THE SIGNIFICANCE OF THE FIGURE OF MERIT OF SMALL ARMS AMMUNITION IN RELATION TO THE PROBABILITY OF HITTING A TARGET

S.P. Datta, M.A. Khambete and M.G. Tamboli
Inspectorate of Armaments, Kirkee

(*Received* 28 *Mar.* 66; *revised* 5 *Aug.* 66)

An attempt has been made in this article to study the relationship between the F of M of 7·62 mm Ammunition and the probability of hitting a 12″ × 12″ stationary target (*i.e.* the size of the chest of a man), at ranges upto 500 yards. Firing trials have been carried out to varify the mathematically derived conclusions.

Accuracy Proof as prescribed for Small Arms Ammunition (SAA) consists of firing four series of twenty rounds each against four vertical square targets placed at 500 yards. The Figure of Merit (F of M) or the mean radial deviation is calculated separately for each target; the mean of four targets which is taken as the F of M is thus a quantitative evaluation of the performance of the ammunition and the weapon. F of M is measured radially in inches at 500 yards. The less its value, the more is the probability of the bullets hitting the target. The probability of hitting a standing man at 300 yards with ammunition of F of M of 6·5″ from a fixed rifle is about 0·86. If it is proposed to raise it to 0·98 we must raise the acceptance quality of 7·62 mm. ammunition to a F of M of 4·0″ as against the present Indian acceptance standard of 6·5″.

FIGURE OF MERIT

In small arms shooting, an error in any direction is equally likely as the horizontal and the vertical dispersions are equal. While proving (SAA) no separate deviations are determined for the horizontal or the vertical dispersion. Instead, the distances of each round from the mean point of impact (MPI) are measured. The MPI is obtained by finding the horizontal and vertical distances from some datum. The deviations of each round measured from the MPI are known as residuals. The mean of these residuals is known as the mean radial deviation or the Figure of Merit (F of M) and is denoted by ϵ. The circle with centre at the MPI having radius ϵ represents the 54·41% probability zone, *i.e.* the chance of a shot falling in such a circle is ·5441 *i.e.* on the assumption of the Gaussian Distribution for these radial distances.

RELATIONSHIP BETWEEN THE DISTANCE (TO THE TARGET) AND THE FIGURE OF MERIT

An application of simple geometric considerations to the Fof M indicates that it should generally vary directly with the distance from the firing point to the target. The F of M for 7·62 mm ammunition lots are determined at 500 yards. Firing trials were carried out to determine the relationship between (*a*) the computed F of M for distances less than 500 yards and (*b*) the F of M obtained by actual firing trials, at those distances.

Table 1 presents the two sets of values thus obtained. It will be seen that the F of M is fairly directly proportional to the distance and that the computed values agree fairly closely with the values obtained at the firing trials.

Relationship between observed F of M and its calculated observed probabilities of hitting a 12″×12″ *target*

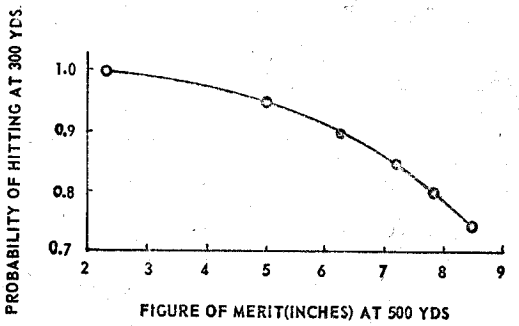
Two trials were carried out by firing twenty rounds series from a barrel mounted on a fixed stand. The target (12″×12″) was so placed as to ensure that its centre coincided with the MPI. The data obtained at these two trials carried out at two different occasions, is given in Table 2. The calculated and observed values for the probability of hit are very close indeed.

TABLE 1
FIGURES OF MERIT FOR 7·62 MM AMMUNITION FOR DIFFERENT RANGES

Range (yd.)	Experimental value (in.)	Calculated value (in.)	Experimental value (in.)	Calculated value (in.)
	Firing Trial I		*Firing Trial II*	
500	6·6	6·6	6·1	6·1
400	4·9	5·3	4·1	4·9
300	4·2	4·0	3·7	3·7
200	2·7	2·7	2·2	2·4
100	1·5	1·3	1·6	1·2

TABLE 2
COMPARISON OF EXPECTED AND OBSERVED PROBABILITY OF HITS

Range (yd.)	Observed F of M At 500 Yds. (in.)	Calculated Probability of Hit (Proportions)	Observed Hit (Proportions)	Observed F of M At 500 Yds. (in.)	Calculated Probability of Hit (Proportions)	Obsered Hit (Proportions)
		Firing Trail I			*Firing Trail II*	
500	6·6	0·548	0·55	6·1	0·608	0·65
400		0·768	0·75		0·865	0·80
300		0·846	0·85		0·921	0·95
200		0·980	0·96		0·998	1·00
100		1·000	1·00		1·000	1·00



Fsg. 1—Probability of hits with different ammunitions.

It is evident from the data given in Table 2 that the chance of hitting a stationary man with the current outturn 7·62 mm. ammunition (*i.e.* F of M 6·5″ at 500 yd.) falls rapidly with the increase in the range after 200 yd. While at 200 yd., we can expect almost every round to hit the stationary man, at a distance of 500 yd. 50% of the rounds will fail to hit him. The probability of hit decreases with an increase in the value of F of M. Relationship of the theoretically calculated probability of hits on a stationary target of size 12″×12″ at 300 yd. with different ammunition lots having F of M upto 8″ has been shown graphically in Fig. 1. The F of M required theoretically for a desired probability of hit can be easily determined from the graph. For example to ensure a probability hit of ·98 on a 12″×12″ stationary target at a distance of 300 ydr the ammunition lot must have a F of M of 4·0″. These theoretically calculated values are supported by the experimentally observed values as shown in Table 1. Most of the lots of 7·62 mm. ammunition imported from Australia, UK and USA have a F of M of 4·0″.

THE PROBLEM OF HITTING A MOVING TARGET

If a man target (12″×12″) is moving in the direction of the line of aim, it won't cause any displacement from the line. If he is moving at right angles to the line of aim, it will cause the maximum displacement from the line. Let us imagine that it is running at a speed of 100 yd. per 15 sec. at right angles to the line af aim, at a distance of 200 yd. from the firer. The bullet will take about 0·2 sec. to reach the target at 200 yd. During this interval, the man target would have moved 1·3 yd. say from the line of aim. Unless a suitable correction is made for this displacement by the firer, by suitably off-setting his line of aim, the chance of hitting a running man at 200 yd. with ammunition of F of M of 6·5 is very remote.