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REPORT No. T.R 13

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THE EFFECTS OF DRIFT,
CROSSWIND AND BARREL WEAR
ON DISPLACEMENT OF H.E.S.H. SHELL
FIRED FROM THE 120mm. GUN
IN CONQUEROR

INVENTORY 1971
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Chobham Lane,
Chertsey,
Surrey.

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January
1958

USASGUK
CONTROL NO.

664201578
Reg # 12445

17617-57-001

(40)
557287

1. Guss, 120mm.

2. Guss panels,

I. HESH. Shells.

II. Wickland, C. J.

III. Project FV 214/FV. I. E.

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FIGHTING VEHICLES RESEARCH AND DEVELOPMENT ESTABLISHMENT, *SB*

COPY NO: 40
FILE NO: RFV/T/27/57

PROJECT NO: FV.214/FV.1.E
REPORT NO: TR.13

RESEARCH DIVISION

TRIALS GROUP REPORT

ON

THE EFFECTS OF DRIFT, CROSSWIND AND PARREL
WEAR ON DISPLACEMENT OF HESH SHELL FIRED
FROM THE 120 M.M. GUN IN CONQUEROR

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ABSTRACT

This Report describes further firings carried out to obtain information on the lateral and vertical displacements of HESH shell fired from the 120 m.m. gun in Conqueror.

Values are given for the lateral displacements due to drift and crosswind. A recommendation is made to compensate for the vertical displacement of the shell due to barrel wear.

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App. I.	DETAILS OF GUNS AND AMMUNITION.

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ORIGIN:

F.V.R.D.E. Research Trials Group.

1. INTRODUCTION

F.V.R.D.E. Report No. TR7 dated 20th February 1957, contains information on the effects of drift, crosswind and gun barrel wear on the lateral and vertical displacements of HESH Shell fired from the 120 mm. Gun in Conqueror. As only one gun was used during the trials, it was considered desirable to stage further trials using five other gun barrels in various stages of life. The results and recommendations given in this report are based on both sets of firings, i.e. six barrels.

2. TRIALS PROCEDURE

2.1 Five 120 mm. Gun barrels (one new and one in each of the four quarters of life) were used and series of HES Ammunition (10 rounds per series from the same batch) were fired as shown in Table 1.

Table 1.

Barrel life	Range (Yds.)			Remarks
	1000	1500	2000	
New	1	1	1	At 1000 yds. 1 series with Ch. temperature at 94° F, one other at 114° F
1st Qtr.	1	1	1	
2nd Qtr.	4	1	1	
3rd Qtr.	1	1	1	1 series at 1000 and 1 series at 1500 yd. with Ch. temperature at 90° F.
4th Qtr.	2	2	1	

N.B. Charge temperature was controlled at 70° F except where stated.

2.2 For all firings the guns were instrumented using the F.V.R.D.E. muzzle boresight and reference telescope technique, thus any effects of gun bend were eliminated. Muzzle velocity and the speed and direction of the wind were recorded during the flight of each round. Details of ammunition used and the measurements of each gun barrel are given in Appendix I.

3. RESULTS

3.1 Drift and crosswind

The positions of the mean points of impact have been plotted according to the speed and direction of the wind and they are shown in Fig. 1. A straight line through each set of points, fitted by the Method of Least Squares, gives the precise values shown in Table 2.

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Table 2.

Range (yd.)	Lateral displacement due to		No. of Series fired
	Drift (irs.)	Crosswind (ins./10 f.p.s.)	
1000	29.14	21.79	17
1500	53.67	53.36	14
2000	83.72	120.7	13

The differences between the old values (shown in Report TR.7) for drift and crosswind and those given in Table 2 above are shown in Fig. 2.

3.2 Vertical displacement of m.p.i. due to barrel wear

A plot of the mean points of impact of 24 series from Report TR.7 (1 gun) and 20 series from 5 guns fired in this trial, is shown in Fig. 3 where vertical displacement against barrel wear shows that using the angles of tangent elevation recommended it is possible to draw a straight line through each set of points with the same angle at the three ranges of 1000, 1500 and 2000 yds. This allows the use of the same simple method of compensating for barrel wear, which is to offset the sight datum (the zero range setting for HESH) according to the state of wear, as suggested in Report TR.7.

The angles of tangent elevation recommended are those found necessary midway through the first quarter of life. These together with the changes in tangent elevation found necessary to compensate for drop of the m.p.i. due to barrel wear are shown in Table 3 below and in Figure 4.

Table 3

Range (yd.)	Tangent elev. (min.)	Compensating Methods (1) and (2)
1000	29	(1) 0.8 min. per 0.05 in. of barrel wear measured at 1 in. C. of R. or, (2) 1.0 min. per quarter of barrel life.
1500	48	
2000	71.5	

Either of the two methods shown in Table 3 appears to give adequate compensation for barrel wear although in Method (1) the adjustments recommended are made a little more frequently. Even so, corrections in terms of quarter of gun life are probably more attractive to the User as these can probably be based on the number of full Service charge rounds fired¹ whereas Method (2) demands a knowledge of the bore diameter at 1 in. C. of R. which may not be readily available, particularly under battle conditions.

4. EFFECT OF CHARGE TEMPERATURE ON MUZZLE VELOCITY AND DISPLACEMENT OF M.P.I.

- 4.1 During the firings reported in Report TR.7 the average charge temperature was about 58°F varying from series to series from 50°F to 67°F. Subsequent to these earlier firings a heated ammunition wagon has been taken into use at Kirkcudbright and for these firings the charge temperature was controlled at 70°F (except where stated in Table 1). Using this charge temperature the firings of 15 series (3 from each of 5 guns in various stages of life) gave muzzle velocities as shown in Table 4.

¹Results from previous trials suggest that barrel wear due to firing HESH Shell is negligible.

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Table 4.

Firings with Charge at 70°F

Barrel Life	Bore dia. (ins) (mean at 1" C. of R.)	Total wear	Mean M.V. of 3 series	Total Spread
New	4.701	} 0.2 } inches }	2583	} 60 f.p.s. }
1st Qtr.	4.757		2574	
2nd Qtr.	4.784		2572	
3rd Qtr.	4.858		2541	
4th Qtr.	4.902		2523	

Further firings, with the gun in 2nd qtr. of life, and using charge temperatures up to 114°F showed an increase in the muzzle velocity from 2572 f.s. to 2585 f.s. The small difference (13 f.s.) was not reflected in the position of the mean points of impact of the series fired.

5. CONCLUSIONS

5.1 The results of firings of 44 series of HES (i.e. the inert filled) shell shows that:-

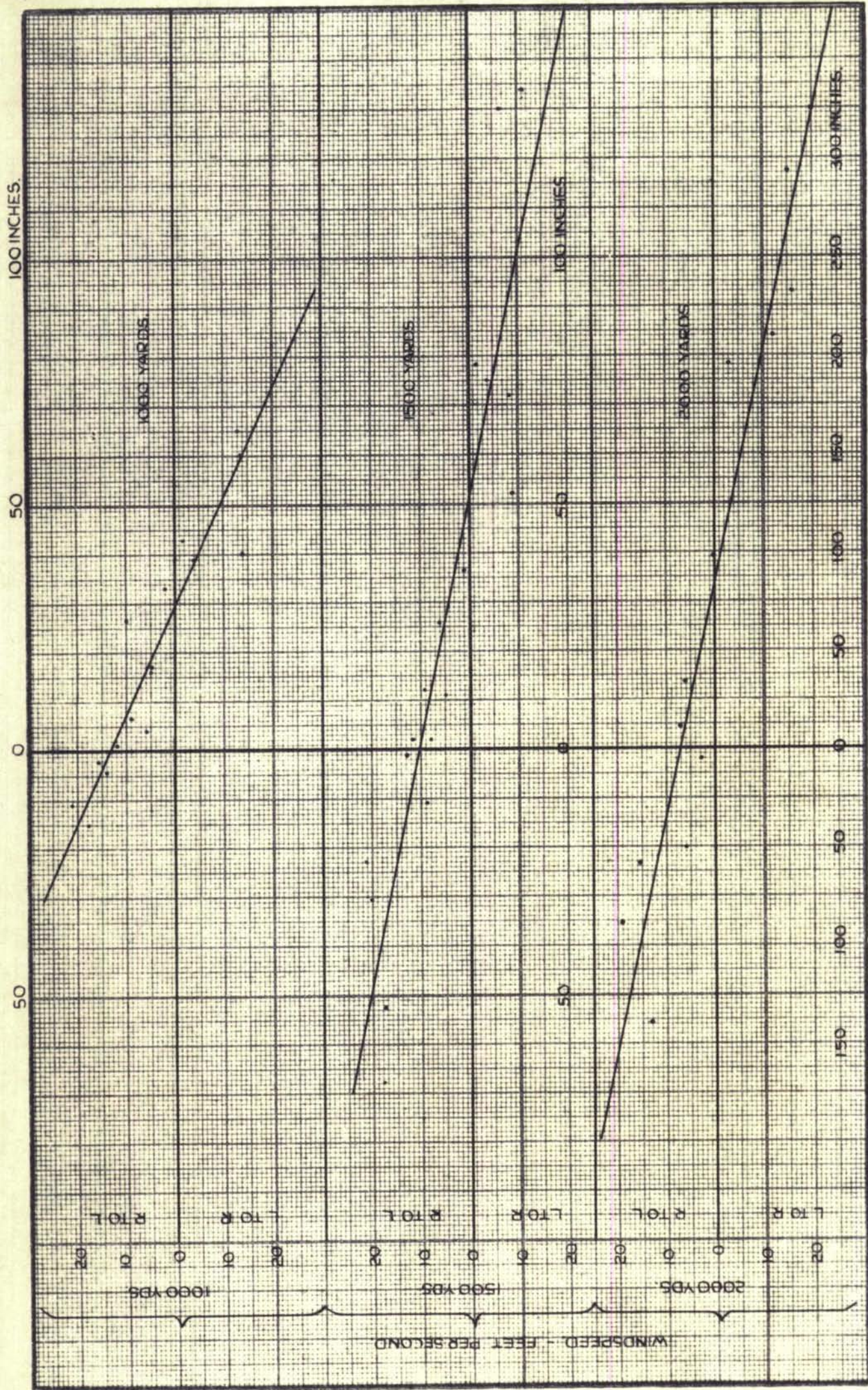
- (i) the lateral displacement of the HESH shell due to drift should be 29 inches at 1000 yd., 54 inches at 1500 yd. and 84 inches at 2000 yd.
- (ii) the lateral displacement of the HESH due to a 10 f.p.s. crosswind should be 22 inches at 1000 yd., 55 inches at 1500 yd. and 121 inches at 2000 yd.

These values supersede those given in the earlier Report TR.7.

5.2 The vertical displacement of HESH shell due to barrel wear (caused by firing AFDS shot) will, unless compensated, have a serious effect on the probability of hitting even when the range to the target is known accurately.

6. RECOMMENDATIONS

To compensate for the effect of barrel wear on the vertical displacement of HESH shell, it is recommended that the same principle be adopted as recommended in Report TR.7 excepting that the HESH range scale datum mark be modified by the addition of suitable markings below it, the markings representing a correction of 1.0 min per quarter of gun life. It may be more acceptable to the User if the cursor can be changed at the intervals suggested with the datum line opposite the HESH scale offset (stepped down) by the amount required. This should avoid possible confusion as to which line is to be used in the event of having several lines below the common datum line.



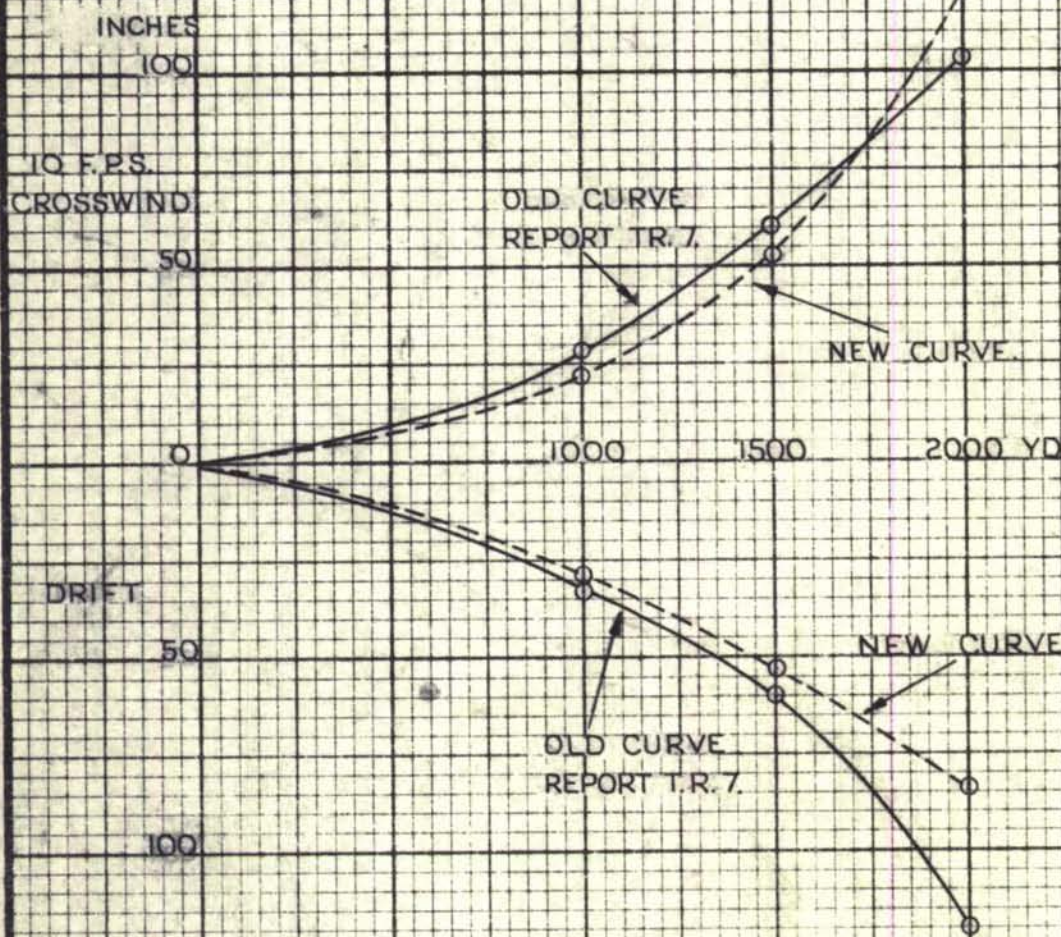
EFFECTS OF DRIFT AND CROSSWIND - H.E.S. SHELL

120^M. GUN IN CONQUEROR.

FIGHTING VEHICLES RESEARCH AND DEVELOPMENT ESTABLISHMENT.

REPORT N^o
T.R. 13

FIG. N^o 1.

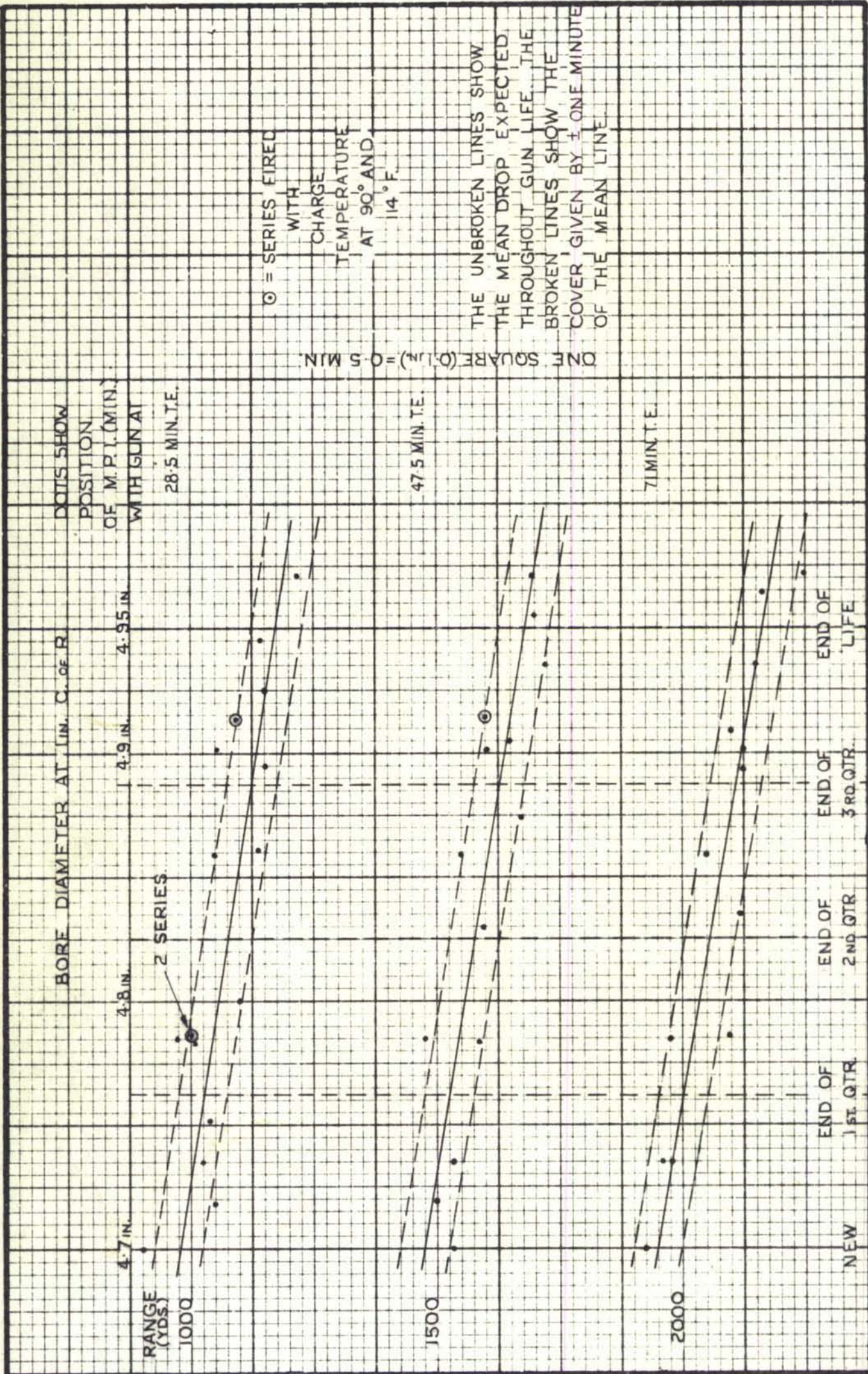


RANGE (YDS.)	DRIFT (INS.)	CROSSWIND (10 F.P.S.) (INS.)
1000	29	22
1500	54	53
2000	84	121

LATERAL DISPLACEMENT DUE TO DRIFT AND CROSSWIND.
(H.E.S. PROJECTILE).

120 MM. GUN IN CONQUEROR.

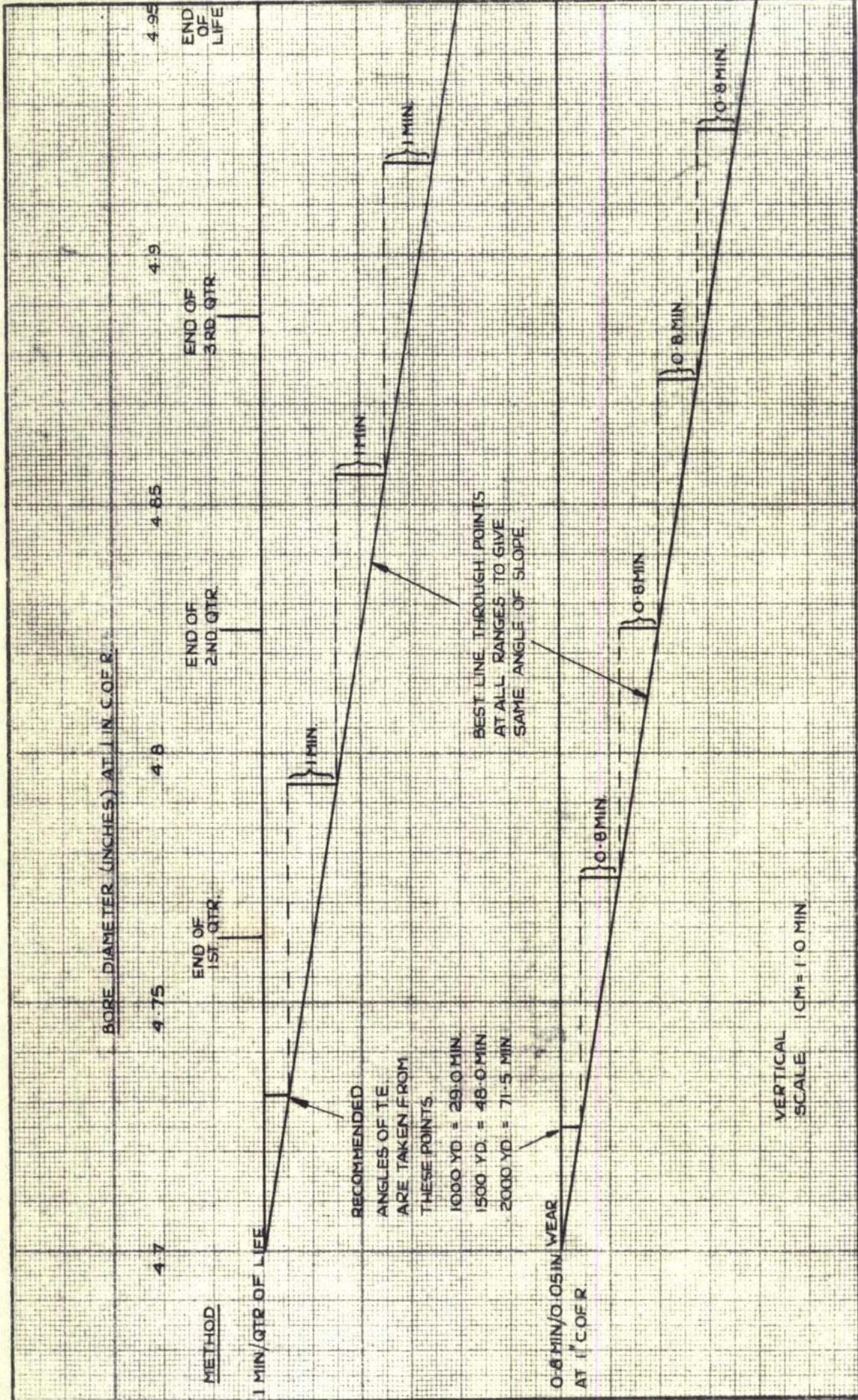
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DISPLACEMENT OF M.P.I. WITH WEAR OF GUN BARREL (H.E.S. PROJECTILE)

120 MM. GUN IN CONQUEROR.

REPORT N° T. R. 13



METHODS TO COMPENSATE FOR DROP OF H.E.S.H. SHELL DUE TO BARREL WEAR.

120 M/M. GUN IN CONQUEROR.

FIGHTING VEHICLES RESEARCH AND DEVELOPMENT ESTABLISHMENT.

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FIG. N° 4

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APPENDIX I

PARTICULARS OF GUN BARRELS

Barrel No.	Qtr. of life in which fired.	Bore dia. (in) 1 in. C of R.	No. of HES rds. fired.	Remarks
L/507	From new until end of life.	4.701 at start 4.974 at end of firing.	264.	Details from Report TR.7.
L/509	New	4.701	30	
L/60	1st Qtr.	4.737	30	
L/428	2nd Qtr.	4.784	60	
L/308	3rd Qtr.	4.858	30	
E/2001	4th Qtr.	4.902	50	

PARTICULARS OF AMMUNITION

120 m.m. shell. H.E.S. inert. CY 3-56

Shell Prac, L 1A3.

120 m.m. Cartridge For Shell Prac.

L 16A6 NH 033. Lot KA 924. CY 1/57.

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