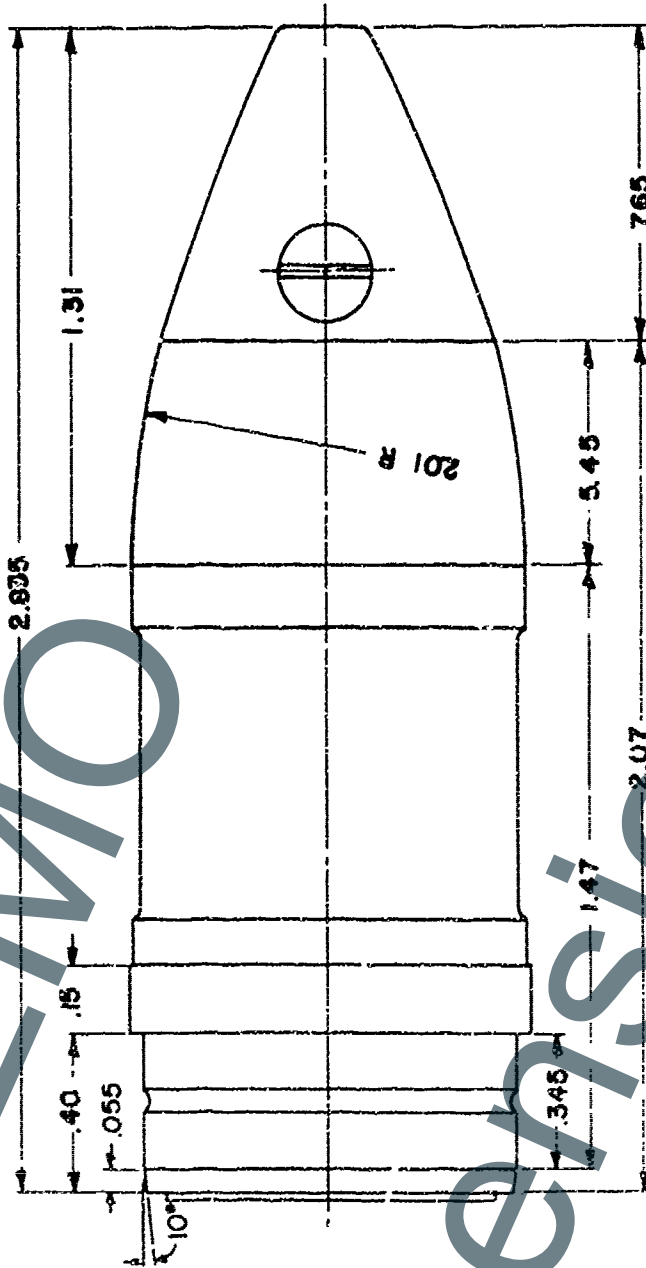
ALL DIMENSIONS IN CALIBERS
1 CAL. = 0.787"



SHELL, HEI, 20 MM, M97
FUZE, PD, M75

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ALL DIMENSIONS IN CALIBERS
1 CAL = 2.244"



SHELL, HE, 57-MM, M306
FUZE, PD, M89

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dimensione ridotta

SECTION II
DESCRIPTION

	<u>Paragraph</u>
Drawings - - - - -	2
Dimensions- - - - -	3
Physical characteristics - - - - -	4

2. Drawings.

Shell: Metal parts assembly and details	75-2-359
Fuze: Assembly and details	73-2-233
Details	73-2-234 and 235

3. Dimensions.

Chamfer: Angle	10°
Length	0.055 cal
Band: Distance from chamfer	0.345 cal
Distance from base	0.40 cal
Width	0.15 cal
Cylindrical body: Length	1.47 cal
Ogive: Length	0.545 cal
Radius of arc	2.01 cal
Fuze: Length (outside)	0.765 cal
Length: Shell	2.07 cal
Shell and fuze	2.835 cal
Ogive and fuze	1.31 cal

4. Physical characteristics.

Weight (standard)	2.75 lb
Weight (as tested) *	2.86 lb
Base to center of gravity	1.237 cal
Axial moment of inertia	2.18 lb. in ²
Traverse moment of inertia	8.89 lb. in ²

* See BRL Memo Reports 300 and 348D.

SECTION III

INTERIOR BALLISTIC DATA

Theoretical yaw in bore - - - - -	<u>Paragraph</u>
	5
5. Theoretical yaw in bore.	
Minimum	11 min
Maximum	18 min

SECTION IV

EXTERIOR BALLISTIC DATA

Aerodynamic data - - - - -	<u>Paragraph</u>
	6
Firing table data - - - - -	7

6. Aerodynamic data.

a. Drag.

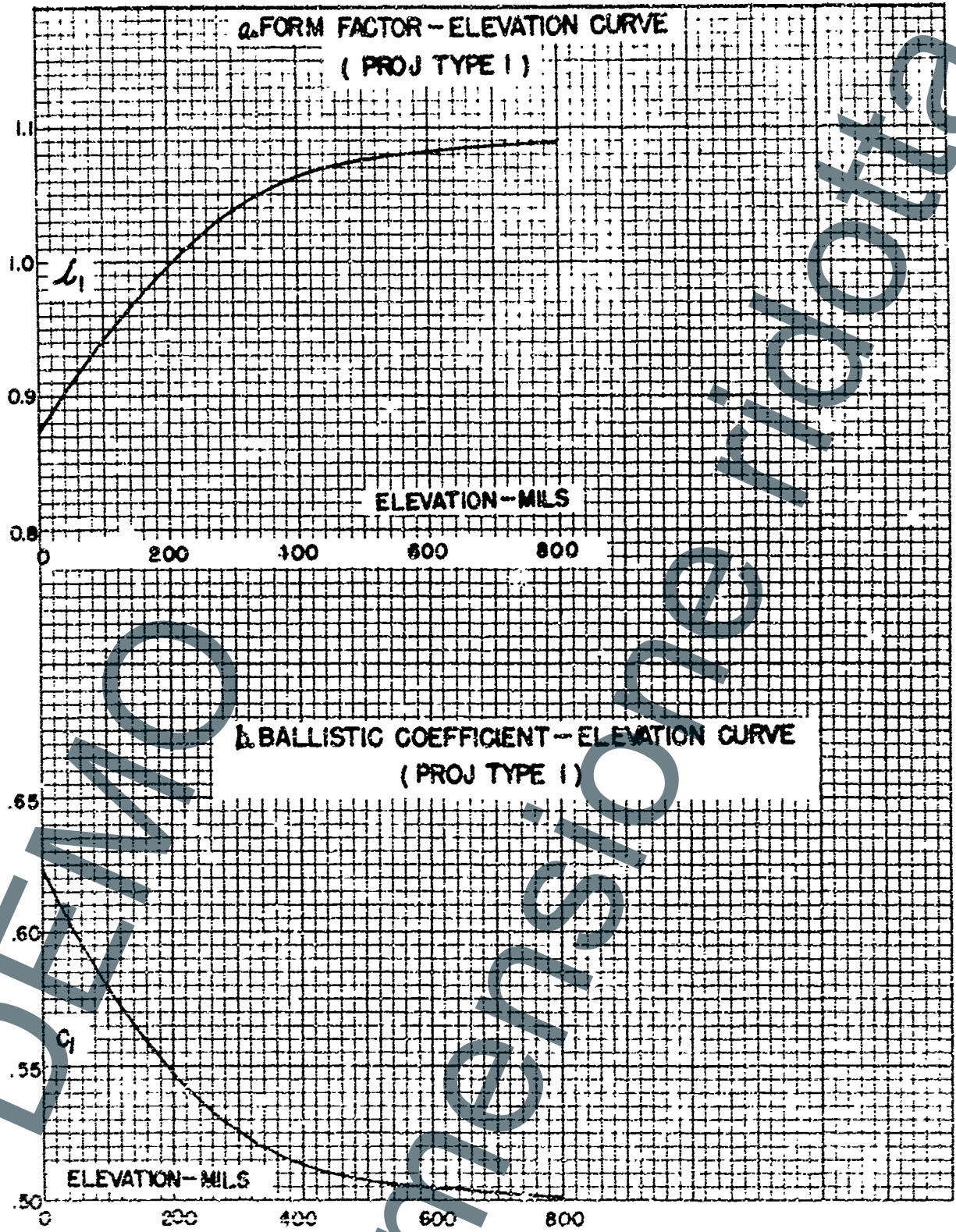
Drag function				G_1
Form factor (from time of flight)				0.86
Velocity (fps):	Muzzle	1200	Mean	978
Drag coefficient, K_D		0.191		0.105

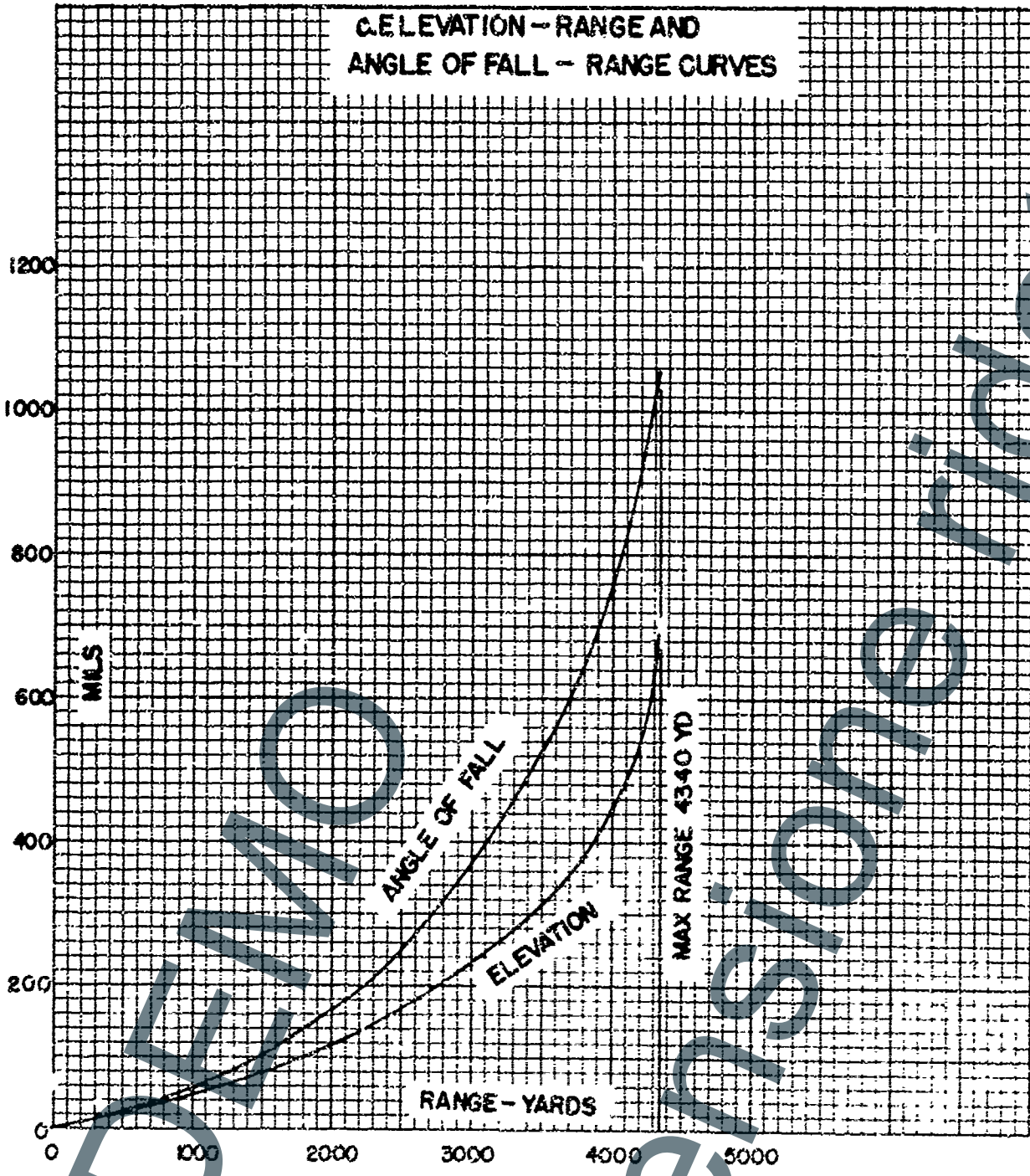
b. Stability. These data were obtained with the experimental Shell T22 with a PD Fuze; its physical characteristics are given in paragraph 4 (see Ballistic Research Laboratory Memorandum Reports No. 300 and 348D).

Muzzle velocity	1176 fps
Twist of rifling	1/30
Stability factor (standard)	1.62
Moment coefficient, K_M	1.31

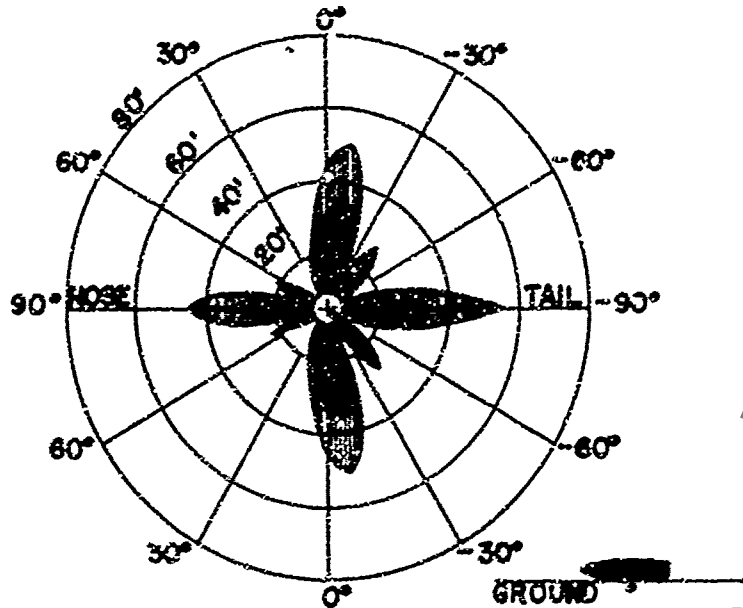
7. Firing table data. FT 57-E-1.

Rifle, 57-mm, M18. Twist of rifling: 1/30. Muzzle velocity: 1200 fps. OCM items 27443 and 28073 recommended and approved standardization of the HE Shell M306.

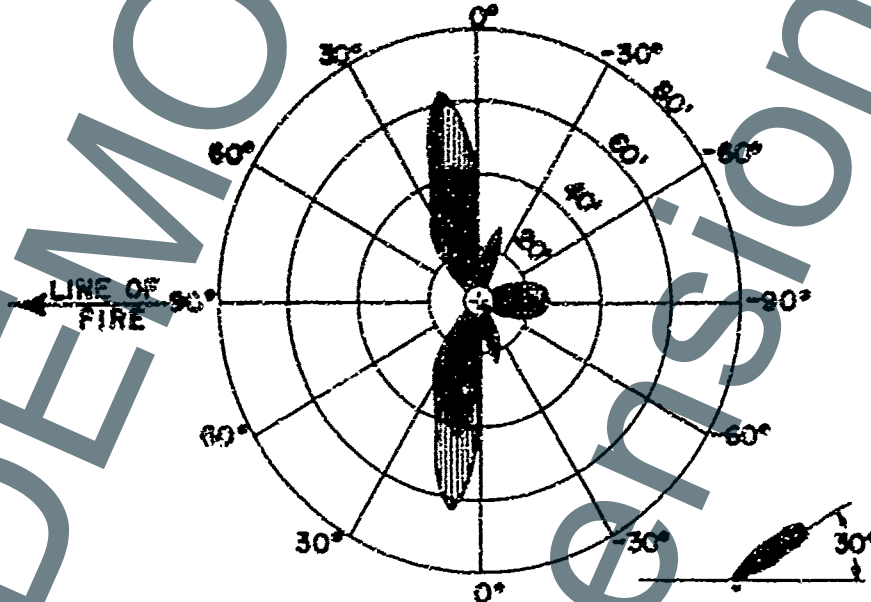




CASUALTIES
TANK GUNS



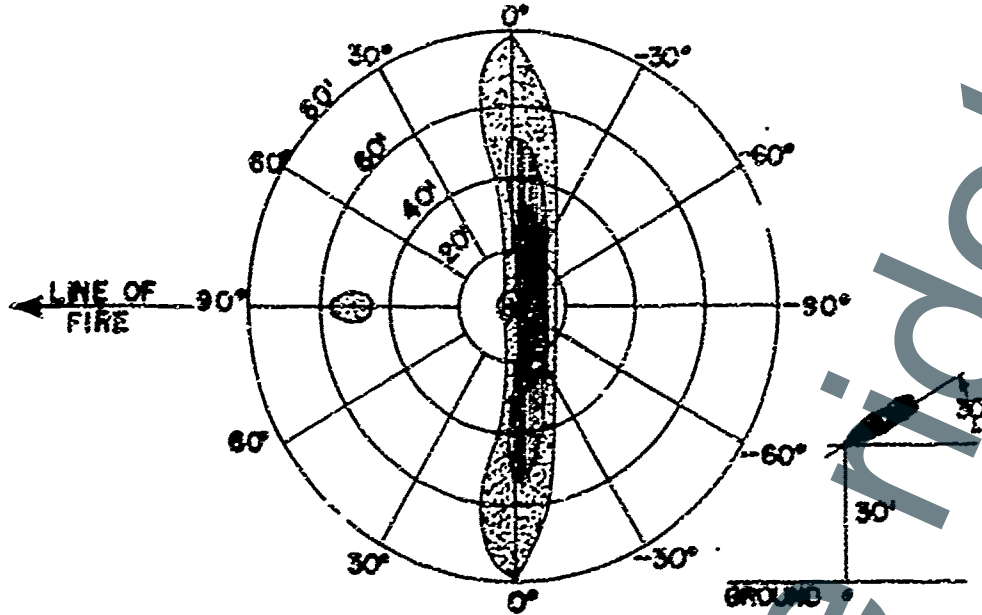
INCLINATION 0°
HEIGHT OF BURST 0 FT
REMAINING VELOCITY 0 FPS



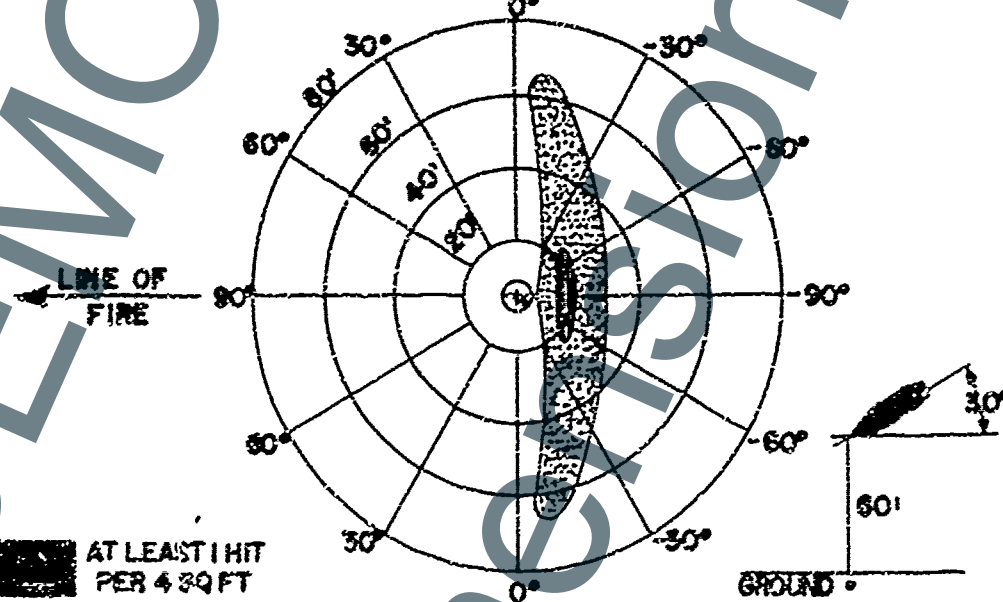
INCLINATION 30°
HEIGHT OF BURST 0 FT
REMAINING VELOCITY 800 FPS

 AT LEAST 1 HIT
PER 0.5 SQ FT
 AT LEAST 1 HIT
PER 4 SQ FT




**CASUALTIES
TANK GUNS**



**INCLINATION 30°
HEIGHT OF BURST 30 FT
REMAINING VELOCITY 800 FPS**



**INCLINATION 30°
HEIGHT OF BURST 60 FT
REMAINING VELOCITY 800 FPS**

-  AT LEAST 1 HIT PER 4 SQ FT
-  AT LEAST 1 HIT PER 10 SQ FT
-  AT LEAST 1 HIT PER 25 SQ FT

d. Perforation of 1/8-inch Mild Steel.

TABLE 39
PERFORATION OF 1/8 IN. MILD STEEL

Distance from burst (ft)	Total number of effective fragments	Average number of effective frag- ments per sq ft	For the lightest effective fragment	
			Weight (oz)	Velocity (fps)
r	N	B	m	v
20	534	0.108	0.049	2390
30	442	0.0391	0.065	2180
40	385	0.0192	0.082	2010
60	300	0.0068	0.127	1790
80	242	0.0030	0.185	1580
100	197	0.0016	0.253	1430
130	132	0.0008	0.375	1270
160	86	0.0003	0.509	1160
190	57	0.0001	0.655	1080
225	36	0.0001	0.820	1020

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SECTION V
EFFECT DATA

Fragmentation Paragraph 8

8. Fragmentation. The fragmentation of the F^W Shell M309 should be approximately the same as that of the HE Shell M48, of which it is a modification. For data on fragmentation of the M48 Shell, see BRLM 75-1-48.

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Ballistic Research Laboratories
Handbook of Ballistic and
Engineering Data for Ammunition,
No. 75-1-310

Ballistic Research Lab.
Aberdeen Proving Ground,
Maryland.
8 March 1949

BALLISTIC AND ENGINEERING DATA

for

Shell, HEAT, 75-mm, M310

with

Fuze, BD, M62A1 or M91

<u>Section</u>		<u>Paragraph</u>
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V	Effect data- - - - -	8

SECTION I

GENERAL

	<u>Paragraph</u>
Purpose - - - - -	1

1. **Purpose.** The purpose of this number of the handbook is to furnish a concise collection of information regarding the shape, dynamics, ballistics and effects of the 75-mm High Explosive Antitank Shell M310 with the Base Detonating Fuze M62A1 or M91. This information is collected from the drawings, reports, and firing tables pertaining to this ammunition.

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