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RDTE PROJECT NO

USATECOM PROJECT NO 8-WE-600-018-002

USAIB PROJECT NO 3300

USACDC AC NO

MILITARY POTENTIAL TEST OF

RIFLE, 5.56-MM, AR-18

FINAL REPORT

By

CAPTAIN ALAN R. BURNE
CAPTAIN JOHN H. HENNESSEY, JR.
SFC JAMES W. CREWS

January 1970

UNITED STATES ARMY INFANTRY BOARD
Fort Benning, Georgia 31905

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AMSTE-BC 10 FEB 1970

SUBJECT: Reports of Military Potential Test of Rifle 5.56mm, AR18, USATECOM Project Nos. 8-WE-600-018-001/002

Commanding Officer
US Army Small Arms Systems Agency
ATTN: AMXAA-WS
Aberdeen Proving Ground, Md 21005

1. References.

a. Letter, AMSTE-BC, HQ USATECOM, Dec 64, subject: Final Report of Military Potential Test of the Rifle, 5.56mm, AR18, USATECOM Project No. 8-4-0110-01A/02A.

b. Ballistic Research Laboratories Memorandum Report No. 635, dated Feb 65, subject: A Kinematic Evaluation of the AR18 Rifle, Cal. 0.223.

c. Letter, AMSTE-BC, HQ USATECOM, dated 28 Jan 66, subject: Analysis of Results of SAWS Engineering and Service Tests, USATECOM Project Nos. 8-5-0400-03 thru 06.

d. Message, AMXAA-WS, USASASA, dated 282030Z Oct 69, subject: Abbreviated Army Test of AR18 Rifle.

e. The Aberdeen Research and Development Center Memorandum Report, dated Feb 70, subject: Evaluation of the Dynamics of the Cal. 0.223, AR18 Rifle.

2. Approval Statement. Inclosed reports are approved.

3. Background.

a. Reference 1a forwarded results of a Military Potential Test (MPT) conducted by the Aberdeen Proving Ground (APG) and USA Infantry Board (USAIB). A kinematic analysis was conducted concurrently with ref 1a and was reported by ref 1b. The AR18 Rifle was included in the Small Arms Weapons System (SAWS) tests conducted by APG and USAIB and reported by ref 1c.

b. By ref 1d a requirement for an abbreviated MPT of a modified AR18 Rifle was established. A concurrent dynamic evaluation was conducted by the Aberdeen Research and Development Center (ARDC). Thirteen weapons were delivered to this command for test. Nine were tested by APG, one by ARDC and three by USAIB. Testing was conducted from Nov 1969 to Feb 1970. Inclosure 1 provides results of engineering type tests as conducted by APG. Inclosure 2 provides results of user type tests as conducted by USAIB. Reference 1e will be forwarded by ARDC under separate cover.

c. In the absence of officially stated requirements, the test rifle (AR18) was compared directly to the M16A1 Rifle. In addition, as applicable, the criteria in Small Arms Purchase Description (SAPD) 253F was utilized. Approximately the same number of rounds were fired using equal numbers of test and comparison weapons.

d. This activity was conducted as an abbreviated test, and is not equivalent in degree to formal engineering and service tests intended to define suitability for US Army use.

4. Test Results.

a. A total of 27 criteria were established for the test weapons of which 17 were met. Failure to meet the established criteria was evident in ten instances. The test weapon was equal to or better than the control weapon in areas of weight and dimension, cyclic rate uniformity, semi-automatic accuracy, training aspects, functioning at temperature extremes, vehicular transportability, maintainability, bayonet employment, flash signature, and temperature-humidity sensitivity. The test weapon was not equal to the control weapon in two aspects of safety, reliability, durability, functioning in dynamic dust, unlubricated functioning, two human factors handling aspects, noise signature, and recoil reaction.

b. Deficiencies: Inadequate durability was evident as indicated by breakage of parts such as charging handle key, hammer, and the hooks on the hammer which engage the sear. The latter condition can result in a runaway gun which in fact occurred, but only after 8580 rounds had been fired.

c. Shortcomings:

(1) Unacceptable functioning occurred when unlubricated, and in the dynamic dust environment, as compared to the M16A1 Rifle.

(2) Excessive heat was transferred from the barrel to the handguard during sustained fire.

(3) Breakages occurred at the welds that attached the bulkhead plate to the receiver, and the alternate safety mechanism casting broke.

(4) The AR18 fired when the selector switch was placed between SAFE and SEMI-AUTO position.

(5) The alternate safety and selector switch does not have an indicator as to what position the safety is in.

(6) The adhesive did not hold the recoil pad to the buttstock.

(7) In addition, minor shortcomings were noted such as: windage adjustment not adequately defined, rear sight scale for determining zero not clearly visible, loss of bulkhead plunger pin and bolt catch snap ring, breakage of sight snap ring and breakage of extractors after 5766, 6680 rounds.

d. Reliability and Durability:

(1) Malfunction rates per thousand rounds fired by the USAIB was 2.18 for control rifles and 3.77 for the test rifle, based on at least 18,000 rounds per system. In firing of at least 30,000 rounds from each system during the endurance phase at APG, malfunction rates per thousand rounds fired were 2.77 for the control weapon and 6.67 for the test weapon. (Any discrepancies in malfunction rates between the two test agencies is ascribed to the small sample size of weapons).

(2) The predominant malfunction in the APG report (endurance phase) in both the control (52 of 86) and test weapon (106 of 200) is "failure of the bolt to remain rearward" (FBR). (This type of malfunction is normally operator-correctable in 5 seconds or less.)

(3) Also, in the same endurance test, 70 "failures to fire" (FFR) in 18,000 rounds were ascribed to a defective sear which was later determined to have had improper metallurgical heat treatment. After replacement of the sears, only 5 FFR's occurred in an additional 12,000 rounds.

e. Extreme Temperature (Minus 50^{o} F): In this phase, the performance of the test rifle was superior to the control rifle. In firing a total of 9000 rounds, 3000 in each of the three weapons, 11 malfunctions were charged to the test rifle. Under identical conditions, the control rifle yielded 112 malfunctions. After firing a 100 round cycle and

reconditioning prior to the next 100 round cycle, moisture accumulated in the control rifle mechanism and froze. This condition caused "failure to feed the first round" (FF1) and "failure of the bolt to close" (FBC). When firing 2 to 3 rounds after a reconditioning period, acceptable performance of the M16A1 is restored. Also, cyclic rates of the test rifle were less affected by the cold temperature, indicating desirable dynamic uniformity.

f. Maintenance: The maintenance package was incomplete due to lack of a small arms equipment case (cleaning kit) and omissions in the operators manual. These factors did not interfere with testing but are stated as shortcomings. Maintenance requirements for care and cleaning are comparable.

5. Comments.

a. In addition to breakages which rendered the weapon inoperable, other breakages are cited in the reports which although listed individually as shortcomings, are further factors contributing to the overall assessment of a durability deficiency with the test rifle.

b. Previously reported deficiencies such as breakages of upper and lower receiver, guide rod assemblies, etc, have been corrected. For a detailed listing of deficiencies and shortcomings, current and past, see Appendix III of the inclosed reports.

c. It is conjectured that insufficient energy to fully cycle the weapon due to excessive frictional forces in the weapon mechanism is the cause for unacceptable performance of the test rifle in the unlubricated condition. Similarly, excessive frictional forces between chamber wall and cartridge case in the dust condition probably caused the failures to extract; chrome plating of the chamber, as in the M16A1, might improve this aspect of performance.

d. In previous kinematic tests of the AR18 rifle, reference 1b, it was reported that the basic design was good, but deficiencies were found in the mechanism and feed system, i.e., magazine, breech ramp, hammer pivot pin, etc. In the dynamic retest of reference 1e, it was found that the weapon is sensitive to mount rigidity; bolt bounce occurs so as to cause misfires. Also, the hammer pivot pin lock needs improvement. Inadvertent disassembly can still occur. From the overall kinematic standpoint, specific changes previously recommended have improved weapon performance.

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6. Conclusion. The AR18 Rifle has demonstrated substantially improved military potential as compared to earlier tests. In order to determine suitability further improvement in design and fabrication is required.

FOR THE COMMANDER:

s/William H. Hubbard
WILLIAM H. HUBBARD
Colonel, GS
DCS for Test & Eval

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RDTE PROJECT NO

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MILITARY POTENTIAL TEST OF

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January 1970

UNITED STATES ARMY INFANTRY BOARD
Fort Benning, Georgia 31905

ABSTRACT

This Military Potential Test of the Rifle, 5.56-mm, AR-18 was conducted by the US Army Infantry Board at Fort Benning, Georgia, during the period 3 December 1969 through 2 January 1970. Three AR-18 rifles and, for comparison and control purposes, three M16A1 rifles, were furnished for testing. Nine test soldiers, representative of those who can be expected to use the rifle, were used in testing. The rifle was tested under field and simulated combat conditions. A minimum of 6,000 rounds was fired in each test and control rifle. The purpose of the test was to determine whether deficiencies and shortcomings reported in two previous tests of the AR-18 rifle had been corrected.

Specific subtests conducted were preoperational inspection and physical characteristics, training, safety, known distance accuracy (semiautomatic), maintenance, durability/reliability/portability, bayonet employment, and human factors engineering. Durability was the principal deficiency reported in previous tests; and, although some deficiencies and shortcomings had been corrected, this overall lack of durability still exists, as evidenced by an excessive number of breakages and a larger number of malfunctions. The AR-18 was comparable to the M16A1 with respect to training, maintenance, semiautomatic accuracy, most of the portability aspects, bayonet employment, and some aspects of human factors engineering. It was inferior to the M16A1 as to durability and reliability, safety, and some physical and human factors characteristics. It was superior to the M16A1 with regard to compactness afforded by its folding stock, dual firing controls, low and clean sight line, and automatic hit capability in automatic fire.

It was concluded that the AR-18 has military potential, but prior to any additional testing, further development is required.

FOREWORD

The US Army Infantry Board was responsible for test planning, test execution, and test reporting.

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SECTION 1. SUMMARY

1.1 BACKGROUND

1.1.1 The Rifle, 5.56-mm AR-18 (AR-18) was designed and produced by a private manufacturer. Several US Army tests of the AR-18 were conducted in years past. In 1964 the US Army Infantry Board (USAIB) conducted a Military Potential Test (MPT) of the AR-18 (ref 3, app IV), and in 1965 the AR-18 was one of several rifles tested by the USAIB in the service type Small Arms Weapons Systems Test (SAWS) (ref 4, app IV). In those tests, the AR-18 was found to have potential for military use but it exhibited a number of deficiencies and shortcomings which would have to be corrected before the rifle could be considered for US Army use.

1.1.2 Subsequent to the SAWS tests, the developer modified the AR-18 in an attempt to eliminate deficiencies and improve its performance, and in 1969 requested further testing by the US Army.

1.1.3 In November 1969, the US Army Test and Evaluation Command (USATECOM) directed that USAIB conduct a user type MPT of the AR-18, and that the Materiel Test Directorate, Aberdeen Proving Ground, (MTD, APG) conduct an engineering type MPT of the rifle (ref 9, app IV).

1.1.4 Materiel for test was delivered to USAIB on 3 December 1969.

1.2 DESCRIPTION OF MATERIEL (See figs 1 through 5, app I for photographs)

1.2.1 The AR-18 is a lightweight, air-cooled, gas-operated, magazine-fed, shoulder- or hip-fired rifle, designed for either full automatic or semiautomatic fire. It utilizes a 20-round magazine. The unloaded weight of the rifle, without accessories, is approximately 7.4 pounds. The overall length of the rifle is approximately 39 inches (with stock extended).

1.2.2 The barrel (18 inches) is air-cooled and is provided with an open type flash suppressor which is also designed to be a recoil compensator. The flash suppressor serves as a grenade launcher and front bayonet support. The barrel is surrounded by a heat-resisting fiberglas material which serves as a handguard and forearm. The handguard has a heat-resisting metal inner shield. The front sight is adjustable for elevation and the rear sight for windage.

1.2.3 The rifle has a folding buttstock made of synthetic material. With the stock folded, the rifle is approximately 29 inches long.

1.2.4 The receiver is made of lightweight steel stampings.

1.2.5 The following are changes and modifications made to the previously tested AR-18 by the developer:

a. A buttstock damper added.

b. The guide rod assembly staked.

c. The barrel extension wall thickness increased for added strength.

d. A dimension change made on the front and rear sights to raise the line of sight.

e. A telescope mount plate added to the top of the receiver.

f. A dust cover added.

g. The design of the charging handle changed for compatibility with the dust cover, and for left-handed use.

h. The buttstock wall thickness increased.

i. The flash suppressor redesigned to serve as a compensator.

j. The pistol grip material changed to add strength.

k. A lower receiver bracket added.

l. The hinge and bulkhead assembly changed for added strength.

m. Miscellaneous dimensional and component changes to improve performance.

1.2.6 The Rifle, 5.56-mm, M16A1 was used as the control rifle.

1.2.7 Hereinafter, the AR-18 will be referred to as the test item, weapon, or rifle, and the M16A1 as the control item, weapon, or rifle. Collectively, the test and control rifles and associated material will be referred to as the project items, rifles, weapons, or material.

1.3 TEST OBJECTIVES

To determine whether previously reported deficiencies and shortcomings have been corrected with respect to the operational and design inadequacies reported in ref 3, app IV, using current 5.56-mm ammunition and prescribed maintenance.

1.4 SCOPE

1.4.1 This Military Potential Test of the AR-18 was conducted by the USAIB at Fort Benning, Georgia, during the period of 3 December 1969 to 2 January 1970, and was based on an outline plan of test provided by USATECOM. Nine test soldiers, representative of those who can be expected to use and maintain the rifles in the field, were used in

testing. One test soldier was a left-handed firer and one wore glasses. Eight of these soldiers had served in combat and fired the M16A1. Three AR-18's and three M16A1's were furnished USAIB for testing. The three M16A1 rifles were used for comparison and control purposes throughout the conduct of the test. Testing was conducted under field and simulated combat conditions. The test soldiers handled, carried, maintained, and fired the test and control weapons throughout the period of testing, subjecting them to hard usage typical of that to be expected in troop use. Temperatures during testing varied between 24° F. and 76° F. The test and control weapons were subjected to use in moderate to heavy rainfall during 5 days of the test period. (See chart 3-1, app I for meteorological conditions during testing.) A minimum of 6,000 rounds of ammunition, in a mixture of 4 each cartridge, 5.56-mm, Ball, M193 (M193) to 1 each cartridge, 5.56-mm, Tracer, M196 (M196) was fired in each test and control rifle.

1.4.2 The performance of the AR-18 in this test was compared with that of the M16A1 and with criteria developed by the USAIB, since no specific criteria (other than correction of defects of the AR-18 reported in previous tests) was provided. The USAIB developed these criteria based on performance requirements applicable to current military rifles.

1.4.3 The small number of weapons (3 each, test and control) and test soldiers (9), coupled with the limited time available for testing, were insufficient to demonstrate a high degree of statistical reliability in the results obtained. However, if it is assumed that the rifles were representative ones, the results are meaningful.

1.5 SUMMARY OF RESULTS

1.5.1 The following 2 deficiencies and 16 shortcomings were found: (One asterisk indicates those reoccurring from reference 3, app IV, two asterisks indicate those from reference 4, app IV, and those with no asterisks indicate those that were found during this test.)

a. Deficiencies:

(1) Lack of durability of weld between charging handle and charging handle key (Subtest (ST) No 6).

(2) Lack of durability of hammer (ST No 6).

b. Shortcomings:

(1) Lack of durability of safety casting (ST No 3 and ST No 6).

(2) Lack of durability of safety lever snap ring (ST No 3 and ST No 6).

(3) Lack of durability of firing pin spring (ST No 6).

* (4) Excessive heat transfer (ST No 3 and ST No 8).

(5) Lack of durability of bulkhead plunger retaining pin (ST No 6).

(6) Lack of durability of automatic sear (ST No 6).

(7) Lack of durability of sight snap ring (ST No 6).

* (8) Lack of durability of bulkhead plate (ST No 6).

* (9) Excessive trigger pull in one test weapon (ST No 1).

* (10) Awkward rear sight windage adjustment, confusing to several firers (ST No 2).

** (11) No clearly readable visual scale for determining zero on the rear sight (ST No 2).

** (12) Incomplete maintenance package (no small arms maintenance equipment case, ST No 1 and ST No 5).

** (13) Incomplete operating and maintenance manual (OMM); specifically, no training instructions and no zeroing instructions included (ST No 2).

** (14) Firing of test weapons with safety and selector switch between SAFE and SEMI-AUTO Position (ST No 1 and ST No 3).

** (15) No position indicator on alternate safety and selector switch (ST No 2 and ST No 3).

(16) Weak bond of the cement compound between buttstock and butt plate (ST No 6).

1.5.2 The average unloaded weight of the AR-18 rifle was 7.4 pounds, and that of the M16A1 rifle was 6.8 pounds. The average length of the AR-18 rifle with stock extended was 38 5/16 inches. With the stock folded the length was 28 3/16 inches. The average length of the M16A1 was 38 7/8 inches. The trigger pull of the AR-18 rifle was excessive. The average cyclic rate of fire of the AR-18 rifles was 945 rounds per minute and the average cyclic rate of fire of the M16A1 rifles was 862 rounds per minute (ST No 1).

1.5.3 There was no significant difference in the ease of training between the AR-18 and the M16A1 rifles (ST No 2).

1.5.4 The AR-18 rifle did not fully meet the criteria for safety because of firing between SAFE and SEMI, breakages in the safety controls, excessive heat transfer, and lack of an indicator on the alternate safety (ST No 3).

1.5.5 The accuracy of the AR-18 rifle was comparable to the M16A1 rifle (ST No 4 and ST No 6).

1.5.6 The AR-18 rifle was comparable to the M16A1 rifle in the ease of maintenance. There was no significant difference in maintenance requirements of the AR-18 and M16A1 rifles. The design of the AR-18 gas operational system was more favorable than that of the M16A1 in terms of maintenance accessibility (ST No 5).

1.5.7 The AR-18 rifle was not as durable and reliable as the M16A1 rifle and exhibited deficiencies with respect to durability as pointed out in paragraph 1.5.1. Excluding weight and balance, the AR-18 rifle was comparable to the M16A1 in portability. The AR-18 rifle with buttstock folded was superior to the M16A1 in compactness where space was a limiting factor (ST No 6).

1.5.8 The AR-18 rifle was comparable to the M16A1 rifle during bayonet training and employment although the M16A1 rifle was slightly better from the human engineering aspects; i.e., better handling characteristics (ST No 7).

1.5.9 In human factors characteristics the AR-18 was inferior to the M16A1 with respect to weight and balance, heat transfer, rear sight adjustments and markings, trigger pull, assembly of parts, noise (rattling), handling and man-portability (where compactness was not an important consideration). The AR-18 was comparable to the M16A1 with respect to ease of disassembly, cleaning and maintenance, firing controls, capability for zeroing and zero setting retention, semiautomatic accuracy, felt recoil, and signature effects from firing. The AR-18 was superior to the M16A1 in the areas of compactness when the stock was folded, dual firing controls, lower sight line, automatic accuracy, sighting when soldier was wearing the protective mask, and ejection pattern of fired cartridge cases.

1.6 CONCLUSIONS. The US Army Infantry Board concludes that:

a. While the deficiencies and some of the shortcomings previously reported in the Rifle, 5.56-mm, AR-18 have been corrected, the rifle still exhibits a deficiency in its lack of durability and a number of shortcomings.

b. The Rifle, 5.56-mm, AR-18 deomonstrates military potential, but requires further development.

1.7 RECOMMENDATIONS. The United States Army Infantry Board recommends that the Rifle, 5.56-mm, AR-18 not be submitted for further testing until the deficiency and as many of its shortcomings as feasible have been corrected by the developers.

SECTION 2. DETAILS OF TEST

2.1 SUBTEST NO 1, PREOPERATIONAL INSPECTION AND PHYSICAL CHARACTERISTICS

2.1.1 Objective

2.1.1.1 To verify the completeness of the shipment.

2.1.1.2 To determine whether the project weapons, ammunition, and associated operating and maintenance equipment were in suitable condition to be tested.

2.1.1.3 To compare the physical characteristics of the test and control weapons.

2.1.2 Criteria

2.1.2.1 The shipment must be complete.

2.1.2.2 The project weapons and associated operating and maintenance equipment must be in suitable condition for testing.

2.1.3 Method

2.1.3.1 Upon arrival of shipment, examination was made of the test and control weapons, as well as the project ammunition, to determine receipt condition.

2.1.3.2 The test and control weapons and project ammunition were inspected against quantity, lot numbers, and Federal Stock Numbers (FSN) listed in the shipping document.

2.1.3.3 Each test and control weapon was function fired utilizing 160 rounds of M193 ammunition and 40 rounds of M196 ammunition (specified 4:1 ratio). Each weapon fired 10 rounds M196 in the semiautomatic mode, 10 rounds M196 in 3- to 5-round bursts in the automatic mode and 20 rounds in the full automatic mode. Forty rounds of M193 were fired semiautomatically, 40 rounds in 3- to 5-round bursts, and 80 rounds fully automatic.

2.1.3.4 The project weapons were weighed, measured, and photographed. A comparison of the physical characteristics of the test and control weapons was made.

2.1.4 Results

2.1.4.1 All test and control weapons, as well as project ammunition, were complete and in good condition upon receipt. It was noted, however, that no bipods, bayonets, or maintenance equipment cases were shipped. The Operating and Maintenance Manuals (OMM) for the AR-18 were received.

2.1.4.2 The following test and control weapons and associated materiel were received in serviceable condition:

a. M16A1 (Control)	AR-18 (Test)
3091167 (C-1)	A-5285 (T-1)
3091084 (C-2)	A-5358 (T-2)
3123972 (C-3)	A-5335 (T-3)

b. Ammunition (37,480 rounds in 4 lots)

M193 - LC-12822	(3,360 rounds)
M193 - LC-12818	(8,400 rounds)
M193 - LC-12819	(18,480 rounds)
M196 - LC-12226	(7,240 rounds)

NOTE: All test and control items conformed with quantity, lot numbers, and FSN's as listed in the shipping document, OMM, and the current instructional material.

2.1.4.3 The test and control weapons were function fired as described in paragraph 2.1.3.3 with no malfunctions.

2.1.4.4 Photographs of the project weapons are shown in figures 1 through 5, Appendix I.

2.1.4.5 Detailed measurements with comparisons are reflected in Table 2-1, page 2-3.

2.1.5 Analysis

2.1.5.1 All project materiel was found to be in a serviceable and undamaged condition.

2.1.5.2 With the exception of the M-3 bipod and the maintenance equipment case for the AR-18 cleaning equipment, the shipment was complete. Since these items are standard issue and were available, their lack did not affect the conduct of this test.

2.1.5.3 The test and control weapons functioned satisfactorily.

2.1.5.4 Trigger pull in test weapon No 3 (9 1/8 lbs) is excessive in comparison to the maximum allowable trigger pull in the M16A1 (8.5 lbs.). This is a shortcoming.

2.1.5.5 The test weapons are heavier than the control weapons (.65 lbs. greater).

2.1.5.6 Elevation and windage range are greater in the test weapons (greater by 17 clicks elevation and 58 clicks windage).

TABLE 2-1

PHYSICAL CHARACTERISTICS
(Weights in pounds, measurements in inches)

	Control Weapons			Test Weapons			Weapon Average		
	C-1	C-2	C-3	T-1	T-2	T-3	Control	Test	Diff
Serial Number	3091167	3091084	3123972	A-5285	A-5358	A-5335	-	-	-
Wt (rifle only)	6.76	6.77	6.79	7.44	7.39	7.44	6.773	7.423	.650
Empty Mag	-	-	-	-	-	-	.18	.18	0
Full Mag	-	-	-	-	-	-	.69	.69	0
Bayonet (M-7)	-	-	-	-	-	-	.67	.67	0
Rifle & Sling w/empty mag and bayonet	7.91	7.92	7.94	8.60	8.54	8.53	7.923	8.557	.634
Rifle & Sling w/full mag and bayonet	8.42	8.43	8.42	9.11	9.06	9.05	8.423	9.073	.650
Trigger pull (lbs)	8 1/8	7 5/8	8 1/8	8 1/8	8 1/8	9 1/8	7 7/8	8 1/2	5/8
Dimension Length	38 7/8	38 15/16	38 7/8	38 5/16	38 5/16	38 5/16	38 7/8	38 5/16	3/4
w/buttstock folded	-	-	-	28 7/8	28 13/16	28 7/8	-	28 13/16	N/A
Width	2 23/32	2 23/32	2 3/4	3 1/16	3 3/32	3 1/16	2 23/32	3 1/16	21/16
w/buttstock folded	-	-	-	3 15/16	3 7/8	3 15/16	-	3 15/16	N/A
Height	8 11/16	8 11/16	8 11/16	8 3/16	8 3/16	8 3/16	8 11/16	8 3/16	11/16
Bayonet (M-7)	-	-	-	-	-	-	11 1/2	11 1/2	0
Rifle and Bayonet	44	44	44	43 7/16	43 7/16	43 7/16	44	43 7/16	3/4
w/buttstock folded	-	-	-	34	33 15/16	34	-	33 31/32	N/A
Sight radius	19 13/16	19 13/16	19 13/16	19 1/2	19 1/2	19 1/2	19 13/16	19 1/2	5/6
Front Sight Blade (Height)	-	-	-	-	-	-	.724	.778	.054
-	-	-	-	total clicks elevation -			61	78	17
-	-	-	-	total clicks windage -			32	90	58
Cyclic rate after 500 rds (rds/min)	855.6	873.4	858.8	935.4	958.6	940.0	861.9	944.8	82.9

2.2 SUBTEST NO 2, TRAINING

2.2.1 Objectives

2.2.1.1 To instruct the test soldiers prior to firing, in the functioning, use, and maintenance of the project weapons.

2.2.1.2 To ensure that the test soldiers are adequately trained in the operation and maintenance of the test and control weapons.

2.2.2 Criteria

2.2.2.1 The test soldiers must be sufficiently trained and oriented so as to be capable of safe and thorough operation of test weapons.

2.2.2.2 Degree of training necessary should be comparable to that of the control weapon; specifically, transition time from M16A1 to AR-18 should be comparable to that from the M14 rifle to the M16A1.

2.2.3 Method

2.2.3.1 A class on the project weapons, based on the instructional material furnished, was given to the nine test soldiers. The instruction included:

a. General characteristics and capabilities.

b. Safety factors and limitations.

c. Operation.

d. Maintenance (assembly, disassembly, care and cleaning).

e. Target acquisition and zeroing.

2.2.3.2 A practical exercise included familiarization (pre-test function firing), zeroing at 25 meters, and maintenance of the weapons.

2.2.3.3 A trainfire qualification course was fired by the test soldiers. The number of target hits was recorded, using DA Form 2992, for each firer as he was randomly rotated so as to fire both the test and control items. A comparison of results was made of the project weapons.

NOTE: The trainfire course consists of a series of practical exercises which require the soldier to apply individual rifle marksmanship, under normal terrain conditions. Single (Record Fire I) and multiple (Record Fire II) camouflaged targets are exposed briefly, irregularly, and at ranges unknown to the firer. Sixteen lanes, each 30 meters wide utilize E- and F-type targets in a range spread of 50 to 350 meters. The F-type targets are used in ranges of 50 and 100 meters while the E-type targets are used at all other ranges.

2.2.4 Results

2.2.4.1 The test soldiers were given a 12-hour block of instruction on the project weapons using current instructional material and the AR-18 OMM. This instruction included a class (4 hours), a practical exercise (4 hours), and a trainfire qualification course (4 hours). Through evaluation of trainfire results and observation of maintenance performance, it was evident that the test soldiers were adequately trained (see para 2.2.4.7 below).

2.2.4.2 The following initial difficulties were encountered during assembly and disassembly of the AR-18 rifle:

a. One test soldier could not properly remove the charging handle from the bolt.

b. One test soldier could not properly remove the bolt take-down pin.

c. One test soldier could not properly insert the bolt into the upper receiver.

d. One test soldier could not properly assemble the bolt and upper receiver groups to the lower receiver.

e. One test soldier attempted to insert the cam pin into the bolt incorrectly.

2.2.4.3 Initially, the nine test soldiers stated the following opinions concerning ease of assembly and disassembly:

a. Four test soldiers stated that the AR-18 was more difficult to disassemble than the M16A1.

b. Four of the remaining five test soldiers stated that the AR-18 was easier to disassemble than the M16A1.

c. One test soldier was unable to detect a difference other than in number of parts.

d. All nine test soldiers felt that the M16A1 was easier to assemble than was the AR-18 due to the fewer number of parts of the M16A1.

2.2.4.4 It was observed throughout the conduct of the test that difficulties initially encountered were reduced with increased experience and use of the AR-18.

2.2.4.5 One failure to fire in control weapon (C-3) was observed on the 106th round. Six seconds were taken to reduce this malfunction.

2.2.4.6 The left-handed firer was hit twice by ejecting cartridge cases while operating the control weapons.

2.2.4.7 Qualification scores are listed in Table 2-2 and Table 2-3 below:

TABLE 2-2

FIRERS' HITS AND WEAPON USED
DURING RECORD FIRE 1 AND 2

Firer	Control			Test	
	Weapon	Hits		Weapon	Hits
KILGORE	C-2	62		T-3	50
SIMMONS	C-3	55		T-1	57
TOLBERT	C-3	64		T-1	44
PENN	C-2	62		T-3	46
WIEMERS	C-1	45		T-2	66
LARA	C-2	48		T-3	45
PELZEL	C-1	40		T-2	39
TAYLOR	C-3	52		T-1	48
BOONE	C-1	48		T-2	42

TABLE 2-3

QUALIFICATION SCORES SUMMARY

	Control	Test
Expert (60 hits and over)	3	1
Sharpshooter (45-59 hits)	5	5
Marksman (30-44 hits)	1	3
High score	64 (C-3)	66 (T-2)
Low score	40 (C-1)	39 (T-2)

2.2.4.8 The following observations were made concerning the sight systems of the AR-18:

a. The design of the windage drum enables the firer to make deflection changes with his fingers instead of having to use a cartridge or pointed object. This is considered to be a favorable characteristic.

b. The rear sight windage adjustment was confusing to all firers because of the lack of numbering on the rear sight drum. Additionally, the notches in the drum which serve to assist in turning were mistakenly taken to be "click indicators." When the firers would make what they thought to be a one-click deflection change, they were, in fact, making a two-click change, because there is a two-click deflection range between each notch.

c. It was difficult for firers, especially when in a prone firing position, to read the windage scale due to obstruction by the guide weld plate.

2.2.4.9 The transition time (M16A1 to AR-18) was approximately 12 hours.

2.2.5 Analysis

2.2.5.1 A 12-hour block of instruction is sufficient time to adequately familiarize and train the soldier on the AR-18 if he has prior experience in the operation of the M16A1. The training requirements for both the test and control weapons are comparable.

2.2.5.2 Transition time from M16A1 to the AR-18 is approximately 12 hours, which is that time used by the US Army Training Center and the US Army Infantry School when making transition from the M14 to the M16A1.

2.2.5.3 When a soldier is making the transition from the M16A1 to the AR-18, initially, disassembly and assembly of the AR-18 is difficult and confusing; however, with time (as reflected in Subtest No 8, Human Factors) and increased familiarization with the system, disassembly is easier and faster but assembly remains slightly more difficult and time-consuming than for the M16A1.

2.2.5.4 No significant statistical difference exists in the qualification scores of the test and control weapons.

2.2.5.5 The AR-18 rear sight windage adjustment is confusing to the firers because of a lack of numbering and the presence of notches on the rear sight drum; and the vision obstruction of the windage scale by the guide weld plate. These two factors are shortcomings.

2.2.5.6 The design of the rear sight drum, which permits adjustment without use of a cartridge or a special tool, is desirable.

2.3 SUBTEST NO 3, SAFETY

2.3.1 Objective

To determine the effectiveness of the safety features of the test weapon; specifically, to determine any unsafe characteristics of the test weapon.

2.3.2 Criteria

The test item must require no additional safety precautions regarding operation and maintenance beyond those required for the control item, and shall be safe for field use.

2.3.3 Method

2.3.3.1 During the conduct of all testing, observations were made to determine any unsafe conditions attributable to the test item by nature of its design or operational characteristics.

2.3.3.2 During the preoperational function firing, attempts were made to fire the weapon after the selector switch had been positioned on SAFE and when the selector switch was positioned between SAFE and SEMIAUTOMATIC.

2.3.3.3 During all testing, particular attention was paid to the effectiveness of the safety switch, as to its ease of identification by sight and touch, ease and quietness of operation, and design to prevent accidental shifting of position; specifically, its ability to maintain a positive position during firing exercises and when subjected to rough handling and adverse conditions.

2.3.4 Results

2.3.4.1 All test weapons, but no control weapons, fired when the safety and selector switch was placed between SAFE and SEMI; however, no weapons fired when on the SAFE position.

2.3.4.2 The safety casting on one test weapon (T-1) broke and the alternate safety fell off while firing in the semiautomatic mode. The weapon remained operable; however, with the buttstock folded, the primary selector was covered in such a way that it could not be operated (see fig 6, app I).

2.3.4.3 The safety lever snap ring of the alternate safety and selector switch (right side) on test weapon (T-2) lost its tolerance and fell off during firing. The weapon remained operational; however, with the buttstock folded, the primary selector could not be operated (see fig 7, app I).

2.3.4.4 The alternate safety and selector switch (right side) of the AR-18 test weapons did not have an easily identifiable position indicator.

2.3.4.5 After firing the maximum sustained rate of fire of 12 rounds per minute for 23 minutes, the hand guards of the AR-18 test weapons became so hot that they could not be handled. This condidion did not exist in M16A1 rifles when fired at the same rate for 28 minutes (an arbitrary additional 5 minutes).

2.3.4.6 Ease and quietness of operation of safety controls were comparable in both test and control weapons.

2.3.5 Analysis

2.3.5.1 While the test weapons have a positive safety which operates satisfactorily with minimum noise when set in the SAFE position, it does not fully satisfy the safety criteria in the following areas: the rifle can be fired with the selector lever set between the SAFE and SEMI positions; the settings of the alternate (right hand) selector switch are difficult to identify and set; and there is excessive heat transfer in sustained fire which creates a latent safety hazard. Each of these conditions constitutes a shortcoming.

2.3.5.2 The safety casting and the safety lever snap ring are lacking in durability and their breakage prevents use of the selector lever when the stock is folded. These are shortcomings.

2.4 SUBTEST NO 4, KNOWN DISTANCE ACCURACY (SEMIAUTOMATIC MODE)

2.4.1 Objectives

2.4.1.1 To determine and compare the semiautomatic aimed fire accuracy of the test and control weapons at targets at known distance (100 meters).

2.4.1.2 To determine the test weapon's capability of obtaining an effective zero at a range of 500 meters.

2.4.1.3 To compare the effectiveness of the control and test weapons' sights.

2.4.2 Criteria

2.4.2.1 The test item must equal or exceed the accuracy of the control item when engaging known-distance targets at 100 meters in the semiautomatic mode of fire.

2.4.2.2 The test item's capability to obtain an effective zero at a range of 500 meters must equal or exceed that of the control item.

2.4.2.3 The sights of the test weapon must equal or exceed the effectiveness, durability, and reliability of those of the control weapon.

2.4.3 Method

2.4.3.1 During the conduct of this subtest, 9 firers each fired three 10-round shot groups at A-type targets at a range of 100 meters utilizing the semiautomatic mode of fire with both a test item and a control item. The weapons were zeroed prior to the initiation of this exercise. All firing was done from the prone, sandbag-supported position. M193 ammunition was utilized for the conduct of this subtest. Accuracy data of the test and control weapons were recorded and compared.

2.4.3.2 After the 100-meter accuracy firing, each test soldier attempted to zero a test and a control weapon at a range of 500 meters, firing semiautomatically from the prone, sandbagged position at B-type targets.

2.4.3.3 During the conduct of this subtest, as well as in all other subtests, the firers were observed and questioned as to the ease of adjusting the test weapon's sights, retention of each sight setting, durability, and human factors engineering aspects of the sight system in comparison to those of the control items.

2.4.4 Results

2.4.4.1 Computation of center of impact, extreme spread, mean radius, range and deflection probable error for the AR-18 and M16A1 rifles are shown in Table 2-4.

TABLE 2-4

KNOWN DISTANCE ACCURACY FIRING AT 100 METERS

TEST WEAPON

(measurements in inches)

Firer	Offset	Center of Impact X	Center of Impact Y	Mean Radius	Extreme Spread	Probable Error Deflection	Probable Error Range
1	2.2360	.9833	-2.0083	7.3514	22.25	3.9324	3.5815
2	.8103	.4083	.7000	3.7307	16.90	1.9642	2.4159
3	3.6760	-1.5500	-3.3333	5.3179	20.00	2.2908	3.2682
4	1.4333	-.5666	1.3166	1.7698	7.50	.9930	.9371
5	4.7722	- .9583	-4.6750	3.6606	14.50	1.8443	2.1901
6	5.3987	-1.8416	-5.0750	2.1336	7.10	.8230	1.3329
7	4.5115	1.0333	-4.3916	2.1570	8.50	1.0808	1.2846
8	.7211	-.6000	.4000	1.8534	6.13	.8873	1.0843
9	1.1836	.6333	1.0000	2.6001	10.40	.8930	1.7932
Avg	2.7491	.2731	-1.7851	3.3971	12.59	1.6343	1.9875

CONTROL WEAPON

Firer	Offset	Center of Impact X	Center of Impact Y	Mean Radius	Extreme Spread	Probable Error Deflection	Probable Error Range
1	1.5912	-1.4250	-.7083	2.3994	10.30	1.2226	1.4740
2	4.1696	-3.1916	2.6833	2.2176	8.40	1.3259	1.2219
3	1.9185	-.5083	-1.8500	1.9416	7.60	.8761	1.2244
4	1.7420	1.7416	.0416	1.8939	7.00	.8817	1.0783
5	2.0237	1.9750	.4416	2.8869	10.00	1.4480	1.6596
6	2.7872	-1.9500	-1.9916	1.4031	6.50	.7200	.9047
7	.8595	-.8250	-.2416	2.6683	12.50	1.4774	1.4789
8	6.7199	-2.0750	6.3916	2.4961	9.89	1.2039	1.4510
9	3.2825	.5666	-3.2333	2.2440	9.20	.9967	1.3910
Avg	2.7882	-.6324	.1703	2.2389	9.04	1.1280	1.3204

2.4.4.2 Only three test soldiers were able to obtain a 500-meter zero with the control weapons, and only one test soldier was able to obtain a 500-meter zero with a test weapon. Four different firers obtained zeroes on four different weapons.

2.4.4.3 The test soldiers made no unfavorable comments concerning comparative ease of sight adjustment, sight-setting retention or human factors engineering aspects of sighting during this exercise.

2.4.5 Analysis

2.4.5.1 Even though there were numerical differences in the accuracy data between the test and control weapons in favor of the latter, there was no demonstrated significant difference statistically, due to the small sample size. The criteria established for known distance accuracy, zeroing at 500 meters and sight system durability, reliability and effectiveness are met.

2.4.5.2 Both the test and control weapons are capable of being zeroed at 500 meters. As demonstrated in this exercise, attainment of the 500-meter zero is greatly dependent upon the marksmanship skill of the individual soldier.

SUBTEST NO 5, MAINTENANCE EVALUATION

2.5.1 Objectives

2.5.1.1 To determine the adequacy of the maintenance portion of the OMM for the test item.

2.5.1.2 To determine the comparative ease of maintenance of the test and control weapons.

2.5.2 Criteria

The test item must require no maintenance in excess of that required for the control item.

2.5.3 Method

2.5.3.1 Maintenance was performed on both the test and control items as prescribed by pertinent maintenance instructions (field manuals, technical manuals, OMMs, other). An analysis was made as to the completeness and clarity of these manuals.

2.5.3.2 Maintenance performed during the conduct of all subtests was recorded and compared (maintenance time and method were included).

2.5.3.3 During all testing, particular note was made of any difficulties in maintaining the test and control weapons or of any requirements for special tools and/or equipment.

2.5.3.4 Each test soldier was questioned as to the comparative ease of dissassembly and assembly of the project weapons and as to the nature of any difficulties encountered.

2.5.4 Results

2.5.4.1 An Operating and Maintenance Manual (OMM) accompanied each AR-18 rifle.

2.5.4.2 The OMM for the AR-18 was lacking in the following areas:

a. A lack of supplementary written instructions of pictorial description of assembly, disassembly, and operation of sights.

b. No description of sight changes (elevation and windage).

c. Lack of explanation of the operation of the bolt catch and the alternate safety and selector switch.

d. Lack of clear and complete parts list, to include corresponding photographs and numbers.

2.5.4.3 Maintenance of the AR-18 was comparable to that required by the M16A1 rifle (see chart 3-3, app I for maintenance times and methods).

2.5.4.4 No special tools or equipment were required to maintain the AR-18 test weapon.

2.5.4.5 Six test soldiers felt that the AR-18 was easier to clean and maintain. Additionally, they felt that the AR-18 was easier and less time-consuming to disassemble but was more difficult and time-consuming to assemble.

2.5.4.6 The design of the test rifle permitted ready access to its gas operating components (operating rod, operating rod spring, link, cylinder and piston assembly) for cleaning. The gas operation components of the control rifle (gas tube and carrier key) could not be completely cleaned without special equipment or removal and replacement.

2.5.5 Analysis

2.5.5.1 The test weapons meet the criteria established for maintenance.

2.5.5.2 The Operating and Maintenance Manual is incomplete. This is a shortcoming.

2.5.5.3 The test weapon is easier to disassemble because bolt group parts are released and will slide out of the upper receiver as soon as the guide rod plate, guide rods, and action springs are moved rearward.

2.5.5.4 The test weapons are slightly more difficult and time-consuming to assemble due to the greater number of parts.

2.5.5.5 The design of the gas operating components of the AR-18 rifle is superior to that of the M16A1 from the standpoint of accessibility for cleaning. This is particularly important when the gas system of an automatic weapon is subjected to fouling from firing and adverse conditions of sand, dust, mud, and water.

2.6 SUBTEST NO 6, RELIABILITY, DURABILITY, AND TRANSPORTABILITY

2.6.1 Objectives

2.6.1.1 To determine the degree to which the below listed deficiencies and shortcomings found in the previous test of the rifle, 5.56-mm, AR-18 (references 3 and 4, app IV) were corrected: (One asterisk indicates those from ref 3, app IV, and two asterisks indicate those from ref 4, app IV.)

"a. Deficiencies:

* (1) Last round bolt stop holds the bolt in rearward position while rounds remain in magazine.

* (2) Lack of durability of curved extension of buffer assembly which is used to disassemble the weapon.

* (3) Failure of extractor to extract empty cartridge case.

* (4) Lack of durability of nylon cap which holds the spring in the last round bolt stop.

* (5) Lack of durability of the stock and pistol grip (cracks and separation from weapon).

* (6) Sights could not be zeroed at 500 meter range. (Firers could not raise strike of bullet sufficiently.)

** (7) Broken guide rod weld assemblies.

** (8) Cracked lower receivers in the magazine housing and in butt plate weld.

** (9) Bolt carriers burred, preventing removal of the firing pin.

** (10) Cracked upper receiver pivot.

** (11) Cracked barrel extension.

b. Shortcomings:

* (1) Lack of insulation causes front handguard to become hot when fired excessively.

* (2) Safety and fire selector lever could not be operated when stock was folded.

* (3) Trigger pull was excessive.

* (4) Folding stock lock was not a positive lock.

* (5) Sight adjustment on front and rear sights was awkward and confusing to firers.

** (6) Sights do not have a visual scale for determining zero.

** (7) Incomplete maintenance package (no bore or chamber cleaning brush).

** (8) Incomplete POMM (no minimum requirements for training test soldiers).

** (9) Separation of upper handguard liner from upper handguard.

** (10) Excessive number of double feeds (1 in 995).

** (11) Excessive number of failures of the bolt overriding the base of the round while in magazine (1 in 1072).

** (12) Weapon fires with safety and selector switch between the SAFE and SEMI-AUTO positions.

** (13) Alternate safety and selector has no indicator."

2.6.1.2 To determine, in comparison with the control item, the transportability of the test item.

2.6.1.3 To determine the durability of the test weapon as compared to that of the control weapon.

2.6.1.4 To determine, in comparison with the control item, the reliability of the test item.

2.6.2 Criteria

2.6.2.1 The deficiencies and shortcomings found in the original rifle, 5.56-mm, AR-18 (references 3 and 4, app IV) must have been corrected.

2.6.2.2 The test item must be comparatively equal to or better than the control weapon in terms of man-portability and vehicular transportability.

2.6.2.3 The test item must be as durable or more durable than the control item when exposed to all test conditions.

2.6.2.4 In comparison with the control weapon, the test weapon must have equal or greater reliability in firing after or during exposure to all test conditions.

2.6.3 Method

2.6.3.1 During the conduct of all testing, particular attention was paid to whether the deficiencies/shortcomings cited in paragraph 2.6.1.1 were corrected.

2.6.3.2 The portability of the project weapons was compared by evaluating the ease of handling, weight balance, and compatibility with individual clothing and equipment during individual, vehicular, and heliborne transport.

2.6.3.3 Individual transport: Six combat-equipped test soldiers carried a test and a control item through 10 miles of varied terrain (hills, streams, woods, and underbrush) under the following conditions:

a. The shoulder-slung position was used for the first 2.5 miles. At the completion of the first 2.5 miles, the carrying position was changed to the ready-to-fire (a modified port arms) position and the test soldiers were required to perform a series of tactical movements, to include creeping and crawling during the second 2.5 miles. After completion of the first 5 miles, soldiers were interviewed as to their observations of man-portability of the test and control weapons. All weapons were inspected for damage.

b. The test and control weapons were exchanged and the patrol continued, again through 2.5 miles of varying terrain conditions while carrying the weapons in a manner of their choosing. During this time, the soldiers were required to double-time for 1 mile, in an attempt to observe the comparative weight-balance of the weapon in terms of assisting the soldier in overcoming any terrain obstacles encountered. The last 2.5 miles were negotiated with the soldiers holding the weapon by only 1 hand (of their choosing), in a manner so as to be capable of breaking a fall when required to go from a running position to a prone firing position. Throughout the conduct of this exercise, the test and control weapons were exposed to as many adverse conditions as possible, that would be encountered in combat. A final interview was conducted in which comparative ease of handling, weight balance, compatibility, and strength of weapon were discussed. Additionally, the weapons were checked for damage, stored overnight without maintenance, and function fired.

2.6.3.4 Vehicular transport. The test and control items (carried by 6 combat-equipped test soldiers) were tactically loaded into, transported in and off-loaded from: an armored personnel carrier (M113); and a truck, cargo, 2½-ton, 6x6 (M35A2) over an extended hilly, cross-country terrain. Each vehicle traveled 50 miles. After transport, weapons were inspected for damage and function fired. Interviews with test soldiers were oriented to ascertain the comparative ease of handling, and the compatibility of the weapons with individual clothing and equipment. Additionally, the test and control weapons were checked for comparative damage, and were function fired after unrestrained transport in the cargo compartment of a truck, M35A2 for 50 miles over unimproved, cross-country roads.

2.6.3.5 Heliborne transport. The test and control weapons were tactically loaded into, transported in, and off-loaded in a simulation of combat assault with 6 test soldiers from the UH-1D helicopter 12 times. After transport, the weapons were inspected for damage and were function fired. Interviews with test soldiers were used to evaluate comparative ease of handling and compatibility of the weapons with individual clothing and equipment.

2.6.3.6 The test and control weapons were exposed to extreme conditions of dust, sand, mud, and water, and fired for hit capability utilizing an assault course after user-maintenance was performed to the extent of assuring safety to the firer. Two assault fire exercises were conducted.

NOTE: Assault fire exercise No 1 was a move-out exercise in which a total of 80 rounds was fired by each soldier. Each firer engaged E and F silhouette-type targets firing 3- to 5-round bursts at 100 meters from the prone unsupported position, 75 meters from the kneeling unsupported position, then moving from 75 to 50 meters in the shoulder assault position and finishing moving from 50 to 25 meters from the hip assault position. Assault fire exercise No 2 was also a move-out exercise in which a total of 60 rounds was fired by each soldier. Each firer engaged E and F silhouette-type targets firing 3- to 5-round bursts while moving from 75 to 25 meters. The AR-18 was fired (from the hip) with the buttstock folded. The control weapons were also fired from the hip.

2.6.3.7 The test and control weapons were covered with dust and sand (the dust cover was closed and a magazine was inserted). The firers shook the weapon, checked to insure the bore, chamber, and receiver were free from obstruction and fired the weapon in controlled bursts as required in assault fire exercise No 1.

2.6.3.8 The project weapons, with dust cover closed and magazine inserted, were singly immersed in a barrel of water for 5 minutes. Each firer took appropriate field expedient action to free the bore, chamber, and receiver from any obstruction and negotiated assault fire exercise No 1.

2.6.3.9 Each test and control item, with dust cover closed and magazine inserted, was immersed in mud for 5 minutes. Firers cleared the bore, chamber, and receiver of any obstructions and negotiated assault fire exercise No 1.

2.6.3.10 Each weapon was dropped 5 times from the bed of a truck, M35A2 (in a manner to simulate accidental dropping), onto a grassy field. The weapon was inspected for safety hazards resulting from the fall, the zero was confirmed and the weapon was fired through assault fire exercise No 2.

2.6.3.11 Each weapon was dropped 10 times from a height of 3 feet in such a manner as to ensure that the weapon landed perpendicularly and to simulate accidental dropping during man-portability. The weapon was inspected for safety hazards, the zero was confirmed, and the weapon was fired through assault fire exercise No 2. As in all of the above described exercises, particular attention was paid to the comparative durability and reliability of the test and control weapons.

2.6.3.12 Nine test soldiers negotiated a quick fire course in a prearranged order so as to minimize interfering learning patterns. The test and control weapons were fired in the semiautomatic and automatic modes of fire using M193 ammunition. The course utilized consisted of 17 short-exposure-time (pop-up) targets located at short distances of between 20 and 80 meters from the firing points. Targets were randomly presented and exposure time was regulated by the range controller. Quick fire accuracy was recorded and compared for the test and control weapons in the semiautomatic and automatic modes of fire.

2.6.3.13 A minimum of 6,000 rounds, in a ratio of 4 M193 to 1 M196, was fired through each of the test and control weapons. The rounds fired in all subtests were counted as part of this 6,000-round total. Additionally, one each test and control weapon was fired three consecutive days, after five days storage. No maintenance was performed on either weapon during this time.

2.6.4 Results

2.6.4.1 During the individual transportability exercises, the AR-18 compared favorably with the M16A1 with the exception of the following:

a. Due to the open design of the AR-18 flash suppressor/recoil compensator, the weapon repeatedly caught on vines during all modes of carry.

b. That portion of the charging handle of the AR-18 which protrudes from the upper receiver repeatedly caught on vines, specifically noted when the weapon was carried in the modified port arms position.

c. The buttstock of the AR-18, when carried in the folded position, frequently caught on vines.

d. The hinge plate and bulkhead plunger were uncomfortable and scraped the portion of the soldiers' hands between the thumb and index finger when the AR-18 was carried in the modified port arms position (with rearmost hand on the pistol grip).

e. Due to the lack of a carrying handle and because the weapon felt barrel-heavy, the AR-18 was awkward and uncomfortable when carried in one hand.

f. Malfunctions that occurred during firing are shown in charts 3-2b and 3-2c, Appendix I.

2.6.4.2 In vehicular transport, after being loaded, transported, and off-loaded 20 times over the course of 50 miles in a truck, M35A2, no differences between the test and control weapons were observed. No malfunctions occurred during function firing.

2.6.4.3 Also in vehicular transport, the test soldiers, after being loaded into, transported in, and off-loaded from an armored personnel carrier (M113) 24 times over the course of 50 miles, observed the following unfavorable characteristics of the AR-18 rifles:

a. The hinge plate and bulkhead plunger were uncomfortable and scraped that portion of the hand between the thumb and index finger whenever the pistol grip was held during vehicle exit.

b. The weapon was awkward and uncomfortable during vehicle exit because the weight balance was to the forward portion of the weapon.

c. The protruding charging handle jabbed into the soldiers' inner thighs when the weapon was placed between the legs during transport.

d. No malfunctions occurred during function firing.

2.6.4.4 During heliborne transport, the AR-18 compared favorably in terms of ease of handling to the M16A1 with the exception of awkwardness due to weight balance being to the front of the weapon. No malfunctions occurred during function firing.

2.6.4.5 There were no differences observed between the test and control weapons in terms of ruggedness or capability to withstand normal usage and abuse. Both test and control weapons functioned satisfactorily after subjection to sand, dust, and water. After immersion in a barrel of mud for 5 minutes, none of the weapons would fire due to excessive build-up of mud in the lower receiver and bolt carrier groups.

2.6.4.6 There was a greater number of hits achieved by the test weapons during assault fire exercise No 1 (after exposure to sand, water, and mud). This data is shown in Table 2-5 below.

TABLE 2-5

HIT PROBABILITY OF TEST AND CONTROL WEAPONS
DURING ASSAULT FIRE EXERCISE NO 1

(80 rds per firer - automatic mode)

Weapon	Hits	Total Rounds	Percent
Test	166	720	23.05
Control	130	720	18.05

A significant difference exists between the test and control weapons at a 98% confidence level in favor of the test weapon.

2.6.4.7 Three control weapons sustained three different cracks in the upper handguard (hand gun guard) when dropped from the bed of a truck, M35A2, and one control weapon sustained one crack on the hand gun guard when dropped from a height of 3 feet. The zero settings for both test and control weapons were unaffected. There was no difference between project weapons in hit achievement during assault fire exercise No 2 (after dropping from truck, M35A2, and from a height of 3 feet). Results are shown in Table 2-6 below:

TABLE 2-6

HIT PROBABILITY OF TEST AND CONTROL WEAPONS
DURING ASSAULT FIRE EXERCISE NO 2

(60 rds per firer - automatic mode)

Weapon	Hits	Total Rounds	Percent
Test	74	540	13.70
Control	80	540	14.81

No significant difference exists between the test or control weapons.

2.6.4.8 Hit accuracy data and time data, as recorded during the negotiation of the quick fire course, are shown in Tables 2-7a and Table 2-7b.

2.6.4.9 A summary of malfunctions, by type and weapon, is shown in Table 2-8, page 2-23. Detailed malfunction data are reflected in chart 3-2b, Appendix I.

TABLE 2-7a

HIT ACCURACY DATA ON THE USAIB QUICK FIRE FACILITY

(averages for all firers)

Range (meters)	Weapon	Semiautomatic			Automatic		
		Hits	Total Rounds	Percent	Hits	Total Rounds	Percent
20	Test	42	82	51.21	63	183	34.42
	Control	45	92	48.91	53	192	27.60
40	Test	32	51	62.74	33	101	32.67
	Control	25	53	47.16	19	67	28.35
60	Test	19	55	34.54	19	90	21.11
	Control	12	57	21.05	17	121	14.04
80	Test	27	89	30.33	35	226	13.15
	Control	29	84	34.52	26	193	13.47
Avg	Test	120	277	43.32	150	* 600	25.00
	Control	111	286	38.87	115	* 573	20.06

* A significant difference exists in favor of test weapon (automatic mode) on overall hit probability at the 95% confidence level.

TABLE 2-7b

TIMES OF THE AR-18 AND M16A1
WHEN FIRING THE USAIB QUICK FIRE FACILITY
(time in seconds - times include all firers)

		Time to 1st Rd		Time to 1st Hit		Time between Rounds (burst)	
Range	Weapon	Semi	Auto	Semi	Auto	Semi	Auto
20	Test	*3.29	3.17	4.16	3.76	1.63	1.41
	Control	*2.89	3.17	3.94	4.01	1.66	1.62
40	Test	3.93	3.12	4.14	3.95	1.63	1.57
	Control	3.47	3.55	4.37	4.16	1.64	1.93
60	Test	3.10	3.15	5.08	4.10	1.75	1.67
	Control	3.25	3.10	4.46	4.36	1.67	1.39
80	Test	3.41	3.27	5.11	4.70	*1.65	1.69
	Control	3.16	3.08	4.98	5.34	*1.90	1.78
Avg	Test	*3.40	3.19	4.53	4.10	1.66	1.60
	Control	*3.14	3.20	4.35	4.39	1.74	1.66

* A significant difference at a 90% confidence level.

a. In time to 1st round, there was a significant difference in the test and control weapons in favor of the test weapon at a range of 20 meters in the semiautomatic mode of fire.

b. No significant difference exists in the times to 1st hit.

c. There was a significant difference at a range of 80 meters in favor of the the test weapon in the semiautomatic mode of fire.

TABLE 2-8

MALFUNCTIONS BY TYPE, WEAPON, AND FIRING MODE

(See chart 3-2a, app I, page I-3 for key to malfunction type)

NOTE: Total rounds fired: Control - 18,758; Test - 18,297

Malfunction Type	Control			Test		
	Mode of Fire			Mode of Fire		
	SEMI	AUTO	TOTAL	SEMI	AUTO	TOTAL
FF	7	3	10	15	17	32
DF	1	2	3	6	4	10
FFR	0	2	2	8	6	14
FBR	0	3	3	2	2	4
FBF	0	2	2	-	-	0
FJ	0	5	5	1	7	8
SR	13	0	13	0	1	1
BCS	0	1	1	-	-	0
IFR (cook-off)	0	2	2	-	-	0
TOTAL	21	20	41	32	37	69

Some of the above listed failures to feed (FF) were suspected to have been due to faulty magazines; however, a definite determination as to the exact number so caused could not be made.

The malfunction rate of the control rifle was 1 per 458 rounds fired, and that of the test rifle was 1 per 265 rounds fired.

2.6.4.10 During the 6,000-round reliability firing, one each test and control weapon was fired 3 consecutive days after 5 days storage. No maintenance was performed during this period. A total of 2623 rounds was fired through the test weapon, while 2407 rounds were fired through the control weapon. This firing was done in a mixed semiautomatic and automatic mode. Three malfunctions occurred with the control weapon, while seven malfunctions occurred in the test weapon. The test weapon was slightly dirtier due to carbon build-up in the receiver group.

2.6.4.11 Breakages of the test and control weapons are listed below. See chart 3-2b, Appendix I, for detailed data relative to these breakages.

a. Test Weapons (with number of occurrences from a total of 11)

(1) Broken safety casting (1). (see fig 6, app I)

(2) Broken weld between charging handle and charging handle key (1). (see figs 8 and 9, app I)

(3) Broken firing pin spring (2). (see fig 10, app I)

(4) Inoperable safety lever snap ring (1). (see fig 7, app I)

(5) Bulkhead plunger retaining pin came out of the bulkhead receiver (1).

(6) Broken automatic sear (1). (see fig 11, app I)

(7) Broken hammer (1). (see fig 12, app I)

(8) Rear sight snap ring fell off (1). (see fig 13, app I)

(9) Broken welds between bulkhead receiver and bulkhead plate (1). (see fig 14, app I)

(10) Cement compound between buttstock and butt plate is weak (see fig 15, app I)

b. Control Weapons (with number of occurrences from a total of 4)

(1) Broken extractor spring (1).

(2) Cracked hand gun guards (3).

2.6.5 Analysis

2.6.5.1 The following previously reported 10 deficiencies and 6 shortcomings of the test rifle have been corrected (and were not observed during testing):

a. Deficiencies:

(1) Last round bolt stop holds the bolt in rearward position while rounds remain in magazine.

(2) Lack of durability of curved extension of buffer assembly which is used to disassemble the weapon.

(3) Failure of extractor to extract empty cartridge case.

(4) Lack of durability of nylon cap which holds the spring in the last round bolt stop.

(5) Lack of durability of the stock and pistol grip (cracks and separation from weapon).

(6) Sights could not be zeroed at 500 meter range. (Firers could not raise strike of bullet sufficiently.)

(7) Broken guide rod weld assemblies.

(8) Bolt carriers burred, preventing removal of the firing pin.

(9) Cracked upper receiver pivot.

(10) Cracked barrel extension.

b. Shortcomings:

(1) Safety and fire selector lever could not be operated when stock was folded.

(2) Folding stock did not have a positive lock.

(3) Incomplete maintenance package (no bore or chamber cleaning brush).

(4) Separation of upper handguard liner from upper handguard.

(5) Excessive number of double feeds.

(6) Excessive number of failures to feed with bolt overriding the base of the cartridge.

2.6.5.2 The test rifle still exhibits the following deficiency and 9 shortcomings:

a. Deficiency: lacks durability (as shown by excessive number of breakages listed in paragraph 2.6.4.11).

b. Shortcomings:

(1) Heat transfer is excessive in sustained firing.

(2) Trigger pull is excessive.

(3) Sight adjustment on rear sight is awkward and confusing to firers.

(4) Sight does not have a clearly readable visual scale for determining zero.

(5) Incomplete maintenance package (no small arms maintenance equipment case).

(6) Incomplete OMM (see results in paragraph 2.5.4.2).

(7) Weapon fires with safety and selector switch between the SAFE and SEMI positions.

(8) Alternate safety and selector switch has no indicator.

(9) Lack of durability in bulkhead plate; specifically, broken welds.

2.6.5.3 The test weapon is inferior to the control weapon in terms of transportability because of the following:

a. The AR-18 is barrel-heavy when carried in one hand.

b. The AR-18 does not have a carrying handle.

c. The open-end flash suppressor catches in vegetation.

d. The hinge plate and bulkhead plunger scrape the soldiers' hand when using the pistol grip for support in carrying the weapon.

2.6.5.4 The test weapon is comparable to the control weapon in terms of zero-setting retention, semiautomatic quick fire accuracy, and assault fire hit probability.

2.6.5.5 The test weapon is superior to the control weapon in terms of automatic fire accuracy, and compactness when the stock is folded.

2.6.5.6 The control weapon is superior to the test weapon in terms of durability and reliability (fewer breakages and malfunctions).

2.7 SUBTEST NO 7, BAYONET EMPLOYMENT

2.7.1 Objective

To determine comparative characteristics of the test and control weapons in regard to bayonet employment.

2.7.2 Criteria

The test item must compare favorably to the control weapon in terms of handling and durability characteristics.

2.7.3 Method

The test soldiers received training in the prescribed bayonet drills and negotiated a standard bayonet course as outlined in FM 21-150 dated March 1969 and Army Subject Schedule No 21-150 used by the Leadership Committee of the US Army Infantry School, Fort Benning, Georgia. The test soldiers negotiated the bayonet course in a random manner with both a test and a control weapon so as to ensure that observations made and questions answered would be totally objective and not biased by favoritism or learning factors.

2.7.4 Results

2.7.4.1 These comments and observations were made by the test soldiers concerning the handling characteristics of the test rifle compared with those of the control rifle in bayonet course use:

a. The additional weight of the test rifle coupled with the center of balance (forward) was noticeable when they became tired during negotiation of the course. This was particularly noticeable in the execution of the buttstroke movements.

b. The hinge plate and bulkhead plunger of the test rifle pressed into the rearmost hand and caused discomfort to the soldier when executing the basic bayonet movements.

2.7.4.2 No breakages were experienced with either the test or the control rifles in this subtest.

2.7.5 Analysis

The test and control rifles are comparable for bayonet training use, with a slight advantage to the control rifle due to better weight balance.

2.8 SUBTEST NO 8, HUMAN FACTORS ENGINEERING

2.8.1 Objective

To determine the comparative characteristics of the test and control weapon with respect to the capabilities, limitations, and habit patterns of the human operator.

2.8.2 Criteria

2.8.2.1 The human factors engineering characteristics of the test weapon must be equal to or better than those of the control weapon.

2.8.2.2 The test weapon must be equipped with comparatively easily identifiable and conveniently located safety(s), firing mechanisms and sights, so that:

a. Firing can be accomplished from either shoulder, at all ranges, from any standard firing position.

b. They are located and operated by sight and touch while firers are using necessary protective clothing, to include temperate winter clothing and while firers are operating during hours of reduced visibility.

2.8.2.3 The flash and noise of the test item must be equal to or less than that of the control weapon.

2.8.2.4 The test item must be equal to or less than the control item in terms of recoil energy, as felt by the firer.

2.8.2.5 The comparative ejection pattern of the test weapon must be such as to offer less or equal interference with adjacent firers or with the firer's ability to fire accurately.

2.8.2.6 Heat transfer and heat absorption of the test weapon must be equal to or less than that of the control weapon.

2.8.3 Method

2.8.3.1 Throughout the conduct of all testing, observations were made and questions were asked about the compatibility of the test and control weapons with respect to the inherent skills and limitations of the test soldiers.

2.8.3.2 Special note was made in all subtests with respect to capability for right or left shoulder fire at all ranges and from all firing positions, ease of making sight changes, ease of handling and operating the controls, and ease of maintenance.

2.8.3.3 Test soldiers fired both test and control weapons semiautomatically and automatically for a period of 30 minutes while wearing the CB protective mask. Observations concerning the firing ability of both weapons were made and compared.

2.8.3.4 Test soldiers fired the project weapons during hours of limited visibility to compare the noise and flash characteristics and to compare the ease of handling and manipulation of the weapons, sights, and magazines. Observers were stationed down range to evaluate the noise and blast characteristics during firing. Photographs of the comparative muzzle flash were taken. The camera was positioned on the right flank of the firing position.

2.8.3.5 During the conduct of all testing, the test soldiers were observed and interviewed concerning any discomfort, especially in respect to recoil felt when firing the test and control weapons.

2.8.3.6 Project weapons were fired in pairs with the control weapon on the left and the test weapon 5 meters away on the right. Test and control weapons were rotated until all test weapons had been fired to the left of a control weapon. Observations and interviews were made to determine the amount, if any, of interference caused by the cartridge ejection patterns in both the test and control weapons. A comparison of findings was made.

2.8.3.7 During all testing particular attention was paid to any difficulties in handling which resulted from heat transfer from firing or from heat absorption from environmental conditions. Comparative findings were recorded.

2.8.4 Results

2.8.4.1 As reflected by the end-of-test questionnaire, the following human factors engineering characteristics of the AR-18 rifle were preferred by the test soldiers (the numbers in parentheses indicate how many of the 9-man sample preferred each characteristic):

a. Ease of disassembly and assembly, to include accessibility to the gas system (6 of 9).

b. Ease of operating controls (6 of 9).

c. Ease of sight alignment (5 of 9).

d. Ease of operation and target engagement during hours of limited visibility (6 of 9).

e. Spent cartridge ejection (8 of 9).

f. Ease of cleaning and maintenance (6 of 9).

g. Ease of sight adjustment - front sight only (7 of 9).

2.8.4.2 The following characteristics of the AR-18 rifles, as stated in the final questionnaire, were considered to be unfavorable by the test soldiers (the number in parentheses indicate that portion of the sample which noted the unfavorable characteristic):

a. Weight and balance in transport, firing, and bayonet employment (9 of 9).

b. Excessive trigger pull (8 of 9).

c. Comfort, to include: greater heat transfer; more felt recoil; and weapon parts (bulkhead receiver) that pinched or bruised hand during transport and firing (8 of 9).

d. Difficulty in loading and charging; specifically, lack of easily operable bolt catch (8 of 9).

e. Lack of parts durability, resulting in more breakages (8 of 9).

f. Difficulty in rear sight adjustment (7 of 9).

g. Difficulty in reloading; especially during assault fire, due to difficulty in magazine removal (4 of 9).

h. Excessive noise due to loose external parts (1 of 9).

2.8.4.3 The following are additional unfavorable characteristics which were observed by personnel administering this test:

a. As stated in Subtest 2, confusing rear sight drum due to lack of numbering, and lack of unobstructed rear sight windage scale.

b. As stated in Subtest 3, lack of easily identifiable position indicator on the alternate safety and selector switch.

c. Open design of flash suppressor/recoil compensator caught on vines and underbrush (Subtest 6).

d. In cases of clearing malfunctions, inspection of the receiver and loading, operation was hindered because the bolt catch was not easily accessible. Firers had to put their fingers in the magazine well in order to activate the bolt catch.

e. Loose external parts caused excessive noise (rattling). This would be particularly objectionable during night operations.

f. In the assault role, with the buttstock folded, the bulkhead receiver scraped the individuals' hands and hips.

g. To the observers positioned down range during the night-fire exercise, the AR-18 had a slightly louder noise effect than the M16A1. No discernable difference in flash was observed; however, photographs reveal a slight difference (see figs 16 and 17, app I).

h. On occasion, the charging handle jammed on the dust cover (when movement of the dust cover was restricted by firers' hands) and failed to move rearward.

2.8.4.4 No difference in ease of operation existed between the test and control weapons when fired by soldiers equipped with protective mask.

2.8.5 Analysis

2.8.5.1 The test weapons fail to meet certain human factors engineering criteria due to the following unfavorable characteristics:

a. The noise signature effect of the AR-18 rifle is greater than that of the M16A1 rifle.

b. The AR-18 has more felt recoil than the M16A1.

c. Heat transfer from the barrel to the front handguard of the AR-18 rifle is excessive to the extent of being a latent safety hazard (see Subtest 3, Safety).

2.8.5.2 Other characteristics that compare unfavorably to the M16A1 are as follows:

a. The AR-18 bulkhead plate is uncomfortable during transport, firing, and bayonet employment.

b. The AR-18 does not have an easily operable bolt catch.

c. The AR-18 is barrel-heavy.

d. The rear sight of the AR-18 is awkward and confusing to adjust.

e. The magazine will not slide out of the magazine well without assistance when magazine release is depressed.

f. Trigger pull is excessive.

g. The alternate safety and selector switch has no position indicator.

h. The flash suppressor/recoil compensator is open.

i. The external parts are loose and noisy.

j. The charging handle jams occasionally on the dust cover.

2.8.5.3 The AR-18 compares favorably with or surpasses the M16A1 in terms of human factors engineering in the following characteristics:

a. Ease of cleaning and maintenance, to include disassembly and less carbon build-up.

b. Operation of controls, to include two separate safety and selector switches, which is especially noticed during hours of limited visibility.

c. Has folding stock for more compact transport.

d. Has lower line of sight which affords better quick fire accuracy in the automatic mode.

e. Ejection of spent cartridges to right front is less interfering, particularly to the left-handed firer.

f. The amount of muzzle flash is equal to or less than the M16A1 (see figs 16 and 17, app I).

g. Ease of operation; specifically, sighting by firers equipped with protective mask (no difference noted); and, in terms of compatibility with individual clothing and equipment to include gloves, shell with inserts.

h. Ease of accessibility to the gas system.

SECTION 3. APPENDICES

APPENDIX I. TEST DATA

CHART 3-1

METEOROLOGICAL CONDITIONS DURING FIRING

Date	Weapon Exposure Time (hrs)	Temperature High	Temperature Low	Average Humidity	Winds Direction/Speed	Rain (inches)
4 Dec	3.5	56	29	21%	NE/5 knots	0
5 Dec	7.25	53	27	22%	NE/6 knots	0
6 Dec	4.0	54	41	90%	NE/6 knots	.21
8 Dec	8.5	46	44	70%	NW/7 knots	-
9 Dec	6.5	50	30	69%	NE/6 knots	-
10 Dec	6.5	50	45	95%	NE/12 knots	.59
11 Dec	3.0	63	49	45%	NW/5 knots	-
12 Dec	4.0	56	30	53%	NE/14 knots	-
15 Dec	6.0	60	29	52%	NE/6 knots	-
16 Dec	12.0	58	31	61%	SW/4 knots	-
17 Dec	7.0	56	24	57%	NE/4 knots	-
18 Dec	2.0	62	26	71%	Negligible	-
19 Dec	1.75	62	37	75%	NW/4 knots	-
20 Dec	2.5	42	39	70%	10 to 20, gusting	-
22 Dec	4.5	43	38	50%	NW/10 knots	less than .005
23 Dec	4.5	54	28	70%	variable/ 5 knots	-
29 Dec	4.0	73	41	67%	N/3 knots	-
30 Dec	4.0	76	66	75%	S/20 knots	.054
31 Dec	4.0	46	44	72%	NW/8 knots	.061
Average	5.0/day	55.8	36.7	62.5%		.048/day

CHART 3-2a

KEY TO MALFUNCTION CHART 3-2b, 3-2c, AND TABLE 2-8

FF	-	Failure to feed
FF sr	-	Failure to feed, snubbed round
FFR	-	Failure to fire
FX	-	Failure to extract
FJ	-	Failure to eject
FJ sb	-	Failure to eject, spin back
FBC	-	Failure of bolt to close
SR *	-	Short recoil
IFR	-	Inadvertent firing
FMR	-	Failure to maintain cyclic rate
BUB *	-	Bolt underrode base of round in feeding
DF	-	Double feed, two rounds fed from magazine at once
BCE *	-	Bolt catch engaged bolt carrier instead of bolt after firing the last round in the magazine
BFE *	-	Bolt failed to engage base of round in magazine
BLE *	-	Bolt lacked sufficient energy to force round from magazine
BOB *	-	Bolt overrode base of round in feeding from magazine
FBF	-	Failure of bolt to go forward
FBR	-	Failure of bolt to remain at rear after last round
FCB	-	Failure on closure of bolt
FJC	-	Failure to eject clip
FML **	-	Failure of the magazine to lock in rifle
FTR	-	Failure of trigger to return to forward position
F2R	-	Fired 2 rounds on one rearward movement of trigger
BCS	-	Bolt catch stopped forward movement of bolt before last round of magazine was fired
FS	-	Failure to strip round
FSO	-	Failure of bolt to sear off
FFO *	-	Failure to feed round over to stripping position
FBS	-	Failure of bolt to sear
FRA	-	Failure to remain in assembly
FL *	-	Failure to load by hand charging
PS *	-	Partial strip of round from link

* Most frequently described as the cause of a malfunction, rather than a malfunction itself. For example, a failure to feed due to the bolt overriding the base of a round in feeding from a magazine would be abbreviated as FF (BOB).

** Cause of FF on some occasions.

CHART 3-2b

MALFUNCTIONS AND PART BREAKAGES

(See chart 3-2a, app I, page I-3 for key to malfunction type)

NOTE: Remarks are reflected in remarks section, paragraph c, page I-9

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
a. Control (M16A1)						
FF mag	C-1	5 seconds	S/A	1,038	Unknown	ST 6
FF mag	C-1	15 seconds	S/A	1,249	Unknown	ST 6
FBR	C-1	10 seconds	A	1,258	0	ST 6
FBF	C-1	1 second	A	3,519	19	ST 6
FF	C-1	1 second	S/A	4,530	Unknown	ST 8
DF	C-1	10 seconds	A	5,861	17	ST 8
FBR	C-1	2 seconds	A	5,878	0	ST 8
IFR (cook-off)	C-1	5 seconds	A	5,881	16	ST 8
IFR (cook-off)	C-1	6 seconds	A	5,882	15	ST 8
FF mag	C-2	3 seconds	S/A	839	19	ST 6
FF mag	C-2	2 seconds	S/A	840	18	ST 6
FF mag	C-2	25 seconds	S/A	841	17	ST 6
SR (13 ea)	C-2	1 - 2 seconds (each)	S/A	869 - 881	19 - 7	ST 6
	NOTE: After the 13th SR malfunction, 2 minutes were required to disassemble and lubricate the hammer.					
FBF	C-2	4 mins, 35 sec (see remarks #13)	A	3,888	19	ST 6
FF mag	C-2	7 seconds	A	3,974	19	ST 6
FF mag	C-2	1 second	S/A	4,584	19	ST 8

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
FFR	C-3	3 seconds	A	106	4	ST 1
FFR	C-3	5 seconds	A	1,805	1	ST 6
DF	C-3	6 seconds	S/A	3,531	7	ST 6
FF mag	C-3	25 seconds	A	3,932	19	ST 6
FF mag	C-3	3 seconds	A	3,933	18	ST 6
FBR	C-3	2 seconds	A	3,952	0	ST 6
FJ	C-3	15 seconds	A	4,129	6	ST 6
FJ	C-3	20 seconds	A	4,131	4	ST 6
FJ	C-3	5 seconds	A	4,133	2	ST 6
FJ	C-3	3 seconds	A	4,135	0	ST 6
FJ	C-3	3 seconds	A	4,137	18	ST 6
		NOTE: The last five FJ were due to broken extractor spring. Total time to repair was 12 minutes. See Remarks #14.				
BCS	C-3	25 seconds	A	4,615 (after)	1	ST 8
DF	C-3	5 seconds	A	5,232	Unknown	ST 8

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
b. Test (AR-18)						
Breakage	T-1	See Remarks #1	S/A	978	0	ST 6
FF mag	T-1	15 seconds	A	984	14	ST 6
FF mag	T-1	5 seconds	A	989	9	ST 6
FFR	T-1	10 seconds	S/A	1,425	9	ST 6
Ex T Pull	T-1	See Remarks #2	S/A	2,003	9	ST 6
FF sr	T-1	6 seconds	A	2,344	16	ST 6
FF sr	T-1	6 seconds	A	2,345	15	ST 6

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
FBR	T-1	5 seconds	A	2,440	0	ST 6
DF	T-1	3 seconds	S/A	3,058	11	ST 6
DF	T-1	3 seconds	S/A	3,060	9	ST 6
DF	T-1	3 seconds	S/A	3,175	16	ST 6
FF	T-1	3 seconds	S/A	3,191	16	ST 6
Breakage	T-1	See Remarks #3&4	N/A	3,562	N/A	ST 6
FFR	T-1	7 seconds	A	3,573	15	ST 6
FFR	T-1	11 seconds	A	3,603	4	ST 6
FF mag	T-1	5 seconds	A	3,743	2	ST 6
FFR	T-1	37 seconds	A	3,751	19	ST 6
DF	T-1	1 min, 20 secs	A	3,752	18	ST 6
FF	T-1	19 seconds	S/A	3,847	2	ST 6
FF	T-1	6 seconds	A	4,104	17	ST 6
DF	T-1	2 min, 45 secs	A	4,193	17	ST 6
Ex T Pull	T-1	30 seconds	S/A	4,523	0	ST 8
DF	T-1	14 seconds	A	4,525	17	ST 8
FF mag	T-1	22 seconds	A	4,820	19	ST 8
FFR	T-1	10 seconds	A	4,837	2	ST 8
FF	T-1	35 seconds	A	4,845	14	ST 8
FFR	T-1	6 seconds	A	5,020	5	ST 8
DF	T-1	5 seconds	S/A	5,538	18	ST 8
FF sr	T-1	8 seconds	S/A	6,118	3	ST 8
FFR	T-1	3 seconds	S/A	6,119	2	ST 8

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
FJ	T-2	15 seconds	A	1,618	Unknown	ST 6
FF sr	T-2	2 seconds	S/A	3,059	18	ST 6
Heat Tran	T-2	See Remarks #5	S/A	3,356	Unknown	ST 6
Breakage	T-2	See Remarks #6	S/A	3,507	Unknown	ST 6
FF(FBC)	T-2	25 seconds	A	4,022	19	ST 6
FF(FBC)	T-2	20 seconds	A	4,023	18	ST 6
FJ	T-2	4 seconds	A	4,024	17	ST 6
FJ	T-2	6 seconds	A	4,025	16	ST 6
FJ	T-2	4 seconds	A	4,027	14	ST 6
FJ	T-2	4 seconds	A	4,029	12	ST 6
FJ	T-2	3 seconds	A	4,030	11	ST 6
FJ sb	T-2	5 seconds	A	5,205	Unknown	ST 8
FF	T-2	5 seconds	A	5,206	Unknown	ST 8
FF	T-2	6 seconds	A	5,207	Unknown	ST 8
FJ sb	T-2	7 seconds	S/A	5,510	12	ST 8
Breakage	T-2	See Remarks #7	S/A	5,622	Unknown	ST 8
FF	T-2	10 seconds	S/A	5,765	Unknown	ST 8
FFR	T-2	4 - 6 seconds	S/A	6116 - 6120	19 to 15	ST 8
Breakage	T-2	See Remarks #8	S/A	6,121	15	N/A
Breakage	T-2	See Remarks #9&10	S/A	6,121	N/A	N/A
FF	T-3	26 seconds	S/A	790	3	ST 4
DF	T-3	30 seconds	S/A	955	11	ST 6

Type	Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
FFR	T-3	10 seconds	S/A	958	8	ST 6
FF	T-3	3 seconds	S/A	969	17	ST 6
FF	T-3	3 seconds	S/A	971	15	ST 6
FF	T-3	2 seconds	S/A	975	11	ST 6
FF	T-3	2 seconds	S/A	980	6	ST 6
FBR	T-3	3 seconds	S/A	986	0	ST 6
FF	T-3	3 seconds	S/A	989	17	ST 6
FF	T-3	3 seconds	S/A	997	9	ST 6
FF	T-3	3 seconds	S/A	999	7	ST 6
FBR	T-3	3 seconds	S/A	1,006	0	ST 6
FF	T-3	4 seconds	A	1,026	19	ST 6
FF	T-3	3 seconds	A	1,029	16	ST 6
FF	T-3	3 seconds	A	1,033	12	ST 6
FF	T-3	3 seconds	A	1,037	8	ST 6
FBR	T-3	3 seconds	A	1,045	0	ST 6
NOTE: Due to the number of consecutive malfunctions above, 3 minutes were required for lubrication at this point.						
Heat Tran	T-3	See Remarks #5	S/A	3,772	(after 23 min)	ST 6
FF sr	T-3	6 seconds	S/A	4,092	Unknown	ST 6
SR	T-3	2 min, 15 sec (see breakage below)	A	4,273	18	ST 6
Breakage	T-3	See Remarks #11	A	4,273	N/A	ST 6
DF	T-3	19 seconds	A	4,364	11	ST 6
FFR	T-3	3 seconds	A	4,393	2	ST 6

Type Weapon	Time to Reduce	Mode of Fire	Round Count	Rounds in Magazine	Applicable Subtest
FF(BOB) T-3	5 seconds	A	4,932	1	ST 8
FF mag T-3	7 seconds	S/A	5,764	Unknown	ST 8
DF T-3	10 seconds	S/A	5,766	Unknown	ST 8
Breakage T-3	See Remarks #12	N/A	6,000	N/A	N/A

c. Remarks

1. (T-1) Broken safety casting occurred on 978th round (empty magazine). Four minutes were used (shipping time for replacement part not included) for identification and replacement. This weapon failure occurred during semiautomatic function firing following a 10-mile transportability exercise in Subtest No 6. The weapon remained operable.

2. (T-1) Excessive trigger pull was observed after firing 2,003 rounds during transportability function firing. This condition was reduced by lubrication of the trigger housing in 2 minutes and 30 seconds.

3. (T-1) Lost charging handle key resulting from separation of weld between charging handle and its key was observed prior to reliability firing (3,562 rounds). This failure required approximately 2 minutes to identify and correct (shipping time excluded) and rendered the weapon inoperable.

4. (T-1) A broken firing pin spring was noticed during maintenance after reliability firing (3,562 rounds). This in no apparent way hindered the operation of the rifle. Repair time for this failure was approximately 45 seconds (no shipping time, only that needed to put new spring in and assemble weapon).

5. (T-2 and T-3) Heat transfer. The test weapons could no longer be held by the hand guard assemblies after the weapons were fired semiautomatically (firing the approximate maximum sustained rate of fire) for 23 minutes for a total of 220 rounds. The weapons were fired again after a 15-minute cooling period.

6. (T-2) Prior to reliability firing, on round number 3,507, a failure occurred in that the safety lever snap ring lost its tolerance and fell off the weapon. It could not be replaced, and after the alternate selector switch was removed, the firing was resumed. This failure required 35 seconds to reduce (only replacement of new part, not shipment).

7. (T-2) The bulkhead plunger retaining pin (a part of the bulkhead receiver) fell out and caused the bulkhead plunger and plunger spring to also fall from the weapon. This weapon failure occurred on round number 5,622, during human factors engineering firing.

8. (T-2) Since the minimum number of rounds had been fired (6,000), the automatic sear which occurred during human factors firing was not replaced. A total of 6,121 rounds had been fired to this point.

9. (T-2) Additionally, at the final technical inspection (6,121 rounds) the rear sight snap ring had fallen off causing a stripping effect of the rear sight drum on the rear sight screw.

10. (T-2) The bulkhead plate separated from the bulkhead receiver at the 4 spot welds (round count 6,121). This part, due to test being completed, was not repaired.

11. (T-3) During semiautomatic firing, after a short recoil/failure to cock, a broken hammer was observed. This failure took 4 minutes to identify and replace (shipping time not included). Round count was 4,273 rounds.

12. (T-2) A broken firing pin spring was observed during maintenance after human factors/reliability firing (6,000 rounds). This failure required approximately 45 seconds to reduce (part replacement).

13. (C-3) Excessive reduction time was due to inoperable condition (bolt would not go forward) after immersion in mud for 5 minutes. (Dust cover was closed and magazine was inserted. See paragraph 2.6.3.9.)

14. (C-3) A broken extractor spring was observed to be the cause of 5 consecutive failures to eject. Twelve minutes were required to identify and replace this breakage.

CHART 3-2c

MALFUNCTIONS BY SUBTEST AND TYPE

(See chart 3-2a, app I, page I-3 for key to malfunction type)

Applicable Subtest	Weapon	Malfunction Type
ST 2 Training	C-3	1-FFR
ST 4 K.D. Acc	T-3	1-FF
ST 6 Transport-ability	T-1	4-FF, 1-FBR, 2-FFR
	T-2	1-FJ, 1-FF
	T-3	1-DF, 11-FF, 3-FBR, 1-FFR
	C-1	2-FF, 1-FBR
	C-2	3-FF, 13-SR (failure to cock)
	C-3	1-FFR
ST 6 Durability	T-1	5-DF, 4-FF, 2-FFR
	T-2	2-FF, 5-FJ
	T-3	None
	C-1	1-FBF
	C-2	1-FBR, 1-FF
	C-3	2-FF, 1-FBR
ST 6 Reliability	T-1	None
	T-2	None
	T-3	1-FF, 1-SR
	C-1	None
	C-2	None
	C-3	5-FJ, 1-DF
ST 8 Human Factors	T-1	3-FF, 3-FFR, 2-DF
	T-2	2-FJ, 3-FF, 5-FFR
	T-3	2-FF, 2-DF, 1-FFR
	C-1	1-FF, 1-DF, 1-FBR, 2-IFR
	C-2	1-FF
	C-3	1-DF, 1-BCS

CHART 3-3

OPERATOR MAINTENANCE

(Round count when general (G) or detailed (D) maintenance was performed)

	Control Weapon M16A1			Test Weapon AR-18		
Date	C-1	C-2	C-3	T-1	T-2	T-3
4 Dec	186 G	183 G	188 G	180 G	180 G	179 G
5 Dec	264 G	285 G	287 G	317 G	282 G	293 G
6 Dec	531 G	511 G	556 G	589 G	560 G	573 G
8 Dec	809 G	760 G	830 G	849 G	720 G	904 G
9 Dec	893 G	818 G	890 G	926 G	797 G	952 G
11 Dec	998 D	923 D	995 D	1029 D	942 D	1057 D
12 Dec	1175 G	1091 G	1166 G	1246 G	1128 D	1228 D
15 Dec	1218 G	1151 G	1186 G	1266 G	1148 D	1248
16 Dec	1695 G	1551 G	1686 G	1780 G	1808 D	1878 D
17 Dec	2655 G	2591 G	2645 G	2823 D	2808 D	2902 D
18 Dec	3501 G	3437 G	3478 G	3553 D	3617 D	4111 D
19 Dec	3501 G	3710 G	3751 G	3553 G	3837 D	4331 D
22 Dec	3872	3710 G	3751 G	3553	3837 D	4331 D
23 Dec	4056	3888 G	3952 G	3744	4028 G	4334
29 Dec	4337	4205 G	4250 G	4240	4825 G	4334
30 Dec	5637	5165 D	5210 D	5157	5482 D	5272 D
31 Dec	6279 D	6249 D	6230 D	6176 D	6121 D	6000 D
5 Jan	6279 D	6249 D	6230 D	6176 D	6121 D	6000 D
6 Jan	6279 D	6249 D	6230 D	6176 D	6121 D	6000 D

	CONTROL	TEST
Average time in minutes for general	13.6	14.3
Average time in minutes for detail	39.7	28.0
Shortest time in minutes for one cleaning	5.0 (C-3	6.0 (T-3)
Longest time in minutes for one cleaning	63.0 (C-2)	55.0 (T-1 and T-2)

NOTE: General maintenance (G) was that involving minimum essential disassembly. Detailed maintenance (D) was that involving maximum field stripping permitted of the operator.

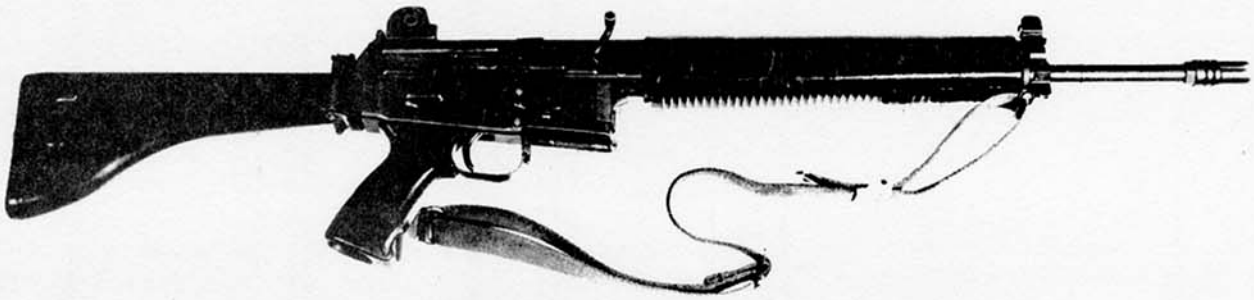

Figure 1

Right Side View of Rifle, 5.56-mm, AR-18

Figure 2

Right Side View of Rifles

A. Rifle, 5.56-mm, M16A1

B. Rifle, 5.56-mm, AR-18

C. Rifle, 5.56-mm, AR-18 with buttstock folded

Figure 3

Left Side View of Rifles

A. Rifle, 5.56-mm, M16A1

B. Rifle, 5.56-mm, AR-18

C. Rifle, 5.56-mm, AR-18 with buttstock folded

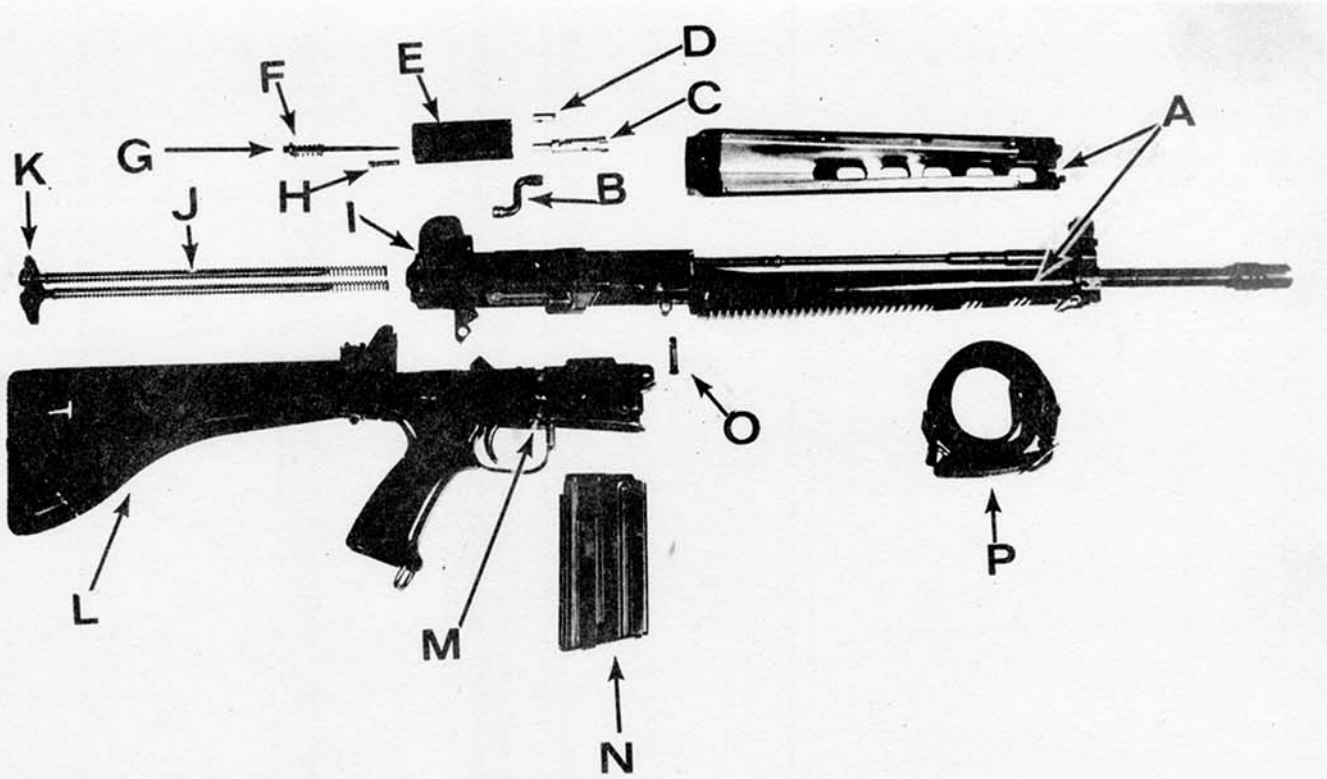

Figure 4

Rifle, 5.56-mm AR-18
(Disassembled)

A. Upper and lower handguard
B. Charging handle
C. Bolt
D. Cam pin
E. Bolt carrier
F. Firing pin spring
G. Firing pin
H. Takedown pin
I. Upper receiver
J. Guide rod and action springs
K. Guide rod plate
L. Buttstock
M. Lower receiver
N. Magazine
O. Takedown pin, upper and lower receivers
P. Rifle sling

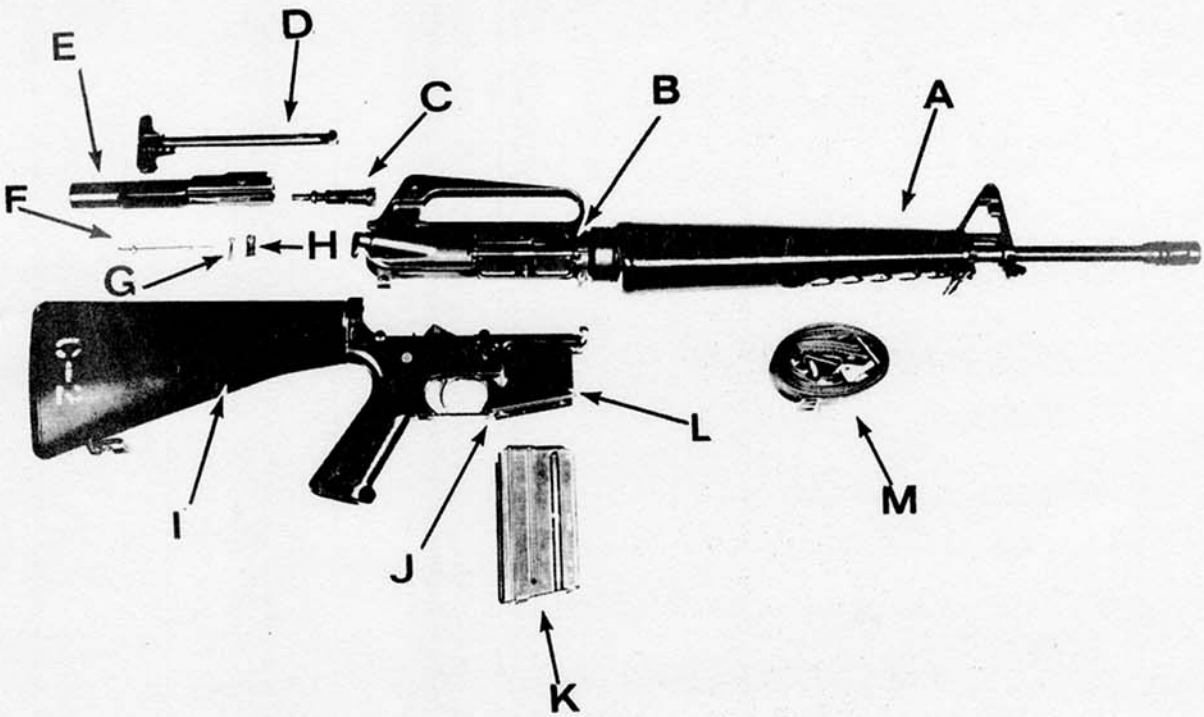

Figure 5

Rifle, 5.56-mm, M16A1
(Disassembled)

A. Hand gun guard
B. Upper receiver
C. Bolt
D. Charging handle
E. Bolt carrier
F. Firing pin
G. Firing pin retaining pin
H. Cam pin
I. Buttstock
J. Lower receiver
K. Rifle magazine
L. Magazine well
M. Rifle sling

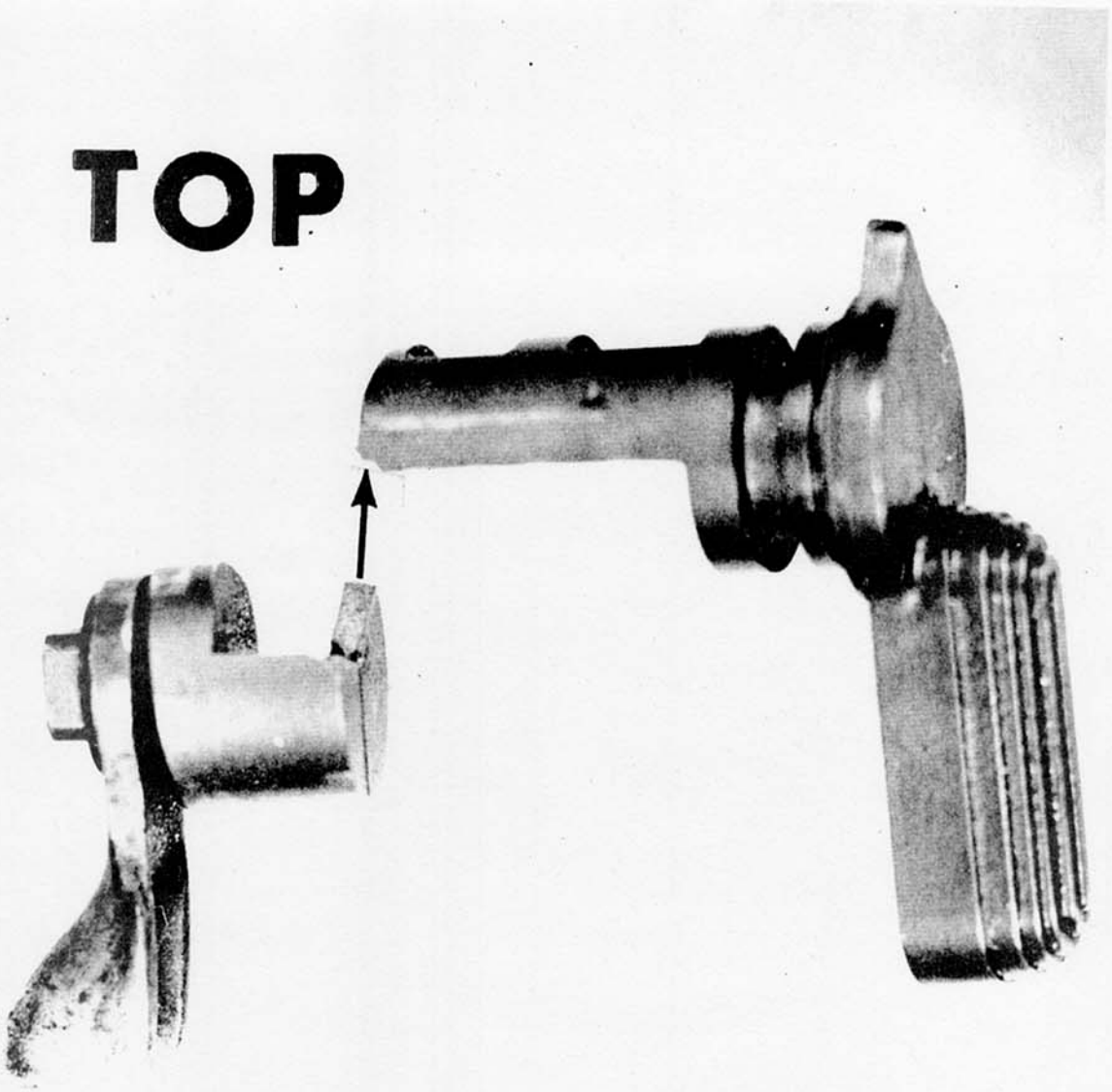

Figure 6

Broken Safety Casting from Rifle, 5.56-mm, AR-18

Arrow indicates area of breakage

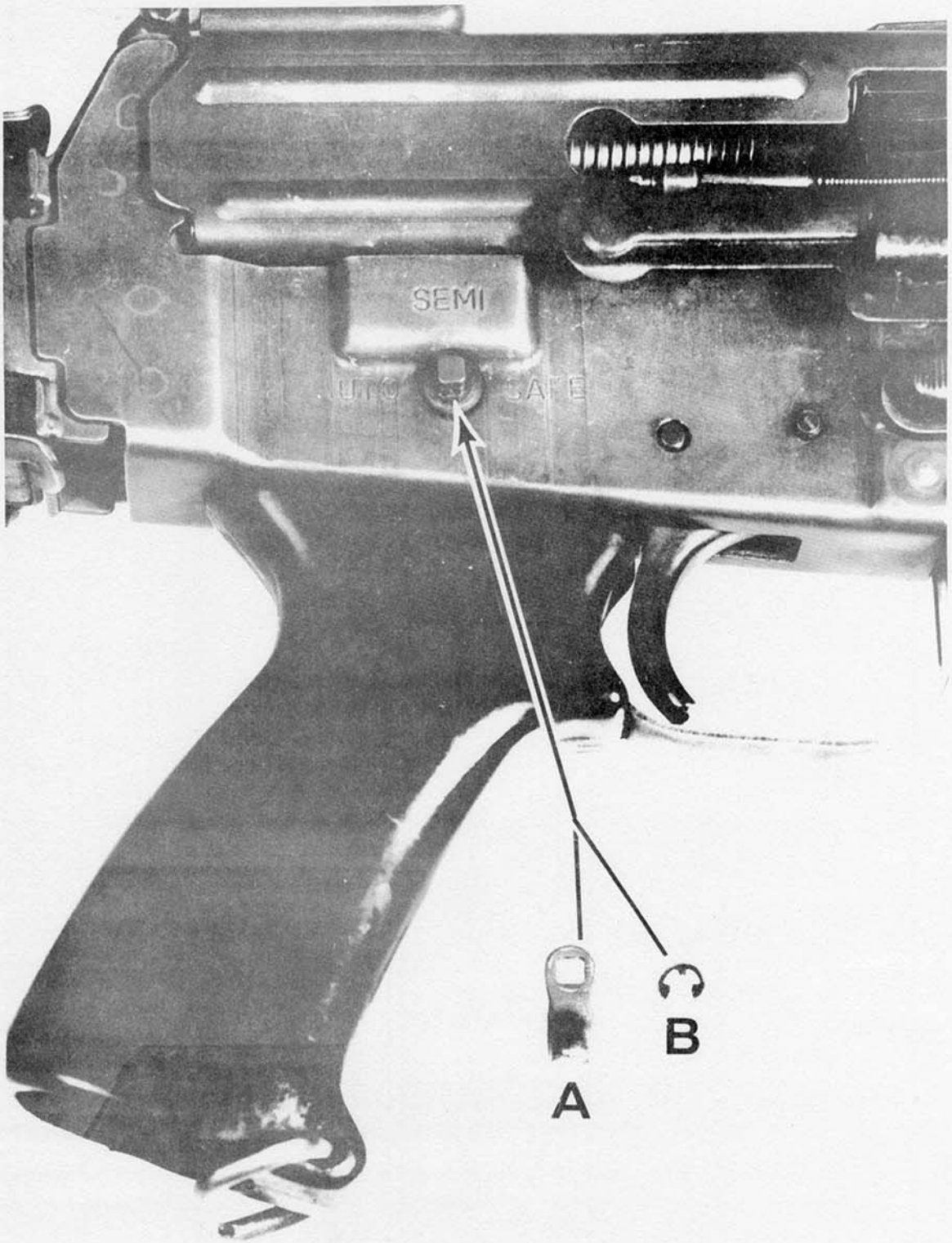

Figure 7

A. Alternate safety lever separated from safety casting as result of snap ring coming off.

B. Safety lever snap ring that came off.

(Arrow points to safety casting from which snap ring and lever separated.)

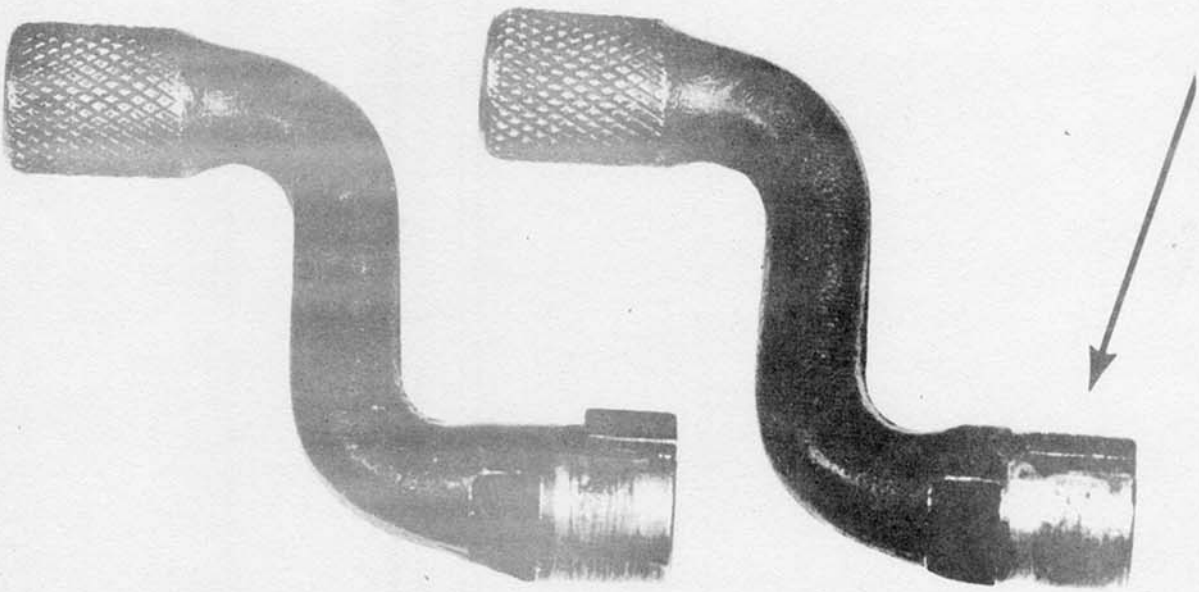

Figure 8

Charging Handle for Rifle, 5.56-mm, AR-18

Arrow shows charging handle with a missing key.

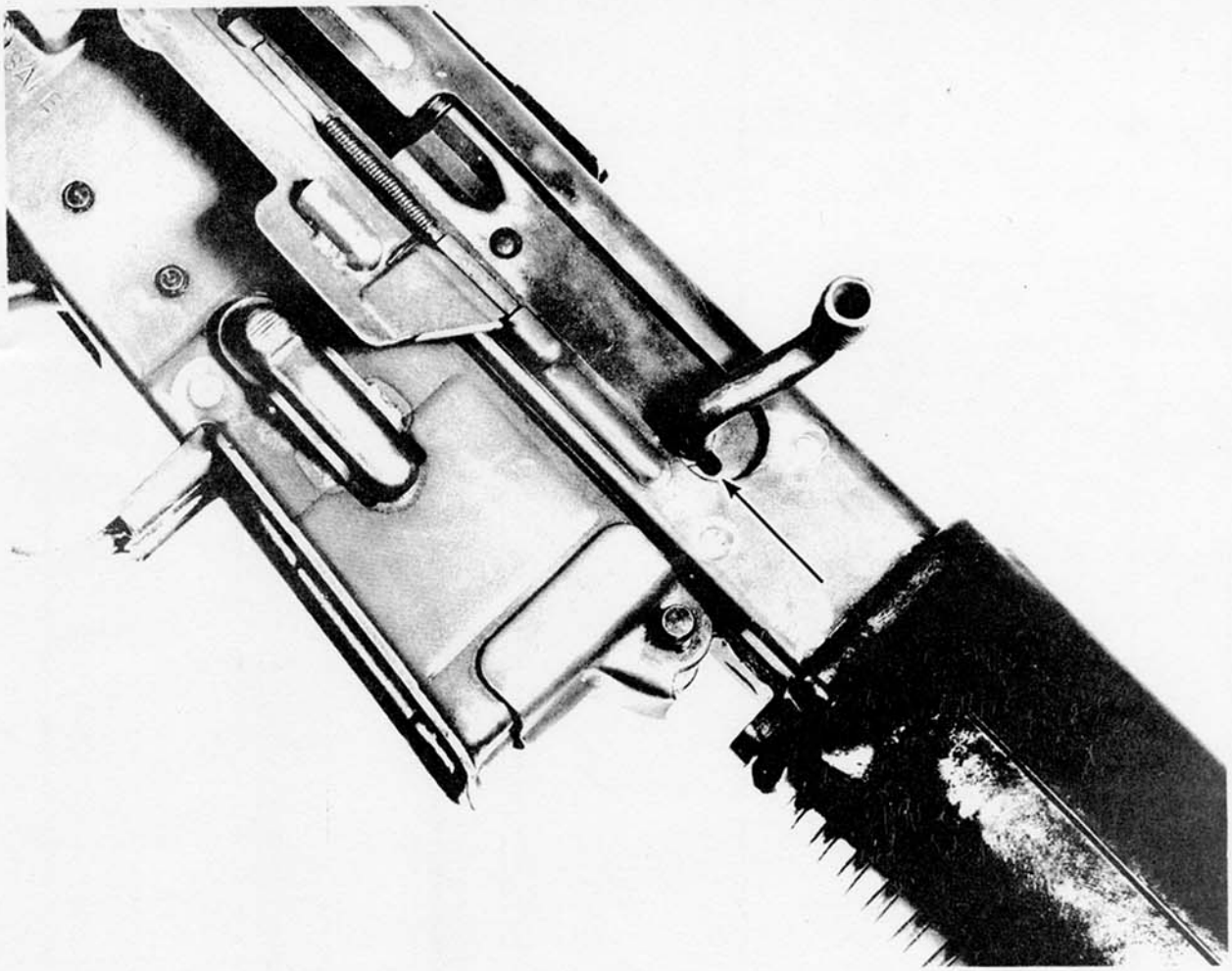

Figure 9

Right Side View of Rifle, 5.56-mm, AR-18

Arrow shows assembled view of charging handle with missing key.

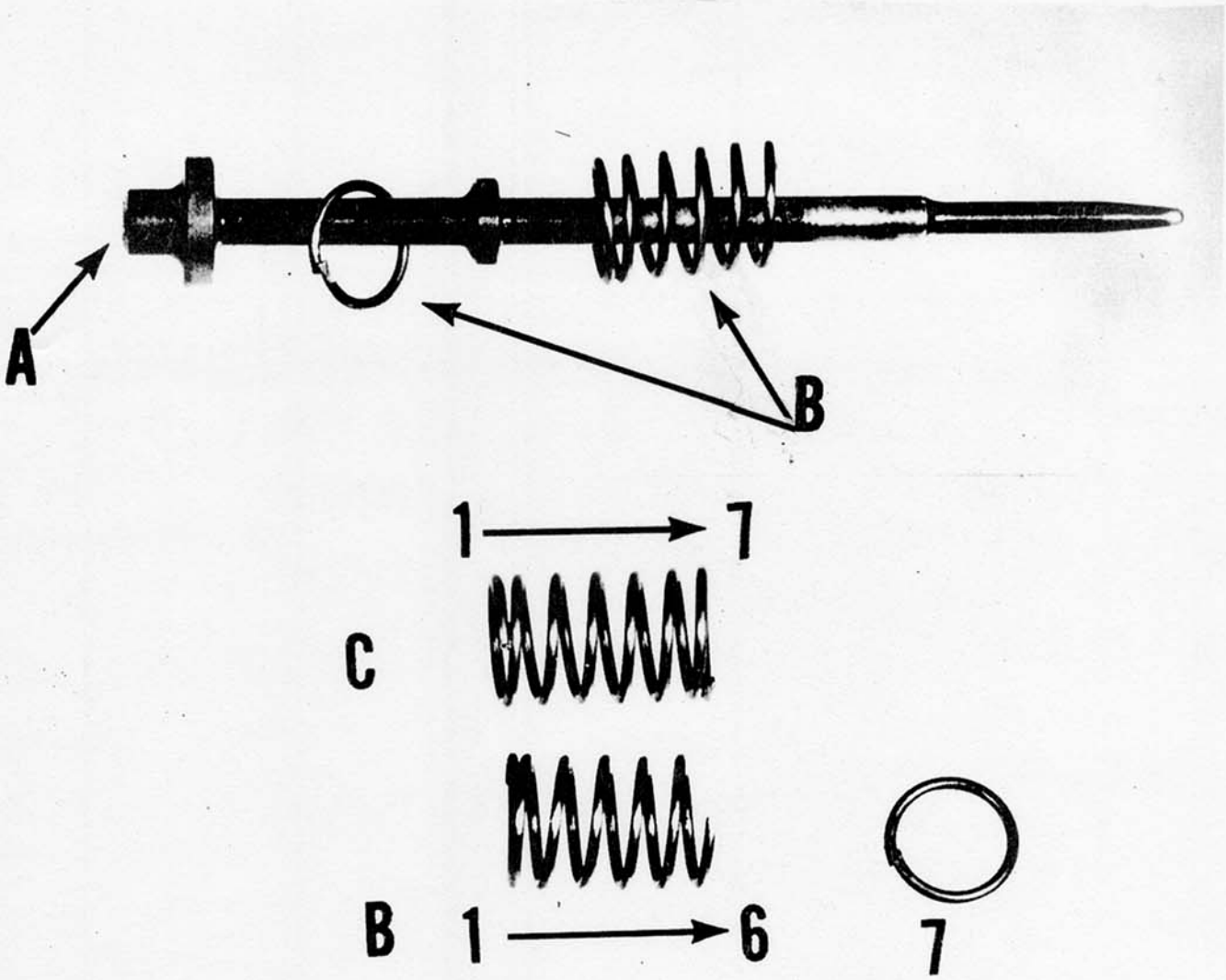

Figure 10

A. Firing pin from Rifle, 5.56-mm, AR-18, with broken spring.

B. Broken firing pin spring.

C. Complete firing pin spring.

(Numbers refer to number of coils.)

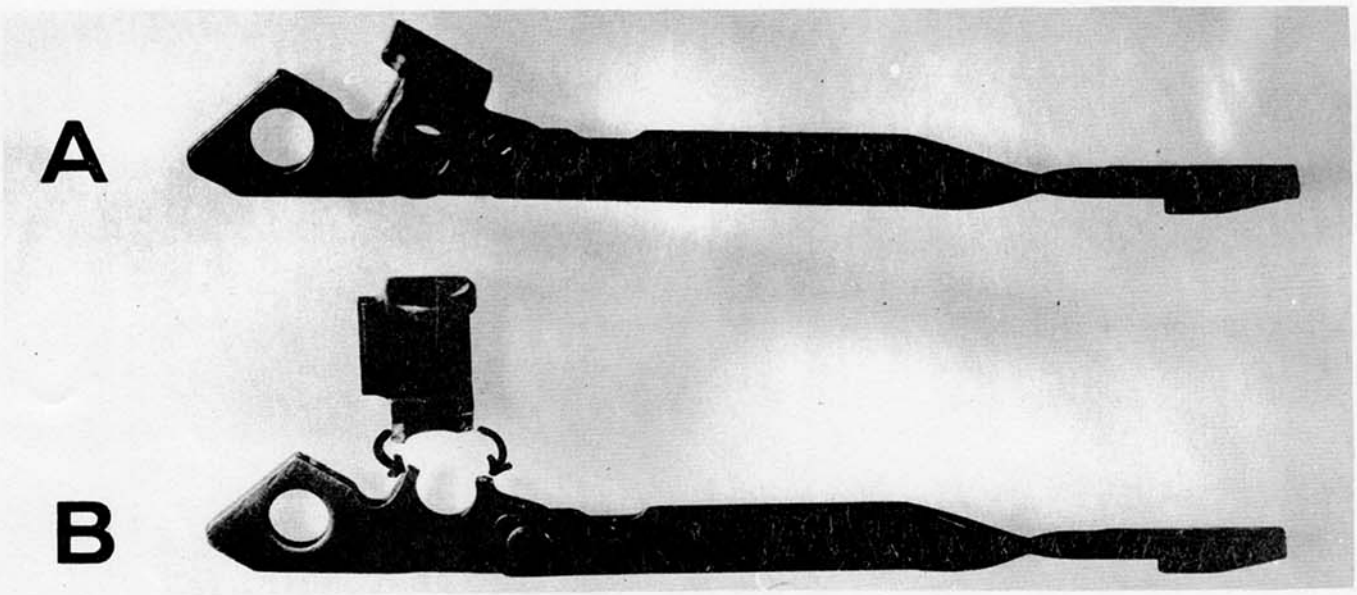

Figure 11

A. Automatic sear, Rifle, 5.56-mm, AR-18

B. Broken automatic sear, Rifle, 5.56-mm, AR-18

(Arrow indicates points of breakage.)

Figure 12

Broken Hammer on Rifle, 5.56-mm, AR-18

Arrow shows broken portion and the area of breakage.

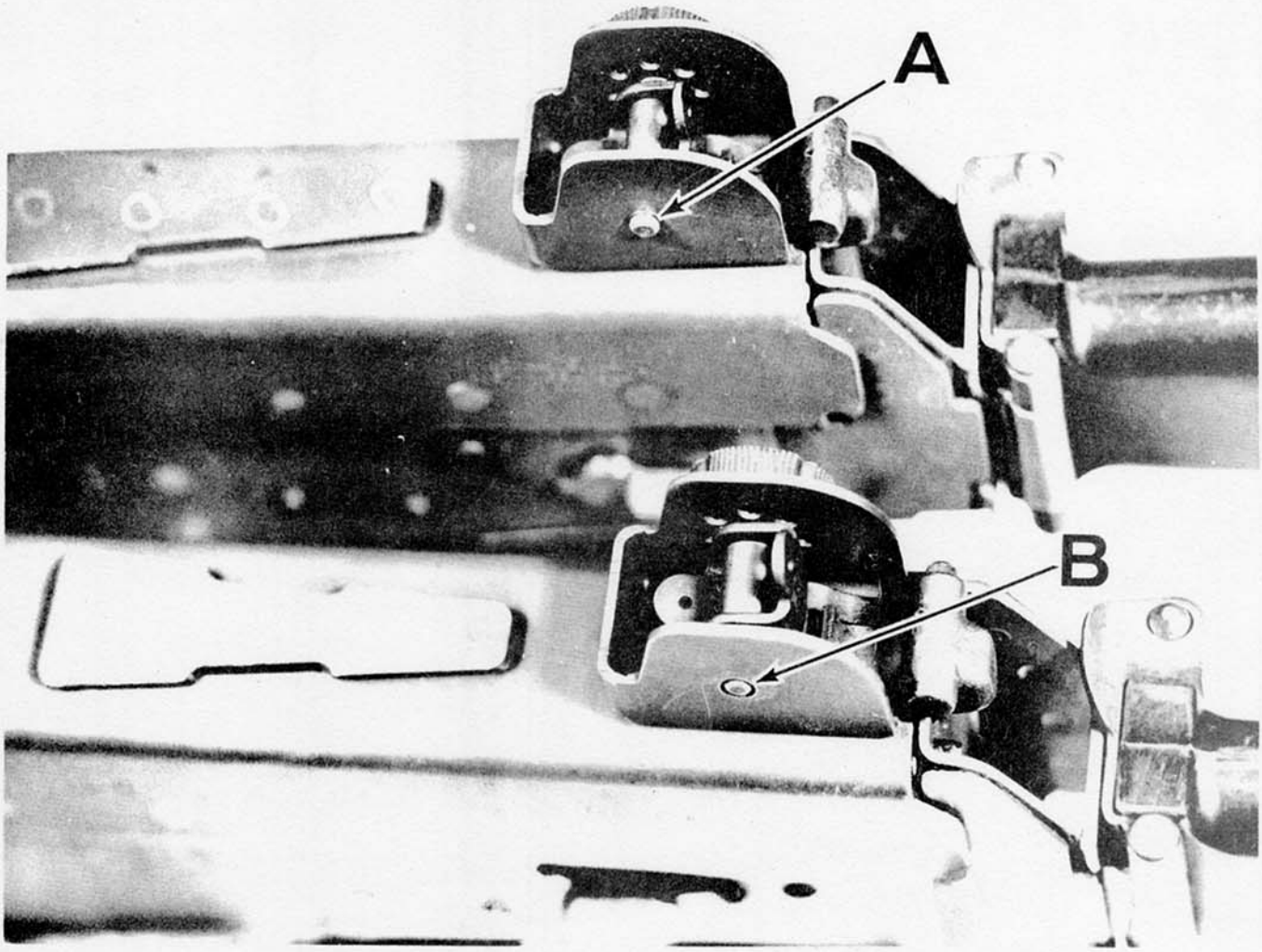

Figure 13

Top View of Rifles, 5.56-mm, AR-18

A. Windage screw for rear sight with snap ring in place.

B. Windage screw for rear sight with snap ring missing.

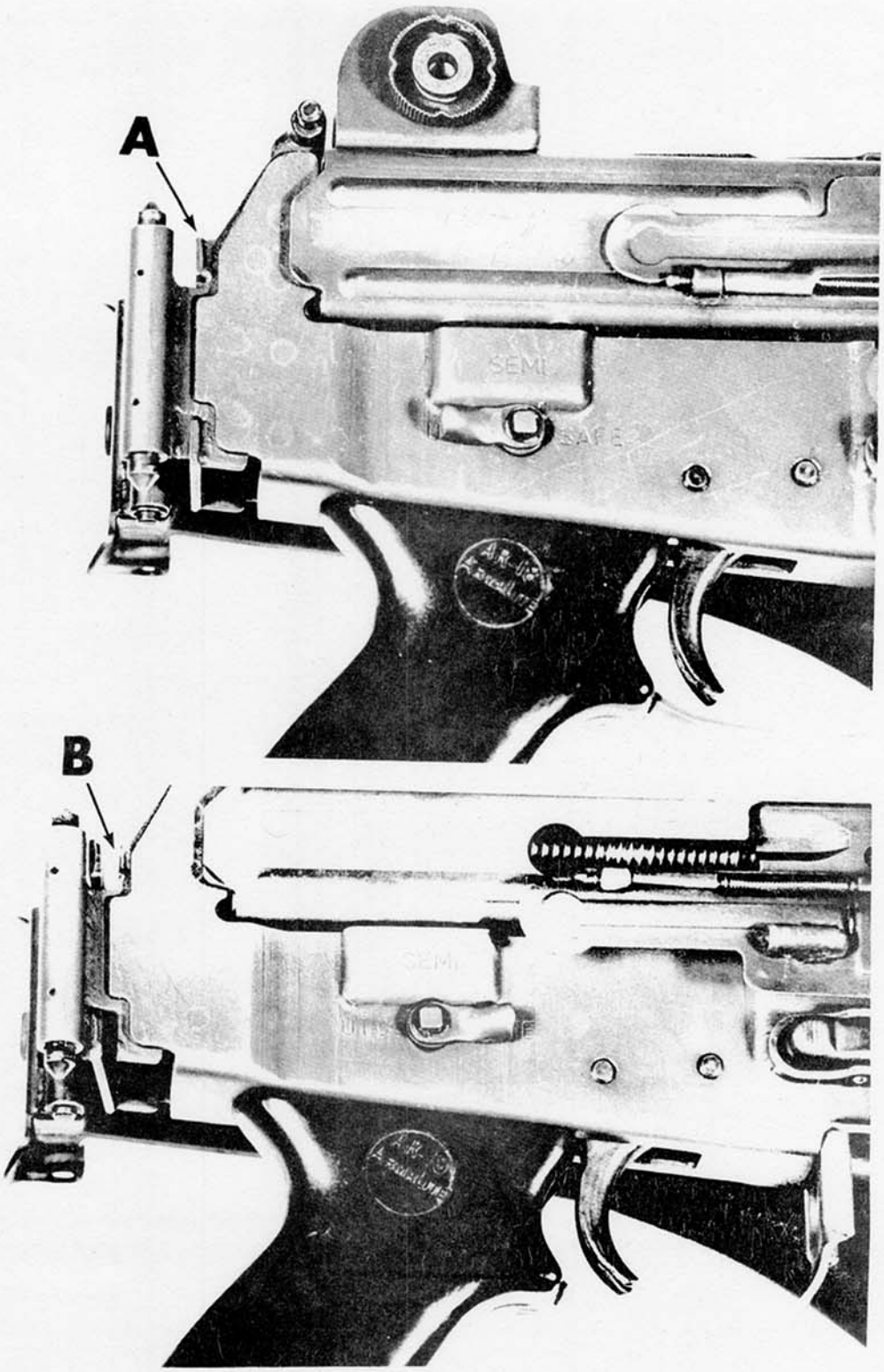

Figure 14

Right Side View of Rifles, 5.56-mm, AR-18

A. Indicates bulkhead plate

B. Indicates space between broken bulkhead plate and receiver

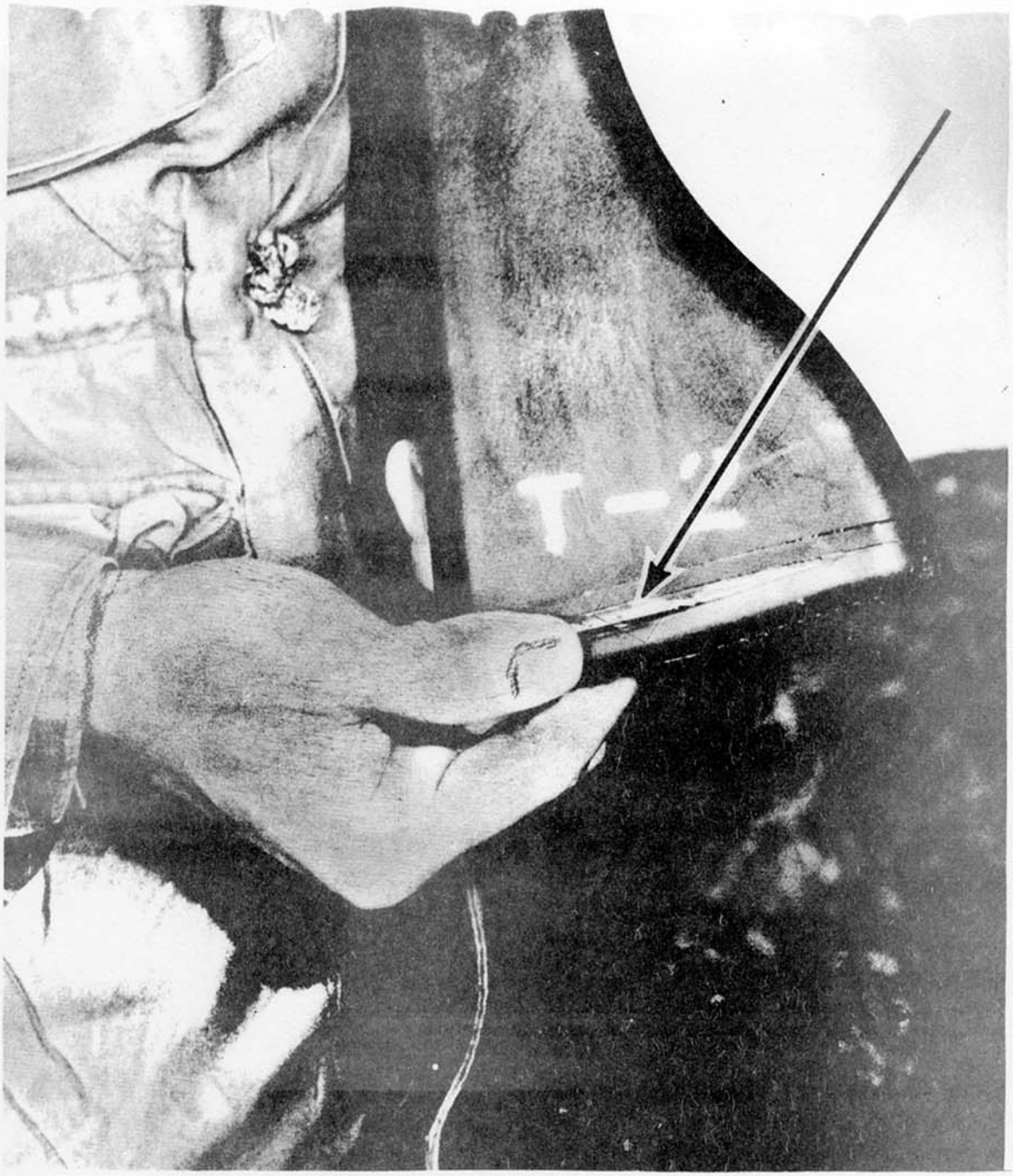

Figure 15

Buttstock of Rifle, 5.56-mm, AR-18

Arrow indicates partial separation of recoil pad from the buttstock.

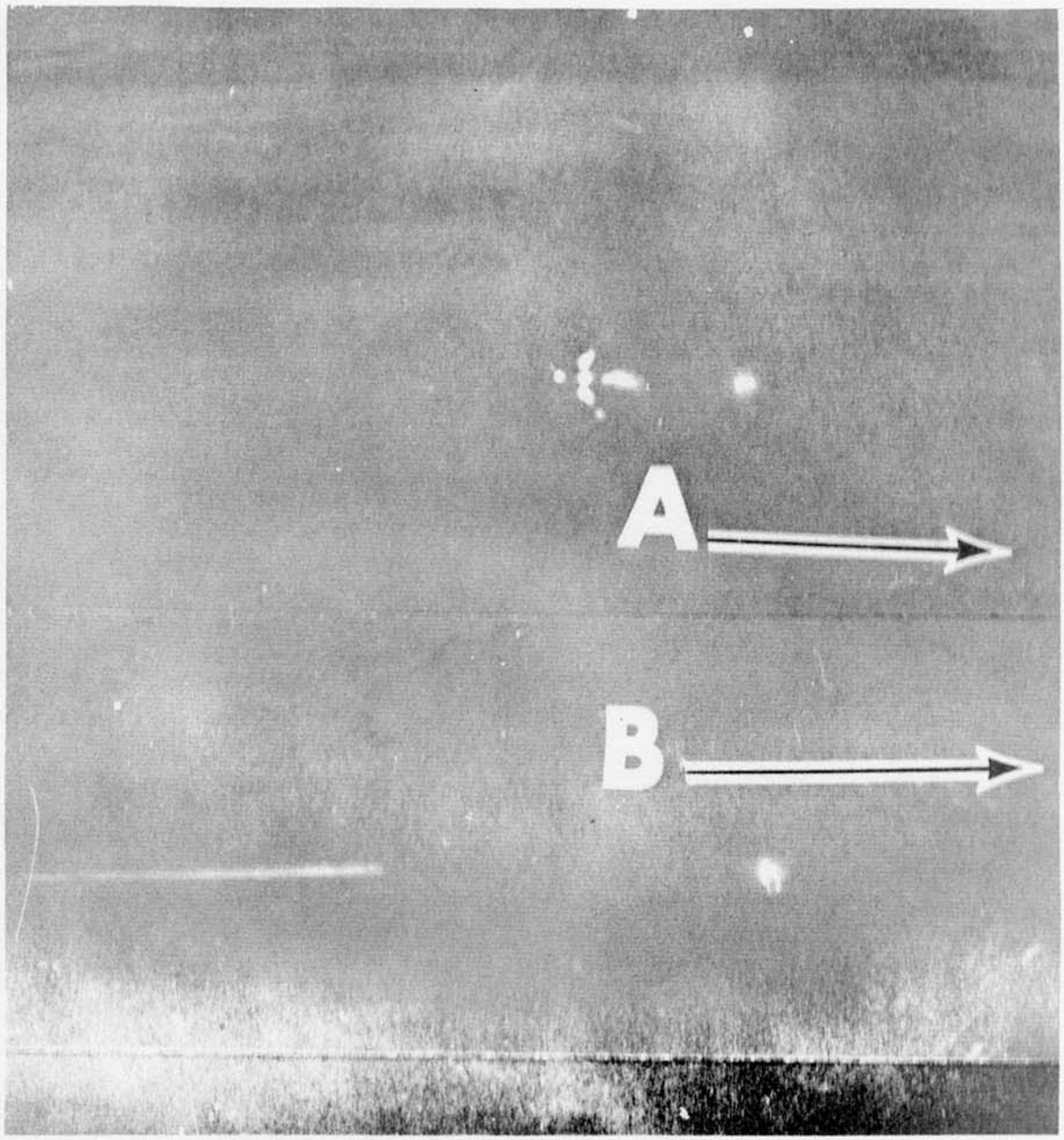

Figure 16

Night Firing (Semiautomatic Mode, Single Round)

A. Muzzle flash of Rifle, 5.56-mm, M16A1

B. Muzzle flash of Rifle, 5.56-mm, AR-18

(Arrow indicates direction of firing.)

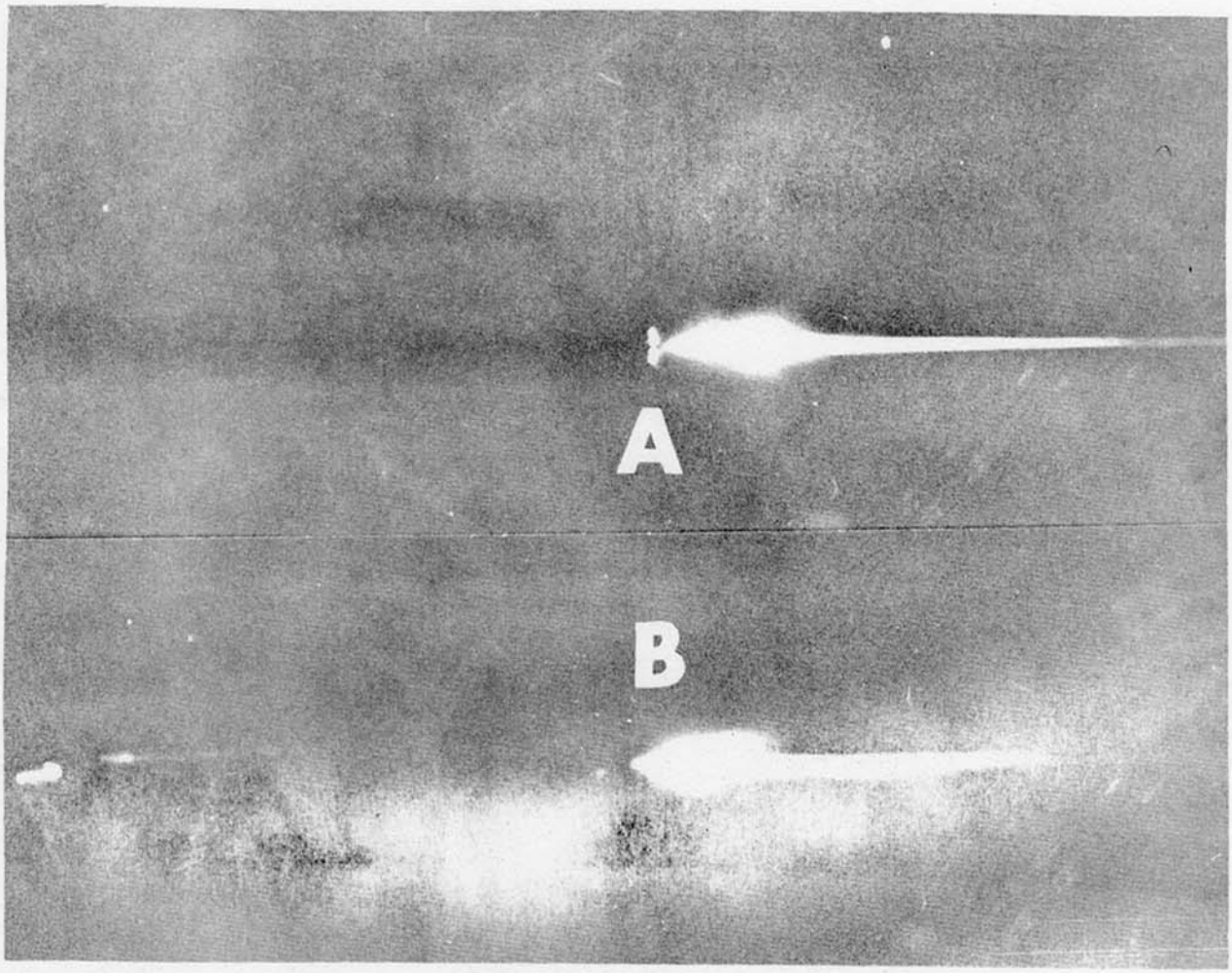

Figure 17

Night Firing (Fully automatic, 3d Burst with 1 Tracer)

A. Muzzle flash of Rifle, 5.56-mm, M16A1

B. Muzzle flash of Rifle, 5.56-mm, AR-18

APPENDIX II. TEST FINDINGS

Item	Source	Requirements	Applicable Subtest	Remarks
1	USAIB	The shipment must be complete and the project materiel must be suitable for testing.	2.1	Met with the exception listed in para 2.1.5.2. See Results in para 2.1.4.1 and Analysis in para 2.1.5.1 and 2.1.5.2.
2	USAIB	The test soldiers must be sufficiently trained and oriented so as to be capable of safe and thorough operation of test weapons.	2.2	Met. See Results in para 2.2.4.1 and Analysis in para 2.2.5.1. Also see Table 2-3.
3	USAIB	Transition time for training from M16A1 to AR-18 should be comparable to that of M14 to M16A1.	2.2	Met. See Analysis in para 2.2.5.2.
4	USAIB	The test item shall require no additional safety precautions regarding operation and maintenance beyond those required for the control item and shall be safe for field use.	2.3	Not met. See Analysis in para 2.3.5.1.
5	USAIB	100-meter accuracy (known-distance) of the test item must be at least equal to that of the control item (semiautomatic) mode).	2.4	Met. See Table 2-4 and Analysis in para 2.4.5.1.
6	USAIB	The test item must have an equal capability to that of the control item for zeroing at a range of 500 meters.	2.4	Met. See Results in para 2.4.4.2 and Analysis in para 2.4.5.1 and 2.4.5.2.
7	USAIB	The sights of the test weapon must equal or exceed the effectiveness, durability, and reliability of those of the control weapon.	2.4	Met. See Analysis in para 2.4.5.1.

Item	Source	Requirements	Applicable Subtest	Remarks
8	USAIB	The test item must require no maintenance in excess of that required for the control item.	2.5	Met. See Analysis in para 2.5.5.1. See Shortcomings in para 2.5.4.2 (Results) and in Analysis, para 2.5.5.2
9	USAIB	The deficiencies and shortcomings found in the original Rifle, 5.56-mm, AR-18, must have been corrected. See item 20 for detailed listing.	2.6	Not met. See Analysis in para 2.6.5.1 and 2.6.5.2.
10	USAIB	The test item must be equal to or better than the control item in man-portability and vehicular transportability.	2.6	Met. See Results in para 2.6.4.1 and Analysis in para 2.6.5.5.
11	USAIB	The test weapon must be at least as durable as the control weapon.	2.6	Not met. See Results in para 2.6.4.11 and Analysis in para 2.6.5.6.
12	USAIB	The test weapon must be as reliable or more reliable than the control weapon.	2.6	Not met. See Results in para 2.6.4.11, Table 2-8, and Analysis in para 2.6.5.6.
13	USAIB	The test item must compare favorably to the control weapon in terms of handling and durability characteristics during employment with a bayonet.	2.7	Met. See exception and explanation in para 2.7.5.
14	USAIB	Human factors engineering characteristics of the test item must at least equal those of the control item.	2.8	Not met. See Analysis in para 2.8.5.1.
15	USAIB	Test weapon must have easily identifiable and conveniently located safety(s), firing mechanisms, and sights so to be able to fire from either shoulder, at any range, and so to be located and operated by sight and touch while firers are using necessary protective clothing, to include temperate winter clothing, and while firers are operating during hours of reduced visibility.	2.8	Met. See explanation in Analysis in para 2.8.5.3.

Item	Source	Requirements	Applicable Subtest	Remarks
16	USAIB	The flash and noise of the test weapon must be equal to or less than that of the control weapon.	2.8	Not completely met. See Analysis in para 2.8.5.1a and para 2.8.5.3f.
17	USAIB	The test weapon must be equal to or less than the control weapon in terms of felt recoil energy.	2.8	Not completely met. See Analysis in para 2.8.5.1b.
18	USAIB	The ejection pattern of the test weapon must be such as to offer less or equal interference with adjacent firers or with the firer's ability to fire accurately.	2.8	Met. See Analysis in para 2.8.5.3e.
19	USAIB	Heat transfer and heat absorption of the test weapon must be equal to or less than that of the control weapon	2.8	Not met. See Analysis in para 2.3.5.1 and para 2.8.5.1c.
20	PREVIOUS FOUND DEFICIENCIES AND SHORTCOMINGS			
a.	Deficiencies			
	MPT	Last round bolt stop holds the bolt in rearward position while rounds remain in magazine.	2.6	Corrected. Para 2.6.5.1a.
	MPT	Lack of durability of curved extension of buffer assembly which is used to disassemble the weapon.	2.6	Corrected. Para 2.6.5.1a.
	MPT	Failure of extractor to extract empty cartridge case.	2.6	Corrected. Para 2.6.5.1a.
	MPT	Lack of durability of nylon cap which holds the spring in the last round bolt stop.	2.6	Corrected. Para 2.6.5.1a.
	MPT	Lack of durability of the stock and pistol grip.	2.6	Corrected. Para 2.6.5.1a.
	MPT	Sights could not be zeroed at 500-meter range.	2.6	Corrected. Para 2.6.5.1a.
	SAWS Test	Broken guide rod weld assemblies.	2.6	Corrected. Para 2.6.5.1a.

Item	Source	Requirements	Applicable Subtest	Remarks
	SAWS Test	Bolt carries burred, preventing removal of the firing pin.	2.6	Corrected. Para 2.6.5.1a.
	SAWS Test	Cracked upper receiver pivot.	2.6	Corrected. Para 2.6.5.1a.
	SAWS Test	Cracked barrel extension.	2.6	Corrected. Para 2.6.5.1a.
b.	Shortcomings			
	MPT	Lack of insulation causes front handguard to become hot when fired excessively.	2.3 and 2.6	Not corrected. Para 2.3.5.1 and para 2.6.5.2b and para 2.8.5.1c.
	MPT	Safety and fire selector lever could not be operated when stock was folded.	2.6	Corrected. Para 2.6.5.1b. See also para 2.3.5.2.
	MPT	Trigger pull was excessive.	2.1 and 2.6	Not corrected. Para 2.1.5.4 and para 2.6.5.2b.
	MPT	Folding stock lock was not positive.	2.6	Corrected. Para 2.6.5.1b.
	MPT	Sight adjustment on front and rear sights was awkward and confusing to firers.	2.6	Partially corrected (front sight). Para 2.6.5.2b.
	SAWS Test	Sights do not have a visual scale for determining zero.	2.2 and 2.6	Not corrected. Para 2.6.5.2b and para 2.2.5.5.
	SAWS Test	Incomplete maintenance package (no bore or chamber brush).	2.6	Corrected. Para 2.6.5.1b. See also para 2.1.5.2 and para 2.6.5.2b.
	SAWS Test	Incomplete POMM (no minimum requirements for training test soldiers).	2.5 and 2.6	Not corrected. Para 2.5.4.2 and para 2.6.5.2b.
	SAWS Test	Separation of upper handguard liner from upper handguard.	2.6	Corrected. Para 2.6.5.1b.

Item	Source	Requirements	Applicable Subtest	Remarks
	SAWS	Excessive number of double feeds (1 in 995).	2.6	Corrected. Para 2.6.5.1b.
	SAWS	Excessive number of failures of the bolt overriding the base of the round while in magazine (1 in 1072).	2.6	Corrected. Para 2.6.5.1b.
	SAWS	Weapon fires with safety and selector switch between the SAFE and SEMI-AUTO positions.	2.3 and 2.6	Not corrected. Para 2.3.5.1 and para 2.6.5.2b.
	SAWS	Alternate safety and selector has no indicator.	2.3 and 2.6	Not corrected. Para 2.3.5.1 and para 2.6.5.2b.

APPENDIX III. DEFICIENCIES & SHORTCOMINGS

1. DEFICIENCIES

Newly Found

Deficiency	Suggested Corrective Action	Remarks
1.1 The AR-18 lacks durability.	Improve durability.	All subtests. None.

Note: The breakages listed below (1.2 and 1.3) are classified specifically as deficiencies because each occurrence singly renders the weapon inoperable. The overall lack-of-durability deficiency includes those durability-related breakages which are individually classified as shortcomings (section 2, below).

1.2 The charging handle key on the AR-18 rifle broke.	Make the charging handle and charging handle key one assembly.	Subtest No 6. EPR KL-2.
1.3 The hammer on the AR-18 broke making it impossible to cock the rifle.	Unknown	Subtest No 6. EPR KL-6.

2. SHORTCOMINGS

Newly Found

Shortcoming	Suggested Corrective Action	Remarks
2.1 The safety casting broke.	Make the safety casting of more durable material.	Subtest Nos 3 & 6. EPR KL-1.
2.2 The safety lever snap ring lost its tolerance.	Improve tolerance of the snap ring.	Subtest Nos 3 & 6. EPR KL-3.
2.3 Two firing pin springs broke at the last coil.	Unknown	Subtest No 6. EPR KL-4 and KL-8-(4-1).
2.4 The automatic sear broke.	Unknown	Subtest No 6. EPR KL-9.
2.5 The sight snap ring broke.	Improve tolerance of snap ring.	Subtest No 6. EPR KL-10

Shortcoming	Suggested Corrective Action	Remarks
2.6 The bulkhead plunger retaining pin lost its tolerance and fell out of the bulkhead receiver.	Unknown	Subtest No 6. EPR KL-7.
2.7 The adhesive for the buttstock was weak and did not hold the recoil pad to the buttstock.	Use a stonger compound.	Subtest No 6.

3. PREVIOUS (RECURRING) SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
3.1 The heat transfer from the barrel to the handguard was excessive.	Redesign.	Subtest Nos 3 & 8. EPR KL-5.
3.2 The bulkhead plate broke.	Unknown	Subtest No 6. EPR KL-11
3.3 The trigger pull is excessive.	Unknown	Subtest No 1.
3.4 The windage adjustments are not defined.	The windage drum should be marked for easier reading and adjusting.	Subtest No 2.
3.5 Rear sight does not have a clearly readable visual scale for determining zero.	Unknown	Subtest No 2.
3.6 Incomplete maintenance package because of lack of small arms maintenance equipment case.	Produce a small arms maintenance equipment case.	Subtest Nos 1 & 5.
3.7 The operator's maintenance manual was incomplete.	Rewrite to include more comprehensive and complete description.	Subtest No 5.
3.8 The AR-18 fired when the selector switch was placed between SAFE and SEMI-AUTO position.	Unknown	Subtest Nos 1 & 3.

Shortcoming	Suggested Corrective Action	Remarks
3.9 The alternate safety and selector switch does not have an indicator as to what position the safety is in.	Mark or redesign alternate safety and selector switch.	Subtest Nos 2 & 3.

APPENDIX IV. REFERENCES

1. Manufacturer's Pamphlet, The Armalite AR-18 Combat Rifle, Caliber 5.56-mm, undated.

2. POMM 9-1005-278-12, Rifle, 5.56-mm, AR-18, undated.

3. Final Report of Military Potential Test of Rifle, 5.56-mm, AR-18, USATECOM Project No 8-4-001-02A, 2 November 1964.

4. Approved Service Test Report for Small Arms Weapons Systems (SAWS), USATECOM Project No 8-5-0400-04, 4 January 1966.

5. FM 23-9, Rifle, 5.56-mm, XM16E1, dated July 1966.

6. FM 23-71, Rifle Marksmanship, dated December 1966, with change 1, dated 1 February 1968.

7. TM 9-1005-249-12, Rifle, 5.56-mm, M16A1, w/change (1005-073-9421), dated 2 August 1968, with change 1, dated 27 June 1969 and change 2, dated 12 September 1969.

8. FM 21-150, Combatives, dated March 1969.

9. Letter, AMSTE-BC, 12 November 1969, subject: "Test Directive for Military Potential Test of Rifle, 5.56-mm, AR18, USATECOM Project No 8-WE-600-018-001/002."

10. OMM, Rifle, 5.56-mm, AR-18, undated.

11. USAIB, Equipment Performance Reports, Numbers KL-1 to KL-11, dates from 12 December 1969 to 8 January 1970.

12. Army Subject Schedule No 21-150, Physical Contact - Confidence Training, undated.

APPENDIX V. ABBREVIATIONS

1. A - Automatic mode of fire
2. AMC - Army Materiel Command
3. APG - Aberdeen Proving Ground
4. APP - Appendix
5. AR-18 - Rifle, 5.56-mm, AR-18
6. Auto - Automatic mode of fire
7. Avg - Average
8. C - Control
9. CB - Chemical biological
10. DA - Department of the Army
11. Diff - Difference
12. DTD - Dated
13. ea - Each
14. EPR - Equipment Performance Report
15. Fig - Figure
16. FM - Field Manual
17. FSN - Federal Stock Number
18. Lbs - Pounds
19. M3 - Bipod, M3
20. M7 - Bayonet, M7
21. M14 - Rifle, 7.62-mm, M14
22. M16A1 - Rifle, 5.56-mm, M16A1
23. M35A2 - Truck, cargo, 2½-ton, 6x6, (M35A2)
24. M113 - Armored Personnel Carrier, M113

25. M193 - Cartridge, 5.56-mm, Ball, M193
26. M196 - Cartridge, 5.56-mm, Tracer, M196
27. Mag - Magazine
28. Min - Minute
29. MPT - Military potential test
30. MTD - Materiel Test Directorate
31. No - Number
32. OMM - Operating and Maintenance Manual
33. Para - Paragraph
34. POMM - Preliminary Operating and Maintenance Manual
35. Proj - Project
36. Rds - Rounds
37. Ref - Reference
38. Reg - Regulation
39. S/A - Semiautomatic mode of fire
40. SAFE - Safety or No-fire position
41. SAWS - Small Arms Weapons Systems
42. Semi - Semiautomatic mode of fire
43. SN - Serial Number
44. ST - Subtest
45. T - Test
46. TM - Technical manual
47. UH-1D - Helicopter, UH-1D
48. USAIB - US Army Infantry Board
49. USAIS - US Army Infantry School

50. USATECOM - US Army Test and Evaluation Command

51. w/ - With

52. Wt - Weight

53. X - Horizontal Ordinant (Accuracy data)

54. Y - Vertical Ordinant (Accuracy data)

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13. ABSTRACT This Military Potential Test of the Rifle, 5.56-mm, AR-18 was conducted by the US Army Infantry Board at Fort Benning, Georgia, during the period 3 December 1969 through 2 January 1970. Three AR-18 rifles and, for comparison and control purposes, three M16A1 rifles, were furnished for testing. Nine test soldiers, representative of those who can be expected to use the rifle, were used in testing. The rifle was tested under field and simulated combat conditions. A minimum of 6,000 rounds was fired in each test and control rifle. The purpose of the test was to determine whether deficiencies and shortcomings reported in two previous tests of the AR-18 rifle had been corrected. (U)

Specific subtests conducted were preoperational inspection and physical characteristics, training, safety, known distance accuracy (semiautomatic), maintenance, durability/reliability/portability, bayonet employment, and human factors engineering. Durability was the principal deficiency reported in previous tests; and, although some deficiencies and shortcomings had been corrected, this overall lack of durability still exists, as evidenced by an excessive number of breakages and a larger number of malfunctions. The AR-18 was comparable to the M16A1 with respect to training, maintenance, semiautomatic accuracy, most of the portability aspects, bayonet employment, and some aspects of human factors engineering. It was inferior to the M16A1 as to durability and reliability, safety, and some physical and human factors characteristics. It was superior to the M16A1 with regard to compactness afforded by its folding stock, dual firing controls, low clean sight line, and automatic hit capability in automatic fire. The AR-18 has military potential, but further development is required. (U)

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14. KEY WORDS	LINK A		LINK B		LINK C	
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