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UNITED STATES ARMY INFANTRY BOARD

FORT BENNING, GEORGIA

REPORT OF PROJECT

APR 13 1960

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PROJECT NR 2876

DATE 18 Mar 60

Evaluation of Single Flechette (M Project 504-05-002) (II)

TABLE OF CONTENTS ATTACHED AS A FOLD-OUT TO BACK COVER

[REDACTED]

HEADQUARTERS
UNITED STATES COMBAT ARMY COMMAND
Fort Monroe, Virginia

ATDEV-3 474/2(S)(12 Apr 60)

12 April 1960

SUBJECT: US Army Infantry Board Report of Test of Project Nr 2876,
Evaluation of Single Flechette (DA Project 504-05-002) (U)

TO: Chief of Research and Development
Department of the Army
Washington 25, DC

APR 1960

UNCLASSIFIED
DATE 10/1/00 BY [REDACTED]

1. (U) Reference is made to:

a. Letter, CRD/D 15638, Office, Chief of Research and Development, Department of the Army, 17 November 1959, subject: "Development of All-Purpose Hand-Held Weapon (U)."

b. Message, ATBC 12-101, US Army Infantry Board, 23 December 1959. (SECRET) (NOTAL)

2. (U) A copy of subject report is inclosed.

3. (C) This headquarters concurs with the conclusions of the President, US Army Infantry Board, at paragraph 7 of the inclosed report, and approves the recommendations at paragraph 8.

4. (C) This headquarters recommends that development of the Single Flechette be continued and directed toward, but not limited to, the correction of deficiencies listed in annex B of subject report, and that the improved ammunition be submitted to the US Army Infantry Board for further tests.

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[REDACTED]

5. (U) It is requested that this headquarters, ATTN: Deputy Chief of Staff for Materiel Developments, be advised of action taken on above recommendation.

FOR THE COMMANDER:

William A. Keil
WILLIAM A. KEIL
Major, AGC
Asst Adjutant General

1 Incl
Rept of USA Inf Bd,
Proj Nr 2876,
18 Mar 60, W/anx A-D

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UNITED STATES ARMY INFANTRY BOARD
Fort Benning, Georgia

18 March 1960

REPORT OF PROJECT NR 2876
EVALUATION OF SINGLE FLECHETTE
(DA PROJECT 594-05-002) (U)

1. (U) AUTHORITY.

a. Directive. Ltr, ATDEV-3 474/15(C) (12 Oct 59), Hq USCONARC, 12 Oct 59, subject: "Evaluation of Single Flechette (U)."

b. Purpose. To determine whether the single flechette has sufficient military value under temperate weather conditions to warrant further development.

c. Scope. The United States Army Infantry Board conducted the temperate phase of this project. The United States Army Arctic Test Board will conduct the arctic phase of this project. No airborne phase is planned.

2. (U) REFERENCES. (Annex D.)

3. (C) DESCRIPTION OF MATERIEL.

a. Test. Cartridge, .22 Caliber, Arrow, Lot Nrs 6A, 7, 8, and 9, hereinafter referred to as the test item (Annex C), contains a 10 grain, arrow-shaped, steel projectile (called a flechette) that has a length of 1 1/4 inches and a body diameter of .072 inches. At the rear of the cartridge there is a moveable primer piston (Annex C). When the weapon is fired, the firing pin strikes the piston and drives it forward, setting off the primer, which in turn sets off the propellant. Expanding gases cause the primer piston to be driven to the rear where it strikes the face of the bolt with sufficient force to actuate the gun mechanism. (This type of gun mechanism was not furnished for this evaluation.) At the same time, the sabot with flechette is pushed from the cartridge case into the bore of the weapon. The flechette is then pulled through the bore by the magnesium, four-section sabot which grips the forward half of the flechette (Annex C). At the muzzle the sabot-flechette assembly is given a high rate of counter-clockwise spin by a rifled section known as the stripper. The centrifugal force thus created as this assembly leaves the barrel causes the four quarter sections of the sabot to separate from the flechette, leaving a "clean" projectile. The muzzle velocity of the flechette is approximately 4600 fps. The rifles used to fire the test ammunition in this evaluation were bolt-action Winchester Model 70's, modified and re-barreled to accept the .22 caliber single flechette round. Other modifications made to the weapon were: (1) Substitution of a special bolt to absorb the force of the primer piston, (2) Substitution of a smooth bore, and (3) Addition of a stripper on the end of the barrel. The stripper has four teeth similar to the lands in a standard barrel. These stripper teeth

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B-1837

have a 5° counter-clockwise cant which imparts spin to the sabot.

b. Control. No control ammunition, in the usual sense, was used during this evaluation. However, when appropriate, test results of a similar concurrent evaluation of 6.35mm simplex ammunition and its control ammunition (7.62mm, NATO, Ball, M59) are quoted for comparison. For simplicity, both 6.35mm and 7.62mm ammunition are hereinafter referred to as the control ammunition.

4. (S) BACKGROUND. The single flechette is a prototype round developed for Frankford Arsenal by Aircraft Armaments, Inc., to meet a requirement to replace standard small arm ammunition. It is to be at least equal to standard ammunition in accuracy and penetration while possessing a greater casualty producing capability and having less weight (ref 4, Annex D). This round was engineer tested at Aberdeen Proving Ground, Maryland, during the last half of 1959. On 9 November 1959, Chief of Ordnance proposed to Chief of Research and Development, DA (ref 6, Annex D), that development of an all-purpose hand-held weapon system be initiated, using single flechette ammunition in the direct fire role. Single flechette ammunition was furnished this Board for test in November 1959 and testing was completed on 14 December 1959. On 23 December this Board, in a preliminary report to USCONARC (ref 7, Annex D), concluded that single flechette ammunition has the potential for fulfilling the requirements of the direct fire ammunition for the All-Purpose Hand-Held Weapon. This item has not been proposed for Tripartite Standardization.

5. (S) SUMMARY OF TEST RESULTS. The single flechette was tested to determine its characteristics. Applicable portions of the plan of test for Project 2787, Evaluation of Small Caliber High Velocity Rifles (ref 2, Annex D) were used in the conduct of this evaluation. Results of test follow:

a. Physical Characteristics. The test item was much lighter and smaller than standard NATO ammunition or the 6.35mm ammunition used for comparison in this evaluation. The cartridge case did not possess the degree of hardness and rigidity required in a military cartridge (par 1, Annex B).

b. Accuracy. Semiautomatic accuracy of the test item was inferior to that of standard NATO ammunition (par 2, Annex B). The test item was especially suitable for a direct fire role due to its flat trajectory (maximum ordinate 5 inches at 500 yards) and relatively light recoil. During this evaluation there was no necessity to make sight setting adjustments to compensate for wind. Accuracy appeared to be adversely affected as the weapon heated (Test Nr 2, Annex A).

c. Penetration. The test item performed satisfactorily in all media except sand (par 7, Annex B).

d. Sabot Dispersion and Penetration. When firing the test item the danger zone forward of the gun is excessive (par 4, Annex B).

e. [REDACTED] The life of the stripper was of too short a duration for that of a component of a military rifle (par 5, Annex B).

f. General. Although no specific test concerning position disclosure was conducted, excessive muzzle flash was noted during all firing of the flechette cartridge.

6. (C) DISCUSSION. Representatives from Frankford Arsenal and Aircraft Armaments have familiarized this Board with the concept of the rifle in which this test ammunition will ultimately be used. The following aspects of this rifle system were taken into consideration by the Board in arriving at the conclusions and recommendations:

a. The proposed rifle would weigh approximately 3.5 pounds. This weight, when coupled with the light weight of the flechette ammunition, would permit the user to carry a much larger ammunition supply than at present.

b. The proposed rifle would incorporate design features to reduce or eliminate the tendency of present weapons when fired automatically to ride off the target.

c. The proposed rifle would have a cyclic rate of approximately 2,000 rounds per minute and a controlled burst (1 to 5 rounds) trigger mechanism. These controlled bursts of automatic fire theoretically would increase hit probability, thus offsetting the reduced single round accuracy of the test ammunition.

7. (S) CONCLUSIONS. The United States Army Infantry Board concludes that:

a. The single flechette has sufficient military value under temperate weather conditions to warrant further development.

b. The single flechette has more potential than either 6.35mm simplex or 7.62mm NATO ammunition for meeting the proposed direct fire ammunition requirements of the All-Purpose Hand-Held Weapon (ref 5, Annex D).

8. (U) RECOMMENDATION. It is recommended that development be continued and directed toward, but not limited to, the correction of deficiencies listed in Annex B, and that the improved ammunition be submitted to this Board for further tests.

ANNEXES

- A. Details of Test
- B. Deficiencies and Suggested Modifications
- C. Photograph
- D. References

Henry B. Kunzig
HENRY B. KUNZIG
Colonel, Infantry
President

SECRET

ANNEX A - DETAILS OF TEST

Report of Project Nr 2876

TEST NR 1. PHYSICAL CHARACTERISTICS.

1. (U) PURPOSE. To determine the physical characteristics of the test ammunition.

2. (U) METHOD.

a. The test ammunition was weighed, measured, and photographed and the results were recorded.

b. Technical publications from Aircraft Armaments, Inc., were studied and pertinent data were extracted.

3. (S) RESULTS.

a. Physical Characteristics:

	Overall Weight (Grains)	Overall Length (Inches)	Case Diameter (Inches)
Flechette	86	2.31	.296
6.35mm Short	229.2	2.28	.418
6.35mm Long	237.6	2.48	.418
7.62mm NATO	376	2.79	.471

b. During handling it was found that the forward half of the cartridge case was so soft that it was easily bent by hand. Representatives of Aircraft Armaments recommended that each round be chambered by hand since the case would be bent by mechanical chambering.

4. (S) ANALYSIS. The single flechette round is considerably lighter and less bulky than present standard ammunition. The cartridge case does not possess the degree of hardness and rigidity required in a military cartridge.

TEST NR 2. ACCURACY.

1. (U) PURPOSE. To determine the accuracy characteristics of the test ammunition when fired from Winchester Model 70 rifles (modified).

2. (U) METHOD.

a. Using a bench rest, each of three expert riflemen fired the following with each of three weapons:

A

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- (1) After zeroing, one 10-round group at 100 meters ("A" target).
- (2) After zeroing, three 10-round groups at 200 meters ("A" target).
- (3) After zeroing, three 10-round groups at 300 meters ("B" target).
- (4) After zeroing, one 10-round group at 400 meters ("B" target bull's-eye mounted on a 12' x 12' target frame).

b. Maximum spread and mean radius were computed and recorded for each shot group. The average of these measurements was determined. The total rounds fired at each range and the number which completely missed the target frame were recorded.

c. To determine the effect of heat upon the accuracy of the weapon four 5-round groups were fired from one rifle in a machine rest at 400 meters ("B" target bull's-eye mounted on a 12' x 12' target frame). The rifle was cold at the start of the first shot group. Approximately 36 seconds were required to fire each 5-round group and there were approximately 3 minutes between groups. Maximum spread and mean radius for each group were computed and recorded.

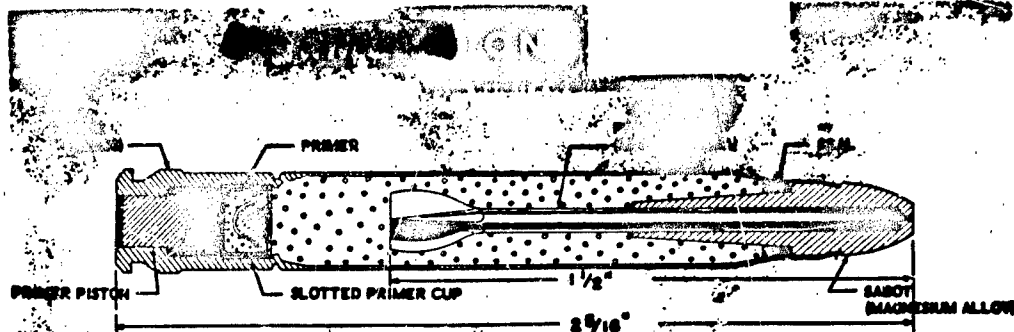
3. (S) RESULTS.

a. Average mean radius (MR) and maximum spread (MS) (inches) for groups fired from a bench rest:*

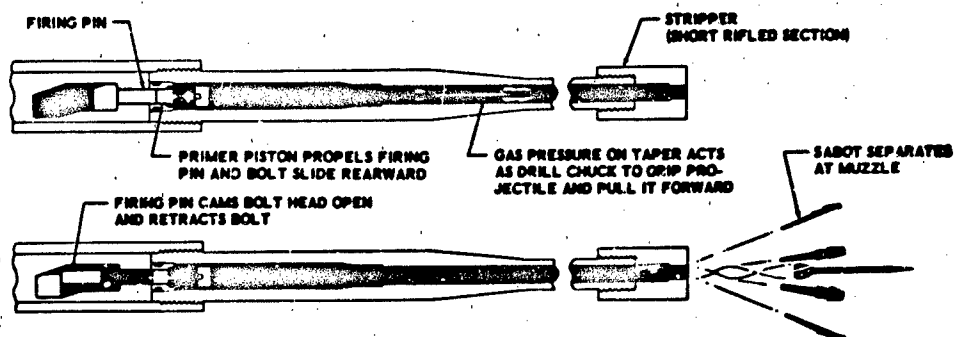
Range (Meters)	.22 CAL** FLECHETTE		6.35MM SHORT		6.35MM LONG		7.62MM NATO	
	MR	MS	MR	MS	MR	MS	MR	MS
100	4.28	10.44	—	—	—	—	—	—
200***	7.72	20.24	—	—	—	—	—	—
300	8.64	23.40	5.04	16.68	4.80	15.00	5.88	17.20
400****	18.84	54.36	6.84	20.40	6.24	19.32	7.92	27.60

Notes:

* An undetermined number of all flechette rounds fired were erratic and did not hit the target. In all accuracy firing at least 8 out of each 10 rounds were hits; therefore, the MR and MS shown for the flechette are for the best 8 out of 10 rounds in each 10 round group.



ACTION



UNITED STATES ARMY INFANTRY BOARD FORT BENNING, GEORGIA

PROJECT NR
2876

DATE
18 Jan 1960

NEGATIVE NR
09-166-63/AJ-60

EVALUATION OF SINGLE FLECHETTE

Upper - Cutaway of Single Flechette Cartridge.

Lower - Schematic drawing of primer actuated gun mechanism and stripper functioning.

ANNEX C

ANNEX B - DEFICIENCIES AND SUGGESTED MODIFICATIONS

Report of Project Nr 2876

(S) The deficiencies listed in this annex are those that remain uncorrected at the completion of this project. They are listed in two categories: major deficiencies and minor deficiencies. The former are those deficiencies which must be corrected to make the item suitable for Army use. The latter are those deficiencies, the correction or elimination of which will increase the efficiency or desirability of the item but which need not be corrected to make the item suitable for Army use.

<u>Major Deficiency</u>	<u>Results</u>	<u>Suggested Modification</u>
1. Cartridge case lacks rigidity and hardness (Test Nr 1).	Case would bend under normal usage.	Harden case.
2. Accuracy of semiautomatic fire is not satisfactory (Test Nr 2).	Does not meet military characteristics.	Correct.
3. Weapon appears to lose accuracy as it heats (Test Nr 2).	Adversely affects accuracy of the weapon.	Correct.
4. Danger zone for sabot particles is excessive (Test Nr 4).	Is distracting and dangerous to friendly soldiers.	Reduce in size or eliminate danger zone of sabot particles.
5. Life of stripper is too short. (Test Nr 5).	Would require frequent replacement of stripper.	Increase stripper life.
<u>Minor Deficiency</u>	<u>Results</u>	<u>Suggested Modification</u>
6. Muzzle flash is excessive (Test Nr 2).	Would reveal firer's position.	Correct.
7. Does not penetrate 6" of sand (Test Nr 3).	Reduces the ammunition's effectiveness against targets protected by earthworks.	Improve.

3. (S) **RESULTS.** Number of rounds fired before stripper required replacement. **Results of all strippers are shown below:**

<u>Stripper Nr</u>	<u>Nr of Rounds</u>
1	465
2	403*
3	497
4	173**

Total $1538 \div 4 = 384$ rounds average

Notes:

* This stripper was not completely worn out when it was replaced.

** One stripper tooth was chipped on this stripper whereas all other strippers wore out gradually.

4. (S) **ANALYSIS.** Stripper life is very short and must be increased considerably to be acceptable.

b. The size of the witness panel was varied from 12' x 12' to one-quarter of 48' x 24' panel as required.

c. The maximum horizontal distance of the sabot hits on the witness panel from the actual point of aim at each range was measured and recorded.

d. The penetration effect of the sabot particles on the witness panel was determined and recorded for each range.

3. (S) RESULTS. The maximum horizontal dispersion and the penetration effect at various ranges is shown below:

Range (Feet)	Size of Target (Feet)		Maximum Horizontal Dispersion (Feet)	Sabot Particle Effect*
	Width	Height		
15	12	12	4	Broke paper face and severely dented, or sabot particle actually stuck into the witness panel.
25	12	12	6.5	Broke paper face and slightly dented the witness panel.
35	12	12	12' x 12' witness panel was not large enough to intercept all sabot particles.	Broke paper face and made slight scratches in the witness panel.
45	one-fourth of 48 x 24 target		14	Broke paper face.

*Note: The effect stated is for the majority of the hits; however, in subsequent firing of this type there have been exceptions such as one sabot particle sticking into the board at 45 feet.

4. (S) ANALYSIS. Although no criterion has been established as to an acceptable cone of dispersion, it appears that present tactical concepts would not permit this large danger zone forward of the gun.

TEST NR 5. STRIPPER LIFE.

1. (U) PURPOSE. To determine the average life expectancy of the stripper before accuracy of the rifle is affected.

2. (U) METHOD.

a. ~~Accuracy~~ was kept of all rounds fired.

b. When the rifle lost its initial accuracy the stripper was replaced.

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d. Number of rounds of test and control ammunition that perforated 6 inches of sand and a 1 inch witness board at each range is shown below:

<u>Range (Meters)</u>	<u>.22 Cal* Flechette</u>	<u>6.35mm Short</u>	<u>6.35mm Long</u>	<u>7.62mm NATO</u>
20	1	0	0	0
40	0	2	1	1
60	1	4	2	4
100	0	5	5	0
300	1	4	5	5

Note:

*The .22 Caliber flechette was broken up or badly twisted upon impact with sand.

e. The mean radius (MR) prior to and after passing through brush, and the percent of rounds perforating the witness plate are shown below.

<u>Type Ammunition</u>	<u>MR Prior to Entering Brush</u>	<u>MR After Passing Through Brush</u>	<u>Change (Inches)</u>	<u>% Perforating 1" Witness Plate</u>
.22 Cal Flechette*	20.60	27.88	+7.28	79.3
6.35mm Short	5.80	16.42	+10.62	100
6.35mm Long	4.84	16.44	+11.60	100
7.62mm NATO	8.24	13.93	+5.69	100

*Note: A total of 102 flechette rounds were fired. Five of these 102 rounds did not get through the brush target. Both test and control ammunition tumbled after striking the brush target.

4. (S) ANALYSIS. Flechette penetration is satisfactory in all media except sand.

TEST NR 4. SABOT DISPERSION AND PENETRATION.

1. (U) PURPOSE. To determine the cone of dispersion for the sabot particles and the penetration capabilities of these particles.

2. (U) METHOD:

a. Shot groups varying from 10 rounds to 58 rounds were fired from various ranges into a witness panel made of 1 inch commercially dressed pine boards (actual measurement 3/4 inch) faced with brown wrapping paper.

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sand. A witness plate, constructed of 1 inch commercially dressed pine boards (actual measurement 3/4 inch) was placed 1 foot in rear of the target. Penetration effects were recorded for each range.

e. Ninety rounds were fired in ten round groups into a fixture containing approximately 12 inches of green, freshly cut, lightly packed brush (limbs varied from very small to approximately 3/4 inch in diameter) at 400 meters. Mean radius before the projectiles entered the brush was determined for each 10-round shot group. The change in mean radius and the performance characteristics of the projectiles were recorded. The change in mean radius and the results of penetration, tumbling, yawing, etc., were determined by observing a witness panel made of 1 inch commercially dressed pine boards (actual measurement 3/4 inch) placed 10 feet in rear of the brush.

3. (S) RESULTS.

a. Number of pine boards perforated by the test and control ammunition is shown below:

<u>Range (Meters)</u>	<u>Type Ammunition</u>	<u>Average Nr of Pine Boards Perforated</u>
400	.22 Caliber Flechette	7.6
	6.35mm Short	10.2
	6.35mm Long	10.4*
	7.62mm NATO	11.3(+)**

Notes:

* A total of 11 rounds instead of 10 was fired with this type ammunition.

** One round perforated the last board; therefore, the exact average cannot be computed.

b. Test and control ammunition perforated both sides of the steel helmet (w/liners) and body armor 100 per cent of the time at 400 meters.

c. The average number of pine boards perforated by test and control ammunition after perforating the steel plate is shown below:

<u>Range (Meters)</u>	<u>Type Ammunition</u>	<u>Steel Plate Perforated</u>	<u>Average Nr of Pine Boards Perforated</u>
400	.22 Caliber Flechette	Yes	3.8*
	6.35mm Short	Yes	1.8
	6.35mm Long	Yes	2.6
	7.62mm NATO	Yes	9.4

* A total of 7 rounds instead of 5 was fired with this type ammunition.

[REDACTED]

c. Accuracy is adversely affected as the stripper wears out.

d. During the conduct of the accuracy test it was noticed that the longer a weapon was fired the less accurate it seemed to be. An analysis of the probable causes led to the belief that as the weapon heated it lost some of its accuracy. In order to verify these suspicions, the test described in paragraph 2c and reported in paragraph 3c was devised and conducted. The results shown in paragraph 3c indicate that the MR and MS of the fourth group (when the weapon was the hottest) were indeed much larger than for the three previous groups. Although the results of this test are not conclusive, there is reasonable cause to believe that accuracy is adversely affected as the temperature of the weapon increases.

e. The trajectory is such that no sight change would be required to hit a man-sized target between 0 and 400 meters.

f. Wind has no noticeable effect upon the trajectory of the flachette between 0 and 400 meters.

g. Muzzle flash with the test ammunition-weapon combination is excessive.

TEST NR 3. PENETRATION.

1. (V) PURPOSE. To determine the penetration capabilities of the test ammunition in several different media.

2. (U) METHOD.

a. Ten rounds were fired from 400 meters into 17 layers of 1 inch commercially dressed pine boards (actual measurement 3/4 inch) spaced at 1 inch intervals. The number of boards perforated by each round was recorded and the average number of boards perforated by all rounds was then computed.

b. The test ammunition was fired against standard US steel helmets (with liners) and body armor at 400 meters. Firing was conducted until 10 fair hits (strikes more than 1 inch from the periphery of the profile of the helmet) were obtained. The number of hits and the number of perforations obtained were recorded.

c. Five rounds were fired from 400 meters into 10 gauge mild steel plate (SAE 1010, maximum Rockwell hardness C-30). Layers of 1 inch commercially dressed pine boards (actual measurement 3/4 inch), spaced at 1 inch intervals, were placed behind the steel plate. The number of pine boards perforated after the round perforated the steel plate was determined and recorded.

d. Five rounds were fired at ranges of 20, 40, 60, 100 and 300 meters into a box constructed of 1/4 inch plywood, containing 6 inches of

A [REDACTED]

[REDACTED]

**Due to the lightness of recoil when the flechette cartridge was fired, the rifle was quickly and easily realigned on the target.

***Due to a loss in accuracy, the stripper on rifle Nr 8 was replaced after a total of 173 rounds.

****Due to a loss in accuracy, the strippers on all flechette rifles were replaced prior to firing at 400 meters.

b. Total rounds fired at each range and number of rounds which completely missed the target frame:

Range (Meters)	Size of Target (ft)		Total Rounds Fired	Number of Misses	Per Cent of Misses
	Width	Height			
100	4 x	6	94	4	4.2
200	6 x	6	295	24	8.1
300	6 x	6	316	46	14.5
400	12 x	12	90	9	10

c. Mean radius and maximum spread (inches) for groups fired from a machine rest at 400 meters.*

Group Nr	1	2	3	4
MR	7.92	13.32	9.12	27.36
MS	24.00	38.76	24.84	104.40

*Note: All groups were fired from rifle Nr 9.

d. The firers were able to use the same sight setting from 100 through 400 meters (Maximum range tested). At no time was it necessary to make a sight change to compensate for the wind.

e. Although not specifically a part of this test, an excessive amount of muzzle flash was noted during all firing of the flechette cartridge.

4. (S) ANALYSIS.

a. An undetermined number of all test rounds fired was erratic in flight.

b. Accuracy of a misautomatic fire, as represented by the best 30 per cent of all rounds fired, is not as good as that of the 7.62mm. Ball proposed for the All-Purpose Hand-Held Weapon (ref 5, Annex D).

ANNEX B - REFERENCES

Report of Project Nr 2876

1. OTCM 34142, Office Chief of Ordnance, 27 Mar 52, subject: "Rifle, Caliber .30, Lightweight - Military Characteristics (L)."
2. Plan of Test of Project Nr 276, US Army Inf Bd, 14 Feb 58, Evaluation of High Velocity Small Caliber Rifles (U).
3. Report Nr ER-1590, Aircraft Armaments, Inc., January 1959, subject: "Proposal for Special Type Small Arms Ammunition, Continuation of Development."
4. Par 238, Combat Developments Objective Guide, USCOMARC, 21 Sep 59.
5. Draft Military Characteristics for All-Purpose Hand-Held Weapon, US Army Inf Bd, 13 Oct 59.
6. DF, Chief of Ordnance to CRD, dated 9 Nov 59, subject: "Development of All-Purpose Hand-Held Weapon (U)."
7. Msg, ATTC 12-101, USA Inf Bd, 23 Dec 59.

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