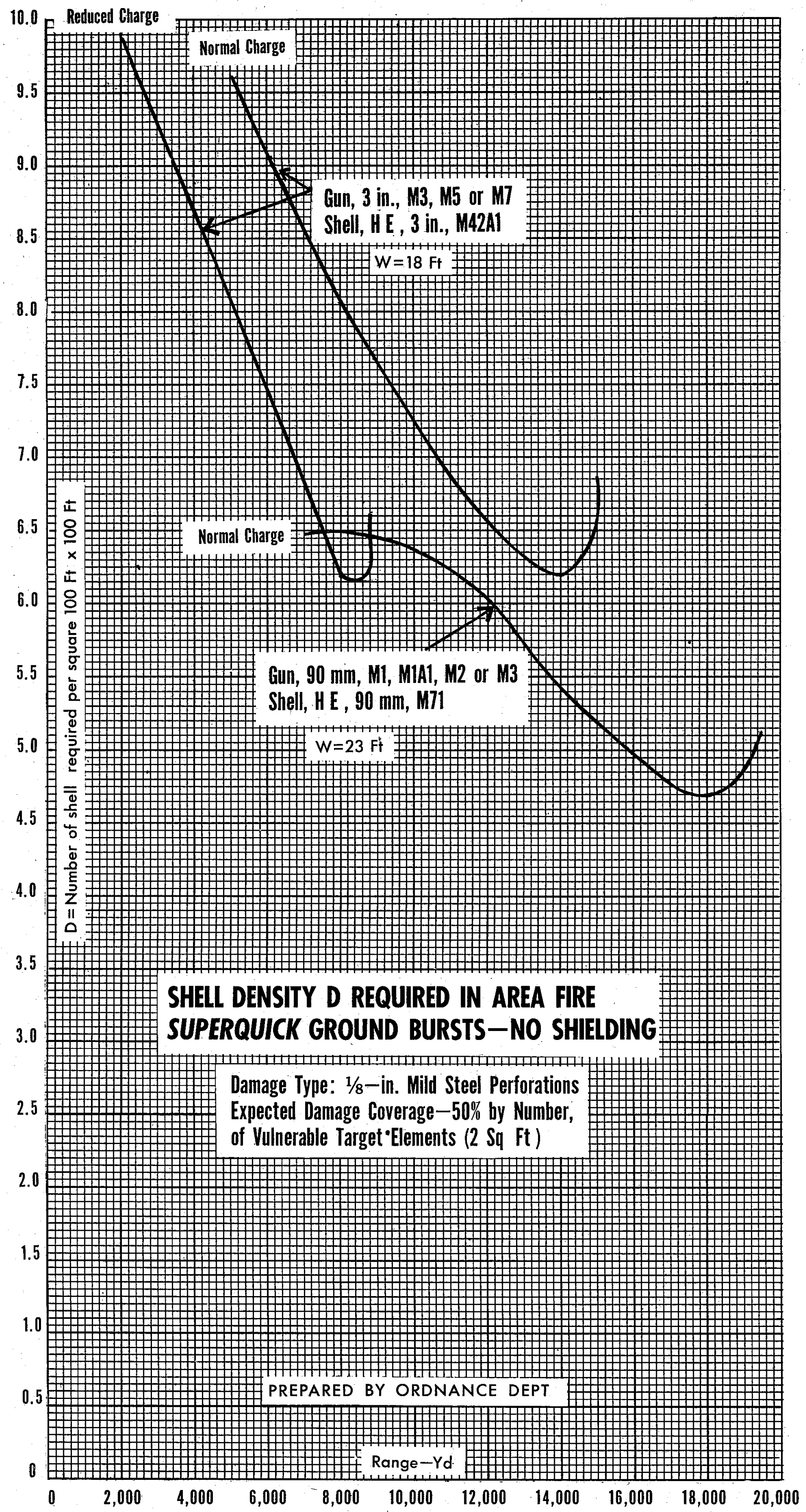
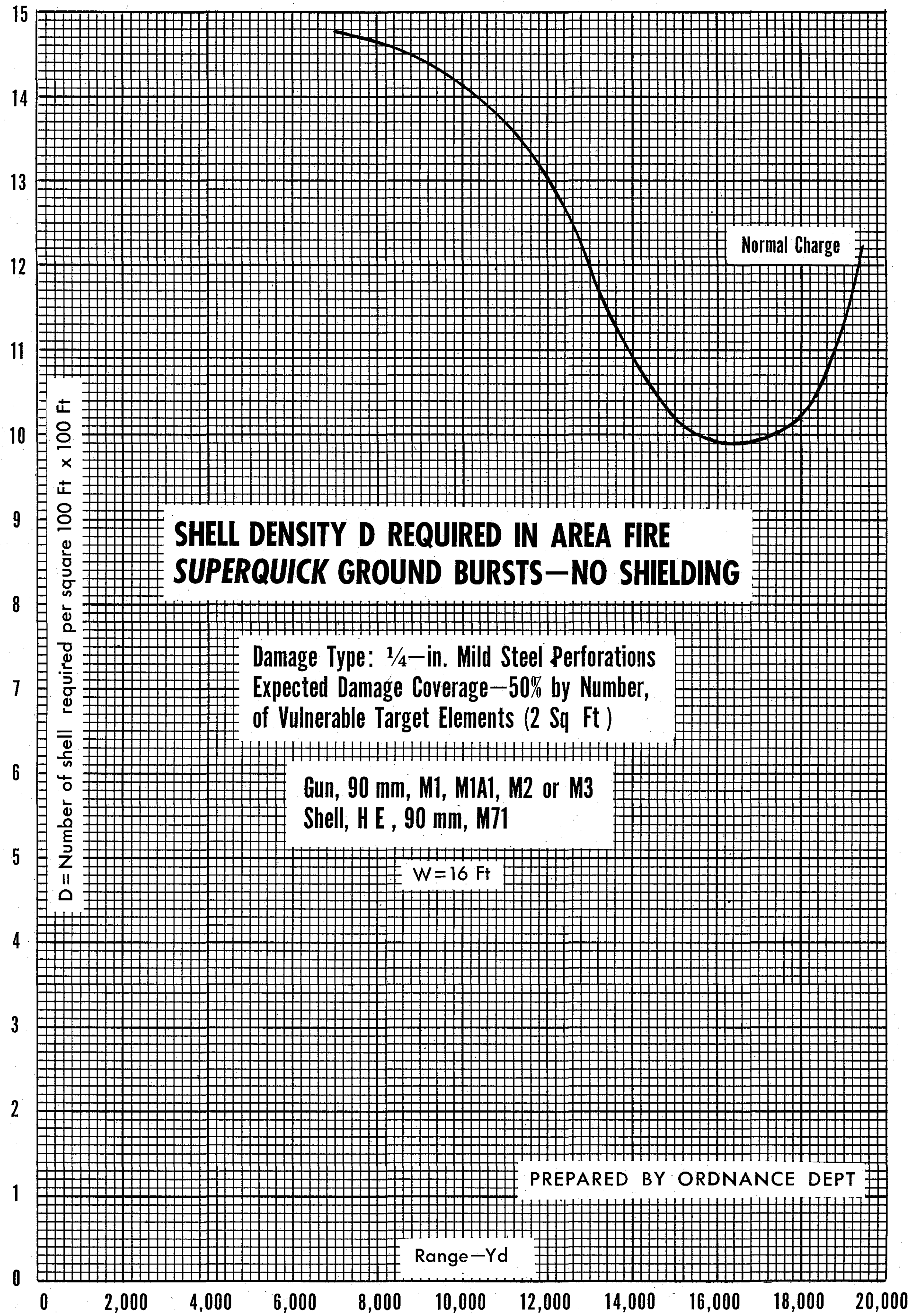


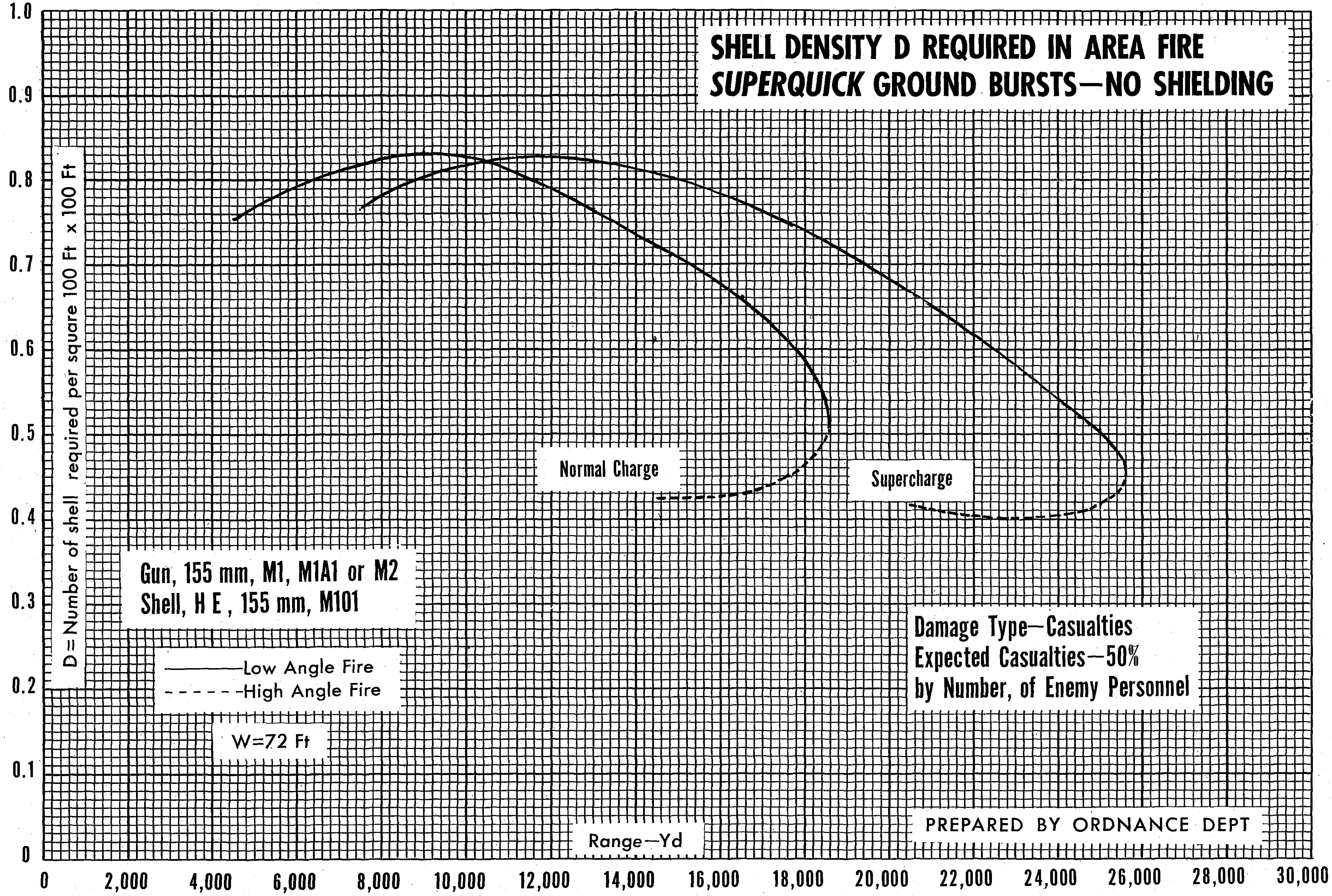
W=Width of fringe around target area requiring the burst density D.

FIGURE 30



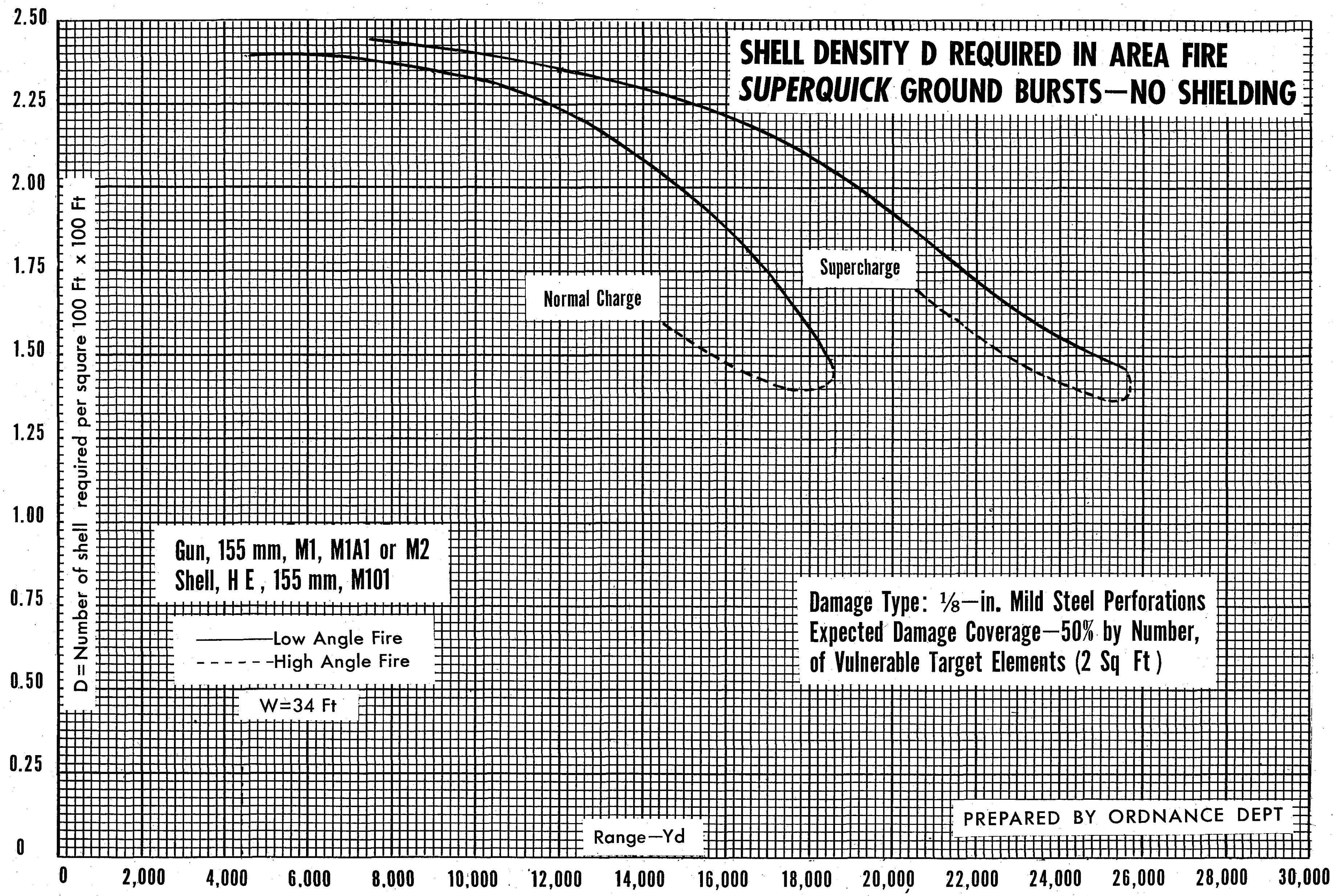
W=Width of fringe around target area requiring the burst density D.

FIGURE 31



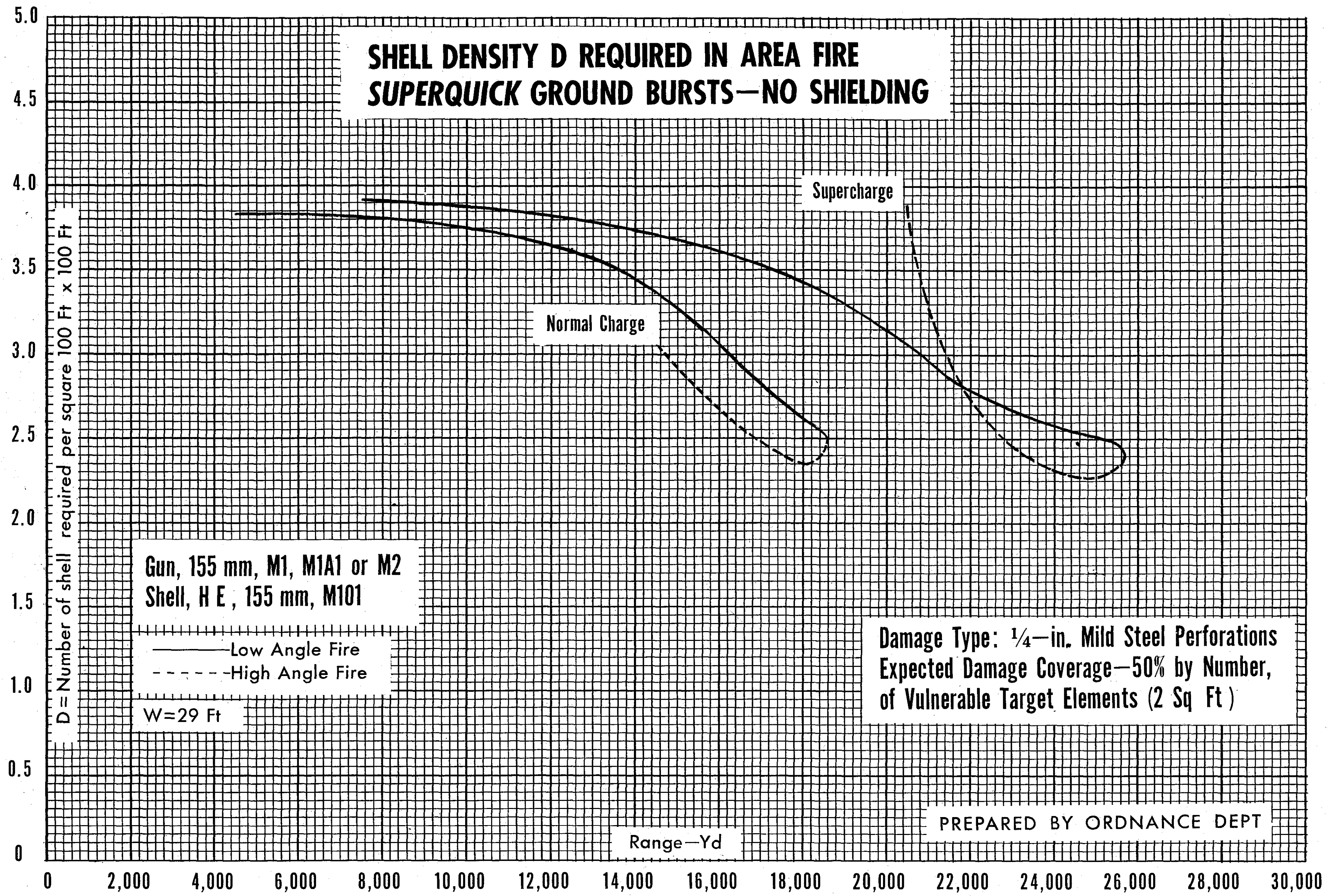
W=Width of fringe around target area requiring the burst density D.

FIGURE 32



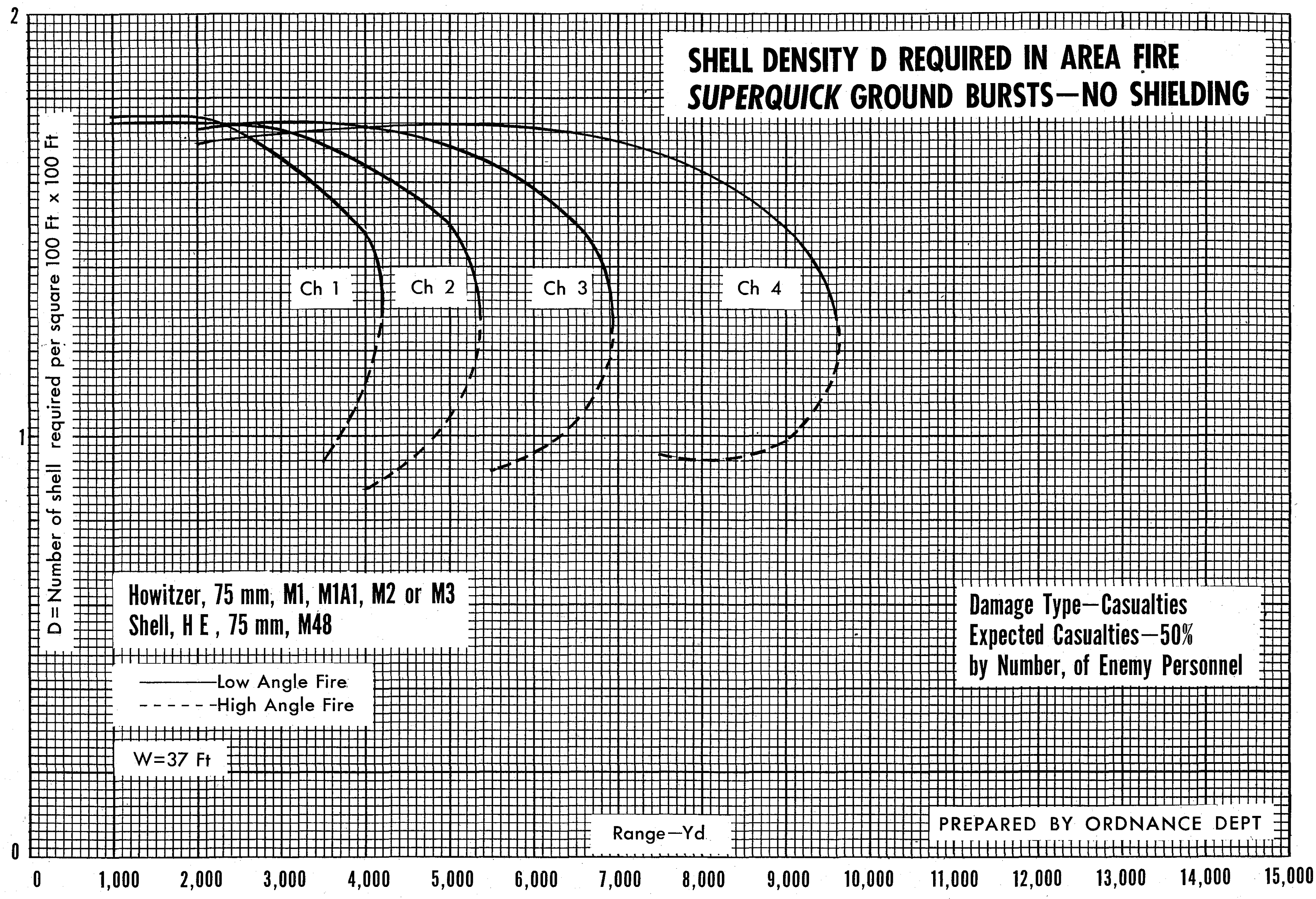
W=Width of fringe around target area requiring the burst density D.

FIGURE 33



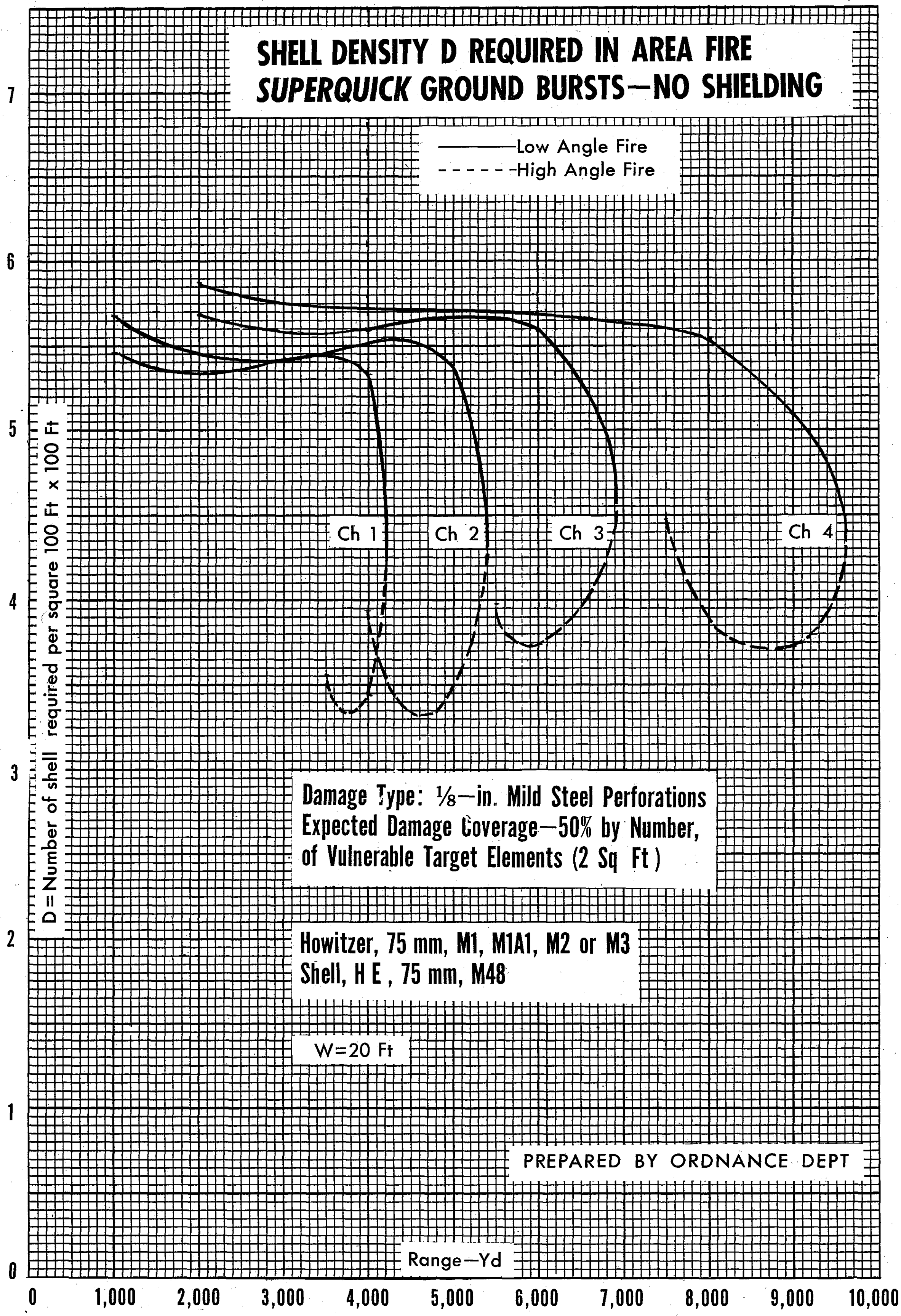
W=Width of fringe around target area requiring the burst density D.

FIGURE 34



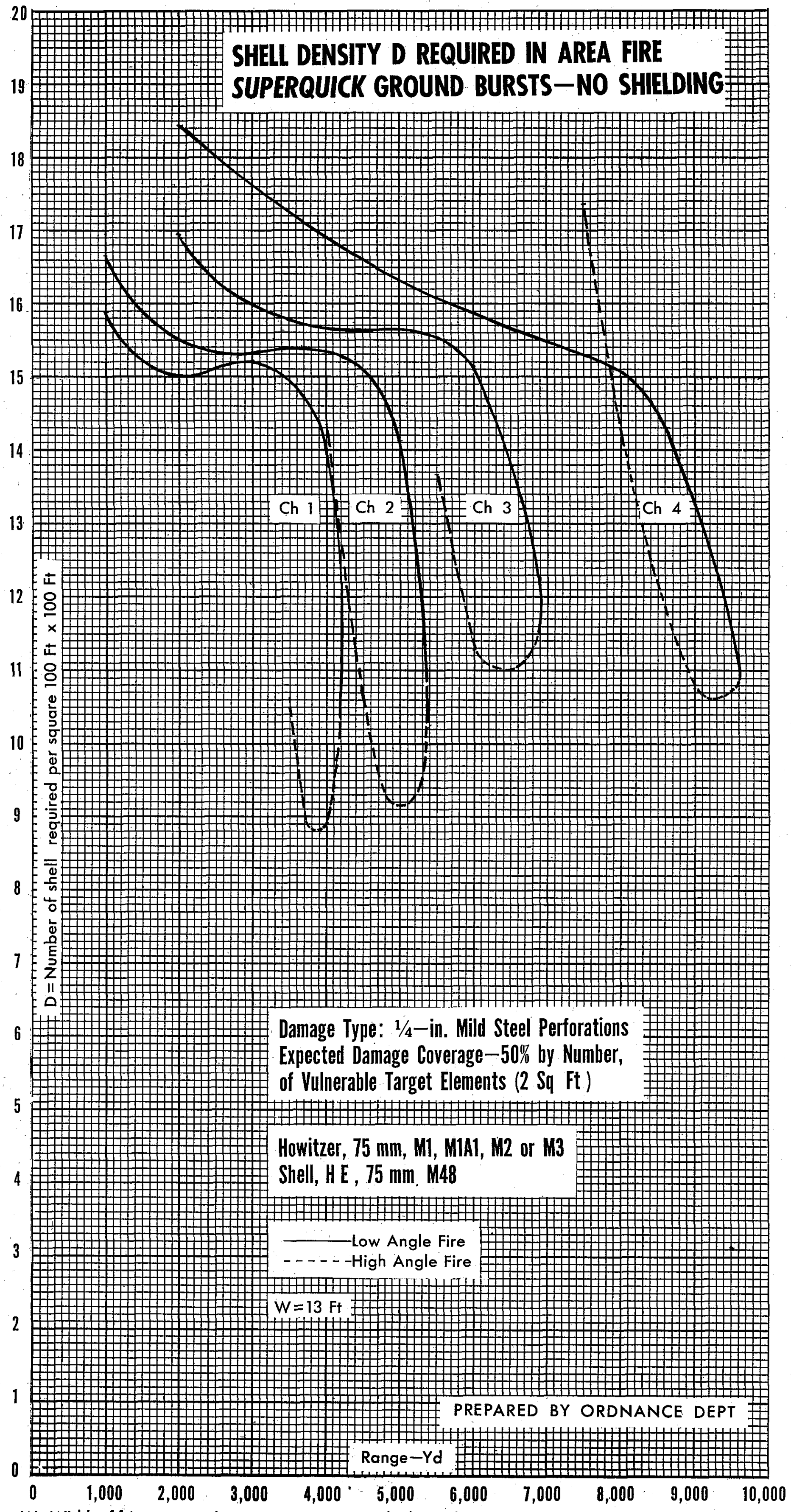
W=Width of fringe around target area requiring the burst density D.

FIGURE 35



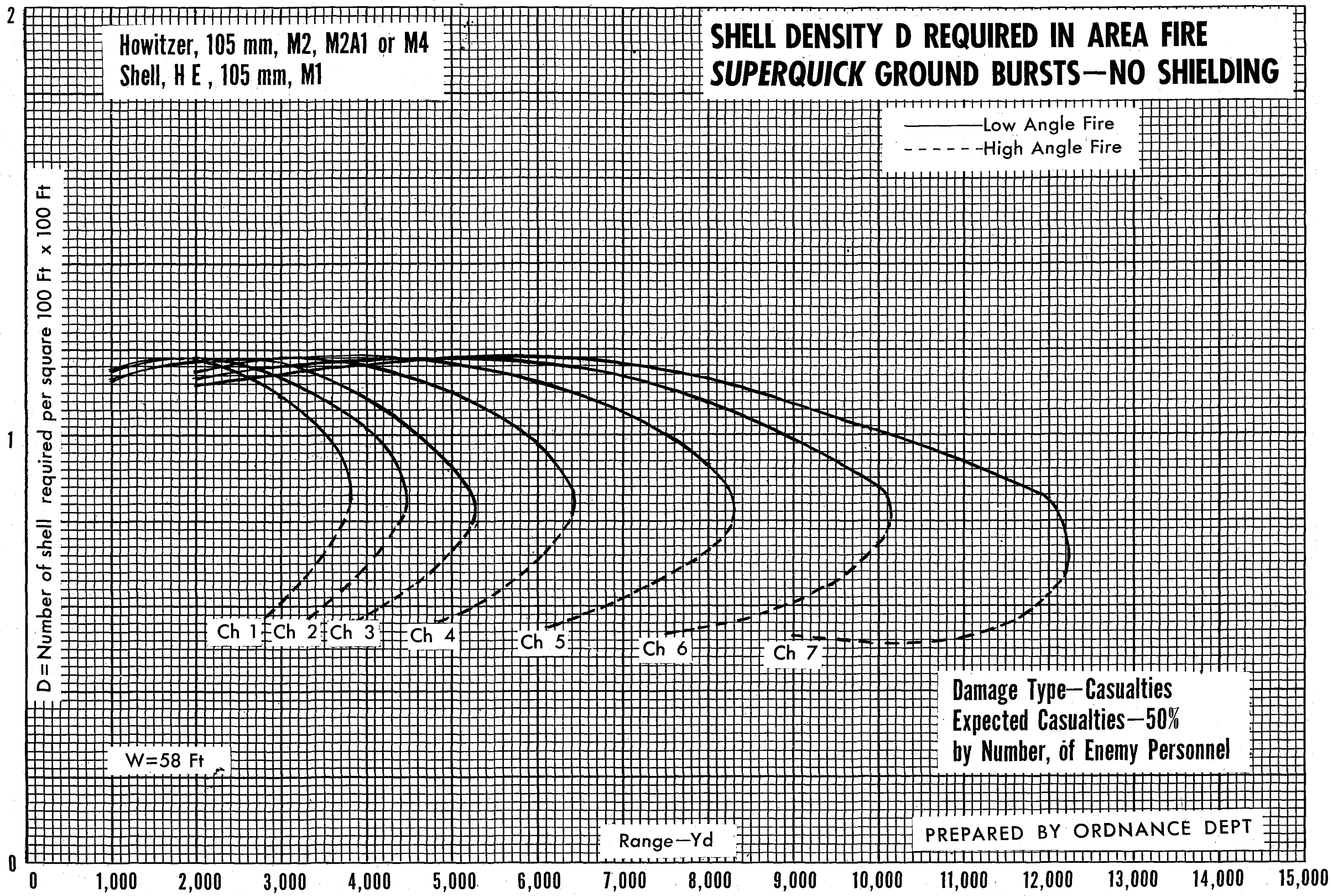
W=Width of fringe around target area requiring the burst density D.

FIGURE 36



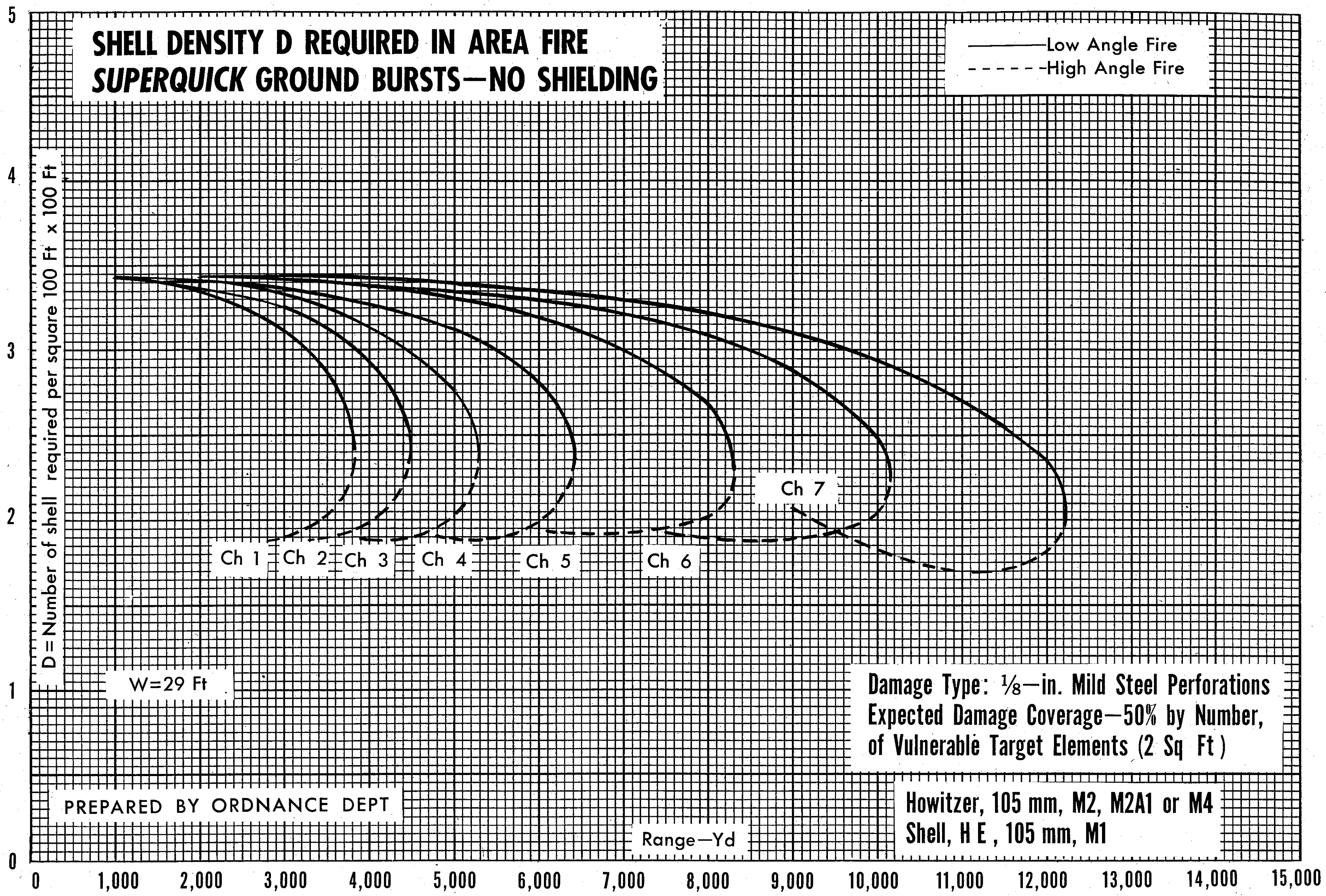
W=Width of fringe around target area requiring the burst density D.

FIGURE 37



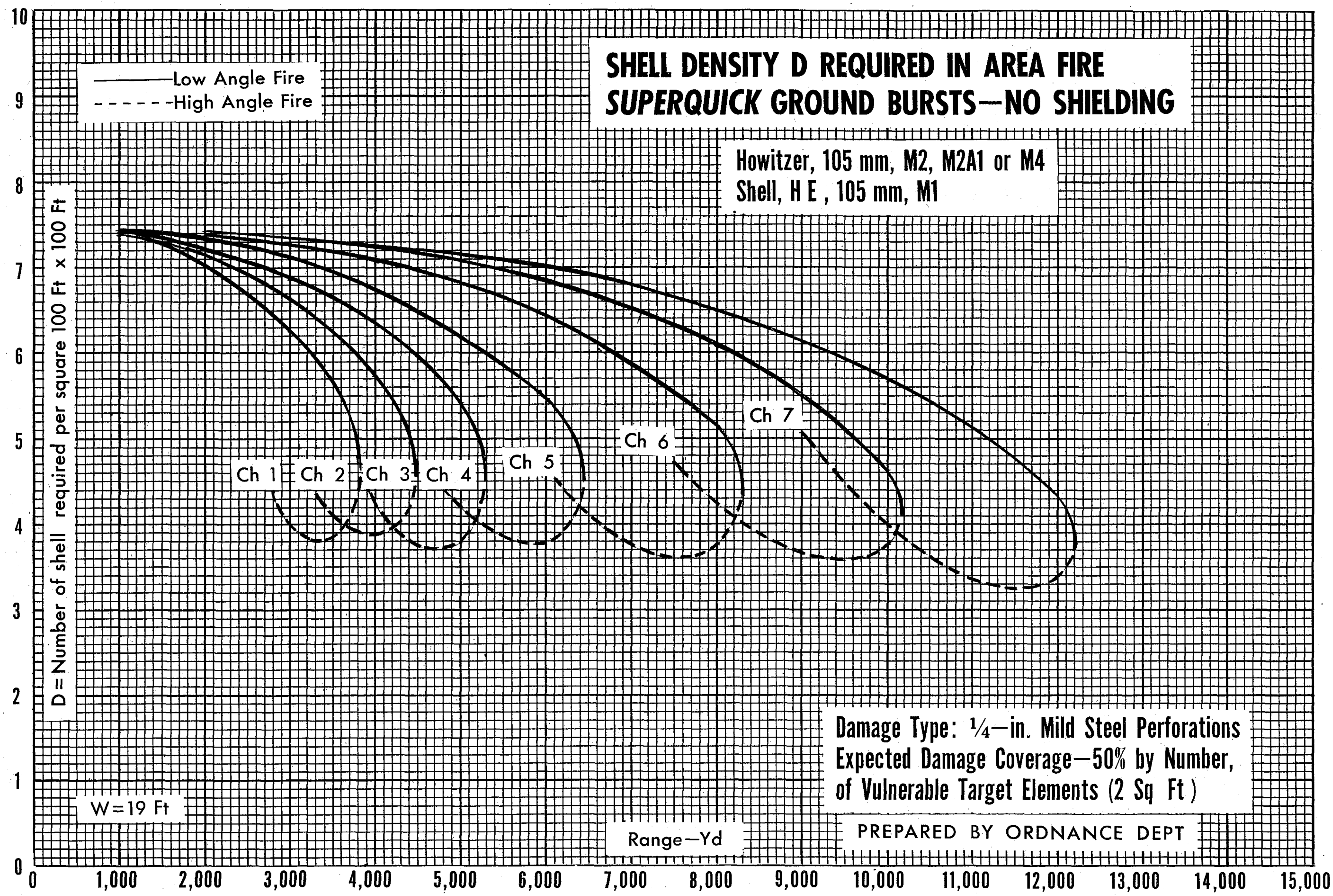
W=Width of fringe around target area requiring the burst density D.

FIGURE 38



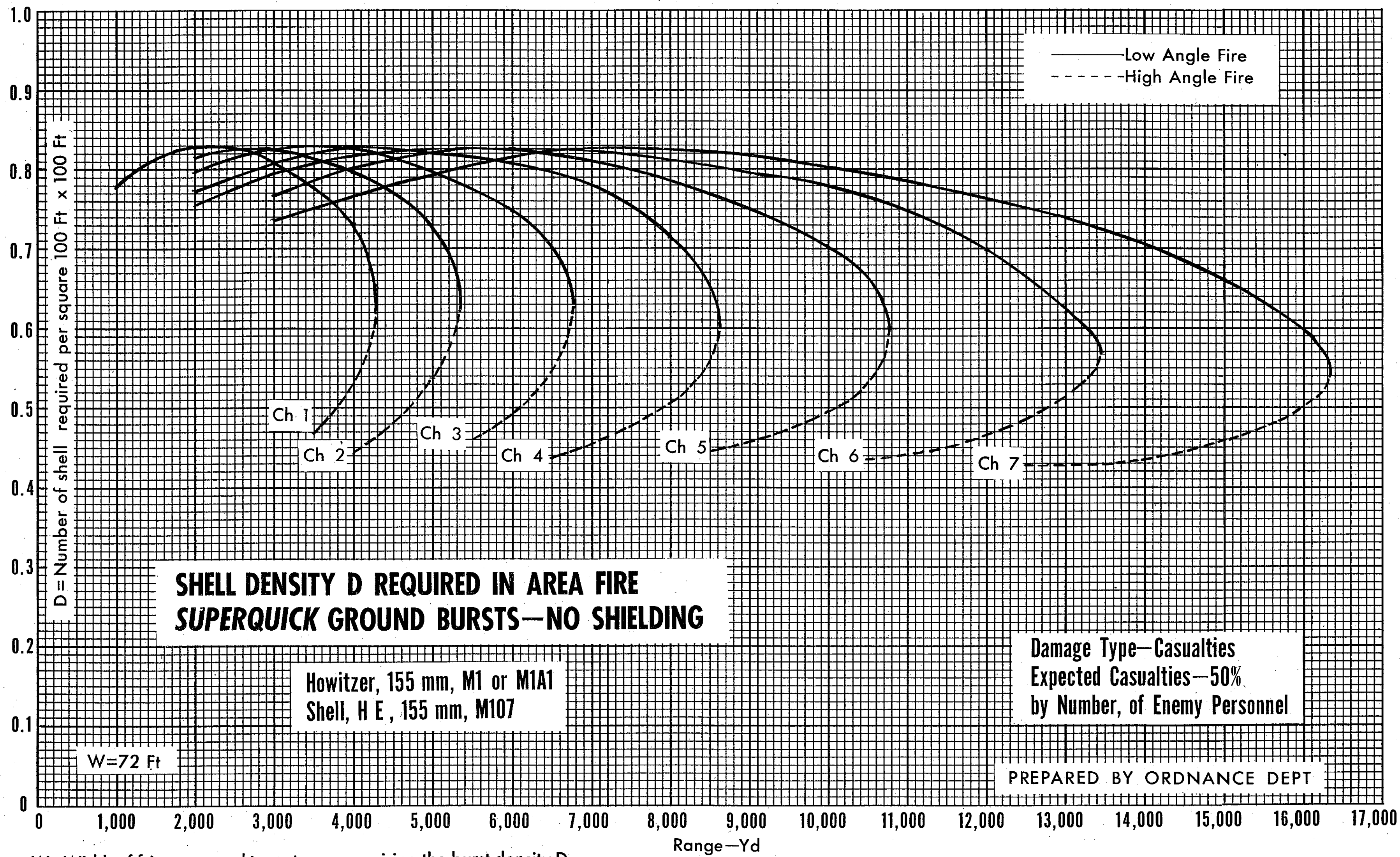
W=Width of fringe around target area requiring the burst density D.

FIGURE 39



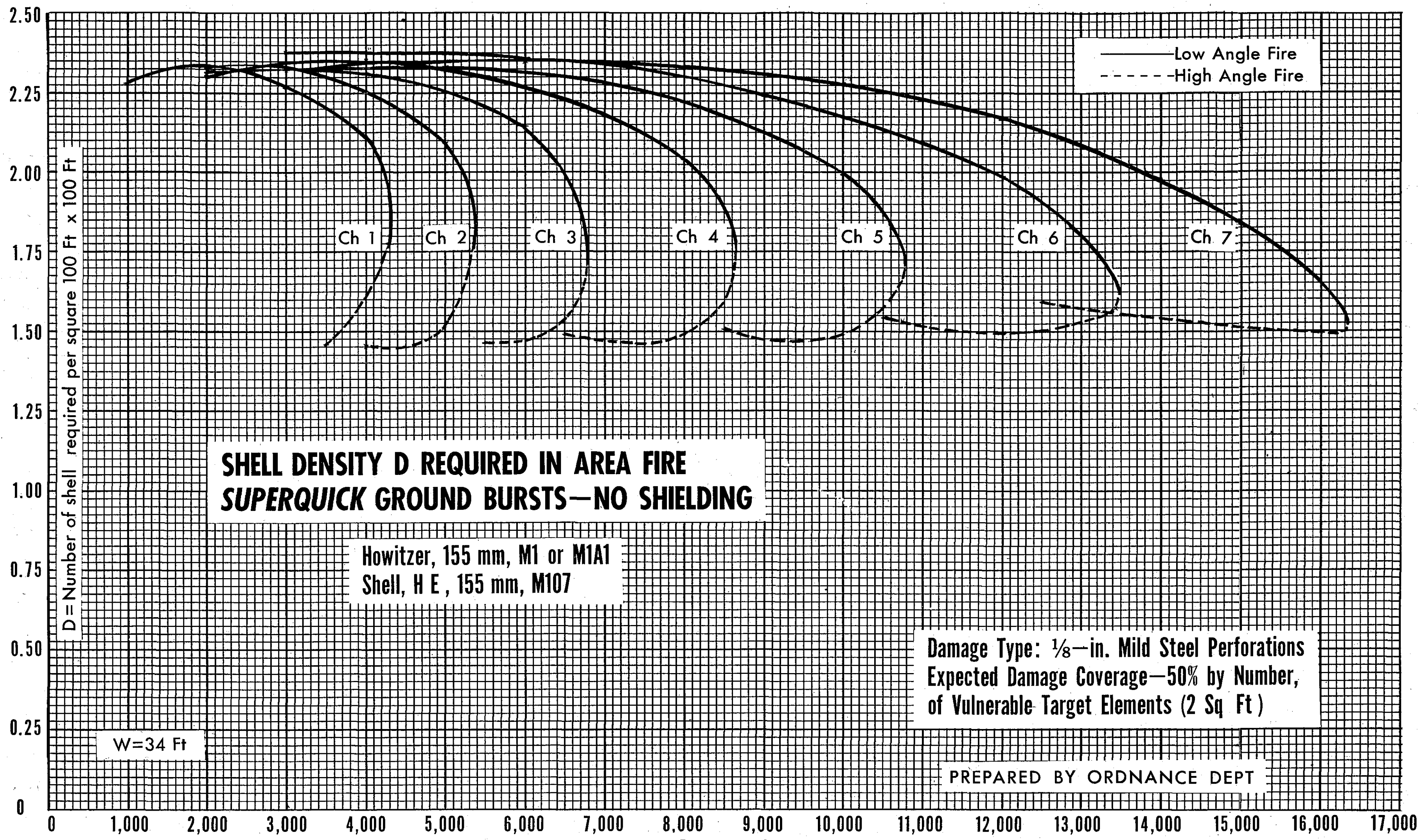
W=Width of fringe around target area requiring the burst density D.

FIGURE 40



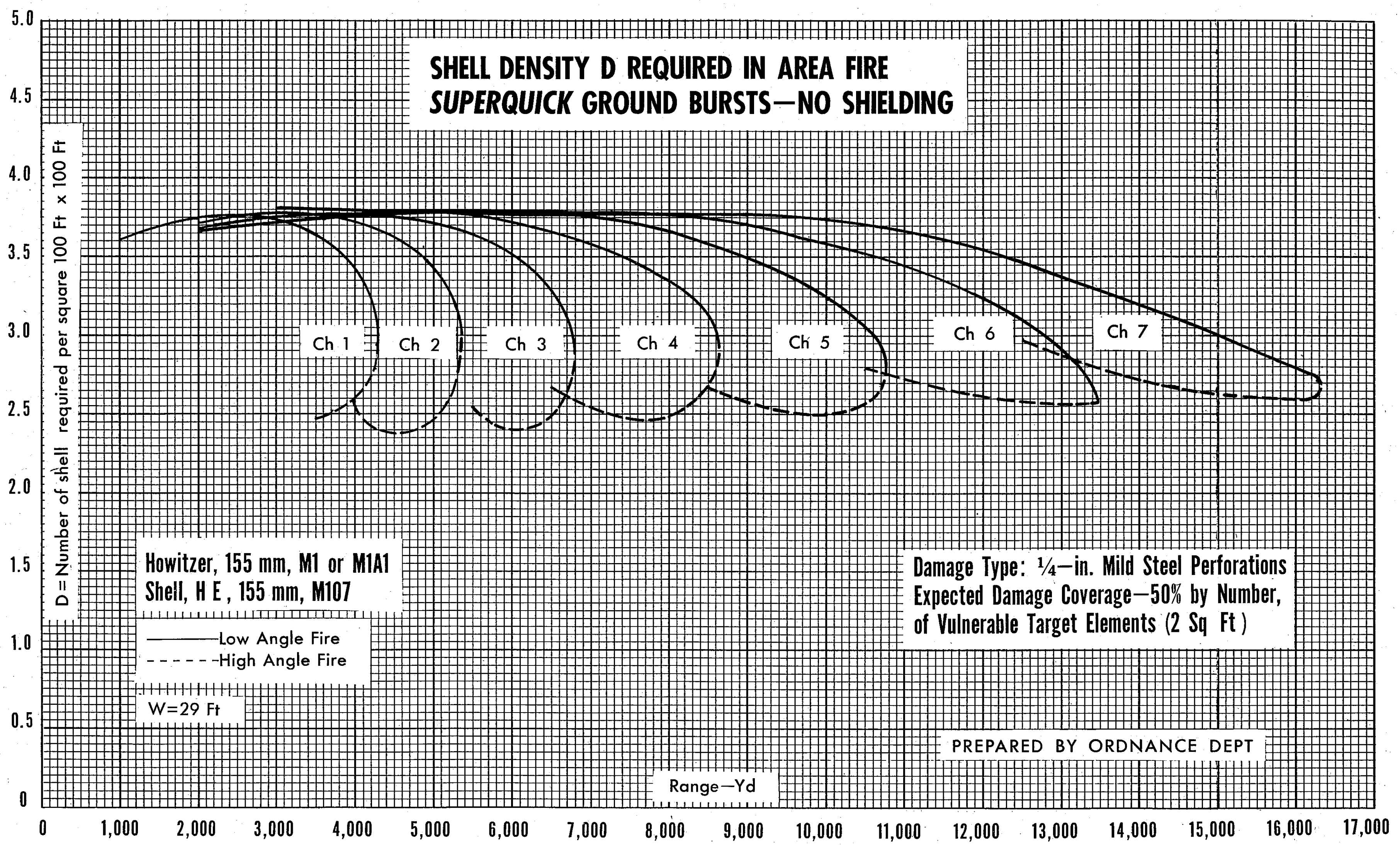
W=Width of fringe around target area requiring the burst density D.

FIGURE 41



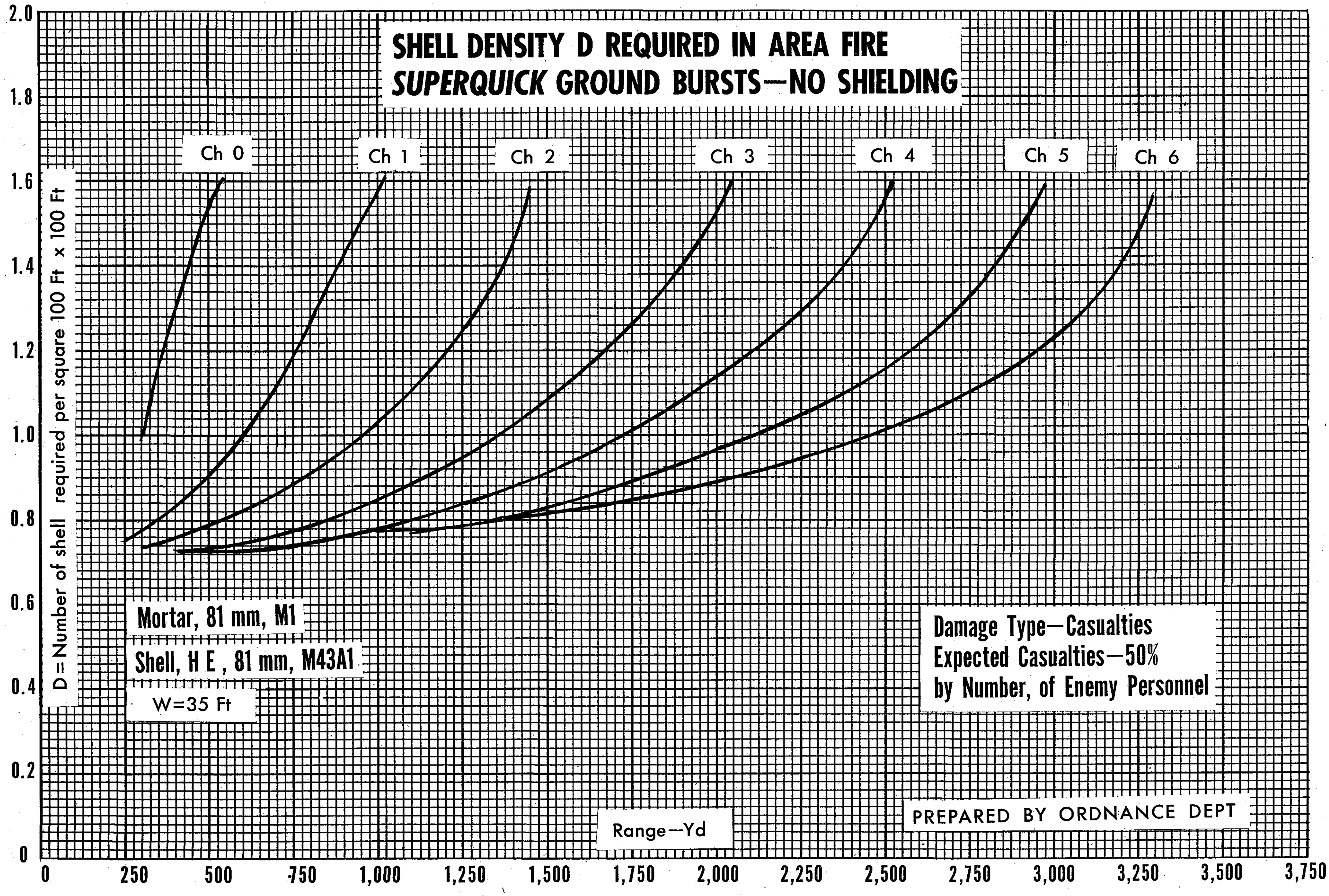
W=Width of fringe around target area requiring the burst density D.

FIGURE 42



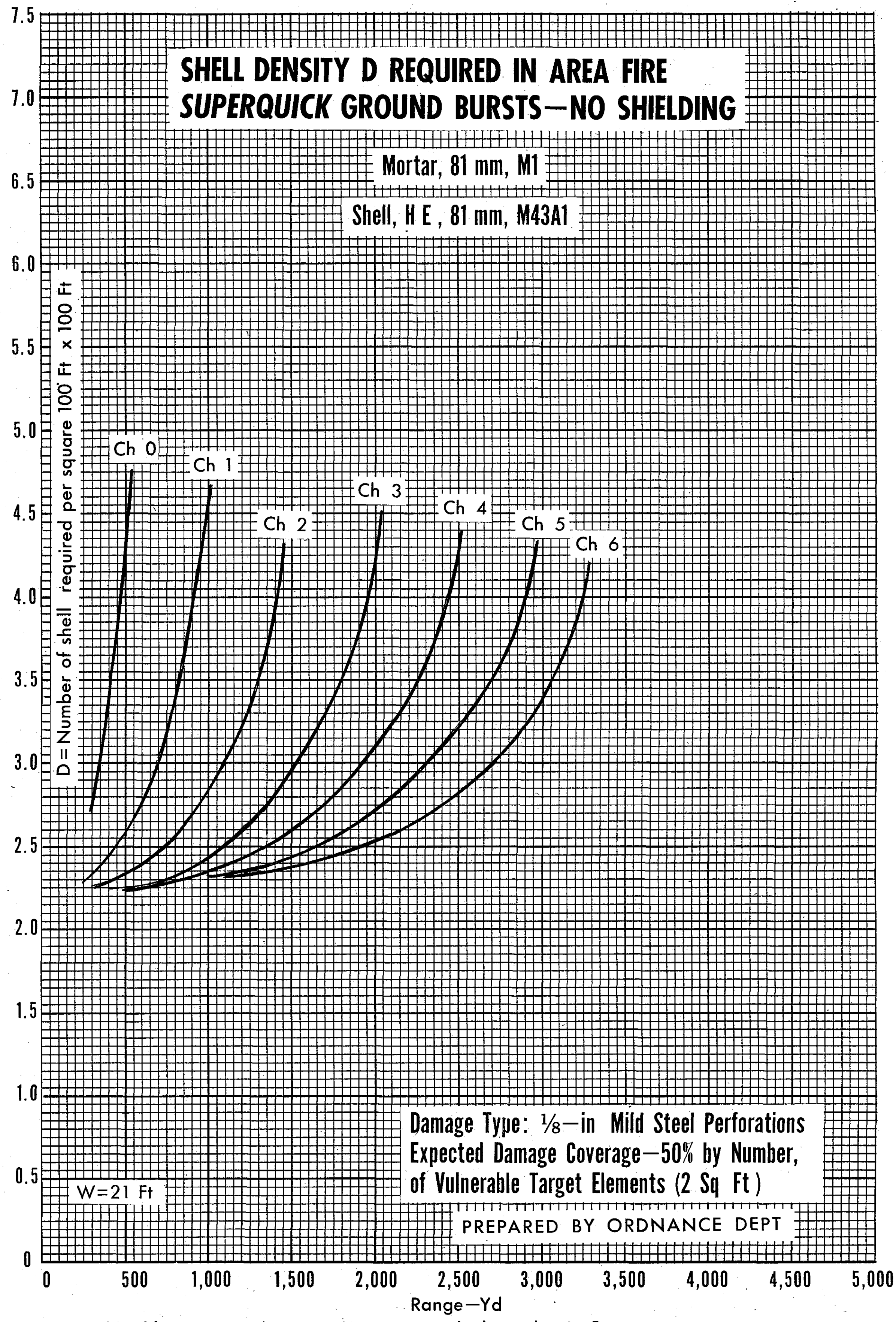
W=Width of fringe around target area requiring the burst density D.

FIGURE 43



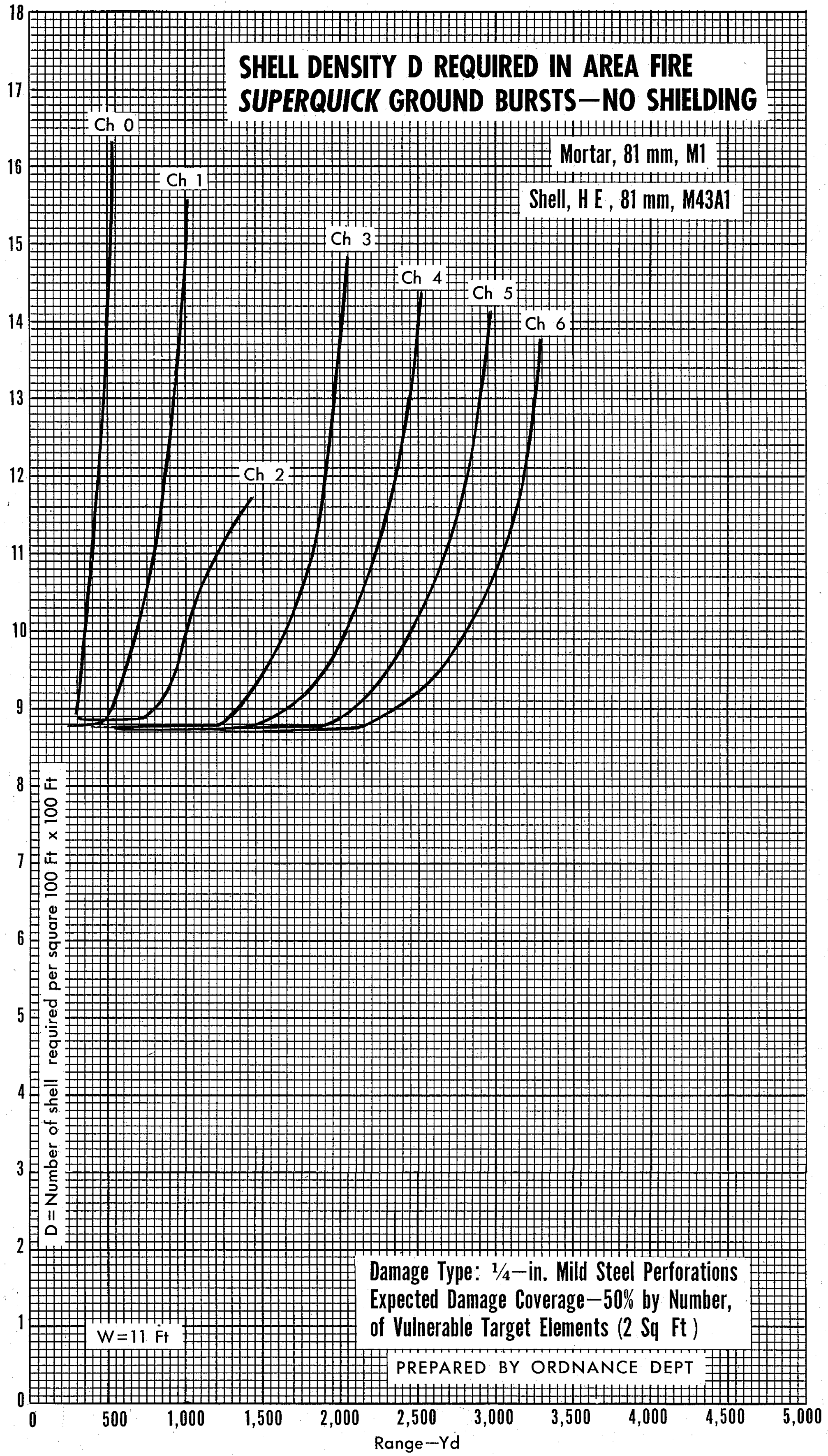
W=Width of fringe around target area requiring the burst density D.

FIGURE 44



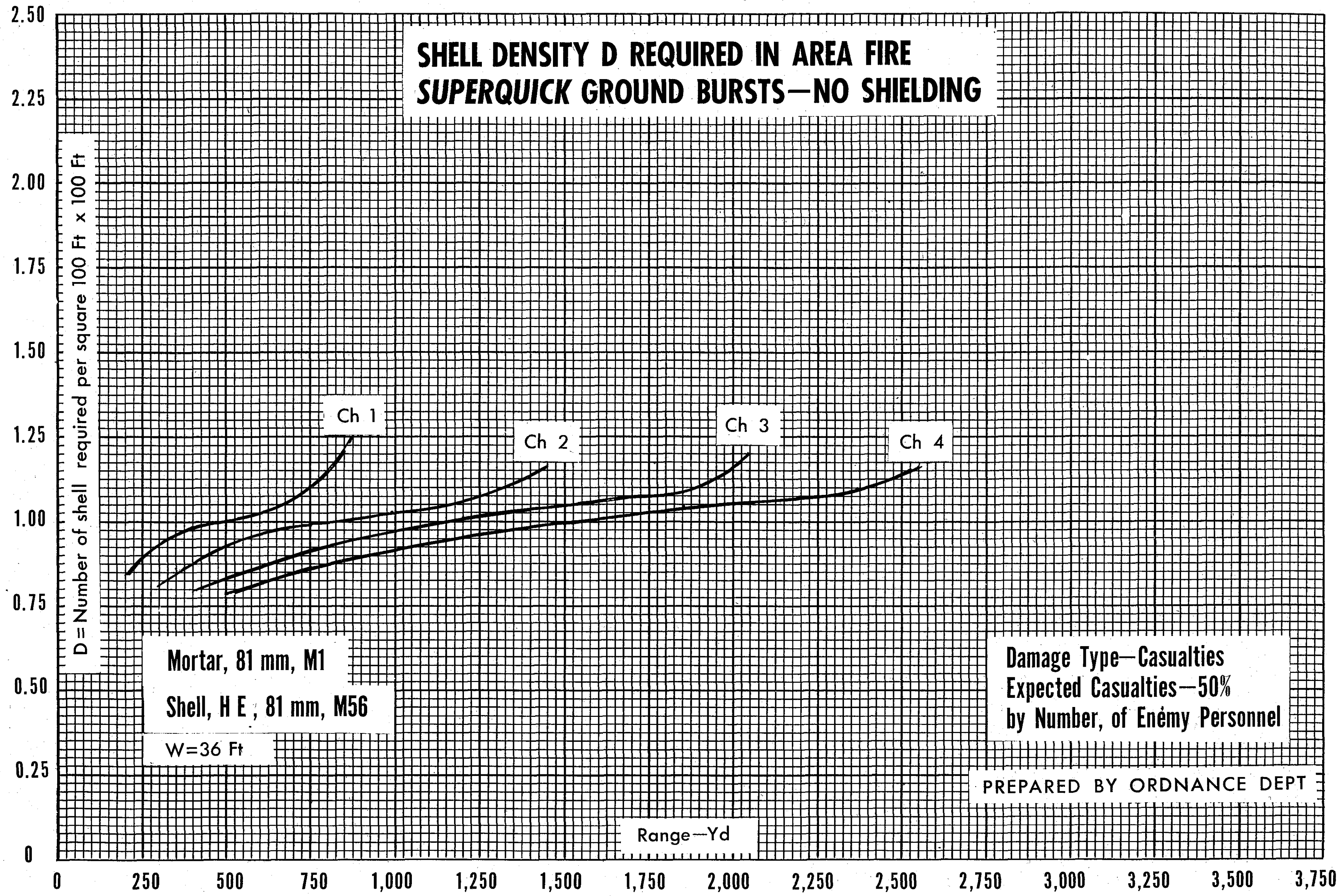
W=Width of fringe around target area requiring the burst density D.

FIGURE 45



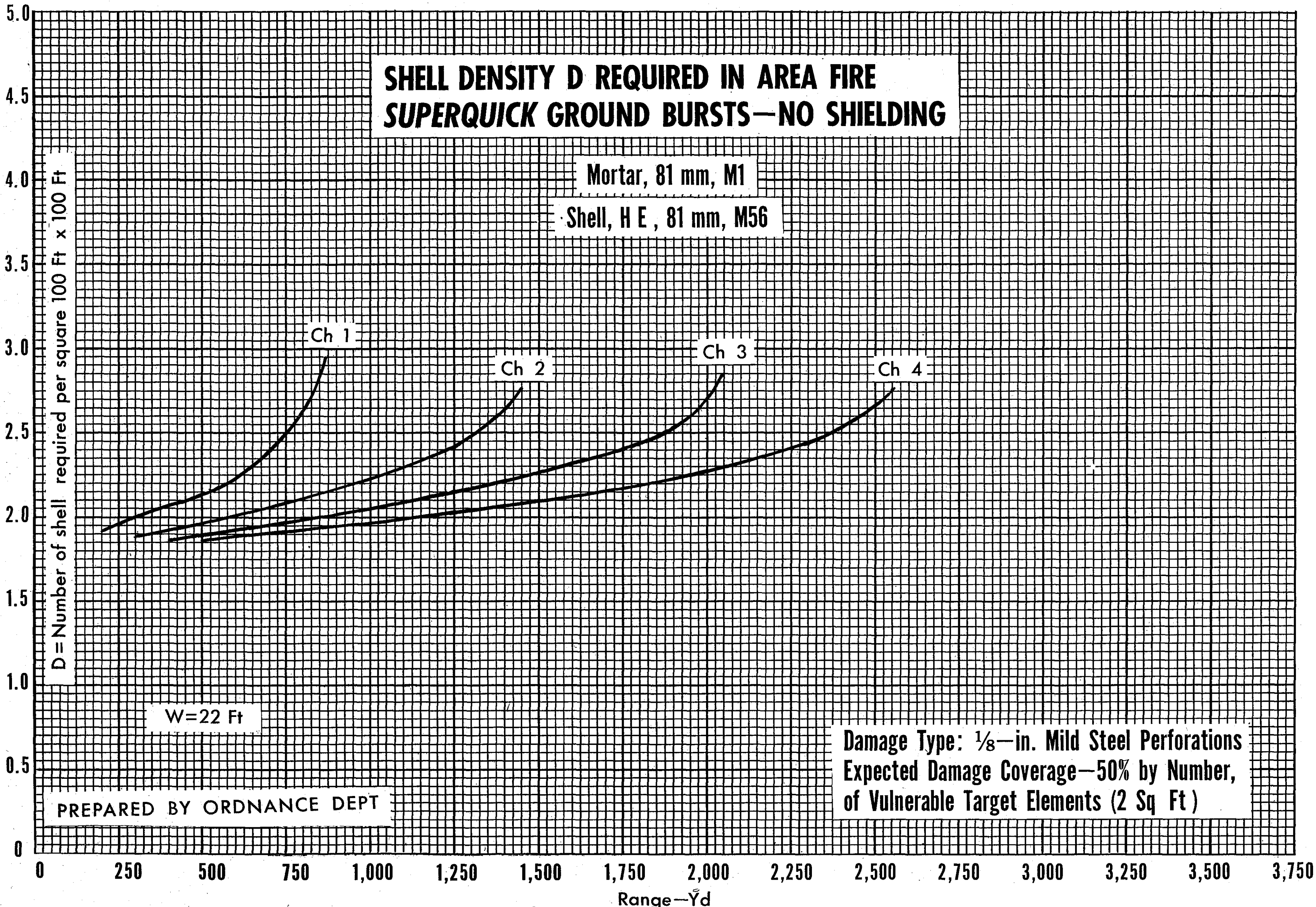
W=Width of fringe around target area requiring the burst density D.

FIGURE 46



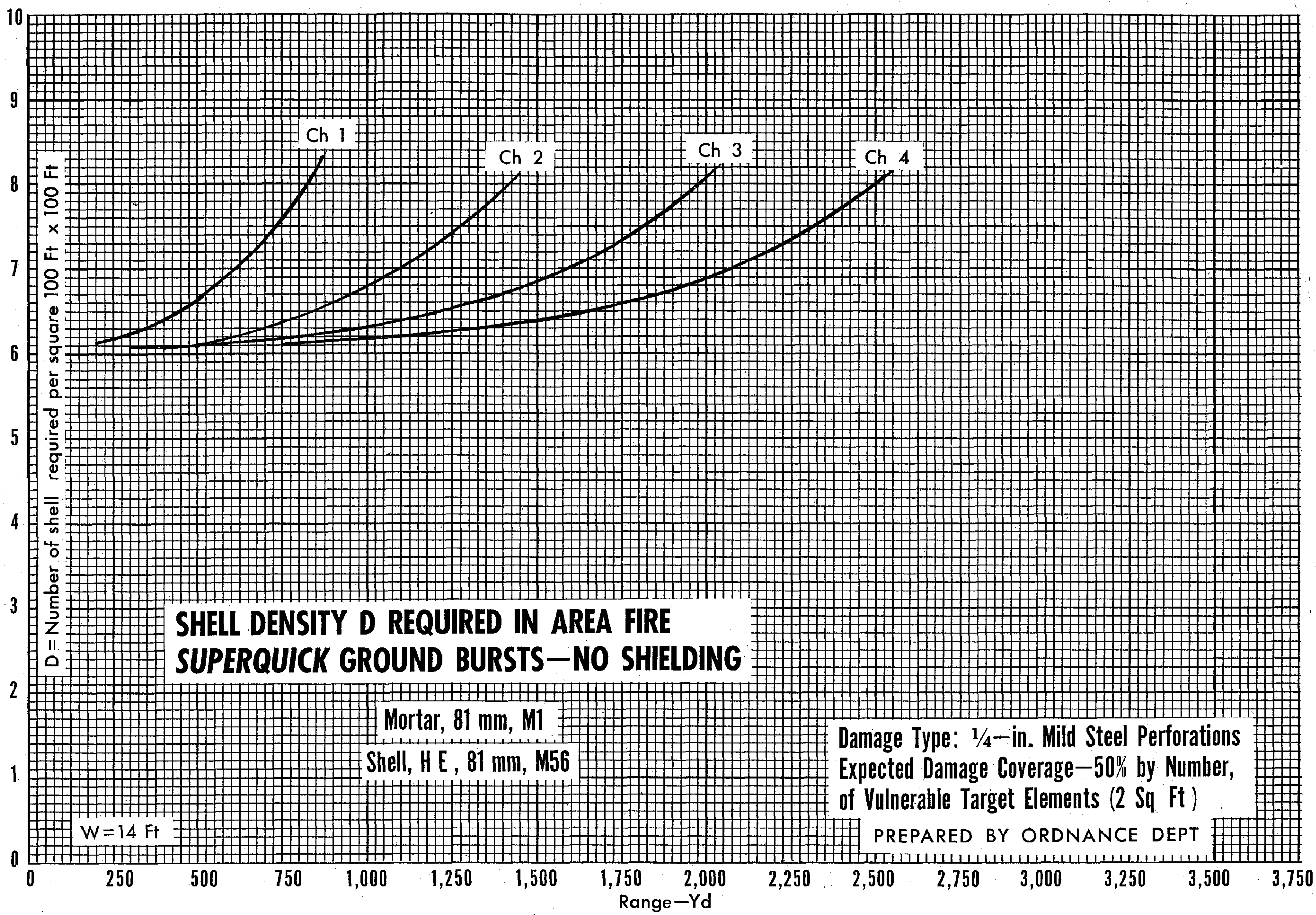
W=Width of fringe around target area requiring the burst density D.

FIGURE 47



W=Width of fringe around target area requiring the burst density D.

FIGURE 48



W=Width of fringe around target area requiring the burst density D.

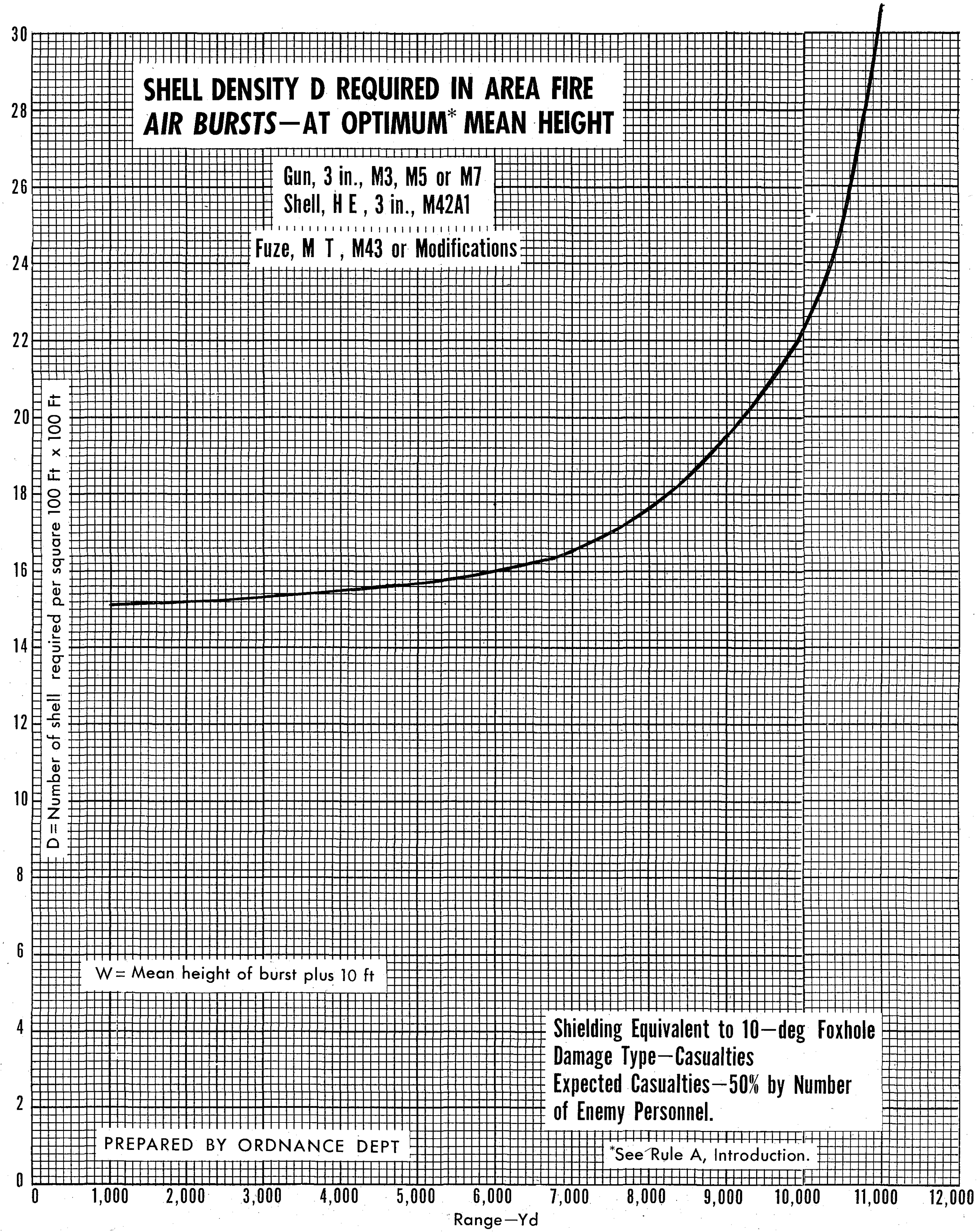
FIGURE 49

AIR BURSTS

BURST DENSITIES REQUIRED IN AREA FIRE

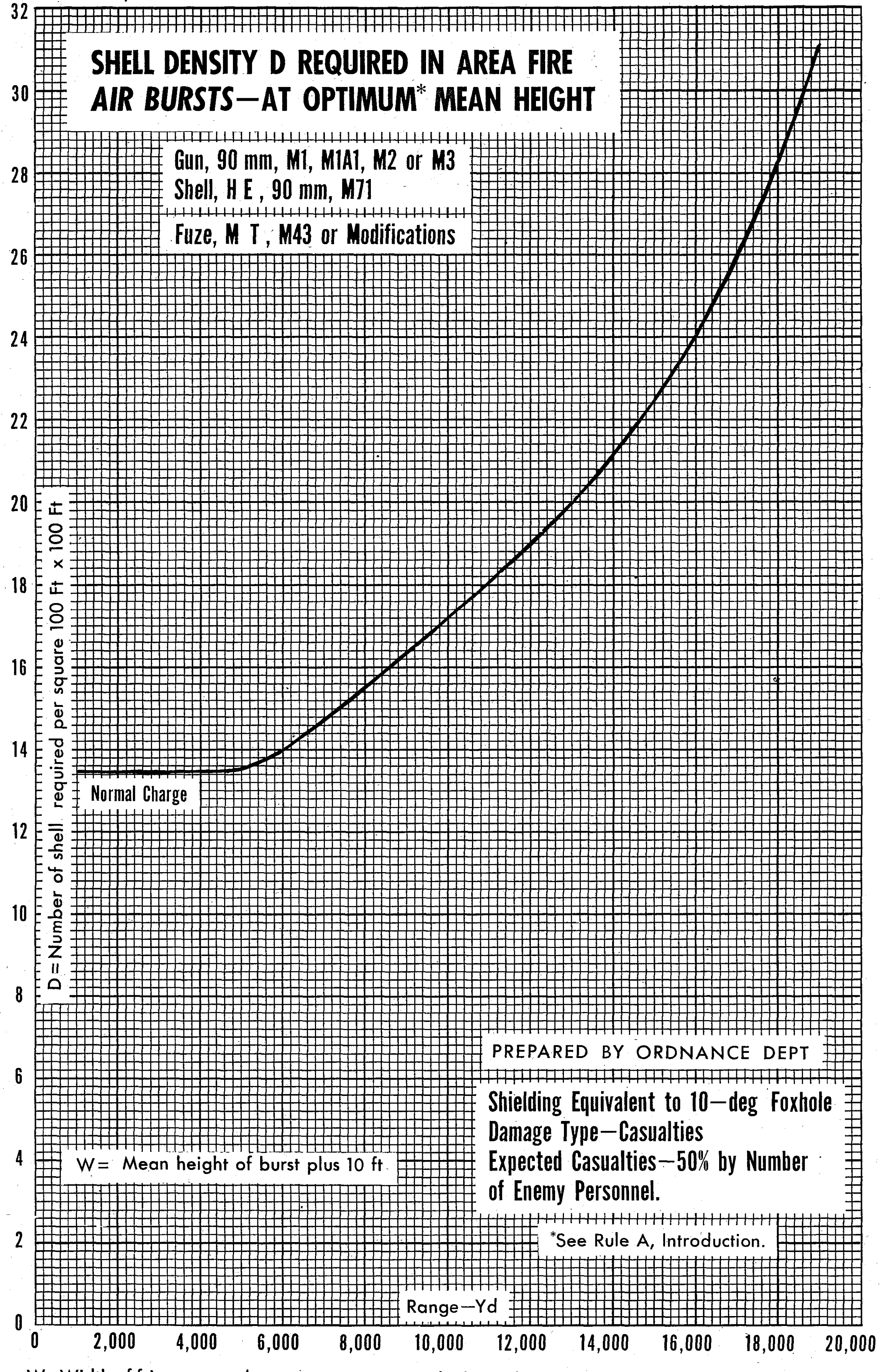
Figures 50 to 56 give the shell densities D per unit area (100 feet x 100 feet) required to cause 50 percent casualties over a given target area. It is understood that the mean height H of burst has been adjusted to the value which is twice the probable error in the height of burst as listed in the firing tables, restricting H, however, to values between 30 feet and 120 feet, and that the width W[1] of the additional fringe of area over which the burst density D is to be extended equals H + 10. To obtain p percent casualties the values of D obtained from the graphs should be multiplied by the factor F written beneath p in Table 70.

[1]The one exception to this evaluation of W is in the case of the 155mm Howitzer when W should be taken as 2H.



W = Width of fringe around target area requiring the burst density D.

FIGURE 50



W=Width of fringe around target area requiring the burst density D.

FIGURE 51

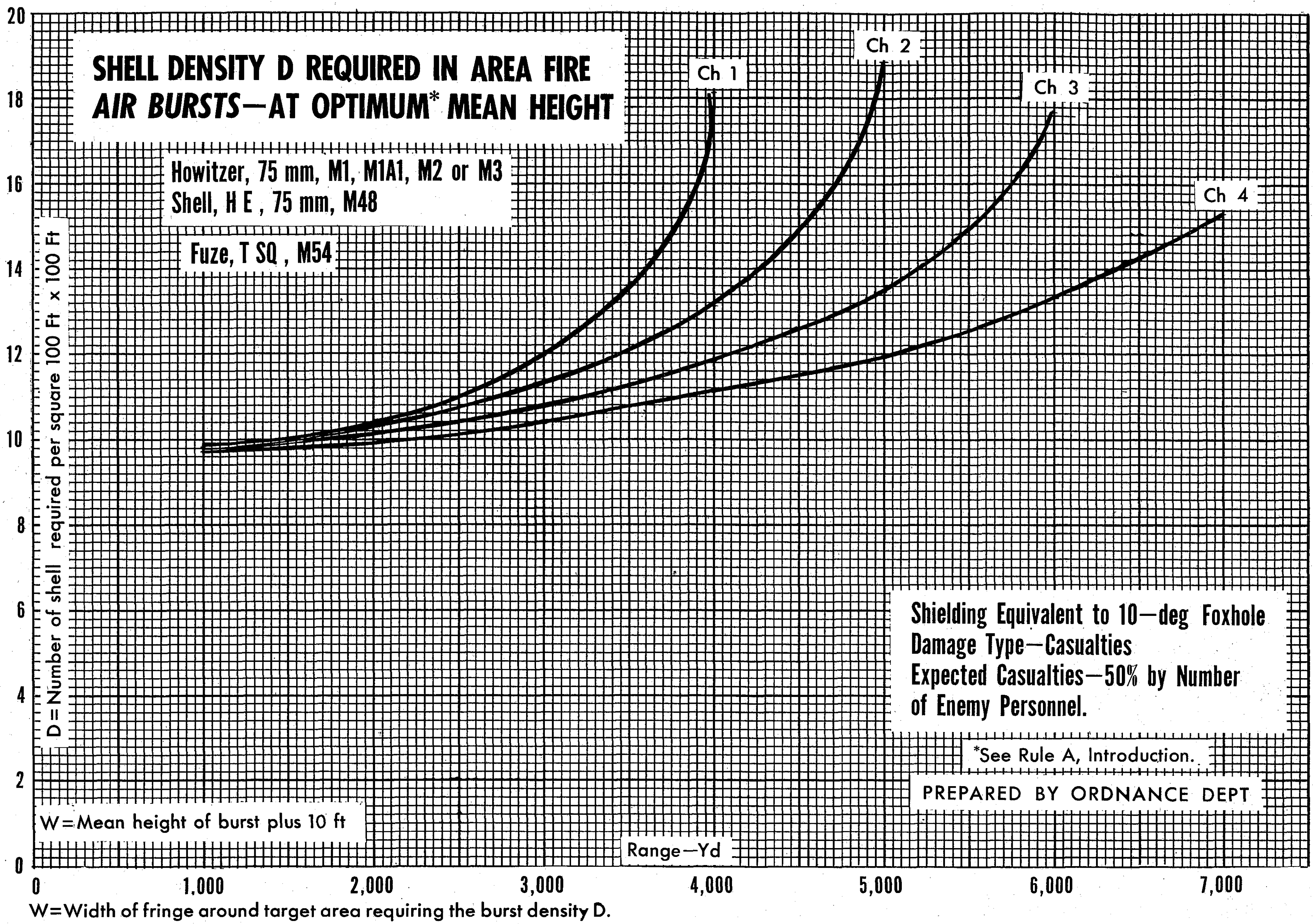
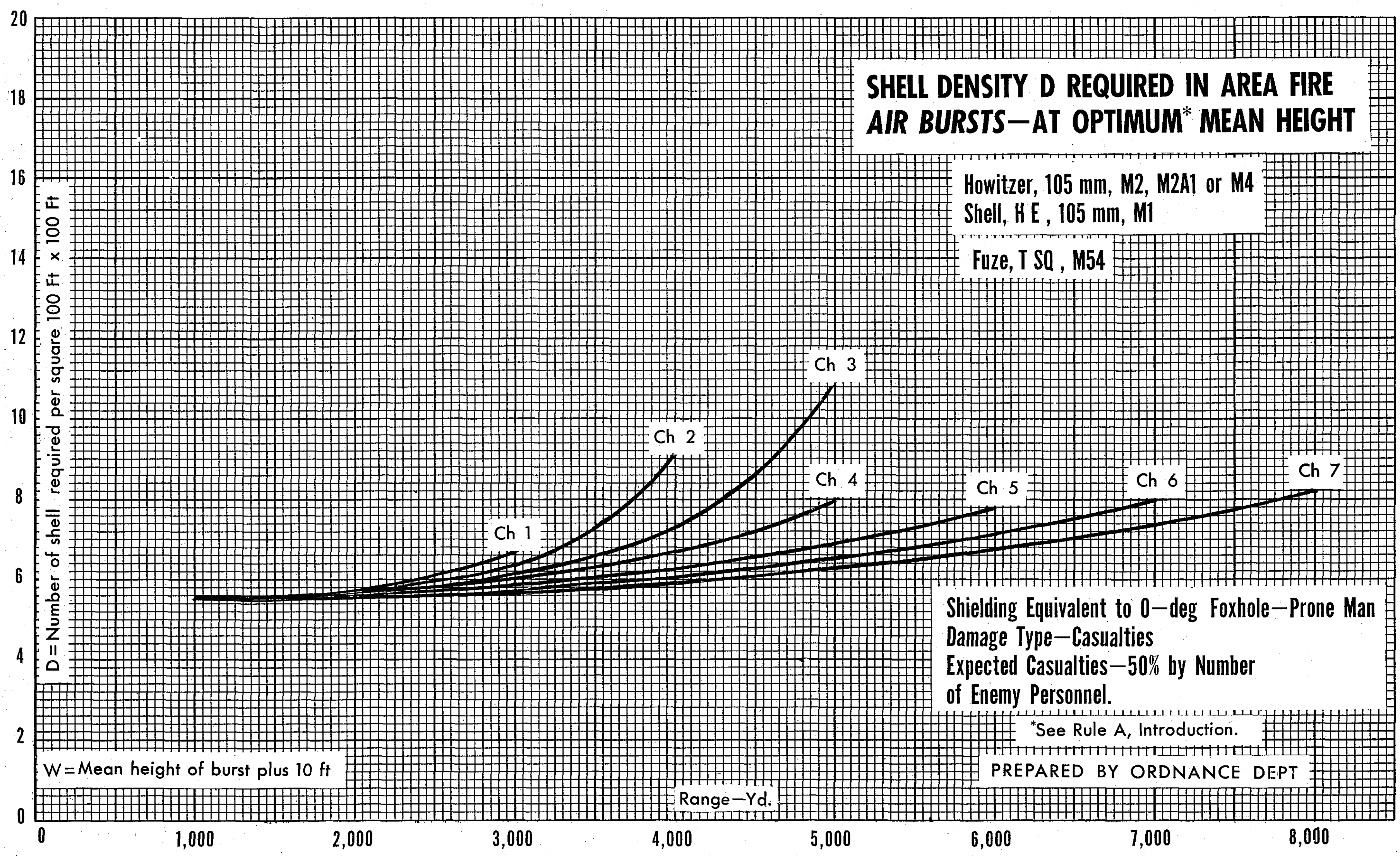
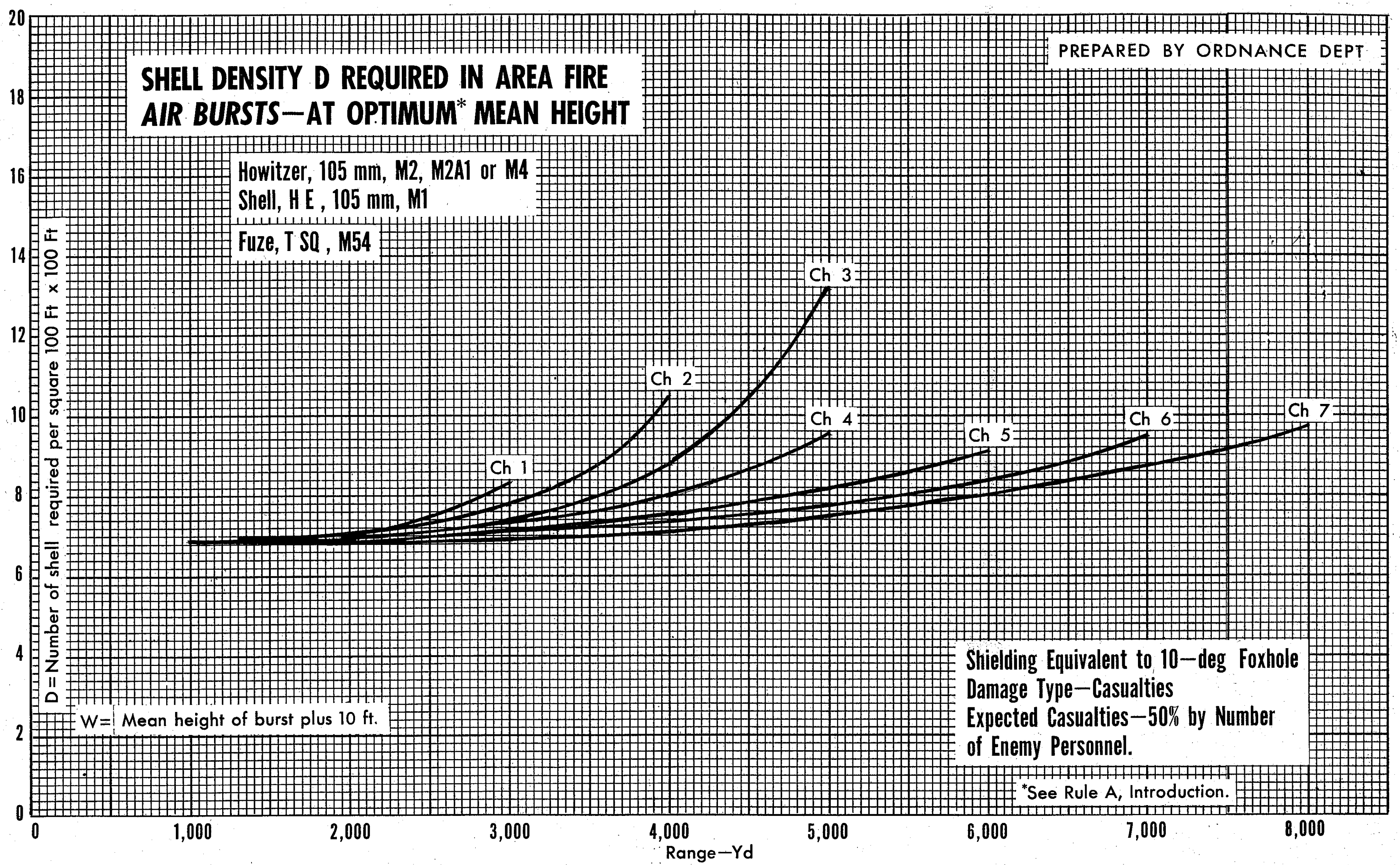

SHELL DENSITY D REQUIRED IN AREA FIRE
AIR BURSTS—AT OPTIMUM* MEAN HEIGHT
Howitzer, 75 mm, M1, M1A1, M2 or M3
Shell, H E, 75 mm, M48
Fuze, T SQ, M54
Ch 1
Ch 2
Ch 3
Ch 4
D = Number of shell required per square 100 Ft x 100 Ft
20
18
16
14
12
10
8
6
4
2
0
Shielding Equivalent to 10—deg Foxhole
Damage Type—Casualties
Expected Casualties—50% by Number
of Enemy Personnel.
*See Rule A, Introduction.
PREPARED BY ORDNANCE DEPT
W = Mean height of burst plus 10 ft
Range—Yd
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
W = Width of fringe around target area requiring the burst density D.

FIGURE 52



W=Width of fringe around target area requiring the burst density D.

FIGURE 53



W=Width of fringe around target area requiring the burst density D.

FIGURE 54

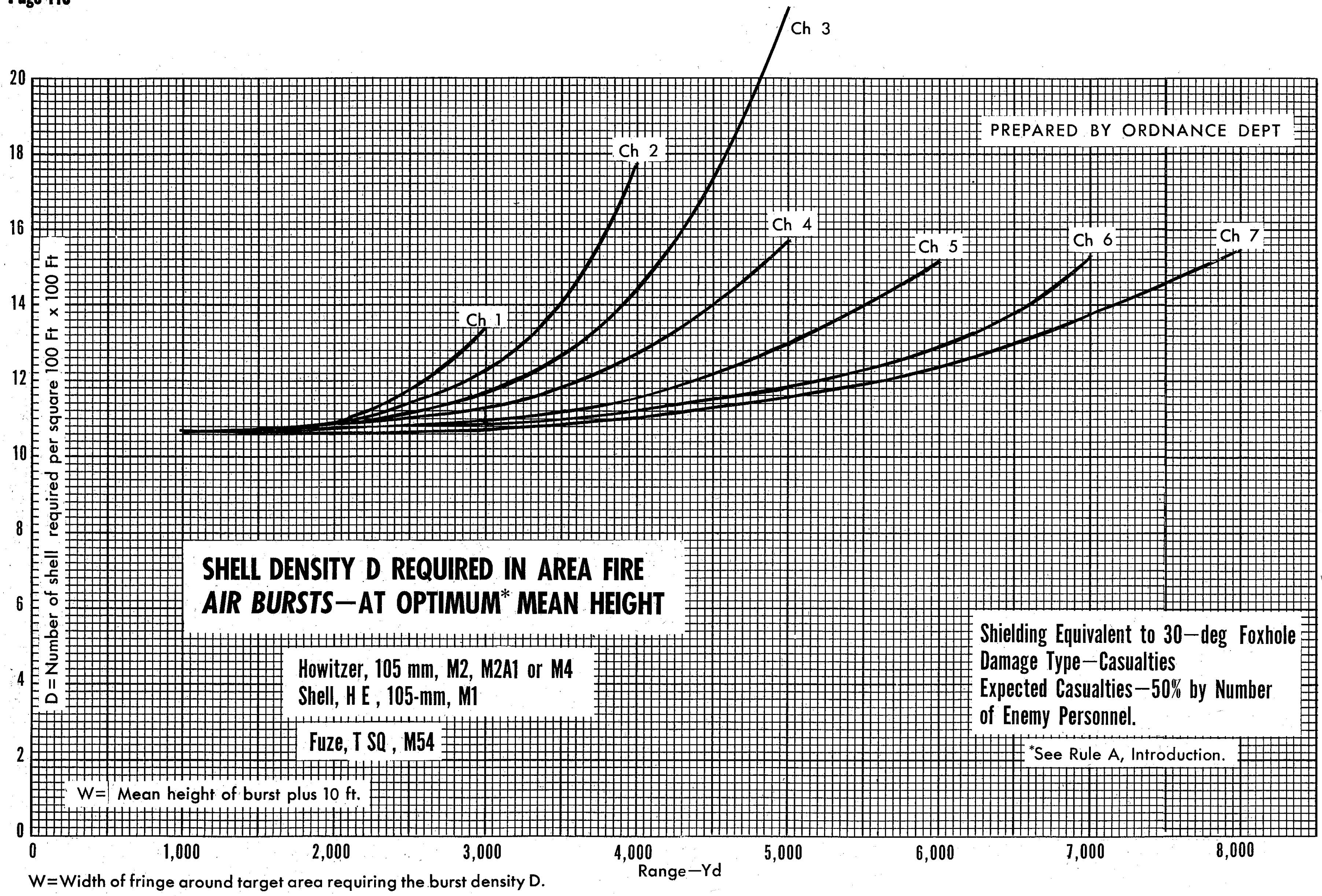
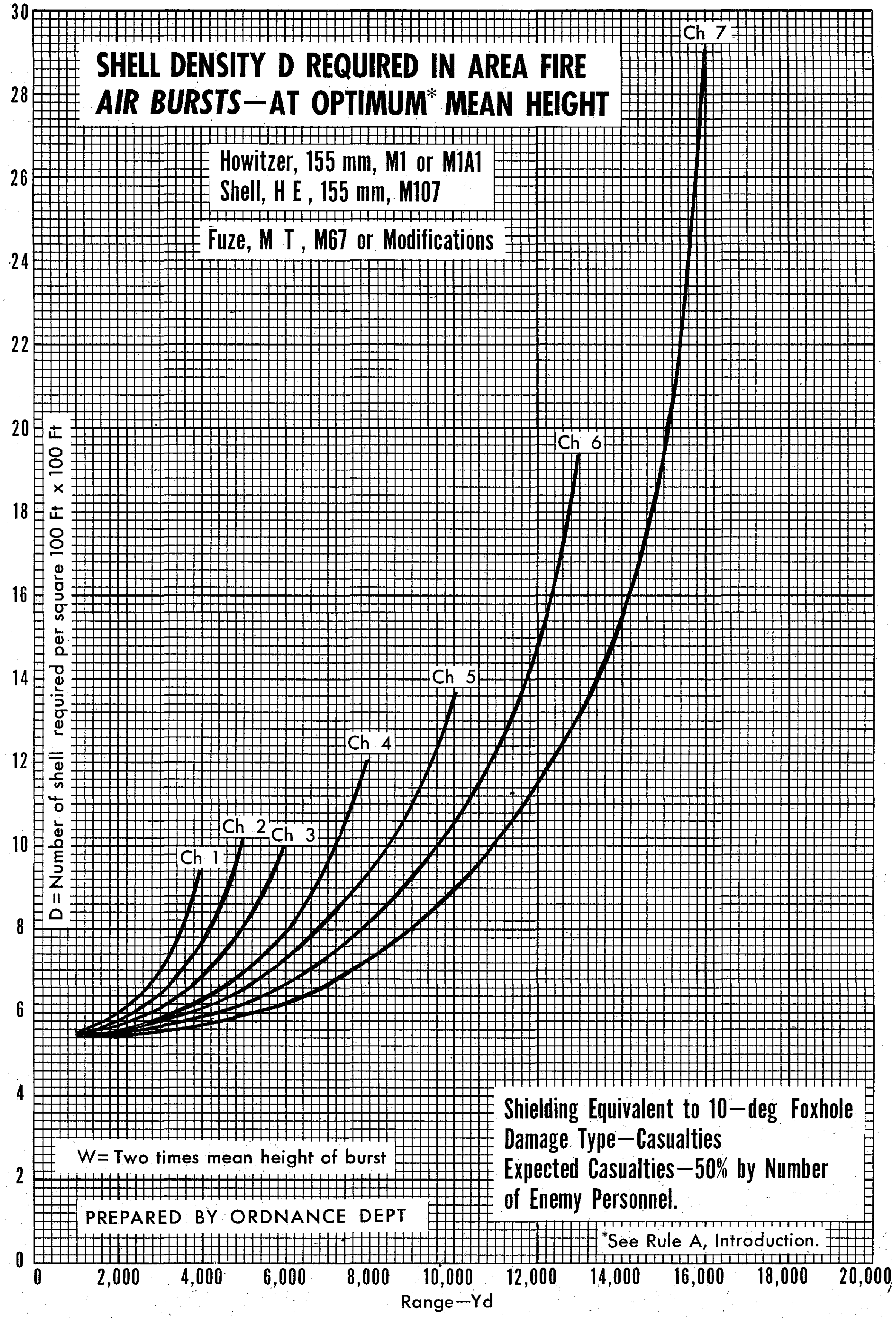

Ch 1
Ch 2
Ch 3
Ch 4
Ch 5
Ch 6
Ch 7
PREPARED BY ORDNANCE DEPT
D=Number of shell required per square 100 Ft x 100 Ft
20
18
16
14
12
10
8
6
4
2
0
SHELL DENSITY D REQUIRED IN AREA FIRE
AIR BURSTS—AT OPTIMUM* MEAN HEIGHT
Howitzer, 105 mm, M2, M2A1 or M4
Shell, H E, 105-mm, M1
Fuze, T SQ, M54
Shielding Equivalent to 30—deg Foxhole
Damage Type—Casualties
Expected Casualties—50% by Number
of Enemy Personnel.
*See Rule A, Introduction.
W= Mean height of burst plus 10 ft.
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Range—Yd
W=Width of fringe around target area requiring the burst density D.

FIGURE 55



W=Width of fringe around target area requiring the burst density D.

FIGURE 56

Volume III Part 9

ARTILLERY FIRE AGAINST ARTILLERY MATERIEL

1. GENERAL.

For several gun-ammunition combinations, ranges, and types of fire, the following tables give the number of rounds to be fired to obtain a certain degree of destruction of enemy artillery.

There is an advantage in total weight of projectiles in using the smallest shell which will reach the target, and frequently, in time fire, among shell of the same caliber in using that with the highest muzzle velocity.

2. THE TARGET.

The target considered is the German 88mm AA gun Flak 18 or Flak 41. In general the degree of destruction considered is that necessary to prevent temporarily the use of the piece as an anti-aircraft weapon. The most vulnerable part of a piece is the counter recoil mechanism. Perforation of the counter recoil gas cylinder is considered as a main cause of damage but not the only cause, and this prevents the use of the piece temporarily. Somewhat more damage is required to prevent the use of the piece against ground targets (for instance, anti-tank use) than for anti-aircraft use, and for the former case the figures of the tables should be increased about 20 percent.

The numbers are approximately correct for *other artillery targets.* They should be increased by not more than 50 percent for more highly resistant targets, or for the requirement of more serious damage. If the target piece is of different size than the Flak 18 or Flak 41, the numbers should be altered. For targets of smaller gun area the numbers should be increased, about by the same factor as the area is smaller, except for fire at very short ranges.

Effect of the fire against personnel has been neglected. The most common effect of counter battery fire is to prevent manning the guns. For the effect against personnel see Part 8 of this volume. In general the best condition for fire against personnel is also nearly the best for fire against artillery, so that tables 71 and 72 indicate the added effect against materiel if anti-personnel fire is conducted.

Table 70 gives the percent of guns damaged when the number of rounds differs by a given fraction from that listed in tables 71 and 72.

3. AIMED FIRE.

If the enemy piece is accurately located, the fire should be directed at the piece itself. In Table 72 are given the number of rounds required for 90 percent probability of damaging the target in aimed fire. The figures for time fire are based on the assumption that the fuze time is set so that the center of burst is at the target. The significance of the numbers listed under Impact, Time, Time and Impact is explained in paragraphs 5 and 6.

Firing table probable errors have been assumed, and consequently the numbers refer to observed fire, well adjusted.

4. AREA FIRE.

If only the general location of the enemy pieces is known, the fire must be directed over a general area. The number of rounds required for given probability of damaging one piece known to be in the area is then proportional to the area over which the fire is distributed. The probability of hitting another piece in the area is, of course, the same, so the number of rounds required to put out of action half the enemy pieces in the area is independent of the number of enemy guns in the area.

The number of rounds per 10,000 square yards of the area over which the fire is directed, required to damage half the enemy pieces located in the area, is listed in Table 71. The fact that the number of rounds is listed for an area of 10,000 square yards (100 yard by 100 yard square) is not to be interpreted as meaning that area fire over such a small area is possible without wasting ammunition outside the area. The numbers listed must be multiplied by the total area in square yards under fire divided by 10,000.

Even so, there is a band of area at the edge of the target in which the probability of hitting a target with fragments is lower than 50 percent, being in fact 25 percent at edges away from corners. This could be overcome by increasing the number of rounds near the edge. Frequently, however, in area fire the concentration of targets is suspected to be greater at the center of the area, and consequently the effect of a round of ammunition is greater here.

The significance of the numbers listed under impact, time, time and impact is explained in paragraphs 5 and 6. In the case of time fire the height of center of burst is taken as one mil for ranges not exceeding 10,000 yards, and 30 feet for longer ranges. This is a simple workable rule giving very close to maximum effect of fire against the materiel for the problem in hand. When the probable error is large a mean height of burst equal to two probable errors in the height of burst, as given in the firing table, is preferable for maximum effect against personnel. The tabulated numbers are applicable to this case.

5. IMPACT FIRE.

The numbers tabulated opposite *Impact* in the tables are those caused by direct hits only. *No damage due to blast or fragments from near misses has been considered,* since this depends on the degree of shielding and the way the weapon is emplaced.

These figures are consequently *conservative,* since if no shielding or revetments are present there will be considerable damage due to fragments.

6. TIME FIRE.

The numbers of rounds required for air burst fire are entered opposite *Time and Impact* in the tables.

The values tabulated opposite *Time* give the number of rounds required when the damage is caused only by fragments arising from air bursts. This is separately listed for purpose of general interest.

In Table 72, Aimed Fire, the fuze setting is assumed to be such that the center of burst occurs at the target. In Table 71, Area Fire, the height of center of burst is assumed to be one mil for ranges up to 10,000 yards, and 30 feet for greater ranges.

Due to the dispersion in fuze functioning, half the shell will burst below the center of burst and half above it. In the case of aimed fire, with center of burst at the target and not above it, the half with delayed functioning will strike the ground before bursting. In the case of area fire, with higher center of burst, there will still be a considerable number of shell striking the ground before bursting. These shell may strike the target and destroy it by direct hits. The effect of these hits has been ignored in the line marked *Time.* It has been included in the line marked *Time and Impact.*

The entries under *Time and Impact therefore give the combined effect of air burst and direct hits.* However, as in the case of the entry on the line marked *Impact,* the effect of fragment damage from near miss ground bursts, which occur with the shell fuzed combination time and superquick, is neglected, since this damage depends greatly on the shielding and type of revetment. In the case of minimum shielding the entries are therefore conservative when the combination time and superquick fuze is used.

7. COMPARISON OF GROUND BURST AND AIR BURST.

No general statement of the relative effectiveness of ground burst and air burst fire is possible since this depends entirely on the emplacements. With no shielding at all by revetments, ground bursts are generally more effective against materiel and personnel in the open *but personnel in fox holes or trenches are to be attacked by air burst fire.* Since counter battery fire is largely directed against personnel, and when air bursts are employed, the numbers listed opposite *Time and Impact* should indicate the damage done to materiel.

In the case of aimed fire (Table 72) except at the longer ranges with the heavier weapons, the *Impact* entries are lower than those of *Time and Impact,* which means that direct hits are more effective than air bursts, and PD fuzes, set superquick, are superior to time fuzes *if the effect against materiel alone is desired.*

The added effect of fragment damage from near miss ground bursts, which is neglected in all the numbers listed and depends on the revetments present, will be greatest for the PD fuze set superquick, next for the combination time and superquick setting, and absent for time fuzes with no combination superquick feature.

The ratios of the required numbers of rounds listed under *Impact* to those under *Time and Impact* are therefore:

a. Somewhat greater than the ratios of required rounds for actual fire with PD fuze (set SQ) as against time fuzes with both T and SQ.

b. Considerably greater than the ratios of required rounds for actual fire with PD fuze (set SQ) and time fuzes with no superquick feature.

c. More nearly correct the greater the shielding due to revetments.

8. COMPARISON OF AIMED AND AREA FIRE.

The numbers listed in Tables 71 and 72 for the same gun ammunition combination and range are not directly comparable, since they refer to entirely different quantities, those in 72 being number of rounds per enemy piece attacked, and those in 71 number of rounds per 10,000 square yards area fired upon.

In general, *aimed fire,* if the enemy pieces are accurately located, *is at least as good as area fire and is almost always better* when the same height of center of burst is used. At great ranges, where dispersion is large, and with very many enemy pieces in a small area, area fire may be essentially as good, since the rounds fired at neighboring enemy pieces may overlap due to dispersion. In this case, rounds aimed at one piece may damage its neighbor. If this situation, of extremely high area concentration of enemy pieces, holds, then the numbers given in Table 72 for aimed fire may be high (since any given weapon may be damaged by rounds aimed at its neighbor) and the numbers in Table 71 pertaining to area fire may represent the true damage figures, even if aimed fire is used. In general, it is most profitable to fire the same number of rounds at each enemy piece, all other factors being equal.

TABLE 71

NUMBER OF ROUNDS REQUIRED AGAINST ENEMY ARTILLERY FOR 50% EFFECT FOR 10,000 SQ YD IN AREA FIRE

Gun and Ammunition	Muzzle Velocity f/s	Type of Fire	Range (yd)					
			2,000	5,000	10,000	15,000	20,000	25,000
Howitzer, 75mm, M1, M1A1, M2, M3 Shell, HE, M48 Fuze, TSQ, M54 Fuze, PD, M48A2	1,250	Impact Time Time and impact	210 230 170	680 700 500				
Howitzer, 155mm, M1 Shell, HE, M107 Fuze, MT, M67A1 Fuze, PD, M51A3	1,850	Impact Time Time and impact	70 43 38	260 67 59	790 160 150	1,400 300 280		
Gun, 155mm, M1, M1A1, M2 Shell, HE, M101 Fuze, MT, M67A1 Fuze, PD, M51A3	2,800	Impact Time Time and impact	27 26 26	92 53 48	330 92 83	810 180 160	1,300 320 290	1,700
Howitzer, 240mm, M1 Shell, HE, M114 Fuze, MT, M67A1 Fuze, PD, M51A3	2,300	Impact Time Time and impact					1,100 120 110	1,400 160 150

TABLE 72

NUMBER OF ROUNDS REQUIRED AGAINST ENEMY ARTILLERY FOR 90% PROBABILITY OF AT LEAST ONE EFFECTIVE HIT IN AIMED FIRE

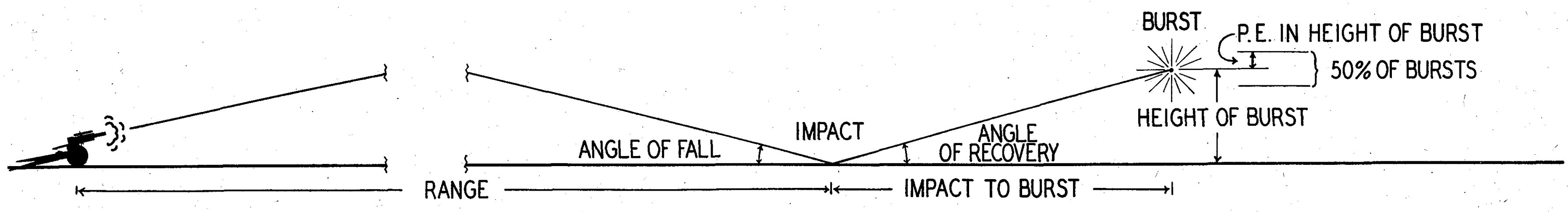
Gun and Ammunition	MV f/s	Type of fire	Range (yd)						
			2,000	5,000	10,000	15,000	20,000	25,000	30,000
Howitzer, 75mm, M1, M1A1, M2, M3 Shell, HE, M48 Fuze, TSQ, M54 Fuze, PD, M48 and Mod	1,250	Impact Time Time and Impact	24 340 43	460 1,400 560					
Gun, 75mm, M1897, M1897A1, M1897A2, M1897A3, M1897A4 Shell, HE, M48 Fuze, TSQ, M54 Fuze, PD, M48 and Mod	1,950	Impact Time Time and Impact	7 340 15	120 790 180					
Gun, 76mm, M1A1, M1AC, M1A2 Shell, HE, M42A1 Fuze, MT, M43A5 Fuze, PD, M48 and Mod	2,700	Impact Time Time and Impact	6 270 13	55 430 87					
Gun, 90mm, M1, M1A1, M2, M3 Shell, HE, M71 Fuze, MT, M43A5 Fuze, PD, M48 and Mod	2,700	Impact Time Time and Impact	3 260 7	42 360 68	770 1,400 730				
Howitzer, 105mm, M2, M2A1, M4 Shell, HE, M1 Fuze, TSQ, M54 Fuze, PD, M48 and Mod	1,020	Impact Time Time and Impact	24 250 41	460 820 430					
Howitzer, 105mm, M2, M2A1, M4 Shell, HE, M1 Fuze, TSQ, M54 Fuze, PD, M48 and Mod	1,550	Impact Time Time and Impact	6 270 13	91 450 130					
Gun, 4.5 inch, M1 Shell, HE, M65 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,820	Impact Time Time and Impact	3 410 7	19 430 36	380 960 420	2,600 3,400 2,000			
Gun, 4.5 inch, M1 Shell, HE, M65 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	2,275	Impact Time Time and Impact	16 500 31	39 560 69	460 1,200 520	2,300 4,000 2,100	7,700 9,000 5,900		
Howitzer, 155mm, M1917, M1917A1, M1918 Shell, HE, M102 Fuze, TSQ, M55A1 Fuze, PD, M51 and Mod	1,082	Impact Time Time and Impact	10 170 19	190 380 190					
Howitzer, 155mm, M1917, M1917A1, M1918 Shell, HE, M102 Fuze, TSQ, M55A1 Fuze, PD, M51 and Mod	1,476	Impact Time Time and Impact	7 210 14	130 320 140					
Howitzer, 155mm, M1 Shell, HE, M107 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,220	Impact Time Time and Impact	7 240 14	69 320 96					
Howitzer, 155mm, M1 Shell, HE, M107 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,850	Impact Time Time and Impact	3 340 7	23 320 41	250 590 270	2,300 1,900 1,400			

TABLE 72 (Continued)

Gun and Ammunition	MV f/s	Type of fire	Range (yd) 2,000	5,000	10,000	15,000	20,000	25,000	30,000
Gun, 155mm, M1917, M1917A1, M1918 Shell, HE, M101 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,955	Impact Time Time and impact	5 370 11	42 340 68	570 770 460	2,900 2,300 1,700			
Gun, 155mm, M1917, M1917A1, M1918 Shell, HE, M101 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	2,410	Impact Time Time and Impact	4 450 9	23 410 42	250 480 240	1,600 1,500 1,000	5,900 3,700 2,800		
Gun, 155mm, M1, M1A1, M2 Shell, HE, M101 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	2,100	Impact Time Time and Impact		81 330 110	570 700 430	2,300 1,800 1,300			
Gun, 155mm, M1, M1A1, M2 Shell, HE, M101 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	2,800	Impact Time Time and Impact	9 520 18	48 460 80	330 590 310	2,300 960 790	4,500 2,500 1,800	11,000 4,500 4,000	
Howitzer, 8 inch, M1 Shell, HE, M106 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,380	Impact Time Time and Impact	3 210 7	28 220 45	380 390 250				
Howitzer, 8 inch, M1 Shell, HE, M106 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,950	Impact Time Time and Impact		3 290 7	54 280 78	330 430 260			
Gun, 8 inch, M1 Shell, HE, M103 Fuze, MT, M67A1 Fuze, PD, M51A2 Mod 3 and Mod	2,600	Impact Time Time and Impact				130 410 160	770 1,100 640	2,300 3,100 1,900	
Gun, 8 inch, M1 Shell, HE, M103 Fuze, MT, M67A1 Fuze, PD, M51A2 Mod 3 and Mod	2,850	Impact Time Time and Impact					1,100 1,400 850	2,300 3,400 1,900	25,000 7,000 6,200
Howitzer, 240mm, M1 Shell, HE, M114 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,500	Impact Time Time and Impact			330 320 220	2,300 1,200 950			
Howitzer, 240mm, M1 Shell, HE, M114 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	1,740	Impact Time Time and Impact				1,100 1,600 930			
Howitzer, 240mm, M1 Shell, HE, M114 Fuze, MT, M67A1 Fuze, PD, M51 and Mod	2,300	Impact Time Time and Impact					2,300 1,000 820	7,700 2,400 2,100	

Volume III Part 10

RICOCHET TRAJECTORY



1. GENERAL.

The figure titled Ricochet Trajectory shows the position of the burst with respect to the impact after ricochet from level ground when a point detonating delay fuze is used. The quantities *angle of fall*, *angle of recovery*, distance from *impact to burst*, *height of burst*, and *probable error in height of burst* are tabulated against range for several combinations of gun and ammunition. The tables apply not only to the gun and ammunition listed but to any gun and charge firing the ammunition with the tabulated muzzle velocity and any fuze of the same standard contour with the tabulated delay time. Ricochets are not ordinarily expected at longer ranges (larger angles of fall) than those tabulated. The angle and velocity of recovery and consequent position of burst depend on the slope of the soil, the soil density and other factors. These tables are based on data gathered on level soil which is a sand clay mixture, well integrated and believed to be a general average of soil hardness. The probable error in height of burst will depend on the uniformity of the surface in the impact area.

Note: The following tables contain data for the fuze listed and certain listed fuze delay times only. These same fuzes have other delay times than that listed. However, the delay time is indicated on each fuze as part of the fuze nomenclature.

TABLE 73

Howitzer, 75mm, M1, M1A1, M2, M3
Shell, HE, M48

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 700 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000	109 242 415	155 265 315	26 17 7	12 14 7	2 3 2
Charge 2 MV 810 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000	82 178 295	120 220 295	32 24 15	12 16 14	2 3 3
Charge 3 MV 950 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000	58 127 208 305 425	90 175 245 295 315	40 33 25 17 8	11 21 18 15 8	2 4 4 4 3
Charge 4 MV 1,250 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000	38 86 142 206 279 363	60 125 190 245 285 310	51 42 35 28 21 14	11 16 20 21 18 14	2 3 4 4 4 4

TABLE 74

Gun, 75mm, M1897 Series
Shell, HE, M48

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Reduced Charge MV 950 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000	59 126 206 301	90 170 245 295	40 33 25 17	11 17 18 16	2 3 4 4
Normal Charge MV 1,500 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000	26 65 115 174 240 313 394	45 100 160 220 265 300 315	62 50 41 33 26 19 13	8 15 19 22 21 17 12	2 3 4 5 5 4 4
Super Charge MV 1,950 f/s Fuze, PD, M48, M48A2 and M51A4 (0.05 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000	13 36 70 116 171 234 303 378	25 60 105 160 215 260 295 315	28 23 19 14 12 9 7 5	2 4 6 7 8 7 6 4	0 1 1 1 2 2 2 1

Note: Data also applies to the Gun, 75mm, M3 and M6.

TABLE 75

Gun, 76 mm, M1A1, M1A1C, M1A2
Shell, HE, M42A1

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
MV 2,700 f/s Fuze, PD, M48, M48A2 and M51A4 (0.05 sec delay)	1,000	8	20	40	3	0
	2,000	20	35	33	4	1
	3,000	38	60	26	5	1
	4,000	65	100	21	6	1
	5,000	106	150	16	7	1
	6,000	163	210	12	7	2
	7,000	233	260	9	7	2
	8,000	315	300	6	6	1
	9,000	407	315	4	4	1

Note: The data on distance from impact to burst, height of burst and PE in height of burst are approximately true for any 3 inch gun firing this projectile with MV from 2,600 to 2,800 f/s.

TABLE 76

Gun, 90 mm, M1, M1A1, M2, M3
Shell, HE, M71

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
MV 2,700 f/s Fuze, PD, M48, M48A2 and M51A4 (0.05 sec delay)	1,000	7	20	41	2	0
	2,000	17	30	36	3	1
	3,000	30	50	32	5	1
	4,000	47	75	28	6	1
	5,000	69	105	23	7	1
	6,000	98	140	19	8	2
	7,000	136	180	15	8	2
	8,000	187	230	12	8	2
	9,000	249	270	9	8	2
	10,000	314	300	7	6	2

TABLE 77

Howitzer, 105 mm, M2, M2A1, M4
Shell, HE, M1

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 650 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	126	170	24	12	2
	2,000	272	285	15	13	3
Charge 2 MV 710 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	104	145	27	12	2
	2,000	226	260	19	15	3
	3,000	370	315	10	10	3
Charge 3 MV 780 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	87	125	31	12	2
	2,000	188	230	23	16	3
	3,000	304	295	15	14	3
Charge 4 MV 875 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	69	105	36	11	2
	2,000	147	195	29	17	3
	3,000	237	265	21	17	4
	4,000	343	305	14	13	3
Charge 5 MV 1,020 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	51	80	44	10	2
	2,000	109	155	37	17	3
	3,000	174	220	30	20	4
	4,000	247	270	23	19	4
	5,000	331	305	17	15	4
	6,000	430	315	10	9	3
Charge 6 MV 1,235 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	39	65	51	10	2
	2,000	86	125	43	17	3
	3,000	138	185	36	20	4
	4,000	198	235	30	21	4
	5,000	265	280	24	20	4
	6,000	339	305	17	16	4
	7,000	422	315	10	10	4
Charge 7 MV 1,500 f/s Fuze, PD, M48A1, M48A2 and M51A4 (0.15 sec delay)	1,000	25	45	65	8	2
	2,000	60	95	54	15	3
	3,000	104	145	44	19	4
	4,000	156	200	37	22	4
	5,000	214	250	29	22	5
	6,000	278	285	23	20	5
	7,000	348	310	17	16	4
	8,000	423	315	10	10	4

Note: Data for Charges 1-5 applies also to Howitzer, 105 mm, M3.

TABLE 78

Gun, 4.5 inch, M1
Shell, HE, M65

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Normal Charge MV 1,820 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	16	30	83	7	1
	2,000	36	60	74	13	2
	3,000	60	95	65	18	3
	4,000	89	130	56	22	4
	5,000	125	170	48	24	5
	6,000	168	215	39	25	5
	7,000	219	250	32	24	5
	8,000	274	285	26	22	5
	9,000	334	305	19	18	5
	10,000	395	315	14	13	4
Super Charge MV 2,275 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	10	20	105	7	1
	2,000	22	40	96	11	2
	3,000	37	60	87	15	3
	4,000	54	85	78	20	4
	5,000	75	110	70	23	4
	6,000	100	140	61	26	5
	7,000	130	175	52	27	5
	8,000	167	215	44	28	6
	9,000	211	250	36	27	6
	10,000	261	280	29	24	5
	11,000	317	300	22	20	5
	12,000	376	315	17	16	5
	13,000	438	315	11	11	4

TABLE 79

Howitzer, 155 mm, M1917, M1917A1, M1918
Shell, HE, M102

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 679 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	112	155	26	12	2
	2,000	241	265	18	14	3
	3,000	397	315	9	8	3
Charge 2 MV 741 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	95	135	30	12	2
	2,000	200	240	22	16	3
	3,000	322	300	14	13	3
Charge 3 MV 831 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	75	110	35	12	2
	2,000	158	205	27	17	4
	3,000	251	275	20	17	4
	4,000	361	310	13	12	3
Charge 4 MV 938 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	58	90	40	11	2
	2,000	124	170	34	17	3
	3,000	196	235	27	19	4
	4,000	277	285	21	18	4
	5,000	371	310	14	13	4
Charge 5 MV 1,082 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	46	75	47	10	2
	2,000	97	140	41	16	3
	3,000	153	200	34	20	4
	4,000	216	250	27	21	4
	5,000	286	290	21	19	4
	6,000	366	310	15	14	4
Charge 6 MV 1,357 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	32	55	58	10	2
	2,000	72	110	49	15	3
	3,000	118	165	41	20	4
	4,000	171	215	34	22	4
	5,000	229	260	28	22	5
	6,000	292	290	22	19	4
	7,000	359	310	16	15	4
	8,000	432	315	10	10	4
Charge 7 MV 1,476 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	25	45	64	8	2
	2,000	60	95	54	15	3
	3,000	102	145	45	19	4
	4,000	151	195	38	22	4
	5,000	206	245	31	23	5
	6,000	265	280	25	22	5
	7,000	328	305	19	18	4
	8,000	395	315	14	13	4

TABLE 80

Howitzer, 155mm, M1 — Shell, HE, M107

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 680 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000	112 240 397	155 265 315	26 18 9	12 14 8	2 3 3
Charge 2 MV 770 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000	87 185 297 436	125 225 295 315	31 24 16 7	12 16 14 7	2 3 3 3
Charge 3 MV 880 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000	68 141 223 318 433	105 185 255 300 315	37 30 23 16 8	12 17 18 15 8	2 3 4 4 3
Charge 4 MV 1,020 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000	50 106 168 237 315 406	80 150 215 265 300 315	45 38 31 24 18 11	10 17 20 20 16 11	2 3 4 4 4 4
Charge 5 MV 1,220 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000	38 82 133 188 249 315 389	60 120 180 230 270 300 315	51 45 38 32 26 20 13	9 16 20 22 21 18 12	2 3 4 5 5 4 4
Charge 6 MV 1,520 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000	24 54 92 138 190 247 307 371 439	40 85 130 185 230 270 300 310 315	66 56 48 40 34 27 21 16 10	7 14 19 22 23 22 19 15 10	2 3 4 4 5 5 5 4 4
Charge 7 MV 1,850 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000	15 35 60 92 130 176 228 286 348 411	30 60 95 130 175 220 260 290 310 315	83 74 64 55 46 38 30 24 18 13	7 13 18 21 24 25 24 21 17 13	1 2 4 4 5 5 5 5 4 4

TABLE 81

Gun, 155mm, M1917, M1917A1, M1918 — Shell, HE, M101

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Normal Charge MV 1,955 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000	14 32 53 79 111 151 198 253 314 380 448	30 55 85 115 155 195 235 275 300 315 315	89 81 71 61 52 44 36 28 21 15 10	8 13 18 21 24 26 25 23 20 15 9	2 3 4 4 5 5 5 5 5 4 4
Super Charge MV 2,410 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000	9 20 33 49 68 91 120 154 195 245 302 365 432	20 35 55 80 105 130 165 200 235 270 295 310 315	111 102 92 83 74 65 56 47 39 31 24 18 11	7 11 15 19 23 25 28 28 28 25 22 17 11	1 2 3 4 4 5 6 6 6 6 5 5 4

TABLE 82

Gun, 155mm, M1, M1A1, M2
Shell, HE, M101

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Normal Charge MV 2,100 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	12	25	96	7	1
	2,000	28	50	86	13	2
	3,000	47	75	77	17	3
	4,000	70	105	67	21	4
	5,000	98	140	58	24	5
	6,000	132	180	49	26	5
	7,000	173	215	40	26	5
	8,000	221	255	33	25	5
	9,000	276	285	26	22	5
	10,000	336	305	20	18	5
	11,000	399	315	14	14	4
Super Charge MV 2,800 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	7	20	130	7	1
	2,000	14	30	121	10	2
	3,000	22	40	112	13	3
	4,000	33	55	102	17	3
	5,000	46	75	93	21	4
	6,000	62	95	84	24	4
	7,000	82	120	74	26	5
	8,000	107	150	65	29	6
	9,000	135	180	56	30	6
	10,000	169	215	47	30	6
	11,000	207	245	39	29	6
	12,000	252	275	31	26	6
	13,000	302	295	24	22	5
	14,000	358	310	19	18	5
	15,000	419	315	14	14	5

HOWITZER, 8 in. M1, SHELL HE, M106

TABLE 83

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 820 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	76	110	34	11	2
	2,000	158	205	27	17	4
	3,000	251	275	20	17	4
	4,000	358	310	13	12	3
Charge 2 MV 900 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	63	95	39	11	2
	2,000	132	180	32	17	3
	3,000	206	245	26	19	4
	4,000	291	290	19	17	4
	5,000	387	315	12	11	3
Charge 3 MV 1,000 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	50	80	44	10	2
	2,000	106	150	38	17	3
	3,000	167	215	31	20	4
	4,000	235	265	25	20	4
	5,000	309	300	19	17	4
	6,000	393	315	13	12	4
Charge 4 MV 1,150 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	41	65	50	10	2
	2,000	86	125	44	16	3
	3,000	137	185	38	21	4
	4,000	192	235	32	22	5
	5,000	252	275	26	21	5
	6,000	317	300	19	18	4
	7,000	388	315	14	13	4

TABLE 83 (Continued)

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 5 MV 1,380 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	28	50	60	9	2
	2,000	64	100	52	15	3
	3,000	107	150	45	20	4
	4,000	154	200	38	23	5
	5,000	206	245	32	23	5
	6,000	262	280	26	22	5
	7,000	321	300	20	19	5
	8,000	384	315	15	14	4
Charge 6 MV 1,640 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	20	35	73	8	2
	2,000	45	70	65	14	3
	3,000	75	110	56	19	4
	4,000	111	155	48	22	4
	5,000	154	200	41	24	5
	6,000	203	240	34	24	5
	7,000	256	275	28	23	5
	8,000	313	300	22	20	5
	9,000	372	310	17	16	5
	10,000	434	315	11	11	4
Charge 7 MV 1,950 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	1,000	16	30	92	8	2
	2,000	33	55	80	13	3
	3,000	53	85	71	18	4
	4,000	76	110	63	21	4
	5,000	105	150	55	24	5
	6,000	139	185	47	26	5
	7,000	180	225	40	27	6
	8,000	227	260	33	26	6
	9,000	279	285	26	23	5
	10,000	335	305	21	19	5
	11,000	393	315	15	14	4

GUN, 8 in. M1, SHELL, HE, M103

TABLE 84

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Reduced Charge MV 2,100 f/s Fuze, PD, M51A1 Mod 1 and M51A2 Mod 3 (0.05 sec delay)	1,000	11	20	33	2	0
	2,000	24	40	31	4	1
	3,000	39	65	28	5	1
	4,000	56	85	26	7	1
	5,000	75	110	24	8	2
	6,000	97	140	22	9	2
	7,000	122	170	19	10	2
	8,000	150	195	17	10	2
	9,000	183	225	15	10	2
	10,000	220	255	13	10	2
	11,000	261	280	11	9	2
	12,000	306	295	9	8	2
	13,000	357	310	7	6	2
	14,000	412	315	5	5	2
Normal Charge MV 2,600 f/s Fuze, PD, M51A1 Mod 1 and M51A2 Mod 3 (0.05 sec delay)	15,000	272	285	11	10	2
	16,000	310	300	9	8	2
	17,000	351	310	7	7	2
	18,000	395	315	6	6	2
	19,000	442	315	4	4	2
Super Charge MV 2,850 f/s Fuze, PD, M51A1 Mod 1 and M51A2 Mod 3 (0.05 sec delay)	17,000	275	285	12	10	2
	18,000	309	300	10	9	2
	19,000	347	305	8	7	2
	20,000	387	315	6	6	2
	21,000	430	315	5	4	2

TABLE 85

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Reduced Charge MV 2,100 f/s Fuze, PD, M51A4 Mod 3 (0.15 sec delay)	1,000	11	20	97	6	1
	2,000	24	40	89	10	2
	3,000	39	65	81	15	3
	4,000	56	85	74	18	3
	5,000	75	110	66	22	4
	6,000	97	140	59	24	5
	7,000	122	170	52	26	5
	8,000	150	195	46	26	5
	9,000	183	225	40	27	6
	10,000	220	255	35	27	6
	11,000	261	280	30	26	6
	12,000	306	295	27	24	6
	13,000	357	310	24	23	6
	14,000	412	315	23	22	7
Normal Charge MV 2,600 f/s Fuze, PD, M51A4 Mod 3 (0.15 sec delay)	15,000	272	285	32	27	6
	16,000	310	300	29	26	6
	17,000	351	310	27	25	7
	18,000	395	315	25	24	7
	19,000	442	315	24	23	9
Super Charge MV 2,850 f/s Fuze, PD, M51A4 Mod 3 (0.15 sec delay)	17,000	275	285	33	29	6
	18,000	309	300	30	27	6
	19,000	347	305	28	26	7
	20,000	387	315	26	25	8
	21,000	430	315	26	24	9

TABLE 86

Howitzer, 240 mm, M1

Shell, HE, M114

	Range	Angle of Fall	Angle of Recovery	Impact to Burst	Height of Burst	PE in Height of Burst
	yd	mils	mils	yd	ft	ft
Charge 1 MV 1,500 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	9,000 10,000	371 428	310 315	17 11	16 11	5 4
Charge 2 MV 1,740 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	11,000	405	315	15	14	4
Charge 3 MV 2,020 f/s Fuze, PD, M51A3 and M51A4 (0.15 sec delay)	13,000	407	315	15	14	4

Note: Few ricochets expected with Charge 4 at minimum elevation with level carriage.

Volume III Part 11

ARMOR PENETRATION

(THIS PART SUPERSEDES VOLUME II PART 1, PAGES 1 TO 29. PAGES 31 TO 52 ARE NOT SUPERSEDED.)

1. GENERAL.

This section provides information pertaining to the performance of armor-piercing projectiles against homogeneous and face-hardened armor plate. The various theories and analyses of the mechanics of armor penetration will not be dealt with in this discussion, although such knowledge is necessary for better evaluation of results obtained from test firings of projectiles against armor plate. It also allows these findings to be interpreted more easily and accurately. It is from the test firings that data are obtained and compiled as a basis for determining penetrations.

2. ARMOR PENETRATION AND STRIKING VELOCITY CURVES.

Armor penetration data are graphically presented for standard and limited procurement projectiles when fired against armor plate at various angles of impact and plate obliquities. These data are shown for both rolled homogeneous armor and face-hardened plates. From the charts, the thickness of armor plate which can be penetrated, at a given range or striking velocity, can be determined. It will be noted that certain portions of the penetration curve are shown as broken lines. This represents an estimated performance for which actual firing data have not been obtained. **The penetration curves are compiled for intact or shattered projectile, with the greater portion of the fragments, completely penetrating the plate.**

3. CHARTS.

The chart shown in Figure 57 is for use in conjunction with the examples given below to illustrate the use of the striking velocity and armor penetration curves.

4. ILLUSTRATIVE EXAMPLES.

The following examples and the chart shown in Figure 57 illustrate the use of the striking velocity and armor penetration curves. The range scale in yards and the penetration scale in inches are shown along the bottom of the chart, the striking velocity in feet per second is shown along the left-hand border. The striking velocity curve is designated by showing the muzzle velocity upon which it is based. The penetration curves are designated to indicate the obliquity upon which they are based.

(1) Example I.

Given—3-inch plate thickness.

Required—The striking velocity and maximum range at which penetration at 20-degree obliquity can be achieved.

Solution—(1) Enter the penetration scale at point "A" which represents 3-inch plate thickness. (2) Proceed upward along the vertical line until the intersection with the 20-degree obliquity penetration curve is reached at "B". (3) From "B" proceed left along a line until the intersection with the striking velocity curve at "C" is reached. (4) From "C" continue left along the horizontal line to "E" where the striking velocity of 2,160 feet per second can be read; then proceed downward from "C" along the vertical line to "D" where the range of 1,430 yards is found. Thus, a striking velocity of 2,160 feet per second is needed to penetrate 3 inches of plate, and the maximum range at which the projectile will penetrate the plate is 1,430 yards.

(2) Example 2.

Given—1,430-yard range.

Required—The maximum thickness of armor plate which can be penetrated at 20-degree obliquity and the corresponding striking velocity required.

Solution—(1) Enter the range scale at 1,430 yards on "D" and proceed upward on a vertical line to point "C" where the striking velocity curve is intersected. (2) Proceed right from "C" along a horizontal line to "B" where the penetration curve for 20-degree obliquity is intersected. (3) Then proceed downward along a vertical line to "A" where a thickness of 3 inches is read. (4) From point "C" proceed left along horizontal line to "E" where a striking velocity of 2,160 feet per second is read.

(3) Example 3.

Given—2,160 feet per second striking velocity.

Required—The range and thickness of 20-degree obliquity armor plate which can be penetrated.

Solution—(1) Enter the striking velocity scale at point "E" which represents 2,160 feet per second. (2) Proceed right to point "C" and then downward along the vertical line to "D" where the range of 1,430 yards can be read. (3) From point "C" proceed right to "B" on the 20-degree obliquity curve and then downward along the vertical line to "A" where the thickness of 3 inches can be read.

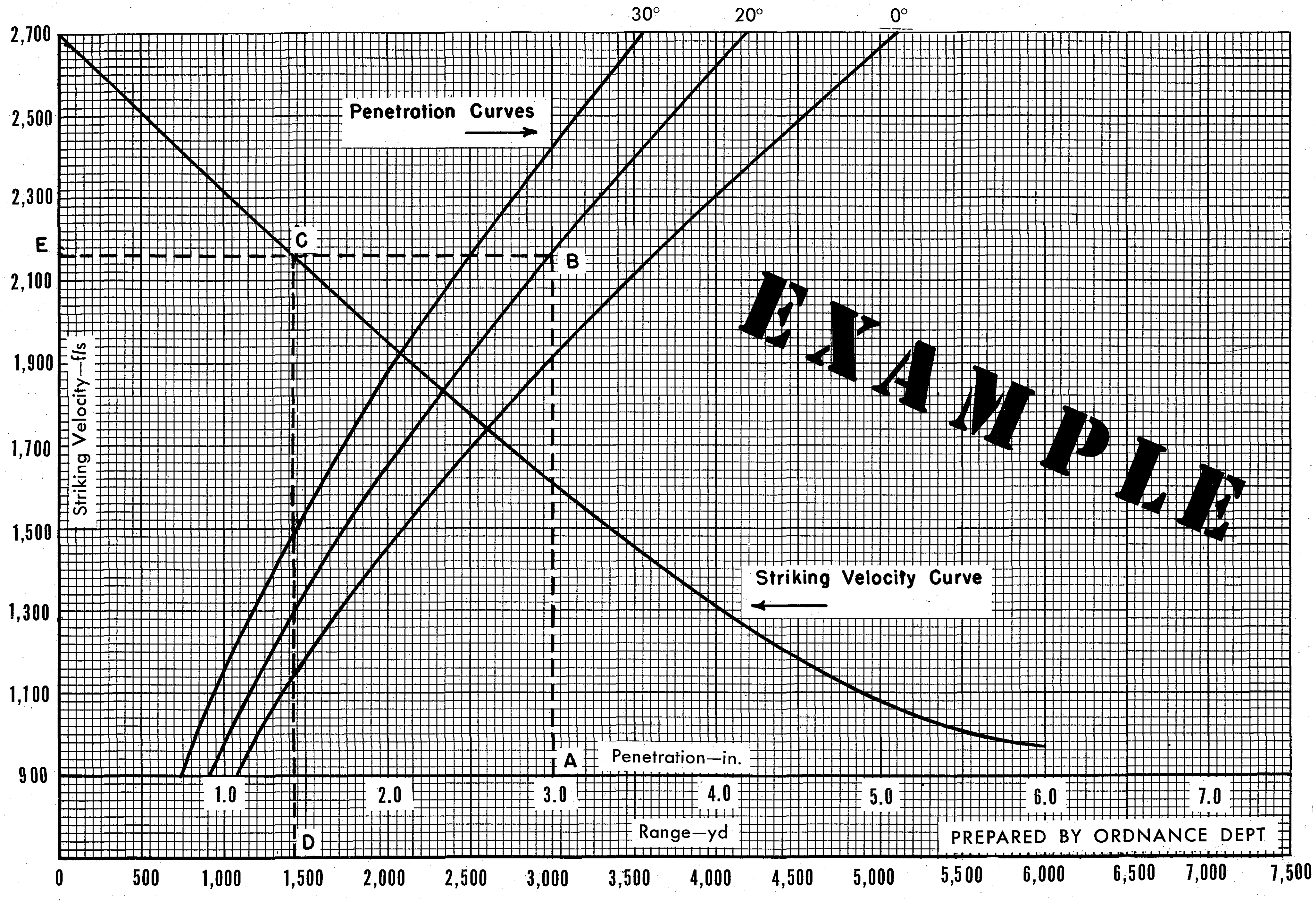

30°
20°
0°
Penetration Curves
Striking Velocity—f/s
2,700
2,500
2,300
E
C
B
2,100
1,900
1,700
1,500
1,300
1,100
900
EXAMPLE
Striking Velocity Curve
A
Penetration—in.
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Range—yd
D
PREPARED BY ORDNANCE DEPT
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
6,500
7,000
7,500

FIGURE 57

TABLE 87
ARMOR-PIERCING AMMUNITION CHARACTERISTICS

(These characteristics were used in the computation of the armor penetration and striking velocity curves.)

Projectile Model and Caliber	Proj Wt lb	Gun	Muzzle Vel f/s	Based on **	Figure No.
.30 cal AP, M2	166 grains	24-in. barrel MG	2,775	$C_5=0.250$*	58, 59
.50 cal AP, M2	708 grains	36-in. barrel MG 45-in. barrel MG	2,835 2,935	$C_5=0.458$ $C_5=0.458$	60, 61
20mm, AP-T, M75	2,548 grains	M2	2,555	$C_6=0.344$*	62, 63
20mm, AP-T, M95	2,000 grains	M2	2,800	$C_5=0.403$	64, 65
37mm, APC-T, M51B1 and M51B2	1.92	M3, M6	2,900	$C_6=0.544$	66, 67
37mm, APC-T, M59	1.91	AN-M9 M1A2	2,800 2,050	$C_1=0.492$ $C_1=0.610$*	68, 69
37mm, AP-T, M80	1.66	AN-M9 M4	3,050 1,825	$C_1=0.78$ $C_1=0.78$	70, 71
40mm, AP-T, M81 or M81A1	1.96	M1	2,870	$C_6=0.615$*	72, 73
57mm, AP-T, M70	6.28	M1	2,950	$C_1=0.974$	74, 75
57mm, APC-T, M86	7.27	M1	2,700	$C_6=1.31$	76, 77
75mm, APC-T, M61 or M61A1	14.96	M4, AN-M5A1 M10, M3	2,030	FT75-AY-1	78, 79
3 in. & 76mm, APC-T, M62 or M62A1	15.44	3 in. M5, M7 76mm, M1A1, M1A1C, M1A2	2,600	FT3-W-1 FT76-C-1	80, 81
3 in. & 76mm HVAP-T, M93 (T4E20), T4E17	9.36	3 in. M5, M7 76mm, M1A1, M1A1C, M1A2	3,400	$C_7=0.885$	82
90mm, APC-T, M82	24.11	M1, M2, M3	2,800 2,670	FT90-F-1	83, 84
90mm, AP-T, T33	24.06	M1, M2, M3	2,800	$C_7=1.86$	85
90mm, HVAP-T, T30E16	16.80	M1, M2, M3	3,350	$C_7=1.11$	86

*Variable ballistic coefficient.

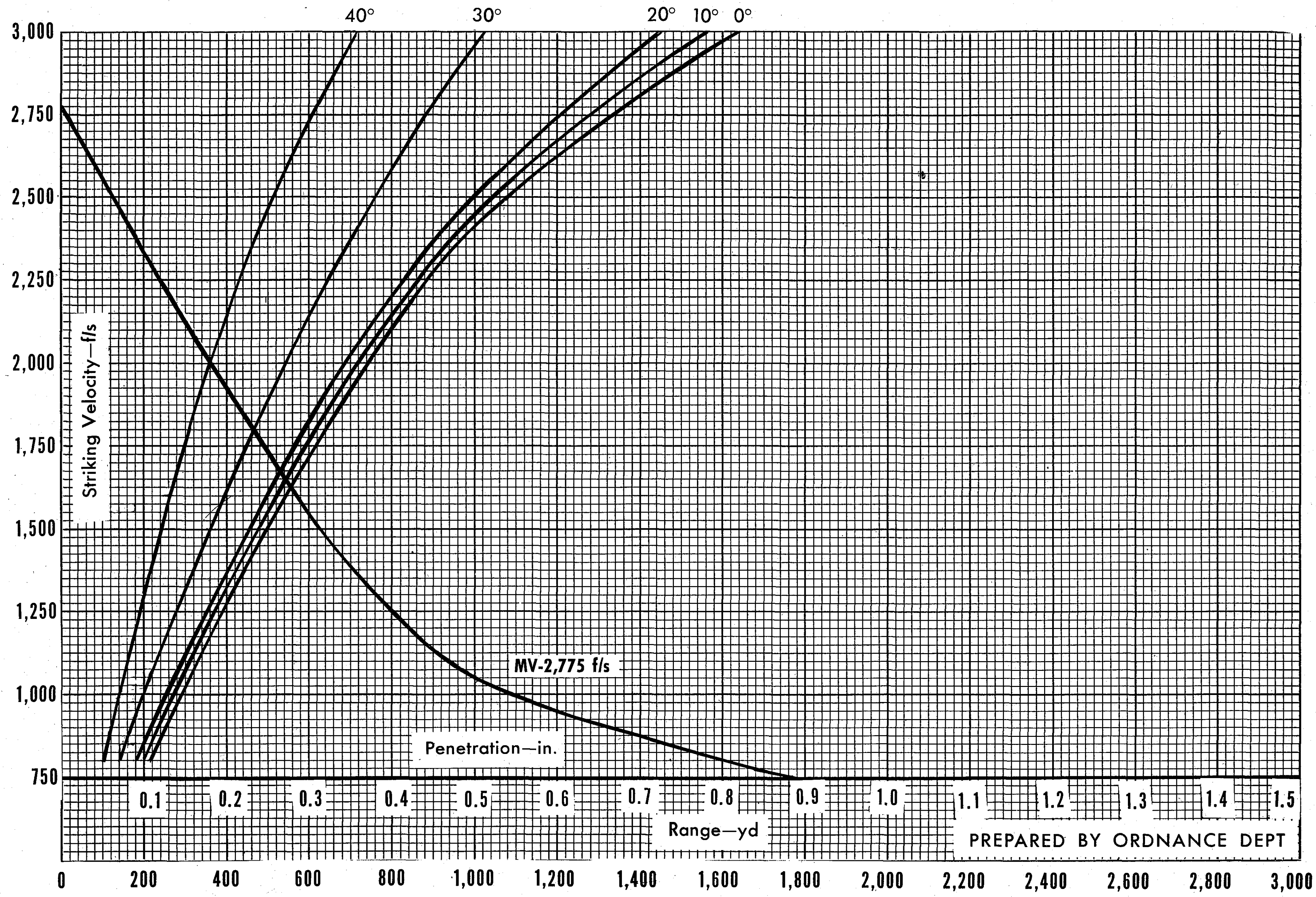
**Striking velocity curves are based on calculation made by Siacci's Method, using the indicated ballistic coefficients unless a Firing Table number is indicated.

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

ROLLED HOMOGENEOUS ARMOR PLATE

NAVY CRITERION*

BULLET, AP, .30 CAL, M2



*See definition, page 134

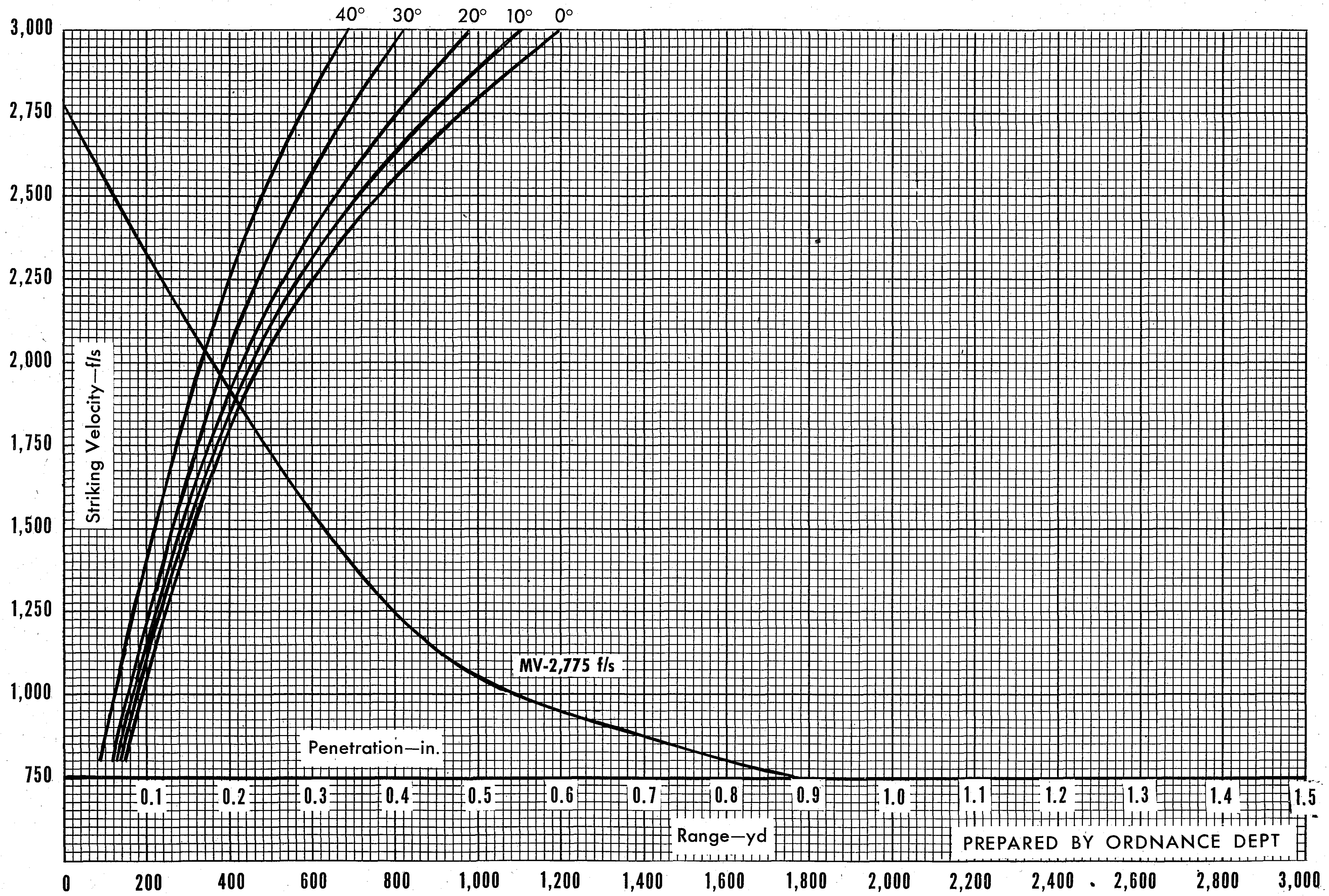
FIGURE 58

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*

FACE HARDENED ARMOR PLATE

BULLET, AP, .30 CAL, M2

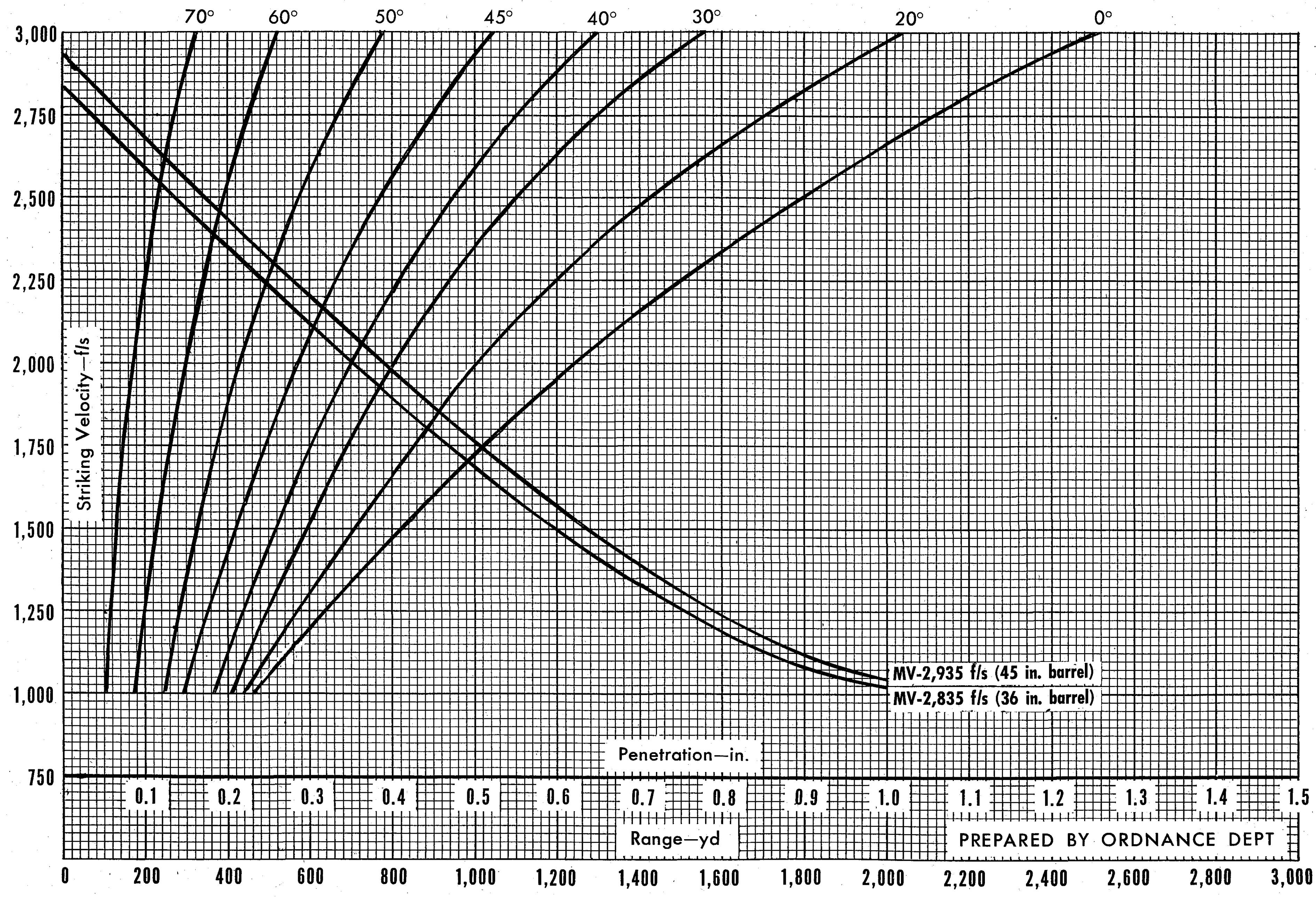


*See definition, page 134

FIGURE 59

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*

ROLLED HOMOGENEOUS ARMOR PLATE — BULLET, AP, .50 CAL, M2



*See definition, page 134

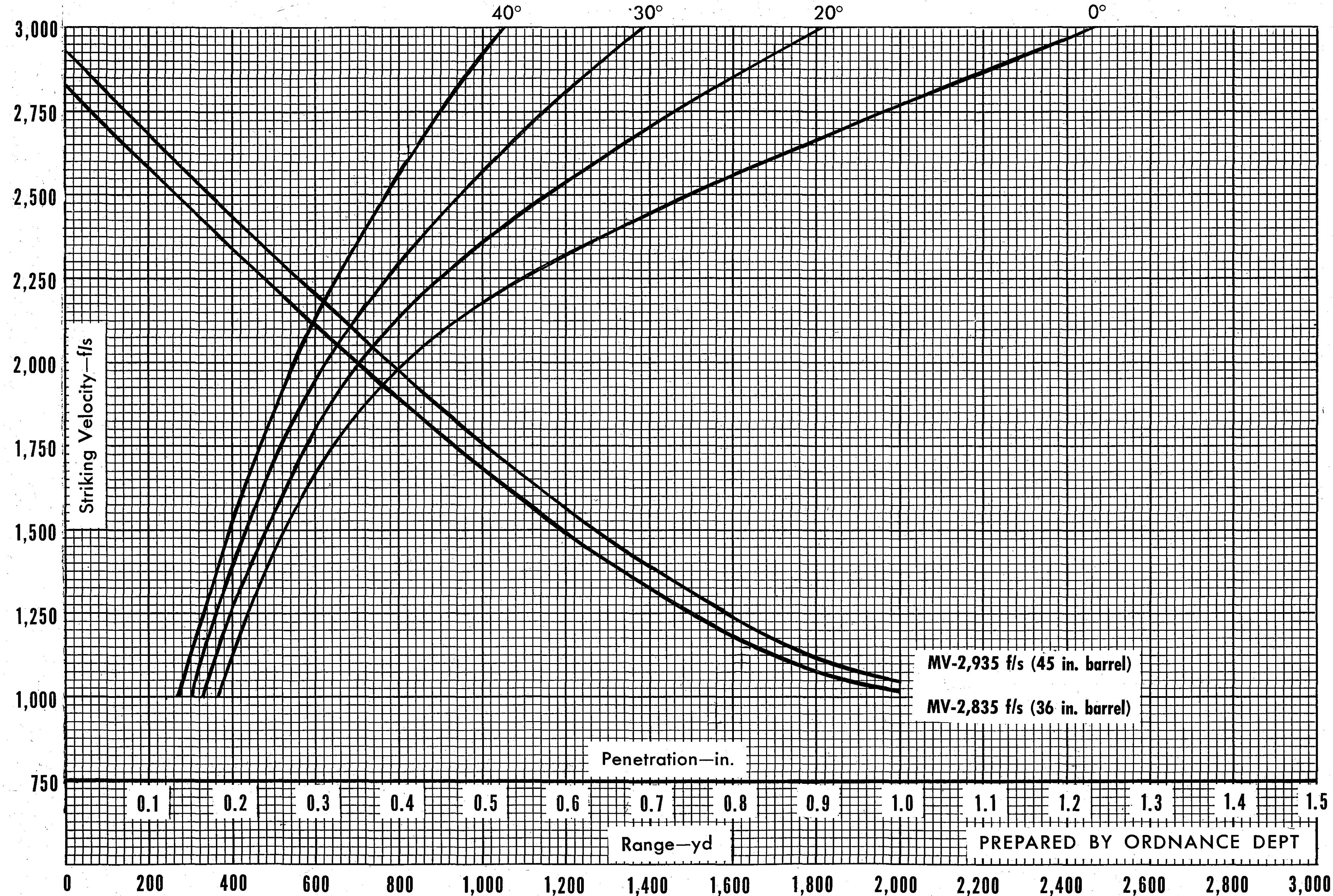
FIGURE 60

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*

FACE HARDENED ARMOR PLATE

BULLET, AP, .50 CAL , M2



*See definition, page 134

FIGURE 61

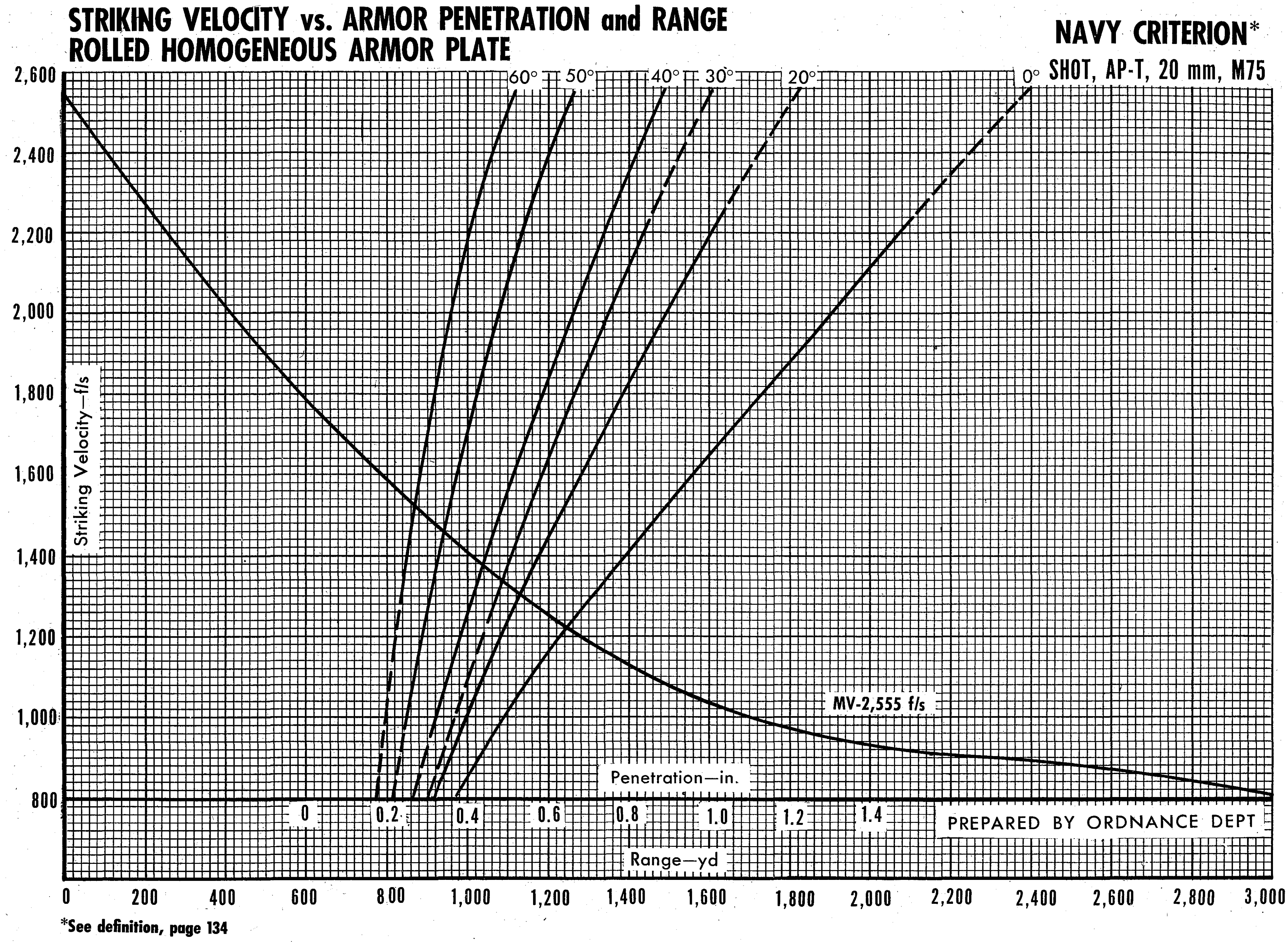
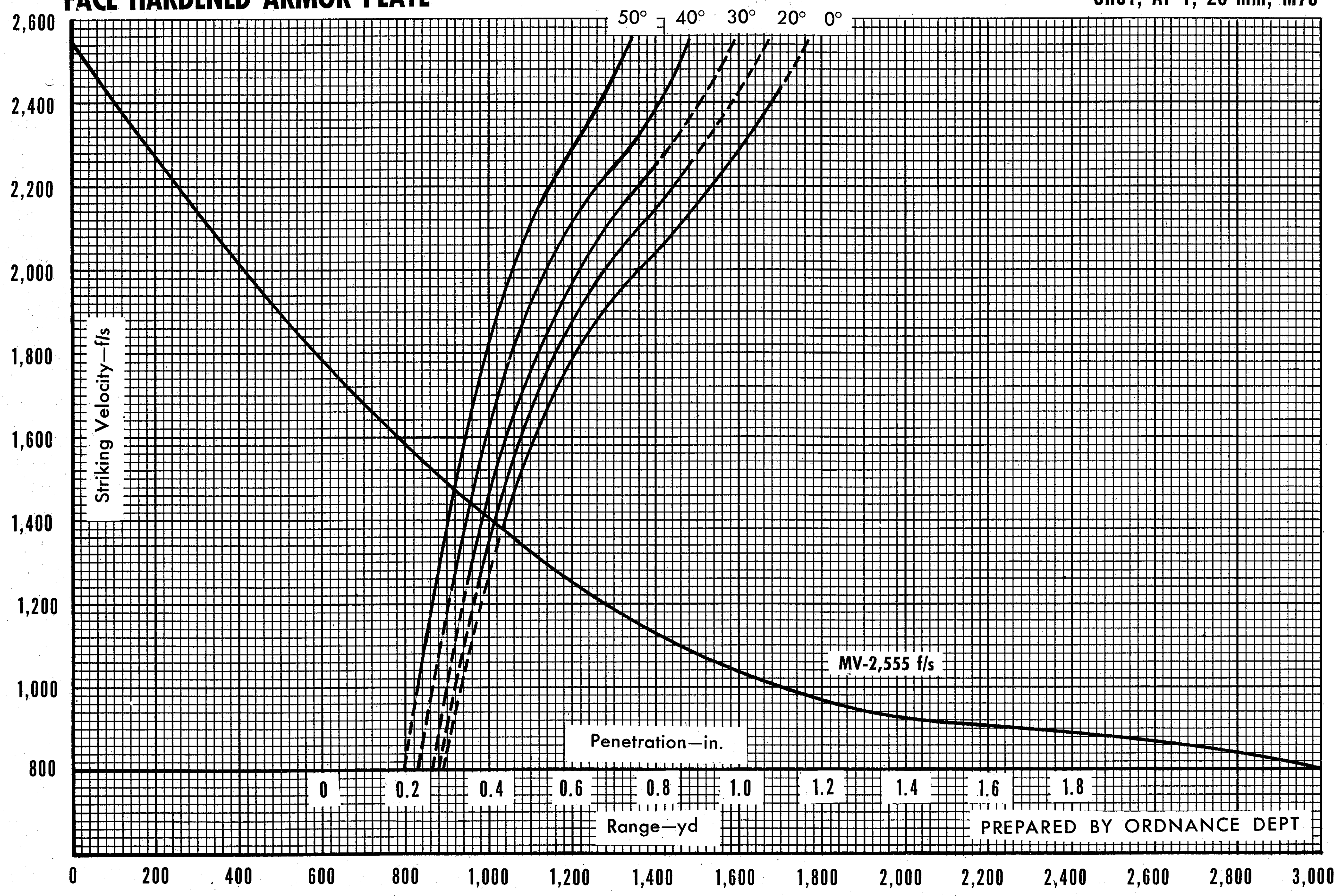

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE
ROLLED HOMOGENEOUS ARMOR PLATE
NAVY CRITERION*
SHOT, AP-T, 20 mm, M75
60°
50°
40°
30°
20°
0°
Striking Velocity—f/s
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
MV-2,555 f/s
Penetration—in.
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
PREPARED BY ORDNANCE DEPT
Range—yd
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
*See definition, page 134

FIGURE 62

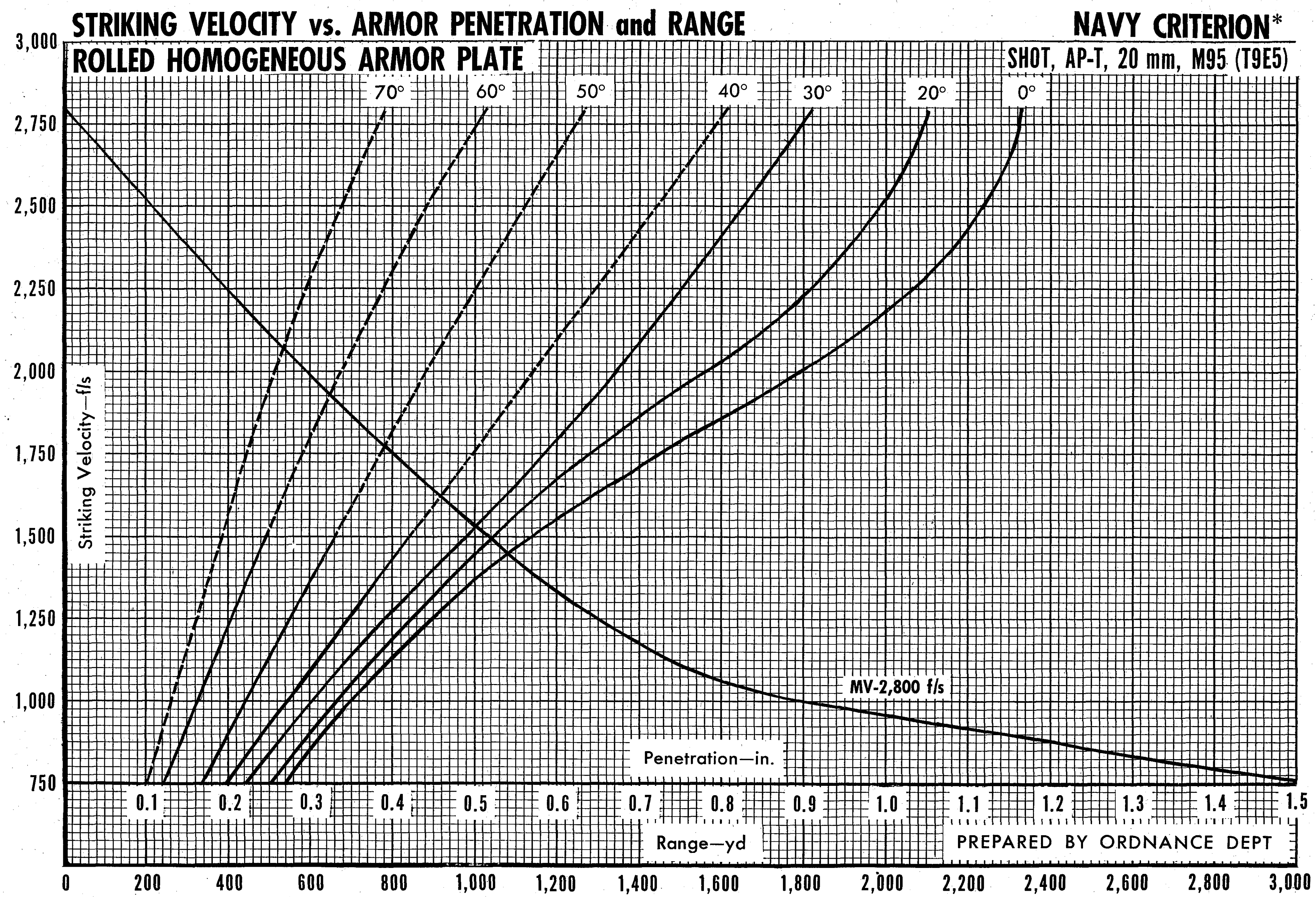
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE
FACE HARDENED ARMOR PLATE

NAVY CRITERION*
SHOT, AP-T, 20 mm, M75



*See definition, page 134

FIGURE 63



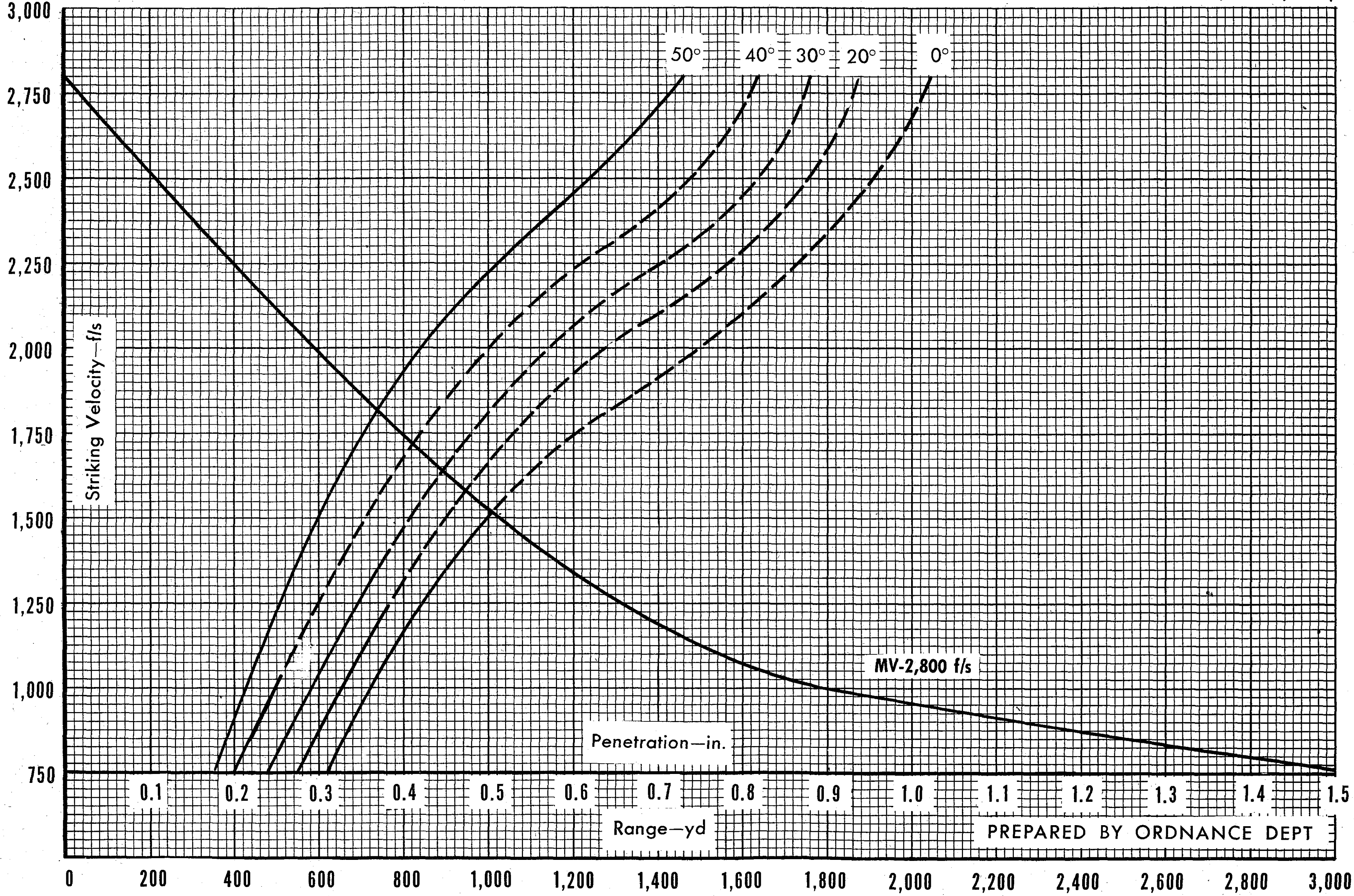
*See definition, page 134

FIGURE 64

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE FACE HARDENED ARMOR PLATE

NAVY CRITERION*

SHOT, AP-T, 20 mm, M95 (T9E5)

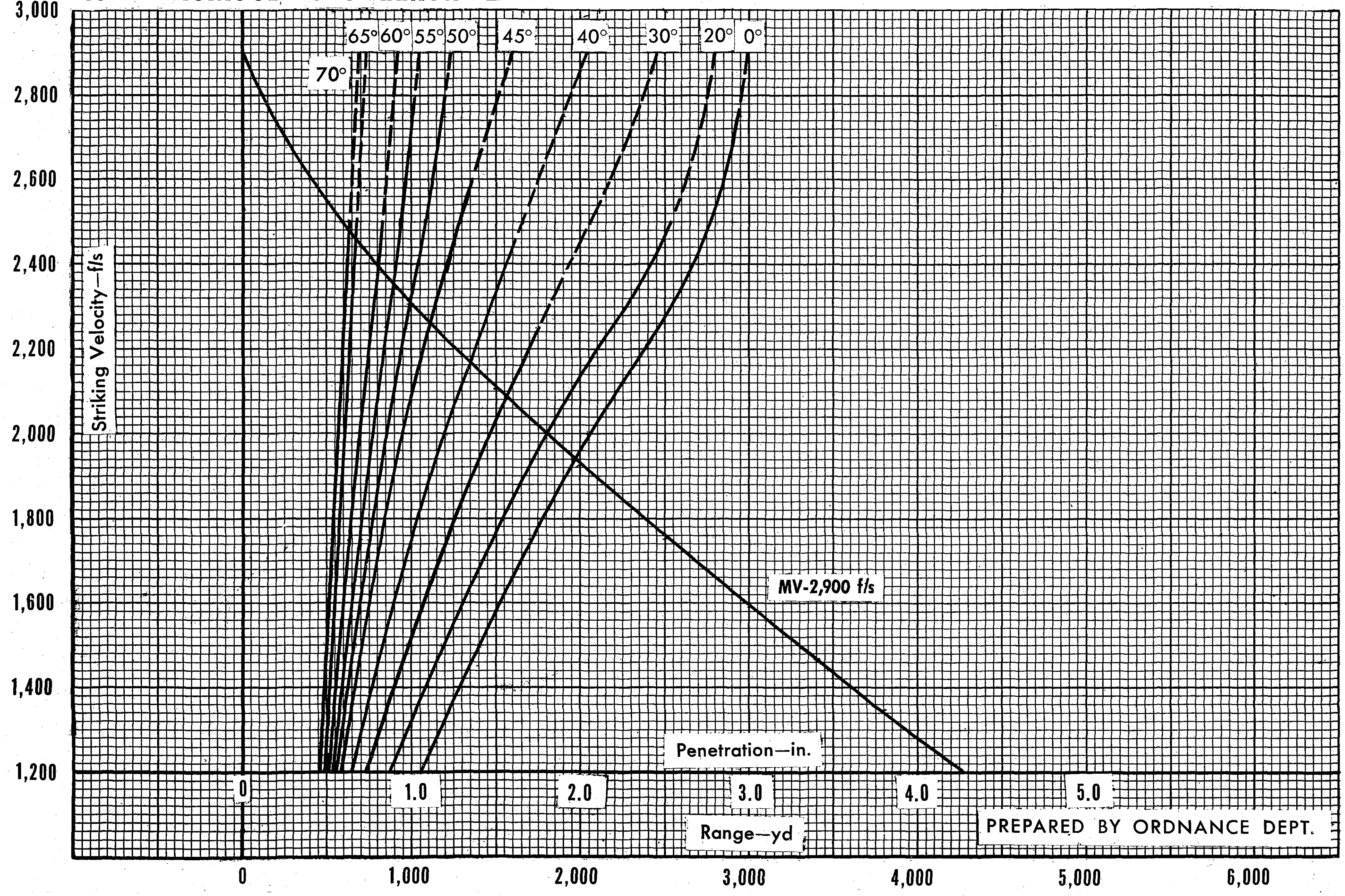


*See definition, page 134

FIGURE 65

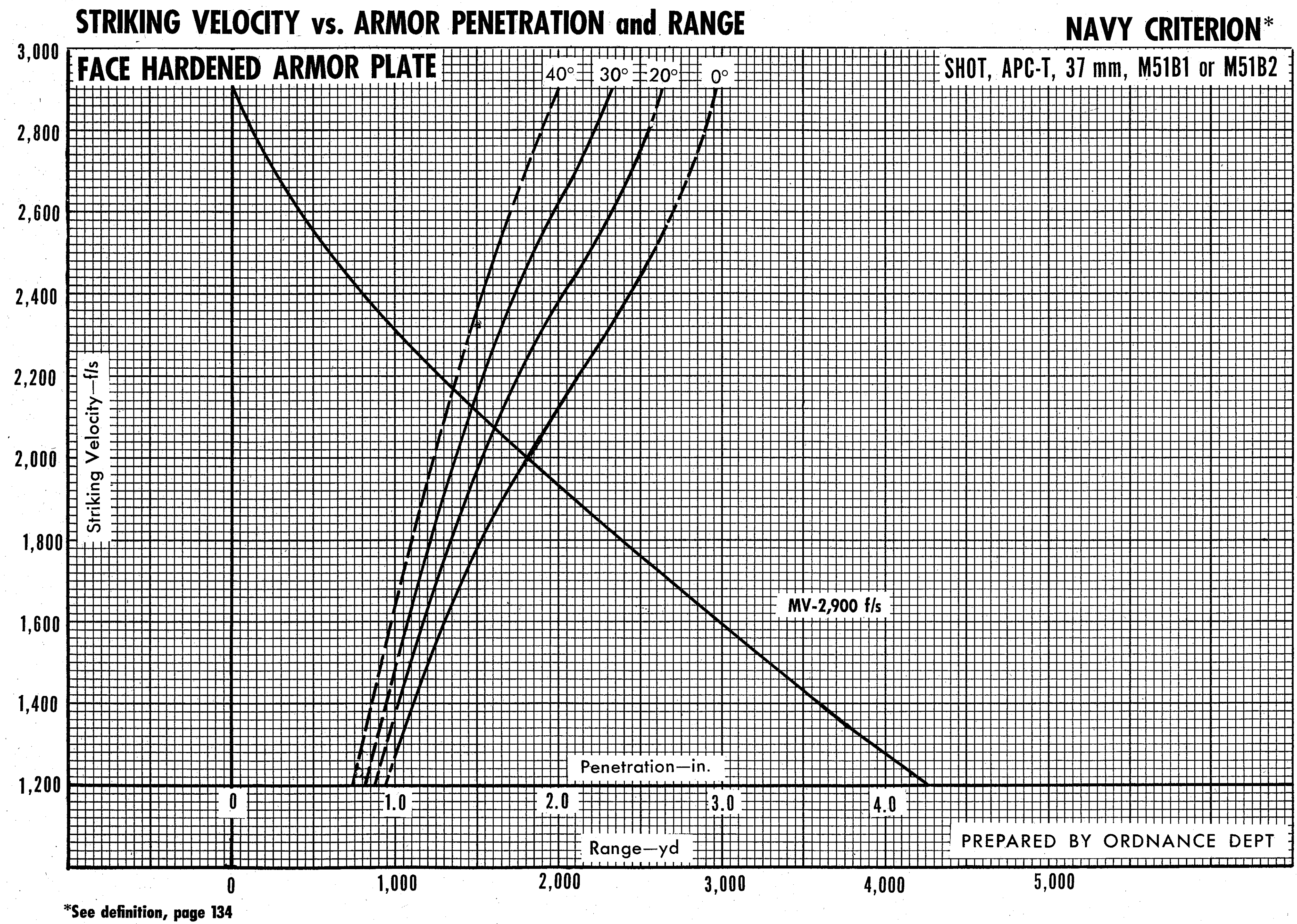
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE
ROLLED HOMOGENEOUS ARMOR PLATE

NAVY CRITERION*
SHOT, APC-T, 37 mm, M51B1 or M51B2



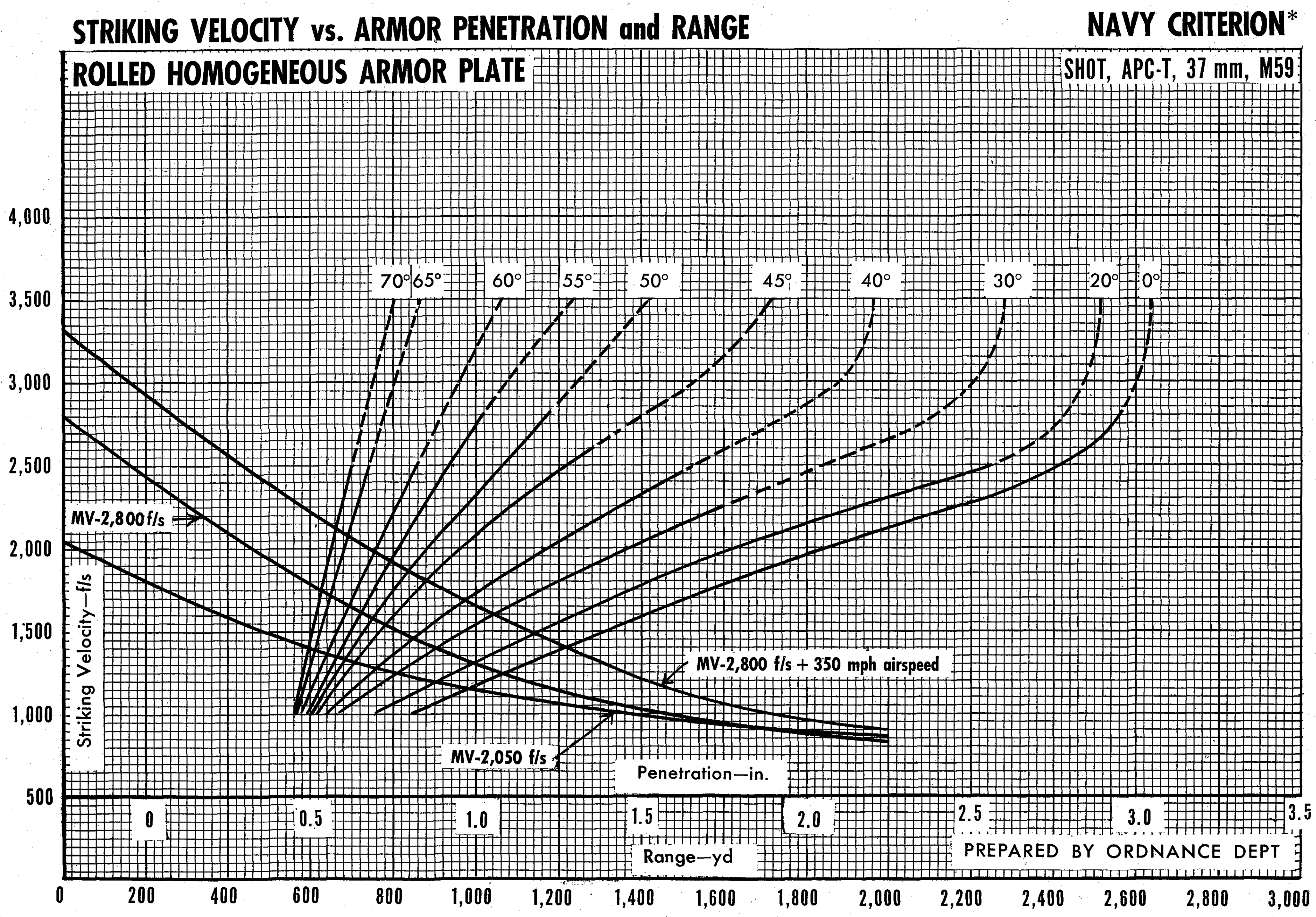
*See definition, page 134

FIGURE 66



*See definition, page 134

FIGURE 67

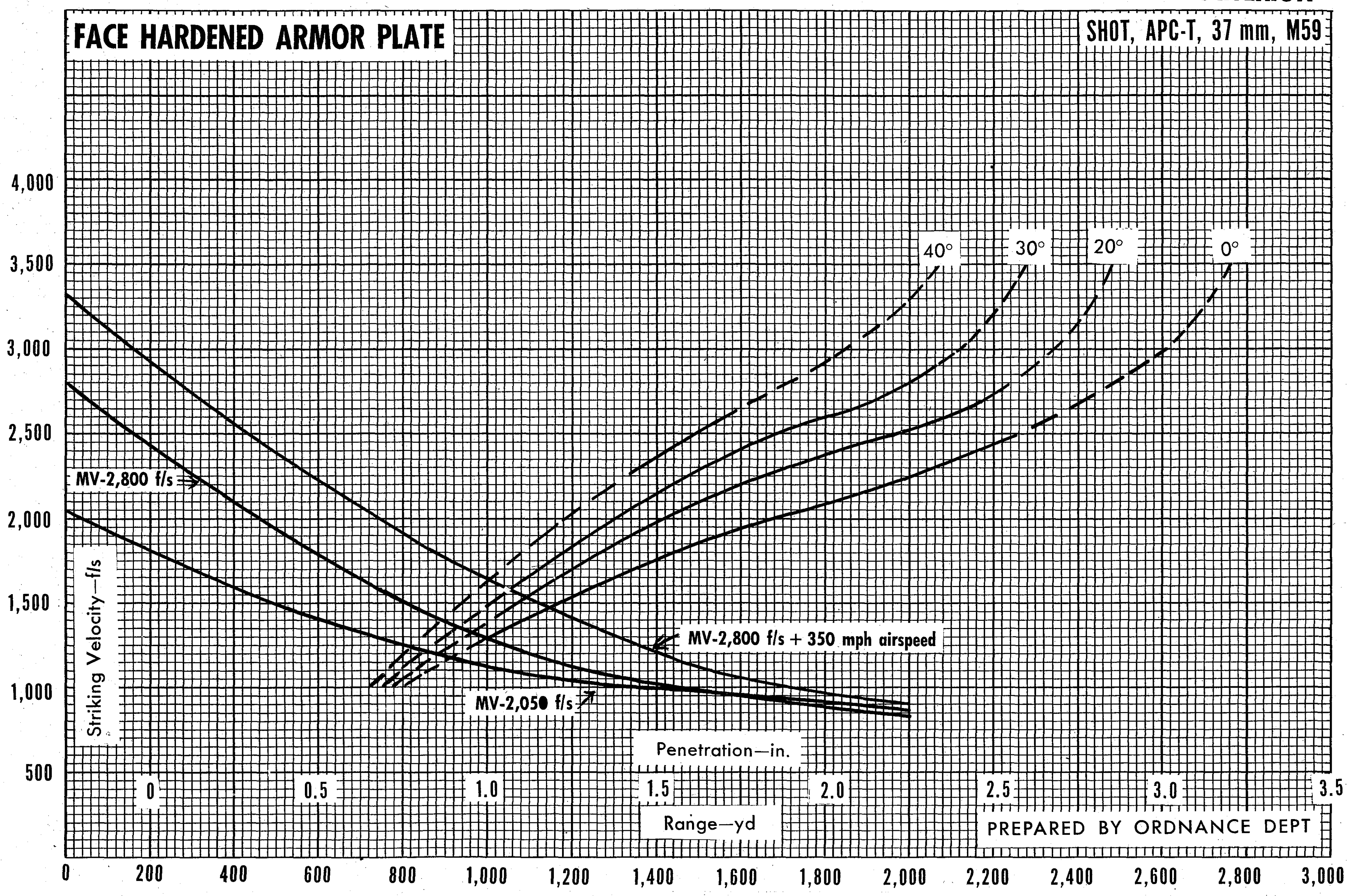


*See definition, page 134

FIGURE 68

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*

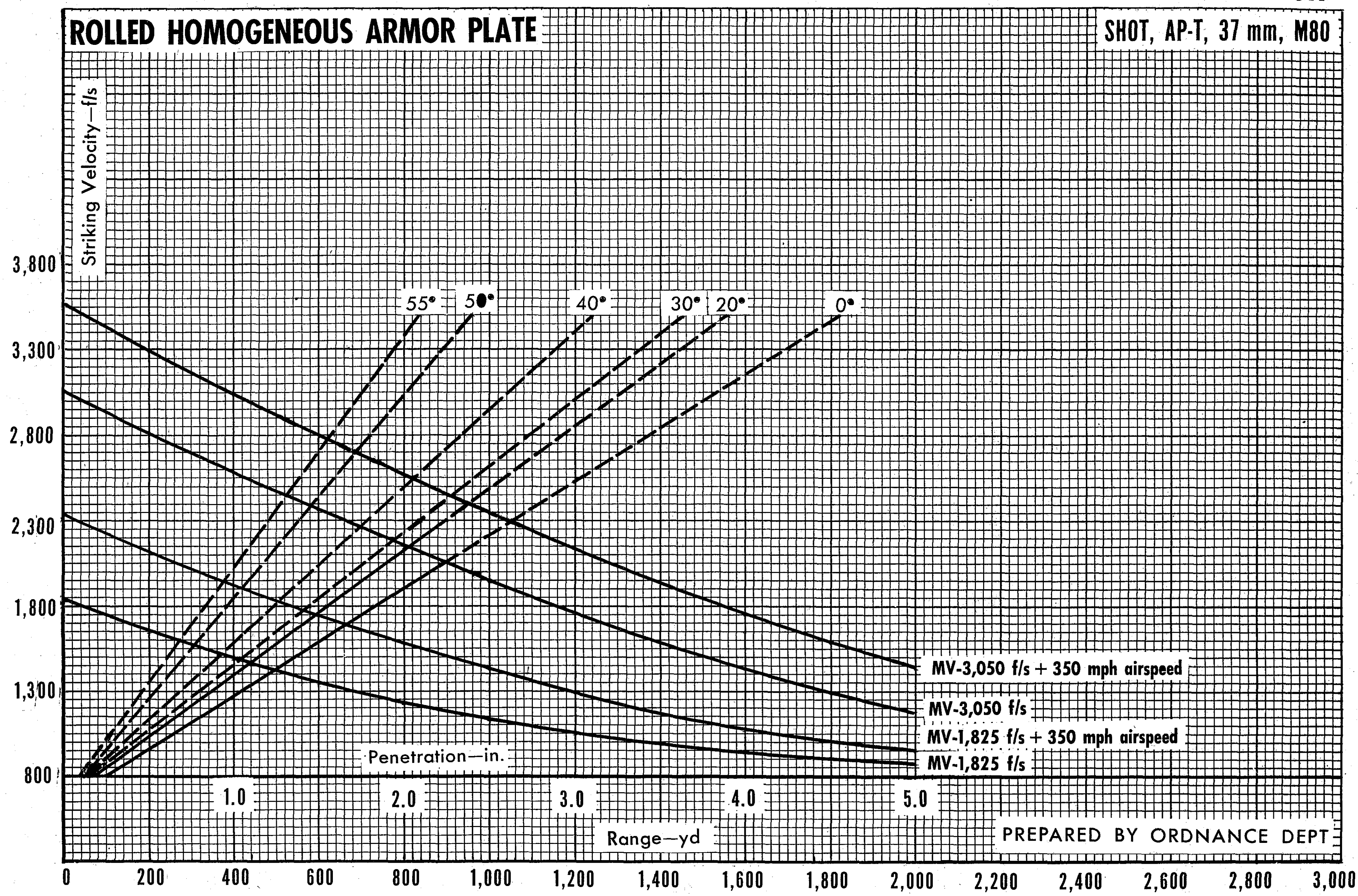


*See definition, page 134

FIGURE 69

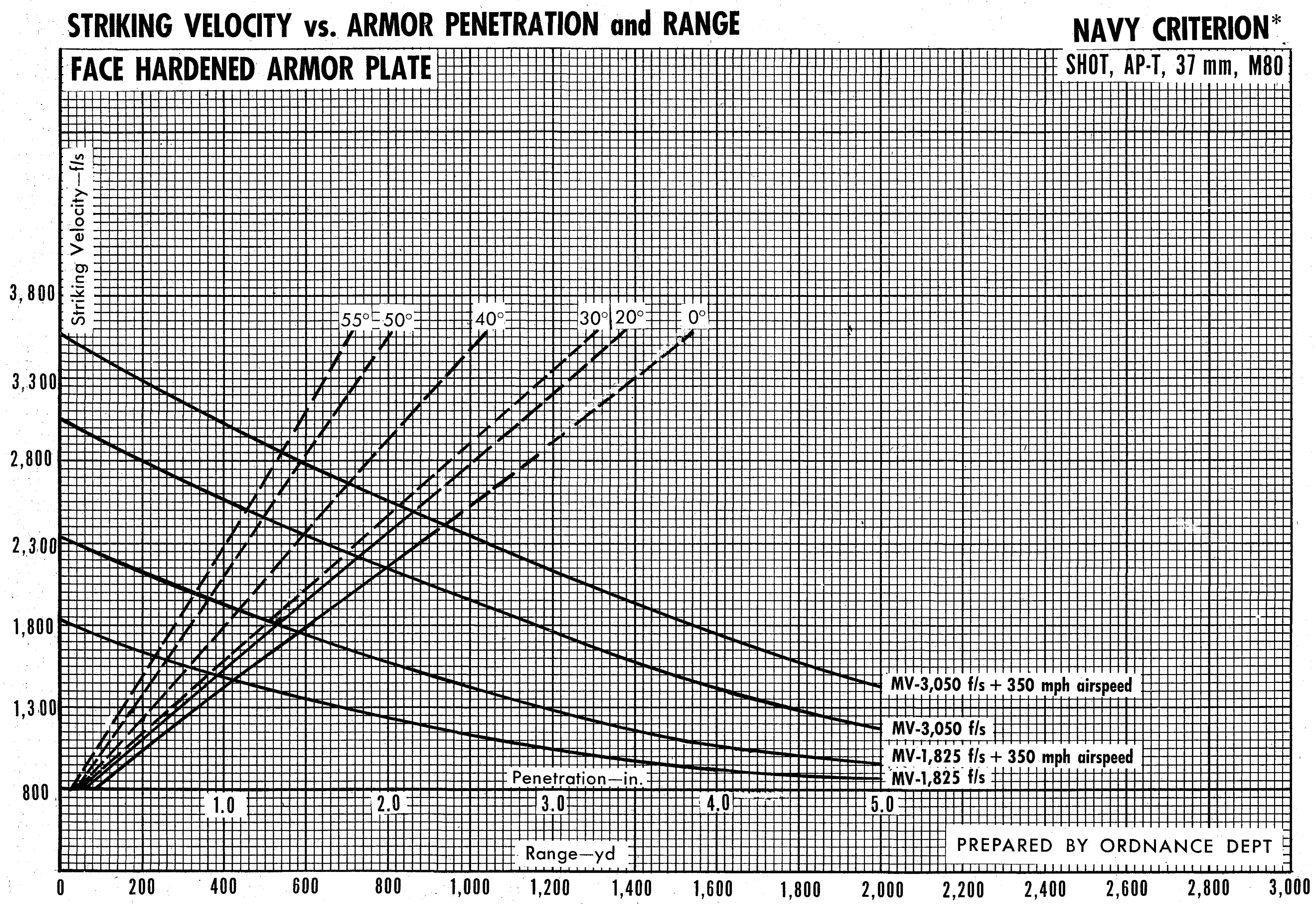
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*



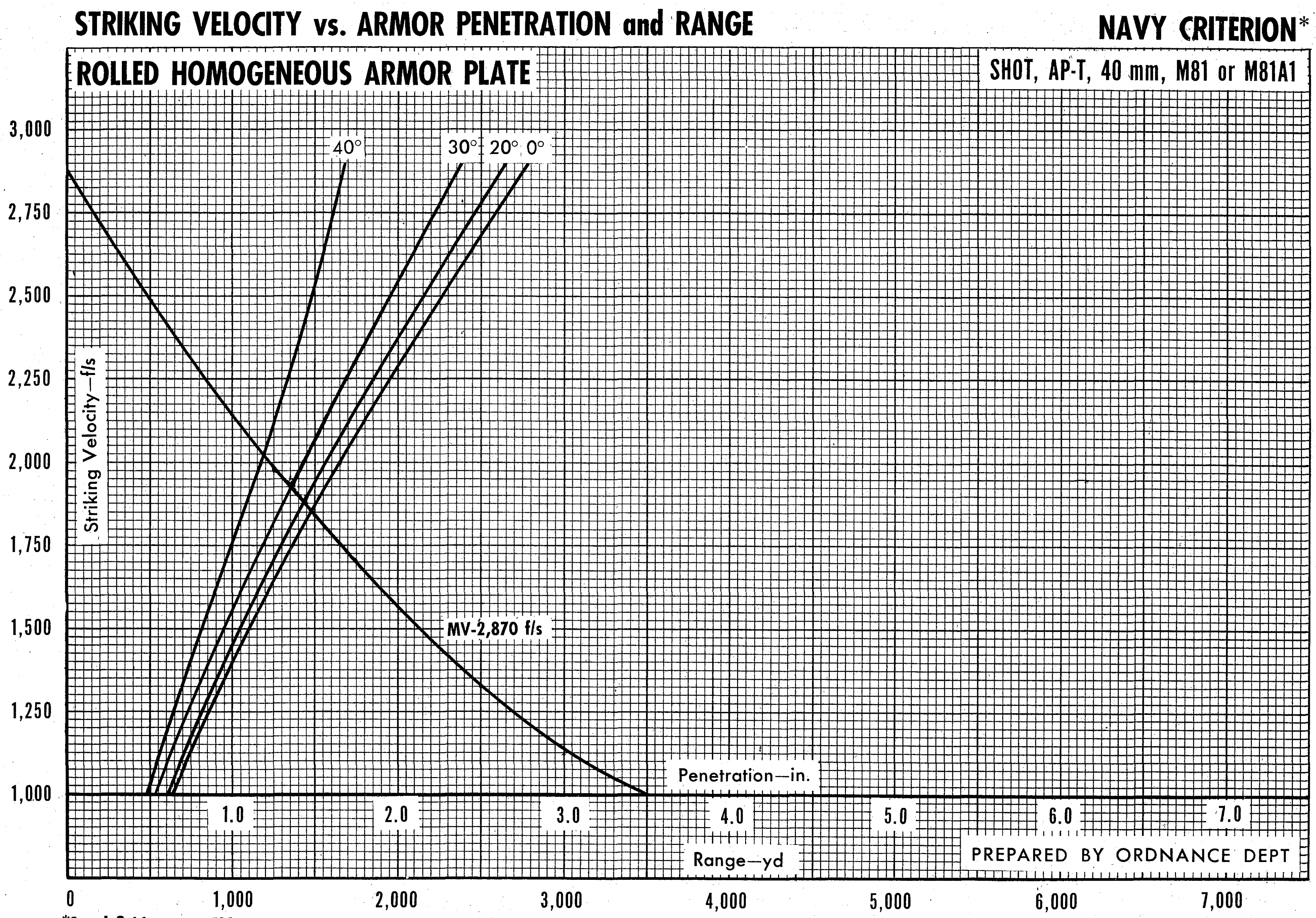
*See definition, page 134

FIGURE 70



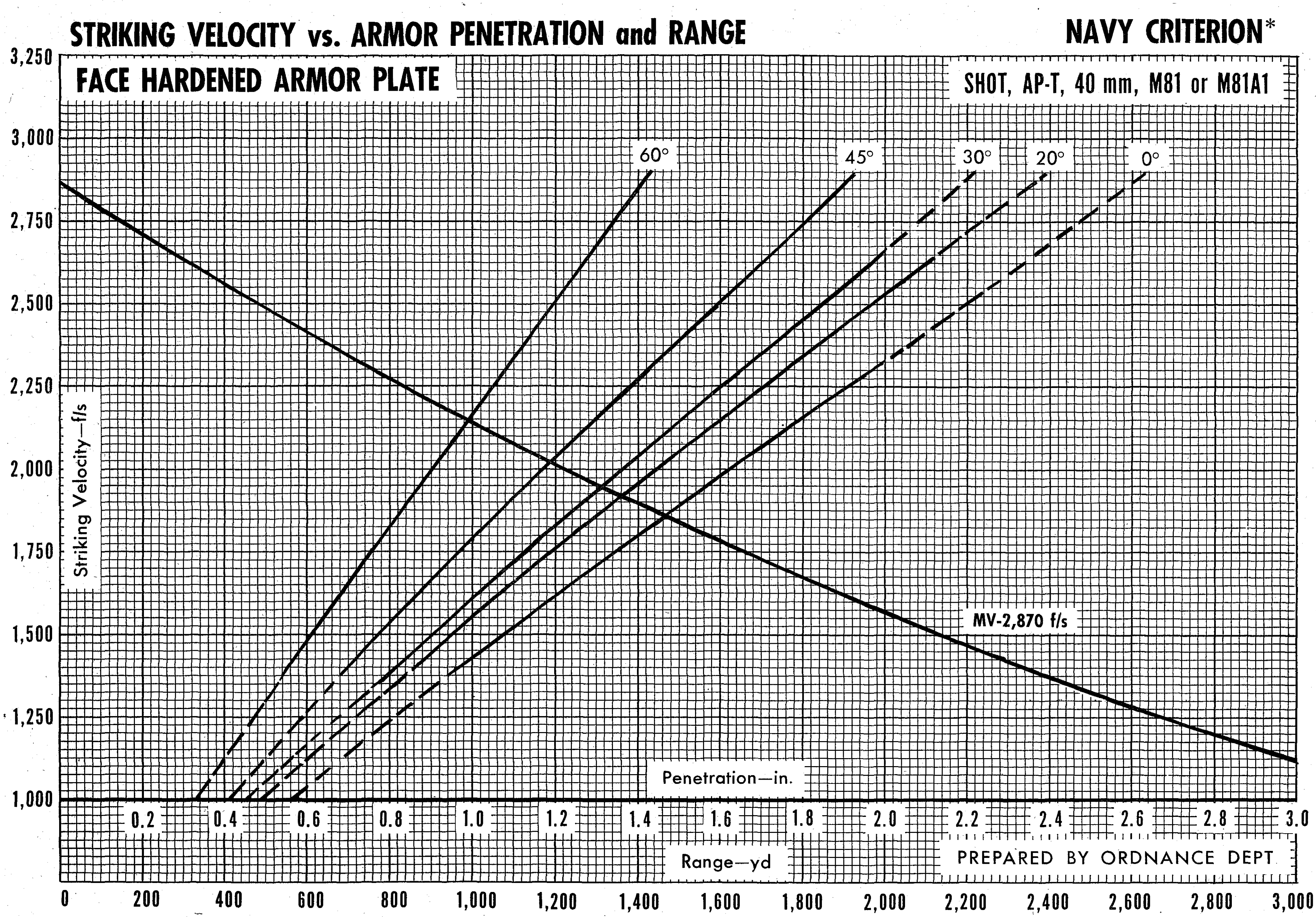
*See definition, page 134

FIGURE 71



*See definition, page 134

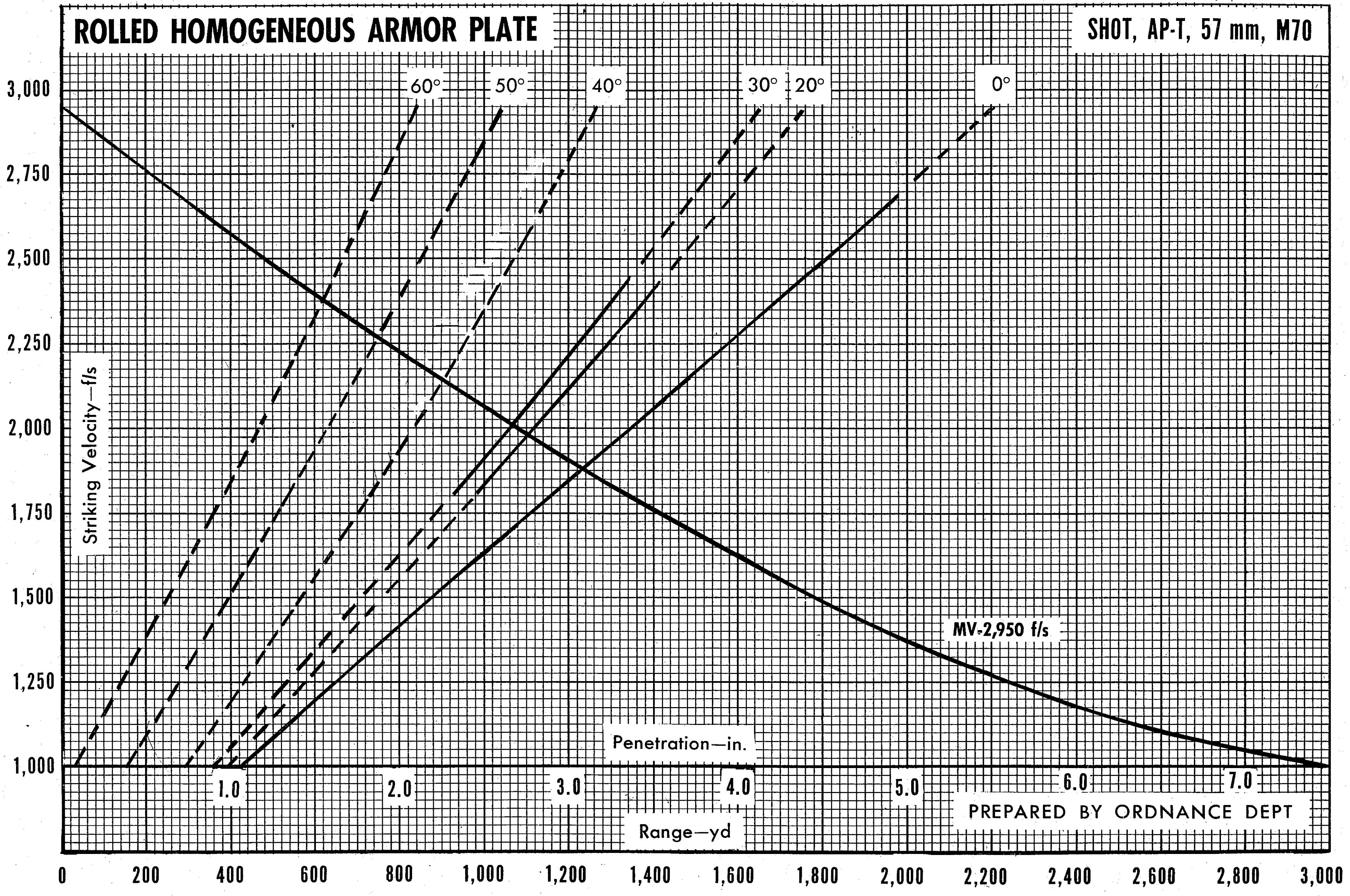
FIGURE 72



*See definition, page 134

FIGURE 73

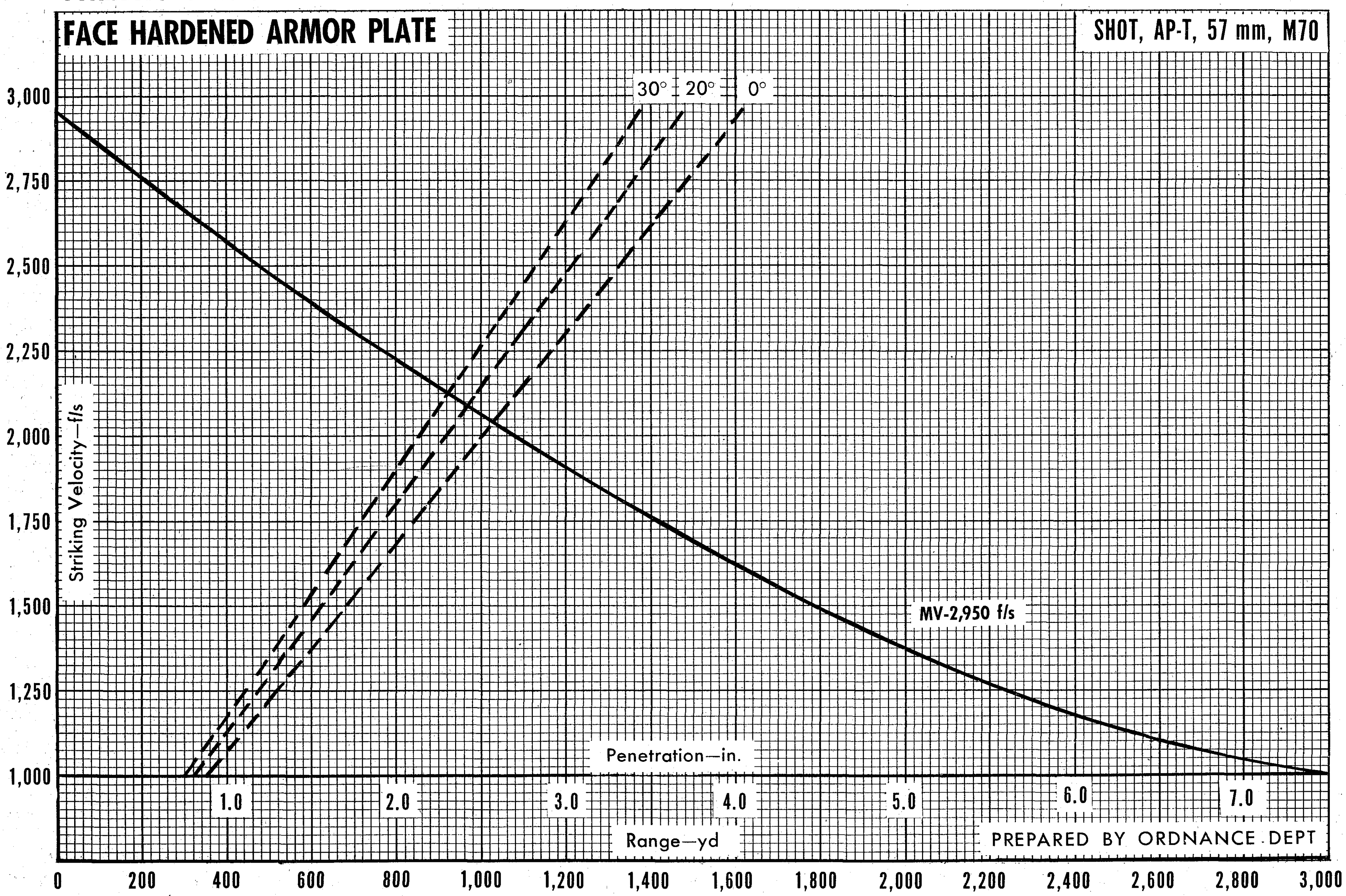
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*



*See definition, page 134

FIGURE 74

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*



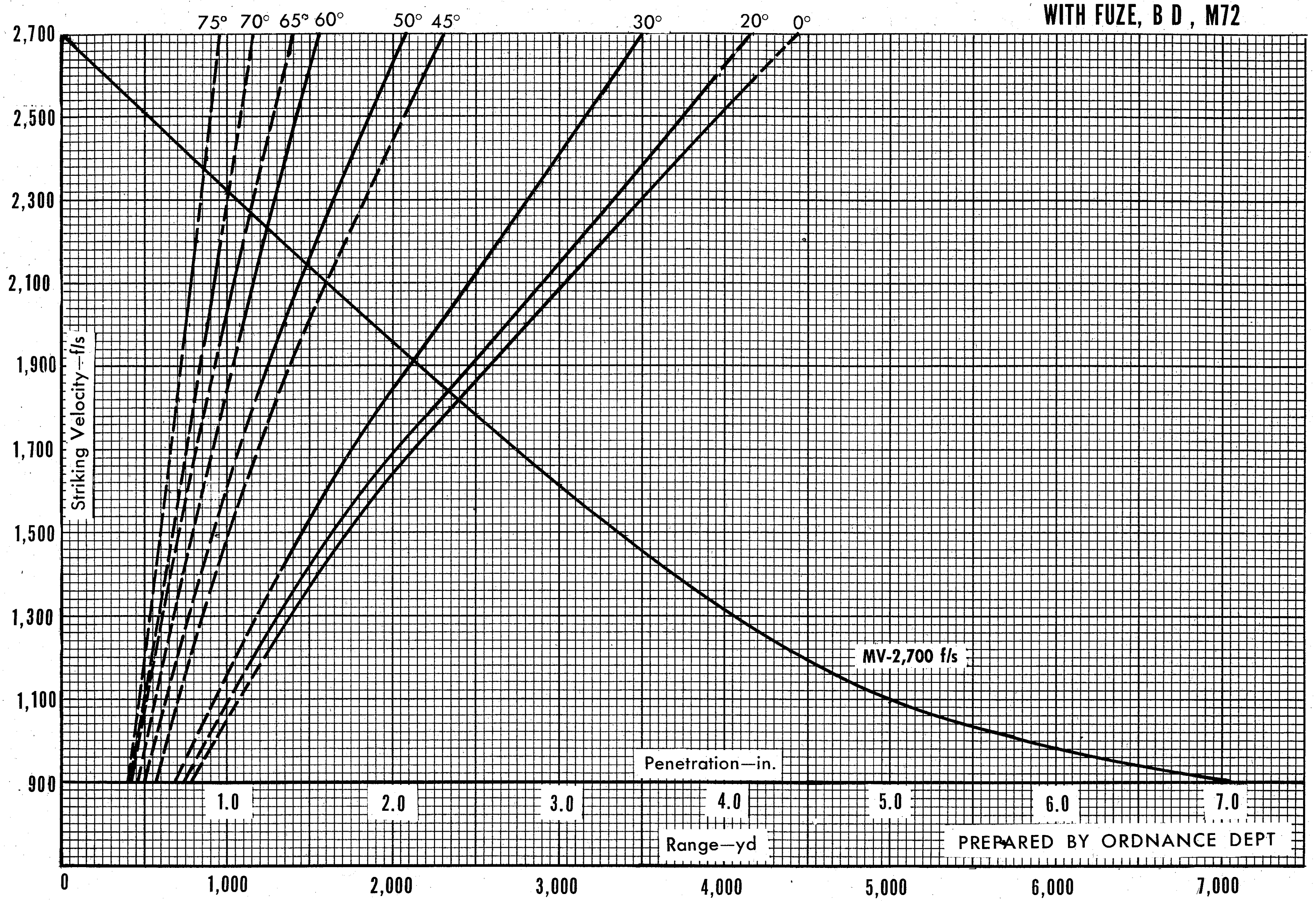
*See definition, page 134

FIGURE 75

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE ROLLED HOMOGENEOUS ARMOR PLATE

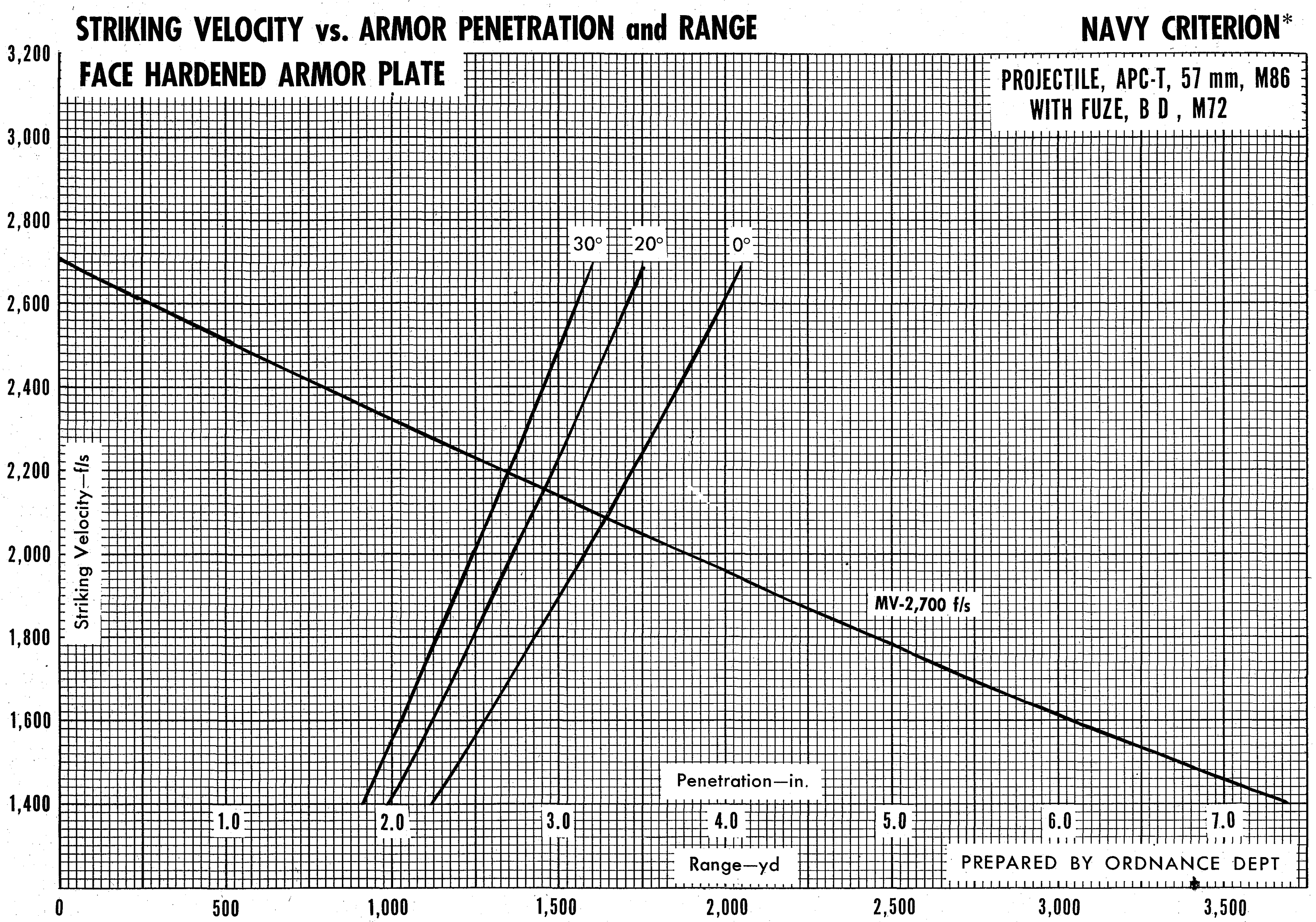
NAVY CRITERION*

PROJECTILE, APC-T, 57 mm, M86
WITH FUZE, B D , M72



*See definition, page 134

FIGURE 76

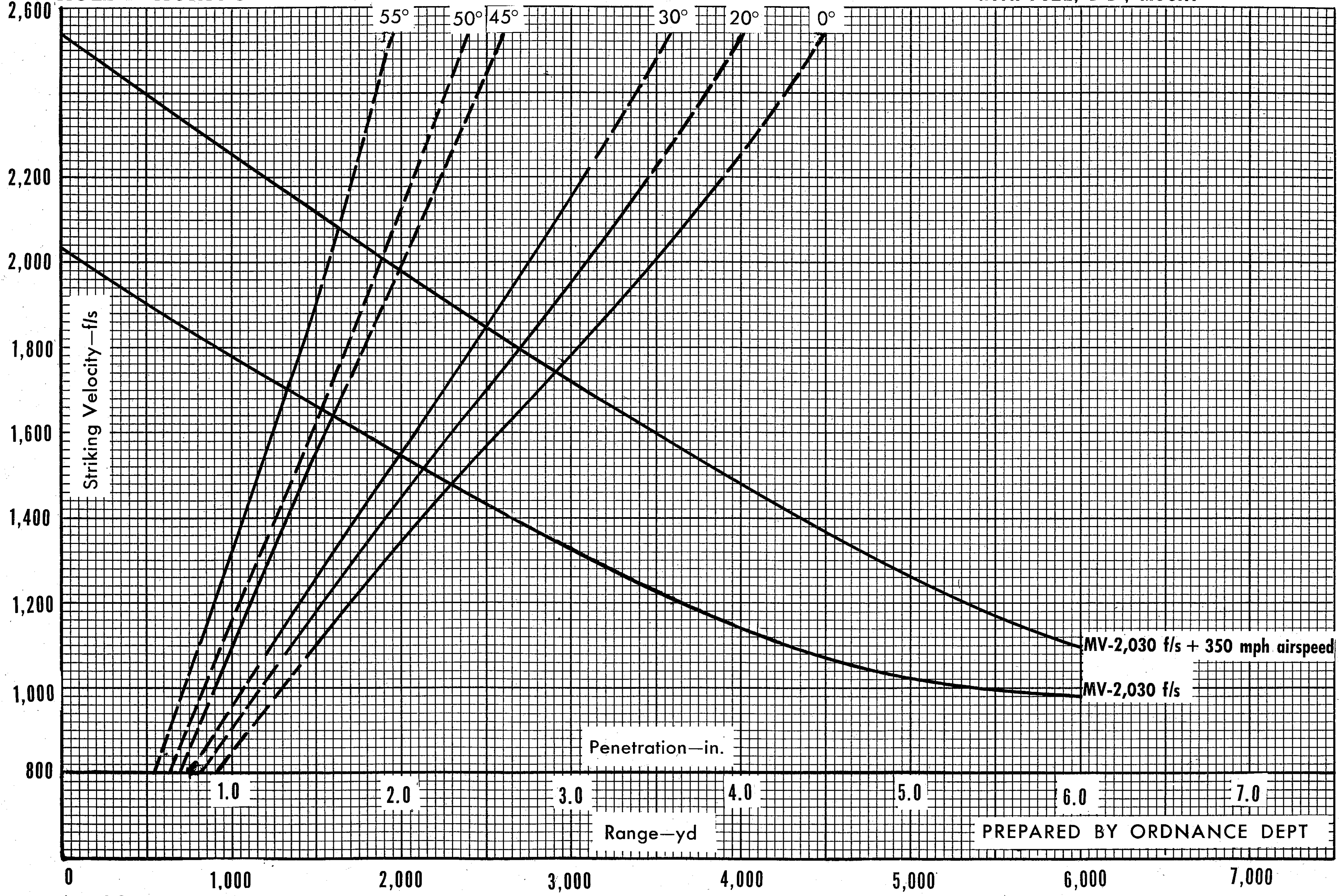


*See definition, page 134

FIGURE 77

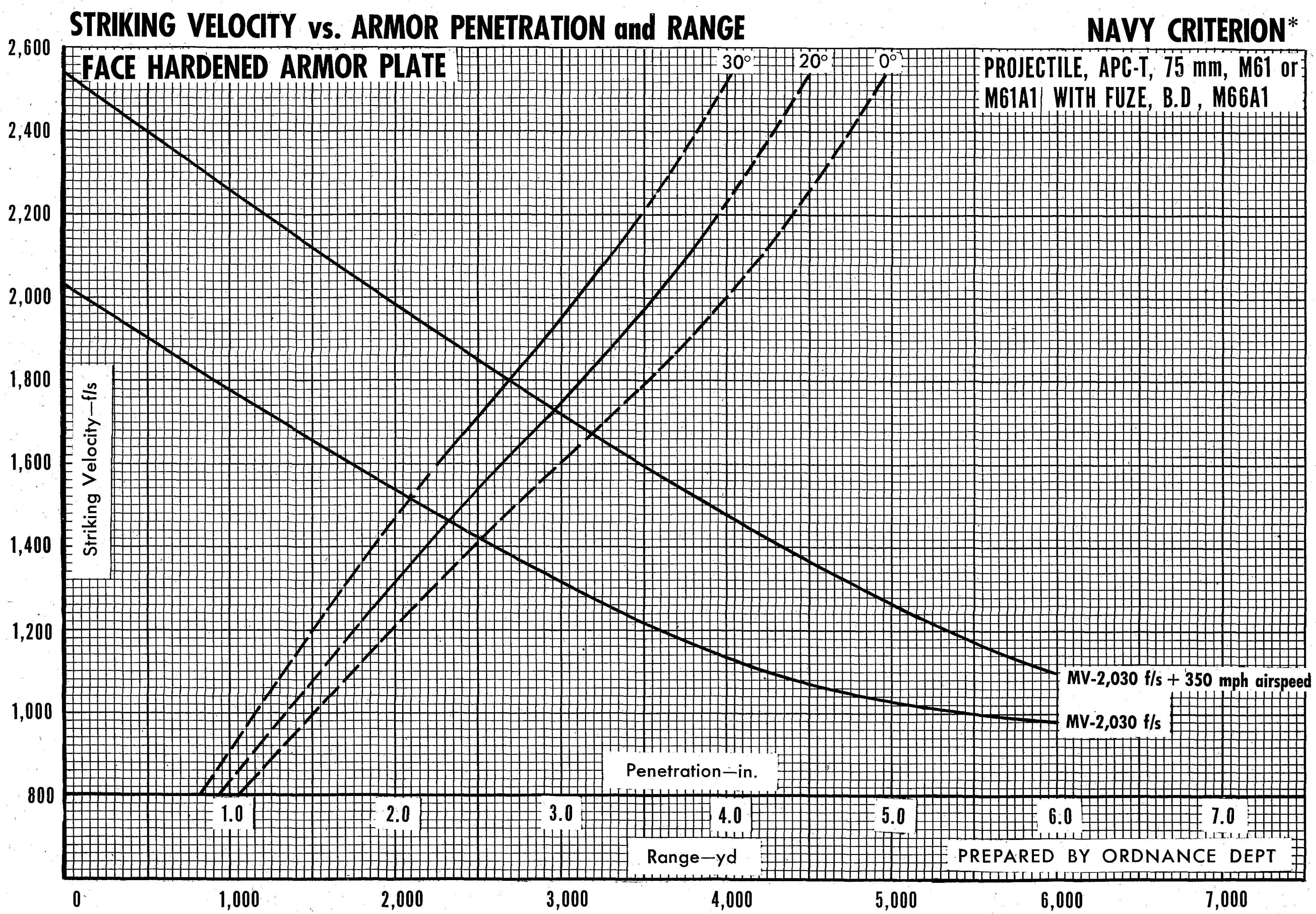
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE
ROLLED HOMOGENEOUS ARMOR PLATE

NAVY CRITERION*
PROJECTILE, APC-T, 75 mm, M61 or M61A1
WITH FUZE, B D, M66A1



*See definition, page 134

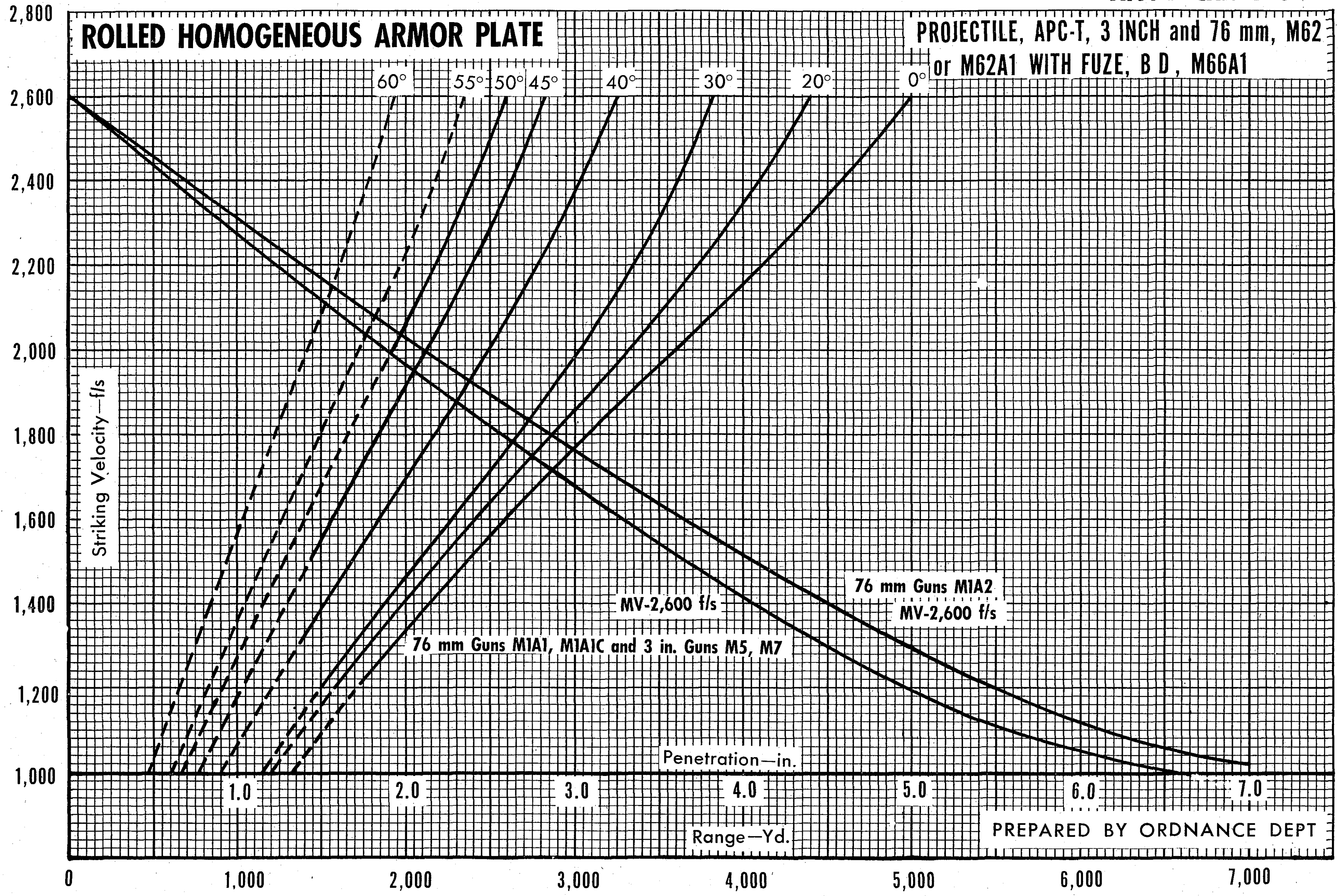
FIGURE 78



*See definition, page 134

FIGURE 79

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*

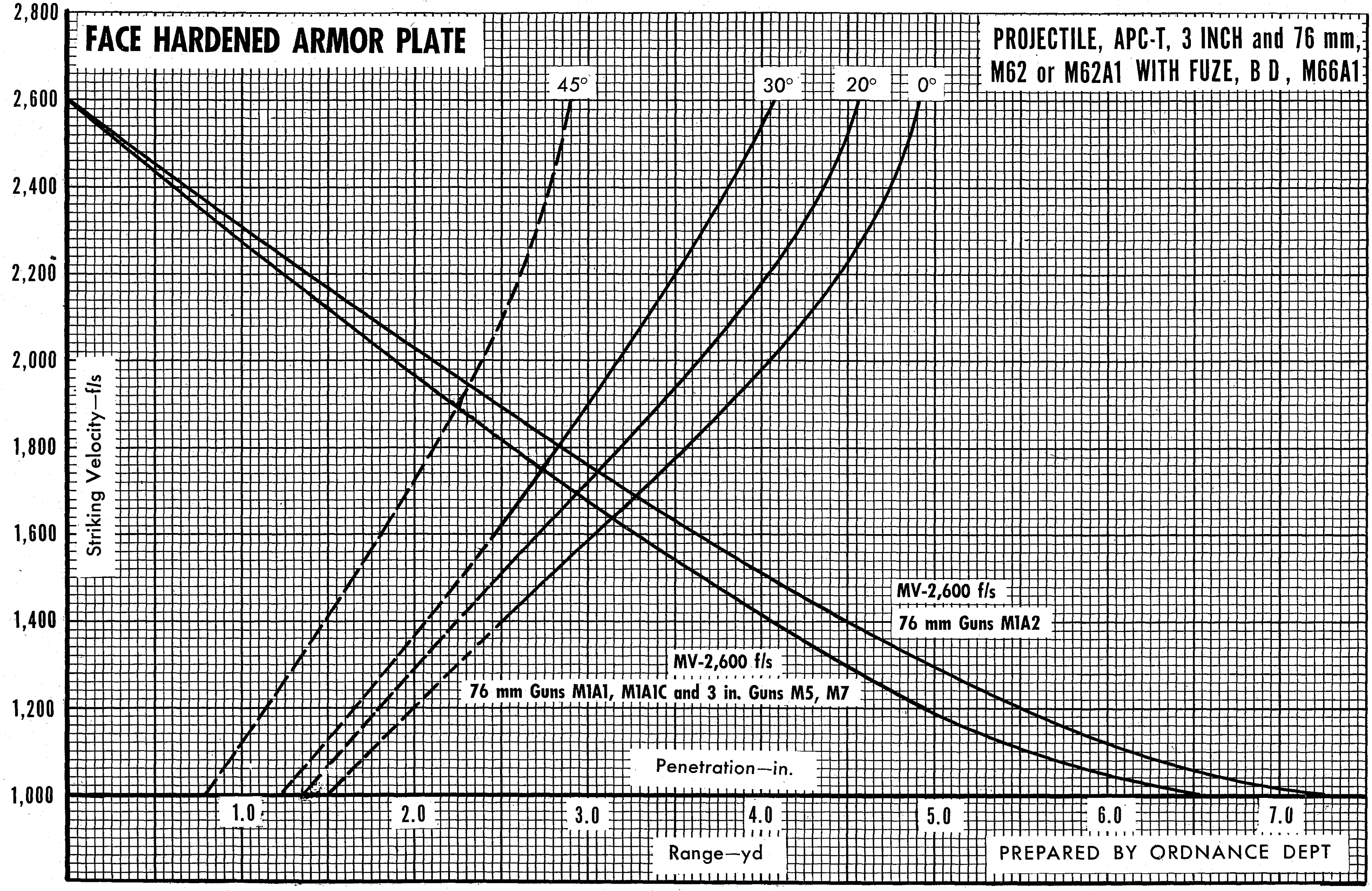


*See definition, page 134

FIGURE 80

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*



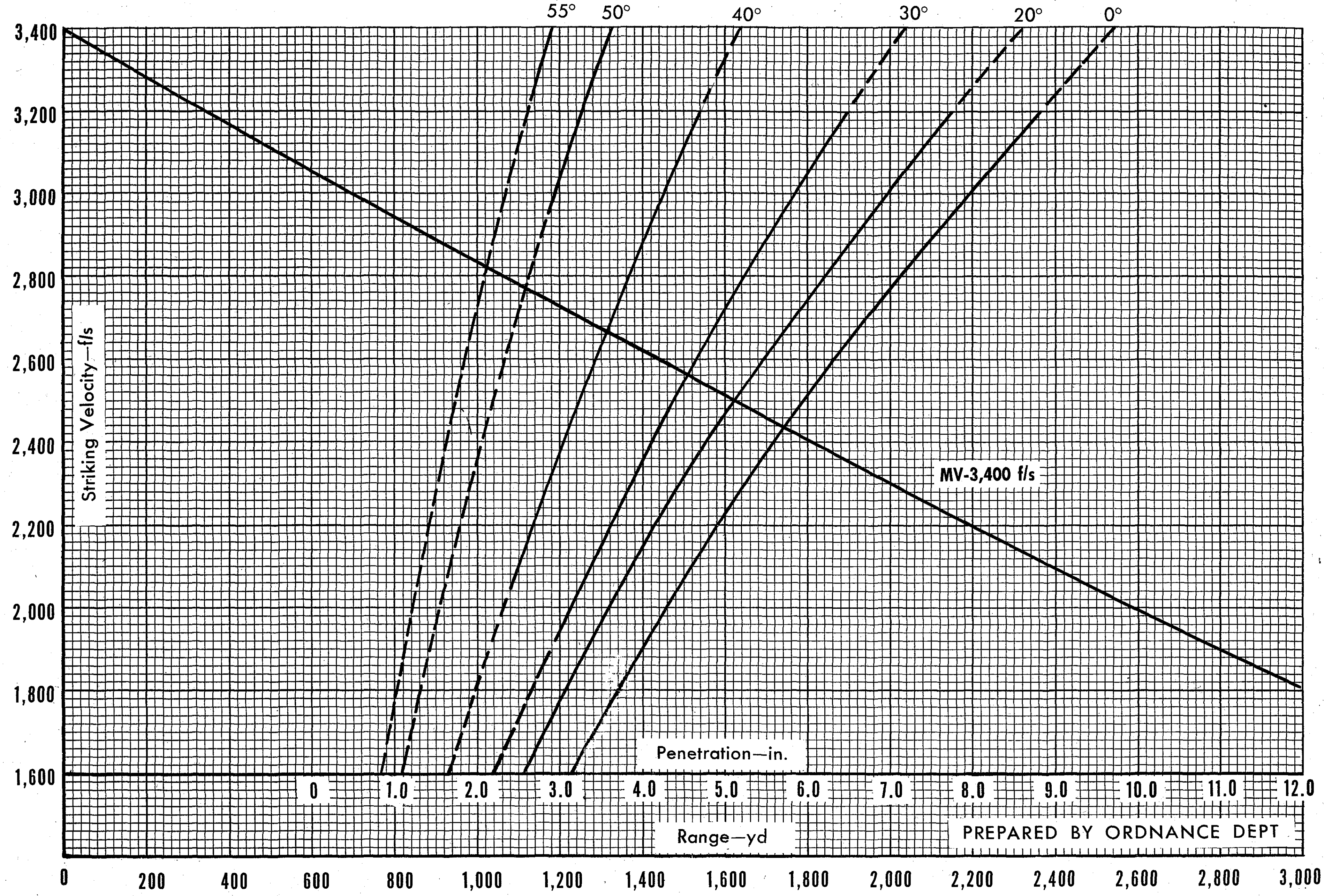
*See definition, page 134

FIGURE 81

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE ROLLED HOMOGENEOUS ARMOR PLATE

NAVY CRITERION*

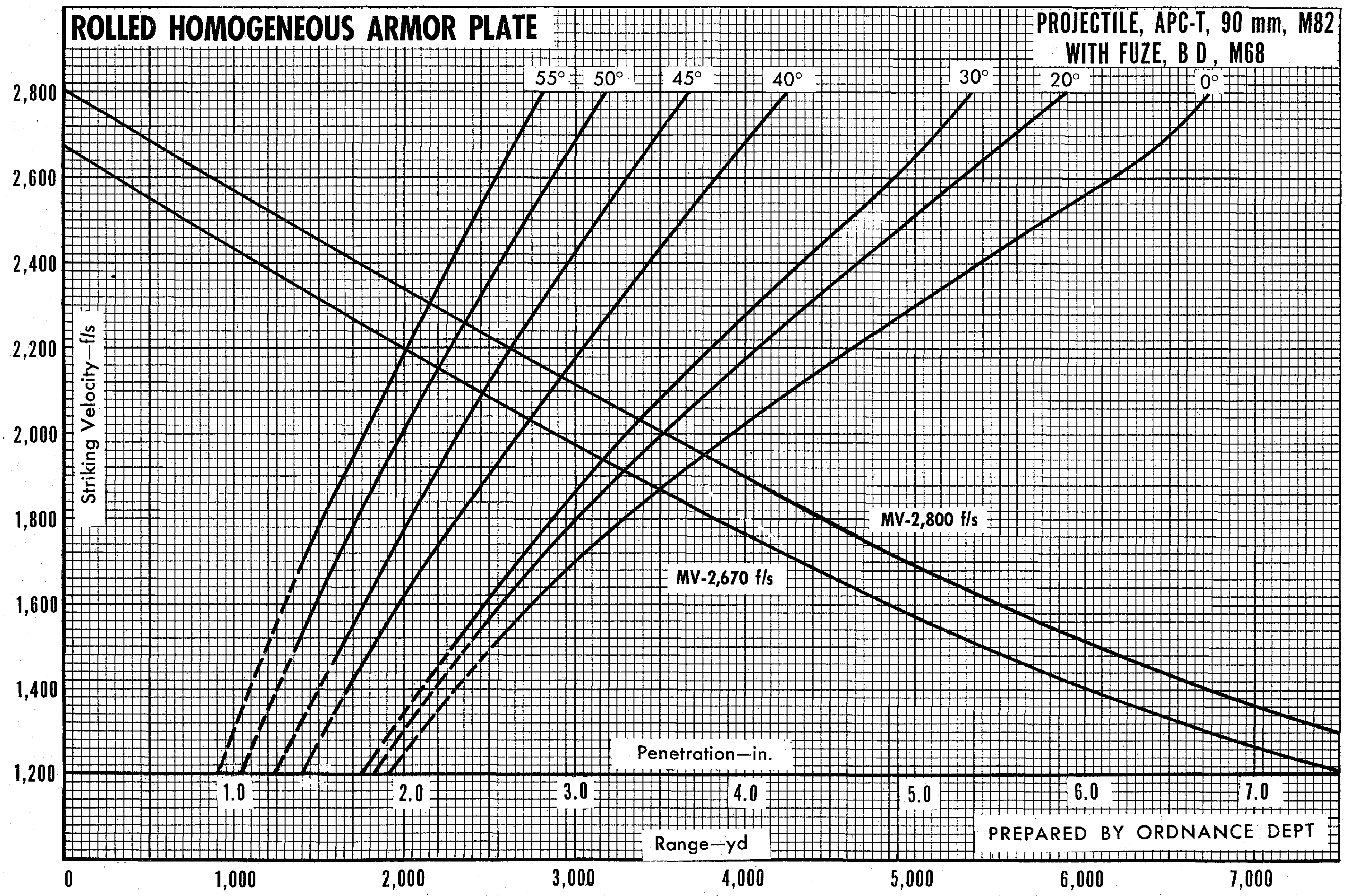
SHOT, HVAP, 3 INCH and 76 mm, T4E17 or M93 (T4E20)



*See definition, page 134

FIGURE 82

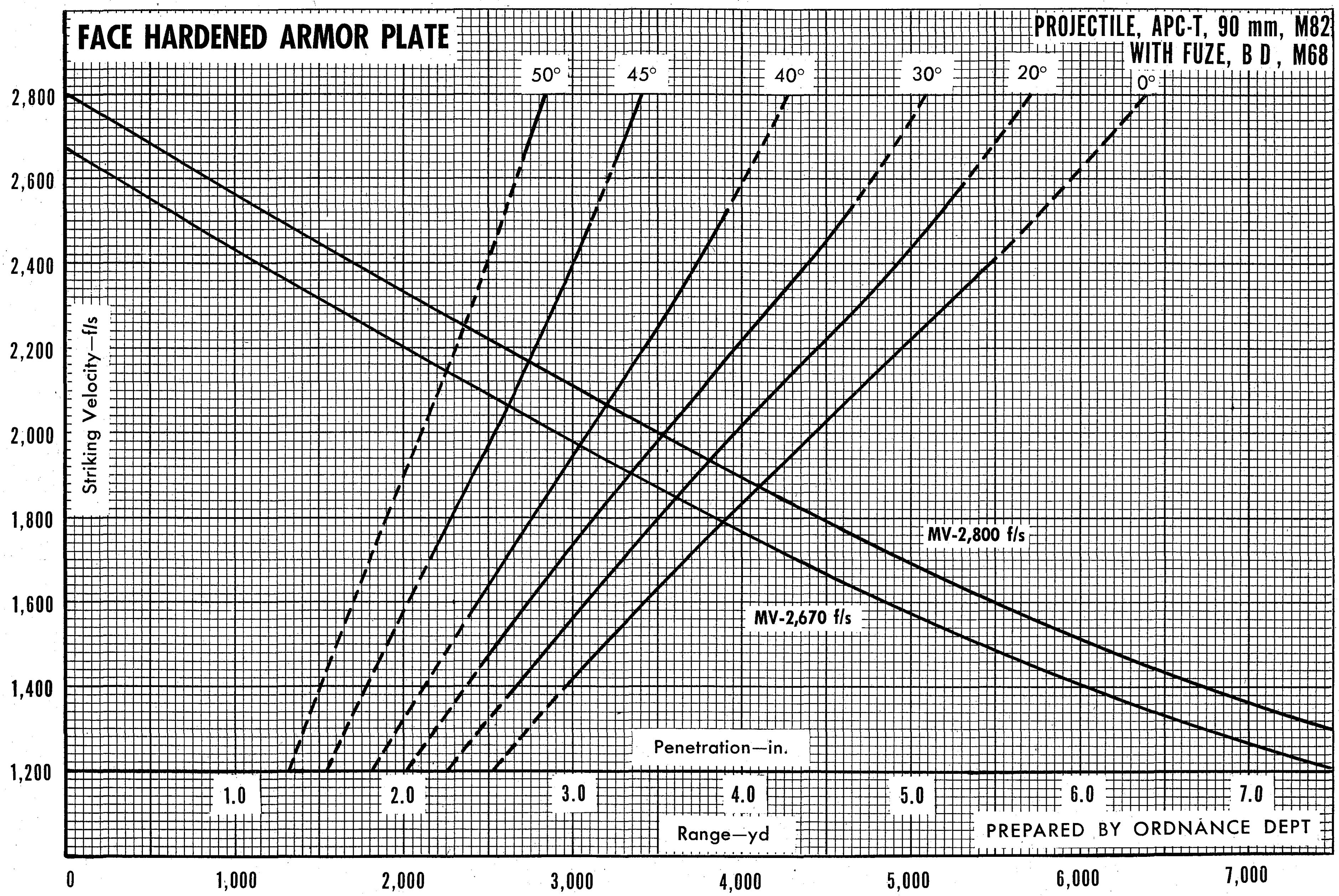
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*



*See definition, page 134

FIGURE 83

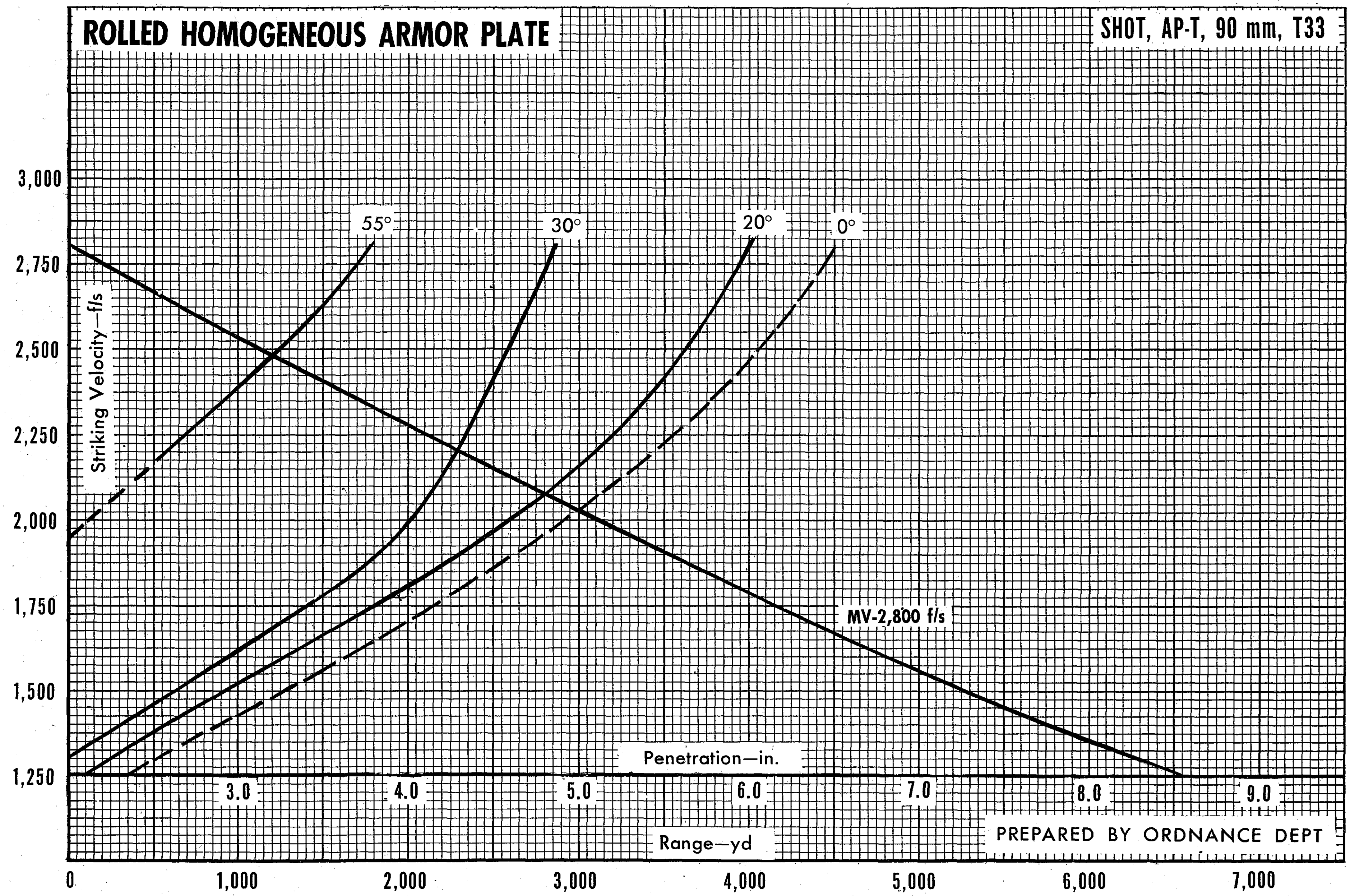
STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*



*See definition, page 134

FIGURE 84

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE — NAVY CRITERION*

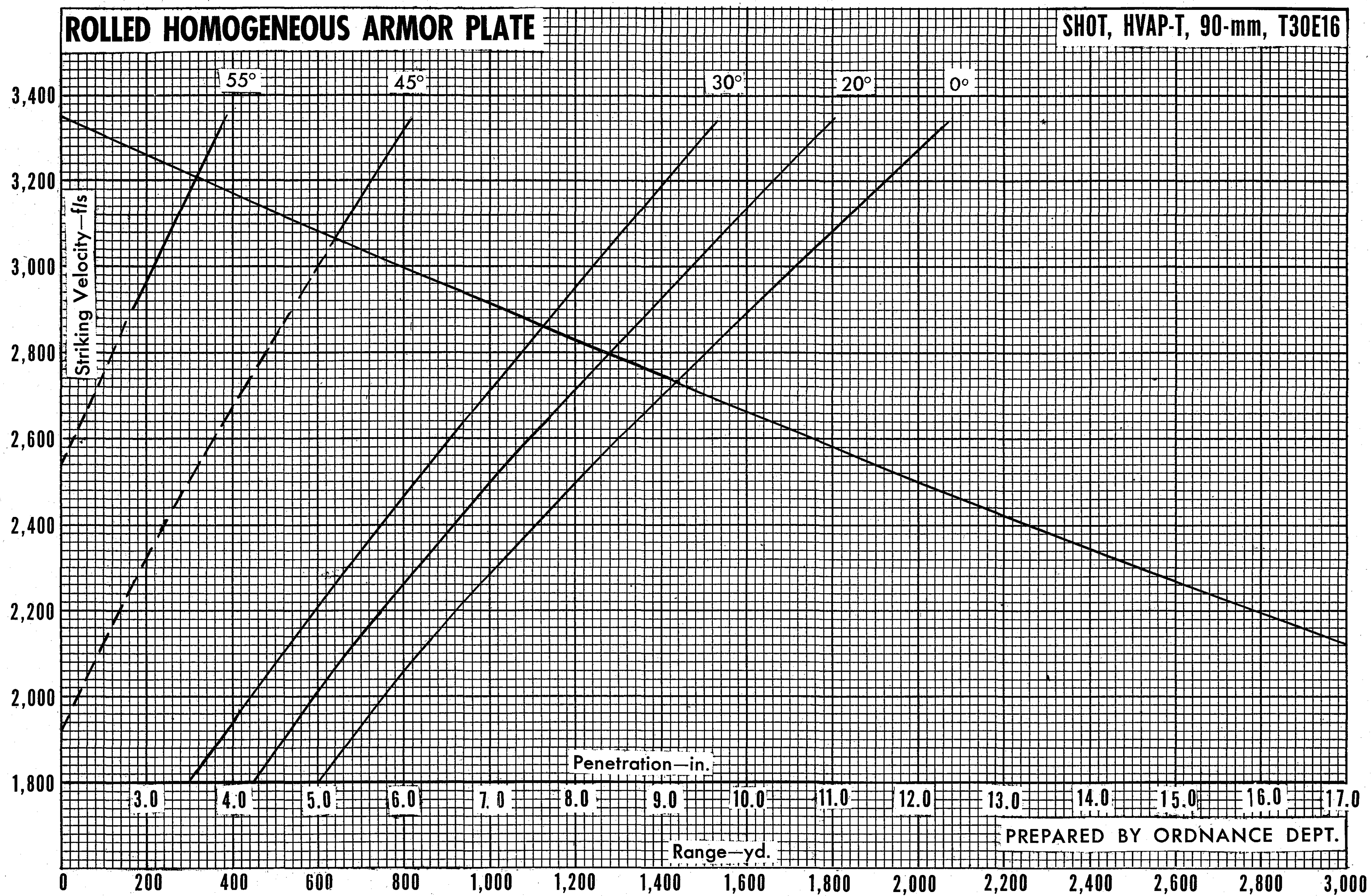


*See definition, page 134

FIGURE 85

STRIKING VELOCITY vs. ARMOR PENETRATION and RANGE

NAVY CRITERION*



*See definition, page 134

FIGURE 86

Volume III Part 12

ATTACK OF JAPANESE LOG AND/OR EARTH FORTIFICATIONS

1. GENERAL.

Japanese log and/or earth fortifications of the type considered in this discussion are built with vertical walls made of several layers of logs or of one or more layers of earth-filled oil drums and with log roofs, the whole covered with earth. They are usually constructed quite low so as to be almost invisible. In cases, however, where the water table is high, the fortifications would of necessity lie mostly above ground and be more easily seen. The structures are usually well compartmentalized into bays so that a shell detonating in one bay will do a minimum of damage in a bay next to it.

2. BOMBING OF LOG AND/OR EARTH FORTIFICATIONS.

Bombs are not very effective against this type of target due to the small percentage of hits scored, the resilience of palm-log shoring, the dispersion of personnel in bays, and the high recovery coefficient of these targets. Direct hits are required since near-misses seem to do negligible damage. See Volume III Part 3 for penetrations of bombs in earth.

3. ARTILLERY AND MORTAR ATTACK.

In artillery attack it is required that the projectile perforate the earth covering and log or oil drum walls and detonate inside the fortifications. Since the materials of the bunkers are rather soft, ordinary HE projectiles may be used without fear of their deforming. A suitable delay fuze is required to bring about the detonation inside. The ordinary PD fuzes with delay setting attached to most HE artillery projectiles would be satisfactory at ranges for which striking velocities are relatively low. The CP M78 (T105) Fuze, where it can be attached to a projectile, may be used at all ranges. Its use is required at the shorter ranges of certain weapons where the striking velocity is high and an ordinary PD fuze would malfunction.

The treatment is limited to giving the maximum ranges at which the various weapon-ammunition combinations will perforate a given thickness of earth and/or logs as the case may be.

In the case of earth filled drums it may be assumed that the steel walls are equivalent to 6 inches of earth in stopping power. Thus the thickness of earth in a vertical wall would be considered increased by as many times 6 inches as there are layers of steel drums.

It appears that soft woods like palm should be as easily penetrable as earth while hardwoods like oak, ebony, or mahogany would be equivalent in stopping power to two times their thickness of earth. Medium hard woods like pine or spruce should come in between.

The data are given in graphs representing the *thickness of earth penetrated or the thickness of logs in the walls* versus range for the various weapons. There is one set of graphs for the attack of vertical walls with low-angle fire and a second set for the attack of roofs with high-angle fire.

It is clear that as high-angle fire is practiced, relatively light weapons like the 75mm and 105mm howitzers, the 155mm mortar, and the 81mm mortar are of borderline usefulness in attacking heavier type roofs of log fortifications. It would seem from the graphs that a well-made bunker or pillbox with three layers of logs and say 5 or 6 feet of earth would stand up against any of the light weapons used in high-angle fire. Such targets would be vulnerable to high-angle fire from the 4.5 inch Gun M1, the 155mm Gun M1, the 155mm Howitzer M1 or the 8 inch Howitzer M1. Questions of probable errors would, however, come to the fore.

In direct fire against a vertical wall of similar construction to that of the roof just mentioned, the 57mm, 75mm, 76mm, 3 inch and 90mm would be effective. The 105mm Howitzer M2A1 would also be effective but the 105mm Howitzer M3 and the 75mm Howitzer would be at the limit of their effectiveness at point blank range. Heavier direct firing guns and howitzers will all defeat such a wall.

4. ROCKET ATTACK.

It appears from experiments that the 2.36 inch rocket is ineffective against log and earth fortifications. It can be effective only if it enters an embrasure since it does not have much penetrating power. This would require attack from extremely small ranges of approximately 15 yards.

At a range of 150 feet the 4.5 inch Rocket, M9, can penetrate 4 feet of earth and three layers of 1-foot pine logs. Data for the newer spin stabilized 4.5 inch Rocket, T38, are given in one of the figures.

When fired from a plane flying low and level at 350 miles per hour the 5 inch HVAR is estimated to penetrate 21 feet of earth at 1,000 yards range and 19 feet at 2,000 yards. The small angle of fall of this rocket limits its use to the attack of vertical walls. With the BD fuze at 0.02 second delay there might be some danger of the rocket passing all the way through a bunker and then detonating.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

LOW-ANGLE FIRE

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

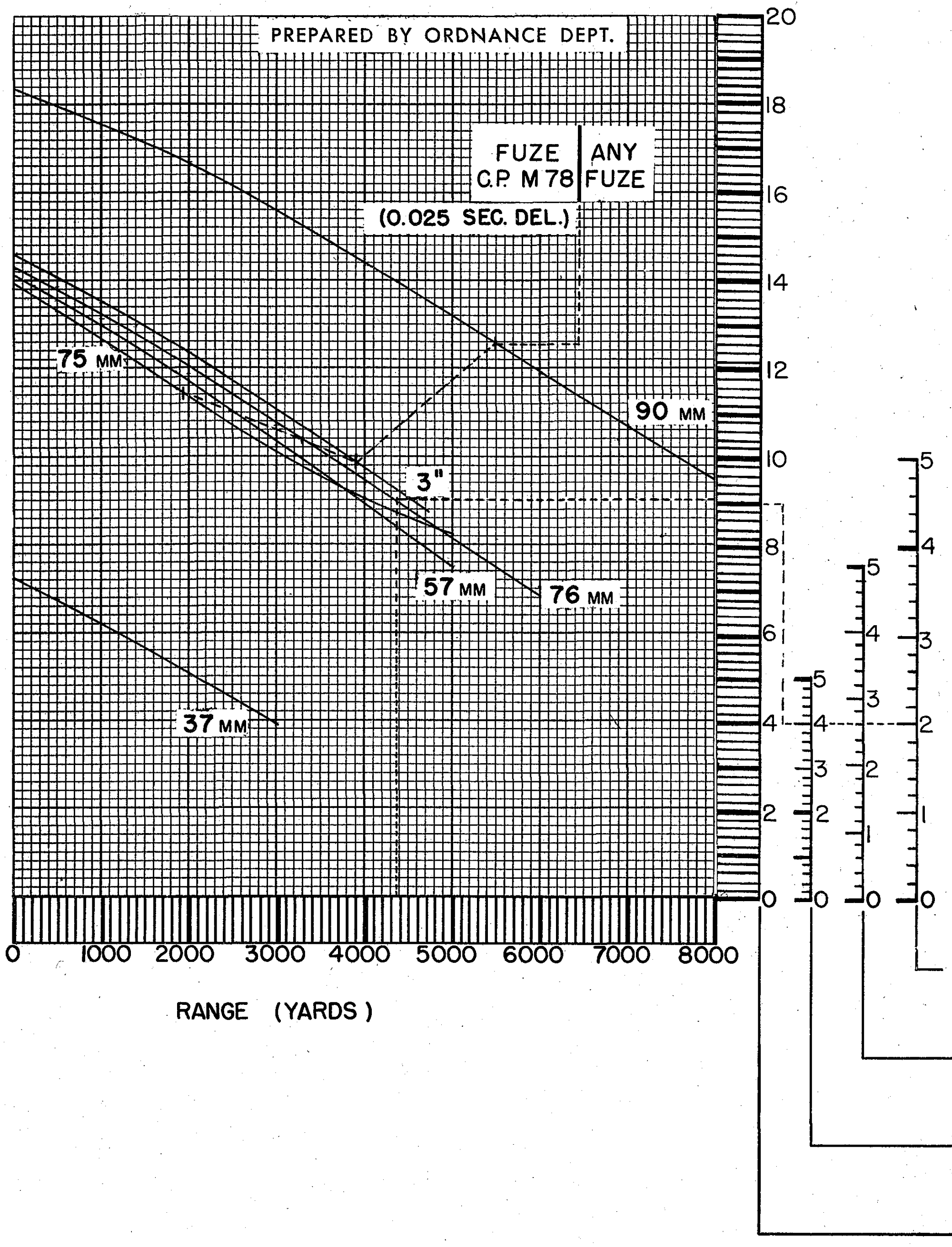


FIGURE 87

90 mm—90 mm Guns, M1A1, M2 or M3 with Shell, HE, M71; MV 2,700 f/s.
3 in.—3 in. Guns, M5 or M7 with Shell, HE, M42A1; MV 2,800 f/s.
76 mm—76 mm Guns, M1A1, M1A1C or M1A2 with Shell, HE, M42A1; MV 2,700 f/s.
75 mm—75 mm Gun, M3 with Shell, HE, M48; MV 1,980 f/s.
57 mm—57 mm Guns, M1 or M1A1 with Projectile, APC–T, M86; MV 2700 f/s.
37 mm—37 mm Guns M3 or M3A1 with Shell, HE, M63; MV 2600 f/s.

All the above shell with standard PD Fuze with 0.05 sec. or greater delay, including Fuze, CP, M78 (T105) (0.025 sec. delay) may be used at ranges greater than the ranges indicated by the dash line on the curves. The use of the M78 Fuze *is* mandatory at shorter ranges.

Example:

A Japanese bunker has vertical walls consisting of 2 feet of hardwood logs with an enbankment 5 feet thick. At what maximum range will the 76 mm Gun, M1A2 firing Shell, HE, M42A1 perforate?

At the right of the diagram it is seen that 2 feet of hardwood logs (lower horizontal dashed line) is equivalent to 4 feet of earth to which must be added 5 feet of earth (right vertical dashed line). Following the remaining dashed lines shows that the maximum range of penetration is 4,350 yards.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

LOW-ANGLE FIRE

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

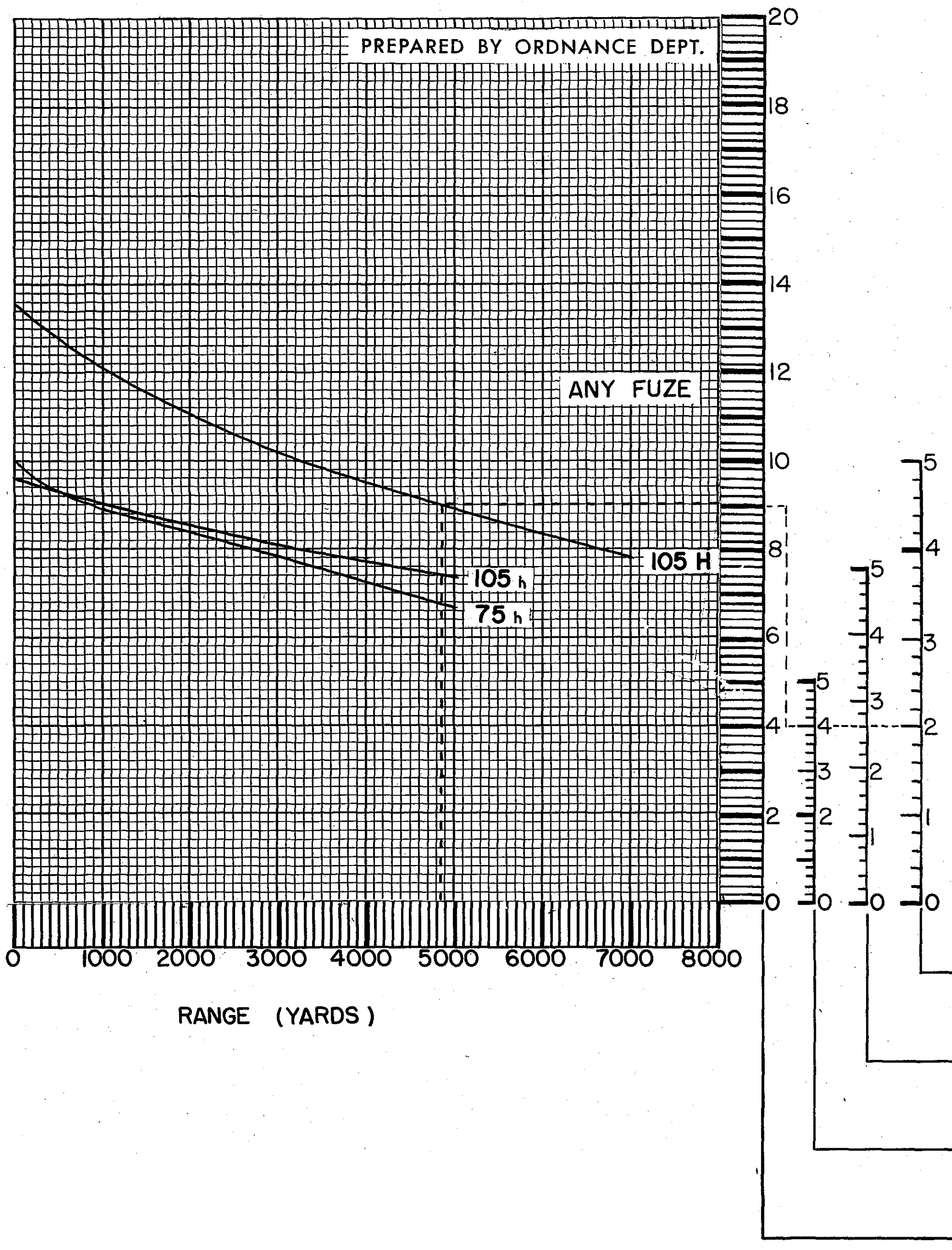


FIGURE 88

105H—105 mm Howitzer, M2A1 with Shell, HE, M1; MV 1550 f/s.
105h—105 mm Howitzer, M3 with Shell, HE, M1; MV 1020 f/s.
75h—75 mm Howitzer, M1, M1A1, M2 or M3 with Shell, HE, M48; MV 1250 f/s.
All the above shell using Fuze, PD, M48 or Mod. or any other PD Fuze, including Fuze, CP, M78 (T105) (0.025 sec. delay). The use of the M78 Fuze *is not* mandatory.

Example:

A Japanese bunker has vertical walls consisting of 2 feet of hardwood logs with a horizontal embankment 5 feet thick. At what maximum range will the 105 mm Howitzer, M2A1 firing Shell, HE, M1 perforate?

At the right of the diagram it is seen that 2 feet of hardwood logs (lower horizontal dashed line) is equivalent to 4 feet of earth to which must be added 5 feet of earth (right vertical dashed line). Following the remaining dashed lines shows that the maximum range of perforation is 4,850 yards.

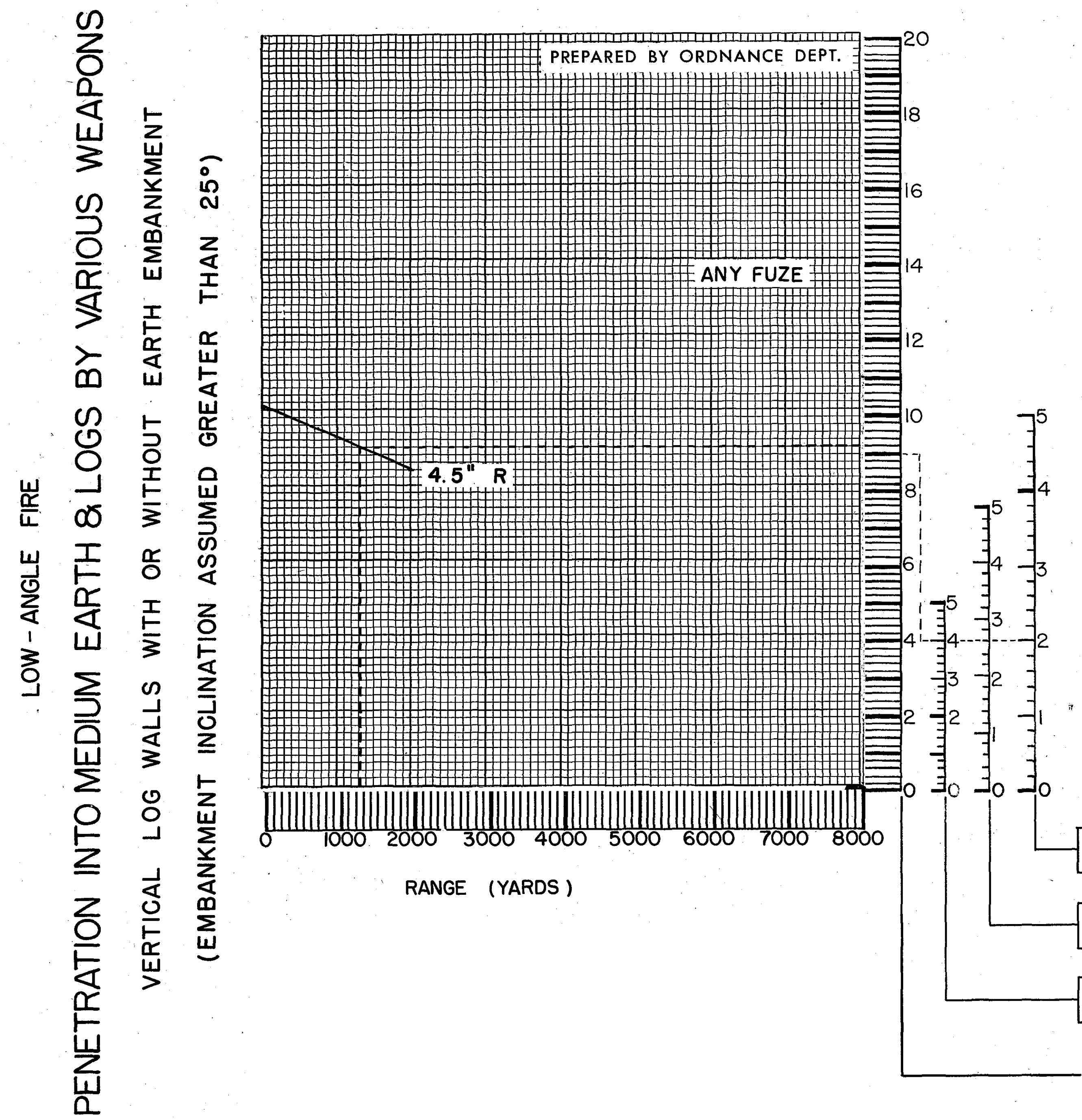


FIGURE 89

4.5 in. R—4.5 in. HE Rocket Shell, T38 with Fuze, PD, M48A2 or Fuze, CP, M78 (T105) (0.025 sec. delay). The use of the M78 Fuze *is not* mandatory.

Example:

A Japanese bunker has vertical walls consisting of 2 feet of hardwood logs with a horizontal embankment 5 feet thick. At what maximum range will the 4.5 in. HE Rocket Shell, T38 perforate?

At the right of the diagram it is seen that 2 feet of hardwood logs (lower horizontal dashed line) is equivalent to 4 feet of earth to which must be added 5 feet of earth (right vertical dashed line). Following the remaining dashed lines shows that the maximum range of penetration is 1,300 yards.

LOW-ANGLE FIRE

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

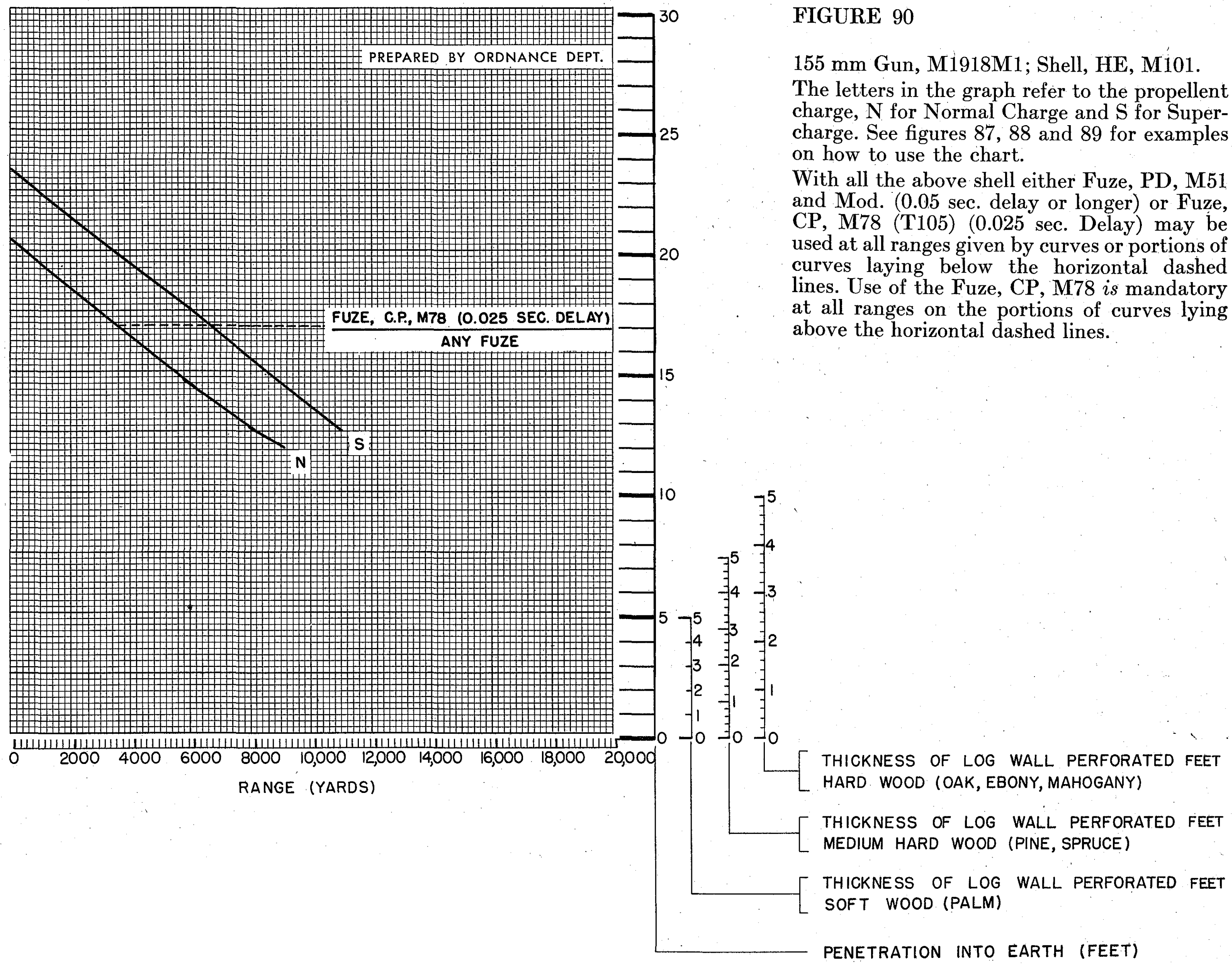


FIGURE 90

155 mm Gun, M1918M1; Shell, HE, M101.

The letters in the graph refer to the propellent charge, N for Normal Charge and S for Supercharge. See figures 87, 88 and 89 for examples on how to use the chart.

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec. delay or longer) or Fuze, CP, M78 (T105) (0.025 sec. Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves lying above the horizontal dashed lines.

LOW-ANGLE FIRE

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

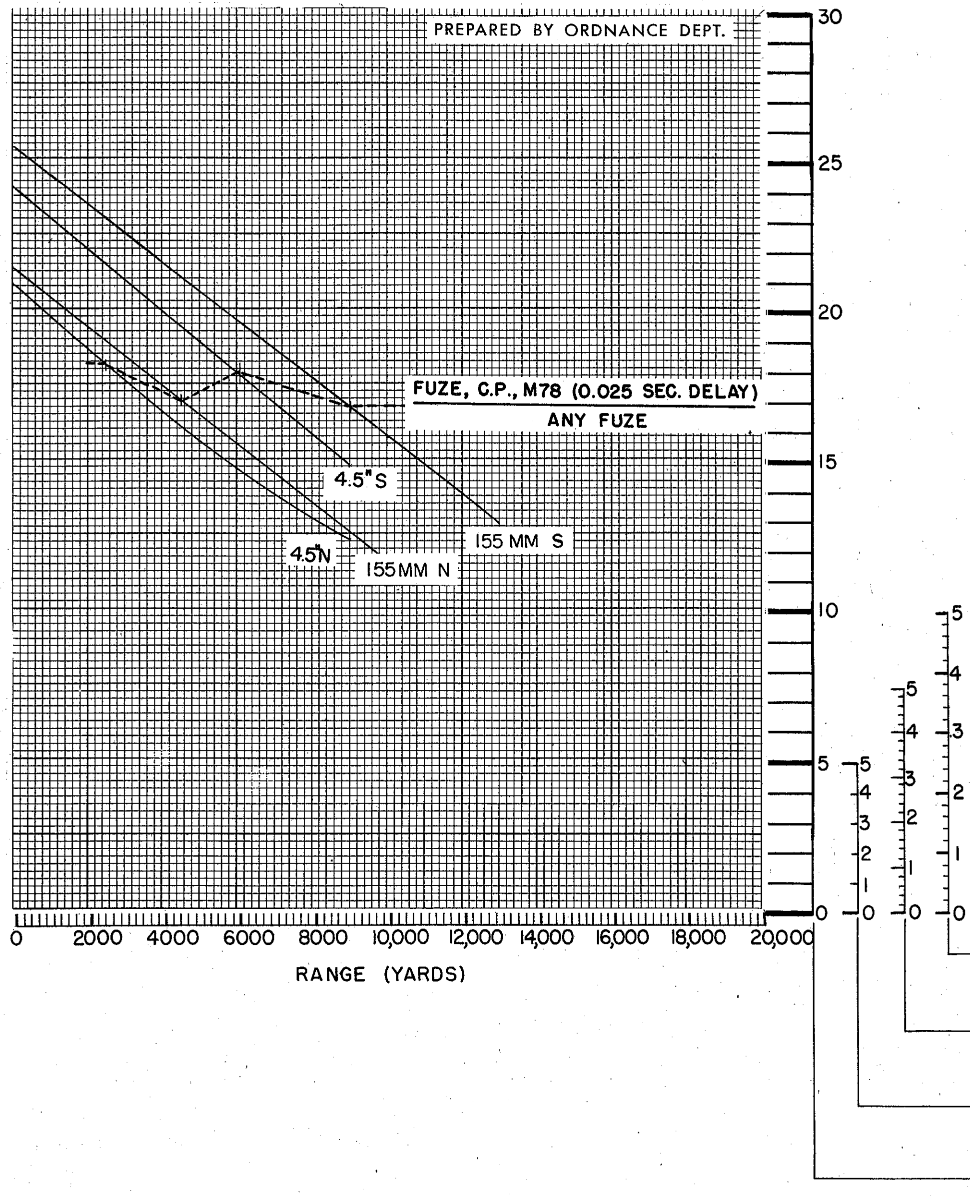


FIGURE 91

155 mm Gun, M1; Shell, H.E, M101.
4.5 in. Gun, M1; Shell, HE, M65
The letters in the graph refer to the propellent charge. N for Normal Charge and S for Supercharge. See figures 87, 88 and 89 for examples on how to use the chart.

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec delay or longer) or Fuze, CP, M78 (T105) (0.025 sec Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves lying above the horizontal dashed lines.

LOW-ANGLE FIRE

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

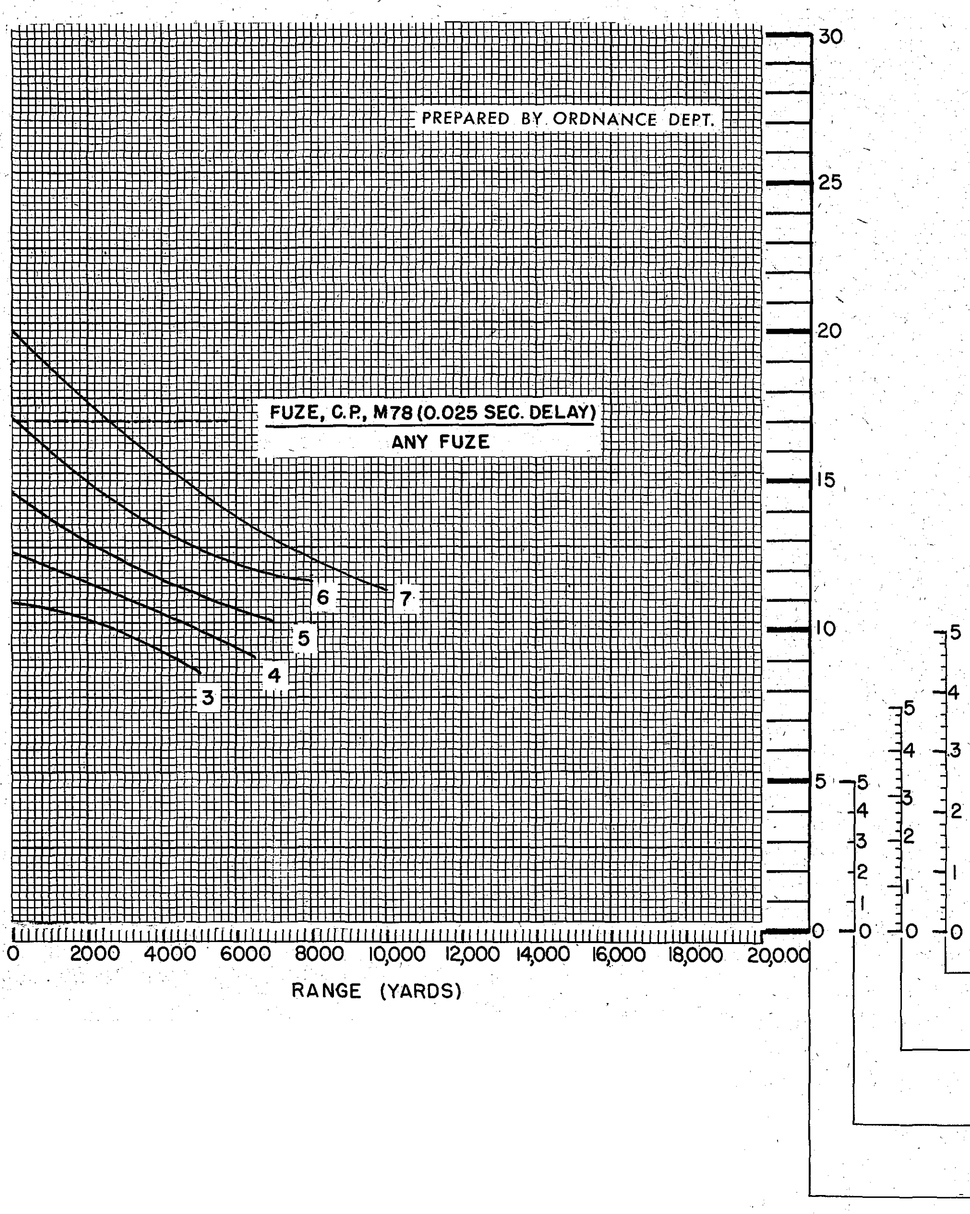


FIGURE 92

155 mm Howitzer, M1; Shell, HE, M107. The figures in the graph refer to the zone numbers of the propellent charge. See figures 87, 88 and 89 for examples on how to use the chart.

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec Delay or longer) or Fuze, CP, M78 (T105) (0.025 sec Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves lying above the horizontal dashed lines.

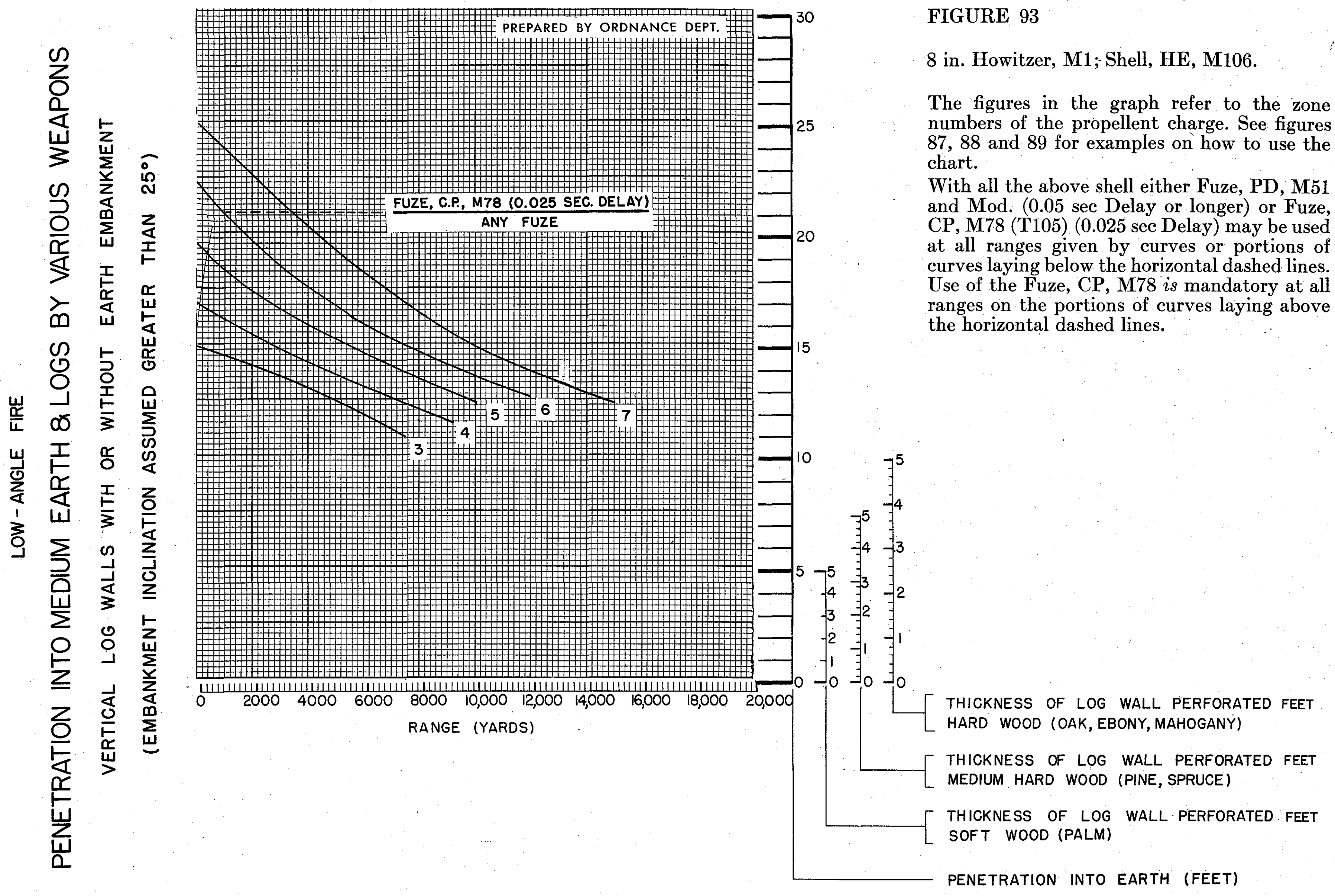


FIGURE 93

8 in. Howitzer, M1; Shell, HE, M106.

The figures in the graph refer to the zone numbers of the propellent charge. See figures 87, 88 and 89 for examples on how to use the chart.

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec Delay or longer) or Fuze, CP, M78 (T105) (0.025 sec Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves laying above the horizontal dashed lines.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

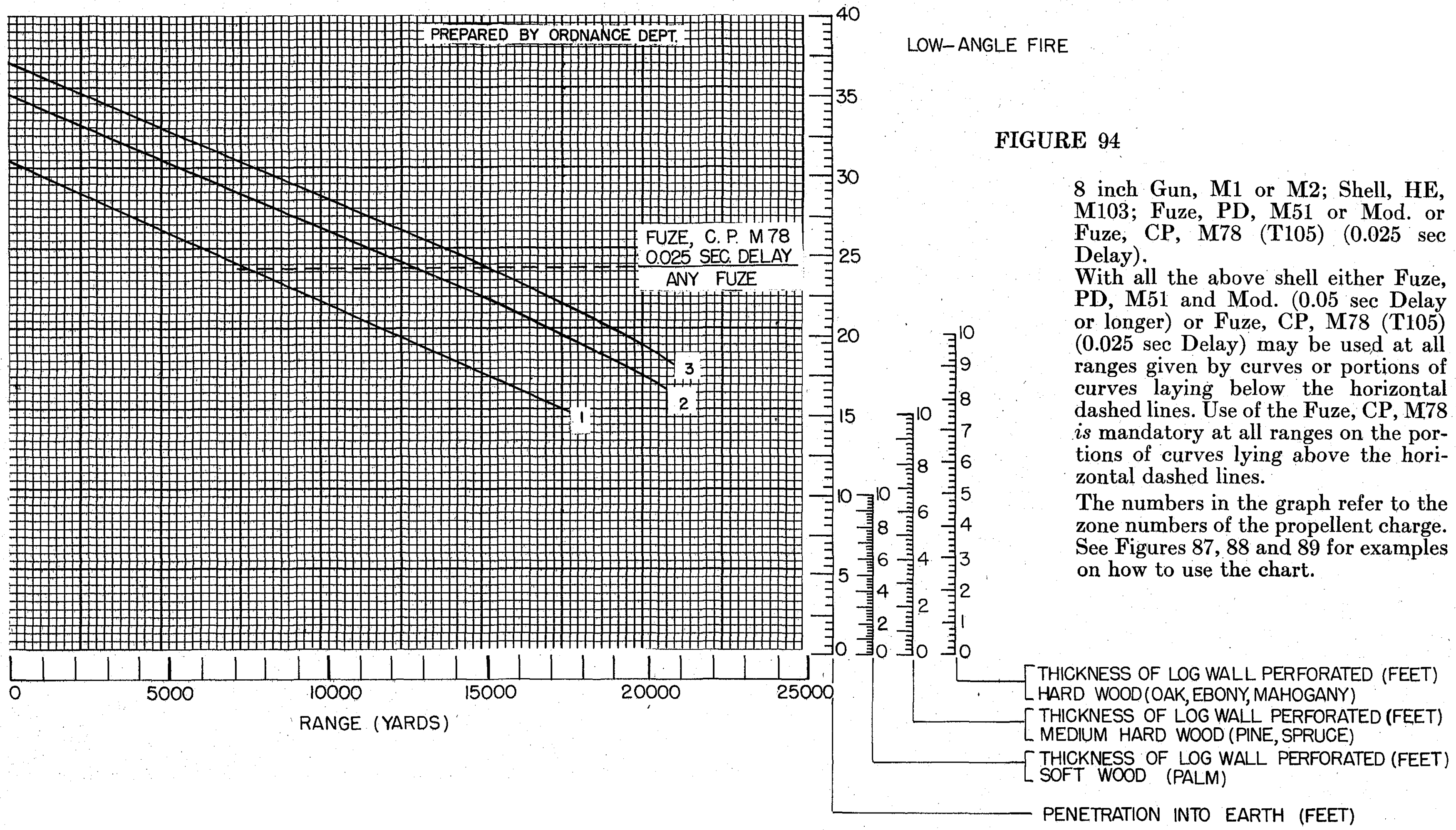


FIGURE 94

8 inch Gun, M1 or M2; Shell, HE, M103; Fuze, PD, M51 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec Delay or longer) or Fuze, CP, M78 (T105) (0.025 sec Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves lying above the horizontal dashed lines.

The numbers in the graph refer to the zone numbers of the propellent charge. See Figures 87, 88 and 89 for examples on how to use the chart.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

VERTICAL LOG WALLS WITH OR WITHOUT EARTH EMBANKMENT

(EMBANKMENT INCLINATION ASSUMED GREATER THAN 25°)

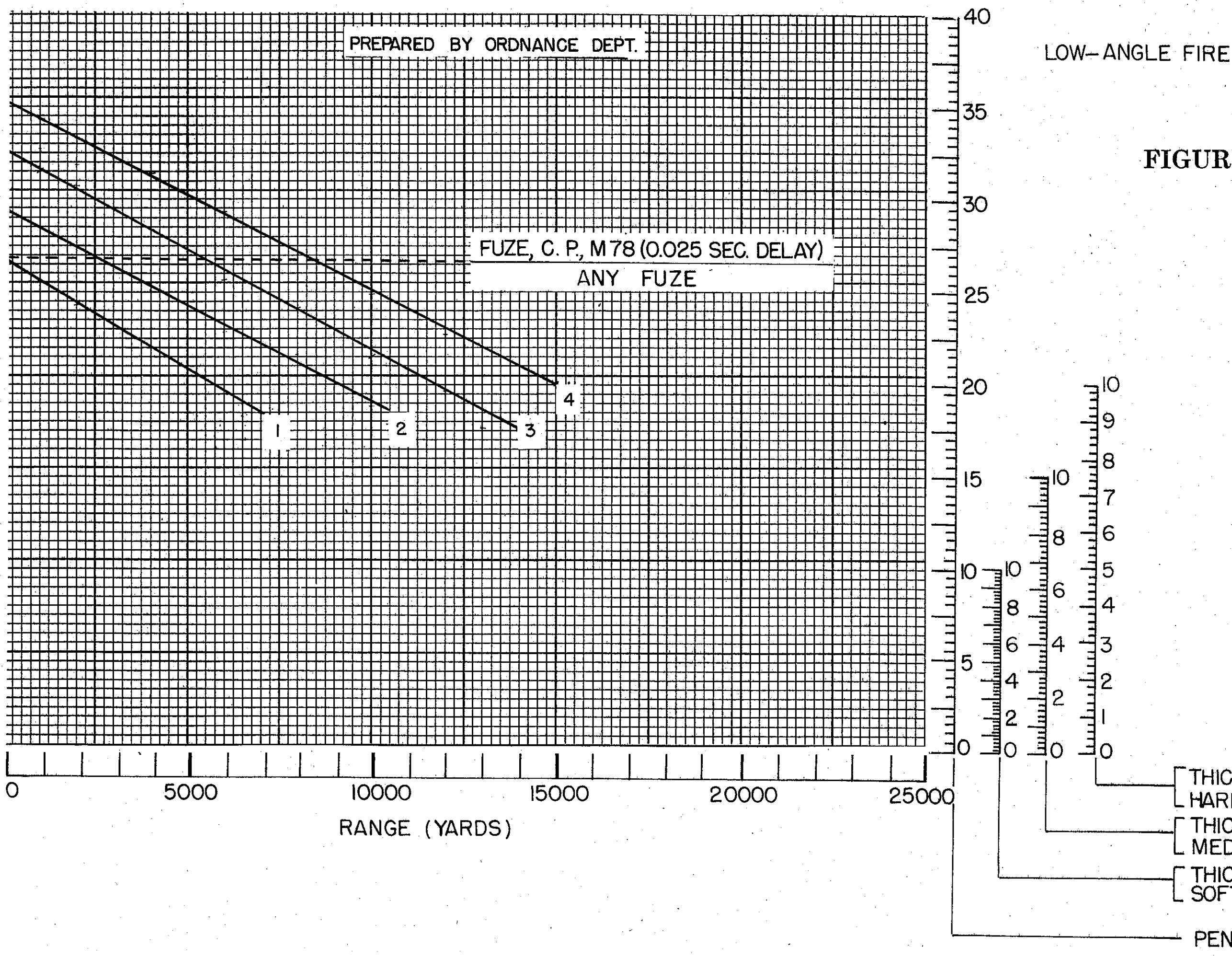


FIGURE 95

240 mm Howitzer, M1; Shell, HE, M114; Fuze, PD, M51 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

With all the above shell either Fuze, PD, M51 and Mod. (0.05 sec delay or longer) or Fuze, CP, M78 (T105) (0.025 sec Delay) may be used at all ranges given by curves or portions of curves laying below the horizontal dashed lines. Use of the Fuze, CP, M78 *is* mandatory at all ranges on the portions of curves lying above the horizontal dashed lines.

The figures in the graph refer to the zone numbers of the propellent charge. See figures 87, 88 and 89 for examples on how to use the chart.

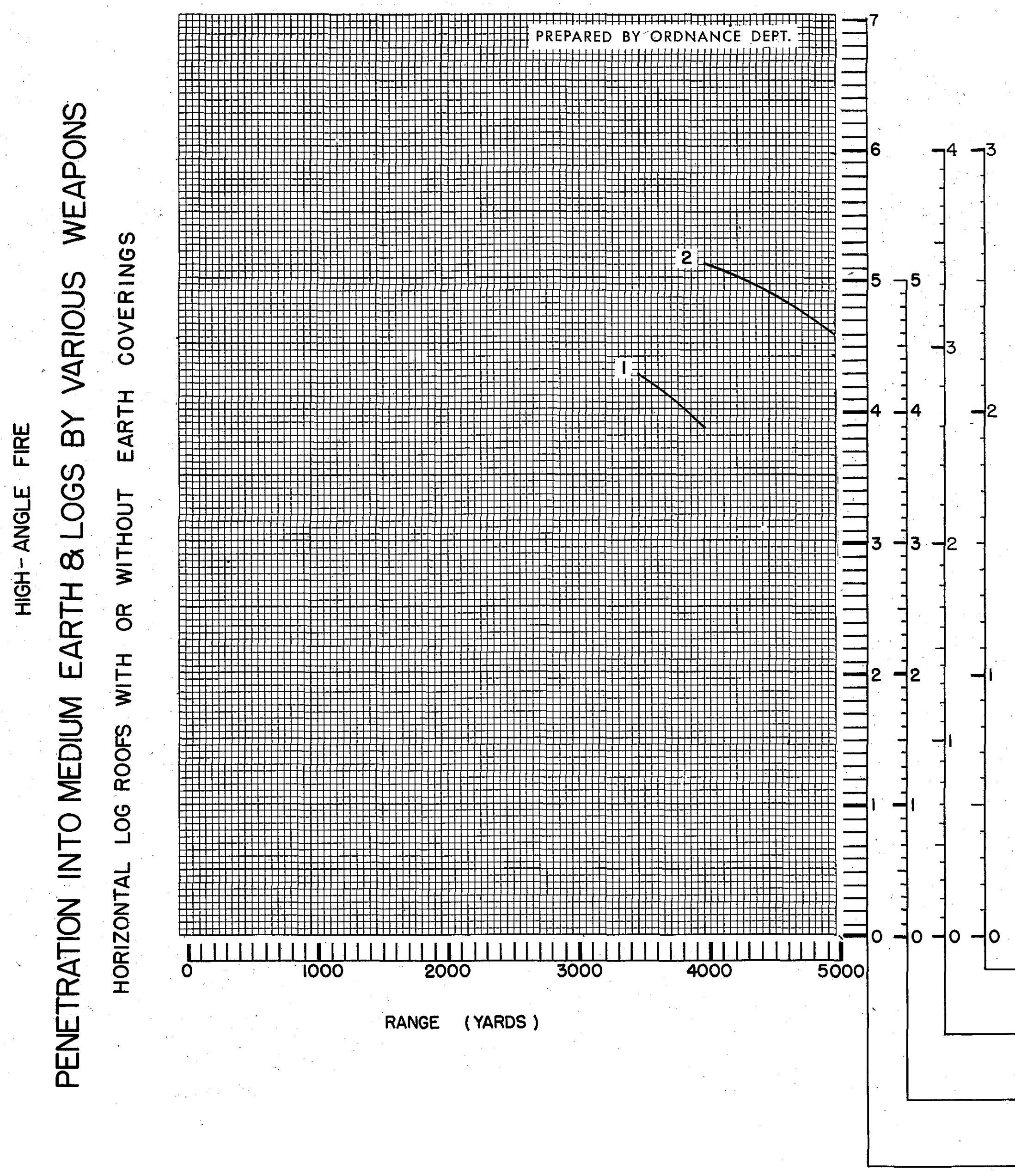


FIGURE 96

75 mm Howitzer, M1, M1A1, M2 or M3; Shell, HE, M48; Fuze, PD, M48 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).
(Use of the M78 Fuze *is not* mandatory.)
The figures in the graph refer to the zone numbers of the propellent charge. See figures 87, 88 and 89 for examples on how to use the chart.

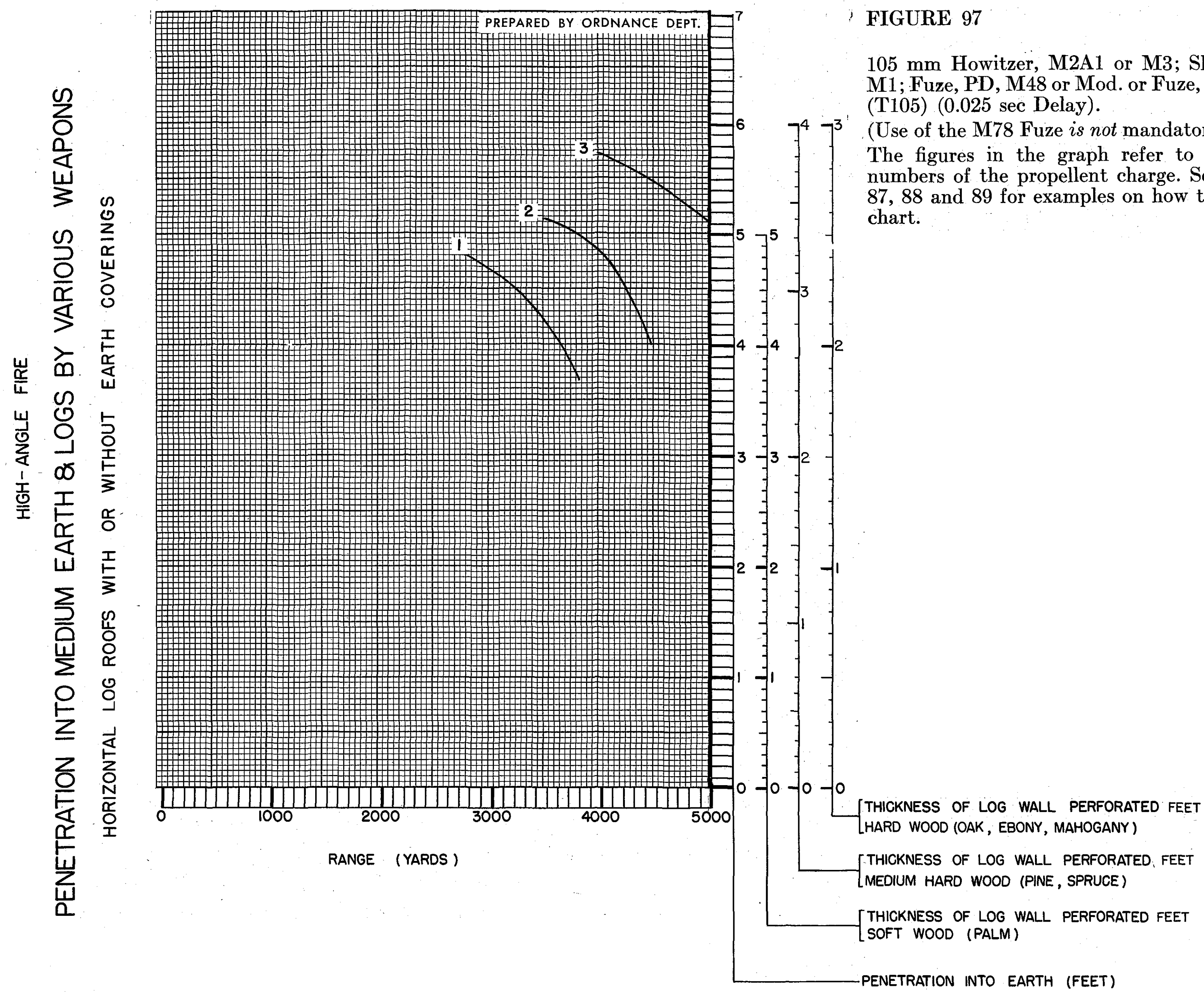


FIGURE 97

105 mm Howitzer, M2A1 or M3; Shell, HE, M1; Fuze, PD, M48 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

(Use of the M78 Fuze *is not* mandatory.)

The figures in the graph refer to the zone numbers of the propellent charge. See figures 87, 88 and 89 for examples on how to use the chart.

HIGH-ANGLE FIRE

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

HORIZONTAL LOG ROOFS WITH OR WITHOUT EARTH COVERINGS

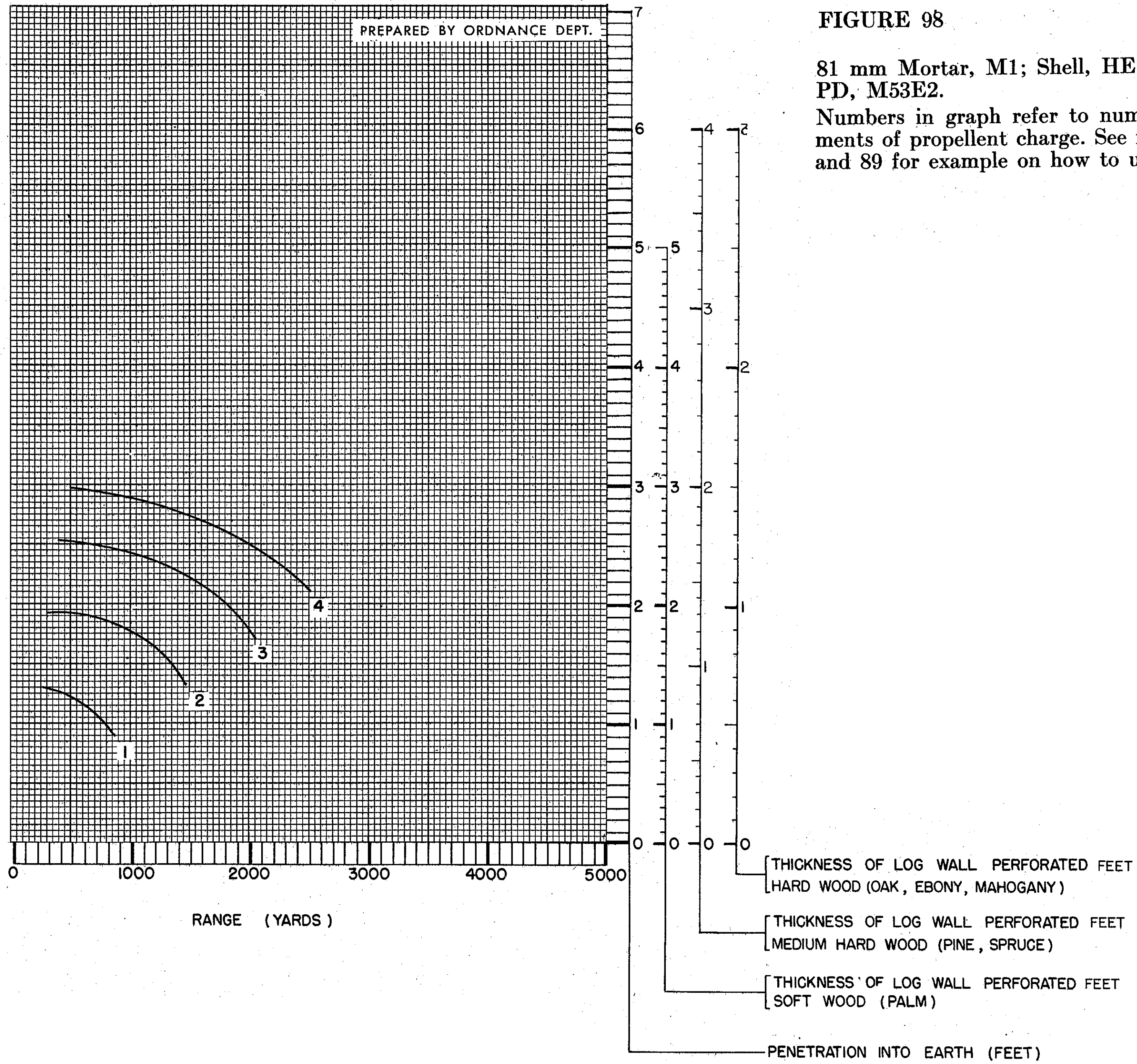


FIGURE 98

81 mm Mortar, M1; Shell, HE, M56; Fuze, PD, M53E2.

Numbers in graph refer to number of increments of propellent charge. See figures 87, 88 and 89 for example on how to use the chart.

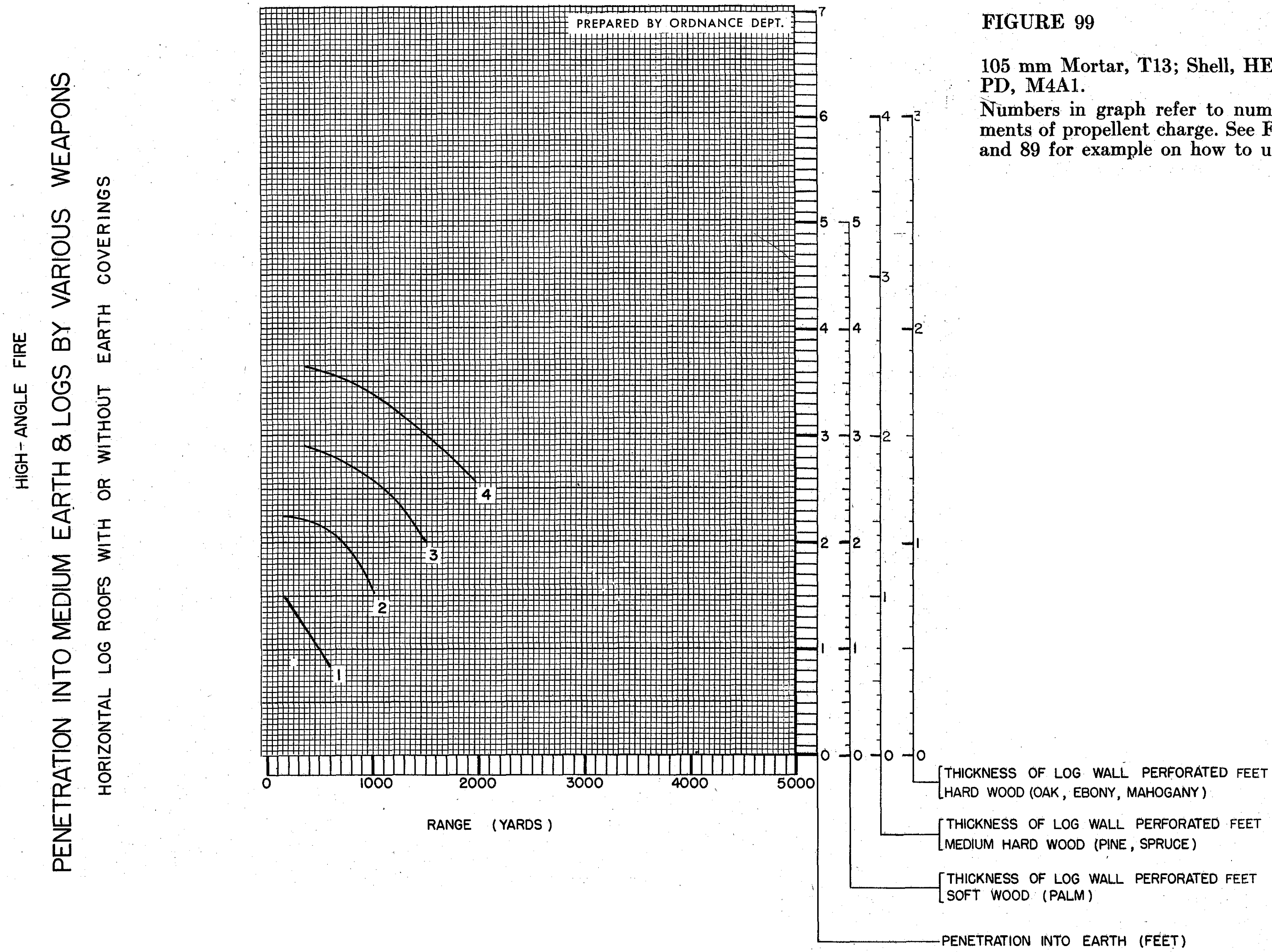


FIGURE 99

105 mm Mortar, T13; Shell, HE, T17; Fuze, PD, M4A1.

Numbers in graph refer to number of increments of propellent charge. See Figures 87, 88 and 89 for example on how to use the chart.

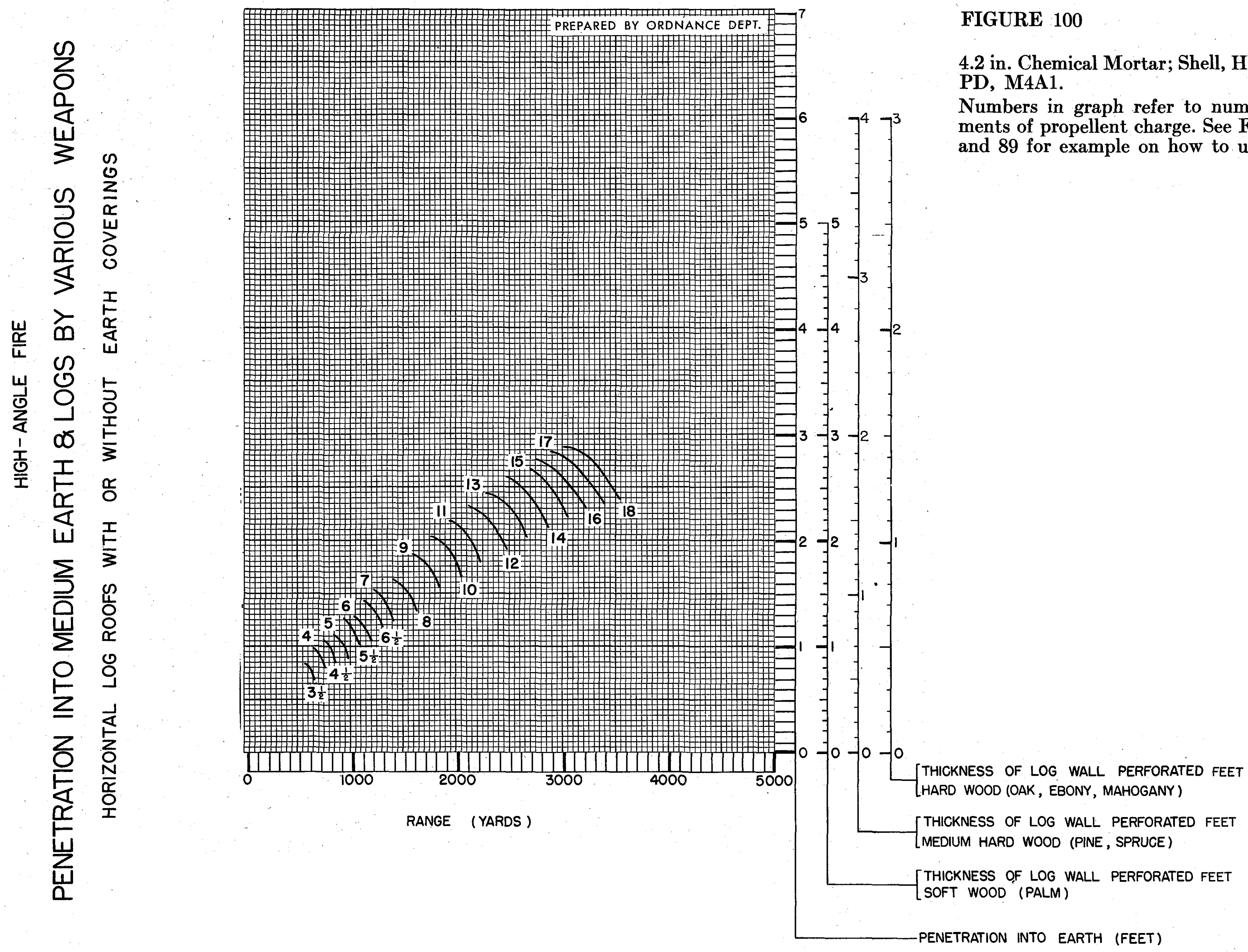


FIGURE 100

4.2 in. Chemical Mortar; Shell, HE, M3; Fuze, PD, M4A1.

Numbers in graph refer to number of increments of propellent charge. See Figures 87, 88 and 89 for example on how to use the chart.

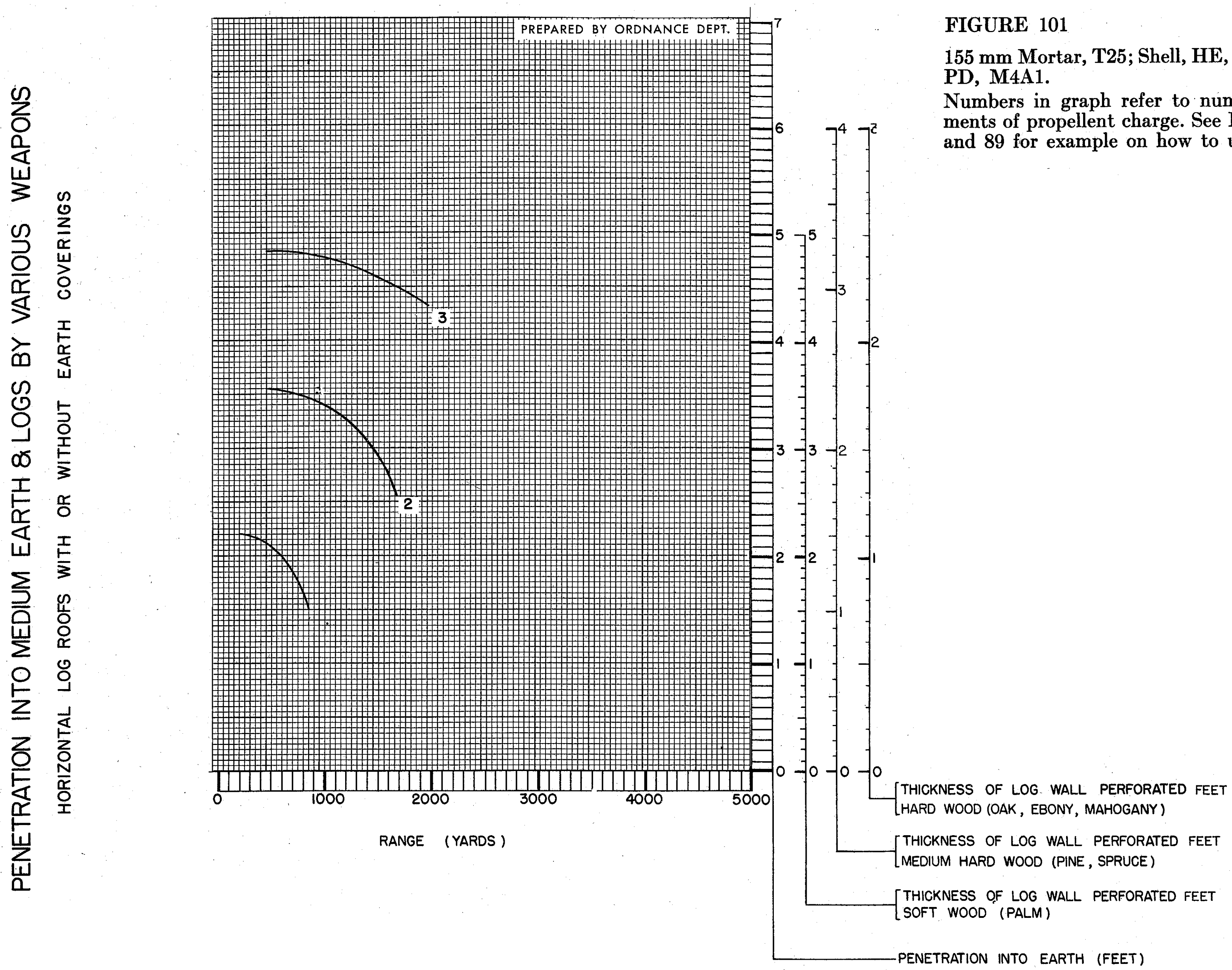


FIGURE 101

155 mm Mortar, T25; Shell, HE, T26E1; Fuze, PD, M4A1.

Numbers in graph refer to number of increments of propellent charge. See Figures 87, 88 and 89 for example on how to use the chart.

HIGH-ANGLE FIRE

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

HORIZONTAL LOG ROOFS WITH OR WITHOUT EARTH COVERINGS

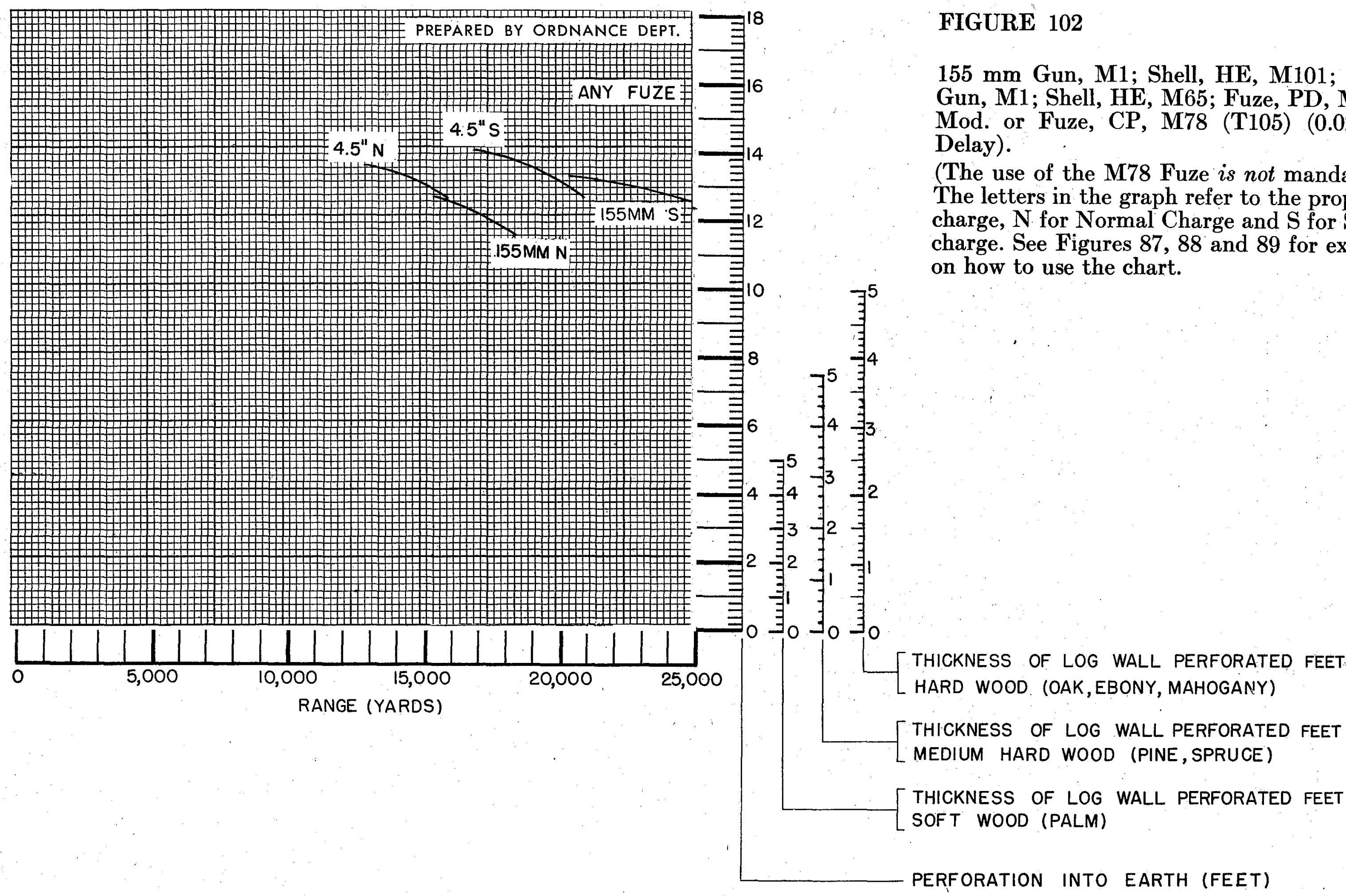


FIGURE 102

155 mm Gun, M1; Shell, HE, M101; 4.5 in. Gun, M1; Shell, HE, M65; Fuze, PD, M51 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

(The use of the M78 Fuze *is not* mandatory.) The letters in the graph refer to the propellent charge, N for Normal Charge and S for Supercharge. See Figures 87, 88 and 89 for example on how to use the chart.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

HIGH-ANGLE FIRE

HORIZONTAL LOG ROOFS WITH OR WITHOUT EARTH COVERINGS

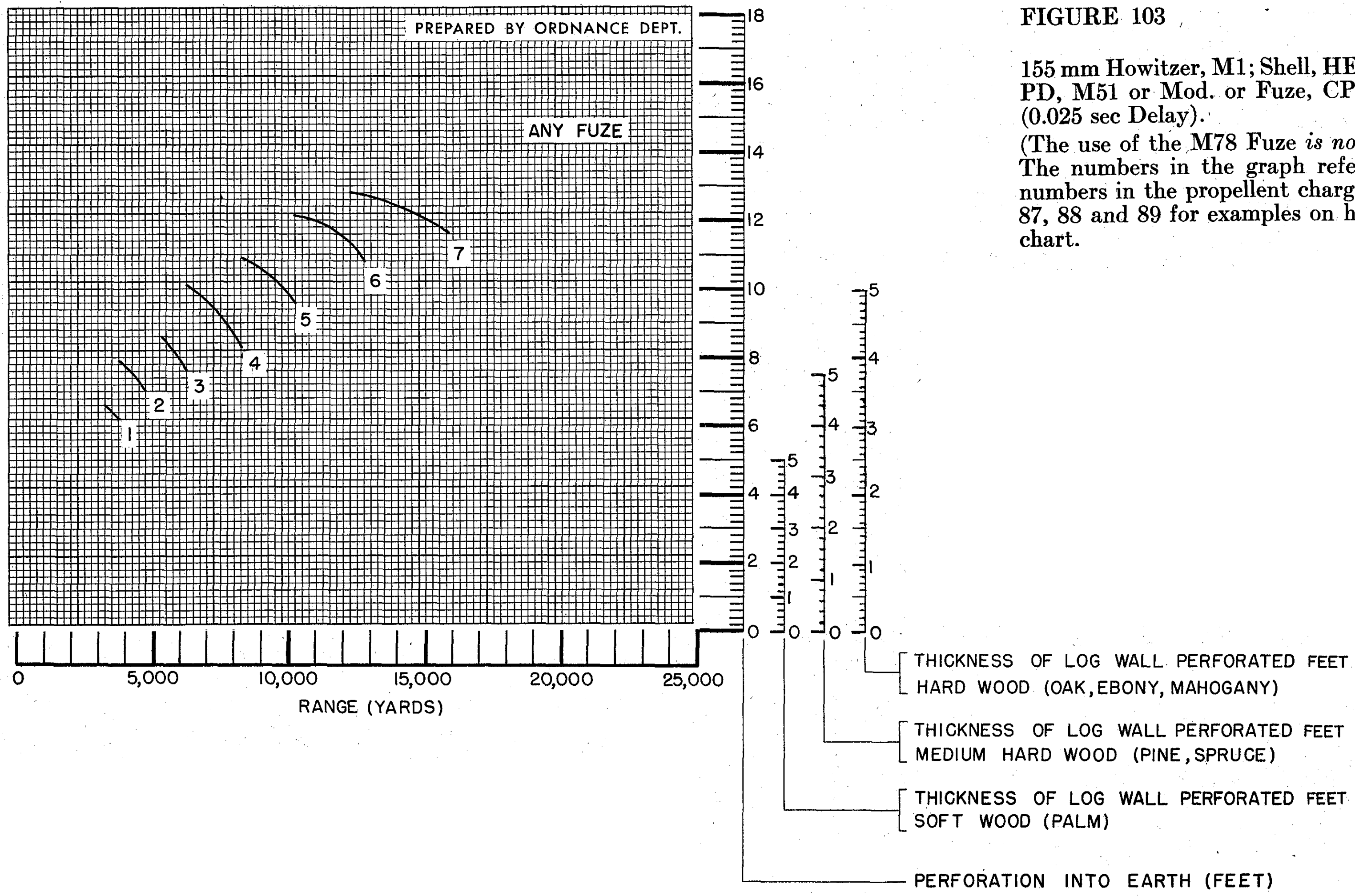


FIGURE 103

155 mm Howitzer, M1; Shell, HE, M107; Fuze, PD, M51 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

(The use of the M78 Fuze *is not* mandatory.) The numbers in the graph refer to the zone numbers in the propellent charge. See Figures 87, 88 and 89 for examples on how to use the chart.

PENETRATION INTO MEDIUM EARTH & LOGS BY VARIOUS WEAPONS

HORIZONTAL LOG ROOFS WITH OR WITHOUT EARTH COVERINGS

HIGH-ANGLE FIRE

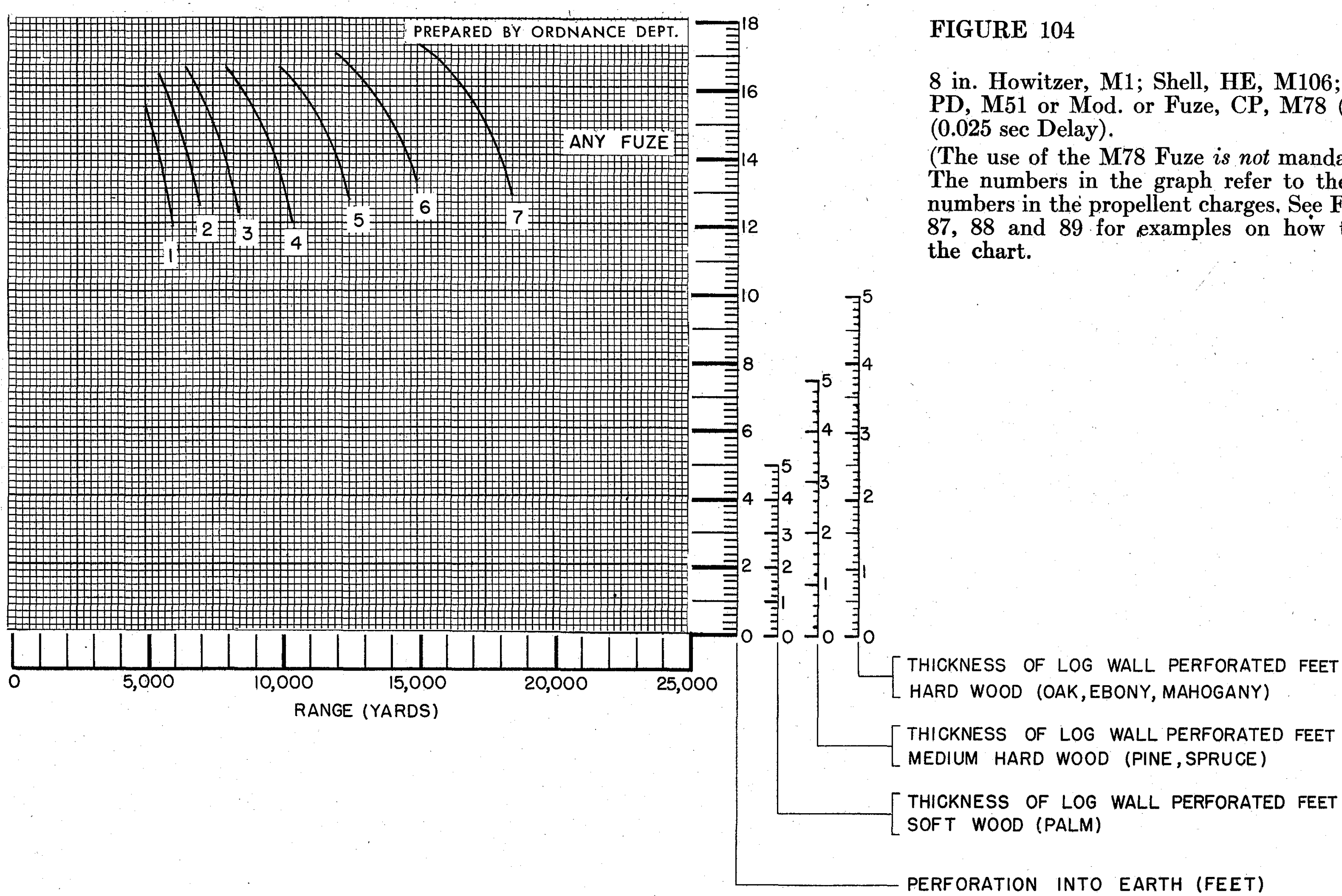


FIGURE 104

8 in. Howitzer, M1; Shell, HE, M106; Fuze, PD, M51 or Mod. or Fuze, CP, M78 (T105) (0.025 sec Delay).

(The use of the M78 Fuze *is not* mandatory.) The numbers in the graph refer to the zone numbers in the propellent charges. See Figures 87, 88 and 89 for examples on how to use the chart.

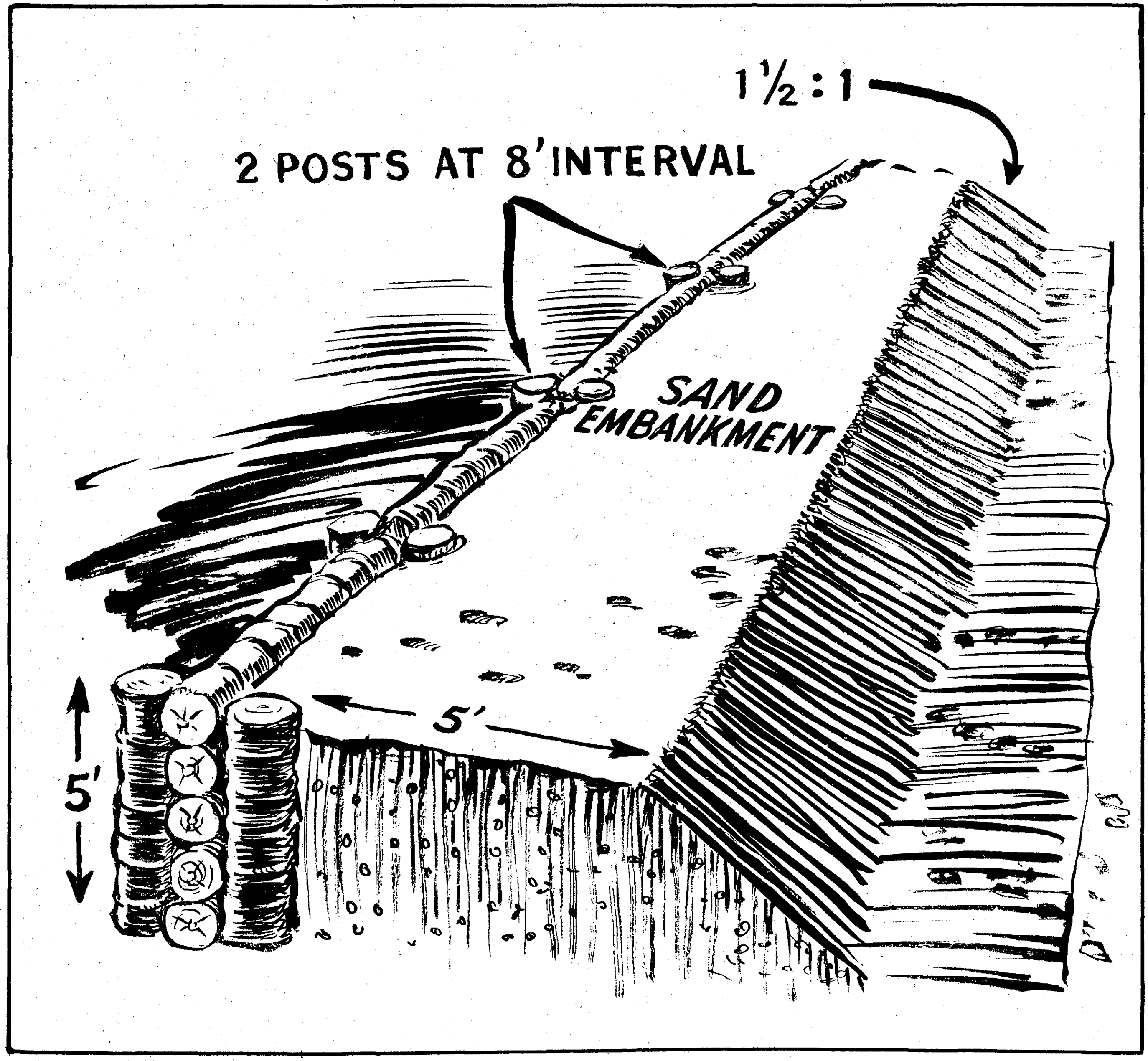
Volume III Part 13

ROCKET, DEMOLITION, 7.2 inch T37

1. NUMBER OF EFFECTIVE ROUNDS REQUIRED FOR REASONABLE ASSURANCE OF BREACHING VARIOUS TYPES OF OBSTACLES TO PERMIT PASSAGE OF MEDIUM TANK.

Figures in the listing which follows are based on tests, or on multiples of figures obtained from tests, using the T-37 rocket fired from the M17 rocket launcher. The test results pertain to effective rounds; hence the figures presented herein do not allow for duds or for rounds going beyond or falling short of the target.

On the average, each effective round displaces approximately ⅔-cubic yard of concrete. However, the amount displaced by any given round is observed to vary considerably, the first rounds of any one series causing surface damage and cracking but little actual displacement.



BREACHING OF TANK OBSTACLES

FIGURE 105

JAP LOG WALLS

Height—5 ft.
No. of Rounds—5 or less

BREACHING OF TANK OBSTACLES

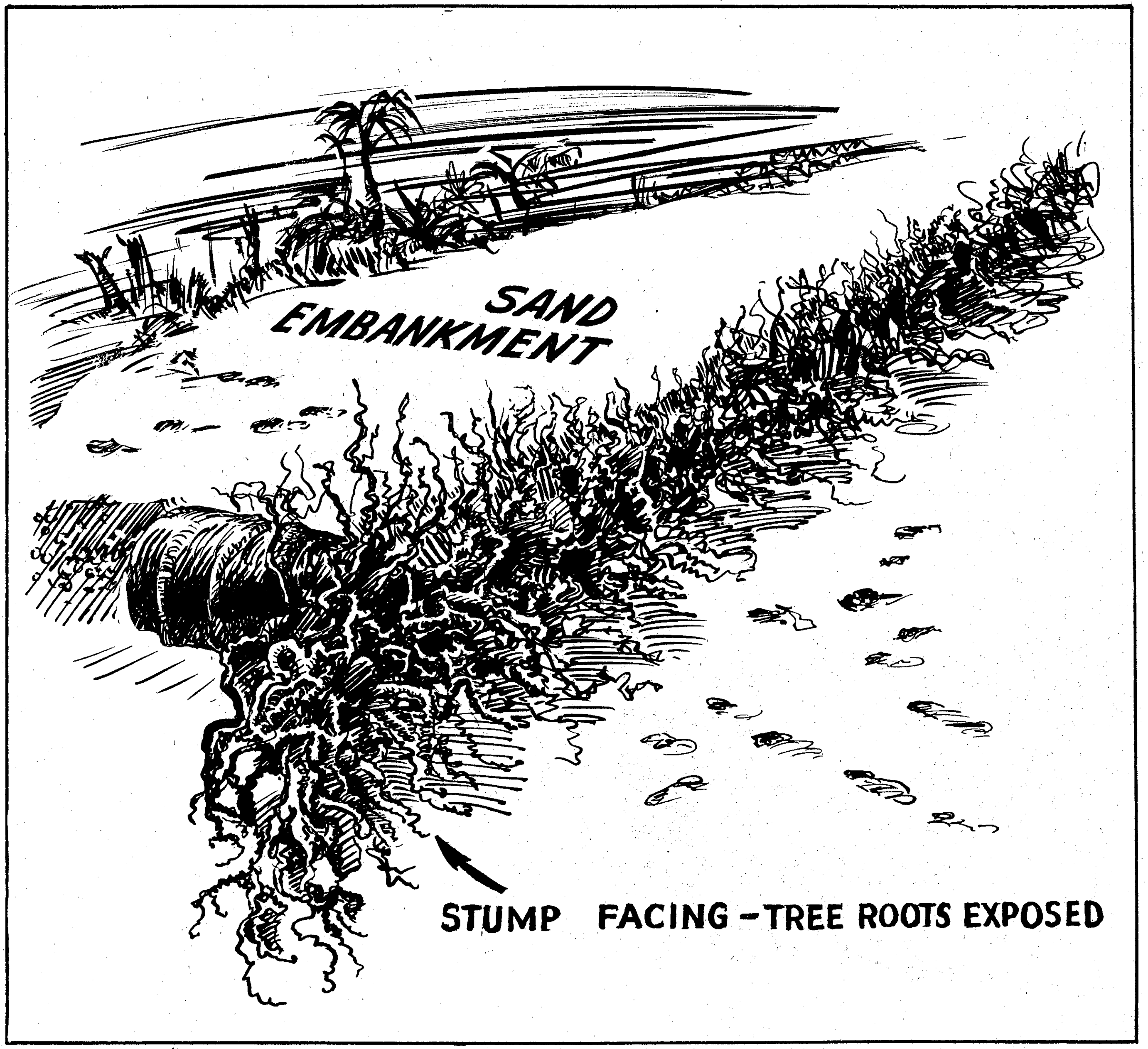
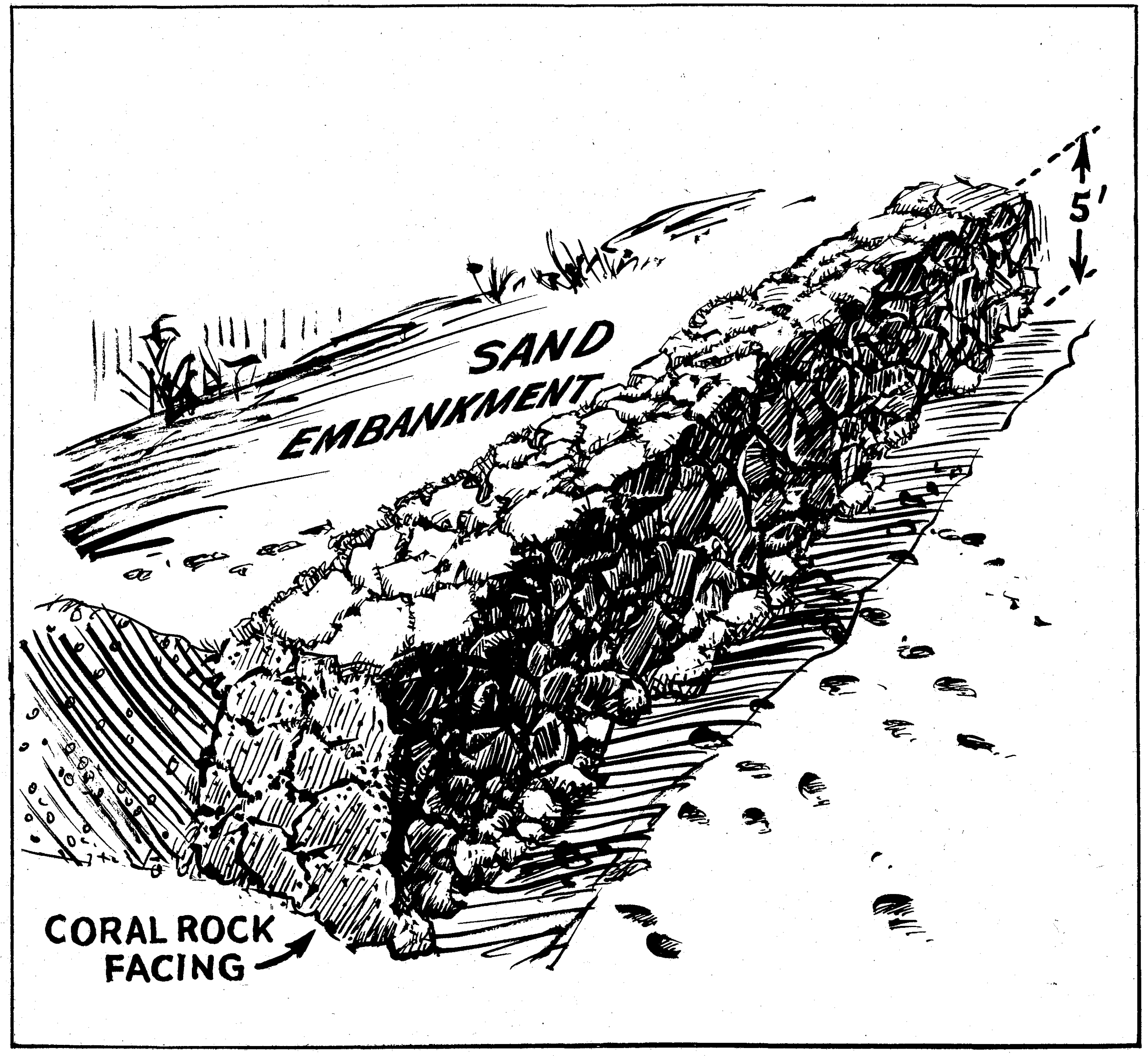


FIGURE 106

JAP STUMP WALLS

Height—Approx. 4 ft.
No. of Rounds—5 or less



BREACHING OF TANK OBSTACLES

FIGURE 107

JAP CORAL WALL

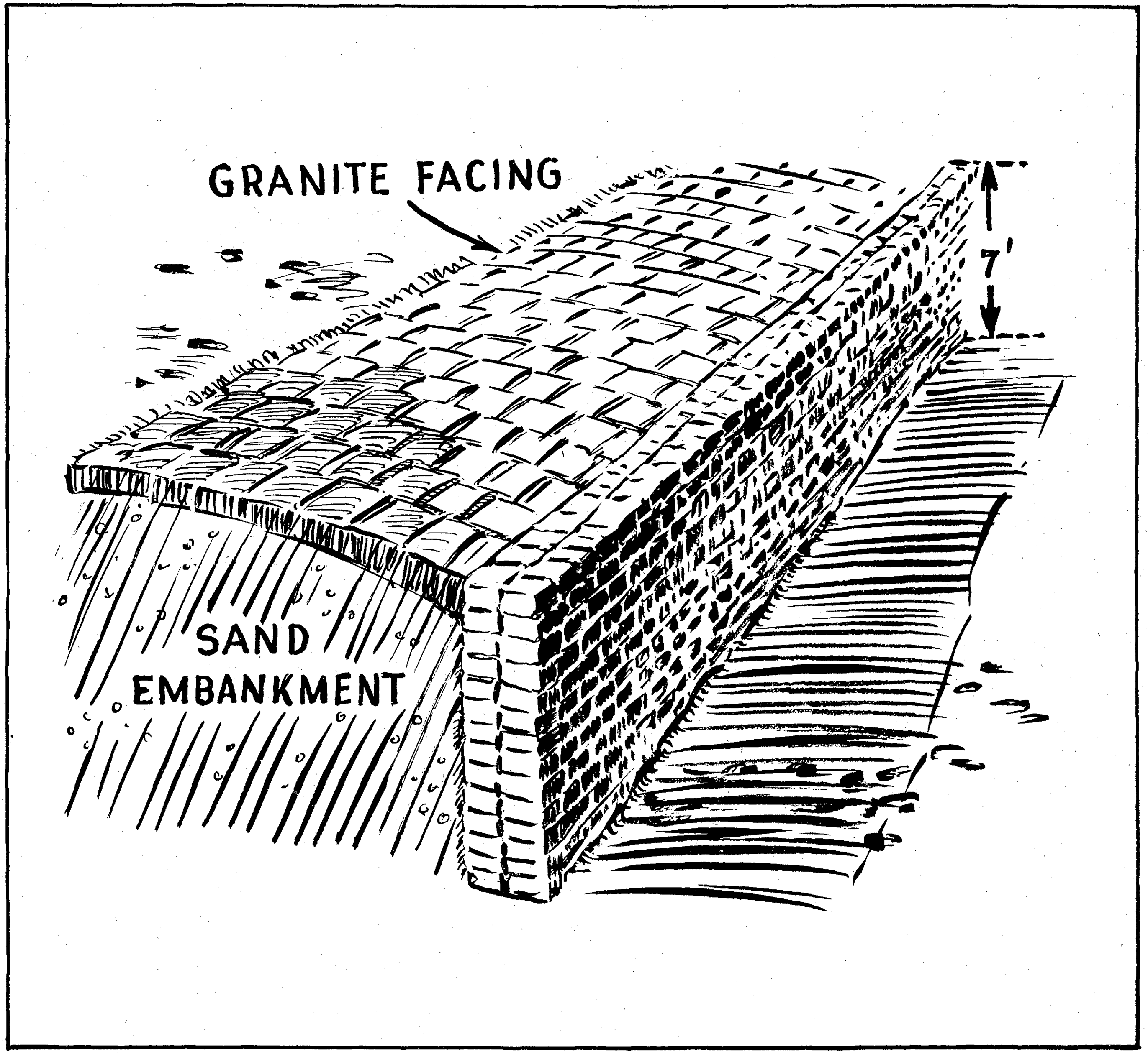
Height—5 ft.
No. of Rounds—5 or less

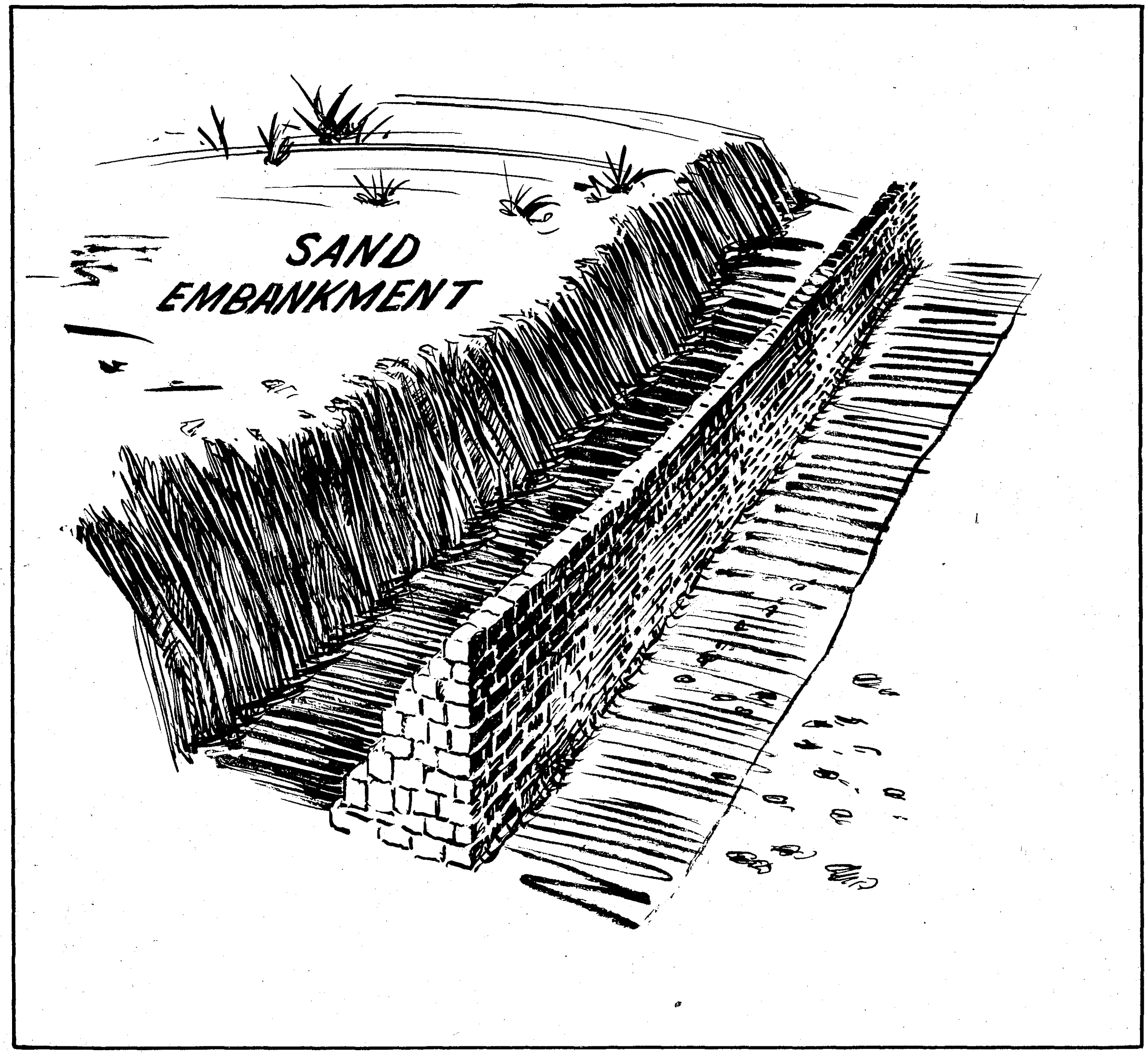
BLOCK STRUCTURES

FIGURE 108

UNMORTARED BELGIUM BLOCK WALLS

Height—5 ft.
No. of Rounds—5 or less





BLOCK STRUCTURES

FIGURE 109

UNMORTARED BELGIUM BLOCK WALLS

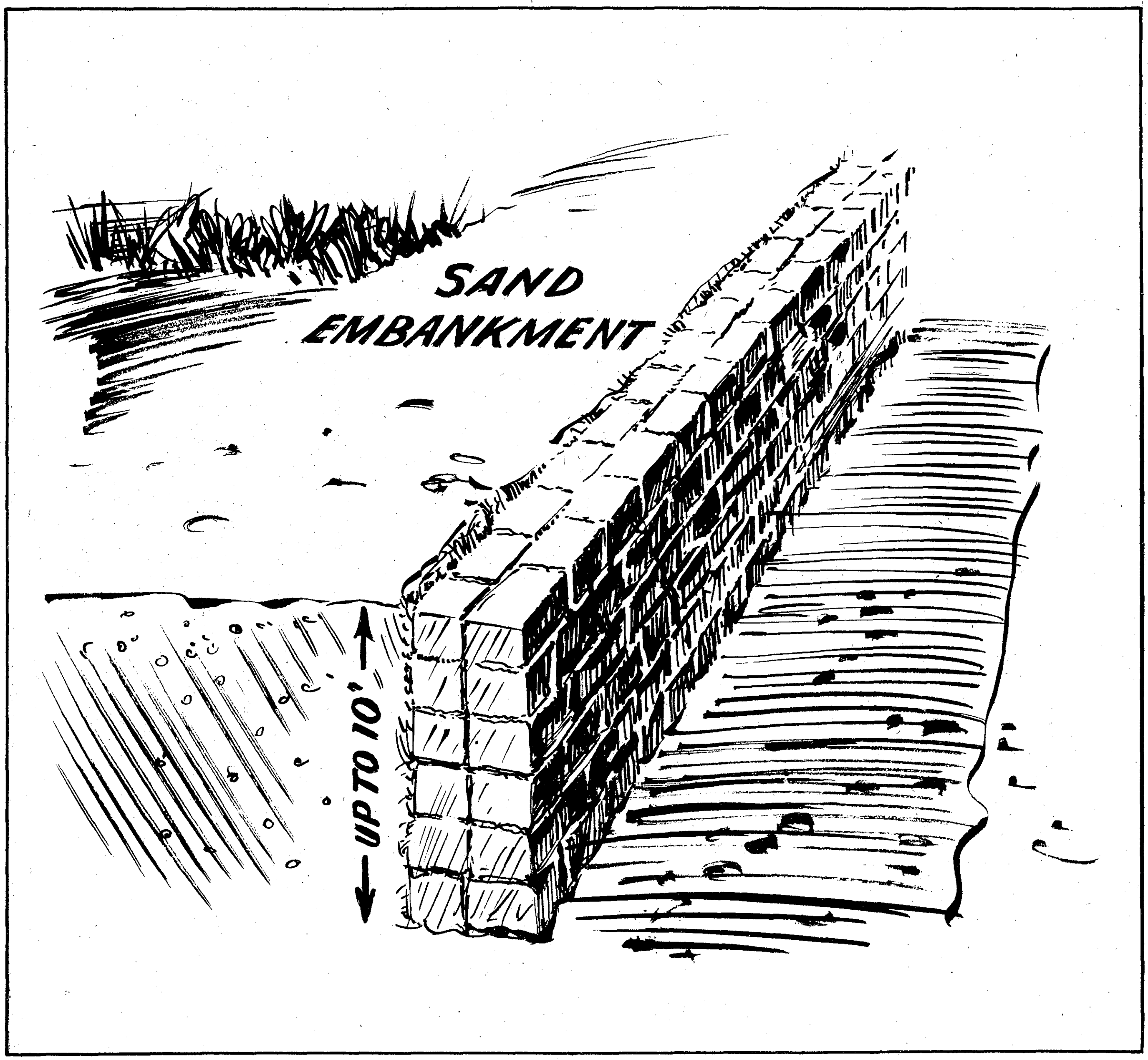
Height—5 ft.
No. of Rounds—5 or less

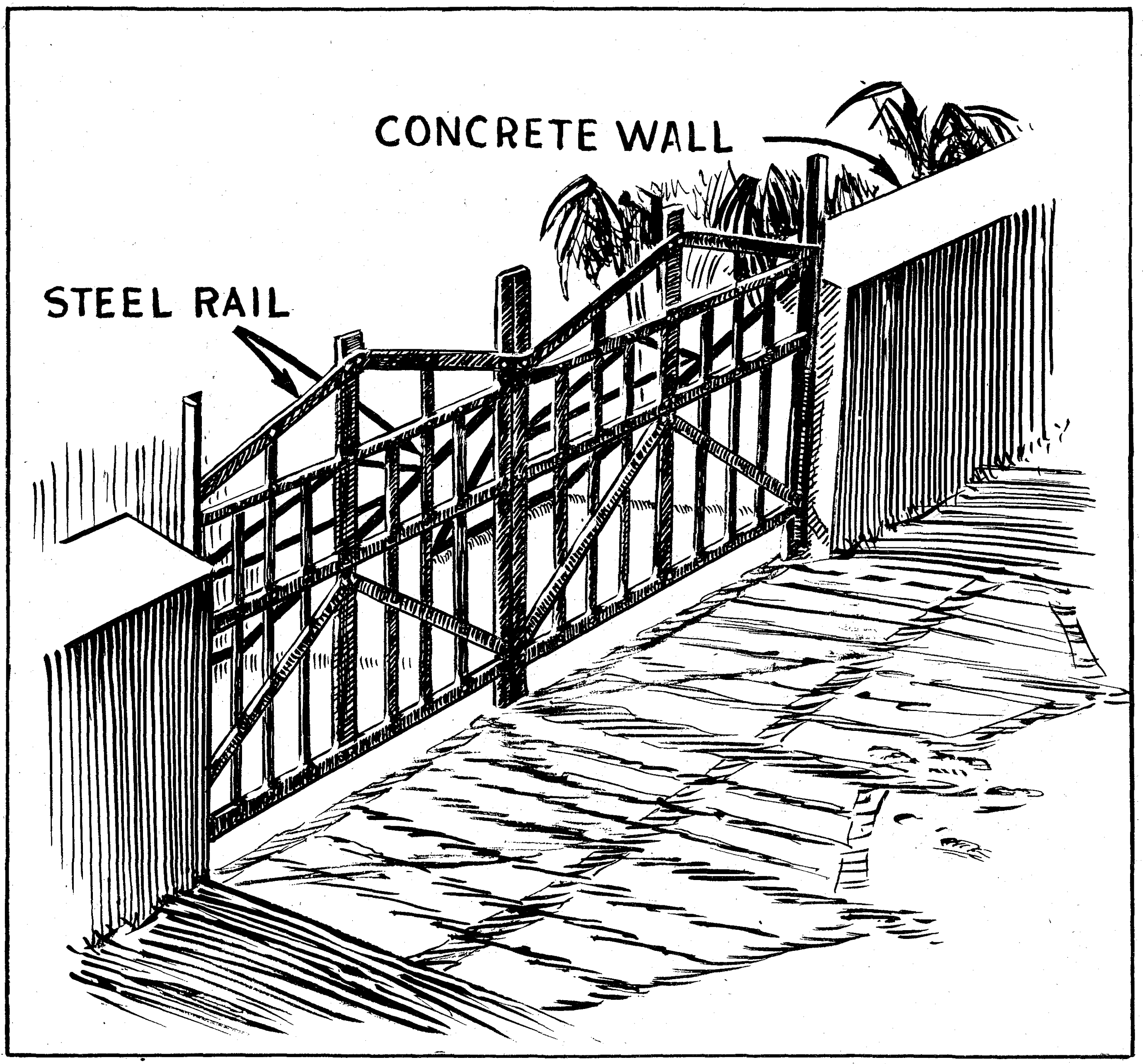
BLOCK STRUCTURES

FIGURE 110

MORTARED GRANITE BLOCK BEACH WALLS

Height—Up to 10 ft.
No. of Rounds—10 to 15





CONCRETE STRUCTURE GATES.

FIGURE 111

ELEMENT C

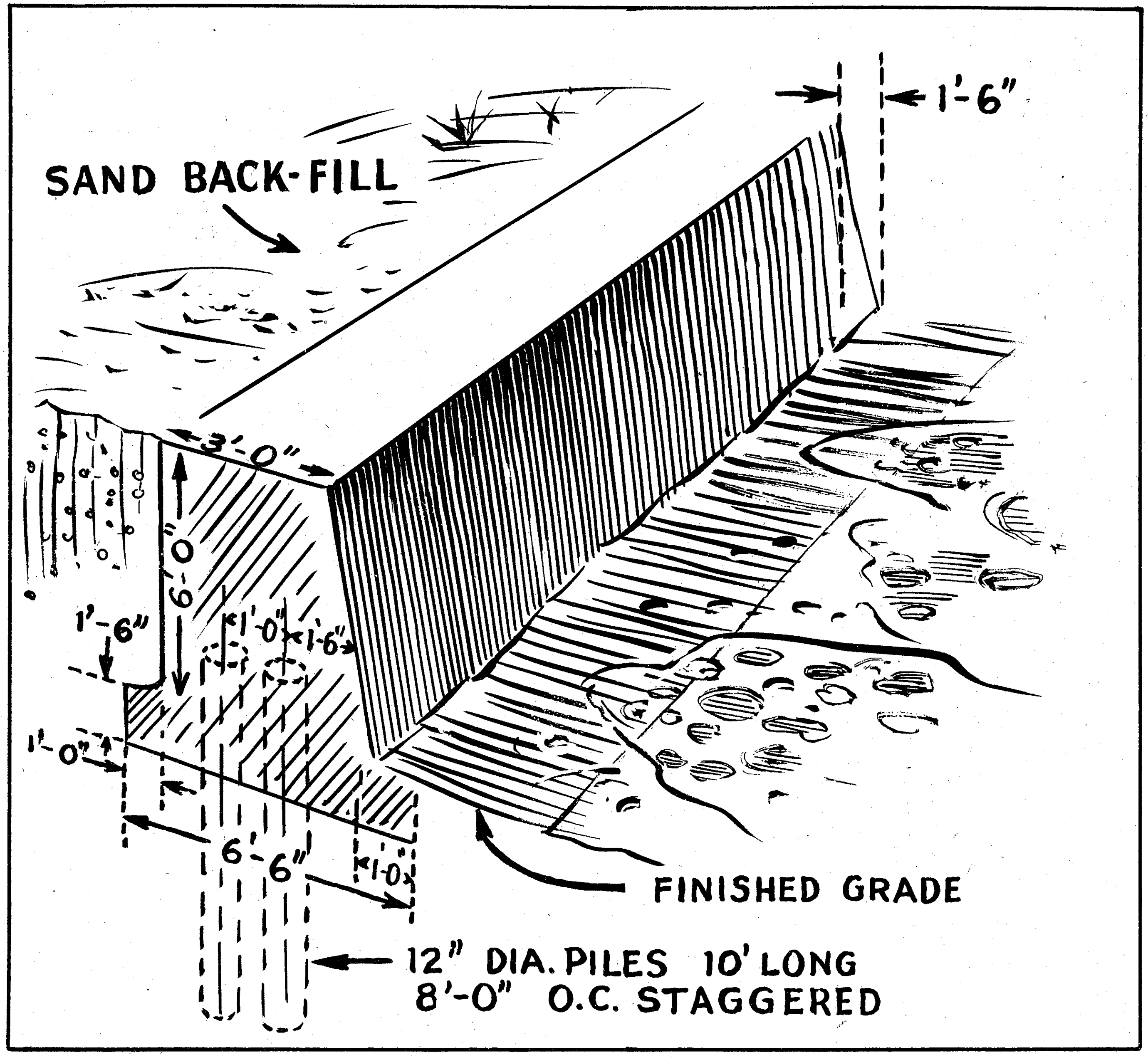
Range—Approx. 100 ft.
No. of Rounds—10 to 15

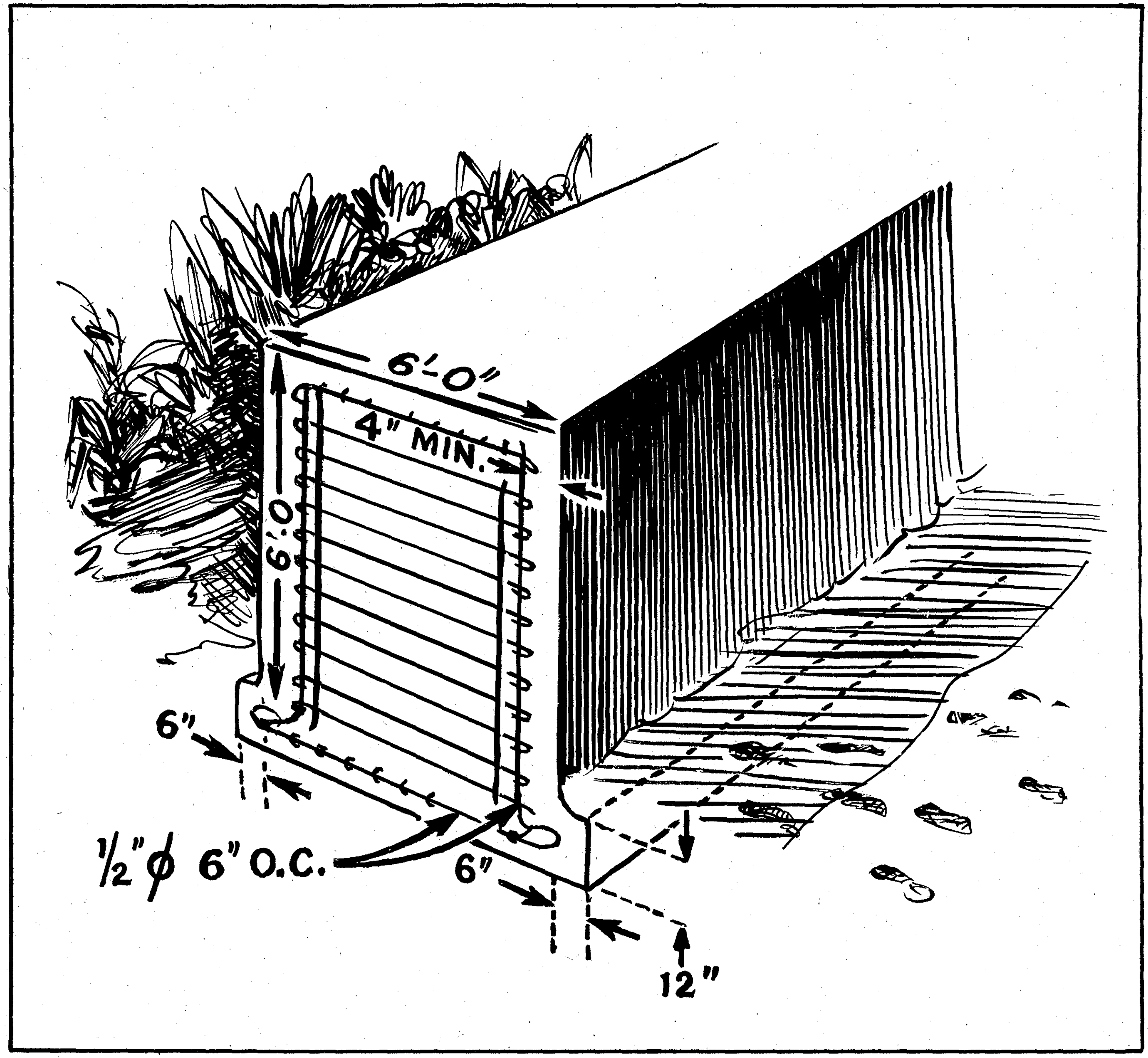
CONCRETE STRUCTURES

FIGURE 112

UNREINFORCED CONCRETE SEA WALLS

Range—Approx. 100 ft.
Height—Up to 6 ft.
Thickness—3¾ ft. (average)
No. of Rounds—5 to 10





CONCRETE STRUCTURES

FIGURE 113

CONCRETE WALLS LIGHTLY REINFORCED

Range—Approx. 100 ft.
Height—Up to 8 ft.
Thickness—Up to 6 ft.
No. of Rounds—10 to 15

CONCRETE STRUCTURES

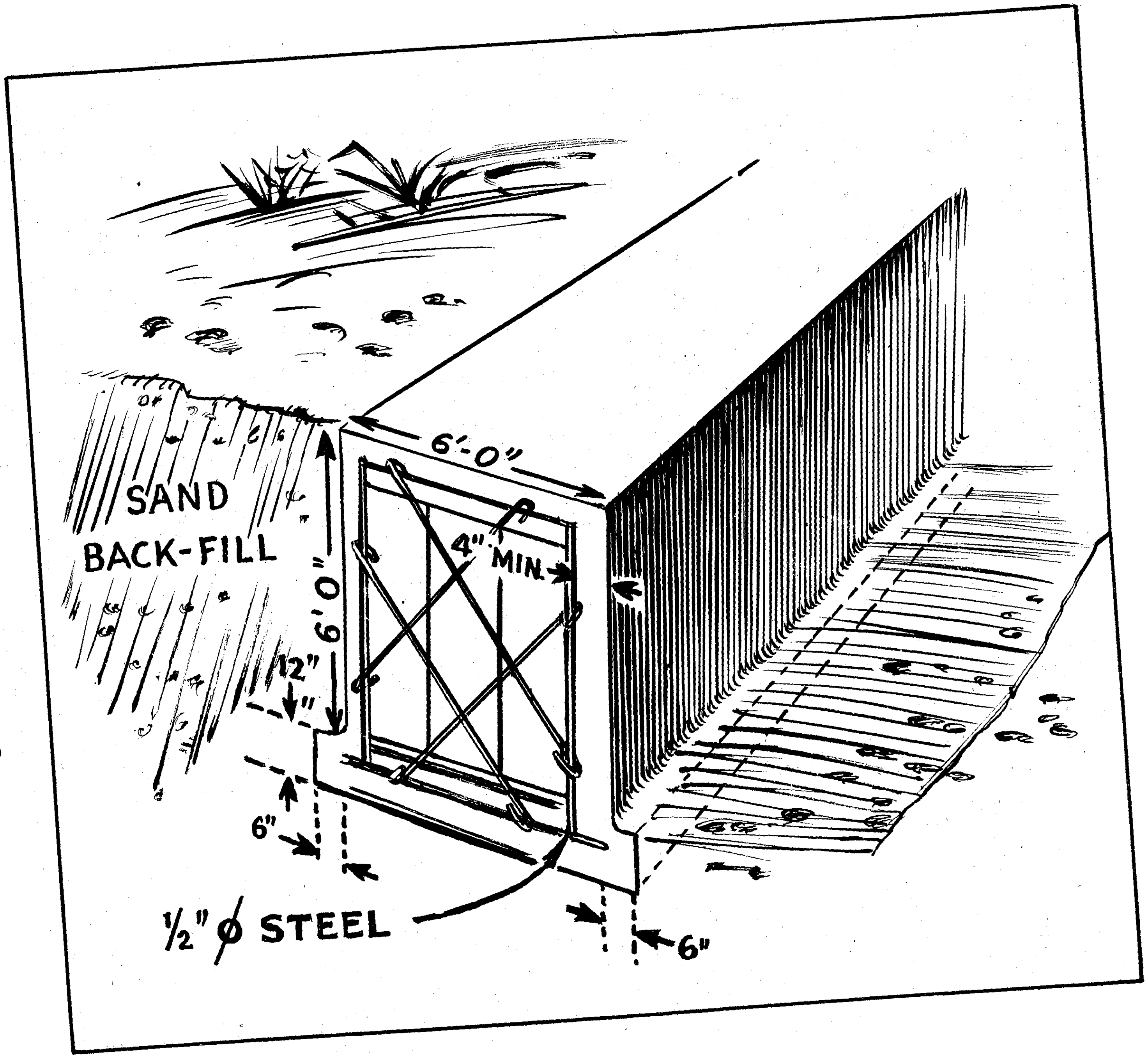


FIGURE 114

HEAVILY REINFORCED CONCRETE OR BACKFILLED WALLS

Range—Approx. 100 ft.
Height—Up to 6 ft.
Thickness—Up to 6 ft.
No. of Rounds—15 to 20

Height—6 to 8 ft.
Thickness—6 to 8 ft.
No. of Rounds—20 to 40

Height—8 to 9 ft.
Thickness—8 to 9 ft.
No. of Rounds—40 to 60

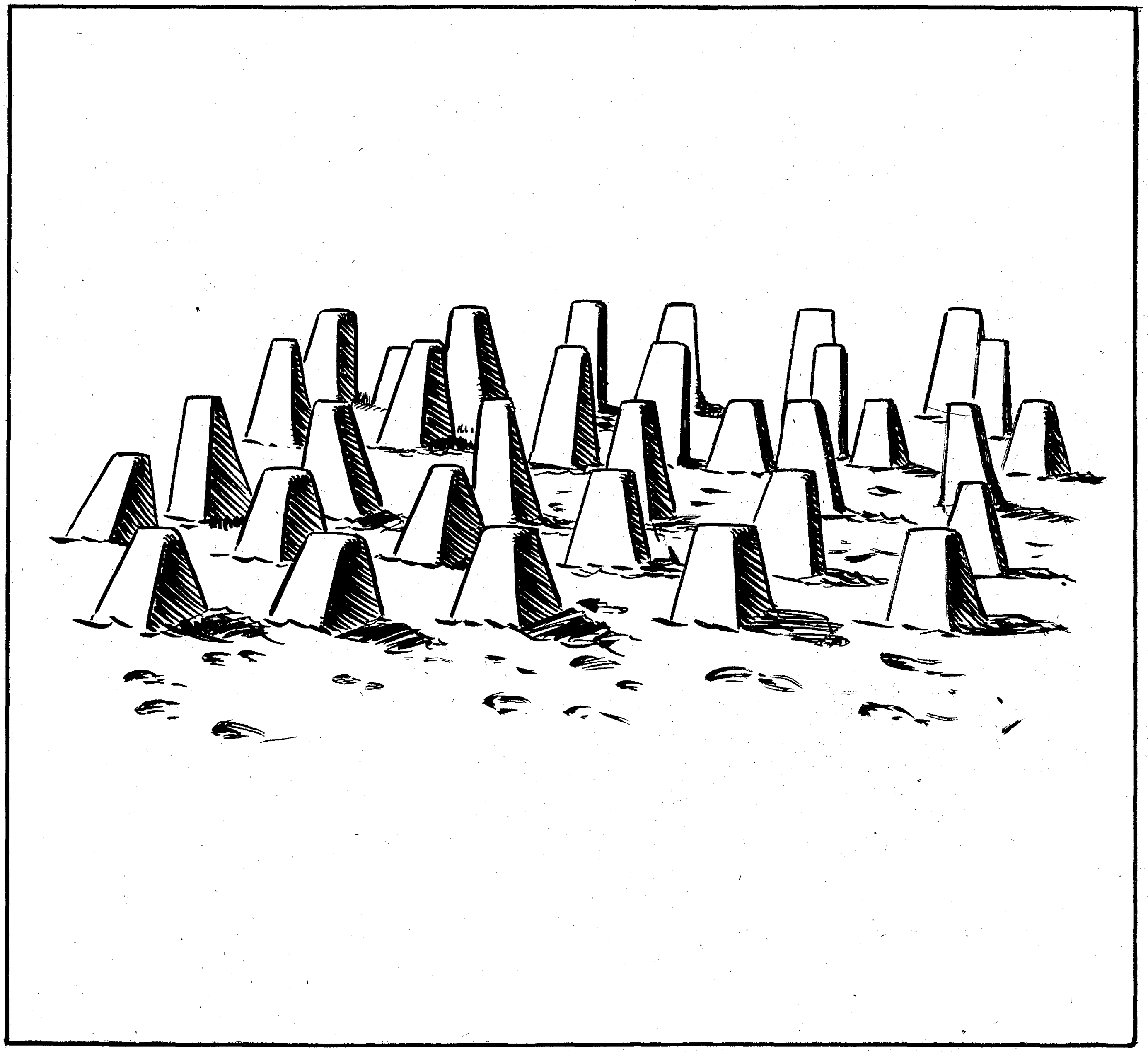


FIGURE 115

DRAGON'S TEETH AND OTHER BANDS OF SMALL REINFORCED CONCRETE TANK BELLYING OBSTACLES

No. of Rounds—10 to 15

TABLE 88

JAP LOG OR DRUM TYPE PILLBOXES

Earth and Log Structures
No. of Rounds—5 to 10

TABLE 89

MINE FIELDS AND WIRE ENTANGLEMENTS

Depth—Not over 40 ft.
No. of Rounds—5 to 10

Depth—Not over 80 ft.
No. of Rounds—15 to 20

Depth—Not over 160 ft.
No. of Rounds—20 to 40

Depth—Not over 240 ft.
No. of Rounds—40 to 60

2. ACCURACY.

The projectile may veer off course when acceleration continues beyond the guide rails of the launcher. For this reason, the dispersion of shots from a given rail may depend quite markedly on the burning time and hence on the temperature. The following table illustrates the effect of temperature on dispersion:

Temperature	Amount of burning while on rails	Mean lateral deviation
10° F	33%	20 mils
Normal	40%	10 mils
120° F	60%	7 mils

Under field conditions, a lateral standard deviation of at least 9 mils and an equal vertical deviation may be expected. That is, at a range of 100 feet, not more than 13 rounds of a launcher-load of 20 rounds may be expected to fall within a wall target area 10 feet long by 3 feet wide. At a range of 200 feet, only 6 out of 20 rounds may be expected to hit such a target area. Figure 116 shows the relation of range to the number of rounds, out of a launcher-load of 20 fired, which may be expected to hit selected wall target areas.

The effect of wind on these projectiles may be neglected for practical purposes.

If two projectiles are fired nearly simultaneously, one may be caught in the blast from the other and suffer a considerable deviation. For this reason, projectiles should be fired at least 1/8 second apart. At close range no round should be fired until the previous one has detonated, since the blast from the detonation of one round may deflect the next round from its target, or cause its detonation prematurely.

ROCKET, DEMOLITION, 7.2", T37

FIRED FROM THE LAUNCHER, ROCKET, MULTIPLE, 7.2", M17

NUMBER OF ROUNDS, OUT OF THE 20 FIRED FROM THE LAUNCHER, EXPECTED TO HIT A VERTICAL TARGET 12 FT WIDE BY 4 FT HIGH, AND ONE 10 FT WIDE BY 3 FT HIGH.

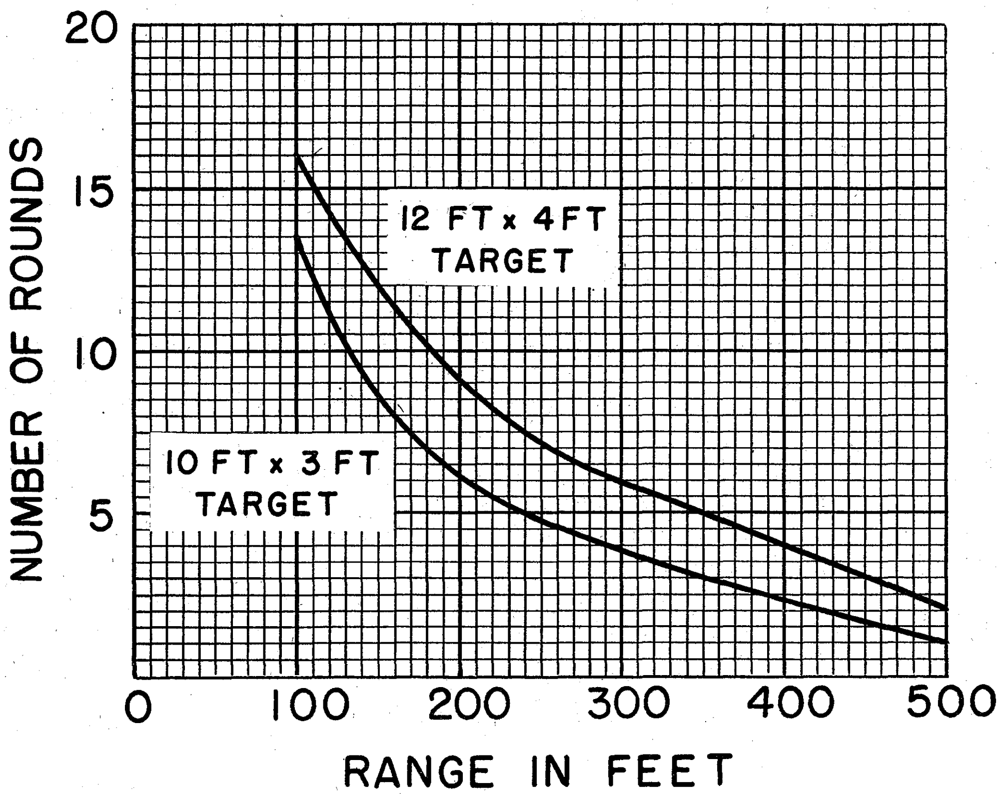


FIGURE 116

NOTES