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LAUNCH CHARACTERISTICS OF THE M-193 (BALL) AND M-196 (TRACER) PROJECTILES FROM THE XM177E2 SUBMACHINE GUN

by

Maynard J. Piddington

September 1968

U.S. ARMY ABERDEEN RESEARCH AND DEVELOPMENT CENTER
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ABERDEEN PROVING GROUND, MARYLAND

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BALLISTIC RESEARCH LABORATORIES

MEMORANDUM REPORT NO. 1938

SEPTEMBER 1968

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B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

MEMORANDUM REPORT NO. 1938

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Aberdeen Proving Ground, Md.
September 1968

LAUNCH CHARACTERISTICS OF THE M-193 (BALL) AND M-196 (TRACER) PROJECTILES FROM THE XM177E2 SUBMACHINE GUN

ABSTRACT

The XM177E2 submachine gun was used as a launch device to gather exterior ballistic behavior data on the M-193 (ball) and M-196 (tracer) projectiles. Various lots of ammunition and suppressors were used in the tests. Some preliminary results of these tests are presented and discussed.

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1. INTRODUCTION

The Project Manager-Rifles, at the request of the Commanding General, AMC, requested an effectiveness study and evaluation comparing the XM177/XM177E1 submachine gun (SMG) with the M16/M16A1 rifle.

The Exterior Ballistics Laboratory (EBL) of the Ballistic Research Laboratories (BRL) initiated its phase of the testing in January of 1968. By then, however, the SMG had become the XM177E2 so that the testing was done with the latter weapon. The XM177E2 SMG was in great demand, however, so that only a barrel with suppressor was available for the EBL tests. From the exterior ballistics point of view, the barrel with suppressor was all that was required to obtain pertinent information on the XM177E2 weapons system. For testing purposes the barrel was installed on the M16A1 rifle action and placed in a Frankford rest for test firing in the small Aerodynamics Range at BRL.

It had initially been planned to test the weapon at various temperatures, either at Aberdeen or at Eglin Air Force Base, Florida, but as early phases of testing were completed it became increasingly obvious from preliminary results that such additional exterior ballistics tests would not add significantly to the results.

It was also initially planned to test only the lot of ammunition that had been used for tests with the M16A1 rifle, but this plan was expanded to include 4 lots which Development and Proof Services (D&PS) had used in tests of other XM177E2 weapons. Identification of these various lots are given in Table 1.

Table 1: Projectile Description

Type	Lot No.	Propellant	Projectile
A	LC12081	Ball	M-196
B	TW18007	IMR	M-196
C	LC12194	Ball	M-193
D	TW18191	IMR	M-193
E	LcSp412	Ball	M-193

As testing progressed, it became quite apparent that the suppressor had a significant influence on the flight behavior of both the M193 and M196 projectiles. To investigate this phenomenon further, two additional suppressors were obtained from D&PS. Thus, three suppressors were used in the tests, signifying various lifes of the weapon. The suppressors had approximately 1000, 3100, and 9200 rounds of ammunition fired through them prior to the EBL tests. Figure 1 is a photograph of one of the suppressors. The ammunition was ball or tracer, each with ball or IMR propellant.

After all of these changes to the original test plan had been completed, the following tests were performed:

(a) Ten rounds of each lot of ammunition were fired through each suppressor and data necessary to obtain the following information were recorded:

1. Dispersion
2. Initial maximum yaw
3. Stability factor
4. Muzzle velocity

Two rounds of each group launched through the 1000 round suppressor had the extended photographic coverage needed to determine additional aerodynamic characteristics.

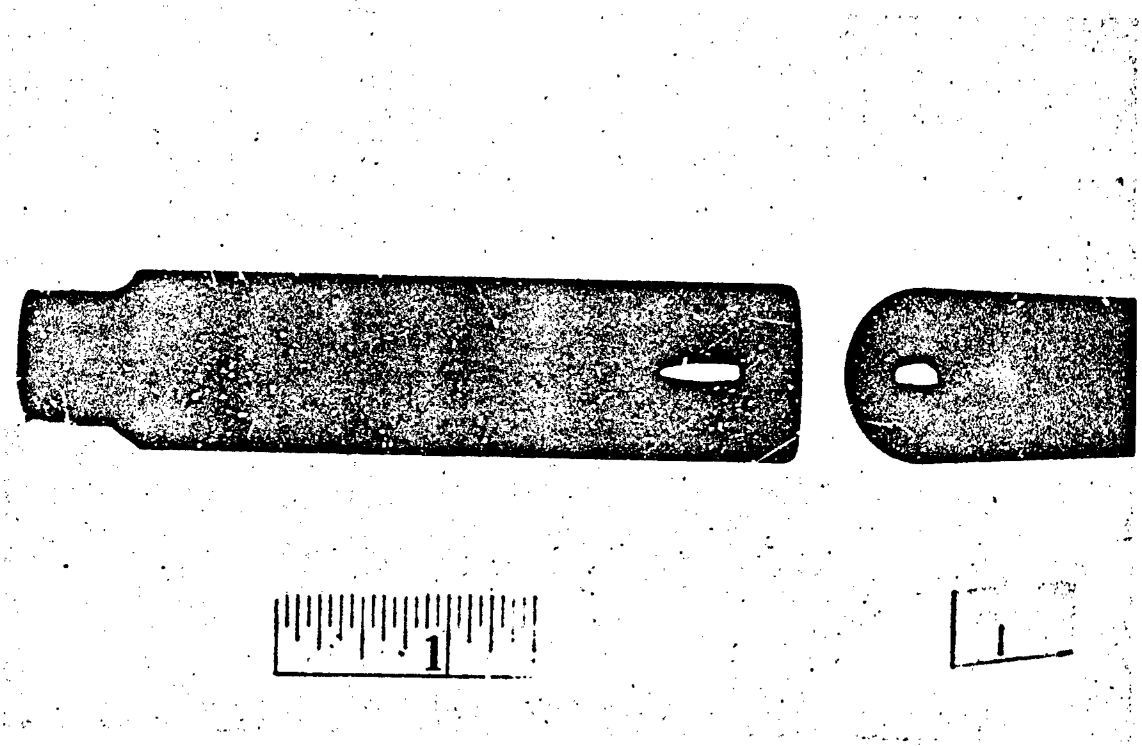

Figure 1. Suppressor

(b) For comparison, ten rounds of each lot of ammunition were launched from the barrel without a suppressor.

Although the above firing tests have been completed, the data have not been fully analyzed. The Project Manager-Rifles, however, requested that whatever data are at hand from these tests, however preliminary, be submitted prior to 1 June 1968 for availability at an IPR (In Progress Review) meeting scheduled at about that time.

Thus, this report is a compilation of some early results of these tests, with some observations and predictions. A more comprehensive report will follow at a later date.

2. RESULTS

2.1 Dispersion

Dispersion data were obtained from target cards placed in the range. The results are presented in Table 2. Dispersion, σ, was computed from the definition:

$$\sigma = \sqrt{\frac{\Sigma R^2}{N-1}}$$

where R = deviation from the center of impact and N = number of observations.

The values of σ are about the center of impact and do not relate in any manner to the aiming point. It was observed, however, that the center of impact shift was quite significant in some cases. For example, the shift from no suppressor to the 9200 round suppressor appeared to be about 60 centimeters at 73 meters from the muzzle (approximately 9 mils).

Table 2: Initial Yaw and Dispersion Results

Type	A	B	C	D	E
Without suppressor					
δ_o (deg)	4.3	4.8	4.0	3.8	5.2
σ (mils)	.38	.55	.36	.26	.30
With 1000 round suppressor					
δ_o (deg)	7.7	7.1	8.2	5.9	9.4
σ (mils)	1.24	1.06	.43	.52	.76
With 3100 round suppressor					
δ_o (deg)	13.2	14.1	17.6	13.4	16.3
σ (mils)	2.86	1.99	.65	.71	.89
With 9200 round suppressor					
δ_o (deg)	20.1	18.7	19.1	16.4	18.3
σ (mils)	2.35	1.79	.97	.72	.87
M16A1 (1 in 12-inch twist)					
δ_o (deg)					5.9
σ (mils)					.37

The data indicate an increase in dispersion with an increase in the number of rounds fired through the suppressor for all lots of ammunition. When no suppressor was used, σ was of the same order of magnitude as obtained from the M16A1 rifle.

The dispersion of the tracer rounds is considerably larger than the dispersion of the ball ammunition when any suppressor was used. The difference is not as pronounced when no suppressor was used.

It should be noted that all values of σ are based on 10 round samples; 10 observations are not a good statistical sample but should give adequate approximations for comparative purposes.

2.2 Initial yaw

The initial maximum yaw, δ_o, was obtained from uncorrected measurements of the photographic plates placed at the position of the expected maximum yaw (1.5 meters from the muzzle). Average δ_o values of the 10 round samples are listed in Table 2. It can be seen that in general as more rounds were launched through the suppressor the initial yaw became larger and larger. The minimum δ_o occurred when the rifle was fired without a suppressor.

There does not appear to be a significant difference in δ_o between the M-193 and the M-196 projectiles. It should be noted, however, that all firings were made from a cold weapon (at least 15 minutes between shots). There is no reason to expect that the same results would occur had the weapon been preheated prior to launching a test round.

The dispersion characteristics and the initial maximum yaw are interrelated and by examining the yaw characteristics one can get an indication of what will happen to the dispersion. For example, examination of the magnitude and orientation of the first maximum yaw indicates that the projectile is very biased in its direction of jump (not necessarily in the same direction as its yaw orientation). This indicates that the dispersion about its center of impact is considerably better than if the initial yaw orientation had been random. This in turn means that in addition to its other functions the suppressor is serving as a yaw inducer.

Figure 2 is a plot of δ_o and its orientation for one lot of ammunition (all lots are about the same). It is interesting that the orientation of yaw is not the same for each suppressor. It is not known whether a new rifle and suppressor would produce the same yaw orientation throughout its life span (it would be an interesting test to conduct).

2.3 Stability factor

The gyroscopic stability factor, s, is normally determined from a series of yaw measurements taken from a number of photographic stations. Except for a few rounds, this has not yet been completed. For the completed rounds, s was determined to be 1.40 and 1.68 for the M-193 and M-196 projectiles, respectively. The M-196 projectile was not tested previously from the M16A1 rifle so no experimental comparison can be made between the two weapons. s for the M-193 projectile, when fired from the M16A1 rifle (1:12 inch twist) was about 1.45.

s values of 1.40 and 1.68 signify ample stability at the normal air density condition. These values reduce to about 1.05 and 1.26 for the more dense air condition (-54°C; standard sea level pressure), still indicating gyroscopic stability. However, rounds with s = 1.05 are dangerously close to the instability region and if one

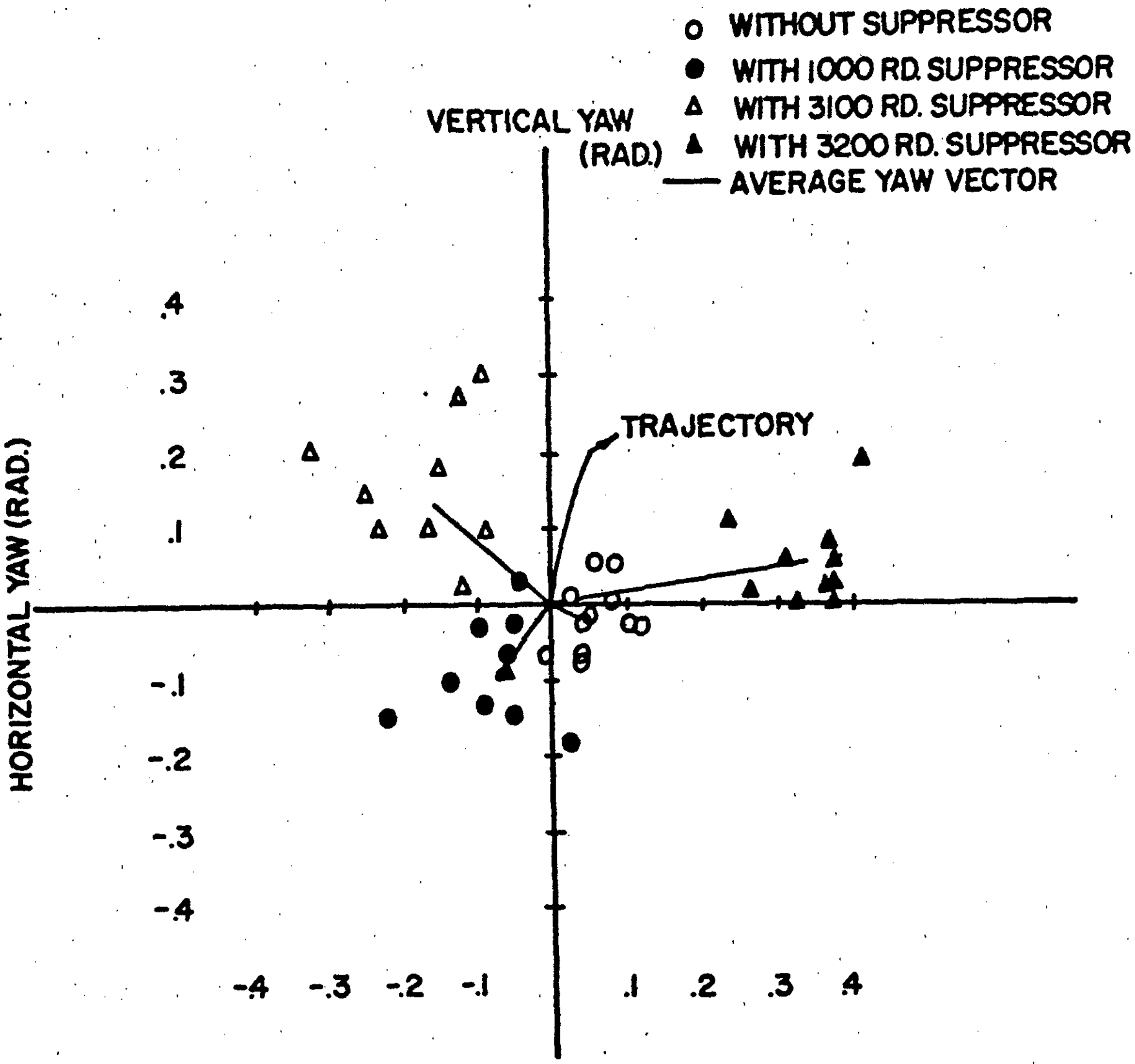

FIG. 2 MAGNITUDE AND ORIENTATION OF THE FIRST MAXIMUM YAW FOR TYPE A PROJECTILE

applies a 10 percent variability factor to this value some rounds will become gyroscopically unstable, resulting in further increased initial yaw and dispersion. This effect was barely noticeable with the 1:12 inch twist M16A1 rifle but should become more obvious with the XM177E2 SMG when tested at -54°C. The degree of increase in yaw and dispersion is not known at this time.

2.4 Muzzle velocity

The muzzle velocity, although not yet well known, appears to be on the order of 865 m/s for both M-193 and M-196 projectiles.

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