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AMSTE-TA

1 April 1966

IMPROVED PERFORMANCE OF AMMUNITION FOR THE M16 RIFLE

1. In the early and mid 1950 era, Department of the Army, R&D, sponsored a small in-house program at D&PS, APG, that eventually paved the way for the present 5.56mm - M16E1 combination. The program embraced two cal. .223 (5.56mm) cartridges along with improvised rifles to test ammunition performance. The first cartridge used a shortened version of the present 5.56mm cartridge case and was designed to fire in a modified cal. .30, carbine, M2. In its final configuration, this cal. .223 carbine fired a 41-grain, flat-base bullet at a muzzle velocity of 3100 feet per second. The second cartridge used a 7.62mm NATO cartridge case necked down to .223, and an experimental Army rifle was modified for the cartridge. In the final version, this cartridge fired a 68-grain boat-tail bullet at 3400 feet per second.

2. Rather complete performance characteristics of both cartridges were established, and rifle-ammunition capabilities were evaluated in both semi- and full-automatic fire. With the information available from these tests, it was possible to state with a high degree of certainty that a rifle-cartridge combination could be designed in cal. .223 (5.56mm) that would be more effective against personnel than the standard 7.62 mm on a "weight" basis. However, the climate within Army using forces in the mid 1950 era was not such that a requirement for a light-weight, small-caliber weapon could be stimulated. The overall recommendation resulting from the D&PS work was to "design and evaluate" a weapon and cartridge which would replace the M2 cal. .30 carbine, the cal. .45 submachine gun, and some applications of the M1 rifle. The cartridge thus recommended was to use a 55 grain boat-tail bullet at a velocity of about 3250 feet per second. The rifle had recommended characteristics, weight, and shape almost identical to those of the present M16. The present standard 5.56mm ammunition is almost identical to that recommended by D&PS in 1954.

3. The performance characteristics, recommended at D&PS for the rifle-ammunition combination, were optimized toward personnel targets at close and medium range -- 0 to 500 yards. The present M16 has been proved an excellent weapon, both in tests and in combat, for its intended use. This lightweight weapon and cartridge combination has been so popular in Viet Nam that it has, in effect, caused a shut down in production of the M14 rifle with its more powerful long-range cartridge. Large quantities of the M16 rifle have been ordered and much larger quantities are rumored for future orders. When issue density of M16 becomes high, consideration as an all-purpose rifle is forced upon us.

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Also, the M16 with a bipod and a slightly heavier barrel can be used as a squad-level automatic weapon. Squad automatic weapons characteristically have been used for heavier fire power roles than the rifle and, therefore, should fire a cartridge with good long-range (500 - 2000 yard) performance. With the strong probability of M16 use extending beyond the Viet Nam conflict to at least limited world-wide application, a cartridge of better long-range performance is required.

4. ⁽⁻⁰⁰⁰⁾ Performance of the present 5.56mm cartridge can be improved considerably by changing from the present 55-grain bullet to the 68-grain bullet previously used by D&PS. Long-range capability of the heavier bullet, in the present 5.56 cartridge case, makes it about equal in lethality to the 7.62mm NATO ball round or the cal. .30 ball, M2 used in the M1 rifle at all ranges. The 68-grain bullet is better, against all targets at all ranges, than the present 5.56mm bullet. In only one characteristic is the heavier bullet slightly inferior -- it has 13% more recoil. This slight increase is hardly noticeable, but it would probably cause a slight increase in burst-fire dispersion. The only change required in the rifle is to use a barrel rifling twist of one turn in 9 inches, instead of the one-in-twelve twist now used. Present ammunition could be used in the new barrels, but the proposed bullet would be unstable in the barrels now in use. For the sake of economy, it would be wise to make an early determination regarding the proposed bullet so that weapons to be produced could have the proper rifling.

5. A bullet drawing is attached as Inclosure #1. This is the bullet used to gather the test data in this study. In order to seat the bullet to the proper depth for a cartridge overall length of the present M193, it causes the crimping cannellure to be seated below the case mouth. A circumferential crimp at the proper location on the case neck, as is done with some U. S. commercial and foreign military cartridges, can be used. If this technique is not desired, the bullet can be slightly modified to move the crimp forward for crimping at the case mouth as is done with most U. S. military small arms cartridges.

6. The performance characteristics summarized in the following paragraphs are primarily aimed at showing comparative values between the present 5.56mm cartridge, with its 55-grain bullet, and a proposed cartridge with a 68-grain bullet. However, where comparative values are available for the 7.62mm ball cartridge used in the M14 rifle, or the cal. .30 ball M2 round used in the M1, these figures will be shown.

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7. A velocity and energy vs. Range comparison of the present 5.56mm cartridge, the cal. .30 ball, M2, and the proposed 68-grain ball in the 5.56mm cartridge case is shown below.

RANGE YARDS	VELOCITY F.P.S.			ENERGY FT LB		
	5.56mm	Cal..30 Ball	68-gr.223	5.56mm	Cal..30 Ball	68-gr.223
0	3250	2796	3000	1265	2653	1370
100		2580	2760		2258	1160
200		2364	2528		1896	974
300	2104	2153	2300	540	1573	806
400		1949	2087		1289	664
500		1753	1881		1043	540
600	1210	1568	1692	178	834	436
700		1396	1522		661	354
800		1239	1373		521	288
1000	843	1031	1238	87	361	233
1500		731	935		181	133
2000		496	749		83	86
2500	330		603	13		56

The superior ballistic shape of the 68-grain bullet causes it to "catch" the 55-grain bullet, which starts 250 f.p.s. faster in about 150 yards; from that point it has a decided velocity advantage. With respect to remaining energy, the proposed 68-grain bullet at 2000 yards is equal to the cal. .30 ball, M2, and both are as good at 2000 yards as the present 5.56mm bullet is at 1000 yards.

8. The proposed 68-grain bullet is superior in penetration of all media at all ranges to the 55-grain 5.56mm standard bullet. It is generally equal to or superior to the cal. .30 ball, M2 round in penetrating media such as pine board, helmets, body armor, and thin armor plate at all ranges.

9. The trajectory of the 68-grain bullet, loaded in the present 5.56 cartridge case, is much flatter at all ranges beyond 200 yards than is the present M193 5.56mm with its 55-grain bullet. The proposed bullet has a flatter trajectory than does the cal. .30 ball, M2, at all ranges. It is greatly superior beyond 1000 yards.

10. The 68-grain bullet has much less wind drift at all ranges than either the 5.56mm or the cal. .30 ball, M2.

11. The average dispersion of the 68-grain bullet, compared with the cal. .30 ball, M2, are shown in inches @ 600 yd (5 10-shot groups).

AMMO TYPE	MEAN RADIUS	MEAN VERTICAL	MEAN HORIZONTAL	EXTREME VERTICAL	EXTREME HORIZONTAL	EXTREME SPREAD
Cal..30 Ball, M2	5.4	3.3	3.7	12.6	14.4	17.5
68-gr .223	3.1	2.4	1.6	8.7	6.7	10.0

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A very rough figure of merit could be drawn for comparison between the two 5.56mm cartridges since they are used in the same weapons. However, because the cal. .30 ball, M2, is twice the weight of the other cartridges and its weapons are much heavier, a figure-of-merit comparison would be less valid. The desirability of each cartridge as reflected in the figure of merit would be the inverse of the number. That is, like in golf, the lower the number, the better the score.

15. The figure of merit, based on cartridge performance and physical characteristics is so heavily in favor of the proposed bullet that an early investigation is recommended.

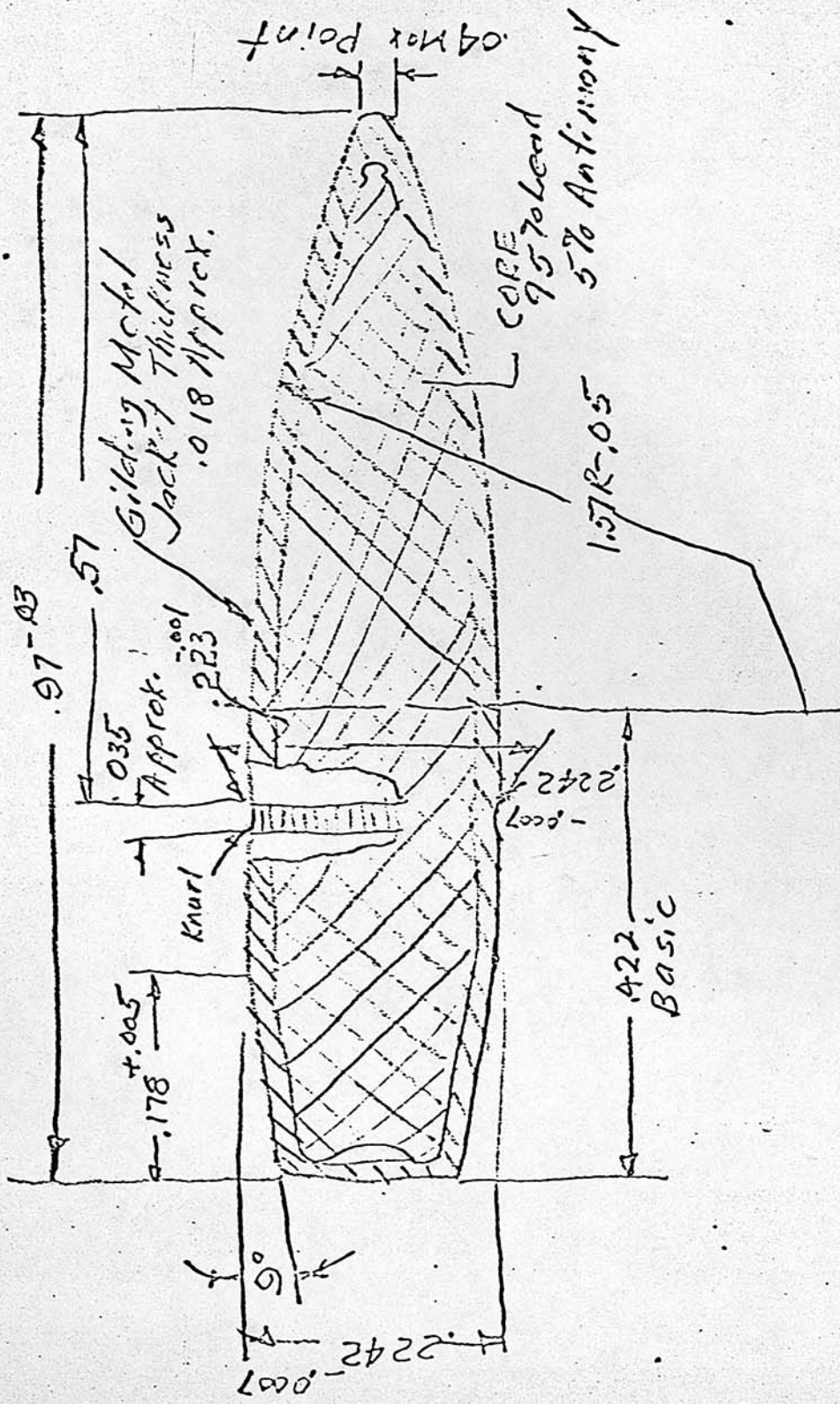
16. It is further recommended that 50,000 bullets of the type shown in Inclosure 1 be purchased from Sierra Bullets, Santa Fe Springs, California, for loading in present 5.56mm cartridge cases. A ball-type propellant for the 7.62mm, Ball, M80, was used to give approximately 3000 ft per second at the muzzle at a pressure of 50,000 p.s.i.. Pressures and velocities near the muzzle can be established in present 5.56mm pressure barrels, even though the bullets are unstable a short distance from the muzzle in the 12"-twist barrels.

17. At least five M16E1 rifles should be fitted with barrels having a rifling twist of one turn in 9 inches. The five rifles and 50,000 rounds of ammunition can be used to establish both engineering- and user-type performance of the proposed cartridge.

- 1 Incl
1. Drawing of Proposed
Bullet

G. A. GUSTAFSON
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Test Analysis and Operations Office

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Caliber .22 Bullet
 Approx wt. 68gr.