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R.A.R.D.E. MEMORANDUM (MX) 15/62

Basic Studies of the Lethality of Shaped Charges

Part I. Penetration Data

E. G. McMahon
O. R. Ottaway
T. M. Finnie

Fort Halstead
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E.G. McMahon
O.R. Ottaway (X1)
T.M. Finnie

Summary

Trials are described in which a number of designs of shaped charges were fired into semi-infinite armour and against representative tank targets with a view to assessing their anti-tank capabilities. The charges were of 5.9 inches diameter and constant weight and type of explosive. They were fitted with conical liners of various materials, angles and wall thickness.

Part I deals with the firings into semi-infinite armour which were intended to give data on depths of penetration and crater volumes and profiles. The results are presented in detail, and some results from experiments which were carried out to amplify points arising from the main programme are also included.

On the basis of the penetration data, certain designs were selected for firing against standard tripartite target assemblies to determine "beyond armour" fragmentation patterns. This work is described in Part II while the lethality of the charges is assessed and the results discussed in the light of other work in Part III.

Approved for issue:

L. Northcott, Principal Superintendent, "MX" Division

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I INTRODUCTION

The investigation described in this report was initiated for the purpose of providing background data for the design of large calibre anti-tank warheads using the shaped charge principle. It has been shown, particularly in work carried out at B.R.L. during the last few years, that the lethality of shaped charge warheads depends primarily on the fragments spalled from the inside surface of the armour, and is not uniquely related to the penetrative ability of the jet, (1,2,3,4,5). Accordingly in the present work the designs investigated included a number which were expected to give relatively low penetration but which it was hoped might prove comparatively lethal.

Each design of charge was fired against semi-infinite armour in order to determine the resulting crater depth and profile. American work had already established certain relations between the crater dimensions and lethality and it was hoped that these might be confirmed and extended by the present work. Those designs which gave very low penetration were not investigated further. The remainder were fired against three types of target, each of which has been agreed, on a tripartite basis, as being representative of modern heavy tank design, (6). For these firings the lethality and distribution of the spalled fragments were measured with a view to assessing the overall lethality of each type of charge. The only variables considered in the charge design were the material, wall thickness and angle of the liner. The cone diameter 5.9 ins., was fixed on the basis that at this calibre most of the charges could be expected to defeat at least one of the tripartite targets.

While the work was in progress a similar series of trials under tripartite sponsorship was carried out at C.A.R.D.E., and has been reported on (7). These trials resulted in a thorough evaluation of the lethality of a very few types of charge, whereas the present trials deal with a much larger number of designs but are less extensive in character. The two sets of results are therefore complementary and use is made of the T.A.T.T.L.E. results in evaluating and discussing the present work.

For convenience of presentation the report is divided into three parts. Part I deals with the experimental details and data obtained from the penetration firings against semi-infinite armour. Part II treats the lethality firings against the tripartite targets in a similar manner, while the main discussion of both sets of results, together with their broader implications is dealt with in Part III.

2. EXPERIMENTAL

2.1 Charge design

The charges were cylindrical in section with a conical metal liner at one end and a central initiating system at the other (Figure 1). The explosive filling was maintained constant at 16lb., excluding the initiating system. This rather large weight was chosen in the interest of reproducibility. Each charge was confined in a mild steel tube of 5.9 ins. internal diameter and 0.125 ins. wall thickness.

2.1.1 The liners

Liners of three different materials were used namely aluminium alloy, copper and steel. These materials had the following specifications:

Aluminium alloy:	B.S. 1476 H.E. 10 W P.
Copper:	B.S. 1433 medium hard.
Steel:	B.S. 970 E.N. 3A.

For each material three cone angles, 45°, 75° and 100° were investigated. The remaining variable parameter was the wall thickness and this was chosen in the case of the copper liners to be 1.5%, 2.5% and 5% of the charge

diameter. The thicknesses of the aluminium and steel liners were determined in such a way that these liners would have the same weight as the corresponding copper liner. A total of 24 designs from the 27 possible combinations of the above parameters were in fact tested.

Each cone was machined from a forging to the dimensions shown in Figure 2, the surface having a good machine finish. It will be observed that in each case the cone was truncated by 20%.

2.1.2 The confinement tube

The confinement was machined from drawn mild steel tube to the required dimensions. The confinement length was adjusted according to the included angle of the liner in order to maintain a constant weight of explosive. Each confinement tube was individually fitted to its cone and the assembly was then locked by three sets of screws which engaged on the base of the cone through the tube.

Two $\frac{1}{4}$" diameter holes were drilled in the confinement tube level with the apex of the liner. These filled with explosive during the casting operation and thus served to lock the charges in position.

2.1.3 The explosive filling

All except five of the charges were filled with RDX/TNT 60/40, Type A of Bridgwater manufacture. The explosive was cast in air, directly into the cone and tube assembly, an adequate header being provided to eliminate core flaws due to shrinkage. The density of the resultant charge was 1.66 to 1.67 gm/cc.

To allow comparisons to be made with previous work, five of the rounds were filled with Plastic Explosive No.2, hand stemmed to a density of 1.55 gm/cc.

All the charges were radiographed (Figure 3) to detect casting or filling flaws. There was no piping but some cast charges showed fine cracking of the filling around the base of the liner and sometimes lack of adhesion between the liner and explosive filling. Complete elimination of the cracking was never entirely achieved. The charges to be fired were selected on the basis of the radiographs the poorer charges being sent for refilling. The P.E.2 charges showed no major defects.

2.1.4 Initiation

The charges were initiated centrally by means of a Briska No. 8 electric detonator acting through a 1in. diameter by 1 in. long Tetryl Pellet, density 1.58 gm/cc, located in a wooden disc attached to the end of the charge (Figure 1).

2.1.5 Stand-off

Most of the charges were fired at a stand-off distance of 1.5 cone diameters from the target. This distance was adopted to simulate approximately the operational stand-off of an actual weapon. A few rounds were fired at 2 cone diameters stand-off, in order to give a more direct comparison with some of the T.A.T.T.L.E. results.

The stand-off distance was measured from the bottom edge of the confinement tube to the surface of the target (Figure 1).

2.2 The Targets

Rolled homogeneous (R.H.) armour plates of 150mm and 60mm thickness and measuring 6ft x 5ft in area, were assembled in a vertical stack to a height of more than 30 inches. (Figure 4). This arrangement permitted about 30 rounds to be fired in fairly rapid succession, the plates being then separated for measurements on each crater. In this way the effect of plate interfaces on penetration and crater profile was minimised while avoiding the need for cutting and assembling individual targets for each round.

The plates conformed to the specification I.T. 80 E. Their full physical and chemical properties, which were supplied by the manufacturers, are shown in Appendix B. For the sake of comparison a few rounds were also fired against mild steel targets of which the corresponding properties are contained in Appendix D.

2.3 The firings

The charge was mounted vertically above the armour, and at the required stand-off from it, by means of a chipboard support. The support was designed so that only the outer rim of the confinement tube should be in contact with it (Figure 4). Strawboard packs of 3in. thickness were disposed around the charge at a distance of at least 9in. in order to decelerate fragments from the confinement tube, which might otherwise cause a safety hazard.

In order to obtain statistically reliable results five identical firings of a given design were carried out in most cases.

2.4 Measurements

After breaking down the stacks, the craters in individual plates were cleared of liner material. The crater diameter was then measured at 1in. intervals of depth using calibrated calipers, which were specially designed so that the 'toes' would be capable of following shape variations in the profile. At each depth the diameter was measured to an accuracy of 0.05ins. in two directions at right angles.

The plate was then set horizontally by means of a spirit level and the crater volume at one inch intervals of depth obtained by titration. Both diameters and volumes were measured by at least two independent observers.

3. RESULTS

3.1 Penetration into R.H. armour

The round by round penetration data for the R.H. armour firings is shown in Appendix A and is summarised in Table 3.1.

3.2 Penetration into mild steel

For the firings into mild steel targets the round by round data is presented in Appendix C. This data is summarised in Table 3.2.

3.3 Comparison of R.H. armour with mild steel

By combining the results found in Tables 3.1 and 3.2 equivalent values of R.H. armour to mild steel were established. These are shown in Table 3.3.

3.4 Effect of cone parameters on crater profile

The crater profiles resulting from the firings into R.H. armour at 1.5 charge diameters stand-off with RDX/TNT as the explosive filling are shown diagrammatically in Figure 5. These diagrams give a clear comparison of the effects of cone material, angle and wall thickness on the crater profile. The same results are presented graphically in Figure 6, with the intention of emphasising the effect of wall thickness on the crater dimensions.

3.5 Effect of stand-off and explosive filling on the crater profile

The effect on crater profile of increasing the stand-off from 1.5 to 2.0 charge diameters is shown in Figure 7(a) for a copper liner of 45° angle and 0.140in. wall thickness. Figure 7(b) compares the crater obtained using RDX/TNT and P.E.2 for a copper liner of 75° angle and 0.140 wall thickness.

3.6 Effect of cone angle on penetration and volume

For a given material and wall thickness the curves in Figure 8 show how the mean depth of penetration achieved changes with the cone angle. Similarly Figure 9 shows the relation between cone angle and crater volume.

3.7 Effect of wall thickness on penetration and volume

The effects of wall thickness on the depth of penetration and crater volume are shown in Figures 10 and 11 respectively.

3.8 Comparison between 5.9in. and 1.625in. diameter charge

Finally to obtain a comparison between these shaped charges of practical warhead calibre and those previously fired on a laboratory scale, the data from each was scaled by calibre and plotted as crater diameter against depth of penetration into R.H. armour, Figure 12. It should be noted that the charges compared do not scale in all respects. Details of cone and charge parameters are shown on the figure.

4. DISCUSSION

In general the experimental results show good reproducibility with respect to both crater volumes and depths of penetration. This implies that the methods used for preparing the charges were of an acceptable standard and that the liners had been produced within satisfactory tolerances. In particular it is evident that the slight cracking observed radiographically in several of the charges did not significantly affect performance. The thinnest of the 45° copper liners gave results which contrasted markedly with the general reproducibility. Table I shows that the three firings with these liners, which had a wall thickness of 0.088 in. gave penetrations of 22.4 in. 9.9 in. and 13.3 ins., although the crater volumes showed normal scatter. The craters from the two lower penetrations were non-symmetrical indicating malformation of the jet. These liners were machined down from thicker cones and it is natural to suspect this operation as being the cause of the poor performance even though the liners were subjected to the usual tolerances. In any case the scatter is so high that it would be dangerous to draw any positive conclusions from these three results and they are not presented graphically.

Of the three materials investigated it is apparent from Figure 8 that the highest penetration is obtained, in general, with copper followed by steel and then aluminium. Figure 9 shows on the other hand that steel and aluminium give a higher crater volume except in the case of very thick liners. Reference to Figure 6 shows that the higher volume results from a larger crater diameter in the relatively early stages of penetration. From the point of view of lethality however the crater diameter at greater depths of penetration, for example at about 12 in. is a much more important parameter. On the basis of the present results there appears to be no significant effect of liner material on the crater diameter at this depth, provided that the penetration reaches this far.

The effect of cone angle on penetration is clear from Figure 8. In every case there is an increase in penetration with decreasing cone angle and there is every indication that higher penetrations would be obtained at angles smaller than the minimum investigated, namely 45°. The crater volume seems to be almost independent of cone angle, Figure 9. Some increase is perhaps shown at the lowest angle in the case of the thinnest liners. Figure 6 suggests a marginal increase in crater diameter at 12in. depth with increasing cone angle.

In general there is a relatively small increase in penetration when the wall thickness of the liner is decreased, Figure 10. In contrast the crater volume increases markedly with decrease in wall thickness, Figure 12, but there is no indication from Figure 6 of a significant dependance of the crater

diameter at 12in. on the wall thickness. These results, however suggest that the investigation could be profitably extended to thinner liners than those used.

The effect of stand-off is shown only in the two firings of a 45° copper liner, wall thickness 0.140 in. at 2.0 cone diameters stand-off. A 10% increase in penetration and 10% decrease in volume compared with the 1.5 diameter firings resulted. Because of a rather sudden change in crater profile at about 12in. depth in the case of the longer stand-off round Figure 7A it is difficult to say whether there is any significant difference in crater diameter at this point for the two stand-offs. Evidently a fuller investigation of stand-off effects is indicated for the more promising types of design.

Apart from a negligible increase in the mean depth of penetration the main result of using P.E.2 as the explosive filling in place of RDX/TNT 60/40 was a reduction of 13% in crater volume associated with a much reduced crater diameter at the point of entry as shown in Figure 7(b).

When planning the trials it was considered necessary to measure the crater diameter and volume at one inch intervals of penetration to permit comparisons between craters of rapidly changing cross-section, especially those of low depth of penetration. It was subsequently found that most of the craters tapered nearly uniformly so that it was possible to calculate the crater diameter from the volume measurement. Figure 13 compares the results obtained by the two methods. The diameter measurements were made at 1in. intervals, whereas the volume measurements were made over 3in. intervals. It is seen that both methods give overlapping results with comparable scatter and it appears therefore that both methods may be used with equal confidence.

A reasonable minimum criterion for a shaped charge anti-tank warhead is that it should consistently defeat at least 12in. of armour. In the calibre considered here, namely 5.9in. none of the aluminium cones meet this criterion, while the lower angled steel cones and most of the copper cones do meet it. On this basis alone a suitable choice for design would be one of the thinner walled 45° steel cones or any of the 45° or 75° copper cones. It will be seen in Part II how this choice is further limited by lethality considerations.

5. CONCLUSIONS

The techniques used in manufacturing the liners, in filling the charges and in the general assembly and firing procedure were such as to give reliable results.

Copper liners give the greatest depth of penetration followed by steel and aluminium, but the latter two materials give larger crater volumes.

Smaller angle cones give greater depths of penetration, while the crater volume is almost independent of cone angle.

Decreasing the wall thickness of the cone results in a slight increase in penetration and a marked increase in crater volume.

Further work on cones with thinner walls and lower angles is indicated. Reference to Part II shows the importance of adequate penetration at higher stand-offs and extension of some of the present results to stand-off distances up to 8 cone diameters would be desirable.

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TABLE 3.1

PENETRATION INTO R.H. ARMOUR

Cone Material	Cone Angle	Wall Thickness inches	No. of Rounds	Mean Depth of Penetration		Scatter of Results	Mean Volume		Scatter of Results
				ins.	Std. Dev.		ccs.	Std.Dev.	
Copper	45°	0.088	3	15.2	-	+7.2 -5.3	692	-	+20 -10
	45°	0.140	5	25.3	0.54	+0.8 -0.5	650	12.6	+15 -17
	45°	0.280	5	22.1	0.87	+1.5 -0.5	396	19	+29 -19
	75°	0.088	3	14.4	-	+0.5 -1.1	660	-	+ 9 - 6
	75°	0.140	5	16.9	0.54	+0.9 -0.5	553	20.5	+27 -30
	75°	0.280	5	14.9	0.32	+0.6 -0.2	378	17	+25 -21
	100°	0.140	5	10.8	0.51	+0.9 -0.4	599	19	+31 -16
	100°	0.280	5	12.5	0.38	+0.6 -0.3	403	11.4	+20 - 8
Steel	45°	0.100	5	16.3	0.93	+0.9 -1.5	788	45.6	+64 -54
	45°	0.160	5	15.2	0.98	+1.7 -0.8	543	19.5	+16 -32
	45°	0.320	5	12.3	0.36	+0.5 -0.3	305	12	+16 -13
	75°	0.100	5	12.7	0.45	+0.7 -0.5	676	37.3	+25 -66
X	75°	0.160	5	12.3	0.24	+0.4 -0.2	520	36	+51 -42
	75°	0.320	5	10.0	1.1	+2.0 -0.8	295	18.8	+19 -21
	100°	0.100	5	10.8	0.31	+0.4 -0.4	670	20.4	+19 -35
	100°	0.160	5	10.3	0.1	+0.1 -0.1	607	15.0	+19 -20
	100°	0.320	5	8.4	0.38	+0.6 -0.4	320	9.6	+14 -12
Aluminium	45°	0.300	5	11.8	0.41	+0.4 -0.5	813	14.6	+19 -14
	45°	0.470	5	10.9	0.44	+0.5 -0.5	594	26	+25 -42
	45°	0.940	5	8.6	0.17	+0.2 -0.2	220	7.6	+ 8 -11
	75°	0.300	5	8.0	0.66	+0.8 -0.6	675	21.2	+35 -22
	75°	0.470	5	7.0	0.09	+0.1 -0.1	497	28	+21 -50
	75°	0.940	5	6.2	0.09	+0.1 -0.1	185	15.7	+20 -15
	100°	0.940	5	4.7	0.22	+0.1 -0.4	165	15.1	+19 -15

TABLE 3.2

PENETRATION INTO MILD STEEL

Cone Material	Cone Angle	Wall Thickness inches	No. of Rounds	Mean Depth of Penetration ins.	Std.Dev.	Scatter of Results	Mean Volume ccs.	Std.Dev.	Scatter of Results
Steel	75°	0.160	5	15.0	0.61	+0.8 -0.6	1013	59	+75 -67
	100°	0.160	5	12.5	0.4	+0.5 -0.5	1260	51	+32 -76
Aluminium	45°	0.940	5	12.2	0.09	+0.1 -0.1	375	23.6	+24 -39
	75°	0.940	4	8.6	0.22	+0.2 -0.3	336	17.8	+25 -16
	100°	0.940	3	6.1	-	+0.2 -0.2	302	-	+19 -16

TABLE 3.3

COMPARISON OF R.H. ARMOUR WITH MILD STEEL

Cone Material	Cone Angle	Wall Thickness inches	R.H. Armour/Mild Steel	
			Penetration	Volume
Steel	75°	0.160	0.82	0.51
	100°	0.160	0.82	0.48
Aluminium	45°	0.940	0.71	0.59
	75°	0.940	0.72	0.55
	100°	0.940	0.77	0.55

APPENDIX A

Contents: Round-by-round penetration data into R.H. Armour

Table Number	Liner Details	Remarks
1	Copper 45° 0.088 inches	
2	Copper 45° 0.140 inches	1.5 C.D. stand-off
2A	Copper 45° 0.140 inches	2.0 C.D. stand-off
3	Copper 45° 0.280 inches	
4	Copper 75° 0.088 inches	
5	Copper 75° 0.140 inches	RDX/TNT 60/40
5A	Copper 75° 0.140 inches	P.E.2
6	Copper 75° 0.280 inches	
7	Copper 100° 0.140 inches	
8	Copper 100° 0.280 inches	
9	Steel 45° 0.100 inches	
10	Steel 45° 0.160 inches	
11	Steel 45° 0.320 inches	
12	Steel 75° 0.100 inches	
13	Steel 75° 0.160 inches	
14	Steel 75° 0.320 inches	
15	Steel 100° 0.100 inches	
16	Steel 100° 0.160 inches	
17	Steel 100° 0.320 inches	
18	Aluminium 45° 0.300 inches	
19	Aluminium 45° 0.470 inches	
20	Aluminium 45° 0.940 inches	
21	Aluminium 75° 0.300 inches	
22	Aluminium 75° 0.470 inches	
23	Aluminium 75° 0.940 inches	
24	Aluminium 100° 0.940 inches	

Appendix A Table 1

FILLING	LINER	TARGET
RDX/TNT 60/40	Material: Copper Cone Angle : 45° Wall thickness : 0.088 inches	R.H. ARMOUR

Round No.		P157		P158		P159						Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		46, 58, 59, 60, 61		46, 58		46, 58, 59							
Depth of Penetration		Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs		
Ins.	mms.												
Crater			712		682		683						692
0	0	3.1	655	3.5	622	3.8	626					3.5	634
1	25	2.6	555	2.5	515	2.8	514					2.6	528
2	51	2.3	478	2.2	438	2.6	418					2.4	445
3	76	2.2	411	2.2	366	2.3	344					2.2	374
4	102	2.2	351	2.3	299	2.4	271					2.3	307
5	127	2.2	280	2.4	226	2.2	182					2.3	229
6	152	1.8	223	2.0	161	1.6	138					1.8	174
7	178	1.3	187	1.6	121	1.3	103					1.4	137
8	203	1.2	168	1.2	35	1.2	83					1.2	95
9	228	1.2	149	0.8	15	1.2	64					1.1	76
10	254	1.2	131	0.7	0	1.2	45					1.0	59
11	279	1.1	110			1.0	25						
12	304	1.1	91			0.8	9						
13	330	1.0	80			0.7	2						
14	355	0.9	70			0.6	0						
15	381	0.9	60										
16	406	0.8	52										
17	431	0.7	41										
18	456	0.8	32										
19	482	0.8	24										
20	508	0.8	18										
21	533	0.6	9										
22	558	0.6	2										
23	583	0.4	0										
Total Depth of Penetration Inches		22.4		9.9		13.3						Mean Total Depth ins. 15.2	
												Standard Deviation -	
Total volume ccs.		712		682		683						Mean Volume ccs. 692	
												Standard Deviation -	

Appendix A Table 2

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 45°; Wall thickness: 0.140 inches

TARGET: R.H. ARMOUR; Stand off: 1.5 C.D.

Round No.		P51		P52		P83		P84		P107		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		24,25,26 27,28,29 30,31		24,25,26 27,28,29 30,31		24,25,26 27,28,29 30,31		24,25,26 27,28,29 30,31		33,46,23 31,30,29 28,47			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			633		665		659		644		651		650
0	0	3.1	603	3.1	625	3.1	609	2.9	608	3.3	602	3.1	609
1	25	2.9	498	2.3	537	2.3	507	2.2	528	2.8	510	2.5	516
2	51	2.2	437	2.3	482	2.1	444	2.0	478	2.3	437	2.2	456
3	76	2.0	370	2.1	417	2.0	382	2.1	418	2.0	379	2.0	393
4	102	1.8	323	2.0	353	2.0	334	2.0	358	2.0	320	2.0	338
5	127	1.6	282	1.9	310	1.9	282	1.9	313	1.8	272	1.8	292
6	152	1.5	243	1.6	260	1.6	239	1.6	258	1.5	231	1.6	246
7	178	1.3	224	1.5	230	1.3	209	1.4	215	1.3	199	1.4	215
8	203	1.3	202	1.3	206	1.3	185	1.3	194	1.2	177	1.3	193
9	228	1.3	182	1.3	188	1.3	165	1.3	172	1.2	159	1.3	173
10	254	1.3	164	1.3	168	1.3	145	1.3	155	1.2	139	1.3	154
11	279	1.3	141	1.3	145	1.2	135	1.2	135	1.2	124	1.2	136
12	304	1.2	120	1.2	119	1.2	105	1.2	114	1.1	104	1.2	112
13	330	1.0	106	1.0	106	1.0	91	1.0	100	0.8	89	1.0	98
14	355	1.0	93	0.9	97	1.0	85	0.9	90	0.8	79	0.9	89
15	381	0.8	76	0.8	80	0.8	68	0.8	74	0.6	69	0.8	73
16	406	0.8	66	0.7	72	0.8	62	0.8	65	0.7	62	0.8	65
17	431	0.7	60	0.7	64	0.6	55	0.7	61	0.6	51	0.7	58
18	456	0.7	54	0.6	59	0.6	49	0.9	55	0.7	46	0.7	53
19	482	0.8	47	1.0	52	0.6	43	0.7	47	0.7	41	0.8	46
20	508	0.7	39	0.6	47	0.7	37	0.6	40	0.6	34	0.6	39
21	533	0.7	32	0.7	38	0.7	30	0.7	35	0.6	29	0.7	33
22	558	0.6	22	0.7	29	0.6	26	0.7	30	0.5	22	0.6	26
23	583	0.7	19	0.8	22	0.5	21	0.7	22	0.5	20	0.6	21
24	609	0.8	10	0.8	12	0.7	16	0.8	14	0.6	12	0.7	13
25	634		0		0	0.7	5		0	0.6	7		2.5
26	660						0			0.6	0		
Total Depth of Penetration Inches		25.0		24.8		25.6		25.0		26.1		Mean Total Depth ins. 25.3	Standard Deviation 0.54
Total Volume ccs.		633		665		659		644		651		Mean Volume ccs. 650	Standard Deviation 12.6

Appendix A Table 2A

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle; 45°; Wall thickness; 0.140 inches

TARGET: R.H. Armour; Standoff: 2 C.D.

Round No.		130		131							Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		57,56,55 54,53,52 51,50,47		57,56,55 54,53,52 51,50,47								
Depth of Penetration ins.	Depth of Penetration mms.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Depth of Penetration ins.	Depth of Penetration mms.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Crater			594		568	27	685	0.8	2	0.8	9		
0	0	3.1	562	2.7	543	28	711		0	0.6	0		
1	25	2.5	481	2.2	480								
2	51	1.9	425	2.0	425								
3	76	1.8	369	1.8	372								
4	102	1.8	327	1.8	324								
5	127	1.5	294	1.5	288								
6	152	1.4	263	1.4	258								
7	178	1.3	239	1.3	236								
8	203	1.3	221	1.3	215								
9	228	1.4	201	1.3	194								
10	254	1.4	174	1.4	169								
11	279	1.4	146	1.3	144								
12	304	1.0	131	1.0	130								
13	330	1.0	119	0.9	119								
14	355	0.9	110	0.9	109								
15	381	0.9	103	0.9	99								
16	406	0.8	94	0.7	90								
17	431	0.9	79	0.9	79								
18	456	0.7	69	0.9	70								
19	482	0.8	62	0.7	65								
20	508	0.8	52	0.8	55								
21	533	0.6	46	0.7	48								
22	558	0.8	36	0.7	40								
23	583	0.7	32	0.5	37								
24	609	0.7	26	0.5	32								
25	634	0.6	19	0.6	25								
26	660	0.6	12	0.5	21								
Total Depth of Penetration Inches		27.3		28.0							Mean Total Depth ins. / Standard Deviation	
Total Volume ccs.		594		568							Mean Volumes ccs / Standard Deviation	

Appendix A Table 3

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 45°; Wall thickness: 0.280 inches

TARGET: R.H. ARMOUR

Round No.		P53		P54		P85		P86		P108		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		24,25 26,27, 28,29		24,25 26,27, 28,29,39		24,25 26,27, 28,29		24,25 26,27, 28,29		33,46, 23,31, 30,29,28			
Depth of Penetration		Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.		
Ins.	mms.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.		
Crater:			377		395		400		425		381		396
0	0	2.4	355	2.3	378	2.5	380	2.5	393	2.7	365	2.5	374
1	25	1.9	306	1.8	323	1.7	325	1.8	342	1.8	306	1.8	320
2	51	1.6	271	1.5	289	1.6	290	1.6	310	1.5	271	1.6	286
3	76	1.4	242	1.5	264	1.5	262	1.5	279	1.5	236	1.5	257
4	102	1.5	217	1.5	235	1.5	232	1.5	254	1.5	206	1.5	229
5	127	1.4	188	1.4	204	1.5	202	1.5	224	1.4	190	1.4	202
6	152	1.3	167	1.3	183	1.3	171	1.4	199	1.3	161	1.3	176
7	178	1.0	153	1.1	164	1.1	147	1.1	179	1.1	142	1.1	157
8	203	1.0	139	1.1	152	1.0	137	1.0	164	1.0	127	1.0	144
9	228	1.0	128	1.0	138	1.0	123	1.0	149	1.0	116	1.0	131
10	254	1.0	113	1.0	124	1.0	108	1.0	133	0.9	103	1.0	116
11	279	1.1	103	1.1	113	1.0	98	1.0	121	0.9	89	1.0	105
12	304	1.0	89	1.0	94	1.2	77	1.1	104	0.9	77	1.0	88
13	330	0.8	79	0.8	86	0.9	66	0.9	94	0.8	68	0.8	79
14	355	0.8	70	0.8	77	0.9	57	0.8	84	0.7	61	0.8	70
15	381	0.7	61	0.7	64	0.7	46	0.7	68	0.6	48	0.7	57
16	406	0.7	55	0.8	55	0.7	40	0.7	59	0.7	42	0.7	50
17	431	0.7	48	0.7	46	0.6	31	0.6	49	0.6	35	0.6	42
18	456	0.6	41	0.6	42	0.6	26	0.6	42	0.7	32	0.6	37
19	482	0.6	37	0.5	36	0.6	21	0.6	37	0.6	24	0.6	31
20	508	0.8	28	0.7	30	0.7	16	0.7	25	0.6	19	0.7	24
21	533	1.1	16	0.7	22	1.0	5	1.0	15	0.7	13	0.9	14
22	558		0	0.8	12		0		0	0.7	5		
23	583			0.6	5						0		
24	609				0								
Total Depth of Penetration Inches		21.6		23.6		21.6		21.6		22.3		Mean Total Depth ins. 22.1	
												Standard Deviation 0.87	
Total Volume ccs.		377		395		400		425		381		Mean Volume ccs. 396	
												Standard Deviation 19	

Appendix A Table 4

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 75°; Wall thickness: 0.088 inches

TARGET: R.H. ARMOUR

Round No.		P160		P161		P162						Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		46,58 59		46,58 59		46,58 59							
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			657		654		669						660
0	0	3.5	593	3.1	604	3.1	613					3.2	603
1	25	2.8	476	2.6	504	2.2	533					2.5	504
2	51	2.2	404	2.1	433	2.0	470					2.1	436
3	76	2.2	344	2.1	371	2.2	412					2.2	376
4	102	2.2	284	2.2	314	2.2	349					2.2	316
5	127	2.0	223	2.0	248	2.1	282					2.0	251
6	152	1.7	179	1.8	203	1.9	233					1.8	205
7	178	1.5	142	1.5	164	1.6	188					1.5	165
8	203	1.4	116	1.4	139	1.4	158					1.4	138
9	228	1.4	88	1.3	114	1.4	134					1.4	112
10	254	1.4	60	1.4	91	1.4	111					1.4	87
11	279	1.3	33	1.5	63	1.6	81					1.5	59
12	304	1.0	12	1.4	38	1.6	44					1.3	31
13	330	0.8	3	1.0	16	1.1	18					1.0	12
14	355	0.7	0	0.8	7	0.8	8					0.8	5
15	381			0.5	0	0.5	0						
Total Depth of Penetration Inches		13.3		14.9		14.9						Mean Total Depth ins. 14.4	
												Standard Deviation -	
Total Volume ccs.		657		654		669						Mean Volume ccs. 660	
												Standard Deviation -	

Appendix A Table 5

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 75°; Wall thickness: 0.140 inches

TARGET: R.H. ARMOUR

Round No.		P22		P23		P24		P25		P109		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		19,20 21,22 23		19,20 21,22		19,20 21,22		19,20 21,22 23		33,46 23,31 30			
Depth of Penetration		Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.		
Ins.	mms.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.		
Crater:			523		548		558		554		580		553
0	0	3.0	503	3.2	515	3.1	528	3.0	528	2.9	541	3.0	523
1	25	2.7	393	2.9	400	2.9	411	2.6	418	2.2	451	2.7	415
2	51	2.1	333	2.3	320	2.3	334	2.0	368	1.9	391	2.1	349
3	76	1.9	278	1.9	273	1.9	284	1.9	319	2.0	340	1.9	299
4	102	1.7	239	1.8	233	1.8	240	1.8	268	1.9	287	1.8	253
5	127	1.5	208	1.6	197	1.6	205	1.6	232	1.7	250	1.6	218
6	152	1.5	178	1.5	163	1.6	173	1.6	198	1.6	210	1.6	184
7	178	1.3	151	1.3	138	1.3	148	1.3	168	1.3	181	1.3	157
8	203	1.2	138	1.3	121	1.2	129	1.3	148	1.3	155	1.3	138
9	228	1.2	118	1.2	102	1.2	108	1.2	130	1.2	135	1.2	119
10	254	1.2	103	1.2	83	1.2	85	1.2	109	1.3	115	1.2	99
11	279	1.2	88	1.1	63	1.1	74	1.1	89	1.2	95	1.1	82
12	304	1.3	63	1.2	47	1.2	63	1.3	68	1.3	75	1.3	63
13	330	0.8	53	0.9	37	1.0	53	1.0	58	1.0	60	0.9	52
14	355	0.9	43	1.1	25	1.0	38	0.9	45	0.9	49	1.0	40
15	381	0.9	23	1.1	7	0.9	22	1.1	20	0.9	31	1.0	21
16	406	0.8	7	0.8	0	1.2	8	1.0	9	0.7	24	0.9	10
17	431	0.9	0				0		0	0.9	6		
18	456										0		
Total Depth of Penetration Inches		17.0		16.4		16.6		16.8		17.8		Mean Total Depth ins. 16.9	
												Standard Deviation 0.54	
Total Volume ccs.		523		548		558		554		580		Mean Volume ccs. 553	
												Standard Deviation 20.5	

Appendix A Table 5A

FITTING: P.E. 2

LINER: Material: Copper; Cone Angle: 75°; Wall thickness: 0.140 inches

TARGET: R.H. ARMOUR

Round No.		P33		P34		P105		P106		P110		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		19,20 21,22 23		19,20 21,22 23		24,25 26,27 28		24,25 26,27 28		33,46 23,31 30			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			474		442		504		469		497		477
0	0	2.7	450	2.5	417	2.8	459	2.5	440	2.6	468	2.6	447
1	25	2.1	383	1.8	362	2.2	389	1.9	384	1.9	397	2.0	383
2	51	1.8	334	1.7	324	1.9	349	1.7	344	1.7	350	1.8	340
3	76	1.6	302	1.5	293	1.7	309	1.6	305	1.7	309	1.6	304
4	102	1.6	270	1.6	266	1.6	279	1.6	278	1.7	269	1.6	272
5	127	1.6	233	1.6	227	1.7	240	1.7	241	1.5	237	1.6	236
6	152	1.5	194	1.4	198	1.8	189	1.8	189	1.5	199	1.6	194
7	178	1.2	165	1.2	166	1.3	159	1.3	162	1.2	155	1.2	161
8	203	1.1	153	1.1	148	1.2	140	1.2	144	1.1	137	1.1	144
9	228	1.1	134	1.1	137	1.1	122	1.2	127	1.1	123	1.1	129
10	254	1.0	119	1.0	122	1.2	109	1.1	111	1.1	108	1.1	114
11	279	1.2	109	1.1	112	1.2	89	1.2	92	1.1	90	1.2	98
12	304	1.2	84	1.3	87	1.3	71	1.3	71	1.2	73	1.3	77
13	330	1.1	69	1.1	72	1.1	54	1.0	54	0.9	51	1.0	60
14	355	1.1	54	1.1	57	0.9	46	0.8	44	1.0	38	1.0	48
15	381	0.8	39	1.0	35	0.8	28	0.9	29	0.7	23	0.8	31
16	406	0.9	26	0.8	23	1.0	19	0.9	18	0.9	16	0.9	20
17	431	0.8	6	1.1	10	0.6	0	0.8	4	0.7	5	0.8	5
18	456		0		0				0		0		
Total Depth of Penetration Inches		17.6		17.8		17.1		17.3		17.8		Mean Total Depth ins. 17.5	
												Standard Deviation 0.31	
Total Volume ccs.		474		442		504		469		497		Mean Volume ccs. 477	
												Standard Deviation 25	

Appendix A Table 6

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 75°; Wall thickness: 0.280 inches

TARGET: R.H. ARMOUR

Round No.		P26		P27		P28		P87		P88		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		19,20 21,22		19,20 21,22		19,20 21,22		24,25 26,27		24,25 26,27			
Depth of Penetration Ins.	mms.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Crater			373		384		357		403		372		378
0	0	2.8	346	2.7	355	2.8	341	2.6	361	2.8	346	2.7	350
1	25	2.3	271	2.2	269	2.2	261	1.8	289	2.1	266	2.1	271
2	51	1.6	231	1.7	229	1.4	228	1.5	258	1.5	234	1.5	236
3	76	1.5	204	1.4	202	1.4	205	1.4	233	1.4	204	1.4	210
4	102	1.4	181	1.3	174	1.3	181	1.4	207	1.3	177	1.3	184
5	127	1.3	166	1.3	154	1.3	160	1.3	183	1.3	154	1.3	163
6	152	1.2	141	1.2	134	1.2	136	1.3	163	1.3	134	1.2	142
7	178	1.0	127	1.1	115	1.0	120	1.1	143	1.1	116	1.1	124
8	203	1.0	114	1.0	103	1.0	108	1.1	126	1.1	102	1.0	111
9	228	1.0	104	1.0	88	1.0	97	1.0	112	1.0	86	1.0	97
10	254	1.0	91	1.0	75	1.0	84	1.1	102	1.0	74	1.0	85
11	279	1.0	80	1.1	63	0.9	69	1.0	92	1.0	59	1.0	73
12	304	1.0	62	1.1	45	1.0	57	1.1	72	1.1	45	1.1	56
13	330	0.9	47	0.9	28	0.9	37	0.9	61	1.0	29	0.9	40
14	355	1.6	32	1.2	15	1.1	22	1.0	49	1.2	10	1.2	26
15	381		0		0		0	1.3	11		0		
16	406								0				
Total Depth of Penetration Inches		14.8		14.8		14.9		15.5		14.7		Mean Total Depth ins. 14.9	
												Standard Deviation 0.32	
Total Volume ccs.		373		384		357		403		372		Mean Volume ccs. 378	
												Standard Deviation 17	

Appendix A Table 7

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 100°; Wall thickness: 0.140 inches

TARGET: R.H. ARMOUR

Round No.		P29		P30		P31		P32		P111		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		19,20		19.20		19,20		19,20		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			584		598		583		630		600		599
0	0	3.4	544	3.2	579	3.2	532	3.4	569	3.1	537	3.3	552
1	25	2.6	421	2.5	439	2.8	428	2.7	440	2.6	443	2.6	434
2	51	2.1	364	2.1	367	2.1	353	2.0	385	2.3	365	2.1	367
3	76	2.0	312	2.1	307	2.2	293	2.0	330	2.2	299	2.1	308
4	102	2.0	254	2.0	254	2.1	238	2.1	278	2.1	238	2.1	252
5	127	1.8	204	2.0	204	2.0	180	2.0	216	2.0	189	2.0	199
6	152	1.9	159	2.0	139	2.0	133	2.0	160	2.0	125	2.0	143
7	178	1.7	115	1.7	85	1.7	83	1.7	103	1.7	86	1.7	94
8	203	1.8	72	1.4	52	1.6	50	1.6	63	1.6	46	1.6	57
9	228	1.2	41	1.3	31	1.3	27	1.4	42	1.2	20	1.3	32
10	254	1.1	26	1.1	10	1.2	7	1.3	18	1.0	2	1.1	13
11	279		11		0		0		0		0		
12	304		0										
Total Depth of Penetration Inches		11.7		10.7		10.6		10.7		10.4		Mean Total Depth ins. 10.8 Standard Deviation 0.51	
Total Volume ccs.		584		598		583		630		600		Mean Volume ccs. 599 Standard Deviation 19	

Appendix A Table 8

FILLING: RDX/TNT 60/40

LINER: Material: Copper; Cone Angle: 100°; Wall thickness: 0.280 inches

TARGET: R.H. ARMOUR

Round No.		P35		P36		P37		P38		P120		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		19,20 21		19,20 21		19,20 21		19,20 21		33,46 23			
Depth of Penetration		Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.	Hole Diam	Residual Vol.		
Ins.	mms.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.	ins.	ccs.		
Crater:			397		399		400		395		423		403
0	0	2.5	369	2.5	370	2.3	384	2.6	373	1.9	403	2.4	380
1	25	1.6	322	1.6	325	1.7	338	1.7	323	1.8	357	1.7	333
2	51	1.3	296	1.3	299	1.4	309	1.3	296	1.6	321	1.4	304
3	76	1.4	272	1.4	273	1.4	286	1.4	270	1.5	288	1.4	280
4	102	1.5	247	1.4	246	1.4	263	1.4	242	1.5	257	1.4	251
5	127	1.4	219	1.4	222	1.4	236	1.4	217	1.5	228	1.4	224
6	152	1.4	192	1.5	187	1.5	203	1.5	187	1.6	188	1.5	191
7	178	1.3	160	1.3	158	1.4	175	1.4	155	1.4	155	1.4	160
8	203	1.3	140	1.3	134	1.3	153	1.3	134	1.3	131	1.3	138
9	228	1.3	119	1.3	113	1.3	131	1.4	111	1.3	113	1.3	117
10	254	1.5	95	1.7	79	1.7	105	1.5	76	1.7	75	1.6	86
11	279	1.6	66	1.4	57	1.2	73	1.5	54	1.6	52	1.5	60
12	304	1.5	30	1.5	17	1.7	40	1.5	16	1.5	10	1.5	23
13	330		0		0	0.8	0		0				
Total Depth of Penetration Inches		12.8		12.4		13.1		12.3		12.2		Mean Total Depth ins. 12.5	
												Standard Deviation 0.38	
Total Volume ccs.		397		399		400		395		423		Mean Volume ccs. 403	
												Standard Deviation 11.4	

Appendix A Table 9

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 45°; Wall thickness: 0.100 inches

TARGET: R.H. ARMOUR

Round No.	P142		P143		P144		P145		P146		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.	55,54 53,52		55,54 53,52		55,54 53,52		55,54 53,52		55,54 53,52 51			
Depth of Penetration Ins. mms.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Crater:		813		763		779		852		734		788
0 0	3.3	765	3.6	710	3.6	716	3.3	782	3.5	679	3.5	730
1 25	3.0	634	2.8	578	3.2	591	3.3	651	2.7	562	3.0	603
2 51	2.8	516	2.4	490	2.6	492	3.1	524	2.4	476	2.65	500
3 76	2.7	411	2.4	416	2.6	411	2.5	431	2.3	405	2.5	415
4 102	2.6	325	2.4	334	2.6	326	2.3	352	2.3	335	2.4	334
5 127	2.3	245	2.4	254	2.3	255	2.3	280	2.4	256	2.35	258
6 152	1.9	189	2.0	195	1.9	195	2.0	224	2.2	192	2.0	199
7 178	1.5	150	1.7	150	1.5	151	1.5	176	1.6	151	1.55	156
8 203	1.5	123	1.4	119	1.4	125	1.3	152	1.4	124	1.4	129
9 228	1.4	100	1.4	95	1.3	104	1.3	126	1.3	103	1.35	106
10 254	1.3	78	1.4	76	1.3	86	1.2	106	1.2	82	1.3	86
11 279	1.1	62	1.4	55	1.2	70	1.2	87	1.2	67	1.2	68
12 304	1.1	42	1.2	32	1.1	50	1.1	66	1.2	45	1.15	47
13 330	1.0	28	1.1	15	1.0	38	1.1	50	1.0	31	1.05	32
14 355	0.9	18	0.6	6	1.0	24	1.1	35	0.9	20	0.9	21
15 381	0.7	5		0	0.9	12	0.6	8	0.6	10		
16 406	0.4	0			0.5	5	0.5	4	0.5	6		
17 431						0		0	0.8	3		
18 456										0		
Total Depth of Penetration Inches	16.0		14.8		16.8		16.8		17.2		Mean Total Depth ins. 16.3	Standard Deviation 0.93
Total Volume ccs.	813		763		779		852		734		Mean Volume ccs. 788	Standard Deviation 45.6

Appendix A. Table 10

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 45°; Wall thickness: 0.160 inches

TARGET: R.H. ARMOUR

Round No.		P39		P92		P94		P95		P96		Mean Hole Diam. Ins.	Mean Residual Volume ccs.
Plate Nos.		19,20 21,22		24,25 26,27 28,		24,25 26,27		24,25 26,27		24,25 26.			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			547		559		511		541		558		543
0	0	3.1	516	3.0	518	2.8	476	2.9	491	2.8	516	2.9	503
1	25	2.5	423	2.4	429	2.3	396	2.3	406	2.4	431	2.4	417
2	51	2.2	353	2.1	379	2.1	336	2.1	341	2.0	371	2.1	356
3	76	2.0	291	2.0	320	2.0	276	2.0	290	2.0	320	2.0	299
4	102	2.0	245	2.0	269	2.0	227	2.1	231	2.0	270	2.0	248
5	127	1.9	193	1.8	219	1.8	176	1.9	186	2.0	216	1.9	198
6	152	1.8	140	1.6	174	1.6	136	1.6	131	1.7	156	1.65	147
7	178	1.4	107	1.4	137	1.3	106	1.4	89	1.4	126	1.4	113
8	203	1.1	87	1.2	117	1.3	90	1.3	81	1.3	101	1.25	95
9	228	1.1	72	1.2	97	1.0	73	1.0	64	1.2	82	1.1	78
10	254	1.0	67	1.1	79	1.1	58	1.1	51	1.2	66	1.1	64
11	279	1.0	51	1.2	67	1.1	40	1.2	44	1.0	48	1.1	50
12	304	1.0	31	0.9	49	1.0	21	1.0	30	1.0	36	1.0	33
13	330	0.8	20	0.9	39	0.7	14	0.7	20	1.1	20	0.8	23
14	355	0.8	14	0.7	33	0.7	8	0.7	11	1.0	9	0.8	15
15	381		0	0.7	22		0		0		0		
16	406			0.7	15								
17	431				0								
Total Depth of Penetration Inches		15.1		16.9		14.7		15.0		14.4		Mean Total Depth ins. 15.2	Standard Deviation 0.98
Total Volume ccs.		547		559		511		541		558		Mean Volume ccs. 543	Standard Deviation 19.5

Appendix A Table 11

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 45°; Wall thickness: 0.320 inches

TARGET: R.H. ARMOUR

Round No.		P97		P98		P99		P100		P112		Mean Hole Diam Ins.	Mean Residual Volume ccs.
Plate Nos.		24,25 26.		24,25		24,25 26		24,25 26		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			292		299		313		298		321		305
0	0	2.2	266	2.1	279	2.1	292	2.1	262	2.0	310	2.1	282
1	25	1.7	214	1.9	220	1.8	241	1.8	215	1.8	255	1.8	229
2	51	1.5	181	1.5	187	1.7	205	1.6	180	1.7	220	1.6	195
3	76	1.5	153	1.5	157	1.5	173	1.4	151	1.6	188	1.5	164
4	102	1.4	126	1.5	130	1.4	144	1.4	122	1.5	151	1.4	135
5	127	1.3	101	1.4	100	1.5	117	1.4	96	1.4	121	1.4	107
6	152	1.3	76	1.3	71	1.4	90	1.4	70	1.2	95	1.3	80
7	178	1.1	59	1.1	50	1.0	66	1.1	51	1.0	65	1.1	58
8	203	0.9	43	0.8	40	0.8	54	1.0	39	0.9	55	0.9	46
9	228	0.7	39	0.8	30	0.8	44	0.8	30	0.9	45	0.8	38
10	254	0.8	31	0.8	22	0.9	34	0.7	20	0.9	32	0.8	28
11	279	0.8	24	0.8	15	0.8	26	0.7	14	1.0	29	0.8	22
12	304	1.0	11	1.6	0	0.9	14	1.0	1	1.0	0	1.1	5
13	330		0				0		0				
Total Depth of Penetration Inches		12.5		12.0		12.8		12.1		12.0		Mean Total Depth ins. 12.3	Standard Deviation 0.36
Total Volume ccs.		292		299		313		298		321		Mean Volume ccs. 305	Standard Deviation 12

Appendix A Table 12

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angles: 75°; Wall thickness: 0.100 inches

TARGET: R.H. ARMOUR

Round No.		P 147		P 148		P 149		P 150		P 151		Mean Hole Diam Ins.	Mean Residual Volume ccs.
Plate Nos.		55,54 53		55,54 53		55,54 53		55,54 53		55,54 53			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			695		701		610		684		689		676
0	0	3.4	654	3.5	656	3.0	565	3.2	614	3.4	639	3.3	626
1	25	2.3	555	2.6	546	2.2	492	2.5	524	2.3	548	2.4	533
2	51	1.9	493	2.4	469	1.9	444	2.4	441	2.2	480	2.15	465
3	76	2.3	428	2.5	386	1.9	393	2.3	367	2.3	416	2.25	398
4	102	2.5	352	2.4	309	2.1	346	2.4	295	2.4	341	2.35	329
5	127	2.4	268	2.3	239	2.1	291	2.3	228	2.4	264	2.3	258
6	152	2.0	205	2.0	176	2.1	230	2.0	168	2.2	190	2.05	194
7	178	1.8	150	1.9	117	1.9	176	1.9	112	1.9	138	1.9	139
8	203	1.6	113	1.6	77	1.8	137	1.5	77	1.7	93	1.65	100
9	228	1.6	80	1.4	51	1.9	97	1.4	47	1.5	63	1.55	68
10	254	1.3	58	1.0	33	1.5	63	1.2	28	1.2	41	1.25	45
11	279	1.2	38	1.0	20	1.4	39	0.9	14	1.2	23	1.15	27
12	304	1.2	20	1.0	4	1.6	9	1.2	2	1.3	5	1.25	8
13	330	0.8	4		0		0		0		0		
14	355		0										
Total Depth of Penetration Inches		13.4		12.5		12.7		12.2		12.8		Mean Total Depth ins. 12.7 Standard Deviation 0.45	
Total Volume ccs.		695		701		610		684		689		Mean Volume ccs. 676 Standard Deviation 37.3	

Appendix A Table 13

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle : 75°; Wall thickness: 0.160 inches

TARGET: R.H. ARMOUR

Round No.		P49		P121		P122		P125		P126		Mean Hole diam. ins.	Mean Residual Volume ccs.
Plate Nos.		24,25 26.		55,54 53.		55,54 53.		55,54 53.		55,54 53.			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			510		478		500		540		571		520
0	0	2.9	454	2.8	440	2.8	463	2.8	476	3.3	513	2.9	469
1	25	2.4	363	2.2	375	2.3	386	2.3	400	2.4	43"	2.3	392
2	51	2.0	299	2.3	306	2.1	328	2.1	342	2.2	37"	2.15	330
3	76	2.0	250	2.0	252	2.0	275	2.1	289	2.1	314	2.05	276
4	102	1.8	209	1.8	203	1.9	226	2.0	237	2.1	253	1.9	227
5	127	1.7	176	1.9	161	1.8	179	1.9	189	2.0	203	1.85	182
6	152	1.7	129	1.8	118	1.7	141	1.9	152	1.9	153	1.8	139
7	178	1.4	97	1.5	92	1.4	109	1.6	115	1.4	120	1.45	107
8	203	1.3	77	1.4	69	1.4	86	1.4	89	1.3	93	1.35	83
9	228	1.1	57	1.4	43	1.2	64	1.3	64	1.2	73	1.25	61
10	254	1.2	39	1.2	27	1.1	46	1.2	43	1.5	53	1.25	42
11	279	1.0	22	1.1	14	1.1	26	1.3	26	1.3	27	1.15	23
12	304	1.2	2	0.6	0	1.2	9	1.4	6	1.2	6	1.1	5
13	330		0				0		0		0		
Total Depth of Penetration Inches		12.1		12.1		12.3		12.7		12.3		Mean Total Depth ins. 12.3	
												Standard Deviation 0.24	
Total Volume ccs.		510		478		500		540		571		Mean Volume ccs. 520	
												Standard Deviation 36	

Appendix A Table 14

FILLING	LINER		TARGET
RDX/TNT 60/40	Material:	Steel	R.H. ARMOUR
	Cone Angle:	75°	
	Wall thickness:	0.320 inches	

Round No.		P101		P102		P103		P104		P113		Mean Hole Diam Ins.	Mean Residual Volume ccs.
Plate Nos.		24,25		24,25		24,25		24,25		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			314		314		271		285		292		295
0	0	2.1	285	2.1	279	2.0	242	2.0	254	2.1	274	2.1	267
1	25	1.7	245	1.7	234	1.7	204	1.6	209	1.5	232	1.6	225
2	51	1.4	221	1.5	204	1.3	177	1.5	184	1.4	207	1.4	199
3	76	1.2	199	1.3	183	1.2	157	1.3	159	1.4	182	1.3	176
4	102	1.2	180	1.3	162	1.3	134	1.3	139	1.3	159	1.3	155
5	127	1.2	161	1.2	140	1.3	113	1.4	116	1.3	133	1.3	133
6	152	1.3	139	1.4	104	1.6	84	1.9	84	1.4	100	1.5	102
7	178	1.2	116	1.4	69	1.3	59	1.5	50	1.4	65	1.4	72
8	203	1.0	100	1.5	43	1.3	37	1.3	27	1.4	38	1.3	49
9	228	1.0	88	1.6	7	1.2	15	1.1	3	1.2	8	1.2	24
10	254	1.2	76		0		0		0		0		15
11	279	1.7	45										
12	304	2.0	0										
Total Depth of Penetration Inches		12.0		9.7		9.5		9.2		9.5		Mean Total Depth ins. 10.0	
												Standard Deviation 1.1	
Total Volume ccs.		314		314		271		285		292		Mean Volume ccs. 295	
												Standard Deviation 18.8	

Appendix A Table 15

FILLING

RDX/TNT 60/40

LINER

Material: Steel
Cone Angle: 100°
Wall thickness : 0.100 inches

TARGET

R.H. ARMOUR

Round No.		P152		P 153		P 154		P 155		P156		Mean Hole Diam. Ins.	Mean Residual Volume ccs.
Plate Nos.		55,54		55,54		55,54		55,54		55,54			
Depth of Penetration		Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.		
Ins.	mms.												
Crater:			635		677		689		673		674		670
0	0	1.9	617	2.1	648	2.2	652	2.1	643	2.0	648	2.05	642
1	25	1.9	576	1.9	600	1.9	600	1.9	592	1.9	606	1.9	595
2	51	1.8	530	2.1	542	2.2	541	2.2	532	2.3	548	2.1	539
3	76	2.4	466	2.4	477	2.4	457	2.4	455	2.4	465	2.4	464
4	102	2.6	379	2.6	370	2.6	365	2.6	362	2.7	364	2.6	368
5	127	2.5	285	2.6	272	2.7	257	2.7	269	2.7	264	2.65	269
6	152	2.5	195	2.5	182	2.4	165	2.5	178	2.7	169	2.5	178
7	178	2.0	108	2.0	92	1.8	78	2.0	83	1.8	80	1.9	88
8	203	1.7	66	1.5	53	1.5	46	1.6	44	1.4	50	1.55	52
9	228	1.5	36	1.2	31	1.3	22	1.3	25	1.2	29	1.3	29
10	254	1.2	18	1.2	13	0.9	7	1.4	8	1.2	13	1.2	12
11	279	1.7	3	0.6	0		0		0		0		
12	304		0										
Total Depth of Penetration Inches		11.2		11.0		10.6		10.4		10.8		Mean Total Depth ins. 10.8 Standard Deviation 0.31	
Total Volume ccs.		635		677		689		673		674		Mean Volume ccs. 670 Standard Deviation 20.4	

Appendix A Table 16

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 100°; Wall thickness: 0.160 inches

TARGET: R.H. ARMOUR

Round No.		P123		P124		P127		P128		P129		Mean Hole Diam Ins.	Mean Residual Volume ccs.
Plate Nos.		55,54		55,54		55,54		55,54		55,54			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			587		598		611		626		615		607
0	0	2.7	525	3.1	557	2.7	550	2.6	550	3.1	554	2.8	547
1	25	2.7	426	2.6	449	2.3	466	2.4	452	2.2	460	2.4	451
2	51	2.2	364	2.1	389	2.3	399	2.2	392	2.1	398	2.2	388
3	76	2.1	306	2.2	324	2.4	329	2.1	332	2.1	338	2.2	326
4	102	2.2	244	2.3	260	2.3	260	2.2	267	2.2	270	2.15	260
5	127	2.1	176	2.1	197	2.1	195	2.3	197	2.2	202	2.15	193
6	152	2.0	122	2.0	140	2.3	134	2.1	141	2.1	146	2.1	137
7	178	1.8	77	1.9	82	1.7	76	1.9	84	2.0	85	1.85	81
8	203	1.3	47	1.6	51	1.5	52	1.5	47	1.5	49	1.5	49
9	228	1.4	19	1.4	22	1.2	27	1.5	21	1.4	23	1.4	22
10	254	1.0	3	1.0	5	1.3	10	1.0	0	1.1	4	1.1	4
11	279		0		0		0				0		
Total Depth of Penetration Inches		10.2		10.3		10.4		10.2		10.4		Mean Total Depth ins. 10.3	
												Standard Deviation 0.1	
Total Volume ccs.		587		598		611		626		615		Mean Volume ccs. 607	
												Standard Deviation 15.4	

Appendix A Table 17

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 100°; Wall thickness: 0.320 inches

TARGET: R.H. ARMOUR

Round No.		P63		P64		P81		P82		P114		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		32,33		32,33		32,33		32,33		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			308		320		321		334		315		320
0	0	2.1	288	2.0	290	2.0	304	1.9	310	2.0	294	2.0	297
1	25	1.7	247	1.6	249	1.7	261	1.8	262	1.6	250	1.7	254
2	51	1.5	215	1.4	216	1.5	232	1.4	232	1.4	220	1.4	223
3	76	1.3	189	1.3	195	1.2	206	1.3	210	1.3	195	1.3	199
4	102	1.4	166	1.4	170	1.3	187	1.3	187	1.4	172	1.4	176
5	127	1.4	138	1.4	145	1.5	162	1.6	158	1.5	141	1.5	149
6	152	1.6	104	1.6	110	2.0	110	1.8	112	1.4	105	1.7	108
7	178	1.9	45	1.8	65	1.9	50	2.1	40	1.9	59	1.9	52
8	203	1.3	7	1.7	29	1.7	0	1.3	2	1.5	16	1.5	11
9	228		0		0				0		0		
Total Depth of Penetration Inches		8.4		9.0		8.0		8.2		8.5		Mean total Depth ins. 8.4	
												Standard Deviation 0.38	
Total Volume ccs.		308		320		321		334		315		Mean Volume ccs. 320	
												Standard Deviation 9.6	

Appendix A Table 18

FILLING: RDX/TNT 60/40

LINER: Material: Aluminium; Cone Angle: 45°; Wall thickness: 0.300 inches

TARGET: R.H. ARMOUR

Round No.		P 132		P 133		P 134		P 135		P 136		Mean Hole Diam. ins.	Mean Residual Volume ccs.
Plate Nos.		55,54, 53		55,54		55,54		55,54		55,54, 53			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			799		825		801		832		809		813
0	0	4.1	724	3.9	754	3.9	707	3.8	760	4.1	725	4.0	734
1	25	3.5	564	3.4	603	3.2	572	3.7	605	3.1	590	3.4	587
2	51	3.0	438	3.0	472	3.0	441	3.3	460	2.9	471	3.05	456
3	76	2.5	350	2.6	375	2.7	350	2.9	352	2.6	377	2.65	361
4	102	2.2	284	2.6	287	2.7	256	2.6	258	2.5	299	2.5	277
5	127	2.2	214	2.0	213	2.0	191	2.2	185	2.5	223	2.2	205
6	152	2.1	162	1.9	163	1.9	144	1.9	136	2.1	161	2.0	153
7	178	1.5	120	1.5	113	1.4	99	1.4	88	1.5	121	1.45	108
8	203	1.4	93	1.5	86	1.4	74	1.4	64	1.4	95	1.4	82
9	228	1.3	69	1.3	63	1.2	55	1.3	46	1.4	73	1.3	61
10	254	1.3	46	1.3	42	1.3	35	1.4	27	1.3	53	1.3	41
11	279	1.3	26	1.4	18	1.2	13	1.1	6	1.3	31	1.25	19
12	304	1.4	3		0		0		0	1.6	3		
13	330		0								0		
Total Depth of Penetration Inches		12.2		11.7		11.5		11.3		12.2		Mean Total Depth ins. 11.8	
												Standard Deviation 0.41	
Total Volume ccs.		799		825		801		832		809		Mean Volume ccs. 813	
												Standard Deviation 14.6	

Appendix A Table 19

FILLING: RDX/TNT 60/40

LINER: Material: Aluminium; Cone Angle: 45°; Wall thickness: 0.470 inches

TARGET: R.H. ARMOUR

Round No.		P55		P56		P89		P90		P115		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		24,25		24,25		24,25		24,25		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			619		610		599		552		590		594
0	0	3.3	545	3.4	562	3.2	532	3.1	499	3.2	545	3.2	537
1	25	2.8	437	2.7	455	2.6	426	2.6	405	2.7	444	2.7	433
2	51	2.5	345	2.4	375	2.3	346	2.4	324	2.5	340	2.4	346
3	76	2.3	271	2.2	301	2.2	269	2.2	256	2.2	274	2.2	274
4	102	2.1	215	2.2	235	2.2	219	2.1	199	2.2	212	2.2	216
5	127	2.0	155	2.1	176	2.1	155	2.0	134	2.0	156	2.0	155
6	152	1.8	105	1.9	120	1.8	99	1.8	79	1.9	90	1.8	99
7	178	1.3	81	1.3	91	1.2	72	1.3	55	1.3	55	1.3	71
8	203	1.1	61	1.2	72	1.2	60	1.2	36	1.2	35	1.2	53
9	228	1.2	46	1.1	57	1.1	40	1.1	20	1.1	16	1.1	36
10	254	1.2	26	1.2	40	1.2	20	0.9	7	0.8	2	1.1	19
11	279		0	1.4	17		0		0		0		
12	304				0								
Total Depth of Penetration Inches		11.0		11.4		11.3		10.6		10.4		Mean Total Depth ins. 10.9 Standard Deviation 0.44	
Total Volume ccs.		619		610		599		552		590		Mean Volume ccs. 594 Standard Deviation 26	

Appendix A Table 20

FILLING	LINER		TARGET
RDX/TNT 60/40	Material:	Aluminium	R.H. ARMOUR
	Cone Angle:	45°	
	Wall thickness:	0.940 inches	

Round No.		P65		P66		P67		P68		P116		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		32,33		32,33		32,33		32,33		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			220		226		217		228		209		220
0	0	1.5	205	1.7	209	1.9	204	1.7	215	1.8	198	1.7	206
1	25	1.5	183	1.3	183	1.3	177	1.5	182	1.3	176	1.4	180
2	51	1.6	143	1.5	153	1.5	145	1.6	145	1.6	138	1.6	145
3	76	1.4	113	1.4	125	1.4	117	1.5	116	1.4	113	1.4	117
4	102	1.3	91	1.4	100	1.3	96	1.4	92	1.4	86	1.4	93
5	127	1.4	73	1.4	78	1.5	70	1.5	70	1.4	59	1.4	70
6	152	1.4	35	1.5	41	1.4	35	1.5	30	1.3	33	1.4	35
7	178	1.0	15	1.1	21	1.0	16	1.0	14	1.0	12	1.0	16
8	203		3	0.7	9	0.9	6		4	0.8	3		5
9	228		0		0		0		0		0		
Total Depth of Penetration Inches		8.4		8.8		8.6		8.4		8.6		Mean Total Depth ins. 8.6	
												Standard Deviation 0.17	
Total Volume ccs.		220		226		217		228		209		Mean Volume ccs. 220	
												Standard Deviation 7.6	

Appendix A Table 21

FILLING	LINER	TARGET
RDX/TNT 60/40	Material: Aluminium Cone Angle: 75° Wall thickness: 0.300 inches	R.H. ARMOUR

Round No.		P137		P138		P139		P140		P141		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		55,54		55,54		55,54		55,54		55,54			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Craters:			672		672		653		666		710		675
0	0	3.5	607	3.6	607	3.4	602	3.5	609	3.4	646	3.5	614
1	25	3.0	481	3.0	481	3.0	482	3.0	494	2.8	522	3.0	492
2	51	2.6	388	2.5	387	2.3	401	2.5	407	2.7	423	2.5	401
3	76	2.6	304	2.5	311	2.4	332	2.3	336	2.6	337	2.5	324
4	102	2.5	223	2.5	235	2.4	265	2.2	274	2.7	244	2.45	248
5	127	2.5	134	2.5	153	2.3	191	2.4	199	2.6	153	2.45	166
6	152	2.2	61	2.3	74	2.3	119	2.4	126	2.5	76	2.35	91
7	178	1.4	7	1.5	10	1.9	50	1.9	60	1.6	11	1.65	28
8	203		0		0	1.6	11	1.8	16		0		
9	228						0		0				
Total Depth of Penetration Inches		7.4		7.5		8.6		8.8		7.6		Mean Total Depth ins. 8.0 Standard Deviation 0.66	
Total Volume ccs.		672		672		653		666		710		Mean Volume ccs. 675 Standard Deviation 21.2	

Appendix A Table 22

FILLING	LINER	TARGET
RDX/TNT 60/40	Material: Aluminium Cone Angle : 75° Wall thickness: 0.470 inches	R.H. ARMOUR

Round No.		P59		P60		P69		P70		P117		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		32,33		32,33		32,33		32,33		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			507		507		518		506		447		497
0	0	3.0	430	2.8	440	2.8	454	2.7	437	2.7	405	2.8	433
1	25	2.5	332	2.4	352	2.4	368	2.4	357	2.1	325	2.4	347
2	51	2.1	271	2.2	292	2.2	298	2.2	300	2.0	270	2.1	286
3	76	2.0	211	2.1	232	2.1	238	2.1	236	2.0	215	2.1	226
4	102	1.9	156	2.1	171	2.1	185	2.0	185	2.0	160	2.0	171
5	127	2.0	105	2.0	117	2.1	133	2.0	125	1.9	109	2.0	118
6	152	2.4	41	2.1	47	2.1	58	2.3	56	2.2	45	2.2	49
7	178	0.6	0	0.8	0	1.2	0	0.9	0	1.0	0	0.9	
Total Depth of Penetration Inches		6.9		7.0		7.1		7.0		7.1		Mean Total Depth ins. 7.0 Standard Deviation 0.09	
Total Volume ccs.		507		507		518		506		447		Mean Volume ccs. 497 Standard Deviation 28	

Appendix A Table 23

FILLING

RDX/TNT 60/40

LINER

Material: Aluminium
Cone Angle: 75°
Wall thickness: 0.940 inches

TARGET

R.H. ARMOUR

Round No.		P61		P62		P71		P72		P118		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		32,33		32,33		32,33		32,33		33,46			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			172		205		170		192		185		185
0	0	1.7	142	2.1	172	1.6	140	1.7	160	1.4	138	1.7	150
1	25	1.3	118	1.5	132	1.2	115	1.2	139	1.1	117	1.3	124
2	51	1.3	95	1.3	107	1.2	96	1.3	118	1.3	94	1.3	102
3	76	1.3	77	1.3	83	1.2	80	1.3	98	1.2	72	1.3	82
4	102	1.4	54	1.4	58	1.1	61	1.3	78	1.2	55	1.3	61
5	127	1.4	32	1.5	38	1.3	42	1.4	53	1.2	34	1.4	40
6	152	1.5	4	1.2	2	1.5	5	1.6	2	1.4	5	1.4	4
7	178		0		0		0		0		0		
Total Depth of Penetration Inches		6.2		6.1		6.3		6.2		6.3		Mean Total Depth ins. 6.2 Standard Deviation 0.09	
Total Volume ccs.		172		205		170		192		173		Mean Volume ccs. 185 Standard Deviation 15.7	

Appendix A Table 24

FILLING: RDX/TNT 60/40

LINER: Material: Aluminium; Cone Angle: 100°; Wall thickness: 0.940 inches

TARGET: R.H. ARMOUR

Round No.		P47		P48		P73		P74		P119		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		19		19		32		32		33			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			175		150		164		184		150		165
0	0	1.7	130	1.6	104	1.6	118	1.7	127	1.6	105	1.6	117
1	25	1.3	105	1.3	77	1.3	92	1.3	102	1.2	85	1.3	92
2	51	1.5	80	1.4	56	1.4	78	1.5	77	1.2	65	1.4	71
3	76	1.4	55	1.5	33	1.5	50	1.5	44	1.4	41	1.5	45
4	102	1.4	25	1.2	5	1.5	28	1.3	14	1.4	19	1.4	18
5	127		0		0		0		0		0		
Total Depth of Penetration Inches		4.8		4.3		4.8		4.8		4.8		Mean Total Depth ins. 4.7	
												Standard Deviation 0.22	
Total Volume ccs.		175		150		164		184		150		Mean Volume ccs. 165	
												Standard Deviation 15.1	

Appendix B Table 1

ROLLED HOMOGENOUS ARMOUR

TARGET PLATE PHYSICAL PARAMETERS

Plate No.	Thickness mm	Yield Tons/sq.in.	U.T.S. Tons/sq.in.	Elong %	Area Reduct. %	B.H.N.	Izod ft. lb.
19	150	47.5	57.8	24.0	60.6	-	67,68,68
20	150	47.2	57.2	23.0	61.7	-	70,71,70
21	60	50.4	57.6	21.0	60.4	262	70,72,72
22	60	46.8	55.2	22.0	62.8	255	68,70,70
23	60	54.4	62.0	20.0	58.0	285	68,69,68
24	150	46.5	57.8	25.0	60.4	-	69,69,70
25	150	46.0	56.5	24.0	59.8	-	74,73,73
26	60	52.4	60.8	21.0	60.4	277	69,70,70
27	60	54.8	61.2	19.5	59.2	277	70,69,71
28	60	54.8	62.8	20.0	58.0	285	61,63,62
29	60	50.0	58.4	21.0	60.4	269	60,61,58
30	60	52.4	60.8	23.0	59.2	277	72,72,70
31	60	52.8	60.4	22.0	59.2	277	66,68,68
32	150	48.3	58.5	24.0	58.6	-	67,66,66
33	150	45.5	56.0	25.0	63.0	-	74,74,73
46	150	47.8	58.0	25.0	61.7	-	70,70,72
47	60	54.0	62.0	21.0	59.2	285	73,71,71
53	60	49.6	57.2	22.0	62.8	262	72,73,73
54	150	46.8	57.0	24.0	61.1	-	66,66,66
55	150	47.5	58.0	22.0	59.8	-	73,72,72
56							
57							
58	150	48.5	58.0	24.0	64.7	271	75,73,76
59	150	47.5	56.5	23.5	64.2	269	75,74,75
60	60	55.2	63.2	18.5	58.0	293	66,65,66
61	60	50.4	58.8	20.0	59.2	269	70,69,71

Appendix B Table 2

ROLLED HOMOGENOUS ARMOUR

TARGET PLATE CHEMICAL COMPOSITIONS

Plate No.	C %	Si %	S %	P %	Mn %	Ni %	Cr %	Mo %
19	0.29	0.20	0.010	0.017	0.55	0.22	3.23	0.55
20	0.27	0.25	0.012	0.012	0.59	0.30	3.35	0.55
21	0.28	0.28	0.015	0.018	0.58	0.52	1.53	0.35
22	0.30	0.23	0.020	0.018	0.56	0.56	1.47	0.31
23	0.33	0.43	0.017	0.013	0.66	0.56	1.51	0.40
24	0.30	0.22	0.011	0.013	0.60	0.19	3.20	0.54
25	0.27	0.25	0.012	0.012	0.59	0.30	3.35	0.55
26	0.29	0.49	0.016	0.016	0.63	0.58	1.54	0.40
27	0.30	0.47	0.015	0.016	0.62	0.56	1.51	0.36
28	0.30	0.37	0.013	0.013	0.64	0.56	1.48	0.36
29	0.32	0.41	0.018	0.014	0.69	0.54	1.54	0.41
30	0.33	0.45	0.016	0.010	0.65	0.61	1.56	0.36
31	0.29	0.40	0.015	0.019	0.57	0.51	1.43	0.38
32	0.27	0.28	0.016	0.014	0.55	0.18	3.21	0.58
33	0.30	0.27	0.012	0.020	0.57	0.19	3.40	0.51
46	0.30	0.22	0.011	0.013	0.60	0.19	3.20	0.54
47	0.29	0.40	0.015	0.019	0.57	0.51	1.43	0.38
53	0.28	0.28	0.015	0.018	0.58	0.52	1.53	0.35
54	0.27	0.28	0.016	0.014	0.55	0.18	3.21	0.58
55	0.30	0.22	0.011	0.013	0.60	0.19	3.20	0.54
56								
57								
58	0.26	0.20	0.010	0.015	0.60	0.14	3.40	0.53
59	0.29	0.25	0.014	0.016	0.60	0.12	3.29	0.54
60	0.33	0.43	0.017	0.013	0.66	0.56	1.51	0.40
61	0.30	0.47	0.015	0.016	0.62	0.56	1.51	0.36

Appendix C Table 1

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 75°; Wall thickness: 0.160 inches

TARGET: MILD STEEL

Round No.		P1		P2		P3		P6				Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		1,2,3, 4,5,6,		1,2,3, 4,5,6,		1,2,3, 4,5,6		1,2,3, 4,5,6, 7					
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			1088		1024		993		946				1013
0	0	3.1	1010	3.2	962	3.2	925	3.1	871			3.2	942
1	25	2.9	898	2.8	845	2.9	808	3.0	751			2.9	826
2	51	2.8	802	2.7	745	2.5	720	2.7	644			2.7	728
3	76	2.5	690	2.6	633	2.6	621	2.2	580			2.5	631
4	102	2.5	603	2.5	548	2.6	542	2.4	511			2.5	551
5	127	2.2	487	2.1	439	2.2	425	2.2	418			2.2	442
6	152	2.2	432	2.1	381	2.3	366	2.2	357			2.2	384
7	178	1.9	323	2.1	299	2.0	268	2.0	284			2.0	294
8	203	1.8	276	1.7	259	1.8	218	1.7	245			1.8	249
9	228	1.8	228	1.9	217	1.8	181	1.8	197			1.8	206
10	254	1.4	146	1.5	144	1.4	133	1.5	157			1.5	145
11	279	1.6	118	1.6	116	1.7	100	1.5	132			1.6	117
12	304	1.4	89	1.6	87	1.5	71	1.4	101			1.5	87
13	330	1.3	34	1.3	30	1.4	25	1.3	58			1.3	37
14	355	1.2	15	1.2	8	1.0	12	1.3	36			1.2	18
15	381	0.7	0		0		0	1.2	14				
16	406								0				
Total Depth of Penetration Inches		15.0		14.6		14.4		15.8				Mean Total Depth ins. 15.0	
												Standard Deviation 0.61	
Total Volume ccs.		1088		1024		993		946				Mean Volume ccs. 1013	
												Standard Deviation 59	

Appendix C Table 2

FILLING: RDX/TNT 60/40

LINER: Material: Steel; Cone Angle: 100°; Wall thickness: 0.160

TARGET: MILD STEEL

Round No.		P17		P18		P19		P20		P21		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		12,13,14 15,16,17 18		12,13,14 15,16,17 18		12,13,14 15,16,17 18		12,13,14 15,16,17 18		12,13,14 15,16,17			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			1234		1292		1281		1184		1288		1260
0	0	2.6	1163	2.7	1176	2.8	1192	2.9	1085	3.0	1170	2.8	1157
1	25	2.9	1052	2.9	1092	2.9	1072	2.8	980	3.0	1060	2.9	1051
2	51	2.7	955	2.7	985	2.7	971	2.9	880	3.0	942	2.8	947
3	76	2.7	843	2.7	853	2.7	863	2.4	777	2.9	792	2.7	826
4	102	2.7	754	2.8	745	2.9	766	2.7	691	2.9	684	2.8	728
5	127	2.5	621	2.5	613	2.4	631	2.5	560	2.5	551	2.5	595
6	152	2.5	543	2.5	530	2.5	551	2.5	481	2.7	468	2.55	515
7	178	2.1	412	2.3	390	2.3	393	2.3	363	2.4	330	2.35	378
8	203	2.6	336	2.6	312	2.7	309	2.6	290	2.3	262	2.6	302
9	228	2.1	210	1.8	165	2.1	166	2.1	148	1.7	120	2.0	162
10	254	1.4	172	1.5	135	1.8	127	1.6	109	1.5	90	1.6	127
11	279	1.4	86	1.7	36	1.4	76	1.7	52	1.5	23	1.55	55
12	304	1.6	57	1.3	0	1.8	43	1.5	27	0.8	0	1.4	25
13	330	0.7	0				0		0				
Total Depth of Penetration Inches		13.0		12.2		12.7		12.4		12.0		Mean Total Depth ins. 12.5	
												Standard Deviation 0.4	
Total Volume ccs.		1234		1292		1281		1184		1288		Mean Volume ccs. 1260	
												Standard Deviation 51	

Appendix C Table 3

FILLING: RDX/TNT 60/40

LINER: Material: Aluminium; Cone Angle: 45°; Wall thickness: 0.940 inches

TARGET: MILD STEEL

Round No.		P7		P8		P9		P13		P14		Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		4,5,6, 7,18		4,5,6, 7,18		4,5,6, 7,18		8,9,10, 11,12,13, 14		8,9,10, 11,12,13, 14			
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			382		336		399		382		368		375
0	0	1.8	363	1.8	320	1.7	380	1.8	366	1.8	356	1.8	357
1	25	1.6	337	1.5	295	1.6	349	1.5	337	1.5	331	1.55	330
2	51	2.1	272	2.0	253	2.2	304	1.8	293	1.8	288	2.0	282
3	76	1.8	212	1.7	200	1.8	229	1.8	248	1.8	240	1.8	226
4	102	1.6	172	1.6	154	1.6	188	1.6	203	1.7	198	1.6	183
5	127	1.7	135	1.6	124	1.7	155	1.5	164	1.6	160	1.6	148
6	152	1.5	101	1.4	89	1.6	117	1.6	133	1.5	130	1.5	114
7	178	1.2	76	1.3	62	1.3	88	1.2	99	1.3	91	1.3	83
8	203	1.2	57	1.2	45	1.3	71	1.4	73	1.3	69	1.3	63
9	228	1.0	42	1.0	28	1.2	43	1.0	43	1.0	50	1.05	41
10	254	0.9	25	0.8	14	0.9	30	1.0	33	0.9	34	0.9	27
11	279	1.0	18	0.7	5	1.0	20	0.9	13	0.8	17	0.9	15
12	304	0.5	0	0.6	3	1.2	3	0.7	0	1.0	3	0.8	2
13	330				0		0				0		
Total Depth of Penetration Inches		12.1		12.3		12.2		12.1		12.2		Mean Total Depth ins. 12.2	
												Standard Deviation 0.09	
Total Volume ccs.		382		336		399		382		368		Mean Volume ccs. 375	
												Standard Deviation 23.6	

Appendix C Rable 4

FILLING	LINER	TARGET
RDX/TNT 60/40	Material: Aluminium	MILD STEEL
	Cone Angle : 75°	
	Wall thickness : 0.940 inches	

Round No.		P4		P5		P15		P16				Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		1,2,3, 4		1,2,3, 4		8,9,10, 11,12.		8,9,10, 11,12.					
Depth of Penetration		Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.	Hole Diam ins.	Resi-dual Vol. ccs.		
Ins.	mms.												
Crater:			361		320		328		335				336
0	0	3.5	339	3.4	276	3.4	294	3.5	295			3.55	301
1	25	1.7	223	1.5	194	1.6	233	1.6	228			1.6	220
2	51	1.2	193	1.1	174	1.3	208	1.3	205			1.2	195
3	76	1.5	152	1.6	140	1.6	171	1.5	167			1.55	158
4	102	1.5	123	1.4	111	1.5	145	1.5	138			1.5	129
5	127	1.4	84	1.4	76	1.3	111	1.3	102			1.35	93
6	152	1.4	58	1.3	55	1.4	87	1.3	79			1.35	70
7	178	1.1	27	1.1	30	1.3	45	1.2	44			1.2	37
8	203	1.2	6	1.2	12	1.4	20	1.4	20			1.3	15
9	228		0		0		0		•				
Total Depth of Penetration Inches		8.5		8.8		8.3		8.7				Mean Total Depth ins. 8.6 Standard Deviation 0.22	
Total Volume ccs.		361		320		328		335				Mean Volume ccs. 336 Standard Deviation 17.8	

Appendix C Table 5

FILLING	LINER	TARGET
RDX/TNT 60/40	Material: Aluminium Cone Angle: 100° Wall thickness: 0.940 inches	MILD STEEL

Round No.		P10		P11		P12						Mean Hole Diam ins.	Mean Residual Volume ccs.
Plate Nos.		4,5,6		4,5		4,5,6							
Depth of Penetration		Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.	Hole Diam ins.	Residual Vol. ccs.		
Ins.	mms.												
Crater:			299		286		321						302
0	0	2.2	225	2.0	213	2.1	248					2.1	229
1	25	1.2	195	1.2	183	1.3	214					1.2	197
2	51	1.4	176	1.3	162	1.5	188					1.4	175
3	76	1.6	141	1.6	132	1.5	153					1.6	142
4	102	2.3	80	2.3	72	2.5	73					2.4	75
5	127	1.7	28	1.7	22	1.7	22					1.7	24
6	152	1.1	5		0	0.6	0						
7	178		0										
Total Depth of Penetration Inches		6.3		5.9		6.1						Mean Total Depth ins. 6.1 Standard Deviation -	
Total Volume ccs.		299		286		321						Mean Volume ccs. 302 Standard Deviation -	

Appendix D Table 1

MILD STEEL

TARGET PLATE PHYSICAL PARAMETERS

Plate No.	Thickness ins.	Yield Tons/sq.in.	U.T.S. Tons/sq.in.	Elong. %	Area Reduct. %	B.H.N.	Izod ft. lb.
1	2	15.2	27.7	39	61	116	44,36,52
2	2	14.3	27.2	38	63	116	56,54,54
3	2	14.6	27.9	39	61	108	45,41,37
4	3	14.7	25.4	40	64	118	36,47,39
5	3	15.7	28.0	38	60	131	38,39,36
6	3	11.9	26.6	39	58	113	41,35,40
7	3	14.2	26.6	40	63	119	51,52,35
8	2	14.0	28.5	38	58	124	27,40,32
9	2	15.4	27.6	39	60	131	41,44,42
10	2	15.8	29.0	38	59	131	33,29,30
11	2	14.9	29.8	36	56	120	26,28,30
12	2	12.5	24.2	38	59	123	30,33,37
13	2	14.4	27.6	39	62	119	37,40,46
14	2	15.6	27.8	39	62	115	43,45,37
15	2	12.0	28.1	37	57	124	36,28,26
16	2	15.1	28.0	38	61	123	44,41,47
17	2	13.2	27.6	38	60	116	40,58,42
18	3	12.4	28.8	38	61	124	35,34,36

Appendix D Table 2

MILD STEEL

TARGET PLATE CHEMICAL COMPOSITIONS

Plate No.	C %	Si %	Mn %	Ni %	Cr %	Mo %	V %	Cu %	Al %
1	0.14	0.07	0.61	0.03	0.02	<0.01	<0.01	0.07	<0.005
2	0.19	0.08	0.66	0.04	0.02	"	"	0.07	<0.005
3	0.17	0.08	0.66	0.05	0.02	"	"	0.07	<0.005
4	0.14	0.08	0.52	0.07	0.01	"	"	0.11	0.015
5	0.17	0.07	0.61	0.19	0.03	"	"	0.26	<0.005
6	0.17	0.10	0.59	0.05	0.06	"	"	0.07	0.015
7	0.19	0.05	0.62	0.05	0.02	"	"	0.07	0.015
8	0.22	0.06	0.60	0.05	<0.01	"	"	0.15	0.010
9	0.20	0.07	0.67	0.03	0.01	"	"	0.12	0.005
10	0.19	0.09	0.78	0.06	0.02	"	"	0.11	<0.005
11	0.21	0.06	0.67	0.05	0.01	"	"	0.07	0.005
12	0.22	0.05	0.58	0.05	<0.01	"	"	0.15	<0.005
13	0.19	0.07	0.66	0.05	0.01	"	"	0.09	0.005
14	0.19	0.08	0.60	0.06	0.01	"	"	0.10	<0.005
15	0.22	0.10	0.58	0.05	0.01	"	"	0.12	0.015
16	0.17	0.06	0.60	0.04	0.03	"	"	0.07	<0.005
17	0.18	0.09	0.66	0.05	0.02	"	"	0.08	0.005
18	0.15	0.10	0.58	0.05	0.02	"	"	0.07	0.005

FIG. 1

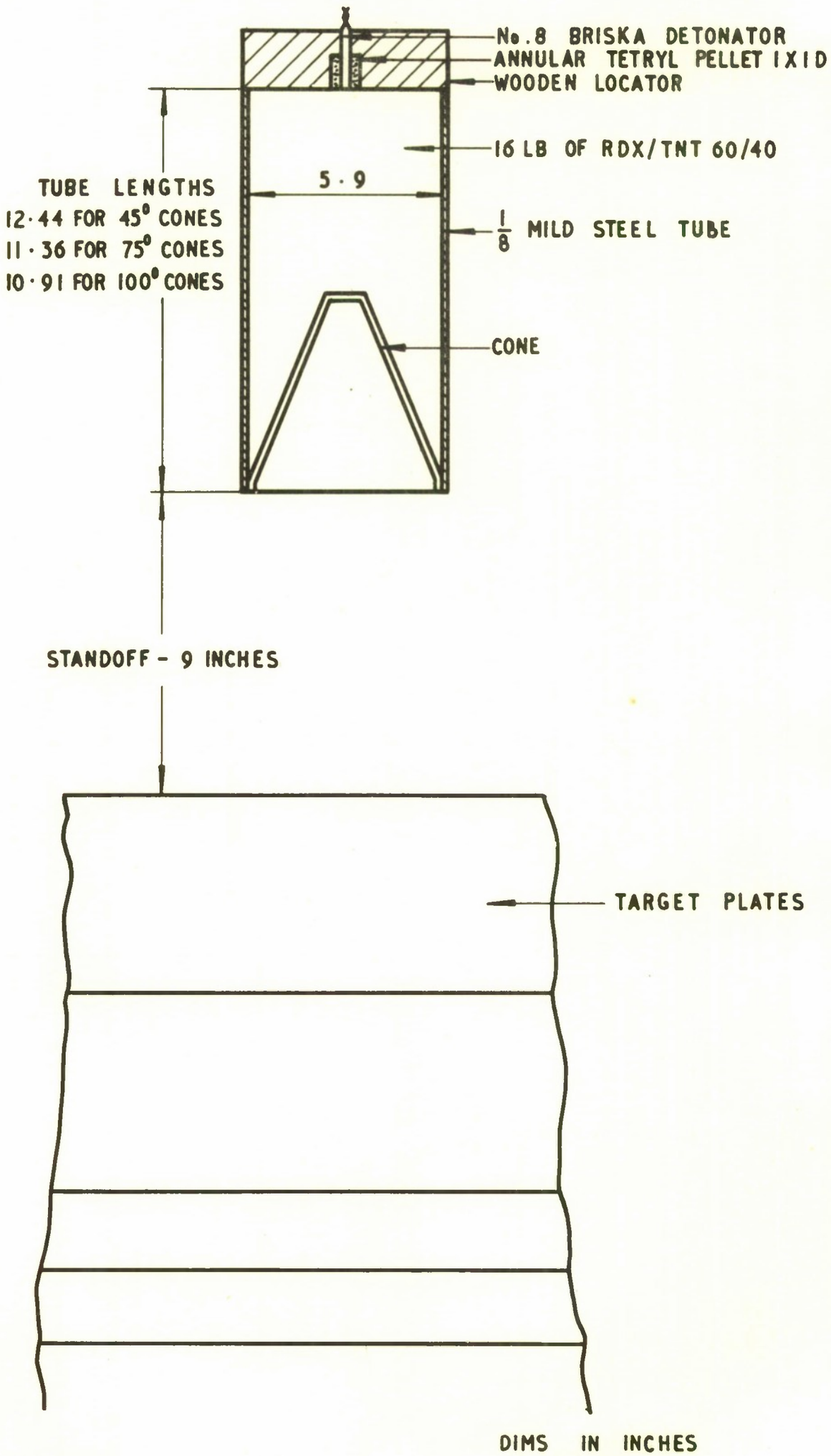
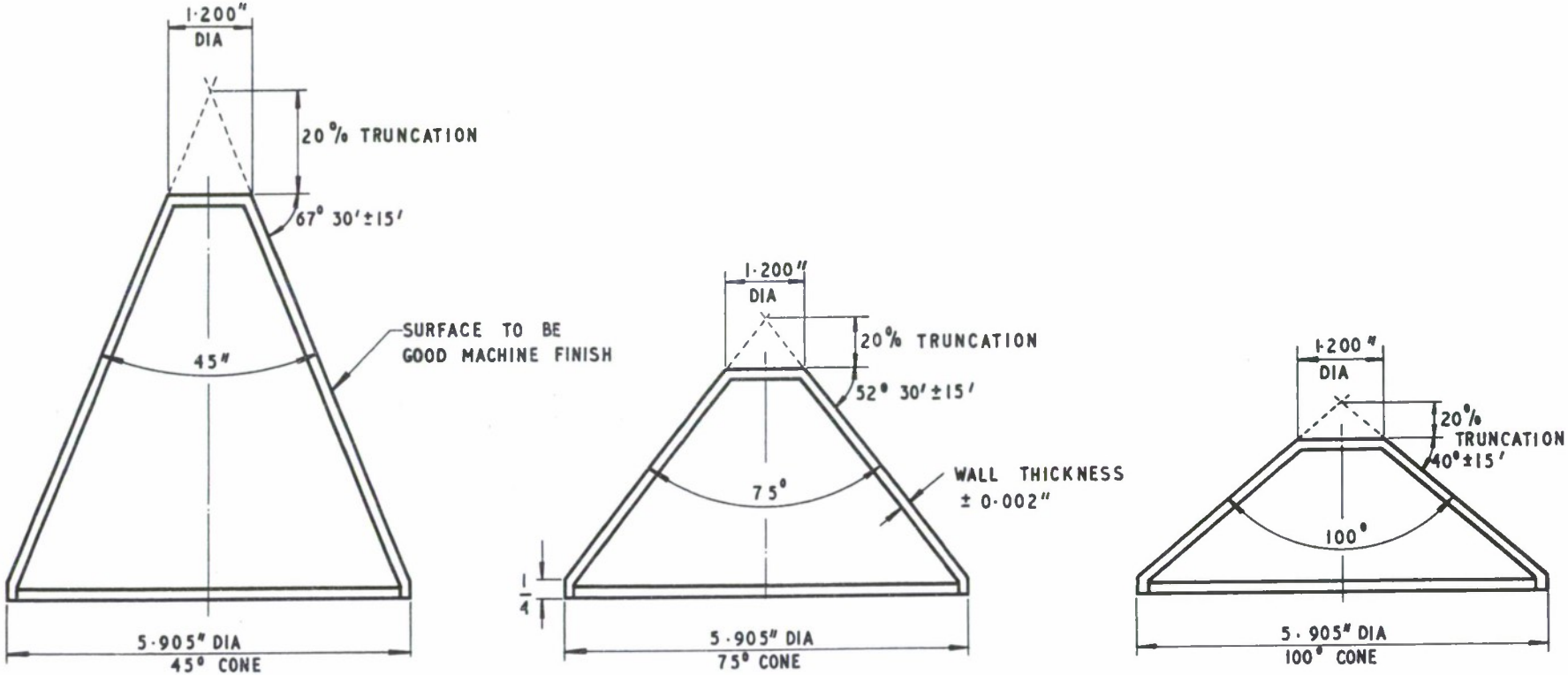


FIG. 1 SCHEMATIC DIAGRAM OF CHARGE AND TARGET LAYOUT

FIG. 2



MATERIAL	SPECIFICATION	WALL THICKNESS (INCHES)	UTS	% AGE ELONGATION
COPPER	BS 1433 MEDIUM HARD	0·088 0·140 0·280	16 TONS/SQIN	20 %
STEEL	B.S. 970 EN 3A	0·100 0·160 0·320	28 TONS/SQIN	25 %
ALUMINIUM ALLOY	BS 1476 HE 10 WP	0·300 0·470 0 980	18 TONS/SQIN	10 %

FIG. 2 TYPES OF CONES

FIG. 3

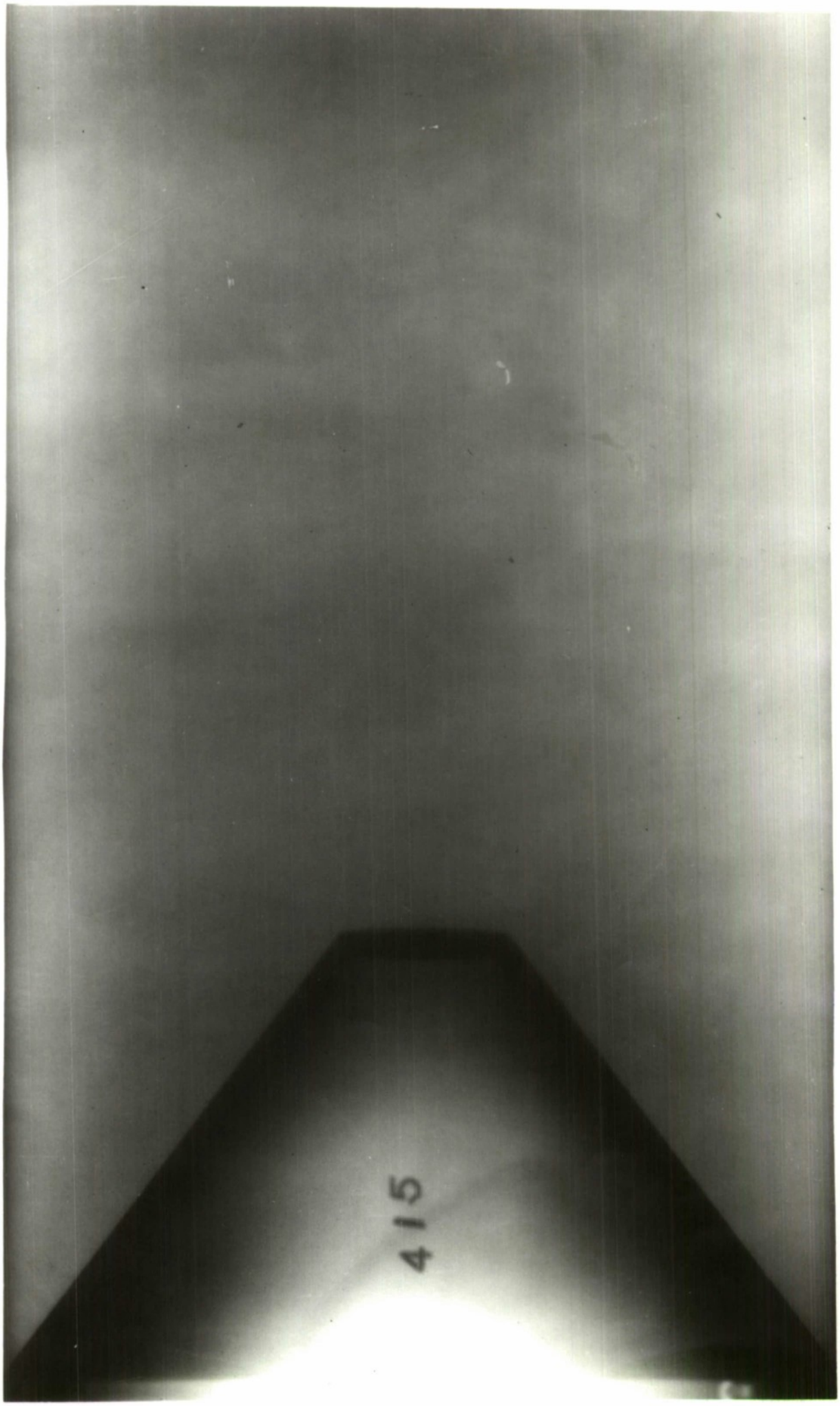


FIG. 3 RADIOGRAPH OF CHARGE

FIG. 4

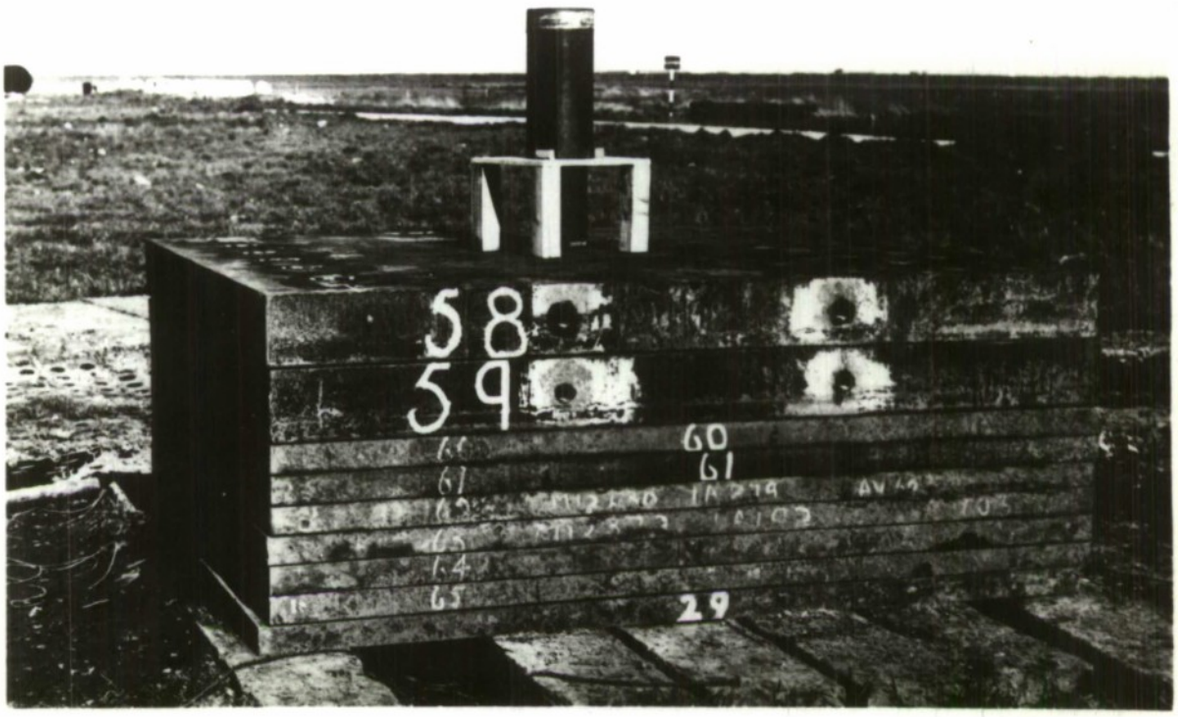
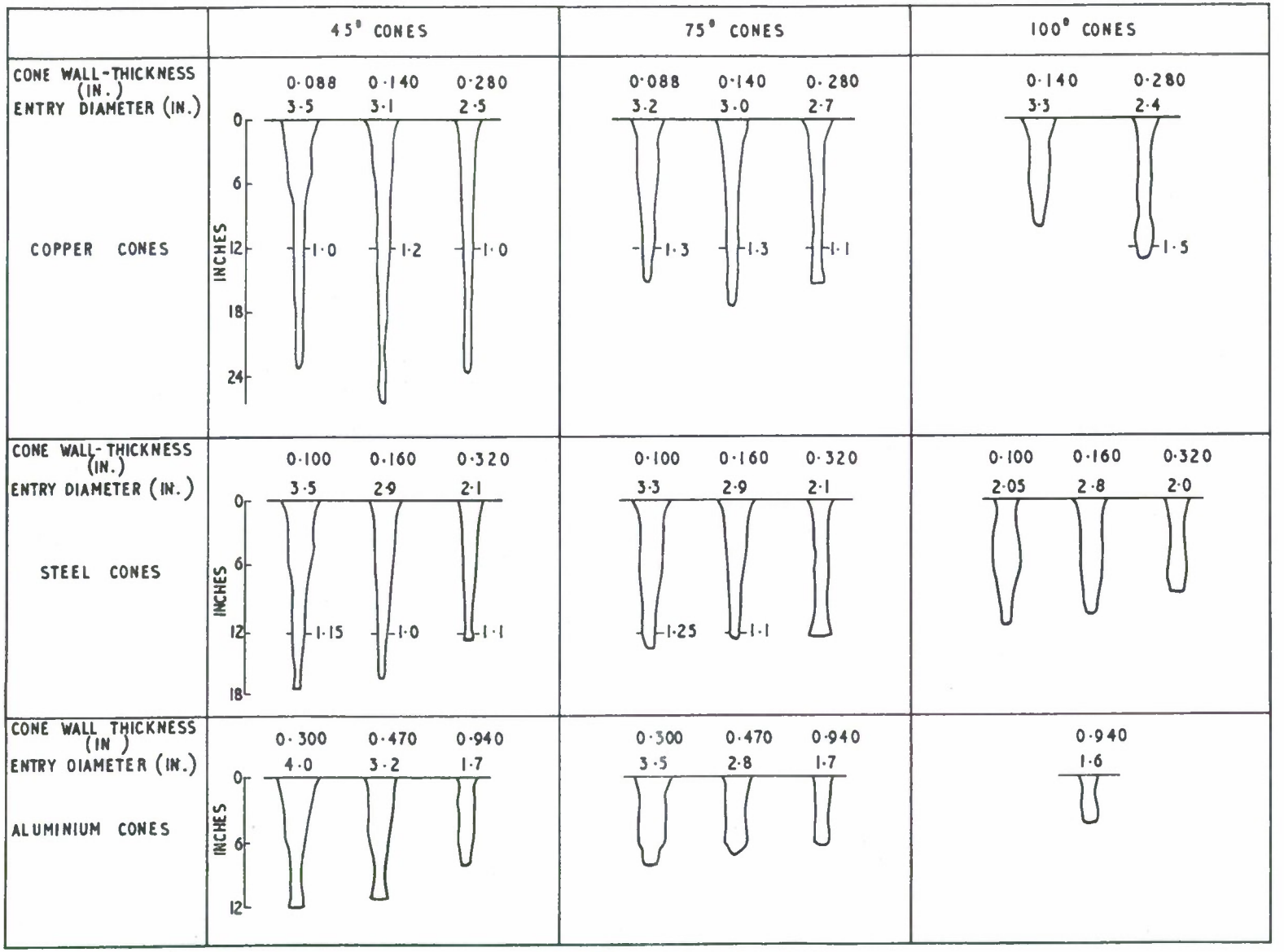


FIG. 4 SEMI-INFINITE TARGET SHOWING CHARGE AND STAND

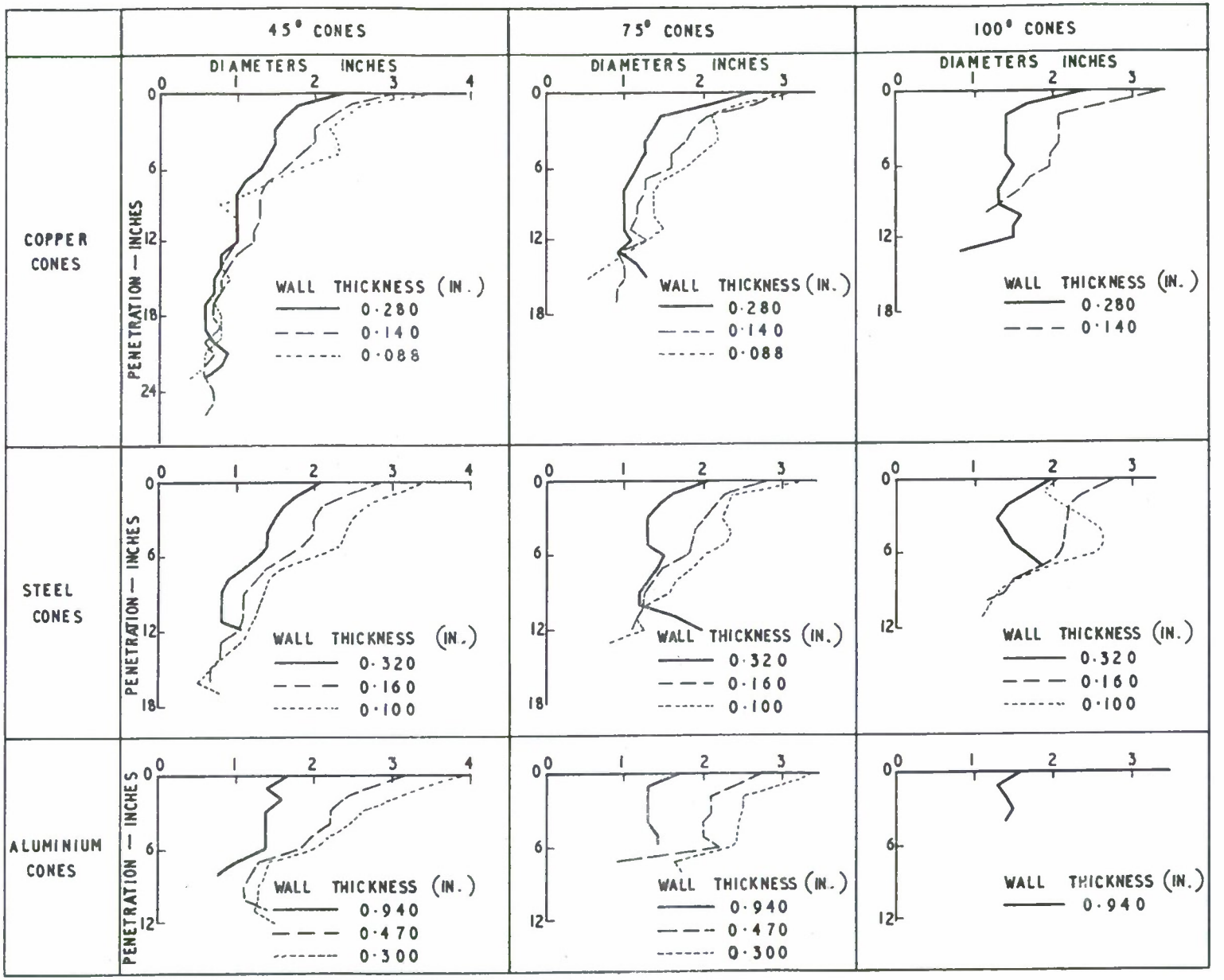
FIG. 5



STANDOFF 1·5 CONE DIAMETERS EXPLOSIVE RDX / TNT 60/40

FIG. 5 COMPARISON OF CRATER PROFILES IN R H ARMOUR WITH CHANGE OF LINER MATERIAL CONE ANGLE AND WALL THICKNESS

FIG. 6



STANDOFF 1·5 CONE DIAMETERS

EXPLOSIVE RDX / TNT 60 / 40

FIG. 6 COMPARISON OF CRATER DIAMETER VS DEPTH OF PENETRATION IN RH ARMOUR WITH CHANGE OF LINER WALL THICKNESS

FIGS. 7(a) AND 7(b)

MATERIAL	COPPER
CONE ANGLE	45°
WALL THICKNESS	0·140 IN.
FILLING	RDX / TNT 60/40
TARGET	R H ARMOUR

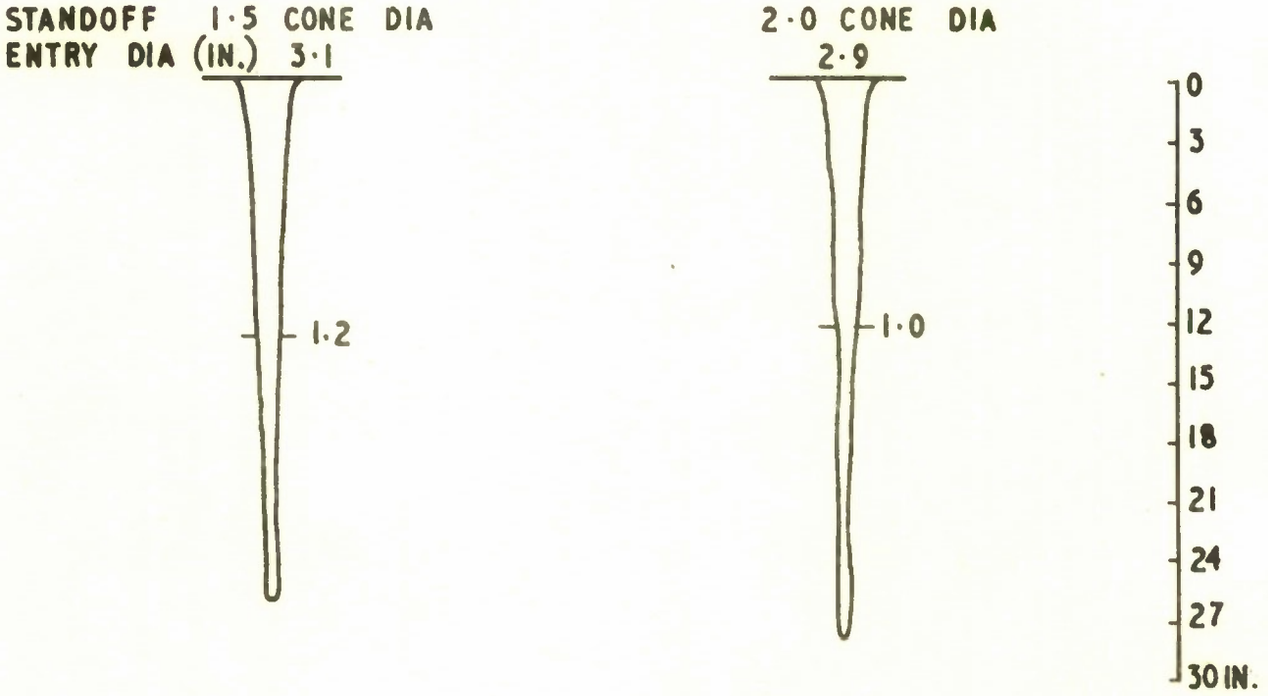


FIG. 7 (a) EFFECT OF STANDOFF ON CRATER PROFILE

MATERIAL	COPPER
CONE ANGLE	75°
WALL THICKNESS	0·140 IN.
STANDOFF	1·5 CONE DIA
TARGET	R H ARMOUR

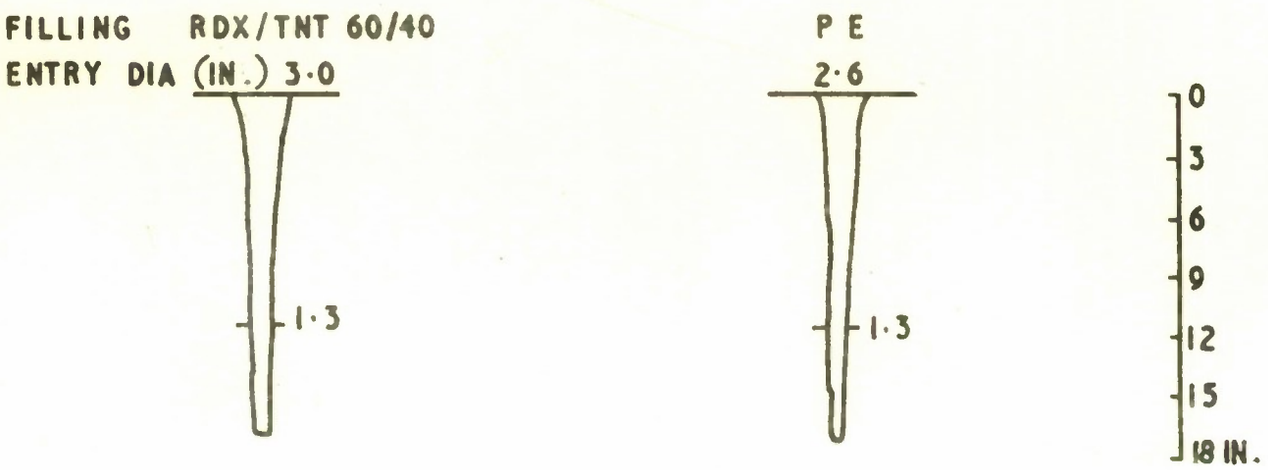


FIG.7 (b) EFFECT OF EXPLOSIVE FILLING ON CRATER PROFILE

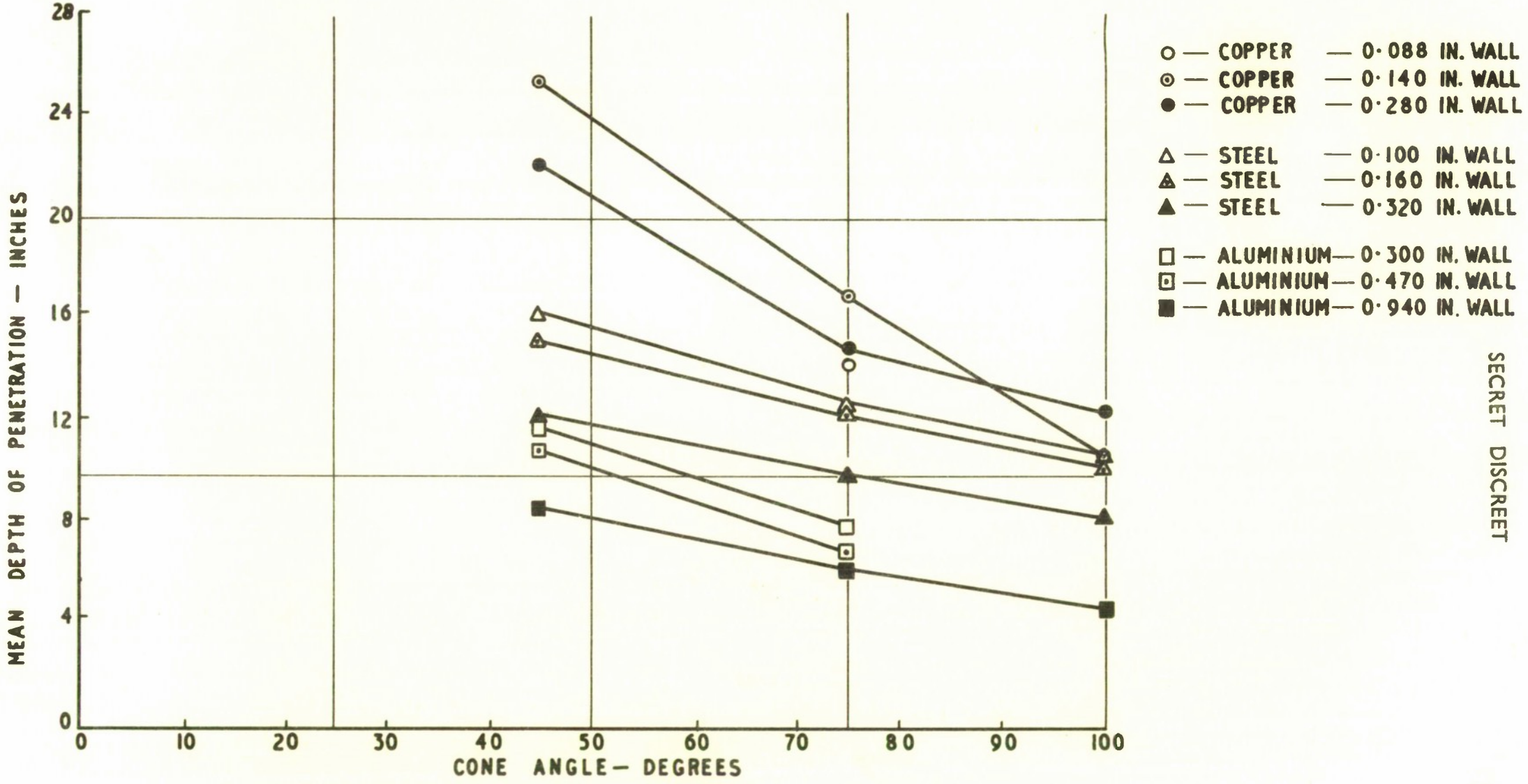


FIG. 8 MEAN DEPTH OF PENETRATION VS CONE ANGLE

TARGET RH ARMOUR

SECRET DISCREET

FIG. 8

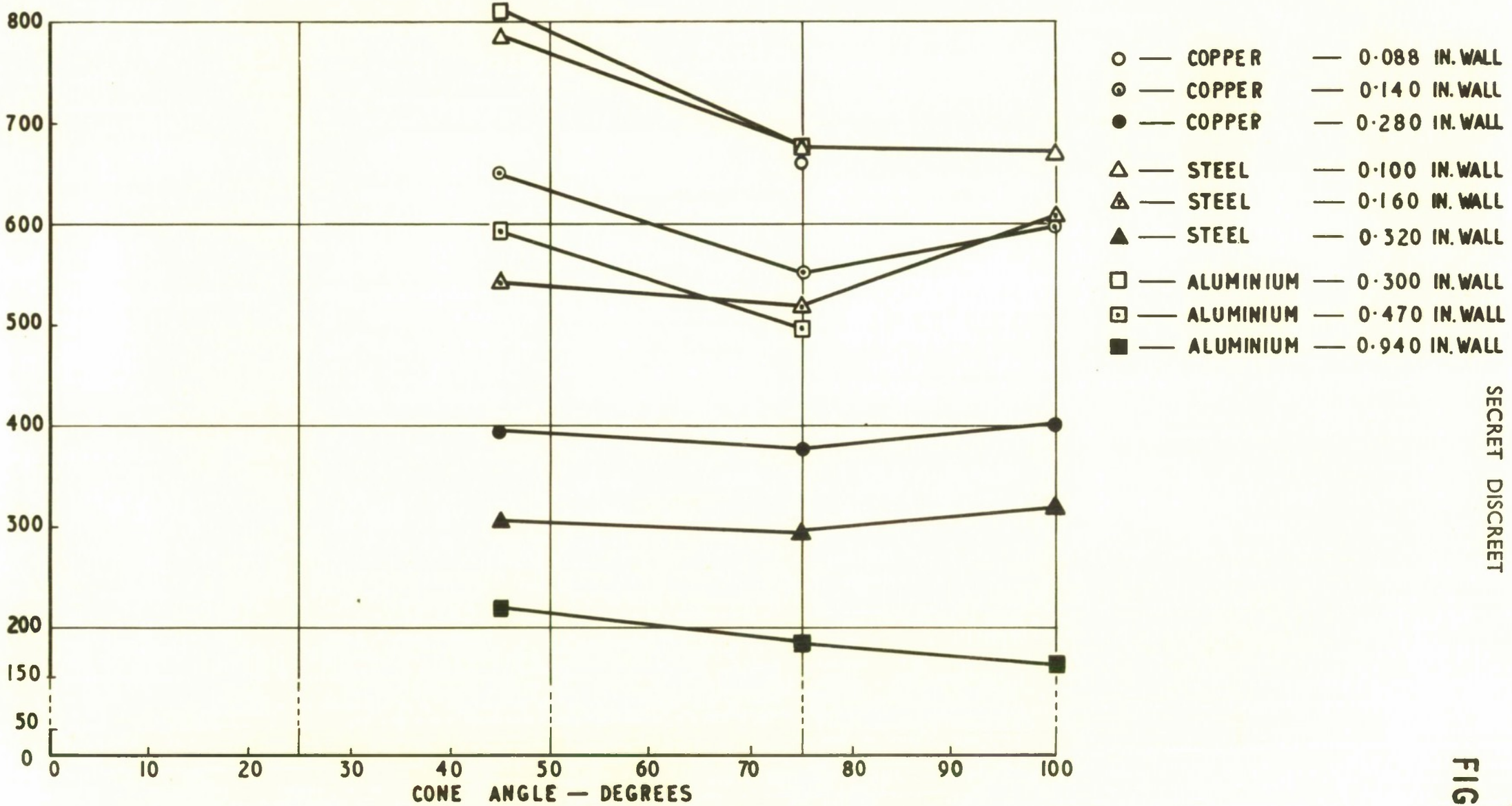


FIG. 9 CRATER VOLUME VS CONE ANGLE
TARGET R H ARMOUR

FIG. 9

FIG. 10

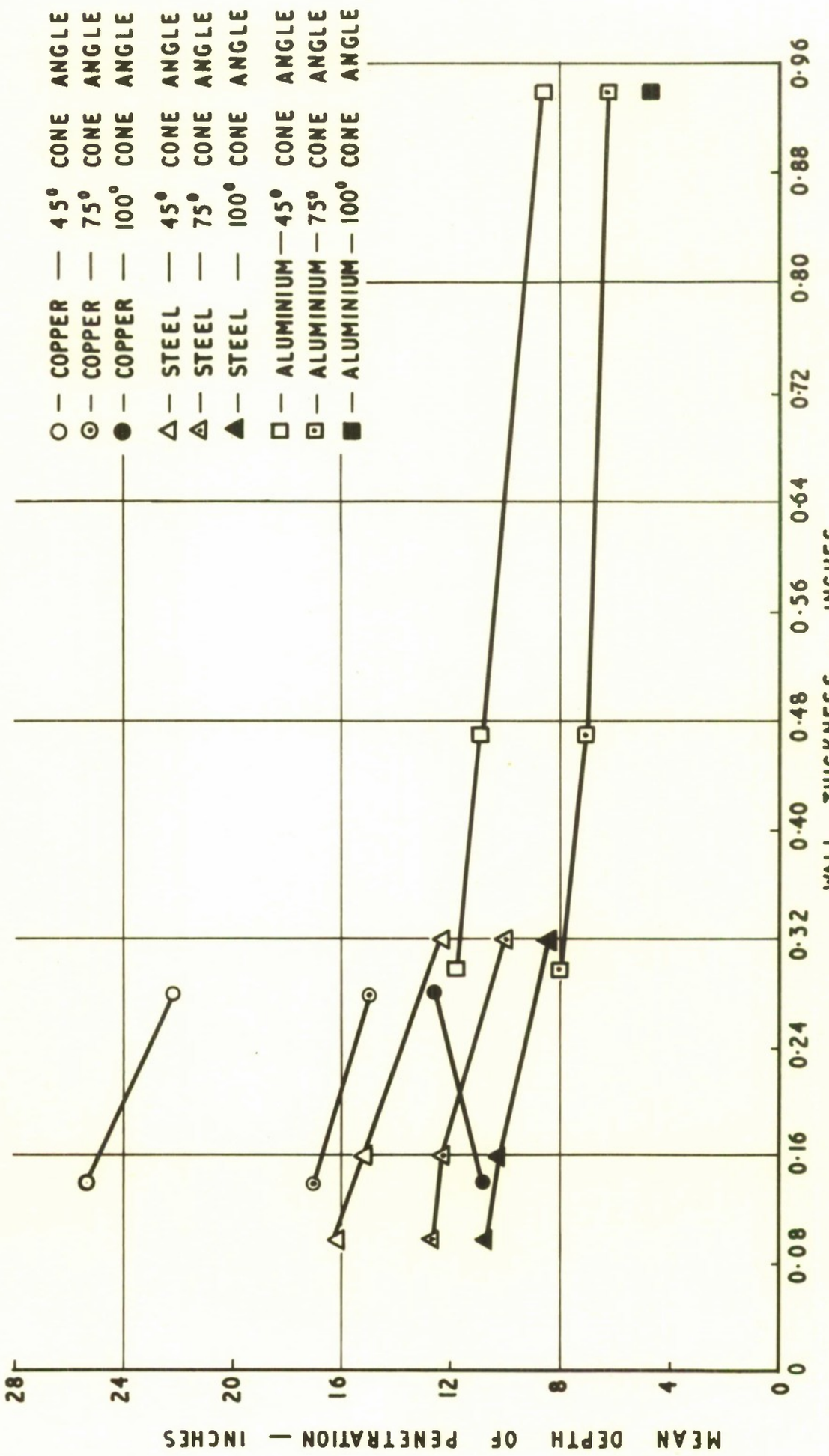


FIG. 10 MEAN DEPTH OF PENETRATION VS WALL THICKNESS

FIG. 11

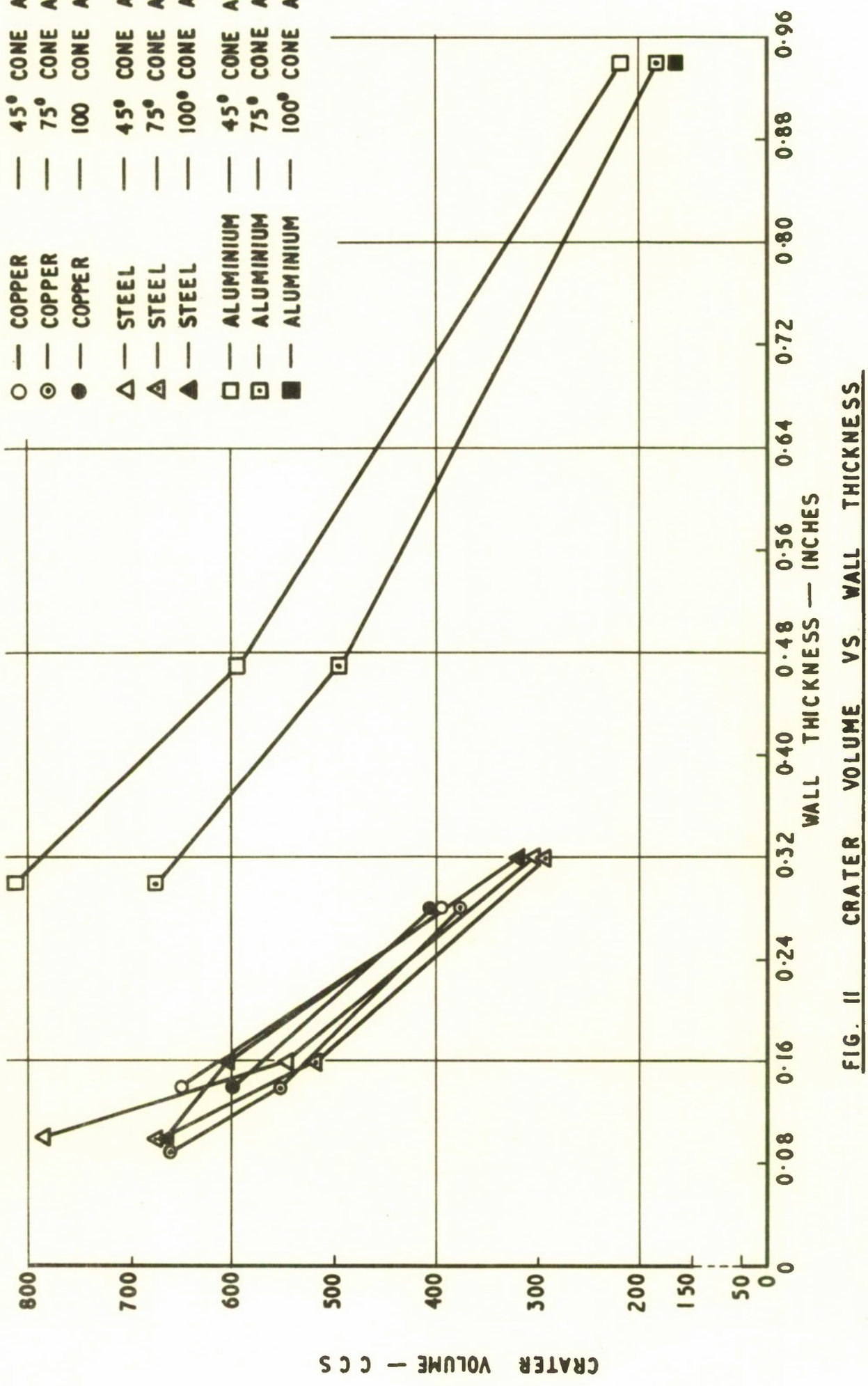


FIG. 11 CRATER VOLUME VS WALL THICKNESS

TARGET R.H ARMOUR

FIG. 12

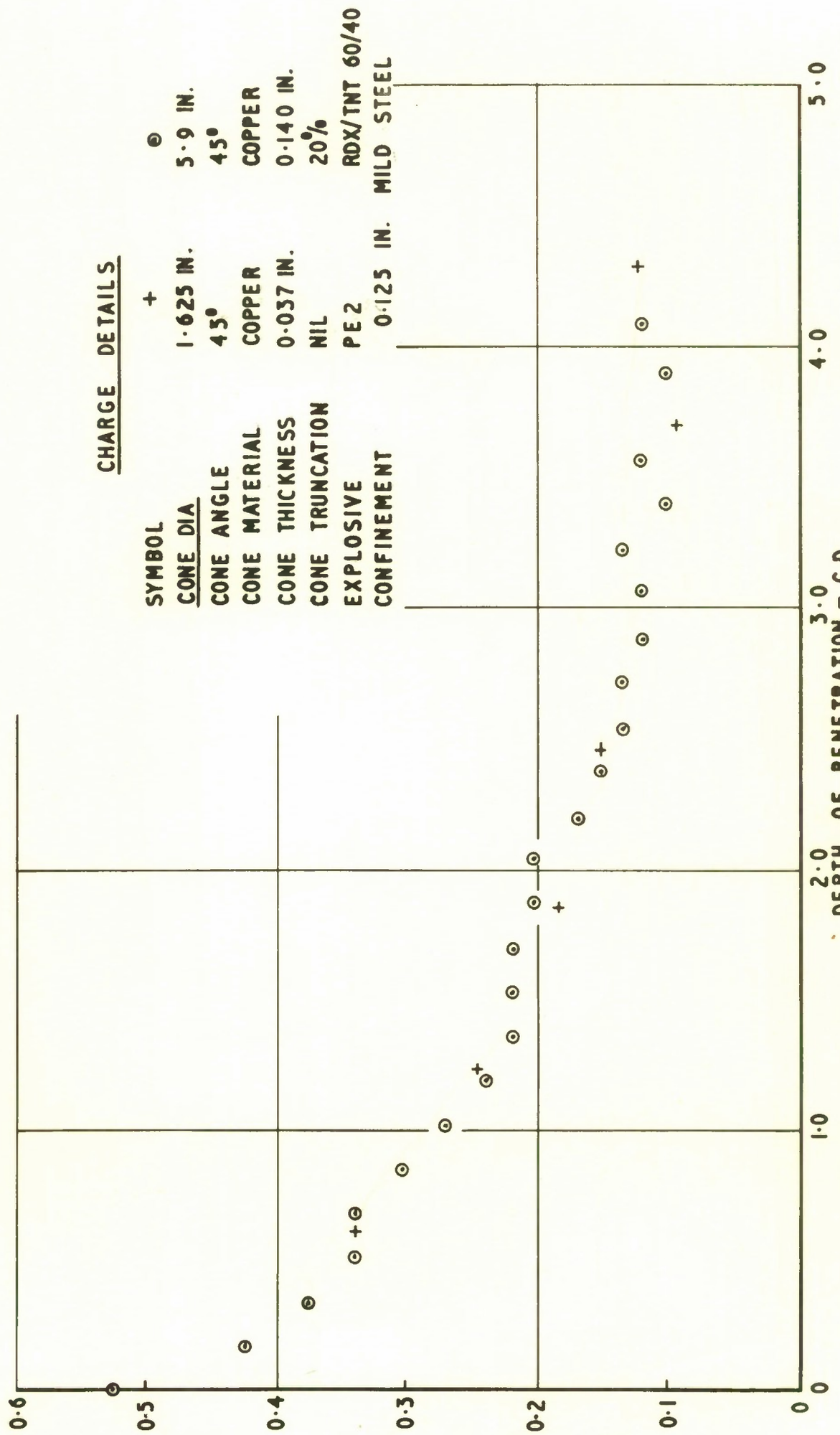


FIG. 12 CRATER DIAMETER VS DEPTH OF PENETRATION — SCALED BY CONE DIAMETER
TARGET R.H. ARMOUR

FIG. 13

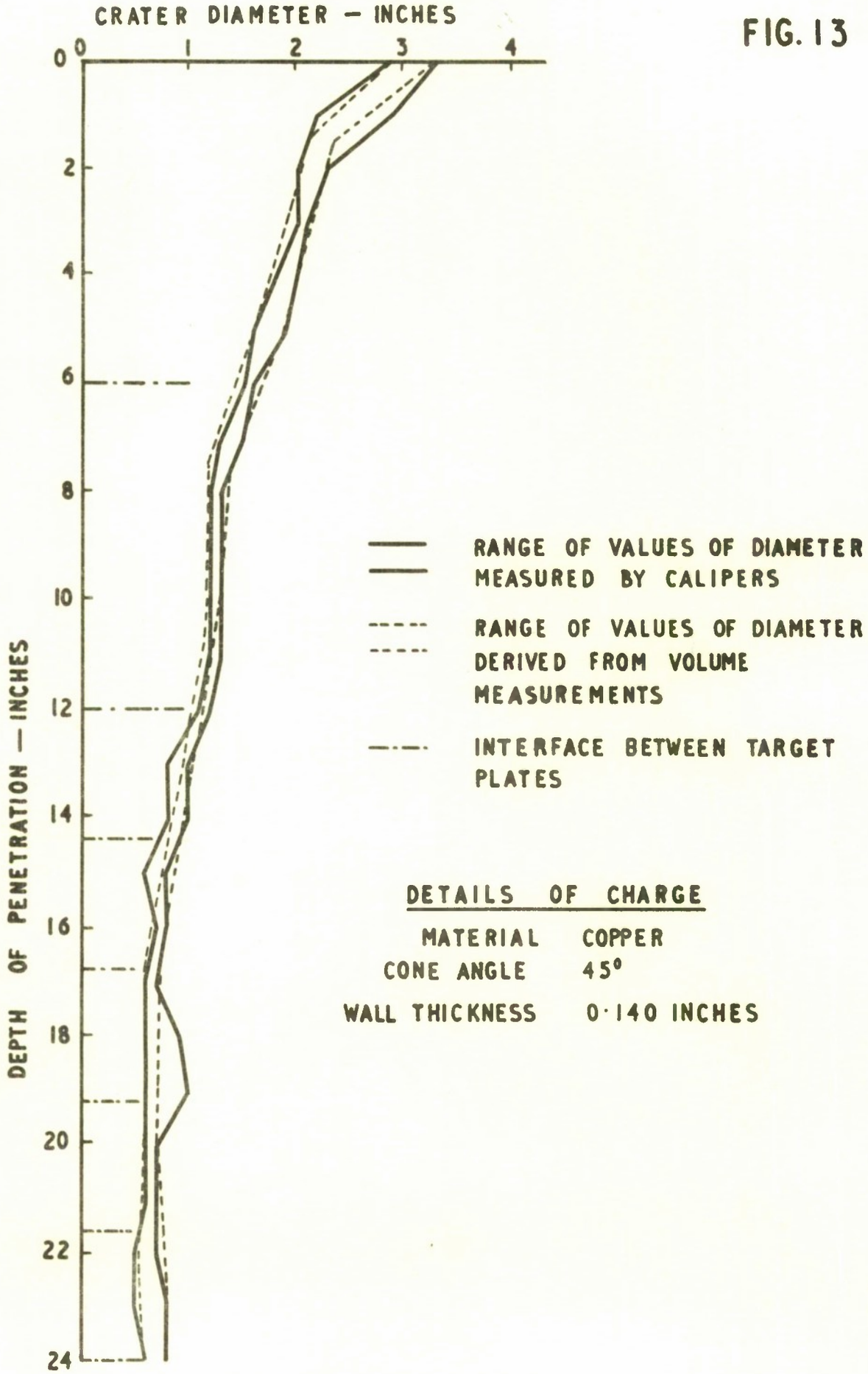


FIG. 13 COMPARISON OF CRATER DIAMETERS MEASURED BY CALIPERS AT 1 INCH INTERVALS OF PENETRATION WITH VALUES OF CRATER DIAMETER DERIVED FROM MEASUREMENTS OF CRATER VOLUME AT 3 INCH INTERVALS OF PENETRATION

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