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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The DT II of three types of caliber .22 rimfire adapters for the M16A1 rifle was conducted by US Army Aberdeen Proving Ground from 30 September 1974 to 24 April 1975 to determine if the adapters met the training-device requirements with respect to safety and physical and operational characteristics. The following subtests were conducted to determine the performance of the test item: initial inspection, safety, extreme temperature, humidity, accuracy and endurance, water spray, dynamic sand and dust, mud, rough handling, maintenance

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20. evaluation, and human factors. Two of the three types of test items satisfied the applicable criteria with the exception of operation at low-temperatures, durability, accuracy, battle-sight zero, and safety in the rough-handling test phases; the third type was withdrawn from testing early.

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SUMMARY

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SUMMARY

RESULTS

Ten each of three types of rimfire adapters (RFA) (identified as RFAs Codes A, B, and C) were tested. The Code C RFA exhibited a high malfunction rate and was withdrawn from the test by request of the manufacturer (Reference 4); only preliminary safety and accuracy tests were conducted with the Code C RFA.

Eighteen criteria were addressed during the testing of the RFAs. Code A met 11 and failed to meet 7 of the criteria; Code B met 13 and failed to meet 5 of the criteria (Appendix B).

RFA Code A had two shortcomings and no deficiencies; RFA Code B had one shortcoming and no deficiencies (Appendix C).

The RFAs of all three manufacturers were compatible with the M16A1 rifle; no other equipment or modifications to the rifle were required (para 2.1). The magazines provided by all three manufacturers accept caliber .22 cartridges other than .22 long rifle (LR); however, all were incapable of accepting 5.56-mm service ammunition (para 2.1).

Use of the Code A or Code B RFAs did not adversely affect the performance, appearance, feel, weight, or maintenance of the M16A1 rifle (para 2.1, 2.2, 2.5, and 2.11). Code C was not tested sufficiently to determine its effects.

Both Code A and Code B RFAs fired when dropped muzzle down (para 2.9). Ruptured cartridge cases occurred in the Code A RFAs; three ruptures in 3000 rounds occurred at +155°F and one rupture occurred in 13,742 rounds at ambient temperature during the endurance test (para 2.3 and 2.5).

The accuracy obtained with any of the three types of RFA was less at all ranges than that of the M16A1 rifle firing M193 ball ammunition. The battle-sight zero of the M16A1 rifle equipped with any of the three types of RFA was significantly different than that of the rifle firing service ammunition at all ranges tested. In general, the accuracy of the Code A RFA compared more closely with that of the M16A1 rifle than did the accuracy of the Code B and C RFAs, Code B compared more closely than Code C (para 2.5). Firers were able to employ the same marksmanship techniques with the RFAs of all manufacturers as with the M16A1 rifle firing service ammunition (para 2.11).

During the endurance test the Code A RFAs had a malfunction rate of 2.5% (40 mean rounds between failures (MRBF)); the Code B RFAs had a malfunction rate of 1.6% (64 MRBF). The Code C RFAs were withdrawn from test prior to the endurance phase due to a high malfunction rate (para 2.5).

The Code B RFAs required replacement of seven parts: five broken firing pins, one worn spring pin, and one ejector spring (which was lost during maintenance). The Code A RFAs required replacement of a broken ejector; furthermore, six magazines were considered to have become unserviceable by the end of the endurance test (para 2.5 and 2.10).

The Code A and Code B RFAs required no more maintenance than that required for the corresponding components of the M16A1 rifle; both Code A and Code B were capable of firing 1000 rounds between cleanings (para 2.5 and 2.11).

The Code A and Code B RFAs were operational at +155°F (malfunction rates of 2.5% and 1.9% respectively). The operation of the RFAs was impaired by lower temperatures. At 0°F Code A had a malfunction rate of 6.7% and Code B had a malfunction rate of 15.1%; at -35°F, limited testing gave malfunction rates of 10.0% and 32.0% for the Code A and Code B RFAs respectively (para 2.3).

The operation of the Code A and Code B RFAs was degraded by the humidity test but both types were still operable. The Code A RFAs had a malfunction rate of 3.2% and the Code B RFAs had a malfunction rate of 8.4% (para 2.4).

Maintenance on all three RFAs was easily accomplished using common tools. Equipment publications were incomplete for the Code A and Code C manufacturers; the manufacturer of Code B did not supply any publications (para 2.10).

CONCLUSIONS

It is concluded that:

a. Code A and Code B RFAs met the training-device requirement (TDR) except in the areas of operation at extreme temperatures, durability, accuracy, and battle-sight zero.

b. The susceptibility of both Code A and Code B RFAs to firing when dropped muzzle down is a safety hazard. The ruptured cartridge cases occurring in Code A RFAs pose a potential safety hazard.

RECOMMENDATIONS

It is recommended that:

a. Additional testing be conducted to determine if the accuracy differences between the RFAs (both Code A and Code B) and the M16A1 rifle firing service ammunition are detrimental to the intended use of the RFAs.

b. If either Code A or Code B RFAs are selected for use, cautions should be included in the equipment publications to warn that an RFA-equipped M16A1 rifle may fire if it is dropped.

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FOREWORD

The Materiel Testing Directorate, US Army Aberdeen Proving Ground, was responsible for test planning, test execution, and test reporting.

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SECTION 1. INTRODUCTION

1.1 BACKGROUND

The RFA provides a method to use caliber .22, LR, rimfire ammunition in the M16A1 rifle for training purposes. The use of caliber .22 ammunition in place of the standard 5.56-mm ammunition will result in monetary savings and allow the use of firing ranges that could not be used with the standard round because of the higher velocity and resulting longer ranges.

Two designs of similar devices were previously tested at the US Army Aberdeen Proving Ground (APG) and reported in the letter report shown as Reference 5. At that time both devices exceeded the malfunction rates specified for the basic M16A1 rifle (Reference 6) and one design would not eject a cartridge (or fired case) without the ejector-equipped magazine in place (considered to be a potentially unsafe condition).

1.2 DESCRIPTION OF MATERIEL

The RFA kit consists of two major components: a magazine (or adapter), for caliber .22 LR ammunition, which will fit the M16A1 rifle, and a bolt assembly, which replaces the M16A1 bolt-carrier group. The caliber .22 bolt assembly consists of a smoothbore barrel configured externally to fit the 5.56-mm chamber, and internally to accept the caliber .22 LR cartridge and a bolt with a rimfire firing pin. The kit is installed in the M16A1 rifle in place of the regular bolt-carrier group; is blowback operated, and is capable of firing in the semiautomatic mode only.

Three contractors have submitted designs for testing; these are generally as described in the previous paragraph; however, each has some distinguishing characteristics, as follows:

a. Code A. The device is enshrouded by a receiver assembly that incloses the recoil spring and bolt assembly. The test magazine outwardly resembles the standard M16A1 magazine, with the exception that it will only accept caliber .22 cartridges.

b. Code B. The recoil spring and bolt assembly are exposed. An insert is provided to change a standard M16A1 magazine to accept caliber .22 ammunition. This insert is assembled into the magazine from the top without having to remove either the follower or the spring.

c. Code C. This kit is similar in appearance to that described in paragraph b above. The magazine and follower are made of plastic, and do not resemble the standard magazine.

1.3 TEST OBJECTIVE

The objective was to evaluate the degree to which the RFA met the TDR with respect to the technical characteristics as they pertain to safety, compatibility, accuracy, endurance, and climatic and adverse conditions.

1.4 SCOPE

The DT II of the RFA for the M16A1 rifle was conducted at APG from 30 September 1974 to 24 April 1975. The test included phases to determine the physical and technical characteristics of the RFA under both normal and adverse climatic and handling conditions. The total number of rounds fired was statistically adequate to detect significant differences in malfunction rates (at the 10% significance level) among the RFA manufacturers. Performance criteria were not available for operation under the adverse conditions of water spray, dynamic sand and dust, and mud.

The test was authorized by the TECOM test directive (Reference 1) and was conducted in accordance with the TECOM-approved test plan (Reference 2) as modified by TECOM letters (References 3 and 4). The RFAs of manufacturers Codes A and B were subjected to all the planned tests; the Code C RFAs were subjected only to some phases of the safety evaluation and accuracy testing before being removed from testing and returned to the manufacturer.

SECTION 2. DETAILS OF TEST

2.1 INITIAL INSPECTION

2.1.1 Objective

The objective was to determine the principal physical and operating characteristics of the RFAs submitted for testing and the adherence to applicable drawings, design requirements, etc.

2.1.2 Criteria

a. The adapter kit will be compatible with the M16A1 rifle and consist of a bolt, bolt-carrier assembly, and magazine. No other equipment or modification will be required (CONARC TDR 095, para III.B.1).

b. The caliber .22 LR bolt assembly will be installed in the M16A1 rifle, replacing the bolt and bolt-carrier assembly (CONARC TDR 095, para III.B.2).

c. The adapter kit will provide an M16A1 rifle 20-round magazine fitted to accept caliber .22 LR ammunition only (CONARC TDR 095, III.B.3).

2.1.3 Method

All RFAs were disassembled, cleaned, and visually inspected; the components that were subjected to the greatest stresses were subjected to magnetic-particle inspection in accordance with TOP/MTP 3-2-807. The physical dimensions and weights were recorded. Characteristic photographs were taken of one of each contractor's RFA and magazine. Each RFA was assembled to 10 M16A1 rifles to determine compatibility and ease of assembly.

2.1.4 Results

Photographs of the test RFAs and magazines are shown in Figure 2.1-1 (Code A contractor) and Figure 2.1-2 (Code B contractor). The RFA of the Code C contractor was not photographed.

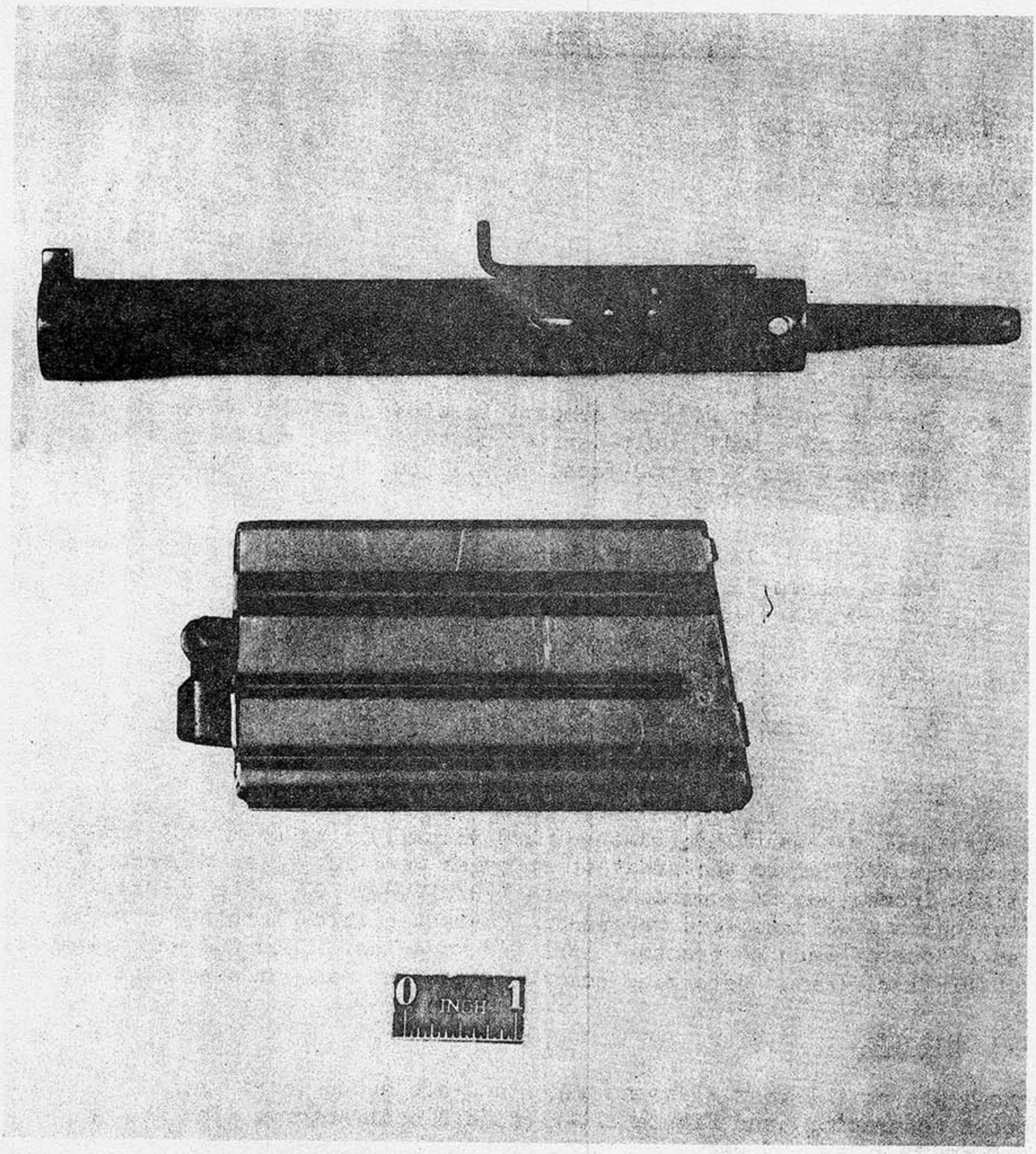

Figure 2.1-1: Code A Rimfire Adapter and Magazine.

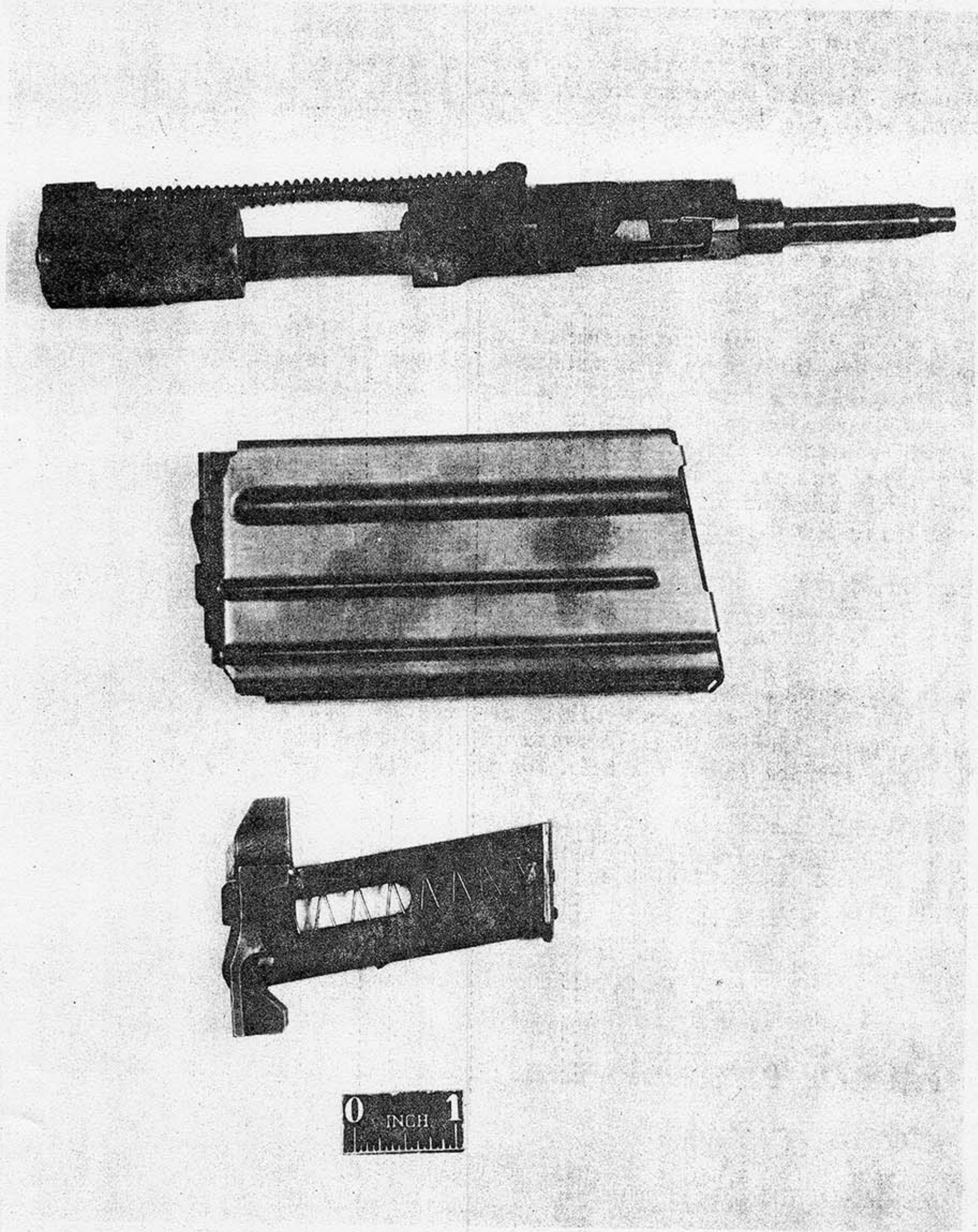

Figure 2.1-2: Code B Rimfire Adapter and Magazine.

The RFA kits of all three contractors consisted of a bolt, a bolt-carrier assembly, and a magazine. Code A and Code C magazines were complete units as received; Code B magazines consisted of a magazine insert for the standard 20-round magazine for the M16A1 rifle; the insert is not compatible with the 30-round magazine due to interference between the insert and the bullet-guide indents in the sidewall of the magazine. The magazines of all three manufacturers would accept caliber .22 cartridges other than the caliber .22 LR, however, none would accept 5.56-mm cartridges.

All nine Code A RFAs assembled easily to the M16A1 rifles and worked freely when hand cycled.

The Code B RFAs would not assemble to the M16A1 rifle without excessive force due to interference between the hex-head screw at the rear of the alignment block of the RFA and the buffer housing of the M16A1 rifle. The lower portion of the head of the screws was ground away to permit proper assembly. Insufficient clearance between the top of the alignment block and the charging handle caused the bolt to bind and to fail to operate in four of the nine adapters. The clearance was corrected by milling 0.010 inch from the top of the alignment blocks.

The Code C RFAs exhibited varying degrees of binding in their operation due to interferences and misalignments. Code C RFAs were returned to the contractor for repair.

Magnetic-particle examination of the Code A and Code B RFAs did not show any indication of defects. Eight of the nine Code C RFAs were free of defects; one (serial No. 2) displayed a 1/8-inch crack in the buffer in the thin section where the hole for the guide rod was drilled.

The physical dimensions and weights of the RFAs are in the following tables: Table 2.1-1, Over-All Dimensions; Table 2.1-2, Barrel Dimensions; Table 2.1-3, Spring and Guide-Rod Dimensions; and Table 2.1-4, Magazines.

Table 2.1-1. Over-All Dimensions

Serial No.	Length, in.	Weight, grams	Serial No.	Length, in.	Weight, grams
	Code A			Code B	
2694	8.556	351.5	57	8.887	425.5
3759	8.557	350.0	59	8.880	425.5
3763	8.563	352.0	63	8.874	424.5
3779	8.547	348.8	65	8.888	428.5
3800	8.567	350.8	66	8.876	425.0
3805	8.551	349.5	70	8.879	424.5
3809	8.555	349.5	73	8.881	427.0
3823	8.583	347.5	74	8.888	426.0
3824	8.553	352.2	75	8.874	427.5
Mean	8.559	350.2	Mean	8.881	426.0

Table 2.1-2. Barrel Dimensions

Serial No.	Bore Diameter, in. 0.10 in. from Muzzle Vert	Hor	1.00 in. from Muzzle Vert	Hor	0.10 in. from Breech Vert	Hor	Barrel Outside Diameter[a], in. Vert	Hor	Barrel Length, in. Totals	Breech to First Shoulder
					Code A					
2694	0.2212	0.2212	0.2222	0.2226	0.2318	0.2320	0.354	0.354	1.878	1.779
3759	.2214	.2215	.2222	.2223	.2328	.2332	.354	.354	1.880	1.781
3763	.2215	.2215	.2225	.2223	.2320	.2322	.354	.354	1.894	1.780
3779	.2210	.2210	.2222	.2222	.2312	.2314	.356	.356	1.887	1.780
3800	.2212	.2211	.2222	.2218	.2315	.2315	.354	.354	1.886	1.779
3805	.2210	.2210	.2221	.2219	.2314	.2312	.354	.354	1.895	1.780
3809	.2215	.2213	.2222	.2220	.2312	.2305	.354	.354	1.880	1.782
3823	.2214	.2214	.2225	.2221	.2310	.2310	.354	.354	1.903	1.781
3824	.2213	.2213	.2223	.2222	.2320	.2318	.356	.356	1.870	1.780
Mean	.2213	.2212	.2223	.2221	.2316	.2316	.354	.354	1.886	1.780
					Code B					
57	0.2246	0.2247	0.2247	0.2247	0.2260	0.2260	0.353	0.353	1.677	1.304
59	.2248	.2255	.2244	.2245	.2268	.2275	.352	.352	1.680	1.304
63	.2247	.2248	.2243	.2245	.2264	.2270	.353	.353	1.677	1.303
65	.2250	.2252	.2244	.2244	.2267	.2262	.353	.353	1.690	1.304
66	.2246	.2246	.2242	.2244	.2265	.2260	.354	.354	1.671	1.304
70	.2245	.2242	.2244	.2244	.2265	.2270	.354	.353	1.687	1.301
73	.2245	.2249	.2244	.2244	.2265	.2258	.354	.354	1.687	1.310
74	.2246	.2245	.2249	.2248	.2259	.2258	.354	.354	1.698	1.306
75	.2245	.2245	.2245	.2245	.2265	.2260	.353	.353	1.680	1.313
Mean	.2246	.2248	.2245	.2245	.2264	.2264	.353	.353	1.683	1.305

[a]Diameter measured at the shoulder nearest the muzzle.

Table 2.1-3. Spring and Guide-Rod Dimensions

	Spring-Guide Rod Dimensions, in.					Spring Dimensions, in.				
							Diameter			
			Length from Front	Diameter			Inside	Outside		
Serial No.	Eccentricity	Total Length	Shoulder	Vert	Hor	Length	Average	Max	Min	Average
				Code A						
2694	0.002	6.669	6.578	0.156	0.156	7.905	0.166	-	-	0.222
3759	.008	6.662	6.573	.156	.156	7.996	.165	-	-	.221
3763	.009	6.664	6.573	.156	.156	8.030	.160	-	-	.220
3779	.001	6.661	6.570	.156	.156	7.975	.164	-	-	.222
3800	.010	6.669	6.575	.156	.156	7.943	.162	-	-	.220
3805	.037	6.657	6.566	.156	.156	7.585	.162	-	-	.222
3809	.001	6.670	6.576	.156	.156	8.014	.164	-	-	.220
3823	.001	6.661	6.569	.156	.156	7.893	.162	-	-	.222
3824	.001	6.670	6.576	.156	.156	7.903	.161	-	-	.221
Mean	.008	6.665	6.573	.156	.156	7.916	.163	-	-	.221
				Code B						
57	0.001	4.581	4.018	0.156	0.157	4.447	0.190	0.257	0.244	-
59	.001	4.579	4.019	.156	.156	4.430	.177	.245	.238	-
63	.008	4.577	4.016	.156	.157	4.407	.177	.248	.237	-
65	.002	4.582	4.019	.157	.157	4.457	.194	.258	.242	-
66	.009	4.584	4.039	.156	.156	4.421	.182	.253	.243	-
70	.008	4.573	4.014	.157	.157	4.376	.185	.245	.240	-
73	.003	4.584	4.016	.157	.157	4.383	.176	.248	.238	-
74	.001	4.585	4.013	.157	.157	4.428	.174	.248	.238	-
75	.004	4.582	4.020	.156	.156	4.506	.187	.248	.238	-
Mean	.004	4.581	4.019	.156	.157	4.428	.182	.250	.240	-

Table 2.1-4. Magazines

Magazine No.	Weight, grams	Indexed Height[a], in.	Weights, grams: Insert	Weights, grams: Magazine	Weights, grams: Total	Indexed Height[a], in.
	Code A		Code B			
1	130.8	1.201	72.5	84.0	156.5	1.235
2	133.0	1.206	72.0	82.0	154.0	1.258
3	131.8	1.206	74.2	83.5	157.7	1.256
4	128.6	1.200	73.4	84.0	157.4	1.273
5	130.0	1.200	73.2	83.2	156.4	1.270
6	128.7	1.218	73.3	83.0	156.3	1.274
7	131.5	1.202	74.0	82.7	156.7	1.276
8	130.0	1.200	73.8	83.0	156.8	1.264
9	130.0	1.200	72.6	83.7	156.3	1.311
10	128.8	1.221	74.0	83.2	157.2	1.262
Mean	130.3	1.205	73.7	83.2	156.5	1.268

[a]The distance from the uppermost edge of the magazine lip to the top edge of the magazine catch.

2.1.5 Analysis

The RFAs of all three manufacturers meet the basic criteria for design characteristics. Code A RFAs were received in good condition with the exception of serial No. 3805, which had a bent spring-guide rod (Table 2.1-3). The RFAs of manufacturer Code B were in good condition except that some parts were slighty oversize for proper fit in the M16A1 rifle; the oversize parts could be easily corrected during manufacture by reducing the height of the alignment block and chamfering or reducing the size of the hex-head screw. The Code C RFAs were improperly manufactured in that they could not be made to operate correctly due to interferences and misalignments.

The magnetic-particle examination showed that the RFAs were free of gross defects in the materials. The one crack detected in Code C RFA serial No. 2 was not in an area subjected to stress; the crack was apparently caused by the guide-rod hole being drilled too close to the edge of the buffer.

The Code A and Code B RFAs were slightly heavier (350 grams and 426 grams respectively) than the standard M16A1 bolt and carrier (326 grams). Both the Code A and Code B magazines were heavier (130.3 grams and 156.5 grams) than the magazine for the M16A1 rifle (83.2 grams).

2.2 SAFETY EVALUATION

2.2.1 Objective

The objective was to reasonably ensure that the RFAs undergoing test will not subject test personnel to undesirable risks when employed as a training device in conjunction with the M16A1 rifle.

2.2.2 Criterion

The adapter will be safe for use with the M16A1 rifle. Drawing the caliber .22 bolt entirely to the rear, without a magazine installed in the rifle, shall extract the cartridge or cartridge case from the chamber and eject it freely and completely out of the receiver (CONARC TDR 095, para III.B.5).

2.2.3 Method

Testing for this phase was conducted in the manner and sequence as follows:

a. Hand cycling. One 10-round magazine was loaded and the ammunition hand cycled through each RFA; the extracted cartridges were examined for evidence of damage. A second 10-round magazine was hand cycled through each RFA with the magazine being removed prior to extracting each cartridge.

b. Velocity. An M16A1 rifle was mounted on a fixed rest and a kraft-paper witness screen was placed to enshroud the weapon in the area that a shooter's face would be located. Each available RFA was assembled to the rifle and one magazine (10 rounds) was fired remotely. Instrumental velocities were measured 15 feet forward of the muzzle by recording the time of flight of each projectile between two lumiline screens positioned 5 and 25 feet in front of the weapon.

c. Cookoff. An RFA was randomly selected from each contractor's sample and subjected to an abbreviated cookoff test. Five trials were fired with one device from each of the manufacturers. The Code A trials consisted of 80 rounds (five 16-round magazines) fired from RFA serial No. 3809 in approximately 1 minute and 40 seconds. The Code B trials were 50 rounds fired from RFA serial No. 70 in approximately 1 minute and 30 seconds. A live cartridge was left in the chamber at the end of each trial and a 10-minute waiting period was observed. The Code C RFAs were not subjected to a cookoff test.

d. Recoil energy. Recoil energy was computed in accordance with the technique prescribed in paragraph 6.2.1 of TOP/MTP 3-2-504.

The weights used in the calculation were as follows: bullet, 40 grains; propellant, 2.5 grains; rifle, 6.35 pounds (M16A1 empty without sling). The muzzle velocity was assumed to be 1175 fps (the highest allowable under the commercial specification of 1135 ± 40 fps).

2.2.4 Results

The results of the various subtests are as follows:

a. Hand cycling. All the Code B RFAs operated properly when hand cycled with the magazine in place or removed.

The Code A RFA operated properly except as follows: serial No. 3759, one failure to extract (FX) with the magazine in; serial No. 3800, two FX with the magazine in; serial No. 2694, one FX with the magazine out; serial No. 3763, three failures to strip a round from the magazine (FS).

Four of the Code C RFAs available for this test phase operated properly except as follows: serial No. 9, one failure to eject (FJ) with the magazine in; serial No. 7, two FS and five FJ with the magazine in; serial No. 4, three FJ and one FS with the magazine in.

b. Velocity. No perforations were found in the witness screen for any of the RFAs of the three manufacturers. Table 2.2-1 summarizes the velocities from the RFAs. Table 2.2-2 tabulates the malfunctions of each RFA fired during the velocity test.

Table 2.2-1. Velocity at 15 Feet, fps

Serial No.	Mean	High	Low	Std Dev
		Code A		
2694	954.7	1050	891	49.6
3759	945.3	991	901	29.0
3763	958.3	1052	904	46.4
3779	977.8	1102	873	63.9
3800	982.7	1077	904	52.1
3805	989.3	1063	885	51.7
3809	1002.0	1082	902	70.0
3823	991.8	1078	899	61.9
3824	976.6	1099	933	46.9
Mean	975.4	1066	899	52.4

Table 2.2-1 (Cont'd)

Serial No.	Mean	High	Low	Std Dev
		Code B		
57	919.8	1035	791	69.4
59	903.9	1008	828	69.0
63	907.8	1082	752	89.1
65	929.2	947	889	16.3
66	916.5	1028	830	88.0
70	916.4	1041	830	84.4
73	914.1	1069	810	76.8
74	871.9	943	770	58.6
75	927.1	1020	811	77.5
Mean	911.9	1019	812	63.9
		Code C		
3	823.6	950	654	97.5
4	914.7	1038	790	90.3
5	821.0	997	749	78.0
7	850.2	1076	661	130.8
9	915.3	1059	780	93.1
Mean	865.0	1024	727	97.9

Table 2.2-2. Malfunctions during Velocity Test

Serial No.	Malfunctions
	Code A
2694	None
3759	None
3763	None
3779	2 each FX
3800	2 each FFR (BNCC)
3805	None
3809	FX
3823	None
3824	None

Table 2.2-2 (Cont'd)

Serial No.	Malfunctions
	Code B
57	2 each F2R
59	F2R
63	None
65	None
66	None
70	FK, BOB
73	F2R
74	None
75	FK
	Code C
3	2 each FFR (BNCC), 4 each FF (BCEC), one FX
4	2 each FFR (BNCC)
5	6 each FF (BCEC), one BOB
7	2 each FF (BCEC), one FJ
9	FFR (BNCC), FF (BCEC), BOB

BCEC = bolt closed on empty chamber.
BNCC = bolt not completely closed.
BOB = bolt override of cartridge base.
FFR = failure to fire.
FK = failure to cock.
F2R = fired two rounds on one rearward movement of the trigger.

c. Cookoff. No cookoffs occurred with either the Code A or Code B RFAs. Table 2.2-3 tabulates the malfunctions that occurred during the cookoff test.

Table 2.2-3. Malfunctions during Cookoff Test

Code A		Code B	
No.	Malfunction	No.	Malfunction
2	FF (BOB)	6	F2R
7	F2R	11	FFR (BNCC)
3	FX	3	FF (BOB)
		3	FJ
		3	FF (BCEC)

d. Recoil energy. Recoil energy was computed to be 0.14 foot-pound.

2.2.5 Analysis

The criteria for extraction of a cartridge or cartridge case is met by Code B and Code C manufacturers. Code A RFAs partly meet the requirement with four failures to extract during the 180 trials of hand charging.

All three manufacturers demonstrate safety to the shooter in that no ejected particles were detected.

The RFAs of manufacturers Code A and B are safe from cookoff hazard on any firing schedule employing five or less magazines.

The approximate recoil energy of 0.14 foot-pound is well below the 15 foot-pound level for unlimited firing as suggested by TOP/MTP 3-2-504.

2.3 EXTREME TEMPERATURE TEST

2.3.1 Objective

The objective was to determine if the RFAs furnished for test are operational in the intermediate and wet climatic categories defined in AR 70-38.

2.3.2 Criteria

a. The adapter will be operational under intermediate and wet categories of weather in accordance with Categories 1, 2, 3, 5, and 6 of AR 70-38 (CONARC TDR 095, para V.B).

b. The test RFA shall operate safely (required) during exposure to environmental tests (TECOM-approved test plan).

2.3.3 Method

Both high-temperature and low-temperature functioning tests were conducted with Code A and Code B RFAs. Three RFAs for each manufacturer and one M16A1 rifle were placed in a climatic chamber together with 3000 rounds of ammunition, 10 magazines, and rifle-cleaning equipment. The items were conditioned at the desired temperature for a minimum of 4 hours. Each RFA was fired 1000 rounds in 100-round groups at 2-hour (minimum) reconditioning intervals. Maintenance was not performed on the RFAs during the 1000-round cycle. The rifles were disassembled, cleaned, and relubricated after every 1000 rounds. The magazines used in the temperature functioning test were those 10 with the fewest malfunctions from the 30 used in the accuracy and endurance test phase. The firings were conducted through a paper target outside the climatic chamber at 25 meters from the weapon; the target was periodically inspected to evaluate possible bullet instability.

The high-temperature test was conducted at +155°F. The RFAs and rifles were lubricated with lubricating oil, semifluid (LSA).

Low-temperature testing was initiated at -35°F but was later changed to 0°F due to functioning problems at -35°F. The RFAs and rifles were lubricated with lubricating oil, weapons (LAW). Operating personnel wore appropriate clothing, including arctic mittens.

2.3.4 Results

A summary of the malfunctions encountered during extreme-temperature testing is in Table 2.3-1 for the +155°F, -35°F, and 0°F firings. The firings at -35°F were terminated at 100 rounds for Code B and 200 rounds for Code A due to the excessively high malfunction rates at that temperature.

Table 2.3-1. Malfunctions at Extreme Temperatures

Temp, °F	RFA Code	No. Rd Fired	No. Malf	Percent Malf
+155	B	3000	56	1.9
	A	3000	74	2.5
0	B	2971	449	15.1
	A	3000	201	6.7
- 35	B	100	32	32.0
	A	200	20	10.0

A listing of the malfunctions by type for each RFA is in Tables A-1 through A-16.

The firing pins in Code B RFAs 63 and 66 broke during the +155°F phase. The firing pin of RFA 63 broke at 560 rounds and the firing pin of RFA 66 broke at 845 rounds. Both firing pins broke at the smallest cross section at the shoulder where the firing-pin spring bears.

The spring pin that retained the barrel on Code B RFA No. 63 loosened and fell from assembly after firing a total of 550 rounds. The lack of the pin allowed the barrel to become misaligned, which in turn made it impossible to load or fire the RFA. The pin was found to be too worn to stay in assembly and was replaced with a new one.

An examination of the paper target showed no evidence of bullet yaw or other indications of bullet instability.

Both Code A and Code B RFAs were easily assembled to the M16A1 rifle by personnel wearing arctic mittens. Some difficulty was encountered in the manipulation of the takedown pin on the rifle, but there were no difficulties associated with the RFAs themselves. It was nearly impossible to handle individual caliber .22 cartridges with arctic mittens or other heavy gloves. It was possible to load both Code A and Code B magazines while wearing wool field glove liners or light cotton work gloves, but such gloves did not give adequate protection for long-term exposure to the cold temperatures. At 0°F, personnel could load no more than approximately 15 magazines (requiring about 10 minutes) while wearing the light gloves or wool glove liners.

Three cartridges ruptured during the +155°F firings of the Code A RFAs; one in serial No. 3759 (at 604 rounds) and two in serial No. 2694 (at 103 and 789 rounds). In all three instances, the forward part of the case was in the chamber and remained intact. The rear parts of the cases were partially fragmented. It was not possible to determine if any parts of the cases were expelled out of the ejection port.

2.3.5 Analysis

At low temperatures of -35°F and 0°F both Code A and Code B RFAs have significantly larger malfunction rates (0.10 significance level) than they displayed, respectively, during the ambient-temperature endurance test. Neither Code A or Code B meets the 5% maximum malfunction-rate criterion applied to the endurance test. Operation of the RFAs was erratic and varied from item to item within each manufacturer; each item within both Code A and Code B had a significantly different malfunction rate (0.10 level) than the other two of the same make. The malfunctions were predominantly short-recoil related; 60% of the Code A and 64% of the Code B malfunctions were directly caused by short recoil.

The malfunction rate of the Code B RFA at +155°F is not significantly greater than that for the endurance test. The Code A RFA had a significantly greater malfunction rate (10% level) at +155°F than at ambient temperature in the endurance test. Both Code A and Code B meet a 5% maximum malfunction-rate criterion (as required at ambient temperature for the endurance test). Within Code A RFAs there were no significant differences (10% level) in the malfunction rates of the three RFAs. Within Code B, RFA serial No. 63 had a significantly smaller malfunction rate (10% level) than the other two RFAs.

The RFAs of manufacturer Code B operated safely throughout the extreme-temperature test firings.

The Code A RFAs operated safely during the 0°F and -35°F firings. The three case ruptures occurring at +155°F with the Code A RFAs are classified as a shortcoming because they are considered a Category II (marginal) safety hazard as defined by MIL-STD-882.

2.4 HUMIDITY TEST

2.4.1 Objective

The objective was to determine the effect of high humidity on the functioning performance of the RFA.

2.4.2 Criteria

a. The adapter will be operational under intermediate and wet categories of weather in accordance with Categories 1, 2, 3, 5, and 6 AR 70-38 (CONARC TDR 095, para V.B).

b. The test RFA shall operate safely (required) during exposure to environmental tests (TECOM-approved test plan).

2.4.3 Method

The three RFAs for each contractor and one rifle that were used for the extreme-temperature tests were exposed to the temperature and humidity conditions shown in Table 2.4-1 for 10 days. Ten magazines for each manufacturer together with 3000 rounds of ammunition for each group of 10 were subjected to the temperature and humidity environment. The weapons, RFAs, and magazines were cleaned and lubricated with LSA prior to testing. The rifles were cleaned and reoiled after every 1000 rounds; the RFAs and magazines were not cleaned or reoiled for the duration of the test. On the third, fifth, eighth, and tenth days of exposure, 250 rounds of ammunition were fired from each RFA.

Table 2.4-1. Storage Schedule for Humidity Test (24 Hours)

No. Hours		Temp, °F		Relative Humidity, %
2	increase to	105	and	90
16	maintain at	105	and	90
2	decrease	105 to 70	increase to	95
4	maintain at	70	and	95

2.4.4 Results

Both Code A and Code B RFAs developed very light rust on a few areas, primarily those areas where the protective coatings were worn sufficiently to expose bare metal. No indications of rust or corrosion were observed on the magazines or M16A1 rifles. The cardboard ammunition cartons (commercial packaging) were weakened, but were serviceable if care was taken during the handling and loading operations.

A summary of the malfunctions encountered during the humidity test is in Table 2.4-2. A breakdown of the types of malfunctions for each RFA is in Tables A-17 through A-22.

Table 2.4-2. Malfunctions Attributable to RFA Systems during the Humidity Test

Code	RFA Serial	No. Rd Fired	No. Malf
A	2694	1000	34
A	3759	1000	45
A	3824	1000	16
B	63	1000	148
B	66	1000	46
B	74	1000	58

The firing pin in RFA 66, Code B, broke during the humidity firings. The firing pin had a total of 4653 rounds fired with it in various subtests, as follows: 893 rounds during humidity firings, 2555 rounds under ambient conditions, 50 rounds at -35°F, 1000 rounds at 0°F, and 155 rounds at +155°F. The firing pin broke in its smallest cross section adjacent to the shoulder on which the firing-pin spring bears.

2.4.5 Analysis

The point estimates and 80% confidence intervals on malfunction rates were calculated on the assumption that the malfunctions were a binomially distributed random variable. The calculated values are in Table 2.4-3; the values from the endurance test are included to facilitate comparisons.

Table 2.4-3. Malfunction Rates

Test	Code	RFA Serial No.	Malf Rate	90% Conf Limits on Malf Rate Lower	90% Conf Limits on Malf Rate Upper
Humidity	B	63	0.148	0.134	0.163
Humidity	B	66	.046	.038	.056
Humidity	B	74	.058	.049	.069
Humidity	B	All	.084	.078	.091
Humidity	A	2694	.034	.027	.043
Humidity	A	3759	.045	.037	.055
Humidity	A	3824	.016	.011	.022
Humidity	A	All	.032	.028	.036
Endurance	B	All	.016	.014	.017
Endurance	A	All	.025	.023	.026

Comparisons of malfunction rates were made utilizing the Chi-square test for comparing two binomial proportions at a significance level of 0.10. The following significance statements were demonstrated:

a. Code A has a smaller over-all malfunction rate.

b. Both Code A and Code B malfunction rates for the humidity test were larger than for the endurance test.

c. For Code B, serial No. 63 had a larger malfunction rate than No. 66 and 74.

d. For Code A, serial No. 3824 had a smaller malfunction rate than No. 2694 and 3759.

In general, the performance of both the Code A and Code B RFAs were degraded by exposure to the humidity conditions. Code A RFAs performed better than Code B and met the 5% malfunction-rate limit required for the endurance test phase; Code B RFAs did not meet the 5% requirement. Both Code A and Code B RFAs operated safely during exposure to a humidity environment.

2.5 ACCURACY AND ENDURANCE TEST

2.5.1 Objective

The objective was to determine the accuracy of the RFA relative to its use in marksmanship training and to determine the functioning life of the assembly.

2.5.2 Criteria

a. The battle-sight zero of the M16A1 rifle converted with the RFA should approximate that of the rifle firing service ammunition out to ranges of 125 meters (CONARC TDR 095, para III.B.6).

b. Accuracy obtained with the RFA, when firing caliber .22 LR ball, standard or high-velocity ammunition, should be equal to the accuracy obtained by the M16A1 when firing 5.56-mm ball, M193 ammunition, out to ranges of 125 meters (CONARC TDR 095, para III.B.7).

c. The RFA and magazine will be capable of withstanding the firing of 5000 rounds, with a malfunction rate not to exceed 5% at a 90% confidence level (Test Directive, AMSTE-BC, 29 July 1974, para 6.e).

2.5.3 Method

Three randomly selected RFAs from each contractor (Code C RFAs were not subjected to all tests) were subjected to the following tests, in the order shown:

a. One M16A1 rifle (APG No. 1) was randomly selected from those available at the time of test. The rifle sights were adjusted with the rear sight centrally located on the windage adjustment and the front sight positioned so that the flange was flush.

   Three 10-shot targets were recorded at ranges of 25, 42, 75, 100, and 125 meters using 5.56-mm M193 ball ammunition. Three of each contractor's RFAs were assembled to the same rifle and three 10-shot targets were fired from each device at each range. The point of aim for all firings was the 6 o'clock position. The firings were conducted from a benchrest with the rifle supported on a sandbag. The same NRA Master-rated rifleman was employed for all the accuracy firings. The rifle was cleaned and lubricated with LSA and three rounds of 5.56-mm ball ammunition were fired between changeovers from one contractor's RFAs to the next.

   Velocity measurements were made concurrently with the accuracy firings. The velocities were recorded at an instrumental point 15 feet from the muzzle, using a 20-foot interval between detectors.

   RFAs from contractor Code C were withdrawn from testing after the accuracy firings, at 25, 42, 75, and 100 meters in accordance with instructions from TECOM (Reference 4).

b. The three RFAs from contractors Codes A and B used for the accuracy firings were disassembled, cleaned, lubricated with LSA, and reassembled. Each RFA was assembled to an M16A1 rifle and fired for a 5000-round endurance test.

   Each RFA-rifle combination was initially fired 20 rounds to record velocities in two 10-shot targets at 125 meters in the manner described in paragraph 2.5.3a. The RFA and the rifle were cooled to range ambient temperature after each 100 rounds fired, and were disassembled, cleaned, inspected, and lubricated after each 1000 rounds. Twenty rounds were fired for accuracy and velocity at each 1000-round interval. Magnetic-particle inspections were also conducted at 1000-round intervals. The final 700 rounds for each RFA were fired in 100-round groups as shown in Table 2.5-1 to determine weapon functioning for various weapon attitudes and orientations. The weapons were hand-held for all conditions.

Table 2.5-1. Schedule for Attitudes Portion of Endurance Firings

How Weapon Was Held	Weapon Elevation
Loosely	0° (level)
Right side up	0° (level)
Left side up	0° (level)
Normally	80° elevation
Loosely	80° elevation
Normally	80° depression
Loosely	80° depression

Ten magazines were allotted to each RFA and were used exclusively for all firings with the assigned RFA. The magazines were hand loaded with 10 rounds of ammunition under ambient range conditions.

All malfunctions, parts breakages, and parts replacements were recorded. For each malfunction, the magazine number and round number in the magazine were noted. The X and Y coordinates for each target were measured to the nearest 0.1 inch relative to the aiming point.

An additional test phase was directed by Reference 3 to serve as a check on the velocity level of the caliber .22 LR ammunition used for the DT II firings (lot RA5668) and of a lot of ammunition (WCC 6414) used for part of the OT II firings. One hundred rounds of each lot were fired for velocity; 50 rounds from each of two caliber .22 target rifles. The rifles were Remington 40X target models with 28-inch barrels.

2.5.4 Results

Due to the large amount of data generated by the accuracy and endurance test, the results are reported in three separate categories: velocity, accuracy, and functioning.

2.5.4.1 Velocity. Table 2.5-2 summarizes the velocities recorded during the initial accuracy test at 25, 42, 75, 100, and 125 meters. Each velocity is the average of the three RFAs for each contractor; all velocities were fired from the same M16A1 rifle.

Table 2.5-2. Velocities at 15 Feet during Initial Accuracy Test

Contractor's Code	Velocity, fps	
	Mean	Std Dev
B	958	69.8
A	1007	46.5
C	888	93.9
5.56	3179	34.2

The velocities recorded before and after each 1000 rounds of the endurance firings are summarized in Table 2.5-3. Each velocity is the average of the three RFAs for each contractor.

Table 2.5-3. Velocities, FPS, at 15 Feet during Endurance Firings

	Measurements											
	Initial		1000 Rd		2000 Rd		3000 Rd		4000 Rd		5000 Rd	
Code	Vel	Std Dev	Vel	Std Dev	Vel	Std Dev	Vel	Std Dev	Vel	Std Dev	Vel	Std Dev
B	936	76.9	963	62.6	957	58.8	952	54.0	954	81.1	969	72.5
A	1019	50.4	1023	51.5	1033	45.9	1028	43.7	1014	45.4	1032	38.8

The results of the ammunition velocity verification firings are summarized in Table 2.5-4.

Table 2.5-4. Velocities of Ammunition Fired from Caliber .22 Target Rifles

	Vel, at 15 Feet, fps					
	Rifle 1086		Rifle 1064		Average	
Ammunition Lot No.	Vel	Std Dev	Vel	Std Dev	Vel	Std Dev
RA 5668	1108	19.5	1124	28.3	1116	23.9
WCC 6414	1121	13.6	1130	16.7	1125	15.1

2.5.4.2 Accuracy. The data from the initial accuracy firings are summarized in Tables 2.5-5 and 2.5-6. Table 2.5-5 shows center-of-impact components averaged over all targets fired at a given range; Figures 2.5-1 and -2 show the same data graphically. The summarized data for dispersion components are in Table 2.5-6 (extreme spread, mean radius, radial standard deviation, vertical standard deviation, and horizontal standard deviation).

Table 2.5-5. Center of Impact, Inches, during Accuracy Phase

	Measurements							
	Horizontal				Vertical			
Range, meters	5.56-MM	Code B	Code A	Code C	5.56-MM	Code B	Code A	Code C
25	3.98	3.91	3.03	3.66	0.12	0.30	0.07	- 0.80
42	5.19	4.98	4.75	5.33	0.72	- 1.02	- 0.26	- 1.33
75	9.56	11.55	8.77	11.99	4.14	- 7.90	- 1.21	-10.49
100	15.27	13.27	14.88	14.92	3.76	-15.19	- 9.71	-17.84
125	16.57	14.57	16.02	-	7.92	-19.87	-17.00	-

Table 2.5-6. Dispersion

Range, meters	RFA Code	Measurements, in.				
		ES	MR	RSD	VSD	HSD
25	A	1.3	0.4	0.5	0.3	0.3
	B	1.6	0.4	0.5	0.3	0.4
	C	2.0	0.6	0.7	0.6	0.4
	5.56	0.9	0.2	0.3	0.2	0.2
42	A	2.3	0.7	0.9	0.5	0.6
	B	2.8	0.8	0.9	0.8	0.6
	C	4.0	1.2	1.4	1.2	0.7
	5.56	1.5	0.4	0.5	0.3	0.4
75	A	4.1	1.2	1.5	1.1	0.9
	B	7.4	1.8	2.3	2.1	1.0
	C	10.9	2.8	3.6	3.4	1.1
	5.56	3.4	0.9	1.1	1.0	0.5
100	A	6.7	1.9	2.3	1.9	1.2
	B	11.8	3.4	4.1	3.6	1.8
	C	17.1	5.1	6.1	5.5	2.3
	5.56	3.0	0.9	1.1	0.8	0.7
125	A	10.2	3.0	3.5	2.5	2.5
	B	15.0	4.3	5.2	4.8	1.9
	5.56	5.7	1.7	2.0	1.5	1.3

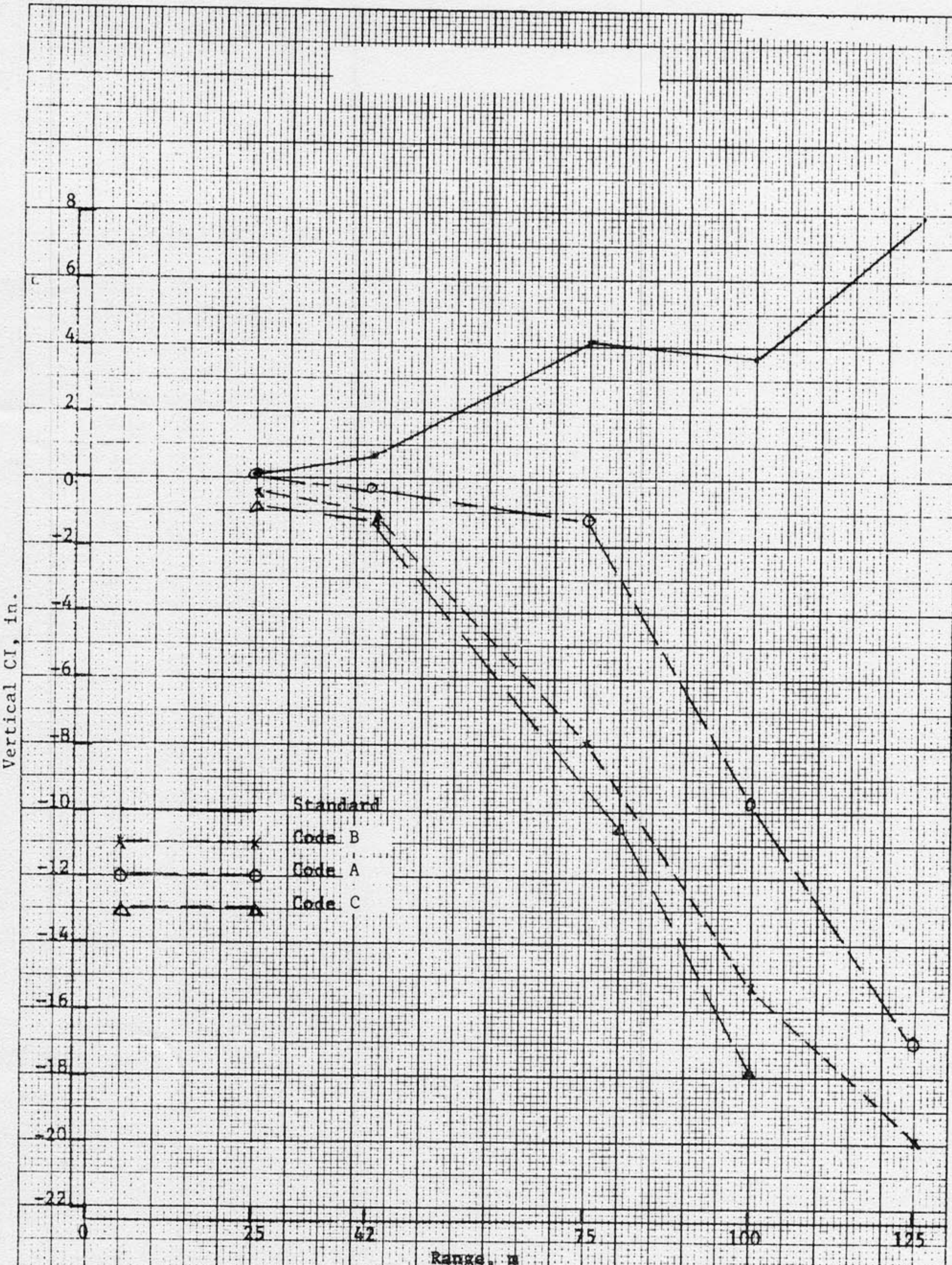

Figure 2.5-1: Vertical Centers of Impact versus Range.

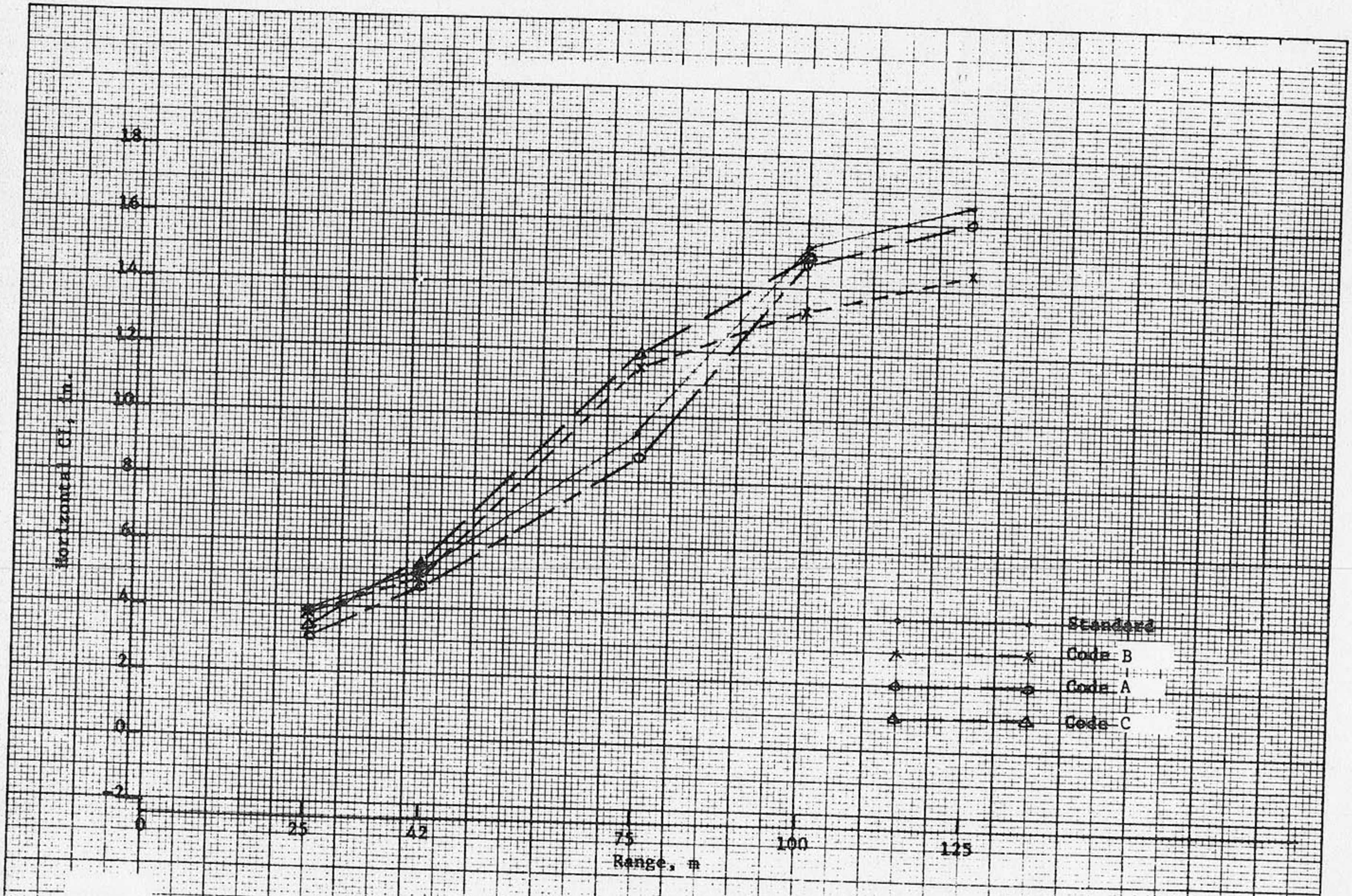

Figure 2.5-2: Horizontal Centers of Impact versus Range.

The accuracy data for the targets fired during the endurance test phase are in Tables 2.5-7 and 2.5-8. The center-of-impact components averaged over all targets at each 1000-round interval are in Table 2.5-7. Table 2.5-8 gives the average dispersion components of the targets. The "Total Rounds Fired" columns indicate rounds from the start of the endurance phase only, and do not include rounds fired previous to the endurance test.

Table 2.5-7. Center of Impact during Endurance Firings

Component	RFA Code	Measurements, in. Total No. of Rd Fired: Initial	1000	2000	3000	4000	5000
Horizontal	A	- 3.0	- 6.1	- 4.2	- 2.6	- 1.8	- 4.7
Vertical	A	-16.5	-16.9	-21.0	-19.2	-20.7	-19.4
Horizontal	B	1.7	4.0	2.7	7.6	6.4	3.6
Vertical	B	-35.1	-27.8	-31.5	-30.2	-28.9	-27.6

Table 2.5-8. Dispersion during Endurance Firings

Total Rd Fired	RFA Code	Measurements, in. Dispersion Component: ES	MR	RSD	VSD	HSD
Initial	A	20.4	5.6	7.2	6.7	2.0
	B	20.1	5.3	6.5	6.1	2.1
1000	A	13.4	3.6	4.5	3.6	2.5
	B	16.1	4.4	5.5	5.1	2.0
2000	A	8.9	2.7	3.2	2.5	1.8
	B	17.7	5.0	6.1	5.6	2.4
3000	A	9.0	2.7	3.2	2.6	1.7
	B	16.1	4.2	5.1	4.7	1.9
4000	A	10.0	2.7	3.3	2.8	1.7
	B	19.5	5.5	6.7	6.4	2.0
5000	A	9.0	2.7	3.2	2.6	1.8
	B	19.3	5.4	6.5	6.1	2.2

2.5.4.3 Functioning. Malfunctions of the RFAs recorded during the endurance test are summarized in Table 2.5-9 for the bulk of the firings and in Table 2.5-10 for the attitudes portion of the firings.

Table 2.5-9. Malfunctions during Endurance Firings

RFA Code	Serial No.	No. Rd Fired	No. Malf	Malf Rate	90% Conf Limits on Malf Rate Lower	Upper
A	3779	4580	71	0.015	0.013	0.018
A	3800	4582	98	.021	.019	.024
A	3823	4580	169	.037	.033	.041
A	All	13742	338	.025	.023	.026
B	70	4590	48	.011	.009	.013
B	73	4590	56	.012	.010	.015
B	75	4570	110	.024	.021	.027
B	All	13750	214	.016	.014	.017

Table 2.5-10. Malfunctions[a] during Attitude Firings (300 Rounds Fired for Each Condition)

Weapon Attitude	RFA Code	No. Malf	Malf Rate	90% Conf Limits on Malf Rate Lower	Upper
Normal, loose grip	A	2	0.007	0.002	0.018
	B	4	.013	.006	.027
Right side up	A	4	.013	.006	.027
	B	5	.017	.008	.031
Left side up	A	26	.087	.066	.111
	B	7	.023	.013	.039
80° depression,	A	9	.030	.018	.047
tight grip	B	26	.087	.066	.111
80° depression,	A	9	.030	.018	.047
loose grip	B	21	.070	.052	.093
80° elevation,	A	16	.053	.037	.074
tight grip	B	21	.070	.052	.093
80° elevation,	A	17	.057	.040	.078
loose grip	B	46	.153	.127	.183

[a]Malfunctions are totaled for the three RFAs of each manufacturer.

Table 2.5-11 shows the individual type and number of the malfunctions included in Table 2.5-9. The ruptured case noted in Table 2.5-11 occurred at round No. 2372 with Code A RFA No. 3800. The forward half of the case was in the chamber and remained intact. The rear half was partially fragmented. An intact empty case was found trapped between the bolt face and the base of the ruptured case. The mouth of the intact case was against the base of the ruptured case. There were no visible indents in the base rim (containing the primer mix) of the ruptured case. It was not possible to determine if any case fragments were expelled from the ejection port of the rifle.

The firing-pin breakages noted in Table 2.5-11 occurred in Code B RFAs 73 and 75 at 2384 rounds and 2746 rounds respectively. Both firing pins separated in the smallest diameter section at the base of the shoulder on which the firing-pin spring bears.

Table 2.5-11. Types of Malfunctions during Endurance Firings

	No. of Occurrences							Attrib-
	Code A			Code B				uted
Type	3779	3800	3823	70	73	75	Cause	to
FF	1	1	3	9	4	1	BCEC due to SR	RFA
FF	1	0	2	2	1	1	BCEC	Mag
FFR	1	6	4	9	1	66	Bolt not completely closed	RFA
FF	0	3	2	2	2	5	Stub on receiver	RFA
FF1	3	14	0	9	4	8	FL	Mag
FFR	1	0	1	1	0	0	Dud cartridge	Ammo
FFR	0	0	0	0	1	1	Broken firing pin	RFA
FJ	61	69	154	9	2	0	Unknown	RFA
FX	0	0	0	0	0	1	Unknown	RFA
FX	0	0	0	0	1	0	Split case	Ammo
DF	1	0	0	0	0	0	Unknown	Mag
BOB	0	0	4	2	0	0	Unknown	RFA
F2R	3	3	0	1	24	5	SR	RFA
FK	0	1	0	5	16	22	SR	RFA
RUP	0	1	0	0	0	0	Unknown	RFA

DF = Double feed.
FF = Failure to feed.
FF1 = Failure to feed first round.
FL = Failure to load by hand charging.
RFA = Rimfire adapter.
RUP = Rupture.
SR = short recoil.

The endurance test was not designed with the direct objective of determining magazine performance or the effect of magazine-rifle-RFA interactions; however, after the test was completed it was evident that there was an effect by the magazine on the functioning of the RFA. Table 2.5-12 contains data showing the number of malfunctions of the RFAs occurring when each magazine was being used. The data cover the 5000 rounds fired with each RFA in the endurance test. The tables do not include data from the rounds fired for targets since these firings emphasized accuracy and magazine-to-weapon assignments were not always observed.

Table 2.5-12. Malfunctions Listed by Magazine

Mag No.	Code A 1000-Rd Cycle No. 1	2	3	4	5	Code A Total Malf	Code B 1000-Rd Cycle No. 1	2	3	4	5	Code B Total Malf
	RFA No. 3779						RFA No. 70					
1	1	1	1	1	1	5	3	5		1	3	12
2	2	1	1	2		6	2			5	7	14
3	1			1		2	1	1	1		2	5
4	[a]11	-	-	-	-	[a]11	1	2			7	10
5			4			4			2	2	8	12
6	2	1	2	2	1	8	1	2		2	9	14
7		1				1				2	6	8
8	1		1	1	1	4		2		4	7	13
9					1	1	1	2		3	7	13
10					1	1	1	1		3	6	11
	RFA No. 3800						RFA No. 73					
11			11	11	16	38	2		1	1	6	10
12			1	1	1	3		3	1	2	7	13
13			1		1	2	2	1		1	7	11
14	1		5			6	1	1		2	1	5
15	2	1	2		6	11	2				6	8
16		2	2			4	1	2	1	1	2	7
17		5	2	1	4	12	4				4	11
18	2	4	3	6	3	18	2		3	3	8	14
19	2	1	3		2	8	1		1	1	4	6
20	3	3	5	3	2	16	2	1		1	6	10
	RFA No. 3823						RFA No. 75					
21	1	2			6	9	4	7			1	12
22			1	1	3	6	5	14	1	1	4	25
23		4	4	19	29	56	3	8	2		1	15
24	4	19	[b]3	-	-	[b]26		2	1	1	1	5
25	1	5	12	41	28	89	4	7			3	14
26			1	1	1	3	7	7		1	1	16
27	1	1		2	1	5	1	2	2	1		6
28	1	11	[c]17	-	-	[c]29	1	3		1		5
29			2	4	1	7	1	3		1	5	10
30			2	1	11	15	1	11		1	3	16

[a]Magazine 4 was removed from test after 30 rounds.
[b]Magazine 24 was removed from test after 210 rounds
[c]Magazine 28 was removed from test after 260 rounds.

In order to determine the possible effects of fouling on the malfunction rates, the malfunctions within each 1000-round cleaning cycle (excluding the malfunctions occurring during target firings) were segregated into two groups representing the first 500 rounds of each cycle and the second 500 rounds of each cycle. The 500-round grouping is shown in Table A-23.

2.5.5 Analysis

2.5.5.1 Velocity. An examination of Table 2.5-4 shows that the ammunition lot used for the DT II firings (lot RA 5668) meets the commercial specification of 1135 ± 40 fps. Comparison of the velocity developed by the target rifles (1116 fps) and the velocities for the RFAs as shown in Table 2.5-2 shows that there is a loss in velocity for the RFAs of all three manufacturers; this loss is probably a result of incomplete obturation within the RFA and between the RFA and the chamber of the M16A1 rifle. The velocities recorded during the 5000-round endurance test (Table 2.5-3) indicate that there were no significant changes in the average velocities or the standard deviation of the velocities of the Code A and Code B RFAs over the 5000-round span.

2.5.5.2 Accuracy. In order to determine if any of the contenders differed from the M16A1 rifle in accuracy, comparisons of the centers of impacts (CIs) and horizontal and vertical deviations of targets fired with the test items were made with the data from the rifle. Table 2.5-13 shows the significant differences. The comparisons were made based on the assumption that the variables were distributed as a random normal variable. Two-sided t-tests were used to determine the difference in CIs at the 0.05 level of significance. One-sided t-tests were used for comparing standard deviations at the 0.05 level of significance.

Table 2.5-13. Significance Statements for Comparison of CI and Standard Deviation of RFAs with M16A1 Rifle (0.05 Level of Significance)

	Sig Statements					
	Hor			Vert		
Range,	RFA Code			RFA Code		
meters	A	B	C	A	B	C
Center of Impact						
25	S	NS	S	NS	S	S
42	S	NS	S	S	S	S
75	S	S	S	S	S	S
100	NS	S	NS	S	S	S
125	NS	S	-	S	S	-

Table 2.5-13 (Cont'd)

Range, meters	Sig Statements: Hor RFA Code A	B	C	Vert RFA Code A	B	C
Standard Deviation						
25	S	S	S	S	S	S
42	S	S	S	NS	S	S
75	S	S	S	NS	S	S
100	NS	S	S	S	S	S
125	S	S	-	S	S	-

Sig = Significance.
S = Significant.
NS = Not significant.

Table 2.5-13 indicates that all the RFAs have generally greater dispersion than the M16A1 rifle; for each range every RFA shows a significant difference in at least two of the four components. The vertical CIs are different, probably as a result of the lower velocity of the caliber .22 cartridge as compared to the 5.56-mm cartridge. Thus the criterion that the battle-sight zero of the M16A1 rifle converted with the RFA should approximate that of the rifle firing service ammunition out to ranges of 125 meters is not met. The RFAs also do not meet the criterion for accuracy as required in paragraph 2.1.2b.

A 2-way analysis of variances was utilized to analyze the target accuracy data from the endurance firings at a 0.10 significance level. The following statements were established:

a. Horizontal components:

1) Code A CI is different than Code B CI, with Code B being further right.

2) There were no differences in standard deviations.

3) Neither CI nor standard deviation differed over the 5000-round test for either Code A or Code B RFAs.

b. Vertical components:

1) Code A differs from Code B as to CI, with Code A being higher.

2) The standard deviations were different, with Code B being larger than Code A in five of the six instances.

3) The CIs and standard deviations did not differ over the 5000 rounds for either Code A or Code B.

It has been suggested that the RFAs could be used in a training process whereby the rifleman would zero his rifle at 42 meters using the caliber .22 RFA adapter and then fire 5.56-mm service ammunition without rezeroing his weapon. An approximate calculation based on a 1000-fps velocity for the caliber .22 bullet and standard ballistics for the M193 5.56-mm cartridge shows that the procedure would result in the 5.56-mm bullet going above where it would have impacted if the rifle had been zeroed with the 5.56-mm ammunition. Table 2.5-14 shows the difference in trajectories.

Table 2.5-14. 5.56-MM Trajectory Mismatch

Range, meters	Vert Mismatch, in.
50	4
100	8
150	13
200	18
250	21
300	25

The figures in Table 2.5-14 are only approximations but it is evident that zeroing an M16A1 rifle using the caliber .22 RFA will result in large errors if 5.56-mm service ammunition is then fired with the same sight settings.

2.5.5.3 Functioning. From Table 2.5-9 it can be seen that the criterion for a maximum 5% malfunction rate at 90% confidence was met by both the Code A RFA with a 2.6% malfunction rate and the Code B RFA with a 1.7% malfunction rate (both rates are the upper 90% confidence limits; actual observed rates were 2.5% for Code A and 1.6% for Code B). The Code B RFAs have a significantly lower malfunction rate than the Code A RFAs. The three Code A RFAs differ significantly from one another. Within Code B; RFA No. 75 has a significantly larger malfunction rate than the remaining two.

As can be seen from Table 2.5-10, the malfunction rates for both Code A and Code B during the attitude firings were generally greater than during the endurance firing, thus indicating that the attitudes have a detrimental effect on the functioning of the RFAs. Table 2.5-15 indicates the significance of the malfunction rates.

Table 2.5-15. Attitude Malfunction Rates Compared to Endurance Malfunction Rates 0.10 Significance Level

Attitudes	Comparison Data	
	Code A	Code B
Normal, loose	Attitude rate smaller	NSD
Right side up	NSD	NSD
Left side up	Attitude rate larger	NSD
80° depressed, tight	NSD	Attitude rate larger
80° depressed, loose	NSD	Attitude rate larger
80° elevated, tight	Attitude rate larger	Attitude rate larger
80° elevated, loose	Attitude rate larger	Attitude rate larger

NSD = No significant difference.

A comparison of the attitude malfunction rates (at a 0.10 significance level) between the Code A and Code B RFAs indicates that the Code A devices have a smaller malfunction rate for the 80° depression tight, 80° depression loose, and 80° elevation loose; the Code B RFAs demonstrated a smaller rate left side up. There were no significant differences at other attitudes.

The breakdown of malfunctions by type shown in Table 2.5-11 indicates a basic difference in the malfunctions between the Code A and Code B RFAs.

Failures to eject were the largest group of malfunctions for the Code A RFAs, accounting for 284 of the 340 malfunctions. No specific cause could be found for the large number of FJs, which appear to be inherent to the design of the Code A RFA. A total of 21 malfunctions was attributable to the magazines. Furthermore, three magazines (No. 4, 24, and 28) had to be removed from the test due to excessively high malfunction rates of the RFA when the magazines were used; three other magazines (No. 11, 23, and 25) are considered to have become defective during the test as they also developed high malfunction rates near the end of the endurance firings. It is believed, therefore, that there is a magazine-RFA interaction that was responsible for most of the malfunctions of the Code A device. It was not possible to determine the root cause of this interaction due to the complexity of the interaction and the lack of component drawings or specifications to compare against the test item. The malfunction rates calculated for the endurance firings are still considered to be valid since the test item is issued and used as an RFA-magazine kit and the malfunctions are attributable to the final system as used by a rifleman.

Of the 215 malfunctions of the Code B RFAs during the endurance firings (Table 2.5-11), 77 were considered as caused by short recoil, 76 by failure of the bolt to close completely, and the remaining 62 by a variety of causes. Table 2.5-14 indicates that there was no evident magazine-RFA relationship for the malfunctions.

Both Code A and Code B were subject to double firing (firing two rounds with one trigger pull). Code A had six occurrences and Code B had 30 occurrences. The double firings are not considered to be hazardous because the second bullet closely follows the path of the first.

The ruptured cartridge cases occurring with Code A RFA No. 3800 is classified as a shortcoming because it is considered a Category II (marginal) safety hazard as defined by MIL-STD-882.

The cleaning-cycle data summarized in Table A-23 were analyzed by a 4-factor analysis of variance with two main effects, manufacturers and cleaning cycles, and two nested factors, RFA within manufacture and half-cycle (500 rounds) within the cleaning cycle. No significant differences were detected for manufacturers, cleaning cycles, or half-cycles. This demonstrates that the RFAs of both Code A and Code B can be fired 1000 rounds between cleanings without detriment to their functioning. The individual RFAs within manufacturers were significantly different. In manufacturer Code A, No. 3823 has a significantly larger malfunction rate than No. 3779 and 3800. In manufacturer Code B, No. 75 has a significantly larger malfunction rate than No. 70 and 73.

2.6 WATER SPRAY TEST

2.6.1 Objective

The objective was to determine the effects of heavy rainfall on the performance of the RFAs.

2.6.2 Criterion

The test RFAs shall operate safely (required) during exposure to a water-spray test environment (TECOM-approved test plan).

2.6.3 Method

The water-spray test was conducted in accordance with TOP/MTP 3-2-059, paragraph 6.2.6.5. Code B RFAs serial No. 59 and 65 were fired in rifles 12 and 10 respectively; Code A RFAs in serial No. 3763 and 3809 were fired in rifles 11 and 13 respectively. A total of 600 rounds was fired with each RFA. The rifles, RFAs, and magazines were oiled with LSA prior to exposure to the water spray.

2.6.4 Results

All the test RFAs operated safely throughout the water-spray test. Table 2.6-1 summarizes the number of malfunctions of each RFA. A detailed listing of the types of malfunctions for each individual RFA is given in Tables A-24 through A-27.

Table 2.6-1. Malfunctions Attributable to RFA Systems during the Water-Spray Test

Code	RFA Serial	No. Rd Fired	No. Malf
B	59	600	119
B	65	600	4
A	3763	600	37
A	3809	600	5

2.6.5 Analysis

Table 2.6-2 shows the malfunction rates and 90% confidence limits for the RFAs subjected to the water-spray test.

Table 2.6-2. Malfunction Rates in Water-Spray Test

RFA Code	RFA No.	Malf Rate	Lower 90% Confidence Limit	Upper 90% Confidence Limit
A	3809	0.008	0.004	0.015
A	3763	.062	.049	.076
A	Both	.035	.028	.043
B	59	.198	.177	.221
B	65	.007	.003	.013
B	Both	.102	.092	.114

Code A RFAs have an over-all malfunction rate significantly lower (10% level) than Code B. Both have significantly higher rates (10% level) for the water-spray test than for the endurance test (para 2.5); this would seemingly indicate that the water-spray test had a detrimental effect; however, there are significant differences in malfunction rates between the two RFAs within each manufacturer, with the better of each pair having a malfunction rate less than the average for the endurance test. Therefore, it is believed that the test results are inconclusive and that it is not possible to determine the effect of the water-spray environment on the functioning of either Code A or B RFAs without further testing.

2.7 DYNAMIC SAND AND DUST TEST

2.7.1 Objective

The objective was to determine the effects of blowing sand and dust on the performance of the RFAs.

2.7.2 Criterion

The test RFAs shall operate safely (required) during exposure to a blowing sand-and-dust test environment (TECOM-approved test plan).

2.7.3 Method

The dynamic sand-and-dust test was conducted in accordance with TOP/MTP 3-2-059, paragraph 6.2.6.6. The test RFA was assembled to an M16A1 rifle and fully loaded with a 10-round magazine. The weapon was mounted in the test chamber; four 10-round magazines, protected by inclosing them in a plastic bag, were also placed in the chamber. The blower and dust feed were started and the weapon was fired until the ammunition was exhausted or until a weapon malfunction occurred that could not be cleared without the use of tools or disassembly of the weapon. Code B RFA serial No. 59 was fired from rifle No. 12, and Code A RFA serial No. 3809 was fired from rifle No. 13.

2.7.4 Results

The Code B RFA fired two rounds, after which the bolt would not close sufficiently to fire again. The Code A RFA fired the 10 rounds from the magazine in the weapon. The second magazine would not feed due to jamming of the follower. An attempt to fire a third magazine resulted in the first round firing properly and the second round firing but failing to eject. Subsequent rounds followed a pattern of firing one round after hand charging then failing to fire the second round due to failure to eject the empty case of the previous round. The test was terminated at the end of the third magazine when a failure to eject occurred that could not be cleared by hand charging; the empty case was wedged between the charging handle and the bolt and prevented free movement of both.

No unsafe conditions or events were observed for either the Code A or Code B RFAs during the dynamic sand-and-dust test.

2.7.5 Analysis

The Code A and Code B RFAs meet the criterion for safety during exposure to blowing sand and dust. Neither type of RFA can function under the test conditions.

2.8 MUD TEST

2.8.1 Objective

The objective was to determine the effects of mud on the performance of the RFAs.

2.8.2 Criterion

The test RFAs shall operate safely (required) during an exposure to a mud test environment (TECOM-approved test plan).

2.8.3 Method

The mud test was conducted in accordance with TOP/MTP 3-2-059, paragraph 6.2.6.8. A total of 50 rounds was fired, 10 from each of five magazines. The viscosity of the mud mixture at the time of test was 4700 centipoises. The weapon muzzle was taped shut, the gun fully loaded, and the safety placed in the SAFE position. The loaded weapon and four magazines were completely immersed in the mud in a horizontal position for 60 seconds. The weapon was then removed from the mud and the tape removed from the muzzle. Cleaning of the weapon and magazines prior to firing was limited to wiping with bare hands. Code B RFA serial No. 65 was fired from rifle No. 10 and Code A RFA serial No. 3763 was fired from rifle No. 11.

2.8.4 Results

The malfunctions that occurred while firing the weapons subjected to the mud test are listed in Table 2.8-1.

Table 2.8-1. Malfunctions of RFAs in Mud Test

Mag	Malfunctions
	Code A
1	None
2	One FF (magazine follower jammed)
3	One FFR (bolt not completely closed), one FF (stub against receiver)
4	One FJ
5	One FF1, two FFR (bolt not completely closed)
	Code B
1	None
2	Two FK
3	One FF (magazine follower jammed)
4	One FF1
5	One FF1

2.8.5 Analysis

The RFAs of both manufacturer Code A and Code B operated safely following exposure to a mud environment. The data are not sufficiently extensive for a statistical analysis of the malfunction rates; however, an inspection of the number and types of malfunctions indicates that the mud had no more than a small detrimental effect on the operation of the RFA. The fact that one magazine of each manufacturer jammed indicates that the operation of the magazines is somewhat impaired by the mud immersion.

2.9 ROUGH HANDLING TEST

2.9.1 Objective

The objective was to provide guidance for evaluating the capability of the RFA to withstand the shocks that could be encountered as a consequence of accidental drops.

2.9.2 Criterion

The test RFA shall operate safely (required) following exposure to the rough-handling test (TECOM-approved test plan).

2.9.3 Method

One RFA from each contractor (previously used in the endurance test) was assembled to an M16A1 rifle and subjected to the 5-foot drop test as prescribed in Appendix D of TOP/MTP 4-2-602. Each rifle/RFA was dropped once in each of four orientations; horizontal (left side up), horizontal (right side up), muzzle impact, and butt impact. An inert cartridge with a live primer was in the RFA chamber during all drops. The rifle bolt was cocked and closed and the safety was off.

Following the 5-foot drop sequence the RFAs were assembled to the same M16A1 rifles that the RFAs had been used with during the endurance test (para 2.5). Three 10-shot accuracy targets were recorded at 125 meters for each RFA as described in the accuracy phase of paragraph 2.5.

After the accuracy firings the RFAs were subjected to the 5-foot drop sequence without being assembled to a rifle. The RFAs were loaded with an inert cartridge with a live primer.

2.9.4 Results

The RFAs of both manufacturers Code A and Code B fired when the RFA-M16A1 rifle assembly was dropped muzzle down. The hammer of the M16A1 rifle did not fall. None of the RFAs fired from butt-impact drops or from horizontal (left and right sides up) impact drops. Table 2.9-1 tabulates the results from the target firings. There were no malfunctions with either Code A or Code B RFAs while firing the targets (30 rounds for each RFA).

Table 2.9-1. Targets Fired after Drop Test

RFA	Dispersion Component, in.				
Code	ES	MR	RSD	VSD	HSD
A	9.0	2.5	3.0	2.2	2.0
B	6.0	1.9	2.2	1.7	1.3

The drop test of the bare RFAs of both manufacturers Code A and Code B resulted in both firing in the muzzle-down orientation; none of the RFAs fired in the horizontal- or butt-impact drops. The barrel of RFA Code B was bent at the mouth to an extent that firing would not be possible. The mouth of the Code A barrel was scarred, but the RFA was serviceable.

2.9.5 Analysis

The forward inertia of the firing pins of the Code A and Code B RFAs is apparently the reason why both fired when dropped muzzle down. This characteristic is classified as a shortcoming because it is considered a Category II (marginal) safety hazard as defined by MIL-STD-882.

The target data presented in Table 2.9-1 were compared to similar data from the last targets fired by the respective RFAs during the endurance test. The only significant difference (at the 0.10 level) was the vertical standard deviation. If uncontrollable variables such as wind conditions are considered together with the statistical analysis, it is evident that the 5-foot drop of the RFA-M16A1 rifle assembly did not affect the accuracy of either the Code A or Code B RFAs.

2.10 MAINTENANCE EVALUATION

2.10.1 Data Acquisition

2.10.1.1 Objective. The objective was to determine and assess the maintenance/maintainability and reliability characteristics of the RFAs submitted for test.

2.10.1.2 Criteria. The adapter kit will require no more maintenance than that required for its corresponding components of the M16A1 rifle (CONARC TDR 095, para III.B.12).

2.10.1.3 Method. Maintenance and repair data were accumulated for all phases of testing. The civilian small-arms repairmen responsible for the RFAs and M16A1 rifles were interviewed to determine additional information. Test logs were maintained to record all parts replacements and maintenance actions. It was not possible to record meaningful maintenance times due to the requirements for unusual procedures; for example, the cleaning required for the endurance test required special cleaning with a solvent to prepare the RFAs for magnetic-particle examination.

2.10.1.4 Results. The RFAs of Code A and Code B manufacturers required only normal care and cleaning (except for the parts breakages noted in para 2.10.4). The time for disassembly, cleaning, and reassembly of all three types of RFA was judged to be approximately the same as that required for the M16A1 bolt-carrier assembly. Periodic examination of the M16A1 rifle bores revealed what appeared to be light deposits of lead near the chamber and the gas port; these deposits were removed by vigorous brushing with the standard brass bore brush. Periodic measurements of the airflow through the M16A1 gas tube did not show any evidence of obstruction by deposits or fouling. Visually, the RFAs of all manufacturers appear very dirty after firing only a few magazines; however, the fouling is of a loose, greasy consistency that is easily removed. Code C RFAs were not tested sufficiently to determine the maintenance requirements.

2.10.1.5 Analysis

The RFA adapter kits of Code A and Code B manufacturers require no more maintenance than that normally given the bolt-carrier assembly of the M16A1 rifle.

2.10.2 Tools and Test Maintenance and Diagnostic Equipment

2.10.2.1 Objective. The objective was to determine whether common and special tools (if needed) are suitable and needed for the intended purpose and prescribed maintenance level.

2.10.2.2 Criteria. The special tools and test equipment outlined in the maintenance literature and/or contained in the maintenance test package shall be necessary and adequate for the performance of all required maintenance tasks at all levels of maintenance when used in conjunction with the authorized common tools and test equipment contained in the applicable tool kits. Common tools should be substituted for special tools whenever possible (AR 702-3, para 2-5c(1)).

2.10.2.3 Method. Throughout the test, common and special tools (if required) as prescribed in the maintenance manuals, will be evaluated to determine suitability and need.

2.10.2.4 Results. The RFA kits of all three manufacturers were easy to clean and service with common tools and equipment. The bolts of all the RFAs require punches of various sizes to remove roll pins when the bolts are disassembled. Field stripping of the RFAs of Code A and Code B can be accomplished without tools; Code C RFAs require a 1/8-inch hex wrench (allen key) to remove the guide rod for field stripping.

2.10.2.5 Analysis. All three RFA kits can be adequately maintained with commonly available tools.

2.10.3 Equipment Publications

2.10.3.1 Objectives. The objectives were to determine:

a. Adequacy of maintenance instructions contained in technical manuals.

b. Adequacy of preventive maintenance services instructions.

c. Accuracy of repair parts and special tool lists.

2.10.3.2 Criterion. The equipment publications in the maintenance test package shall be complete, accurate, easy to read, consistent in nomenclature, simple to follow, and adequate to complete both scheduled and unscheduled maintenance operations and parts acquisition at all levels of maintenance. Draft Army equipment publications shall conform in content and format to those specified in AR 310-3, MIL-M-3878 (A), or MIL-M-63000C (TM) series of military specifications as applicable (AR 702-3, para 2.5c(2)).

2.10.3.3 Method. The equipment publications provided were used for guidance in the performance of maintenance throughout the test. The completeness and accuracy of the contents were evaluated and objective comments of maintenance personnel were noted. None of the publications were considered to be draft Army publications and no attempt was made to evaluate them for format and content with regard to the regulations and specifications cited in the criterion.

2.10.3.4 Results. A single manual, which included both operating and maintenance instructions, was provided by the manufacturer for Code A and Code C. No manual was provided by manufacturer Code B.

The Code A manual contained clear and understandable instructions for the installation, operation, and field maintenance of the RFA. The manual did not contain instructions for detailed disassembly of the bolt.

The Code C manual contained cursory instructions sufficient for installation, operation, and complete disassembly of the RFA kit. It contained no information pertaining to maintenance functions such as cleaning and lubricating.

2.10.3.5 Analysis. None of the three manufacturers provided publications capable of meeting the criterion.

2.10.4 Repair Parts

2.10.4.1 Objective. The objective was to determine the repair-parts usage in order to provide guidance for maintaining the RFAs.

2.10.4.2 Criterion. Repair parts shall be authorized in adequate quantities and diversity at the appropriate maintenance levels, consistent with the maintenance allocation chart and RPSTLs where the tools and skills required to install and align the parts are authorized. Repair parts that are used to maintain the test item must be interchangeable with like parts being replaced (AR 702-3, para 2-5c(3)).

2.10.4.3 Method. Throughout the test, a record was maintained of the component parts that were replaced because of failure, or for other reasons.

2.10.4.4 Results. Table 2.10-1 lists the parts replaced during the test and the parts considered to be no longer serviceable. Spare parts were not supplied with any of the RFAs. Parts were obtained by cannibalizing other RFAs.

Table 2.10-1. Parts Replacement

RFA Code	Item No.	No. Rd Fired	Part Description	Reason for Replacement
B	73	2384	Firing pin	Broken
B	75	2735	Firing pin	Broken
B	63	560	Firing pin	Broken
B	66	845	Firing pin	Broken
B	66	4653	Firing pin	Broken
B	63	550	Spring pin, barrel retaining	Worn, fell from assembly
B	65	60	Ejector spring	Lost during maintenance
A	3809	1026	Ejector	Tip broken off
A	4	30	Magazine	High malfunction rate
A	24	210	Magazine	High malfunction rate
A	28	260	Magazine	High malfunction rate
A	11	500	Magazine	High malfunction rate
A	23	500	Magazine	High malfunction rate
A	25	500	Magazine	High malfunction rate

2.10.4.5 Analysis. The criteria cannot be addressed because no parts were provided and no allocation of parts has yet been determined. It is not possible to calculate a meaningful parts life from the limited data available. From observation of Table 2.10-1, it is evident that Code B RFAs have a high breakage rate for firing pins and that Code A has a high magazine failure rate.

2.11 HUMAN-FACTORS EVALUATION

2.11.1 Objective

The objective was to determine the effectiveness of the human-factors man - item relationship throughout the test of the RFA.

2.11.2 Criteria

a. Use of the adapter with the M16A1 rifle will not adversely affect appearance, feel, and weight of the rifle (CONARC TDR 095, para III.B.4).

b. The insertion and removal of the adapter from the M16A1 rifle shall not require excessive time (approximately 15 seconds) (CONARC TDR 095, para III.B.10).

c. Firers will be able to employ the same marksmanship techniques (position, aiming, sighting, etc.) with the M16A1 caliber .22 LR adapter as with the M16A1 firing service ammunition (CONARC TDR 095, para III.B.8).

2.11.3 Method

Testing and maintenance personnel monitored human-factors man - item relationship and maintenance functions throughout the test and especially in the climatic chamber tests (para 2.4). The following aspects were evaluated:

a. Ease of insertion and removal of the RFA from the M16A1 rifle.

b. Simplicity in servicing and performing maintenance on the RFA.

c. Whether the use of the RFA in the M16A1 rifle is readily apparent to the user (i.e., obvious change in weight or center of gravity, recoil forces, etc.).

d. Ease of loading and unloading the RFA magazines.

e. Ease of determining malfunctions and correcting stoppages.

2.11.4 Results

There was no noticeable change in the visual appearance, weight, or balance of the M16A1 rifle when it was equipped with the RFA of any of the three manufacturers. All candidate RFAs were easy to insert or remove; no more than 15 seconds were required for either operation.

The differences in recoil and noise level between the caliber .22 cartridge and the 5.56-mm service ammunition was immediately obvious to the user of the M16A1 rifle. Interviews with the civilian riflemen who fired the M16A1 rifle, both with and without the RFAs, indicated they felt that the lower recoil and noise of the caliber .22 ammunition were advantageous. Normal marksmanship techniques were applied to firing the RFA equipped M16A1 rifles; no changes were required in loading methods, firing positions, or aiming and sighting procedures.

The magazines of all three manufacturers could be loaded and unloaded easily under normal temperature condition. The lips of the Code A magazine were susceptible to damage in rough handling due to their exposed position; the lips of the Code B magazine are less exposed. The lips of the Code C magazines are of stronger construction.

At +155°F (para 2.3) the external lubrication on the caliber .22 cartridges melted, thereby making them slippery and difficult to load. The necessity of wearing gloves during the low-temperature firings (para 2.3) of 0°F and -35°F slowed the loading of the Code A and Code B magazines; at 0°F, personnel could load a maximum of about 15 magazines (requiring about 10 minutes) while wearing light gloves or wool glove liners. It was nearly impossible to handle individual caliber .22 cartridges with arctic mittens. No difficulty was experienced in handling or using the RFAs (Code A and Code B) at high or low temperatures. The Code C magazines and RFAs were not tested at extreme temperatures.

The malfunctions occurring with all three types of RFA were similar to those occurring with the M16A1 rifle firing service ammunition. Stoppages in the Code B and Code C RFAs could almost always be cleared by charging the weapon. Stoppages with the Code A RFAs were usually caused by failures to eject (para 2.5.5.3), which could not usually be cleared by charging the weapon; it was necessary to remove the empty cartridge case by tilting and shaking the rifle or to remove the RFA from the rifle to gain access to the fired case.

2.11.5 **Analysis**

The human-factors criteria listed in paragraph 2.11.2 were met by all RFA manufacturers.

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SECTION 3. APPENDICES

APPENDIX A - TEST DATA

Table A-1. Malfunctions During +155°F Temperature
Test RFA No. 3759, Code A, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	4	bolt not completely closed	RFA
FF	1	stub in magazine	Mag
FF	1	BCEC due to SR	RFA
RUP	2	ruptured cartridge	RFA
FJ	10	UNK	RFA
FFI	1	FL	Mag
FFR	1	dud cartridge	Ammo

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	17	0	17
Magazine	2	0	2
Ammunition	1	0	1
Total	20	0	20

Table A-2. Malfunctions During +155°F Temperature
Test RFA No. 2694, Code A, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	13	bolt not completely closed	RFA
FF	3	BCEC due to SR	RFA
FF	1	stub in magazine	Mag
RUP	1	ruptured cartridge	RFA
FF	2	magazine would not feed	Mag
FX	1	UNK	RFA
FJ	1	UNK	RFA
FFI	3	FL	Mag
FFR	1	dud cartridge	Ammo

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	19	0	19
Magazine	6	0	6
Ammunition	1	0	1
Total	26	0	26

Table A-3. Malfunctions During +155°F Temperature
Test RFA No. 3824, Code A, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	5	bolt not completely closed	RFA
FF	3	stub in magazine	Mag
FF	2	BCEC due to short recoil	RFA
FF	1	magazine would not feed	Mag
FFI	4	FL	Mag
FF	1	UNK	RFA
FX	1	UNK	RFA
F2R	13	failed to engage sear	RFA
FFR	1	dud cartridge	Ammo

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	9	13	22
Magazine	8	0	8
Ammunition	1	0	1
Total	18	13	31

Table A-4. Malfunctions During +155°F Temperature
Test RFA No. 63, Code B, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	11	bolt not completely closed	RFA
FX	1	UNK	RFA
FK	1	SR	RFA
FRA	1	retaining pin feel from assembly	RFA
FFI	2	FL	Mag
FFR	3	dud cartridge	Ammo
FFR	1	broken firing pin	RFA
F2R	1	failed to engage sear	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	6	1	7
Magazine	2	0	2
Ammunition	3	0	3
Total	11	1	12

Table A-5. Malfunctions During +155°F Temperature
Test RFA No. 66, Code B, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	13	bolt not completely closed	RFA
FFR	3	dud cartridge	Ammo
FFR	1	broken firing pin	RFA
FFI	1	FL	Mag
FF	5	BCEC due to short recoil	RFA
FF	1	magazine would not feed	Mag
FK	3	SR	RFA
FX	2	UNK	RFA
FJ	1	UNK	RFA
FF	1	BOB	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	26	0	26
Magazine	2	0	2
Ammunition	3	0	3
Total	31	0	31

Table A-6. Malfunctions During +155°F Temperature
Test RFA No. 74, Code B, 1000 Rds. Fired

Type	No	Cause	Attributed To
FFR	6	bolt not completely closed	RFA
FFR	5	dud cartridge	Ammo
FF	10	BCEC due to SR	RFA
FF	1	Magazine would not feed	Mag
FFI	1	FL	Mag
FX	1	UNK	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	17	0	17
Magazine	2	0	2
Ammunition	5	0	5
Total	24	0	24

Table A-7. Malfunctions During $0^{o}F$ Temperature Test
RFA No. 3759, Code A, 1000 Rds. Fired

Type	No	Cause	Attributed To
FK	2	SR	RFA
FF	1	BCEC due to SR	RFA
FFI	3	FL	Mag
DF	1	UNK	RFA
FFR	27	bolt not completely closed	RFA
FFR	1	dud cartridge	Ammo
F2R	62	SR, failed to engage sear	RFA
FJ	9	UNK	RFA
FF	1	round stubbed against receiver	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	41	62	103
Magazine	3	0	3
Ammunition	1	0	1
Total	45	62	107

Table A-8. Malfunctions During 0°F Temperature Test
RFA No. 2694, Code A, 1000 Rds Fired

Type	No	Cause	Attributed To
FK	2	SR	RFA
FFI	5	FL	Mag
FFR	7	bolt not completely closed	RFA
F2R	44	SR, failed to engage sear	RFA
FJ	3	UNK	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	12	44	56
Magazine	5	0	5
Total	17	44	61

Table A-9. Malfunctions During 0°F Temperature Test
RFA No. 3824, Code A, 1000 Rds. Fired

Type	No	Cause	Attributed To
FK	2	SR	RFA
FF	3	BCEC due to SR	RFA
FFI	6	FL	Mag
FF	2	round stubbed against receiver	RFA
FFR	12	bolt not completely closed	RFA
F2R	5	SR, failed to engage sear	RFA
FJ	4	Unk	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	23	5	28
Magazine	6	0	6
Total	29	5	34

Table A-10. Malfunctions During 0°F Temperature Test
RFA No. 63, Code B, 971 Rds. Fired

Type	No	Cause	Attributed To
FK	100	SR	RFA
FF	41	BCEC due to short recoil	RFA
FFI	3	FL	Mag
FF	1	magazine would not feed	Mag
FFR	33	bolt not completely closed	RFA
FJ	11	UNK	RFA
F2R	2	SR, failed to engage sear	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	185	2	187
Magazine	4	0	4
Total	189	2	191

Table A-11. Malfunctions During $0^{\circ}F$ Temperature Test
RFA No. 66, Code B, 1000 Rds. Fired

Type	No	Cause	Attributed To
FK	4	SR	RFA
FF	18	BCEC due to SR	RFA
FFI	1	FL	Mag
FFR	43	bolt not completely closed	RFA
FFR	1	dud cartridge	Ammo
FJ	1	UNK	RFA
F2R	31	SR, failed to engage sear	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	66	31	97
Magazine	1	0	1
Ammunition	1	0	1
Total	68	31	99

Table A-12. Malfunctions During $0^{o}F$ Temperature Test
RFA No. 74, Code B, 1000 Rds. Fired

Type	No	Cause	Attributed To
FK	41	SR	RFA
FF	30	BCEC due to SR	RFA
FFI	2	FL	Mag
FF	4	magazine would not feed	Mag
FFR	56	Bolt not completely closed	RFA
FJ	5	UNK	RFA
F2R	22	SR, failed to engage sear	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	132	22	154
Magazine	6	0	6
Total	138	22	160

Table A-13. Malfunctions During -35°F Temperature Test
RFA No. 2694, Code A, 100 Rds. Fired

Type	No	Cause	Attributed To
F2R	12	SR, failed to engage sear	RFA
FK	2	SR	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	2	12	14

Table A-14. Malfunctions During -35°F Temperature Test
RFA 3824, Code A, 100 Rds. Fired

Type	No	Cause	Attributed To
F2R	3	SR, failed to engage sear	RFA
FFR	1	bolt not completely closed	RFA
FK	2	SR	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	3	3	6

Table A-15. Malfunctions During -35°F Temperature Test
RFA No. 66, Code B, 50 Rds Fired

Type	No	Cause	Attributed To
FK	2	SR	RFA
FF	8	BCEC due to SR	RFA
FX	1	UNK	RFA
FJ	1	UNK	RFA
F2R	2	SR, failed to engage sear	RFA
FFR	1	bolt not completely closed	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	13	2	15

Table A-16. Malfunctions During -35°F Temperature Test
RFA No. 63, Code B, 50 Rds Fired

Type	No	Cause	Attributed To
FK	11	SR	RFA
FF	1	BCEC due to SR	RFA
FJ	3	Unk	RFA
FFR	1	bolt not completely closed	RFA
F2R	1	SR, failed to engage sear	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	16	1	17

Table A-17. Malfunctions During Temperature Humidity Test
RFA No. 3759, Code A, 1000 Rds Fired

Type	No.	Cause	Attributed To
FK	1	SR	RFA
FF	2	BCEC due to SR	RFA
FFl	7	FL	Mag
FF	1	Rounds would not feed from magazine.	Mag
FFR	6	Bolt not completely closed.	RFA
FJ	22	Unknown.	RFA
F2R	4	SR, Failed to engage sear.	RFA
FF	2	Round stubbed in magazine.	Mag

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	31	4	35
Magazine	10	0	10
Total	41	4	45

Table A-18. Malfunctions During Temperature Humidity Test
RFA No. 3824, Code A, 1000 Rds Fired

Type	No.	Cause	Attributed To
F2R	2	SR, Failed to engage sear.	RFA
FF1	7	FL	Mag
FF	2	Stubbed against receiver.	RFA
FF	1	Round jammed part way into chamber.	RFA
FFR	3	Dud cartridge.	Ammo
FJ	4	Unknown	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	7	2	9
Mag	7	0	7
Ammo	3	0	3
Total	17	2	19

Table A-19. Malfunctions During Temperature Humidity Test
RFA No. 2694, Code A, 1000 Rds Fired

Type	No.	Cause	Attributed To
F2R	8	SR, Failed to engage sear.	RFA
FF1	13	FL	Mag
FF	1	Stubbed in magazine.	Mag
FF	3	Stubbed against receiver.	RFA
FFR	6	BNCC	RFA
FJ	3	Unknown.	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	12	8	20
Mag	14	0	14
Total	26	8	34

Table A-20. **Malfunctions During Temperature-Humidity Test RFA No. 74, Code B, 1000 Rds Fired**

Type	No.	Cause	Attributed To
FK	12	SR	RFA
FF	3	SR - BCEC	RFA
FF	1	Unknown - Round jammed partway in chamber.	RFA
F2R	4	SR - Bolt failed to engage sear.	RFA
FFR	33	Bolt not completely closed.	RFA
FFR	4	Dud cartridge.	Ammo
FX	2	Unknown.	RFA
FJ	3	Unknown.	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	54	4	58
Ammo	4	0	4
Total	58	4	62

Table A-21. Malfunctions During Temperature-Humidity Test
RFA No. 66, Code B, 1000 Rds Fired

Type	No.	Cause	Attributed To
FK	10	SR	RFA
FF	3	BCEC due to SR.	RFA
FF1	2	FL	Mag
F2R	6	SR, Failed to engage sear.	RFA
FFR	21	BNCC	RFA
FFR	1	Broken firing pin.	RFA
FJ	3	Unknown.	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	38	6	44
Mag	2	0	2
Total	40	6	46

Table A-22. Malfunctions During Temperature-Humidity Test
RFA No. 63, Code B, 1000 Rds Fired

Type	No.	Cause	Attributed To
FK	37	SR	RFA
FF	10	BCEC due to SR	RFA
FF	1	Stubbed against receiver.	RFA
FFl	2	FL	Mag
FFR	93	Bolt not completely closed.	RFA
FFR	6	Dud cartridge.	Ammo
FBC	2	Unknown	RFA
FJ	3	Unknown	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	146	0	146
Mag	2	0	2
Ammo	6	0	6
Total	154	0	154

Table A-23. **Simple Malfunction Rate Per Half Cycle (500 Rds Per Half Cycle)**

Device Code	Serial No.	Half Cycle[a]	Cleaning Cycle 1	2	3	4	Total
A	3779	I	15	5	4	5	29
A	3779	II	3	0	4	2	9
A	3800	I	5	8	12	8	33
A	3800	II	5	8	23	14	50
A	3823	I	5	11	25	37	78
A	3823	II	2	31	16	30	79
B	70	I	6	4	1	8	19
B	70	II	4	11	2	7	24
B	73	I	14	3	1	6	24
B	73	II	3	5	6	6	20
B	75	I	17	34	2	5	58
B	75	II	10	31	4	1	46
A	Mean	I	25	24	41	50	140
A	Mean	II	10	39	43	46	138
A	Mean	I and II	35	63	84	96	278
B	Mean	I	37	41	4	19	101
B	Mean	II	17	47	12	14	90
B	Mean	I and II	54	88	16	33	191

[a] I = First 500 rounds of a 1000-round cleaning cycle.
II = Second 500 rounds of a 1000-round cleaning cycle.

Table A-24. Malfunctions During Water Spray Test
RFA 3763, Code A

Type	No.	Cause	Attributed To
FF	5	BCEC due to short recoil.	RFA
FF	1	Magazine follower did not rise.	Mag
FFl	9	FL	Mag
FFR	2	Bolt not completely closed.	RFA
FJ	17	Unknown.	RFA
FX	1	Unknown.	RFA
FK	2	Short Recoil.	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	27	0	27
Mag	10	0	10
Total	37	0	37

Table A-25. Malfunctions During Water Spray Test
RFA 3809, Code A

Type	No.	Cause	Attributed To
FF1	3	FL.	Mag
FF	2	Stubbed in magazine.	Mag

Summary of Malfunctions

Attibuted To	Stoppages	Other	Total
Mag	5	0	5

Table A-26. Malfunctions During Water Spray Test
RFA 59, Code B

TYPE	No.	Cause	Attributed To
FF	2	BCBC due to short recoil.	RFA
FF	2	Magazine follower did not rise.	Mag
FFR	104	Bolt not completely closed.	RFA
FK	6	SR	RFA
DF	1	Unknown.	Mag
FJ	1	Unknown.	RFA
FX	2	Unknown.	RFA
FF	1	BOB.	RFA

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	116	0	116
Mag	3	0	3
Total	119	0	119

Table A-27. Malfunctions During Water Spray Test
RFA 65, Code B

Type	No.	Cause	Attributed To
FFR	3	Bolt not completely closed.	RFA
FF1	1	FL	Mag

Summary of Malfunctions

Attributed To	Stoppages	Other	Total
RFA	3	0	3
Mag	1	0	1
Total	4	0	4

Section 1. Test Criteria

Item	Source	Criteria	Applicable Subtest	Remarks
1	Para III.B.1[a]	The adapter kit will be compatible with the M16A1 rifle and consist of a bolt, bolt carrier assembly, and magazine. No other equipment or modifications to the rifle are required.	2.1	Met by all manufacturers. See analysis, para 2.1.5.
2	Para III.B.2[a]	The caliber .22 LR bolt assembly will be installed in the M16A1 rifle replacing the bolt and bolt carrier assembly.	2.1	Met by all manufacturers. See analysis, para 2.1.5.
3	Para III.B.3[a]	The adapter kit will provide an M16A1 rifle 20-round magazine fitted to accept caliber .22 LR ammunition only.	2.1	Not met by any manufacturer; all the magazines will accept .22 caliber ammunition other than .22 LR; however, none accept 5.56-mm cartridge. See analysis, para 2.1.5.
4	Para III.B.4[a]	Use of the adapter with the M16A1 rifle will not adversely affect performance (semi-automatic mode), appearance, feel, weight, and maintenance of the rifle.	2.1, 2.2, 2.5, and 2.11	Met by manufacturers Codes A and B; Code C not tested. See analysis, para 2.1.5, 2.2.5, 2.5.5, and 2.11.5.
5	Para III.B.5[a]	The adapter will be safe for use with the M16A1 rifle. Drawing the caliber .22 bolt entirely to the rear, without a magazine being installed in the rifle, shall extract the cartridge or cartridge	2.1, 2.2, 2.3, and 2.5	Extracting criterion met by manufacturers Code B and C; partially met by Code A with four failures to extract in 180 trials. See analysis in para 2.2.5. Safety criterion met by Code B RFA. Code C RFA was not adequately tested to demonstrate safety. Manufacturer Code A met all

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Item	Source	Criteria	Applicable Subtest	Remarks
		case from the chamber and eject it freely and completely out of the receiver.		safety aspects except for case ruptures; see analysis, para 2.1.5, 2.2.5, 2.3.5, and 2.5.5.
6	Para III.B.6[a]	The battle sight zero of the M16A1 rifle converted with the caliber .22 LR adapter should approximate that of the rifle firing service ammunition out to ranges of 125 meters.	2.5	Not met by any manufacturer. It is inherently impossible due to the velocity difference between caliber .22 LR ammunition and 5.56-mm service ammunition. See analysis, para 2.5.5.
7	Para III.B.7[a]	Accuracy obtained with the caliber .22 LR ball, standard or high velocity, should be equal to the accuracy obtained by the M16A1 when firing 5.56-mm ball, M193 ammunition out to ranges of 125 meters.	2.5	Not met by any manufacturer. See analysis, para 2.5.5.
8	Para III.B.8[a]	Firers will be able to employ the same marksmanship techniques (position, aiming, sighting, etc.) with the M16A1 caliber .22 LR adapter as with the M16A1 rifle firing service ammunition.	2.11	Met by all manufacturers. See analysis, para 2.11.5.
9	Para III.B.10[a]	The insertion and removal of the adapter from the M16A1 rifle shall not require excessive time (approximately 15 seconds).	2.11	Met by all manufacturers. See analysis, para 2.11.5.
10	Para III.B.11[a], and Test Directive, para 6.e	The caliber .22 LR bolt assembly and magazine assemblies will be capable of withstanding the firing of 5000 rounds with a malfunction rate not exceeding 5% at a 90% confidence level. Breakage of the	2.5	Malfunction rate met by Code A with 2.5% malfunctions and by Code B with 1.6% malfunctions. Breakage criterion not met by Code A (due to magazine failure) or by Code B (due to firing pin breakage). Code

[a]CONARC TDR No. 095.

Item	Source	Criteria	Applicable Subtest	Remarks
		caliber .22 LR bolt and magazine assemblies in this firing shall not exceed those of the M16A1 rifle bolt and magazine when the same number of service rounds are fired.		C RFAs were removed from test due to high malfunction rate. See analysis, para 2.5.5.
11	Para III.B.12[a]	The adapter kit will require no more maintenance than that required for its corresponding components of the M16A1 rifle.	2.10	Met by manufacturers Code A and Code B. Code C RFAs were not tested sufficiently to determine maintenance needs. See analysis, para 2.10.1.5.
12	Para V.B[a]	The adapter will be operational under intermediate and wet climatic categories of weather in accordance with Categories 1, 2, 3, 5, and 6, AR 70-38.	2.4	Met by Code A and Code B RFAs; however, the performance of both was degraded. Code C RFA were not tested. See analysis, para 2.4.5.
13	Devised by MTD	The test RFAs shall operate safely (required) following exposure to environmental tests.	2.3, 2.4, 2.6, 2.7, and 2.8	Met by manufacturer Code B. Not met by Code A due to cartridge-case ruptures occurring at high temperatures (see para 2.3.5). Code C not tested. See paras 2.3.5, 2.4.5, 2.6.5, 2.7.5, and 2.8.5.
14	Devised by MTD	The test materiel shall operate safely (required) following exposure to rough handling tests.	2.9	Met by manufacturers Code A and Code B. Code C RFAs were not tested. See analysis, para 2.9.5.
15	AR 703-2, para 2-5c(1)	The special tools and test equipment outlined in the maintenance literature and/or contained in the	2.10	Met by all three manufacturers in that maintenance was possible with commonly available tools.

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Item	Source	Criteria	Applicable Subtest	Remarks
		maintenance test package shall be necessary and adequate for the performance of all required maintenance tasks at all levels of maintenance when used in conjunction with the authorized common tools and test equipment in the applicable tool kits. Common tools should be substituted for special tools whenever possible.		No maintenance test packages were supplied. See analysis, para 2.10.2.5.
16	AR 702-3, para 2.5c(2)	The equipment publications contained in the maintenance test package shall be complete, accurate, easy to read, consistent in nomenclature, simple to follow, and adequate to complete both scheduled and unscheduled maintenance operations and parts acquisition at all levels of maintenance. Draft Army equipment publications shall conform in content and format to those specified in AR 310-3, MIL-M-3878(A) or MIL-M-63000C(TM) series of military specifications as applicable.	2.10	Not met by any manufacturer. See para 2.10.3.
17	AR 702-3, para 2.5c(3)	Repair parts shall be authorized in adequate quantities and diversity at the appropriate maintenance levels, consistent with the maintenance allocation charts and RPSTLs where the tools and skills required to install and align the	2.10	These criteria could not be tested. See para 2.10.4.

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Item	Source	Criteria	Applicable Subtest	Remarks
		parts are authorized. Repair parts which are used to maintain the test item must be interchangeable with like parts being replaced.		

Section 2. Critical Issues

None identified.

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APPENDIX C - DEFICIENCIES, SHORTCOMINGS, AND SUGGESTED IMPROVEMENTS

1. Deficiencies

None.

2. Shortcomings

Shortcoming	Suggested Corrective Action	Remarks
2.1 The design of the Code A RFAs is such that case ruptures are experienced.		Three ruptures in 3000 rounds fired occurred at +155°F. One rupture occurred in the 13,742-round endurance test. The ruptures are considered to be a category II (marginal) safety hazard as defined by MIL-STD-882.
2.2 Because of the forward inertia of the firing pins, both Code A and Code B RFAs will fire when dropped muzzle down.		The firings are considered to be a category II (marginal) safety hazard as defined by MIL-STD-882.

3. Corrected Shortcomings

Shortcoming	Corrective Action	Remarks
3.1 Excessive force is required to assemble Code B RFAs to the M16A1 rifle due to interference between the hex-head screw and the rifle buffer.	The lower portion of the head of the screws was ground away.	
3.2 Insufficient clearance between the top of the alignment block and the charging handle causes the bolt to bind in the Code B RFAs.	The clearance was corrected by milling 0.010 inch from the top of the alignment blocks.	

4. Suggested Improvements

None.

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APPENDIX D - MAINTENANCE EVALUATION

Not used.

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APPENDIX E - CRITICAL ISSUES

None identified.

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APPENDIX F - REFERENCES

1. Letter, TECOM, AMSTE-BC, Test Directive for Development Test II and Operational Test II (DT II/OT II) of Rimfire Adapter (RFA) for M16A1 Rifle, TECOM Projects No. 8-WE-623-016-004/005, 29 July 1974.

2. Hines, F. Jr., Test Plan for Development Test II of Rimfire Adapter (RFA) for M16A1 rifle. TECOM Project No. 8-WE-623-016-004/005. US Army Aberdeen Proving Ground. November 1974, with Change 1.

3. Letter, TECOM, AMSTE-IN, Amendment No. 2 to Test Directive for Development Test II (DT II) and Operational Test II (OT II) for the .22 Rimfire Adapter (RFA) for M16A1 Rifle, TECOM Projects No. 8-WE-623-016-004/005, 2 October 1974.

4. Letter, ARMCOM, AMSAR-RDG, Development Test II (DT II) and Operational Test II (OT II) for the .22 Rimfire Adapter (RFA). TECOM Projects No. 8-WE-623-016-004/005, 22 November 1974, with 1st Indorsement, TECOM, AMSTE-IN, 4 December 1974.

5. Brundiek, Hans, Final Letter Report of Military Potential Test of Subcaliber Training Device for M16A1 Rifle, TECOM Project No. 8-WE-623-016-001. US Army Aberdeen Proving Ground. Report No. APG-MT-4089, June 1972. (Distribution Controlled by US Army Small Arms Systems Activity, ATTN: AMXAA-WS. AD 900 623L.)

6. Military Specification MIL-R-44587.

7. Department of the Army Approved Training Device Requirement for Caliber .22 Rimfire Adapter for the M16A1 Rifle, TDR Number CONARC TDR 095.

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APPENDIX G - ABBREVIATIONS

BCEC = bolt closed on empty chamber
BNCC = bolt not completely closed
BOB = bolt overrode base of round in feeding from magazine
CI = center of impact
Dev = deviation
DF = doublefeed, two rounds fed from magazine at once
ES = extreme spread
FBC = failure of bolt to close
FF = failure to feed
FFR = failure to fire
FF1 = failure to feed first round
FJ = failure to eject
FK = failure to cock
FL = failure to load by hand charging
FS = failure to strip a round
FX = failure to extract
F2R = fired two rounds on one rearward movement of the trigger
HSD = horizontal standard deviation
LAW = lubricating oil, weapons
LR = long rifle
LSA = lubricating oil, semifluid
Mag = magazine
Malf = malfunction
MR = mean radius
NS = not significant
RFA = rimfire adapter
RSD = radial standard deviation
RUP = ruptured cartridge case
S = significant
SD = standard deviation
SR = short recoil
Std = standard
Vel = velocity
VSD = vertical standard deviation

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APPENDIX H - DISTRIBUTION LIST

TECOM Project No. 8-WE-623-016-004

Addressee	Final Report
Commander US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005 ATTN: AMSTE-IN	8
AMSTE-SG-H	1
Commander US Army Materiel Command 5001 Eisenhower Avenue Alexandria, Virginia 22333 ATTN: AMCRD-WI	3
AMCRD-R	1
AMCRD-U	1
AMCMA-V	1
AMCQA-P	1
AMCSF	1
Commander US Army Training and Doctrine Command Aberdeen Proving Ground, Maryland 21005 ATTN: TRADOC Liaison Officer, TECOM	10
Commander US Army Operational Test and Evaluation Agency Fort Belvoir, Virginia 22060 ATTN: DCAS-TE-O	3
Commander US Army Logistics Evaluation Agency New Cumberland Army Depot New Cumberland, Pennsylvania 17070 ATTN: LEA-IL	1
Commander Crane Naval Ammunition Depot Crane, Indiana 47522 ATTN: WPECNAD	1
Commander US Army Maintenance Management Center Lexington, Kentucky 40507 ATTN: AMXMD-ID	2

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Commander Eglin Air Force Base Eglin, Florida 32542 ATTN: AIFATL-ATAWG	1
Commander US Army Arctic Test Center APO Seattle 98733	1
Commander US Army Yuma Proving Ground Yuma, Arizona 85364	1
Commander US Army Tropic Test Center Drawer 942 Fort Clayton, Canal Zone 09827	1
Commander US Army Armament Command Rock Island, Illinois 61201 ATTN: AMSAR-RDG AMSAR-ASI AMSAR-QA	 1 3 1
Commander Rock Island Arsenal Rock Island, Illinois 61201 ATTN: SARRI-LS	5
Commander US Army Ordnance Center and School Aberdeen Proving Ground, Maryland 21005	1
HQDA (DAMO-FD) HQDA (DAMO-RQD) HQDA (DAMA-WSW) HQDA (DALO-SME) HQDA (DALO-ZA) HQDA (DAMA-PPM-T) Washington, D. C. 20310	1 1 1 1 1 2
HQDA (DAPC-PMO) Alexandria, Virginia 22331	1

Addressee	Final Report
Project Manager, TRADE Fort Benning, Georgia 31905 ATTN: AMCPM-TRADE	3
Commandant US Marine Corps Washington, D. C. 20380 ATTN: Code RD	1
Commandant US Army Infantry School Fort Benning, Georgia 31905 ATTN: ATSH-I ATSH-CD-MS-F	 1 1
President US Army Infantry Board Fort Benning, Georgia 31905	1
Director US Army Materiel Systems Analysis Activity Aberdeen Proving Ground, Maryland 21005 ATTN: AMXSY-GI	1
Director US Army Ballistic Research Laboratories Aberdeen Proving Ground, Maryland 21005 ATTN: AMXBR-LB	2
Director Development Center Marine Corps Development and Education Command Quantico, Virginia 22134	1
US Marine Corps Liaison Officer US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005	1
US Marine Corps Liaison Officer US Army Infantry Board Fort Benning, Georgia 31705 ATTN: USAIB	1

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Commander US Army Aberdeen Proving Ground Aberdeen Proving Ground, Maryland 21005 ATTN: STEAP-MT-I	4
STEAP-MT-X	1
STEAP-MT-O, Mr. Depkin	1
Commander Defense Documentation Center for Scientific and Technical Information Cameron Station Alexandria, Virginia 22314 ATTN: Document Service Center	2

22 grains

MSL A3, A4 & A5

Priming compositions for Primers Electric

B 7553516

Composition
FA 875
FA 874

2.75 - .50 grains

Lead Styphnate
Barium Nitrate