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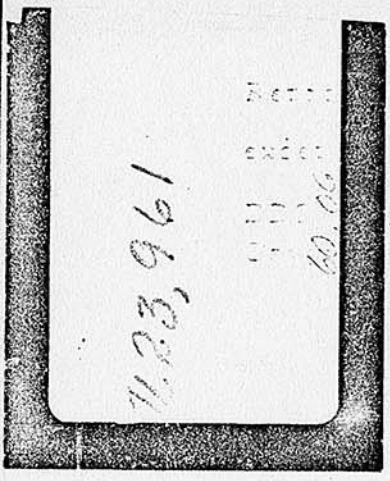
RDT&E Project No. 1X542703D311
USATECOM Project No. 8-WE-300-203-001
Report No. APG-MT-3325



FINAL REPORT ON

ENGINEERING TEST

OF

LAUNCHER, GRENADE, 40-MM, XM203,

ATTACHMENT FOR RIFLES

BY

ERIC KEELE

SEPTEMBER 1969

ABERDEEN PROVING GROUND

ABERDEEN PROVING GROUND, MARYLAND

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AMSTE-DC
SUBJECT: Final Reports for Engineering and Service Tests of Grenade Launcher, 40mm, XM203, USATECOM Project Nos. 8-WE-300-203-001/003

27 OCT 1969

of these tests on 2-3 Jul 69 demonstrated that the above deficiencies were corrected (inclosure 1). The deficiencies were of a nature, which did not require USAIB retest of the weapons incorporating the most recent modifications; therefore, the USAIB report is based exclusively on the original launchers, which accounts for the discrepancy between the reports.

d. This headquarters reclassified the reported deficiency in Appendix III of inclosure 2, pertaining to the battle sight, as a shortcoming for the following reasons:

(1) It was recognized in initial preparation and approval of the technical characteristics that 16° elevation of the system with the battle sight was the maximum attainable for 250 meters range when using ammunition at a nominal velocity of 245 feet per second because of flash hider interference. Above 250 meters, the primary sight is to be utilized.

(2) Usability of the battle sight is stated as a desired, not a required characteristic.

e. By design, the only maintenance required was cleaning of the weapon by the operator. Operator maintenance was comparable to the of the M79 launcher.

f. Originally the launchers failed the reliability/durability requirement: Subsequently, four modified launchers fired 1500 rounds each successfully. These launchers met the reliability/durability requirement.

5. Comment. The requirement for compatibility of the ammunition cited in paragraph 3 above was met. Additionally, the USAIB evaluated the compatibility of the Cartridge, E25, Red Smoke, which can be fired in the M79 launcher. Because of its length, the E25, Cartridge was the only round found incompatible with the XM203 launcher.

6. Conclusion. The Grenade Launcher, XM203, meets the SDR and technical characteristics and is suitable for US Army use.

FOR THE COMMANDER:

WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

2 Incls
as (5 cys ea)

Copy furnished:
CG USAWECOM ATTN: AMSWE-RES (3 cys ea)

AMSTE-BC 27 OCT 1983

SUBJECT: Final Reports for Engineering and Service Tests of Grenade Launcher, 40mm, XM203, USATECOM Project Nos. 8-WE-300-203-001/003

interior ballistic properties of the 40mm proof (XM387E4), practice (M407A1), high explosive (M406A1), Multi-purpose (XM576E1), and signal (XM583 and XM585) rounds. The engineering test (ET) was conducted at Aberdeen Proving Ground (APG). The service test (ST) was conducted at Fort Benning, Georgia by the US Army Infantry Board (USAIB). An additional test was conducted at the contractor plant under the supervision of Project Manager (PM)-Rifles and monitored by APG personnel. Results of all tests are contained in the inclosed final reports.

b. At the request of PM-Rifles, an expedited TECOM position was provided by reference 1e. This action was directed in order that type classification action could be completed on schedule.

c. Reference 1f provides results of tests conducted at the contractor's plant. The purpose of the test was to determine if modifications incorporated after ET/ST in the launcher by Engineer Change Proposals (ECP) provided correction to shortcomings. These results were evaluated by this command and will be further confirmed during an initial production test (IPT).

d. Since the position of this command is unchanged, contents of the letter report are reiterated in the following paragraphs, ref 1e.

4. Test Results.

a. The XM203 Grenade Launcher met the forty-four requirements of the SDR and the technical characteristics to an acceptable degree. The fact that the number of system parts exceeds that of the M79 Launcher by a total of four (110 vs 106) is not considered significant. There are no outstanding deficiencies. Ten shortcomings for the ET are listed in Appendix III of inclosure 1 and 18 shortcomings for ST are listed in Appendix II of inclosure 2.

b. From the findings of the ST the deficiencies were:

(1) Breakage of tie-down strap that attaches the launcher to the weapon.

(2) Breakage of guide rods in the follower assembly.

(3) When using the battle sight, the muzzle interferes with sight picture at 250 meters range.

c. Based on prior information, PM-Rifles initiated corrective action and requested additional tests of modified weapons. Results

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BC

27 OCT 1969

SUBJECT: Final Reports for Engineering and Service Tests of Grenade Launcher, 40mm, XM203, USATECOM Project Nos. 8-WE-300-203-001/003

Project Manager-Rifles
US Army Weapons Command
Rock Island, Ill 61201

1. References.

a. RDT&E Project No. 1X542703D311.

b. Department of the Army Approved Small Development Requirement (SDR) for a 40mm Detachable Grenade Launcher for Individual Weapons.

c. Minutes of Formal In-Process Review (U), Section V, 18 Oct 67.

d. Letter, AMCPM-RS, 2 Jul 69, subject: Formal In-Process Review (Development Acceptance Review) of the XM203 Grenade Launcher Attachment Development (GLAD) Program w/inclosed Agenda and Supporting Data Document.

e. Letter, AMSTE-BC, 25 Jul 69, subject: Letter Reports for Engineer and Service Test of Grenade Launcher, 40mm, XM203 Attachment for Rifles, USATECOM Project Nos. 8-WE-300-203-001/003 (formerly 8-9-0240-13/14).

f. Technical Memorandum Report No 3-69, Project Manager, Rifles, dated Sep 1969, Confirmation Test of Revised XM203 Launcher.

2. Approval Statement. Final reports, inclosures 1 and 2, are approved except as stated herein.

3. Background.

a. The XM203 Grenade Launcher is a single-shot attachment for the M16A1 Rifle and XM177E2 Submachine Gun. The system is required to be capable of firing ammunition that has the external configuration and

RDT&E PROJECT NO. 1X542703D311

USATECOM PROJECT NO. 8-WE-300-203-001

ENGINEERING TEST OF LAUNCHER, GRENADE, 40-MM, XM203, ATTACHMENT FOR RIFLES

FINAL REPORT

BY

ERIC KEELE

SEPTEMBER 1969

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND
21005

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TABLE OF CONTENTS

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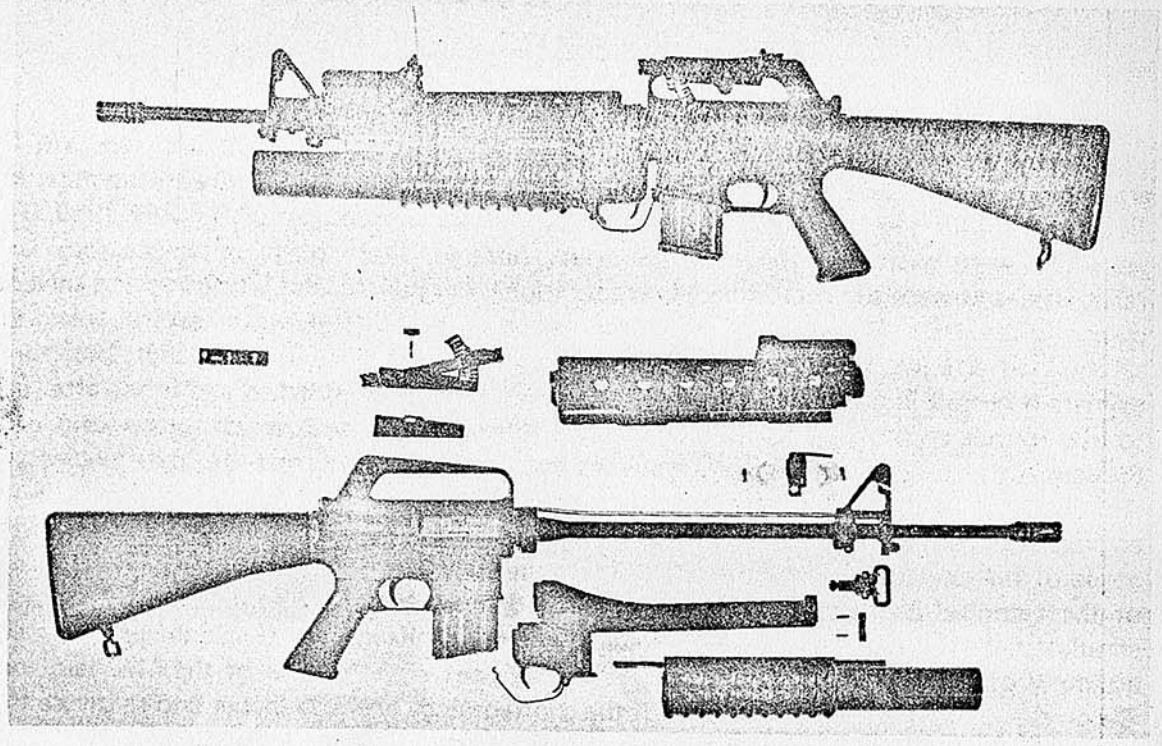
ABSTRACT

The purpose of the test was to evaluate the performance characteristics of the XM203 grenade-launcher attachment and determine compliance with the technical characteristics. Testing was initiated the latter part of April 1969 and was completed 31 July 1969. The launchers were examined for potential safety hazards, fired for velocity, accuracy, and reliability, and were subjected to adverse conditions, ruggedness, and lubricants and solvents compatibility tests. Deficiencies were experienced with the launcher in several areas: the safety inadvertently moved to the ON position with recoil of the launcher; punctured primers occurred in the low-temperature test; tiedown straps deformed and broke after 400 to 500 rounds of firing; and, occasionally, the follower failed to override the cocking lever. Subsequently, modifications were made to the launcher to correct the deficiencies and additional firings were conducted to test the modifications. At the completion of the engineering test and the additional firings, no uncorrected deficiencies existed. Within the scope of the engineering test, the XM203 grenade launcher complied with the requirements of the technical characteristics with the exception of exceeding the total number of parts stipulated; parts broke and became unserviceable in the reliability test; and the precision and accuracy of adjustment of the primary sight was not equal to that of the M79 launcher. Recommendations were made to correct the shortcomings of the launcher and to insure that the final design be tested sufficiently to verify the adequacy of the corrections.

FOREWORD

Materiel Test Directorate was responsible for preparing the test plan, conducting the test, and preparing the test report. In order to complete all testing within the required time frame, various test phases were conducted by George Hendricks and Walter Eller. Acknowledgement is made to these individuals for their technical assistance in the conduct of this test.

US Army Test and Evaluation Command letter, 11 December 1968 directed that this final report be classified confidential; however, downgrading action, per AMCPM-RS letter, 19 August 1968, of the technical characteristics for the 40-mm grenade launcher attachment for rifles has removed the requirement for classification of subject document.



LAUNCHER, 40-MM, XM203

Weight of launcher (includes quadrant sight, hand-guard with battle sight, and bayonet lug) ---------- Approximately 3.5 lb
Weight of M16A1 rifle with XM203 launcher (both weapons empty)---10.2 lb
Length of barrel ---------- 12 in.
Number of lands ---------- 6
Rate of twist ---------- One turn in 48 inches
Type of operation ---------- Manual, single shot
Type sights
  Quadrant ------ Graduated from 50 to 400 meters in 25-meter increments
  Battle -------- Graduated from 50 to 250 meters in 50-meter increments
Muzzle velocity ---------- Approximately 236 fps
Ammunition ---------- Standard family of 40-mm associated with the M79 grenade launcher

Data Compiled: 5 June 1969.

Characteristics Photograph

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USATECOM PROJECT NO. 8-WE-300-203-001

FINAL REPORT ON ENGINEERING TEST OF LAUNCHER, GRENADE, 40-MM, XM203, ATTACHMENT FOR RIFLES

APRIL TO 31 JULY 1969

SECTION 1. INTRODUCTION

1.1 BACKGROUND

Within present squad orgainizations, two soldiers are armed with the M79 grenade launcher and are without the capability of firing at point-type targets except with the M1911A1 caliber .45 pistol. The adoption of a grenade-launcher attachment for the rifle would increase the squad's point-fire capability by adding two rifles and also provide an area-fire capability for every member of the rifle squad, if so desired.

As a result of the XM148 grenade - launcher attachment being found unsatisfactory for operational use in Vietnam, the grenade launcher attachment (GLAD) program was initiated to obtain a suitable replacement launcher for use on rifles. Under the GLAD program, two prototype launchers were subjected to engineer design tests during the summer of 1968. One launcher was of a pivot-action design; the other was a pump-action type. The design of the pump-action design proved to offer the more feasible approach toward a suitable launcher; therefore, development of the concept was continued.

1.2 DESCRIPTION OF MATERIEL

The XM203 grenade - launcher attachment is a single-shot, pump-operated weapon designed to fire all standard 40-mm ammunition associated with he M79 launcher. The mechanism features a forward-moving barrel which is assembled to the underside of the launcher housing with a T-shaped track. The launcher is loaded by inserting a round in the open breech and pulling the barrel rearward to the locked position. The reverse pumping action, or forward motion of the barrel, automatically recocks the mechanism and extracts the fired case.

The primary sight provided with the launcher is adjustable in elevation and deflection independently of range settings and provides range selections from 50 to 400 meters. Additionally, a ladder-type sight, which mounts on the top of the rifle directly behind the front sight, is provided for use as a battle sight. The sight is graduated from 50 to 250 meters in 50-meter increments. The right and left side views of the XM203 grenade launcher attached to the M16A1 rifle are shown in Figure 1.2-1. Close-up views of the primary and battle sights are shown in Figures 1.2-2 and 3.

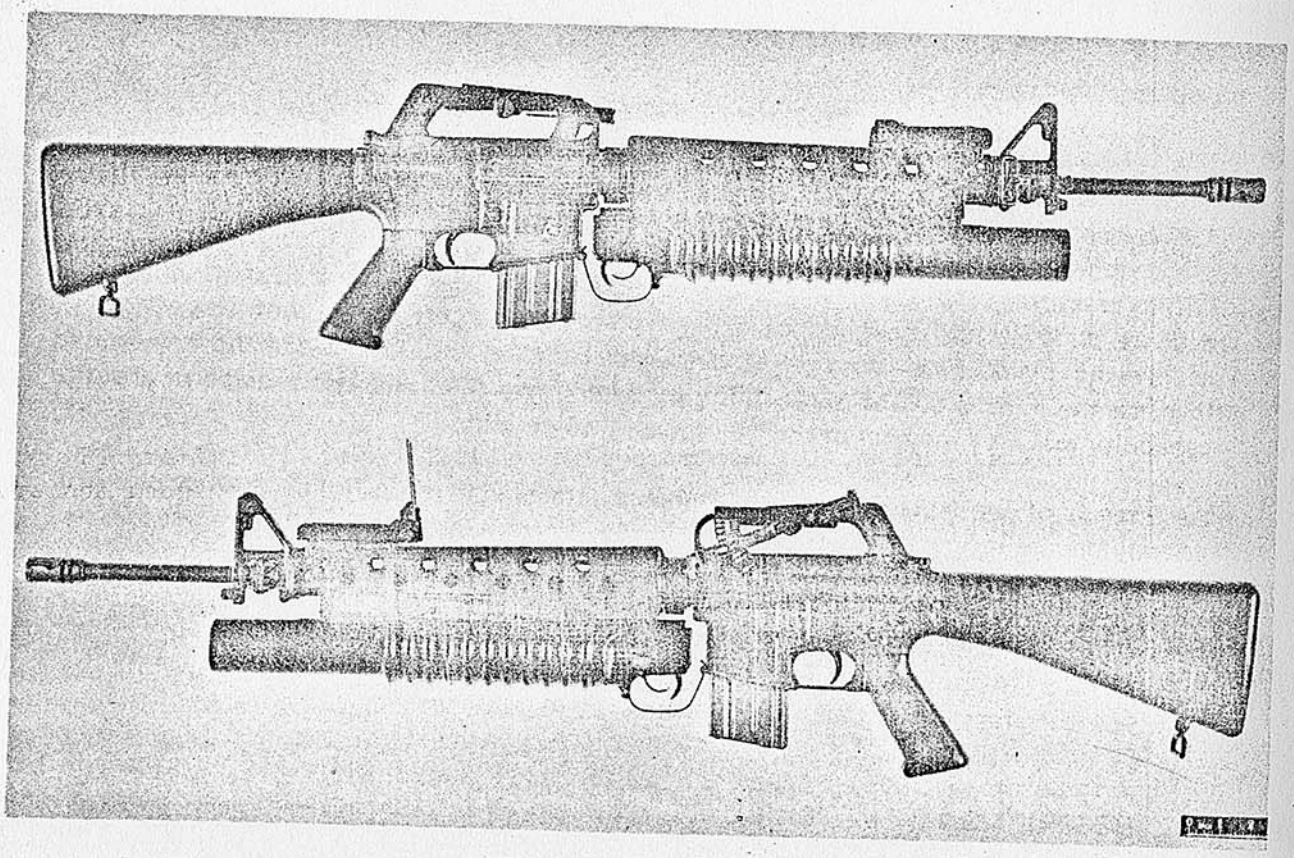

Figure 1.2-1: Right and Left Side Views of the XM203 Grenade Launcher Attached to the M16A1 Rifle.

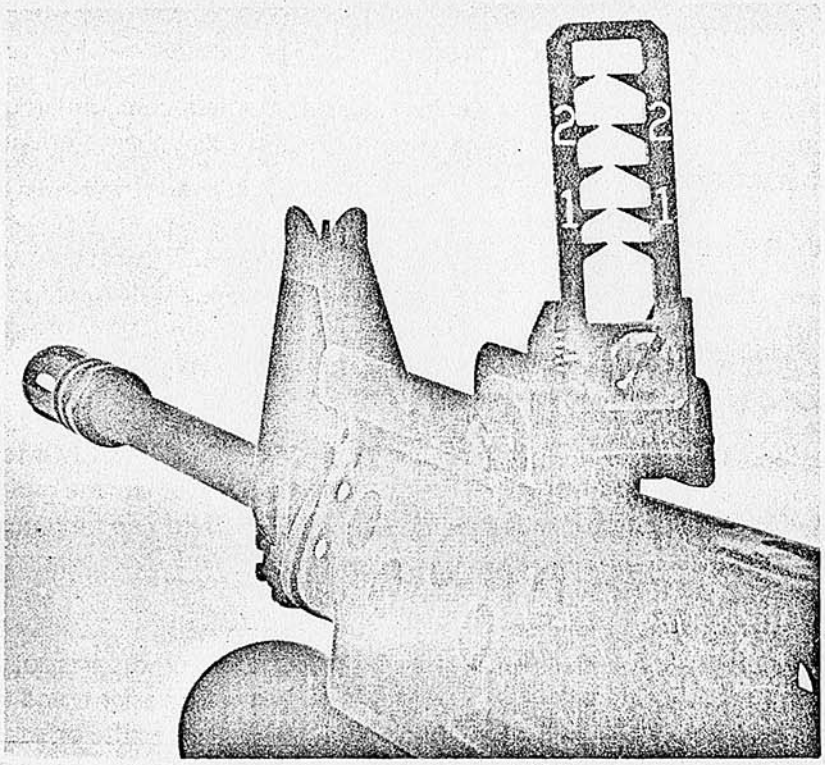

Figure 1.2-~~1~~3: Close-Up View of the ~~Primary~~ Battle Sight for the XM203 Grenade Launcher.

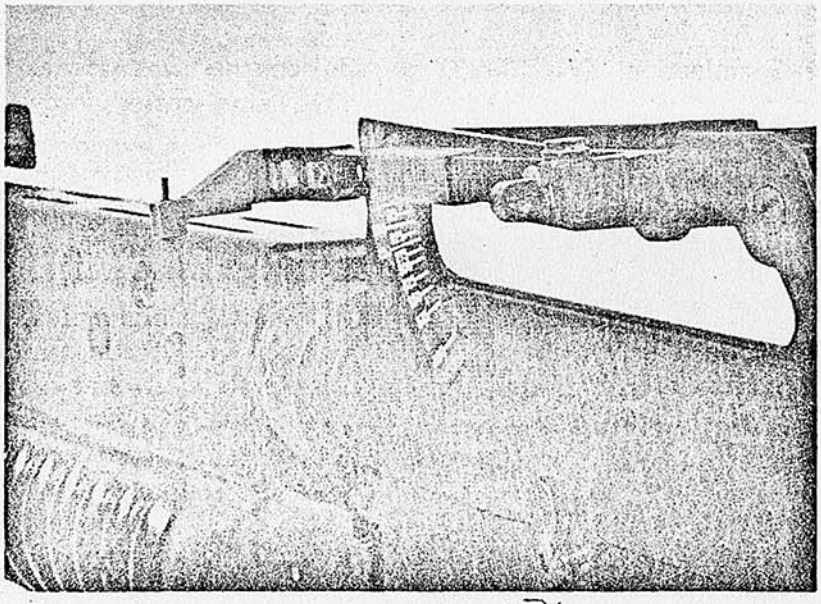

Figure 1.2-~~2~~2: Close-Up View of the ~~Battle~~ Primary Sight for the XM203 Grenade Launcher.

1.3 TEST OBJECTIVES

The test objectives are to evaluate the performance of the launcher under temperate and adverse conditions and determine compliance with the technical characteristics for 40-mm grenade - launcher attachments for rifles.

1.4 SUMMARY OF RESULTS

1.4.1 Subtest Findings

1.4.1.1 Inspection. The XM203 grenade launcher was readily attachable to the M16A1 rifle. However, attachment of the launcher to the XM177E2 submachine gun required that modifications be made to the launcher receiver or the handguard cap be removed from the submachine gun, which entailed removal of the front sight and flash suppressor from the submachine gun.

The grenade launcher has a total of 110 individually manufactured parts, of which 28 are contained in the primary sight, 22 in the cover and attached battlesight, and the remainder in the receiver. The attachment of the launcher adds 2.9 lbs to the rifle or submachine gun.

The operations required for care and maintenance of the XM203 launcher were deemed not to be more difficult nor more time consuming than comparable operations on the M79 launcher. No special tools or cleaning equipment other than those used with the M79 launcher are required for operation maintenance.

1.4.1.2 Safety Examination. The XM203 grenade launcher was safe to fire from the shoulder provided precautions for inherent features, as discussed in par. 2.3.4, were observed.

1.4.1.3 Velocity. The average velocity of the grenades launched from the XM203 launcher was 232.2 feet per second. This velocity was approximately 10 feet per second less than that experienced with the prototype launcher tested and reported in Reference 2, with the the same lot of ammunition. The difference in velocity level was attributed to a difference in the bore diameters of the respective weapons, as discussed in par. 2.4.4.

1.4.1.4 Dispersion Test. The grouping characteristics of the M16A1 rifle were not adversely affected by attachment of the XM203 grenade launcher; however, the attachment of the launcher caused a shift in the rifle center-of-impact location, approximately one mil. The sights on the rifle could be readjusted to compensate for the shift with latitude remaining for further adjustment.

1.4.1.5 Accuracy. The primary sight on the launcher was reasonably well matched to the test lot of ammunition at the 100- and 200-meter ranges; however, the center-of-impact for the groups at the 350-meter range was short. This is directly related to the decrease in velocity level, as the sights were probably calibrated for the higher velocity experienced with the prototype launcher reported in Reference 2.

The battlesight was reasonably well calibrated at the 50-, 100-, 150, and 200-meter ranges; however, the center-of-impact was short when using the 250-meter range setting. To impact the grenades at the 250-meter range when using the battlesight required launching the grenades at an increased elevation. This presented another problem, in that, if the elevation of the launcher was increased, the flash suppressor on the M16A1 rifle blocked the line of sight.

1.4.1.6 Adverse Conditions. The number of malfunctions which occurred in the adverse conditions test are summarized in Table 1.4-I.

Table 1.4-I. Number of Malfunctions in Adverse Conditions Test

Test	No. of Malfunctions
Static dust	0
Dynamic dust	0
Water spray	0
Unlubricated	0
Mud	[a] 2
Salt-water immersion	[b] 10

[a] One malfunction was a failure to fire with a light indent in the primer, which functioned on a second attempt. The other was a failure of the follower to override the cocking lever, which is discussed in par. 1.4.1.9.

[b] Seven of the malfunctions were failures to eject, attributable to the modified extractor which is discussed in par. 2.8.4, and the other three were failures of the follower to override.

1.4.1.7 Low-Temperature Test. With the conduct of the low-temperature test at both -65°F and -25°F, punch-outs and partial punch-outs of the primer occurred. Primer fragments collected in the firing-pin well and restricted movement of the firing pin. This, in turn, caused failures to fire with very light indents in the primers. This condition was classified as a deficiency. At this point the engineering test was suspended and the developer modified the launcher as described in par. 2.8.4. The modifications largely corrected the occurrence of primer punch-outs at -25°F and -65°F, in that, only two partial punch-outs occurred with the retest launchers.

Another problem that was experienced in the low-temperature test (-65°F) was loosening of the handgrip on two of the launchers. The handgrip was reglued to the barrel and did not fail during retest at -65°F.

1.4.1.8 High Temperature (+155°F). There were no problems experienced in the high-temperature test which were attributable to the temperature conditions. The only malfunctions experienced were failures to eject, which were caused by the modified extractor, and failures of the barrel latch and pin which also occurred in the reliability test under ambient temperature conditions.

1.4.1.9 Reliability Test. The reliability test showed that malfunctions occurred similar to those experienced in the adverse conditions tests. As in the mud and salt-water-immersion tests, the occurrence of failures of the follower to override the cocking lever were experienced. When this occurred the launcher barrel could not be closed because the cocking lever protruded between the barrel extension and the follower. The malfunction was cleared by forcing the firing pin to the rear through the firing-pin hole with a small punch or by lowering the back plate and pushing the follower forward with a tool, such as the cleaning rod for the rifle.

Other problems experienced were as follows:

a. The tiedown straps which assemble the launcher to the rifle deformed. The deformation allowed the mounting screws to loosen and in three instances one of the two mounting screws sheared. This occurred with all three launchers after being fired approximately 500 rounds. It also occurred with the launchers fired in the low- and high-temperature test after approximately 400 rounds.

b. With one of the reliability test launchers, after firing 512 rounds, the barrel release latch pin broke and a small piece had broken from the latch where it bears against the barrel extension. When this occurred the barrel would not always remain in the latched position during firing. A similar breakage occurred with one of the launchers being fired under low and high temperatures after approximately 400 rounds; therefore, the failure could not be considered an isolated occurrence. However, the breakage was believed to be directly related to the failure of the tiedown strap, in that, when the strap deformed and the mounting screws loosened, the launcher could move rearward relative to the rifle during recoil. This rearward movement partially released the barrel latch due to the inertia of the latch. Then, the contact surface of the latch, which bears on the barrel extention, rested on the corner of the latch rather than the full lock surface.

c. The retainers on the front end of the cover of the launcher, which engage the handguard cap on the M16A1 rifle, were easily broken during removal of the cover from the rifle.

1.4.1.10 Ruggedness. The firing mechanism of the XM203 launcher and sights withstood the impact of being dropped on hard-packed earth from a height of 3 feet.

1.4.1.11 Solvents and Lubricants Compatibility. With the exception of insect repellent (type FSN 6840-558-0918), no detrimental effects from any of the various cleaners and lubricants were experienced. The insect repellent dissolved the compound used to glue the handgrip to the barrel of the launcher.

1.4.1.12 Additional Firings. As an outcome of an in-process review meeting, three uncorrected deficiencies relative to broken parts and the occurrence of failures of the follower to override were reported. Subsequently, four XM203 grenade launchers were modified and each was fired 1500 rounds. No broken or unserviceable parts, or failures of the follower to override, were experienced. The deficiencies and modifications are described in par. 2.18.1.

1.4.2 Technical Characteristics

Within the scope of the engineering test, the XM203 grenade launcher complied with the requirements of the technical characteristics with the exception of the following:

a. The total number of parts was 110. The requirements specify that the number of parts shall not exceed that of the M79 launcher which is 106.

b. It is required that the launcher be typically capable of firing at least 1000 rounds under normal temperate environmental conditions without incurring broken or unserviceable parts. Deformed tiedown straps occurred with all three launchers fired in the 1000-round reliability phase of the engineering test and the two retainer screws for the tiedown strap were broken. Additionally, the occurrence of a broken barrel release latch pin and unserviceable barrel release latch were experienced with one launcher. However, in the additional firings conducted by the developer, four modified XM203 launchers were fired 1500 rounds each without the occurrence of a broken or unserviceable part.

c. The precision and accuracy of adjustment on the primary sight was not equal to that of the M79 launcher.

1.4.3 Shortcomings and Deficiencies.

At the completion of the engineering test and the additional firings there were no existing deficiencies. The uncorrected shortcomings are as follows:

a. Breakage of the barrel-release-latch pin.

b. Breakage of the retainers on the cover.

c. Failure of the compound used to glue the handgrip to the barrel, at -65°F, and failure of the compound when exposed to insect repellent.

d. The primary sight is not correctly graduated for 350 meters range for the velocity level produced by the launchers.

e. The stop on the sight base of the primary sight prevents the range selector latch from moving into the locked position on the 400-meter setting.

f. The battlesight is not correctly graduated for 250 meters range.

g. The breech plug in the modified launcher loosened during firing under conditions of -25 and -65°F.

h. The new extractor of the modified launcher reduces headspace to the extent that the rim of fired cases lodge between the extractor and the breechface and cause failures to eject.

i. The screws that assembled the battlesight to the cover on the launcher loosened during firing.

j. The launcher cannot readily be assembled to the XM177E2 submachine gun without removal of the handguard cap which entails removal of the front sight and flash suppressor from the submachine gun.

1.5 CONCLUSIONS

It is concluded that:

a. The XM203 grenade launcher complies with the requirements of the technical characteristics, except for exceeding the total number of parts, the occurrence of broken and unserviceable parts in the reliability test, and the precision and accuracy of adjustment of the primary sight is not equal to that of the M79 launcher (ref pars. 2.2 and 2.7).

b. The results of the additional firings with the modified launchers showed that the modifications corrected the three deficiencies existing at the completion of engineering and service tests (ref par. 2.18 and Appendix III).

1.6 RECOMMENDATIONS

It is recommended that:

a. The proposed modifications for corrections of the three deficiencies be incorporated into the XM203 grenade launcher.

b. The shortcomings of the XM203 grenade launcher be corrected and the final design be tested sufficiently to verify the adequacy of the corrections.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

The following subtests were designed to determine the performance charcteristics of the XM203 grenade-launcher attachment and to assess the compatibility of the launcher with the M16A1 rifle and the XM177E2 submachine gun. However, due to the nonavailability of the submachine gun in numbers sufficient for test, only the M16A1 rifle was used.

The criteria for the individual subtests were based on the technical characteristics for 40-mm grenade-launcher attachments for rifles (Reference 1) which were stated in terms of the Army Approved Small Development Requirement (SDR) for a 40-mm detachable grenade launcher for individual weapons.

With the exception of the extreme cold and unlubricated tests, the launchers and rifles were lubricated with MIL-L-46000A semifluid lubricating oil throughout the test. The weapons were lubricated with MIL-L-14107 lubricant in the extreme cold test.

The lot of ammunition employed in the velocity and accuracy tests was cartridge, 40-mm, M407A1, lot MA-79-12. The function lot fired in the remainder of the tests was cartridge, 40-mm, XM387E4, lot MA-34-5.

The abbreviations used throughout the test in the recording of function data are given in Table 2.1-I.

Table 2.1-I. Abbreviations

Abbreviation	Definition
	Launcher Malfunctions
FJ	Failure to eject.
FFRA	Failure to fire due to defective ammunition. This malfunction occurred only in the low temperature test.
FFR	Failure to fire.
FFO	Failure of the follower to override the cocking lever.
BU	Barrel unlatched with the firing of a round.
BFL	Barrel failed to latch with the closing of the barrel.
IMS	Inadvertent movement of the safety from the off-position to the on-position with the firing of a round.
PO	Primer punch-out.
PPO	Partial punch-out of the primer.
PS	The projectile stuck in the bore of the launcher. This malfunction occurred only in the low temperature test.

Abbreviation	Definition
	Rifle Malfunctions
DF	Double feed of two cartridges from the magazine.
FFI	Failure to feed the first round from the magazine.
FF	Failure to feed.
FJ	Failure to eject.

2.2 INITIAL INSPECTION

2.2.1 Objectives

The objectives are:

a. To determine the completeness and serviceability of the test launcher.

b. To determine the physical characteristics of the test launcher and record measurements deemed necessary for reference during test.

2.2.2 Criteria

It is required that:

a. The launcher shall be suitable for attachment to the following point-fire weapons:

1) Rifle, 5.56-mm, M16/M16A1.

2) Submachine gun, 5.56-mm, XM177E2.

b. The launcher shall be of minimum length, consistent with meeting other requirements. It is required that the over-all length of the assembled weapon - launcher combination, with launcher loaded and prepared for firing, not exceed the length of the point-fire weapon to which the launcher is attached.

c. The weight of the assembled weapon - launcher combination (without ammunitions), including the launcher sight, shall not exceed the weight of empty point-fire weapon alone by more than three pounds.

d. The launcher shall provide sufficient firing-pin energy to assure reliable functioning of the primer in the family of ammunition for the M79 launcher.

e. The number of parts in the launcher and sight combined not exceed the number in the M79 launcher with sight.

f. The operations required for care and maintenance shall not be more difficult or time-consuming than the comparable operations required by the M79. The launcher and launcher sight assembled to the rifle shall be compatible with cleaning and maintenance requirements of the rifle.

g. The configuration and mounting arrangements of the launcher and sights will be such as to minimize catching on brush, vines, and equipment or clothing when the rifle - launcher combination is carried and used in a normal manner.

h. Not more than one special tool will be required for operator maintenance, and that this tool will weigh not more than 0.25 pound. Also, not more than one additional special tool will be required by armorer personnel at organizational level for the attachment, removal, and organizational maintenance of the launcher.

i. The launcher will be provided with a fully adjustable sight incorporating the following features:

1) Permits convenient firing of the launcher at all ranges from 30 meters to approximately 400 meters.

2) Permits zeroing of the launcher in both elevation and deflection, independent of the scale for adjustment of range.

3) Provides precision and accuracy of adjustment substantially equal to that of the sights on the M79 launcher.

4) Does not change adjustment in elevation or deflection in consequence of recoil from firing either the launcher or the point-fire weapon to which it is attached.

j. It is desired that the launcher sighting system also incorporated the following features:

1) Provide a "battle sight" for the launcher, centrally located atop the point-fire weapon, so designed and constructed as to cause no significant inconvenience if left in place at all times when the launcher is assembled to the point-fire weapon.

2) The "battle sight" shall provide for firing elevations up to approximately 16 degrees so as to permit accurate aiming for ranges of 50, 100, 150, 200, and 250 meters.

2.2.3 Method

One of the test launchers is disassembled and an examination is made of all parts. The launcher and component parts are photographed and the number of parts are recorded.

The functioning of operating parts is checked manually on all launchers. The following measurements and any others deemed necessary are recorded:

a. Weight of complete launcher system.

b. Weights of various groups of the launcher system.

c. Firing-pin protrusion.

d. Firing-pin energy. (Copper-crusher cylinders and a holding fixture designed for the M79 grenade launcher are employed. Energy levels are determined by using the graphs provided by AMSWE-RDSR, 20 May 1968).

e. Head space.

f. Trigger pull.

g. Barrel-bore measurements.

h. Charging force.

i. Safety actuation.

Performance characteristics relative to any of the criteria for this subtest that are not determined during this subtest are determined in other subtests (i.e., ability of sight to maintain adjustment and setting is determined in the reliability test; the accuracy of the battle sight is determined in the accuracy test, etc.).

2.2.4 Results

The recorded weights and measurements for the launchers are given in Table 2.2-I. Disassembled views of the launcher are in Figures 2.2-1 through 2.2-3. Barrel-bore measurements are contained in Appendix I.

Table 2.2-I. Weights and Measurements

	M16A1 Rifle Serial No.											
	790692	791477	785632	790794	789751	791192	791084	790946	791296	789003	790915	791399
	XM203 Launcher Serial No.											
	34	35	36	37	38	591	592	593	594	595	596	597
M16A1 rifle with launcher attached (both empty, but with sling and magazine), lb.	10.26	10.21	10.19	10.21	10.17	10.22	10.19	10.25	10.19	10.18	10.23	10.29
Primary sight assembly, lb.	0.26											
Barrel assembly, lb.	0.95	0.94	0.94	0.94	0.94	0.95	0.95	0.94	0.94	0.95	0.94	0.94
Cover and battle sight assembly, lb.	0.55	0.56	0.56	0.57	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.57
Housing assembly (includes barrel insulators tie-down strap, and mounting screws), lb.	1.58	1.60	1.59	1.59	1.58	1.59	1.61	1.60	1.60	1.59	1.60	1.62
Bayonet bracket (includes sling swivel), lb.	0.16											
Trigger pull (average of three trials), lb.	9.0	9.3	9.6	10.1	9.4	10.3	9.3	9.6	8.5	9.5	10.1	8.1
Firing pin protrusion, in.	0.092	0.094	0.085	0.090	0.093	0.079	0.084	0.081	0.080	0.083	0.080	0.086
Firing pin indent (average of three trials), in.	0.0080	0.0083	0.0086	0.0082	0.0083	0.0091	0.0081	0.0098	0.0091	0.0085	0.0088	0.0096

Table 2.2-I (Cont'd)

	M16A1 Rifle Serial No.											
	790692	791477	785632	790794	789751	791192	791084	790946	791296	789003	790915	791399
	XM203 Launcher Serial No.											
	34	35	36	37	38	591	592	593	594	595	596	597
Firing pin energy, in.-oz[a].	26.0	27.7	29.5	27.3	27.8	31.8	26.5	36.3	32.3	28.8	30.3	34.8
Headspace, in.[b].	0.082	0.085	0.085	0.082	0.085	0.086 to 0.089	0.081 to 0.083	0.085 to 0.087	0.087	0.085	0.085 to 0.086	0.085 to 0.087
Charging force, lb[c].	7.3	7.9	7.5	8.8	8.6	9.0	8.2	7.5	8.4	8.7	8.9	7.8
Force required to employ safety, lb.	3.9	6.6	4.5	5.1	5.0	3.6	5.2	3.3	3.4	3.5	3.8	4.2
Force required to disengage safety, lb.	1.5	2.0	2.3	1.6	1.6	1.7	1.9	1.9	2.1	2.4	2.1	1.5

[a]The energy levels were determined from the graphs provided by AMSWE-RDSR, 20 May 1968 which correlates depth of firing pin indent into a copper-crusher cylinder and firing pin energy.

[b]The headspace measurement was the distance between the extractor tip and the face of the breech. On some launchers the surface of the extractor was not parrallel with the face of the breech; therefore, the measurements from the outer ends of the contact-surface of the extractor were recorded.

[c]The charging force was the force required to move the barrel forward and move the firing pin to the cocked position.

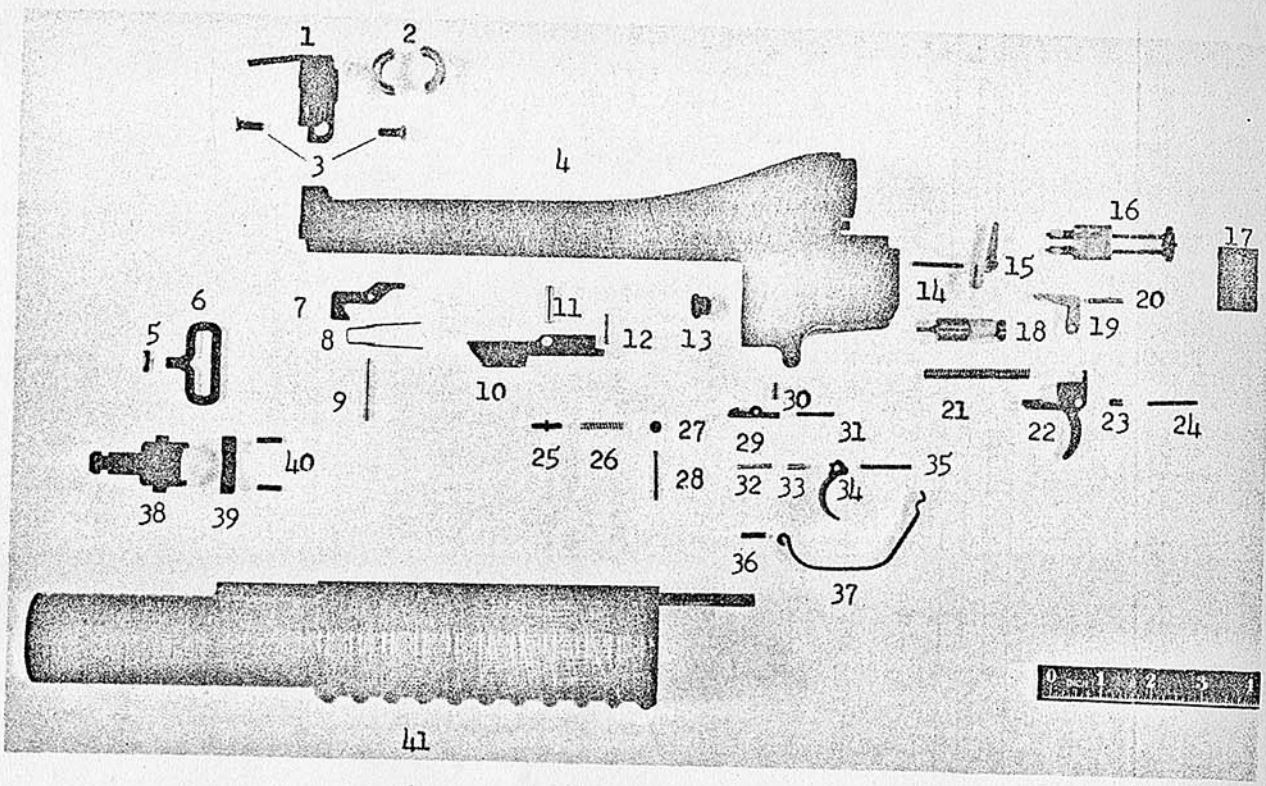

Figure 2.2-1: Disassembled View of XM203 Grenade Launcher.

Parts List for Figure 2.2-1

No.	Identification
1	Tiedown strap
2	Barrel insulators (two each)
3	Mounting screws
4	Housing assembly
5	Spring pin (from M16A1 rifle)
6	Sling swivel (from M16A1 rifle)
7	Barrel-retaining latch
8	Barrel-retaining latch spring
9	Barrel-retaining latch pin
10	Barrel-release latch
11	Barrel-release latch pin
12	Release-latch return spring
13	Breech plug
14	Cocking lever pin
15	Cocking lever
16	Follower assembly
17	Backplate
18	Firing pin
19	Secondary sear
20	Sear spring
21	Firing pin spring
22	Trigger
23	Trigger bushing
24	Trigger pin
25	Ejector
26	Ejector spring
27	Ejector retainer
28	Ejector pin
29	Extractor
30	Extractor spring
31	Extractor pin
32	Safety spring
33	Safety detent
34	Safety
35	Safety pin
36	Trigger-guard pin
37	Trigger guard
38	Bayonet lug
39	Bayonet-lug retainer
40	Bayonet-lug pins (two each)
41	Barrel assembly

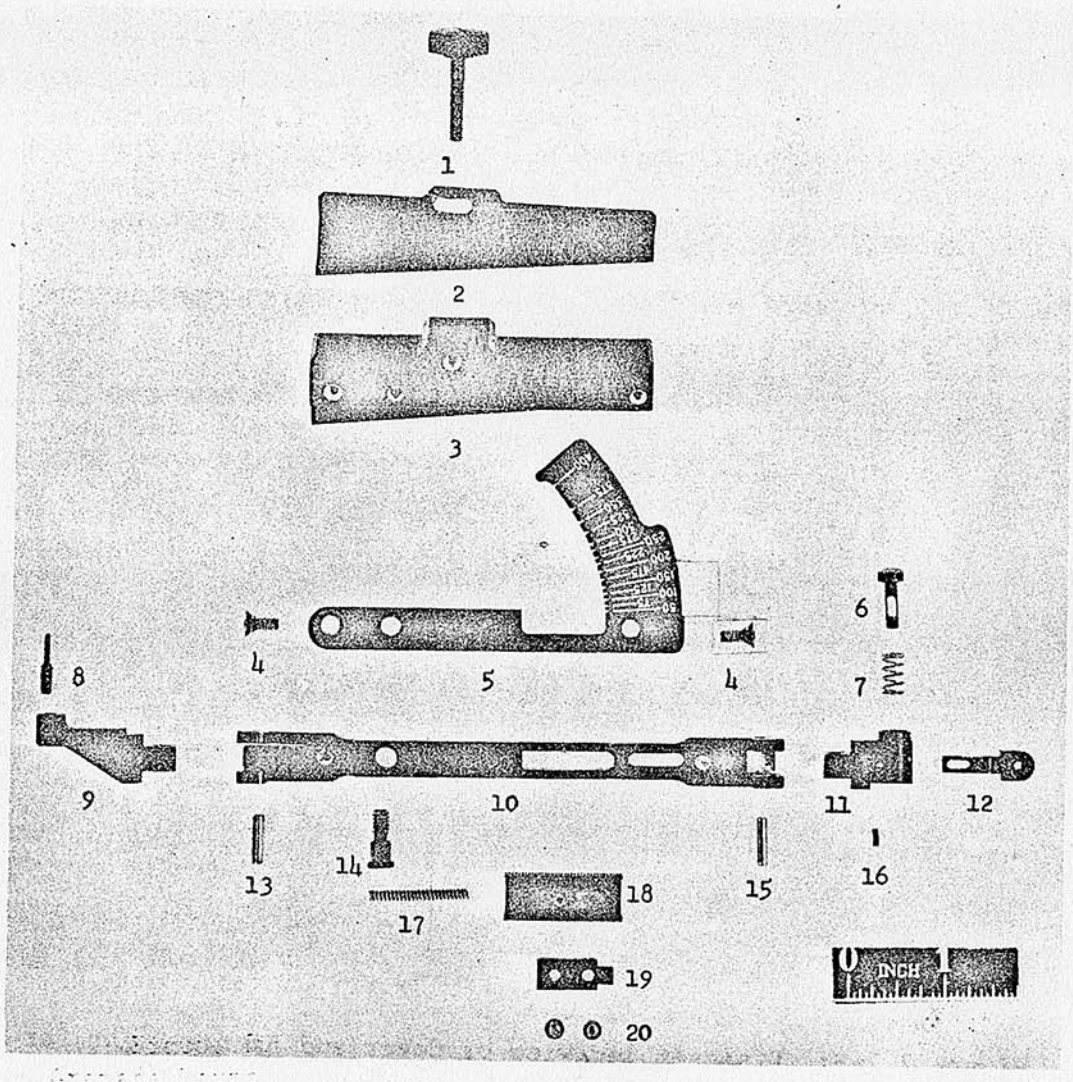

Figure 2.2-2: Disassembled View of Primary Sight for XM203 Grenade Launcher.

Parts List for Figure 2.2-2

No.	Identification	No.	Identification
1	Mounting screw	11	Peep-sight bracket
2	Sight-base mount (right side)	12	Peep sight
3	Sight-base mount (left side)	13	Retainer pin
4	Sight-base retaining screws (two each)	14	Pivot screw
5	Sight base	15	Retainer pin
6	Peep-sight retainer	16	Retainer pin
7	Peep-sight retainer spring	17	Range-selector latch spring
8	Front-sight post	18	Range-selector latch
9	Front-sight bracket	19	Range-latch retainer
10	Sight-arm assembly (five pieces)	20	Latch-retainer screws

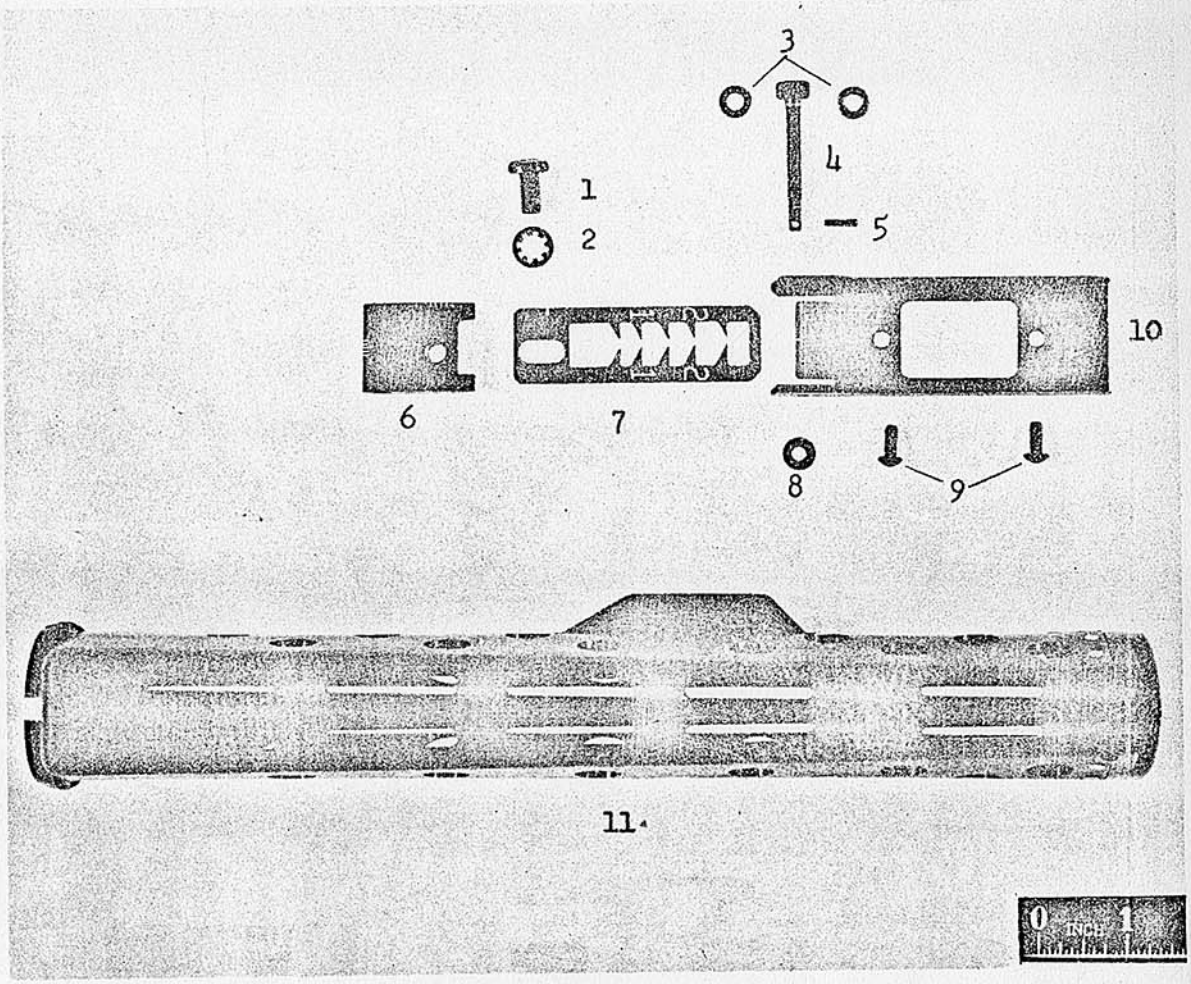

Figure 2.2-3: Disassembled View of Cover and Battle Sight for XM203 Grenade Launcher

Parts List for Figure 2.2-3

No.	Identification
1	Elevation-adjustment screw
2	Washer
3	Spring washers
4	Windage-adjustment screw
5	Pin
6	Sight base
7	Sight leaf
8	Washer
9	Sight-mount base screws (two each)
10	Sight-mount base
11	Cover

During the low-temperature test (par. 2.8), problems were encountered with primer punch-outs. Consequently, a modified extractor, breech plug, and firing pin spring were assembled. The headspace and measurements relative to the firing pin were recorded and are given in Table 2.2-II. An additional measurement on ejector protrusion was included, since it was found that two of the launchers with a large ejector protrusion did not experience failures to eject which were experienced with the launchers with less ejector protrusion.

Table 2.2-II. Measurement on Modified Launchers

	Launcher Serial No.					
	592	593	594	595	596	597
Condition: Before firing after modification.						
Firing-pin protrusion, in.	0.061	0.059	0.058	0.059	0.060	0.060
Ejector protrusion, in.	0.118	0.119	0.118	0.119	0.163	0.167
Headspace, in.	0.080	0.081 to 0.084	0.083 to 0.084	0.080	0.081	0.080
Firing-pin indent, in.	0.0088	0.0083	0.0085	0.0080	0.0086	0.0084
Firing-pin energy, in.-oz.	30.5	28.0	29.0	26.0	30.0	28.5
Condition: After all testing completed.						
Firing-pin protrusion, in.	0.059	0.058	0.058	0.058	0.058	0.057
Ejector protrusion, in.	0.117	0.117	0.119	0.117	0.162	0.167
Headspace, in.	0.078	0.081 to 0.085	0.081 to 0.082	0.081 to 0.082	0.079	0.080
Firing-pin indent, in.	0.0081	0.0078	0.0075	0.0078	0.0082	0.0077
Firing-pin energy, in.-oz.	26.7	25.2	23.5	25.2	27.3	24.3

The operations required for case and maintenance of the XM203 launcher were not more difficult nor time-consuming than for comparable operations on the M79 launcher. In the opinion of the maintenance personnel, the XM203 launcher was easier to disassemble and maintain. No special tools other than the cleaning equipment for the M79 launcher were required for operator maintenance. The attachment and removal of the launcher to or from the M16A1 rifle required no special tools. However, in order to attach the launcher to the XM177E2 submachine gun, removal of the handguard cap was required; this entailed removal of the front sight and flash suppressor, which is beyond the specified maintenance for the organizational level.

The only tool required was for assembly and disassembly of the breech plug from the launcher housing, which should not be necessary below the organizational level. In fact, unless the breech plug breaks, removal of the part should not be necessary for the life of the launcher.

The XM203 launcher was provided with a primary sight which was adjustable in elevation and deflection independently of the scale for selection of range. However, the precision and accuracy, and means of adjustment, were not equal to that of the sights on the M79 launcher. The primary sight was graduated in increments of 25 meters with range selections from 50 to 400 meters. The stop on the sight base would not allow the range-selector latch to lock into position at the 400-meter setting. The stop was on the sight base to prevent over-travel of the sight arm, which it did, but it also prevented the latch from locking into position.

The sight assembled to the carrying handle on the rifle and was easily removed for storage when not in use. The sight did not change adjustment in elevation or deflection with recoil from firing the launcher or rifle. The sight is shown in Figure 1.2-2.

A battle sight, which mounted on top of the M16A1 rifle, was provided. The sight was adjustable in deflection and elevation and was graduated in 50-meter increments from 50 to 250 meters. The design of the sight was such that it did not interfere with the carrying or operation of the rifle if left in position at all times. A shortcoming of the sight was loosening of the screws that assemble the sight- mount base to the cover of the launcher during firing. The battle sight is shown in Figure 1.2-3.

No tests were conducted at APG to determine whether the design of the launcher was such so as to minimuze the tendency of components to catch on brush or vines. It was found, however, that the primary sight was very susceptible to catching on clothes and equipment.

2.2.5 Analysis

The launchers met the requirements of the technical characteristics as outlined under the criteria, par. 2.2.2, with the exception of the following:

a. The XM203 grenade launcher could not readily be assembled to the XM177E2 submachine gun without removal of the handguard cap which required removal of the front sight and flash suppressor.

b. The total number of parts in the launcher exceeded the specified limit of 106 by four parts.

c. The primary sight did not provide the precision and accuracy of adjustment equal to that of the sights on the M79 launcher. Also, the sights were subject to catching on clothes and equipment.

The requirement that the launcher provide sufficient firing-pin energy to assure reliable functioning of the primer in the family of ammunition for the M79 launcher was not completely fulfilled; in that two failures to fire with light indents in the primer occurred with modified launcher Nos. 594 and 597. One occurrence was in the low-temperature test (-25°F) and the other was in the reliability test under normal ambient temperature conditions. In both cases, the items did fire on the second attempt. The firing-pin energy levels of these two launchers after test were 23.5 and 24.3 in.-oz (Table 2.2-II). A third occurrence of a failure to fire with a light indent was experienced with launcher No. 34 in the mud test. As in the other instances, the cartridge was fired on a second attempt. This launcher was as originally received without the modified firing-pin spring, as described in par. 2.8.4. However, the energy level was 26.0 in.-oz which was the lowest of the 12 launchers when originally received. The originally proposed technical requirements specified that the firing-pin energy would not be less than 30.0 in.-oz. If this were still the requirement only five of the 12 launchers, as originally received, met the requirement; only two of the six launchers after modification met the requirement, and none of the six modified launchers after test met the 30 in.-oz requirement.

2.3 SAFETY EXAMINATION

2.3.1 Objective

The objective is to establish that the launcher - rifle combination is safe to operate and fire from the shoulder, and to provide information necessary for a safety release of the test launchers by USATECOM for service tests.

2.3.2 Criteria

It is required that:

a. The launcher be secure against accidental discharge from rough handling when carried loaded and with the safety in the SAFE position.

b. The safety (or safeties) be so designed and located as to be easily identifiable, quickly and conveniently disengaged at will, and reasonable secure against accidental disengagement. The operation shall be so arranged that the SAFE and FIRE positions of the safety can be quickly and easily distinguished, both by sight and by touch while using necessary protective clothing to include temperate winter clothing.

c. The launcher be secure against accidental discharge by a firer assuming any of the standard firing positions rapidly, with the weapon loaded and the safety disengaged (in FIRE position). This condition shall be considered to be met if the launcher withstands, without firing, a vertical free drop of the rifle - launcher assembly butt-downward, from a height of five feet, impacting on a surface of hard-packed earth.

d. The launcher be suitable for safe and effective firing of the various types of 40-mm ammunition, listed below:

1) Cartridge, HE, 40-mm, M406.

2) Cartridge, practice, 40-mm, M407.

3) Cartridge, proof, 40-mm, XM387E3.

4) Cartridge, multiple-projectile, 40-mm, XM576E1.

5) Cartridge, white-star cluster, 40-mm, XM585.

6) Cartridge, white-star parachute, 40-mm, XM583.

e. The launcher be so designed as to prevent the inadvertent chambering and firing of 40-mm high-velocity ammunition, such as the M384, which is intended for use in the M75 or other high-velocity 40-mm launchers.

f. The firing of the launcher, when attached to the point-fire weapons to which it is adapted, shall not produce a free-recoil energy greater than that produced by the M79 launcher when firing the same types of ammunition.

g. The temperature of the chamber area in the test launcher remain safely below the cook-off temperature of the components of the 40-mm M406 cartridge when a complement of 400 rounds is fired within a 4-minute period from the M16A1 rifle to which the launcher is attached.

2.3.3 Methods

2.3.3.1 Dry Firing Examination. An examination is made of the launcher for any potential hazard to the rifleman in firing either the rifle or launcher element of the system from any standard firing position. Also, attempts are made to chamber and fire 40-mm high-velocity ammunition. If the dry-firing examination shows that the design of the XM203 launcher is not changed from that of the prototype launcher tested in Reference 2, any or all of the subsequent paragraphs of this subtest may be omitted and the data previously generated may be referenced.

2.3.3.2 Firing Evaluation. Three launchers are subjected to firings to learn whether any firing hazards exist. As a minimum the following firings are conducted:

a. Five rounds of proof ammunition are remotely fired from three launchers and then an additional five rounds are fired from the shoulder.

b. With the launchers loaded, cocked, and the safety in the FIRE position the rifles are fired 20 rounds semiautomatically, 40 rounds in short bursts, and 40 rounds automatically.

c. Fire the launcher and rifle alternately ten rounds each. For these firings, the rifle selector is set on semiautomatic. Then, ten rounds are fired from the launcher, with the rifle fully loaded and selector set on automatic, but no attempt is made to fire the rifle until after ten rounds are fired with the attached launcher. The rifle is then fired 20 rounds in a continuous burst.

2.3.3.3 Inadvertent Fire Evaluation. Three launchers are assembled to M16A1 rifles and dropped from a 5-foot height, butt end first upon hard-packed earth. Prior to being dropped, the launchers are loaded with a dummy round, cocked and the safety placed in the FIRE position. The procedure is executed three times with each weapon.

2.3.3.4 Ammunition Compatibility. Twenty rounds of each of the following listed types of ammunition are fired from the launcher:

a. Cartridge, 40-mm, XM387E3.

b. Cartridge, practice, 40-mm, M407A1.

c. Cartridge, HE, 40-mm, M406.

d. Cartridge, multiple-projectile, 40-mm, XM576E1.

e. Cartridge, white-star cluster, 40-mm, XM585.

f. Cartridge, white-star parachute, 40-mm, XM583.

2.3.3.5 Recoil Energy. The free-recoil energy of the rifle - launcher combination is calculated and compared with that of the M79 launcher.

2.3.3.6 Cook-Off. Two thermocouples are attached to an inert M406 cartridge chambered in the launcher and one is attached to the rear of the launcher housing. The thermocouples on the cartridge are attached to the base of the projectile and across the face of the primer. The thermocouple on the launcher is attached in the vicinity of the rear mounting bracket. The rifle to which the launcher is attached is then fired 400 rounds within a 4-minute period and the temperatures recorded at the three points. The firing is conducted in a range environment of $+70^{o}F \pm 5$ with the rifle and launcher shielded to prevent rapid cooling from air circulation.

2.3.4 Results

All of the various tests outlined in the methods paragraph were conducted except par. 2.3.3.4. On the basis that the design of the launcher relative to the barrel (rate of twist, length, number of lands and grooves, etc.), had not changed from that of the prototype launcher tested in Reference 2, the XM203 launcher was judged to be safe for firing the various types of 40-mm ammunition listed in par. 2.3.3.4.

During the initial safety evaluation, inspection of the launchers and limited firing disclosed that the XM203 launcher had inherent features for which safety precautions must be observed. These were as follows:

a. The barrel latch could accidentally be depressed by the gunner with rapid grasping of the handgrip on the launcher. This was considered a safety hazard in that live ammunition might be ejected to strike on hard surfaces.

b. The trigger guard on the launcher was fabricated from spring steel and was attached and pivoted from the receiver directly forward of the trigger. The guard was held in position by spring pressure between the pivot point and the front edge of the magazine well on the receiver of the rifle. The spring pressure was high and, in releasing or returning the guard to assembly, the rifleman could easily injure his fingers. The trigger guard had to be released before opening the rifle for removal of the bolt-carrier group. Also, if the guard were bumped from the bottom, it pivoted rapidly upward against the bottom of the trigger. If the rifleman should have his finger between the bottom edge of the trigger and the trigger guard when this happened, it would be possible to inadvertently fire the launcher.

A feature of the launcher which was undesireable, but not considered unsafe was that the launcher could be fired with the barrel unlatched. To cause this, the barrel had to be positioned and held less than 1/8 inch from the locked position. Normally when the barrel latch was depressed, the barrel automatically moved forward 1/2 to 3/4 inch. In such a position, the cocking lever stopped the forward movement of the firing pin. Several rounds were fired with the barrel unlatched and no unsafe effects were observed.

The calculated recoil energy for the XM203 launcher was 14 to 16 ft-lbs, depending upon which round of ammunition was being fired and whether the launcher was assembled to the M16A1 rifle or the lighter XM177E2 submachine gun. In comparison, the recoil energy of the M79 launcher was 22 to 24 ft-lbs.

The firing of 400 rounds from the M16A1 rifle in a 4-minute period did not produce temperatures above the safe level with regard to cook-off of a chambered launcher round. The recorded temperatures are given in Table 2.3-I. The recorded temperatures were well below the cook-off point of the 40-mm, M406, HE cartridge (cook-off data for the M406, HE cartridge are classified).

Table 2.3-I. Temperature Data

Location of Thermocouple	Maximum Temperature Record, °F	Time to Reach Max Temp, min[a]
Base of projectile	+160	14
Face of primer	+186	9
Top, rear of launcher housing	+188	7-1/2

[a]The time to reach maximum temperature was from the time of firing the first round of the 400-round test.

2.3.5 Analysis

The XM203 grenade launcher met the requirements of the technical characteristics as outlined in the criteria (par. 2.3.2), and, other than the two features disclosed during the initial inspection for which safety precautions must be observed, no hazards beyond those normally associated with the firing of the 40-mm, M79 grenade launcher were detected. Subsequently, recommendations for safety release were forward to USATECOM.

2.4 VELOCITY

2.4.1 Objective

The objective is to determine the velocity performance of the launchers.

2.4.2 Criteria

It is required that the velocity performance of the launcher be comparable to that of the M79 launcher so that the average effective range of the launcher will be at least 95% of that obtained with the M79 launcher when firing the same type and lot of ammunition.

2.4.3 Method

All 12, XM203 launchers are fired 20 rounds each and the instrumental velocity at 20 feet from the muzzle is determined. All ammunition is conditioned at $+70^{o} \pm 2^{o}F$ for a minimum period of four hours prior to firing.

All firings are conducted from the benchrest position by one rifleman. Cartridge, 40-mm, M407A1, practice, lot MA-79-12 is fired. This is the same lot of ammunition employed in Reference 2 and is available at APG. Control velocity data are obtained employing three M79 launchers used in Reference 2 which are available at APG.

2.4.4 Results

The instrumental velocity data for the launchers are given in Table 2.4-I.

Table 2.4-I. Velocity Data

The velocity data are in feet per second and are an average of 20-round groups.

Launcher No.	Average Instrumental Velocity 20 Ft from Muzzle	Velocities		Variations		
		Max	Min	Mean	Extreme	Std Dev
Cartridge: 40-mm, M407A1, practice, lot MA-79-12. Launcher: XM203.						
34	229.3	235.5	224.1	2.5	11.4	3.1
35	228.5	236.5	220.7	2.9	15.8	3.8
36	230.5	237.2	226.6	2.2	10.6	2.8
37	228.7	233.2	218.9	2.4	14.3	3.4
38	227.7	232.9	222.2	2.0	10.7	2.7
591	236.4	243.3	231.4	1.8	11.9	2.6
592	234.1	239.1	230.0	2.0	9.1	2.5
593	233.7	238.6	229.8	2.2	8.8	2.7
594	234.7	241.2	227.7	2.0	13.5	2.8
595	234.0	238.7	215.3	2.7	23.4	4.8
596	235.2	241.1	230.0	2.0	11.1	2.6
597	234.7	238.0	229.6	2.2	8.4	2.5
Average	232.3	237.9	225.5	2.2	12.4	3.0
Launcher: M79.						
30887	228.4	232.9	222.3	2.4	10.6	2.9
30965	230.8	234.7	225.0	2.3	9.7	2.8
30898	232.6	237.6	225.7	2.3	11.9	3.0
Average	230.6	235.1	224.3	2.3	10.7	2.9

The average velocity of the projectiles launched from the 12,XM203 grenade launchers was 232.2 feet per seconds. The serial numbers of five of the launchers ranged from 34 through 38 and the remaining seven ranged from 591 through 597. It was noted that the low serial-numbered launchers fired the grenades at an average velocity of 228.9 feet per second while the higher serial-numbered launchers fired the grenades at an average velocity of 234.7 feet per second, a difference in velocity of 5.8 feet per second. Two prototype XM203 launchers tested in the engineer design test (Reference 2) fired the same lot of grenades at 241.6 feet per second. The difference in velocity was attributed to a difference in the bore diameters of the respective weapons. The average land and groove diameter of the launchers are given in Table 2.4-II. Detailed data for the 12 engineering test launchers are contained in Appendix I. The data for the two prototype launchers are extracted from Reference 2.

Table 2.4-II. Comparison of Velocity and Bore-Measurement Data

Launcher Identification	Recorded Velocity, fps	Average Land Diameter, in.	Average Groove Diameter, in.
Ammunition: Cartridge, 40-mm, M407A1, lot MA-79-12.			
	Engineering Test		
Serial Nos. 34 to 38	228.9	1.607 to 1.608	1.628
Serial Nos. 591 to 597	234.7	1.609 to 1.610	1.628 to 1.629
	Engineer Design Test		
Serial Nos. 12 and 13	241.6	1.609 to 1.610	1.626 to 1.627

A comparison of the bore measurement disclosed the groove diameters of the engineering-test launchers were 0.002 inch greater than for the prototype launchers, which would tend to increase gas blowby within the bore. Also, the land diameters were 0.002 inch less in the engineering test launchers serial Nos. 34 to 38 than in the prototype launchers, which would increase the friction of land engraving and, consequently, decrease the velocity of the grenade.

2.4.5 Analysis

The mean projectile velocity of the XM203 launcher was greater than that of the M79 launcher. Therefore, the requirements of the technical characteristics that the velocity performance of the launcher be such that the effective range of the XM203 launcher be at least 95% of that obtained with the M79 when firing the same type and lot of ammunition was met.

2.5 ACCURACY TEST

2.5.1 Objective

The objective is to determine the range accuracy and adequacy of sight graduations for the launcher.

2.5.2 Criteria

The launcher shall have such accuracy at all useable ranges up to 200 meters that one range probable error shall be less than 14 feet (4.3 meters) and one deflection probable error shall be less than three feet (0.9 meter).

2.5.3 Method

Three launchers are attached to M16A1 rifles and 20-round groups are fired by two expert riflemen for ground impact at ranges of 100, 200, and 350 meters. Before firing for record, the sights on the launchers are adjusted by one rifleman to impact the grenades at the 200-meter range. Thereafter, the only sight adjustment made is to set the sight scale at the appropriate graduation for each range.

A similar test using the battle-sight is conducted, firing 10-round groups at each designated range on the sight scale.

All firings are conducted from a benchrest with wind conditions of 10 mph and below for ranges up to and including 200 meters and 5 mph and below for ranges greater than 200 meters.

2.5.4 Results

The results of the range-accuracy firing using the primary sight are given in Table 2.5-I. The center-of-impact data show that the primary sight was not correctly graduated for 350-meters range for the velocity level produced by the launchers with the test lot of ammunition. It should be noted that the data for launcher Nos. 37 and 38 show the center-of-impact of the groups was approximately 25 and 28 meters short while the group center-of-impact for launcher No. 591 was only 8 meters short. This is directly related to the decrease in velocity level of the launchers which is discussed in par. 2.4.4. The group center-of-impact with the launchers tested in the engineer design test (Reference 2) was 346.2 meters at the 350-meter range firing the same lot of ammunition.

Table 2.5-I. Launcher Accuracy Data
Using the Primary Sight

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Spread Range	Defl	Extreme Spread
Ammunition: Cartridge, 40-mm, M407A1, practice, lot MA-79-12.										
Range: 100 meters.										
37	100.6	+0.4	2.2	2.2	0.1	2.8	0.2	10.6	0.9	10.6
38	94.2	0.0	1.6	1.6	0.1	2.1	0.2	7.7	0.5	7.7
591	93.9	-0.1	2.8	2.8	0.1	3.5	0.2	12.6	0.6	12.6
Average	96.2	+0.1	2.2	2.2	0.1	2.8	0.2	10.3	0.7	10.3
Range: 200 meters.										
37	202.2	+0.5	2.9	2.8	0.4	3.5	0.5	13.2	1.8	13.2
38	194.6	0.0	3.7	3.6	0.4	4.4	0.5	15.5	1.9	15.5
591	200.7	+0.5	4.0	3.9	0.3	5.0	0.4	18.9	1.3	18.9
Average	199.2	+0.3	3.5	3.4	0.4	4.3	0.5	15.9	1.7	15.9
Range: 350 meters.										
37	325.4	+3.9	6.9	6.5	1.6	8.2	2.0	30.7	7.6	30.7
38	321.8	+0.1	6.3	5.8	1.8	7.1	2.3	24.4	8.9	24.5
591	341.8	+3.7	7.2	6.8	1.5	8.7	1.9	35.8	7.0	36.0
Average	329.7	+2.6	6.8	6.4	1.6	8.0	2.1	30.3	7.8	30.4

[a]Average of firings by two rifleman, each firing a 20-round group with each launcher.

To determine the accuracy and utility of the 375-meter sight graduation, a 20- round group was fired with each of the launchers by one rifleman. The only sight adjustment made was to set the range scale on the 375-meter graduation. The results are given in Table 2.5-II.

Table 2.5-II. Launcher Accuracy Data
(Additional Firings)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Cartridge: 40-mm, M407A1, practice, lot MA-79-12. Sight Setting: 375 meters.										
37	342.9	+2.7	7.9	7.5	1.6	10.0	2.0	37.5	8.1	37.5
38	329.1	-3.7	5.6	5.0	1.5	6.5	2.1	24.2	7.8	24.9
591	354.7	-1.1	4.9	4.3	1.6	5.1	2.0	17.7	7.6	17.7

[a]Average of one 20-round group fired by one rifleman.

The results of the range-accuracy firings using the battle sight are given in Table 2.5-III. The group center-of-impact when using the maximum range (250 meters) on the battle sight was short. This, as with the primary sight, was directly related to the decrease in velocity level, as the sights were probably calibrated for the higher velocity experienced with the launchers tested in the engineering design test (Reference 2).

Impacting the grenades at the 250-meter range required launching the grenade at an increased elevation. This presented another problem, in that, if the elevation of the launcher was increased to impact the grenades at 250 meters, the flash suppressor on the M16A1 rifle blocked the line of sight. The maximum elevation attainable without interference of the flash suppressor with the line of sight is the present configuration, which impacts the grenades at approximately 230 meters rather than 250 meters.

Table 2.5-III. Launcher Accuracy Data Using
The Battle Sight

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Ammunition: Cartridge, 40-mm, M407A1, practice, lot MA-79-12. Range: 50 meters.										
37	60.9	+0.2	2.0	2.0	0.1	2.6	0.1	7.6	0.3	7.6
38	57.2	+0.1	1.0	1.0	0.1	1.3	0.1	4.3	0.3	4.3
591	57.1	+0.1	1.1	1.1	0.1	1.6	0.1	5.7	0.4	5.7
Average	58.4	+0.1	1.4	1.4	0.1	1.8	0.1	5.9	0.3	5.9

[a]Average of firings by two riflemen, each firing a 10-round group with each launcher.

Table 2.5-III (Cont'd)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Range: 100 meters.										
37	103.6	+0.4	3.0	3.0	0.2	4.7	0.3	16.8	0.9	16.8
38	101.5	0.0	1.8	1.8	0.1	2.3	0.1	7.4	0.3	7.4
591	100.1	+0.2	2.4	2.4	0.1	2.9	0.1	8.3	0.4	8.3
Average	101.7	+0.2	2.4	2.4	0.1	3.3	0.2	10.8	0.5	10.8
Range: 150 meters.										
37	155.1	+0.7	3.2	3.2	0.2	4.5	0.2	15.3	0.7	15.3
38	150.9	+0.3	2.6	2.5	0.1	3.3	0.2	10.9	0.6	10.9
591	153.2	+0.1	2.8	2.8	0.3	3.3	0.4	9.7	1.3	9.7
Average	153.1	+0.4	2.9	2.8	0.2	3.7	0.3	12.0	0.9	12.0
Range: 200 meters.										
37	199.1	+1.1	3.9	3.8	0.4	5.3	0.5	17.5	1.4	17.5
38	198.1	+0.3	4.3	4.2	0.5	5.9	0.7	20.9	2.4	20.9
591	191.1	0.0	4.4	4.4	0.3	5.5	0.4	17.0	1.4	17.1
Average	196.1	+0.5	4.1	4.1	0.4	5.6	0.5	18.5	1.7	18.5
Range: 250 meters.										
37	227.8	+1.6	6.4	6.4	0.5	7.4	0.7	20.5	2.2	20.5
38	227.5	+1.9	3.6	3.5	0.5	4.3	0.7	13.4	2.7	13.5
591	233.3	+0.8	3.7	3.6	0.5	4.7	0.7	14.9	2.0	14.9
Average	229.5	+1.4	4.6	4.5	0.5	5.5	0.7	16.2	2.3	16.3

[a]Average of firings by two riflemen, each firing a 10-round group with each launcher.

The range and deflection probable errors for the launchers at the various ranges, when using both the primary and battle sights, are given in Tables 2.5-IV and 2.5-V.

Table 2.5-IV. Range and Deflection Probable Errors When Using the Primary Sight, meters

Launcher No.	100 Meters		200 Meters		350 Meters	
	Range	Defl	Range	Defl	Range	Defl
37	1.9	0.1	2.4	0.3	5.5	1.3
38	1.4	0.1	2.9	0.3	4.8	1.6
591	2.4	0.1	3.3	0.3	5.9	1.2
Average	1.9	0.1	2.9	0.3	5.4	1.4

Note: The probable errors were calculated by multiplying the range and deflection standard deviations by 0.674.

Table 2.5-V. Range and Deflection Probable Errors When Using the Battle Sight, meters

Launcher No.	50 Meters		100 Meters		150 Meters		200 Meters		250 Meters	
	Range	Defl	Range	Defl	Range	Defl	Range	Defl	Range	Defl
37	1.7	0.1	3.2	0.2	3.6	0.1	3.5	0.3	5.0	0.5
38	0.9	0.1	1.6	0.1	2.2	0.1	4.0	0.5	2.9	0.5
591	1.1	0.1	1.6	0.1	2.2	0.3	3.7	0.3	3.2	0.5
Average	1.2	0.1	2.1	0.1	2.7	0.2	3.7	0.4	3.7	0.5

2.5.5 Analysis

The 95% confidence intervals on the true probable error for the primary and battle sights at 200 meters range were as follows:

a. Primary sight

1) Range PE < 3.3 meters.

2) Deflection PE < 0.4 meters.

b. Battle sight

1) Range PE < 4.2 meters.

2) Deflection PE < 0.4 meters.

Therefore, the XM203 grenade launchers met the requirements of the technical characteristics as outlined in the criteria (par. 2.5.2); however, the inadequacies of the sight graduations on the primary sight at the 350- and 375-meter ranges and those on the battle sight at the 250-meter range were classified as shortcomings.

2.6 DISPERSION TEST

2.6.1 Objective

The objective is to determine any effects on the accuracy and dispersion of the M16A1 rifle from attachment and use of the launcher, and any effects on alignment and security of attachment of the launcher and launcher sights from firing the point-fire element of the weapon.

2.6.2 Criteria

It is required that the attachment of the launcher to the point-fire weapon and the subsequent firing thereof shall not cause a shift in the center of impact of the point-fire weapon which exceeds two mils in deflection or two mils in elevation, when the weapon is fired either from the prone position with elbows supported, or from a foxhole position with the weapon supported.

2.6.3 Method

Three launchers and three M16A1 rifles are tested as follows from a benchrest position with the weapon supported on a sandbag:

a. Phase 1. The M16A1 rifles are zeroed at the 100-meters range on a vertical target by an expert rifleman and the sight setting for each are recorded. Three 10-round groups are then fired with each rifle.

b. Phase 2. The launchers are attached and three 10-round groups are fired from each rifle using the same sight setting established in phase 1.

c. Phase 3. At 50-meters range the launchers are zeroed on a vertical target and three 10-round groups are fired with each launcher. Three additional 10-round groups are fired using the battle sight.

d. Phase 4. Three additional 10-round groups are fired with the rifles using the sight setting established in phase 1.

2.6.4 Results

Dispersion and accuracy data for the M16A1 rifle are given in Table 2.6-I.

Table 2.6-I. Rifle Accuracy Data

All target measurements are in inches and are an average of three 10-round groups at 100-meters range.

Rifle No.	Attached Launcher No.	Group Center from Aiming Point Hor	Group Center from Aiming Point Vert	Mean Radius	Deviations Hor Mean	Deviations Hor Std	Deviations Vert Mean	Deviations Vert Std	Extremes Hor Disp	Extremes Vert Disp	Extremes Spread
Condition: Without launcher attached (Phase 1).											
789003	595	0.0	+3.8	1.2	0.6	0.8	0.8	1.1	2.6	3.7	4.1
790915	596	+0.1	-1.5	1.6	0.7	0.9	1.2	1.7	3.1	5.6	5.6
791399	597	-0.5	+2.6	1.6	0.9	1.2	1.1	1.4	3.6	4.6	5.1
Condition: With launcher attached (Phase 2).											
789003	595	+0.8	+6.1	1.5	0.6	0.8	1.2	1.5	2.5	4.7	4.9
790915	596	-0.9	+3.3	1.3	0.7	0.9	1.0	1.2	3.1	3.6	4.1
791399	597	-0.1	+6.0	1.2	0.7	0.9	0.9	1.1	3.0	3.7	4.2
Condition: After firing the launcher, with launcher attached (Phase 4).											
789003	595	+1.5	+5.8	1.2	0.7	0.9	0.8	1.1	2.9	3.4	3.9
790915	596	-1.2	+2.4	1.2	0.6	0.8	0.9	1.1	2.8	3.7	3.9
591399	597	-1.8	+6.7	1.1	0.7	0.9	0.7	1.0	3.0	3.2	4.0

The shifts in center-of-impact resulting with the rifle when a launcher was attached are given in Table 2.6-II.

Table 2.6-II. Change in Group Center of Impact which Occurred with the Attachment of a Launcher to the M16A1 Rifle

Rifle No.	Attached Launcher No.	Shift in Group Locations[a] Hor	Vert
Range: 100 meters.			
789003	595	+0.8	+2.3
790915	596	-1.0	+4.8
791399	597	+0.4	+3.4

[a]The distance and direction of shift was relative to the group location without a launcher attached.

The sights on the rifles could be readjusted to compensate for the shift with latitude remaining for further adjustment. The recorded sight settings for the M16A1 rifles before attachment of the launchers are given in Table 2.6-III.

Table 2.6-III. Recorded Rifle-Sight Settings Before Attachment of a Launcher

Rifle No.	Attached Launcher No.	No. of Clicks[a] Windage[b]	Elevation[c]
789003	595	23	19
790915	596	19	24
791399	597	16	26

[a]One click in windage or elevation moves the bullet impact at 100 meters approximately 1.1 inches.
[b]The figure represents the number of clicks of windage from the extreme left sight position. The rear sight has a range of 32 clicks of windage.
[c]The figure represents the number of clicks of elevation from the lowest sight position. The front sight has a range of 40 clicks of elevation.

The 50-meter dispersion data for the launchers with both the primary and battle sights are given in Table 2.6-IV. No detrimental effects on the alignment and security of attachment of the launcher or launcher sights from firing the rifle resulted. The security of the launcher and sights were further proven in the reliability test where three launchers were fired 1000 rounds each and the rifles to which the launcher were attached were fired 2000 rounds each.

Table 2.6-IV. Launcher Bench Rest Accuracy Data

All target measurements are in inches and are an average of three 10-round groups at 50 meters range.

Launcher No.	Group Center from Aiming Point		Mean	Deviations				Extremes		
				Hor		Vert		Hor	Vert	
	Hor	Vert	Radius	Mean	Std	Mean	Std	Disp	Disp	Spread
Sight: Primary.										
595	-6.4	+16.9	5.4	2.2	3.0	4.3	5.7	10.1	18.6	19.1
596	+8.9	- 2.1	5.6	2.9	3.8	4.1	5.2	12.7	15.4	19.1
597	+3.4	-12.3	6.7	2.5	3.3	5.9	7.5	11.2	24.4	24.7
Sight: Battle.										
595	-1.5	+ 6.4	4.6	2.0	2.7	3.7	4.6	9.3	14.2	14.7
596	-1.4	+ 1.5	5.6	3.0	3.8	4.0	5.3	12.3	17.4	18.3
597	+4.8	+ 0.5	5.3	1.9	2.6	4.5	6.3	8.4	22.2	22.7

2.6.5 Analysis

The 95% confidence intervals on the true shifts in center-of-impact in elevation and deflection due to the attachment of the launcher to the M16A1 rifle are as follows:

a. Elevation, shift < 1.9 mils.

b. Deflection, shift < 0.3 mils.

Therefore, the requirement of the technical characteristics that the shift in elevation or deflection not exceed two mils was met.

2.7 RELIABILITY AND DURABILITY

2.7.1 Objectives

The objectives are:

a. To determine the reliability of the test launchers.

b. To determine if the attachment and use of the test launchers, particularly extended use, is detrimental to the M16A1 rifle.

2.7.2 Criteria

Criteria are as follows:

a. The launcher shall be capable of firing at least 1000 rounds without incurring broken or unserviceable parts.

b. The attachment and subsequent use of the launcher shall not be detrimental to the accuracy or function performance of the M16A1 rifle.

2.7.3 Method

Three launchers are attached to M16A1 rifles and fired 1000 rounds each. The rounds previously fired for velocity and dispersion are counted as part of the 1000-round total. Throughout the 1000-round test, the following procedures are employed:

a. The launchers are fired in 200-round cycles. After each cycle, the launchers are cleaned and lubricated, and the following measurements are recorded:

1) Charging force.

2) Safety actuation force.

3) Firing-pin energy.

4) Headspace.

5) Firing-pin protrusion.

6) Trigger pull.

b. Velocity measurements of the first 20 rounds of each 200-round cycle are obtained. The ammunition fired for velocity is temperature- conditioned at +70° ± 2°F. Additionally, with each round fired for velocity, the safety is moved to the "ON" position and an attempt is made to fire the launcher.

c. The 200-round cycles with the launchers are fired as follows:

1) At the beginning of the cycle, the launcher and rifle are fired 20 rounds alternately. For these firings, the rifle selector is set on semiautomatic.

2) Then, 20 rounds are fired from the launcher, with the rifle fully loaded and selector set on automatic, but no attempt is made to fire the rifle until after 20 rounds are fired with the attached launcher. The rifle is then fired 20 rounds in a continuous burst.

3) Fire 60 rounds with the launcher.

4) Fire the rifle 80 rounds semiautomatically and 80 rounds automatically.

5) Fire 100 rounds with the launcher.

6) Fire the rifle 100 rounds semiautomatically and 100 rounds automatically.

d. Prior to the test, after firing 500 rounds, and following completion of 1000 rounds of firing with the launchers, three 10-round accuracy groups are fired at 100 meters with each of the rifles and at 50 meters with each of the launchers. Data from the dispersion test, paragraph 2.6, are used for the prior-to-test data.

2.7.4 Results

The function data recorded for the three XM203 grenade launchers during the reliability test are summarized in Table 2.7-I. The M16A1 rifle performance data obtained during the launchers reliability test are summarized in Table 2.7-VI.

Table 2.7-I. Function Data for Reliability Test

No. Rds Fired	Total Fired	Launcher Serial No. 595	596	597
100	100	2-IMS	1-IMS	
At approximately the 100-round point the trigger was modified by the developer to correct the malfunction of the safety moving from the off-position to the on-position with the recoil of the weapon. The modification made to the trigger is shown in Figure 2.7-1.				
100	200			
200	400	2-PPO	10-PPO	
110 to 120	510 to 520	2-FFO [a]5-BU 1-PPO	1-PPO	[b]4-BU
At this point the test was temporarily suspended due to punch-outs and partial punch-outs of the primers which occurred in the low temperature test. The launcher was modified by the developer as follows (a description of the modified parts is contained in paragraph 2.8.4):				
(a) Modified breech plugs were installed.				
(b) The stainless steel firing pin spring was replaced with a cadminum-plated music wire spring.				
(c) Modified extractors were installed.				
(d) A spring-loaded plunger which adjusts headspace was installed.				
80 to 90	600	37-FJ	0	0
200	800	46-FJ [c]3-BU	0	0
200	1000	12-FJ	0	[d]1-FFR

Figure 2.7-1. The Modified Trigger As Received in the M202 Launcher is Shown at the Left. Arrow Indicates the Added Material to Correct the Malfunction of the Safety (See Appendix C - Corrected Deficiency [illegible])

[a]Inspection disclosed that a small piece had broken from the latch and the barrel extension where the barrel latch locks against the barrel extension. Further inspection disclosed the release-latch pin was broken in two pieces of approximately equal length. A new barrel-release-latch pin was installed.
[b]The barrel unlatched during firing. No breakage as described in footnote a had occurred; however, slight deformation of the contact points between the barrel-release latch and the barrel extension was present.
[c]A new barrel-release latch was installed.
[d]There was a light indent in the primer. The round fired on a second attempt.

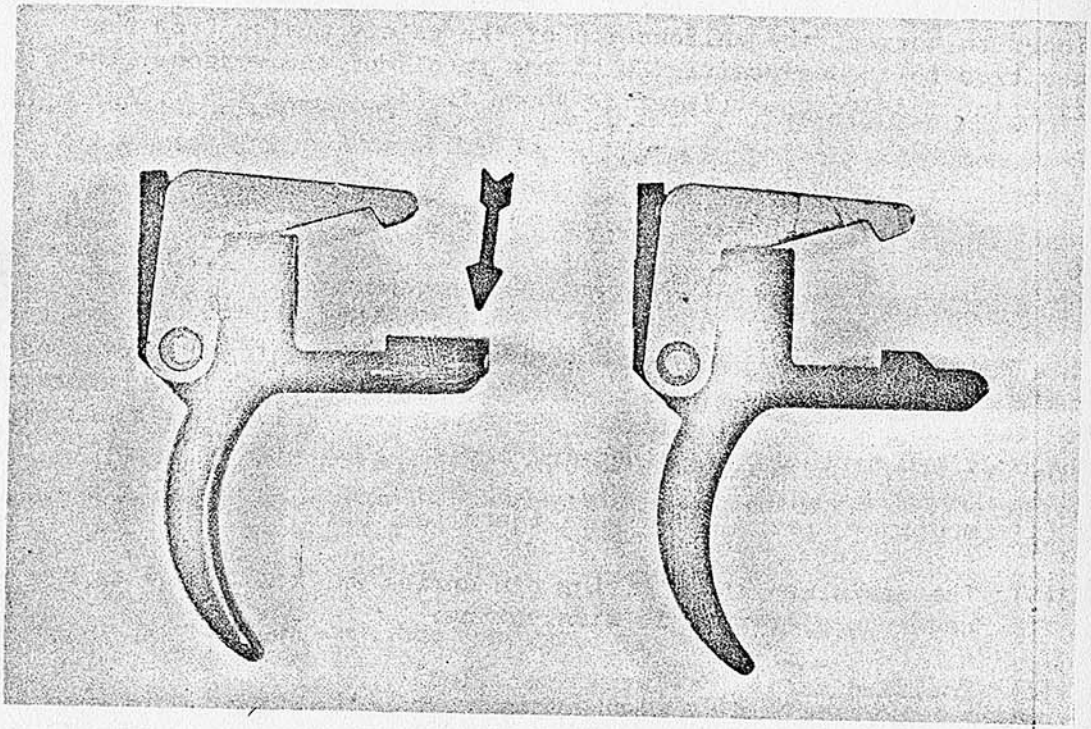

Figure 2.7-1: The Modified Trigger Is Shown on the Left and the Trigger as Received in the XM203 Launcher Is Shown on the Right. The Arrow Indicates the Added Material to Correct the Malfunction of the Safety (Ref Appendix III, Corrected Deficiency 2.1).

The results of the reliability test show that similar malfunctions occurred as were experienced in the adverse conditions tests. The reliability test data are presented in 200-round cycles so that the order of occurrence of the malfunctions can be identified. As in the mud and salt-water immersion tests, occasional occurrences of failures of the follower to override the cocking lever were experienced. When this occurred the launcher barrel could not be closed because the cocking lever protruded between the barrel extension and the follower. The malfunction was cleared by forcing the firing pin to the rear through the firing-pin hole with a small punch or by lowering the back plate and pushing the follower forward with a tool, such as the cleaning rod for the rifle.

Other problems experienced were as follows:

a. The tiedown straps which assembled the launcher to the rifle deformed. The deformation allowed the mounting screws to loosen and in three instances one of the two mounting screws sheared. This occurred with all three launchers after firing approximately 500 rounds. A deformed tiedown strap and one of the screws which sheared are shown in Figure 2.7-2.

b. With one of the reliability test launchers after firing 512 rounds the barrel release latch pin broke and a small piece had broken from the latch where it bears against the barrel extension. When this occurred the barrel would not always remain in the latched position during firing. A similar breakage occurred with one of the launchers being fired under low and high temperatures after approximately 400 rounds; therefore, the failure cannot be considered an isolated occurrence. However, the breakage was believed to be directly related to the failure of the tiedown strap, in that, when the strap deformed and the mounting screws loosened, the launcher could move rearward relative to the rifle during recoil. This rearward movement partially released the barrel latch due to the inertia of the latch. Then, the contact surface of the latch, which bears on the barrel extension, rested on the corner of the latch rather than the full lock surface.

c. The retainers on the front end of the cover of the launcher, which engage the handguard cap on the M16A1 rifle, were easily broken during removal of the cover from the rifle.

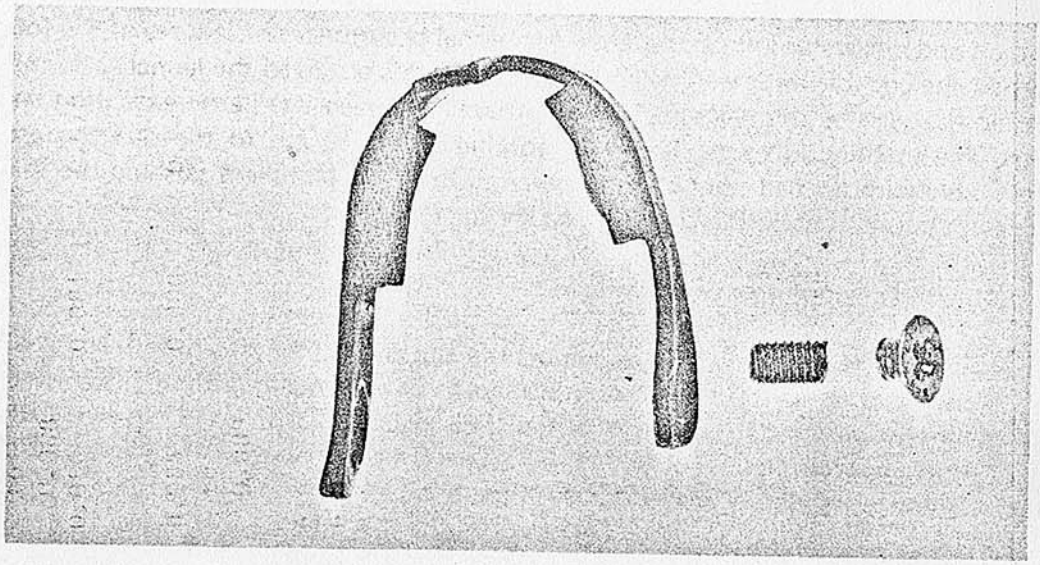

Figure 2.7-2: Deformed Tiedown Strap and One of the Screws Which Sheared in the Reliability Test.

The occurrence of an excessive number of failures to eject with launcher No. 595 was attributed to the modified extractor which reduced the headspace of the launcher. However, it whould be noted that the other two launchers did not experience failures to eject as did launcher No. 595, even though the headspace on all three launchers after modification were comparable (Table 2.7-II). It was found that the ejector protrusion on launcher Nos. 596 and 597 was 0.044 to 0.048 inch greater than on launcher No. 595. A check of the other three launchers which were modified at the time of test suspension disclosed the ejector protrusion on these launchers was comparable with that on launcher No. 592 (Table 2.2-II). The protrusion of the ejector was controlled by the depth of the ejector well in the launcher housing.

The launcher measurements recorded after each 200-round group of the 1000-round test are summarized in Table 2.7-II. The velocity data which were recorded at the beginning of the reliability test and also after each 200-round group are summarized in Table 2.7-III. The accuracy data obtained with the launchers and rifles at the beginning of test, at the 500-round stage and after test are given in Tables 2.7-IV and 2.7-V.

Table 2.7-II. Launcher Measurements Recorded Throughout the Reliability Test

	Launcher Serial No.	No. of Rounds Fired When Data Were Recorded				
		200	400	600[a]	800	1030
Headspace, in.	595	0.085 to 0.086	0.085 to 0.088	0.080	0.078	0.081 to 0.082
	596	0.086 to 0.087	0.086	0.081	0.078 to 0.080	0.079
	597	0.085 to 0.088	0.085 to 0.089	0.080	0.078 to 0.080	0.080
Trigger pull, lb	595	6.6	6.6	6.2	6.4	6.5
	596	6.0	6.0	6.5	6.4	6.3
	597	5.1	5.5	6.4	4.8	5.1
Charging force, lb	595	6.7	9.1	6.4	5.8	6.1
	596	7.3	6.7	6.6	6.2	6.3
	597	6.0	5.8	6.7	5.4	5.4
Safety-actuation force on, lb	595	3.0	2.0	2.2	2.3	2.3
	596	2.7	2.0	1.8	2.3	2.2
	597	2.5	2.5	2.6	2.0	2.1
Safety-actuation force off, lb	595	1.7	2.4	2.3	2.2	2.1
	596	2.0	0.6	1.9	2.0	1.9
	597	1.7	2.2	2.0	1.8	1.9
Firing-pin protrusion, in.	595	0.086	0.087	0.059	0.059	0.058
	596	0.087	0.087	0.060	0.060	0.058
	597	0.088	0.087	0.060	0.059	0.057

[a]At approximately the 500-round point, the modifications listed in Table 2.7-I were assembled. These modifications affected the headspace, firing-pin protrusion, and the firing-pin energy.

Table 2.7-II (Cont'd)

	Launcher Serial No.	No. of Rounds Fired When Data Were Recorded				
		200	400	600[a]	800	1030
Ejector protrusion, in.	595	-	-	0.119	0.119	0.117
	596	-	-	0.163	0.163	0.162
	597	-	-	0.167	0.167	0.167
Firing-pin energy, in.-oz.	595	26.0	26.0	26.0	26.0	26.0
	596	31.5	31.5	30.0	26.0	26.0
	597	26.0	26.0	28.5	[b] -	24.3

[a]At approximately the 500-round point, the modifications listed in Table 2.7-I were assembled. These modifications affected the headspace, firing-pin protrusion, and the firing-pin energy.
[b]Inadvertently omitted.

Table 2.7-III. Velocity Data Recorded During Reliability Test, fps

Launcher No.	Average IV 20 Feet from Muzzle	Variation				Std Dev
		Max	Min	Mean	Extreme	
Cartridge: 40-mm, XM387E4, lot MA-34-5.						
Round Nos.: 20 to 40.						
595	242.2	246.9	234.9	2.6	12.0	3.3
596	241.6	246.6	232.8	2.2	13.8	3.2
597	241.1	246.2	233.2	2.7	13.0	3.4
Round Nos.: 201 to 220.						
595	243.7	247.2	239.2	1.3	8.0	1.8
596	243.1	248.1	238.4	1.8	9.7	2.4
597	241.9	247.9	236.0	2.1	11.9	2.9
Round Nos.: 401 to 420.						
595	243.2	250.2	237.9	2.3	12.3	3.0
596	242.4	250.5	207.7	4.8	42.8	8.9
597	241.7	245.7	232.9	2.3	12.8	3.2
Round Nos.: 601 to 620.						
595	242.8	247.7	238.5	2.0	9.2	2.4
596	244.2	249.3	239.7	2.1	9.6	2.7
597	242.1	246.3	238.3	1.5	8.0	1.9
Round Nos.: 801 to 820.						
595	244.1	248.0	238.5	2.1	9.5	2.6
596	244.5	250.1	237.6	2.7	12.5	3.3
597	243.5	248.0	236.9	2.0	11.1	2.7

Table 2.7-IV. Launcher Dispersion Data Obtained During the Reliability Test[a], inches

Launcher No.	Previous Rounds Fired[a]	Center of Impact Location		Mean Radius	Deviations				Extremes		
					Horizontal		Vertical				
		Hor	Vert		Mean	Std	Mean	Std	Hor Disp	Vert Disp	Spread
595	Before test	- 6.4	+16.9	5.4	2.2	3.0	4.3	5.7	10.1	18.6	19.1
	500	+ 0.6	+14.2	4.3	1.8	2.4	3.6	4.6	7.7	13.3	13.5
	1000	- 0.7	+ 2.8	5.1	1.9	2.5	4.4	5.9	8.7	19.1	19.7
596	Before test	+ 8.9	- 2.1	5.6	2.9	3.8	4.1	5.2	12.7	15.4	19.1
	500	- 0.5	+ 6.6	4.4	2.4	2.8	3.4	4.3	8.3	13.4	13.8
	1000	- 0.2	- 9.9	6.2	2.8	3.4	5.0	6.6	9.7	22.3	23.1
597	Before test	+ 3.4	-12.3	6.7	2.5	3.3	5.9	7.5	11.2	24.4	24.7
	500	+ 0.2	+ 2.4	5.2	3.2	3.9	3.6	4.4	12.4	12.6	15.2
	1000	+13.7	- 5.3	5.4	2.8	3.8	4.0	4.9	13.3	13.7	16.7

[a]The data are an average of three 10-round groups fired at 50-meters range.

Table 2.7-V. Rifle Accuracy Data Obtained During the Reliability Test of the Launcher (100 Meters), inches

Weapon Identification	Center of Impact Location[a]					
	Before Test		After 500 Rds		After 1000 Rds	
	Hor	Vert	Hor	Vert	Hor	Vert
595	0.0	+3.8	+1.7	+3.6	+0.8	+6.4
596	+0.1	-1.5	+0.1	+0.8	-0.5	+1.6
597	-0.5	+2.6	-0.9	+2.6	-0.9	+3.3

[a]The center-of-impact locations are an average of three 10-round groups relative to the aiming point.

Table 2.7-VI. Rifle-Function Data Obtained During the Launcher Reliability Test

Rifle Serial No.	Total Rounds Fired	Malfunction	Remarks
789003	1799	1-FF1	
790915	1805	1-DF	
		1-FF1	
		1-FF	The bolt remained to the rear on the 19th round with the 20th round loose on top of the follower.
791399	1795	1-FJ	

The velocity performance data and the dispersion data of the launchers recorded throughout the reliability test showed no degradation from the firing of the 1000-round test. The bore measurements before and after test for the three reliability test launchers are contained in Appendix I.

The function performance and accuracy data for the M16A1 rifle recorded throughout the reliability test demonstrated that the attachment and subsequent use of the XM203 launcher was not detrimental to the rifle.

2.7.5 Analysis

The technical requirements specified that the launcher be typically capable of firing at least 1000 rounds under normal temperate environmental conditions without incurring broken or unserviceable parts. Deformed tiedown straps occurred with all three launchers fired in the 1000-round reliability phase of the engineering test and the two retainer screws for the tiedown strap were broken. Additionally, the occurrence of a broken barrel release latch pin and unserviceable barrel release latch were experienced with one launcher.

Three failures of the tiedown straps in 3000 rounds (1000 rounds in each of three launchers) gives a lower 95% confidence limit on the true mean-rounds-to failure of 387 rounds. Therefore, the XM203 launcher failed to meet the requirements of the technical characteristics with respect to reliability.

2.8 LOW-TEMPERATURE TEST (-65°F)

2.8.1 Objective

The objective is to determine the functioning performance of the test launchers under conditions of low temperature.

2.8.2 Criteria

It is required that the launcher be capable of being maintained and operated under -25°F temperature conditions and desired that it be capable of the same operation under -65°F conditions.

2.8.3 Method

Three launchers are cleaned, lubricated, and attached to M16A1 rifles. The weapons and ammunition are than subjected to a temperature of -65°F for a minimum of six hours prior to firing. Each launcher is then fired 100 rounds in 20-round groups with a minimum of a 2-hour reconditioning period at temperature between groups.

Each 20-round group is fired as follows:

a. Fire five rounds from the launcher with the rifle loaded, but with the selector set on safe. Then, fire 20 rounds in the semiautomatic mode from the rifle.

b. Fire five rounds from the launcher with the rifle loaded, but with selector set on semiautomatic. Then, fire 20 rounds in the semiautomatic mode from the rifle.

c. Repeat a, but fire the 20 rounds from the rifle in 3- to 5-round bursts.

d. Repeat b, but set the selector on automatic and fire the rifle in 3- to 5-round bursts.

If satisfactory operation occurs at -65°F, no further testing is required under this subtest. If, however, operation is unsatisfactory at -65°F, the test is repeated at -25°F.

2.8.4 Results

The low-temperature test was conducted initially at -65°F; however, due to unsatisfactory operation of the launcher the temperature was raised to -25°F, at which temperature the operation of the launcher was also unsatisfactory. At both the -65°F and -25°F temperatures, punch-outs and partial punch-outs of the primers occurred. Primer fragments collected in the firing- pin well and restricted movement of the firing pin. This, in turn, caused failures to fire with very light indents in the primers. All the failures to fire were fired on the second or third attempts. This condition was classified as a deficiency. At this point the engineering test was suspended and the developer modified the launcher, as follows, to correct the deficiency:

a. New breech plugs were installed which reduced the firing pin protrusion to a range of 0.058 to 0.061 inch. Prior to assembly of the new breech plugs, the firing-pin protrusion ranged from 0.079 to 0.094 inch.

b. The stainless-steel firing pin spring, which was 2-1/4 inches in length, was replaced with a cadmium-plated music wire spring 2 inches in length. This change in springs lowered the firing-pin energy on all except one of the six launchers which were modified (three launchers were modified for use in the temperature conditioning tests and salt-water immersion test and three for the reliability test).

c. New extractors were installed, which according to the developer changed the headspace from 0.089-0.005 inch to 0.085-0.002 inch. However, the headspace on the twelve XM203 launchers originally received for test ranged from 0.081 to 0.089 inch and the headspace on the six launchers after modification ranged from 0.080 to 0.084 inch.

d. A spring-loaded plunger was installed in the barrel extension. This device pushed rearward on the rim of the cartridge case and minimized headspace. The plunger assembly is shown in Figure 2.8-1.

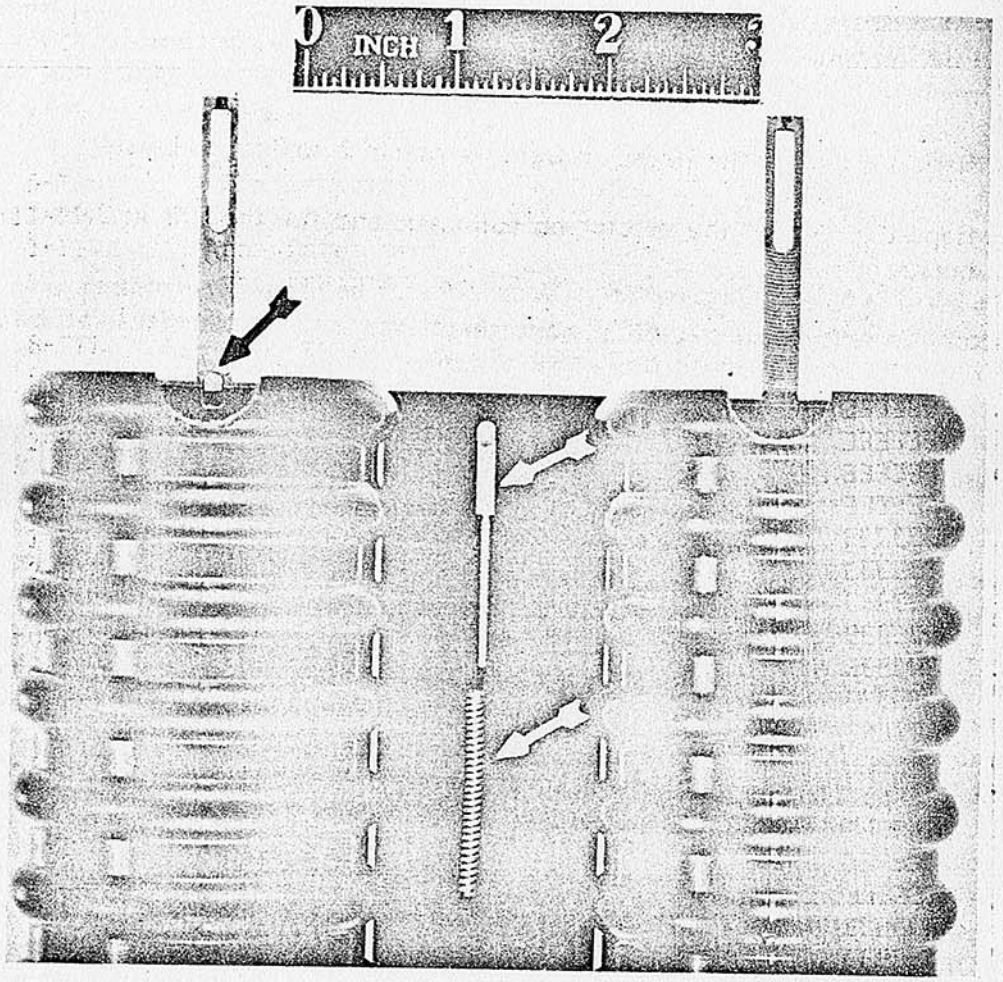

Figure 2.8-1. The Black Arrow Indicates the Spring-Loaded Plunger Which Was Installed in the Barrel Extension. A Plunger and Spring are Shown Between the Barrels (White Arrows). The Barrel on the Right is a Barrel Prior to Modification.

The firing-pin protrusion, firing-pin energy, and headspace measurements on the six modified launchers are given in Table 2.2-II.

On the basis that the operation of the launcher was unsatisfactory at both the -65°F and -25°F temperatures the modified launchers were tested at both temperatures. The function data of the launcher before modification and after modification are given in Tables 2.8-I and 2.8-II.

Table 2.8-I. Launcher Function Data
Prior to Modification

Launcher Serial No.	Malfunctions[a]	Remarks
Temperature: -65°F.		
592	5-FFR 11-PP 1-FFRA	The fragments from the primer punch-outs had collected in the firing pin well which restricted the forward movement of the firing pin and caused the failures to fire.
593	8-FFR 9-PP 1-PPO 2-FFRA	Same remark as with launcher No. 592.
594	1-FFR 1-PP 2-FFRA	Same remark as with launcher No. 592.

A total of 60 rounds of the 100-round test had been fired with each launcher. At this point testing at -65°F was suspended and in accordance with the plan of test the temperature was increased to -25°F.

Temperature: -25°F.		
592	4-FFR 9-PP 4-PPO	The fragments from the primer punch-outs had collected in the firing pin well which restricted the forward movement of the firing pin and caused the failures to fire.
593	4-FFR 16-PP 2-PPO	Same remark as with launcher No. 592.
594	4-FFR 10-PP 4-PPO	Same remark as with launcher No. 592.

A total of 20 rounds of the 100-round test had been fired with each launcher. At this point adverse conditions tests and the reliability test were suspended for modification of the launcher to correct the deficiency relative to the punctured primers. However, to ascertain that the ammunition was not defective and contributing to the primer failure, 50 rounds were fired on each of two M79 launchers using the same lot of ammunition. Results were as follows:

30898	0	No primer malfunctions occurred.

See footnote on following page.

Table 2.8-I (Cont'd)

Launcher Serial No.	Malfunctions[a]	Remarks
30965	0	No primer malfunctions occurred.

[a]Disassembly and inspection of the rounds identified as failures to fire ammunition (FFRA) disclosed the rounds had actually fired with the propellant burning within the case, but failed to generate sufficient pressure to force the projectile out of the case.

Table 2.8-II. Launcher Function Data After Modification

Launcher Serial No.	Malfunctions[a]	Remarks
Temperature: -25°F.		
592	10-FJ 1-PS	The failures to eject were attributed to the reduced headspace on the launcher.
593	1-FFRA	
594	1-FFR	There was a light indent in the primer. The round fired on a second attempt.
Temperature: -65°F.		
592	8-FFRA	
593	9-FFRA	
594	2-PPO 5-FFRA	

[a]See footnote a in Table 2.8-I.

The modifications substantially decreased the occurrence of primer punch-outs at low temperatures in that only two partial punch-outs occurred with the modified launchers at -65°F. Inspection of the firing-pin indents in the primers of the fired cases showed that the firing pin appeared to be cutting the surface of the primer as it impacted. Inspection of the firing-pin configuration showed the contours were within the required specifications of the drawings.

As a result of the modifications to correct the primer punch-outs, two subsequent problems were introduced.

a. Prior to the installation of the new breech plug, the forward travel of the firing pin was stopped by the forward end of the firing-pin well; now the rear of the breech plug stops the forward movement. Inspection after testing at low temperature disclosed looseness of the breech plugs in all three launchers tested.

b. The modified extractor on the launchers reduced headspace to the point that the rims of fired cases lodged between the tip of the extractor and the face of the breech, which caused failures to eject.

The drawings for the 40-mm M118 case specified the rim thickness to be 0.075 to 0.080 inch. A cartridge with a maximum rim thickness in a launcher with headspace less than 0.083 to 0.084 inch experienced failures to eject.

Another problem that was experienced in the low-temperature test (-65°F) was loosening of the handgrip on two of the launchers. The handgrip was reglued to the barrel and did not fail during retest at -65°F.

2.8.5 Analysis

The XM203 grenade launcher met the requirements of the technical characteristics under low-temperature conditions in that no problems were experienced with the modified launchers at -25°F and only two partial punch-outs of the primer occurred at -65°F. However, the operation of the launcher at -65°F was judged to be marginal.

The launcher sight also met the requirements of the technical characteristics in that the sight could be detached, attached, and adjusted for range by an operator wearing arctic mittens.

From the data in Tables 2.8-I and 2.8-II, the functioning (FFRA) of 40-mm ammuniation lot MA-34-5 at -65°F was judged to be unacceptable and classified as a deficiency.

2.9 HIGH-TEMPERATURE TEST (+155°F)

This subtest was conducted with modified XM203 launchers as described in par. 2.8.4.

2.9.1 Objective

The objective is to determine the functioning performance of the test launchers under conditions of high temperature.

2.9.2 Criteria

It is required that the launcher be capable of being maintained and operated under +125°F temperature conditions and desired that it be capable of the same operation under +155°F conditions.

2.9.3 Method

Same as paragraph 2.8, except that testing is conducted at +155°F and, if unsatisfactory performance is encountered, repeat at +125°F.

2.9.4 Results

No problems were experienced in the high temperature test which were attributed to the temperature conditions. Ths only malfunctions experienced were failures to eject which were caused by the modified extractor, and failures of the barrel latch and pin which also occurred in the reliability test under ambient temperature conditions. The function data recorded in the high-temperature test are given in Table. 2.9-I.

Table 2.9-I. Function Data for High-Temperature Test

Launcher Serial No.	Malfunctions	Remarks
592	7-FJ	The failures-to-eject were attributed to the reduced headspace on the modified launchers.
	19-BU	With the occurrence of the first BU the barrel lodged slightly forward of the locked position and the gunner had to force the barrel forward.
593	5-BFL	With each occurrence a screwdriver was used to position the barrel latch. Disassembly and inspection disclosed the latch pin was broken.
594	3-FJ 1-BU	

2.9.5 Analysis

The XM203 grenade launcher met the requirements of the technical characteristics under high-temperature conditions of +125°F and +155°F.

2.10 STATIC DUST TEST

This subtest was conducted with XM203 launchers as originally received.

2.10.1 Objective

The objective is to determine the functioning performance of the test launchers after being subjected to adverse conditions of dust.

2.10.2 Criteria

It is desired that the launcher provide the highest possible degree of functioning reliability, consistent with meeting other requirements, under exposure to adverse environmental conditions of dust.

2.10.3 Method

Three launchers are cleaned, lubricated, and attached to M16A1 rifles. Each launcher is then loaded, the safety placed on the SAFE position, muzzle taped shut, and with 9 rounds of bandoleered ammunition, placed in the dust box and exposed to a blast of dust for 1 minute top side up and for one minute upside down. The dust mixture is specified in MIL-E-5272C (ASG), commonly referred to as silica flour. The mixture is poured at a rate of five pounds per minute through the pour hole while the blower is turned at an approximate handle speed of 60 rpm. Before firing, the shooter removed the tape from the muzzle and attempts to clean the excess dust from the congested areas on the launcher and ammunition by shaking, blowing, and wiping with the bare hands. Each launcher is then fired ten rounds.

2.10.4 Results

All three launchers were operable and no malfunctions or parts breakage occurred. After-firing inspection revealed only small traces of dust within the trigger housings of the launchers.

2.10.5 Analysis

The XM203 grenade launcher met the requirement of the technical characteristics under exposure to adverse environmental conditions of dust.

2.11 DYNAMIC DUST TEST

This subtest was conducted with XM203 launchers as originally received.

2.11.1 Objective

The objective is to determine the functioning performance of the test launchers under conditions of blowing dust.

2.11.2

Same as for paragraph 2.10.2.

2.11.3 Method

Three launchers are cleaned, lubricated, and attached to M16A1 rifles. Each launcher is loaded, the safety placed on the SAFE position and with 14 rounds of ammunition in bandoleers placed in the dynamic-dust chamber. The weapons and ammunition are then exposed to blowing dust which is introduced into the dust chamber at an approximate rate of two pounds per minute. The blower is turned at a handle speed of 60 rpm. Each launcher is then fired 15 rounds employing a rate of fire of approximately one round each ten seconds which makes a total time in the blowing dust of approximately 2-1/2 minutes, provided no problems are encountered. The dust mixture is the same as that described in par. 2.10.3.

2.11.4 Results

All three launchers were operable and no malfunctions or parts breakages occurred. After-firing inspection revealed only small traces of dust within the trigger housings of the launchers.

2.11.5 Analysis

The XM203 grenade launcher met the requirement of the technical characteristics under exposure to adverse environmental conditions of blowing dust.

2.12 MUD TEST

This subtest was conducted with XM203 launchers as originally received.

2.12.1 Objective

The objective is to determine the functioning performance of the test launchers after being subjected to adverse conditions of mud.

2.12.2 Criteria

Same as in par. 2.10.2, except that the adverse condition is mud.

2.12.3 Method

Three launchers are cleaned, lubricated, and attached to M16A1 rifles. Each launcher is loaded, the safety placed on the SAFE position, and with the muzzle taped shut submerged in a mud mixture for 60 seconds. The mud mixture consistes of ten pounds of red clay and two pounds of clean river sand to eight quarts of water. Prior to firing, an attempt is made to clean the weapon by wiping with the bare hands and jarring. An attempt is then made to fire ten rounds. The ammunition is not subjected to the mud except for the initial round which is chambered in the launcher.

2.12.4 Results

The function data recorded during the mud test are given in Table 2.12-I.

Table 2.12-I. Function Data for Mud Test

Launcher Serial No.	Malfunctions	Remarks
Test: Mud		
34	1-FFO 1-PP	The malfunction of the follower was cleared by forcing the firing pin to the rear with a small punch through the firing-pin hole in the breech-face.
35	1-FFR	There was a light indent in the primer. The cartridge fired on a second attempt.
36	0	

Failure of the follower to override the cocking lever was attributed to the design of the launcher rather than the conditions of the mud test, as inspection of the launcher after test disclosed only slight traces of mud within the trigger-housing. Similar occurrences of failures of the follower to override the cocking lever were experienced with launchers in the reliability test under nonadverse conditions. Modifications were applied to the follower assembly and cocking lever and was tested as described in par. 2.18.

The primer punch-out was attributed to excessive headspace and firing-pin protrusion which was corrected by modifications as described in par. 2.8.4.

The failure to fire was attributed to marginal firing-pin energy as discussed in par. 2.2.5.

2.12.5 Analysis

The XM203 grenade launcher met the requirement of the technical characteristics under exposure to adverse environmental conditions of mud.

2.13 WATER SPRAY TEST

This subtest was conducted with XM203 launchers as originally received.

2.13.1 Objective

The objective is to determine the effect of simulated heavy rainfall on the functioning performance of the test launchers.

2.13.2 Criteria

Same as for paragraph 2.10.2, except that the adverse condition is simulated heavy rain.

2.13.3 Method

Three launchers are cleaned, lubricated, and attached to M16A1 rifles. Each launcher is then subjected to a spray of water from special spray nozzles positioned above the weapon. The spray of water falls at a rate of approximately 0.4 inch per minute or 24 ± 3 inches per hour. The average air and water temperatures throughout the test are recorded. While being subjected to the water spray, the launchers are fired as outlined in Table 2.13-I. The ammunition is not subjected to the water spray except for the initial round of each phase which is chamber in the launchers.

Table 2.13-I. Firing Sequence for Water-Spray Test

Test Condition	Exposure Time, min	Cumulative Exposure Time, min	Rain, in.	Cumulative Rain in.
Weapon Horizontal				
Launcher empty, breech closed	5	5	2.0	2.0
Loaded	5	10	2.0	4.0
Fired 5 rounds	4	14	1.6	5.6
Launcher empty, breech closed	5	19	2.0	7.6
Loaded	5	24	2.0	9.6
Fire 5 rounds	4	28	1.6	11.2
Weapon Muzzle Up				
Launcher empty, breech closed	5	33	2.0	13.2
Loaded	5	38	2.0	15.2
Fire 5 rounds	4	42	1.6	16.8
Launcher empty, breech closed	5	47	2.0	18.8
Loaded	5	52	2.0	20.8
Fire 5 rounds	4	56	1.6	22.4
Weapon Muzzle Down				
Launcher empty, breech closed	5	61	2.0	24.4
Loaded	5	66	2.0	26.4
Fire 5 rounds	4	70	1.6	28.0
Launcher empty, breech closed	5	75	2.0	30.0
Loaded	5	80	2.0	32.0
Fire 5 rounds	4	84	1.6	-

2.13.4 Results

All three launchers were operable and no malfunctions or parts breakage occurred. The average air and water temperature throughout the test were +80°F and +65°F, respectively.

2.13.5 Analysis

The XM203 grenade launcher met the requirement of the technical characteristics under exposure to adverse environmental conditions of simulated heavy rainfall.

2.14 UNLUBRICATED TEST

This subtest was conducted with XM203 launchers as originally received.

2.14.1 Objective

The objective is to determine the functioning performance of the test launchers when in an unlubricated condition.

2.14.2 Criteria

No criteria or stated requirements exist for the unlubricated test. However, the launcher attachment is to be compatible with the M16A1 rifle which functions in an unlubricated condition. The launcher shall be capable of functioning with the same reliability while in an unlubricated condition.

2.14.3 Method

Three launchers are cleaned with quick-drying solvent (PS-661-B), not lubricated, and attached to M16A1 rifles. Each launcher is then fired ten rounds.

2.14.4 Results

All three launchers were operable and no malfunctions or parts breakage occurred.

2.14.5 Analysis

The XM102 launcher functioned reliably in an unlubricated condition; therefore, the launcher met the requirement of being compatible with the M16A1 rifle.

2.15 SALT-WATER IMMERSION TEST

This subtest was conducted with modified XM203 launchers as described in par. 2.8.4.

2.15.1 Objective

The objective is to determine the deleterious effects of immersion in salt water on weapon performance.

2.15.2 Criteria

Same as in paragraph 2.10.2, except that the adverse condition is immersion in salt water.

2.15.3 Method

Three launchers are cleaned and lubricated. Each launcher is then submerged in a salt-water solution for 60 seconds. The solution is composed of 20 per cent salt to 80 per cent water, by weight. The salt contains no more than 0.1 per cent sodium iodide nor more than 0.2 per cent impurities. After removal from the salt water, each launcher is attached to an M16A1 rifle, fired 5 rounds, and then exposed to the heat and humidity conditions as shown in Table 2.15-I for a period of ten days. Within the 10-day period, additional 5-round complements are fired on the third, fifth, eighth, and tenth days without the aid of cleaning or additional lubricant. The ammunition is not immersed in the salt-water solution.

Table 2.15-I. Temperature - Humidity Storage Schedule

No. Hrs	Temperature, °F	Relative Humidity
2	Increase to +105	95 ± 2
16	Maintain at +105 ± 3	90 to 95
2	Decrease +105 to 70	95 ± 2
4	Maintain at +70 ± 3	95 ± 2

2.15.4 Results

The function data recorded during the salt-water immersion test are given in Table 2.15-II.

Table 2.15-II. Results of Salt-Water Immersion Test

Day of Test	Malfunctions Launcher Serial No. 592	593	594
1	0	0	0
3	2-FJ	2-FJ	0
5	1-FJ	1-FFO	0
8	1-FJ	1-FFO	0
10	1-FJ	1-FFO	0

The occurrence of the failures to eject was attributed to the modified extractor as discussed in par. 2.8.4. The failures of the follower to override the cocking lever which occurred with the first round fired on each day with launcher No. 593 was attributed to the rusted condition of the guide rods on the follower assembly. This rusted condition was probably due to the surface coating of the guide rods on this particular follower assembly and could probably have been avoided if lubricant were freely applied to the follower on a daily basis.

After-test inspection of the launchers disclosed the parts within the housings of the launchers were relatively free from rust, except for the follower assembly in launcher No. 593. The springs and guide rods showed a heavy accumulation of rust. The cartridge retainers within the chambers of all three launchers were 50% rust covered with etching and pitting.

The tiedown straps were 75% rust-covered with etching and pitting present. Additionally, the triggers, trigger guards, safeties, and battle sights were 15 to 25% rust-covered with some etching and pitting. The part showing the most rust was the range selector on the primary sight, which was 95% covered with surface rust.

2.15.5 Analysis

Two of the three XM203 grenade launchers subjected to the salt-water immersion test did not provide the highest possible degree of functioning reliability due to failures to eject and failures of the follower to override. However, the occurrence of failures to eject were caused by the modified extractor, and the modified follower assembly which was tested by the developer (par. 2.18) corrected the malfunction of failure of the follower to override the cocking lever. The modified follower assembly was tested only under nonadverse range conditions; however, one of the modifications was the replacement of the 1/16-inch diameter return springs with 1/8-inch diameter springs, which supplied additional energy to the follower. This modification, along with daily field maintenance, should provide the functioning reliability required.

2.16 RUGGEDNESS TEST

This subtest was conducted with modified XM203 launchers as described in par. 2.8.4.

2.16.1 Objective

The objective is to determine the ability of the test launchers and sights to withstand being dropped on hard-packed earth.

2.16.2 Criteria

Criteria are as follow:

a. The sighting system for the launcher, when attached to the weapon - launcher combination, shall withstand the impact of dropping the weapon butt-downward from a height of three feet on a hard-packed earth. The sights and mountings shall remain in serviceable condition after three such drops, so that the range and deflection obtained in firing correspond correctly to the respective range and deflection settings which are applied to the sight.

b. The unloaded launcher, when attached to the point-fire weapon, shall withstand dropping on hard-packed earth from a height of three feet, so that the weapon - launcher combination impacts muzzle downward, or butt downward, or on either side, or on the top or bottom. After one drop in each of these six positions, the launcher shall be capable of being safely fired.

2.16.3 Method

One launcher is assembled to an M16A1 rifle and dropped butt downward from a three-foot height on hard-packed earth. Prior to being dropped the launcher sight is adjusted to the 100-meter range and a 10-round group fired. After the final drop, the range setting is checked and reset if necessary and a second 10-round group is fired.

The same weapon is dropped on hard-packed earth from a height of three feet, to impact muzzle downward, butt downward, on each side, on the top, and on the bottom. After each of the drops (six total), the launcher is fired three rounds. The launcher and rifle are loaded with dummy rounds during the drops.

2.16.4 Results

The sights and mountings withstood the impact of dropping the weapon butt downward and the resulting change in group center of impact was less than the round-to-round variation of the impacts that comprised the groups.

In the second phase of the ruggedness test, no unserviceable or broken parts occurred and the launcher was capable of being safely fired after each of the drops.

2.16.5 Analysis

The sight system and the mounting of the XM203 launcher met the requirements of the technical characteristics with respect to the requirements for ruggedness.

2.17 SOLVENTS AND LUBRICANTS COMPATIBILITY

2.17.1 Objective

The objective is to determine the chemical compatibility of the test launchers with various chemical compounds used as cleaners, lubricants, and insecticides.

2.17.2 Criteria

The durability and functional operation of the test launchers must be degraded by reaction of the design material to various chemicals.

2.17.3 Method

All launchers to be tested are cleaned and no lubricant is applied. One launcher is then immersed into one of the chemicals listed below for a 10-minute period on each of four days and stored at ambient temperature. Inspection of each launcher is made prior to each day's immersion, particularly components made of rubber, plastic, or synthetic materials. The following chemicals are used:

a. Bore cleaner (MIL-L-372-B).

b. VV-L-800 lubricant.

c. Gasoline.

d. Kerosene.

e. Diesel fuel.

f. JP-4 jet fuel.

g. Insect repellent (FSN 6840-558-0918).

h. MIL-L-14107 lubricant.

Note: PS-661-B cleaning solvent and MIL-L-46000A lubricant are not included inasmuch as the launchers are subjected to these chemicals throughout the test.

2.17.4 Results

With the exception of insect repellent, none of the chemicals had any detrimental effects on the launchers. The insect repellent dissolved the compound used to glue the handgrip on the barrel of the launcher. At the end of the test the handguard was not loose, but the compound had seeped from both ends; therefore, it would only a matter of time until the handguard loosened.

2.17.5 Analysis

The detrimental effects of the insect repellent on the compound used to glue the handgrip to the barrel on the launcher was classified as a shortcoming.

2.18 ADDITIONAL RELIABILITY FIRINGS

2.18.1 Objectives

On 24 June 1969 the results of the engineering and service tests and an evaluation of the XM203 launcher in SEA were presented at an In-Process Review meeting at USAWECOM. An outcome of the meeting was that three deficiencies which had been disclosed during testing remained uncorrected, all of which would serve as a bar to type classification of the launcher (Reference 3).

The three deficiencies were as follow:

a. The tiedown straps which assembled the launcher to the rifle deformed and eventually broke. Additionally, the deformation allowed the mounting screws to loosen and in three instances during the 1000-round reliability phase of the engineering test one of the two mounting screws sheared.

b. Occasionally the follower failed to override the cocking lever. When this occurred the cocking lever protruded between the barrel extension and the follower and prevented closure of the barrel. This put the launcher temporarily out of action.

c. On two occasions during service tests the guide rods on the follower assembly broke. This put the launcher out of action until the assembly could be replaced.

The developer proposed modifications as follows for correction of the three deficiencies.

a. Tiedown Strap. The tiedown strap would be heat treated for additional strength and the present flat head mounting screws would be replaced with fillister head screws. Additionally, the head of the fillister screws would be drilled to provide use of safety wire for added prevention against the screw loosening during firing.

b. Failure of the Follower to Override the Cocking Lever and Breakage of the Follower Assembly. The configuration of the follower would be changed. The 1/16-inch-diamter guide rods on the assembly would be replaced with 1/8-inch-diamter rods. Additionally, the 1/16-inch-diameter helical compression springs would be replaced with 1/8-inch-diameter springs, which would increase the energy of the follower in overriding the cocking lever. As further assurance against the cocking lever inadvertently being forced up between the barrel extension and the follower, a flat surface would be ground on the front edge of the cocking lever to replace the curved surface. A side and top view of the modified follower assembly is shown in Figures 2.18-1 and 2.18-2.

As a result, additional firings were conducted to determine if the proposed modifications would correct the three existing deficiencies.

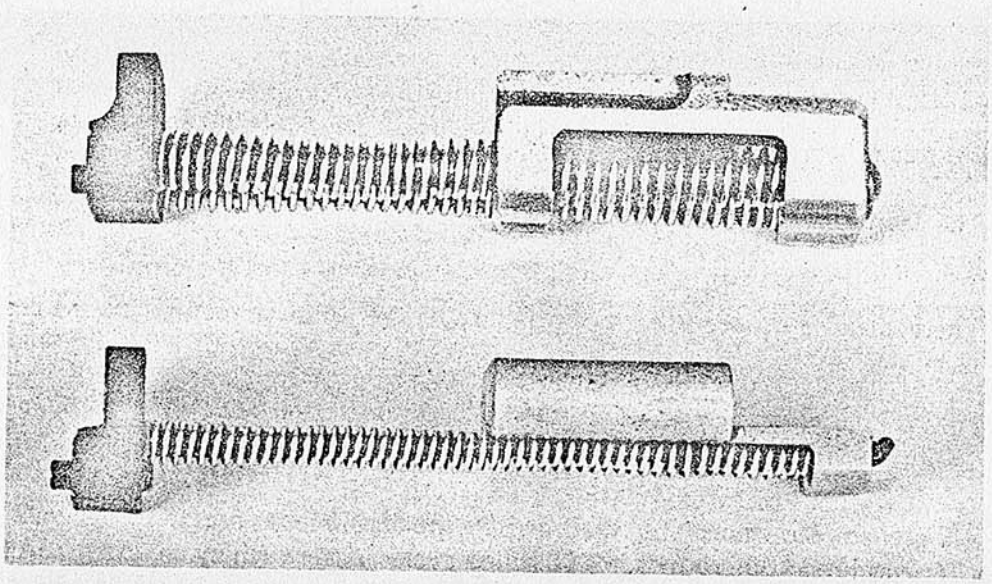

Figure 2.18-1: Side View of The Modified Follower Assembly (TOP) and the Original Assembly (BOTTOM).

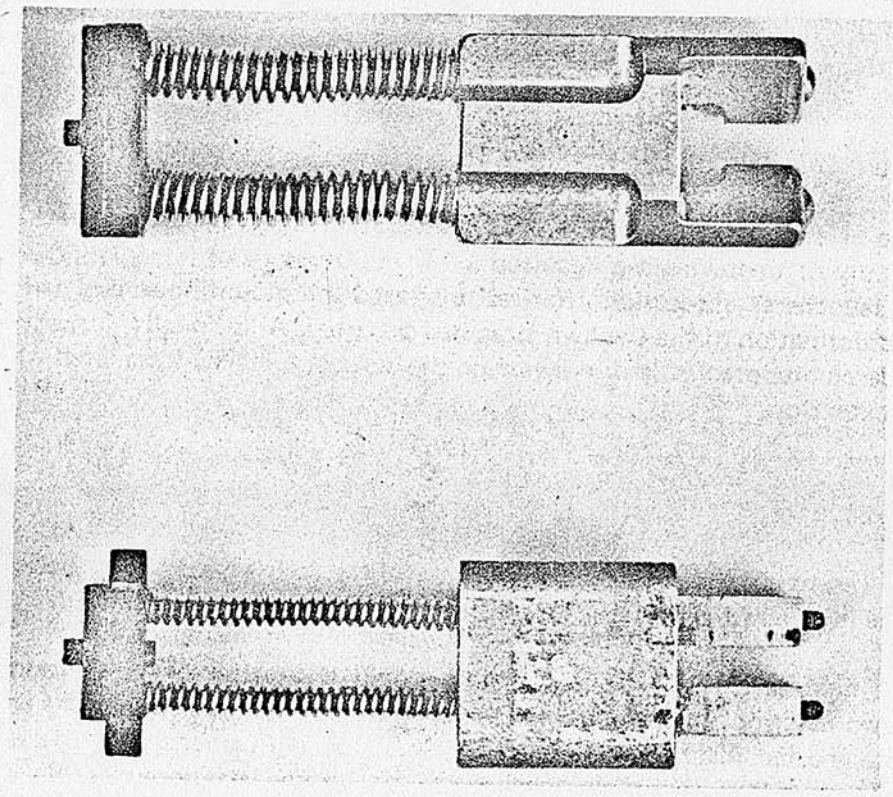

Figure 2.18-2: Top View of the Modified Follower Assembly (TOP) and the Original Assembly (BOTTOM).

2.18.2 Criteria

The criteria are as follows:

a. The launcher shall be capable of firing at least 1000 rounds without incurring broken or unserviceable parts.

b. There shall be no occurrence of a failure of the follower to override the cocking lever.

2.18.3 Method

Four XM203 grenade launchers were modified by the developer as proposed in par. 2.18.1. Each launcher was fired 1500 rounds in 250-round cycles. After each cycle, the M16A1 rifle to which the launcher was attached, was fired 200 rounds in alternate 20-round cycles of 3- to 5-round bursts and 20-round bursts. The launcher was then disassembled, wiped clean of lubricant, inspected, lubricated, and reassembled.

The additional testing was conducted by the developer and monitored by representatives from the Project Manager's Office (AMCPM-RS) and Materiel Test Directorate (STEAP-MT-TI).

2.18.4 Results

No occurrence of a failure of the follower to override the cocking lever, or breakage of the follower assembly or tiedown strap occurred in the 6000 rounds of firing (1500 rounds from each of three launchers). Inspection after test disclosed the mounting screws had remained tight and no deformation of the tiedown strap had occurred. Additionally, inspection of the barrel release latch disclosed little or no wear on the contact surface of the latch which bears on the barrel extension.

2.18.5 Analysis

Based on the results of the foregoing firings, the three following existing deficiencies as reported at the in-process-review meeting are considered to have been corrected.

a. The heat treated tiedown straps withstood the recoil of 1500 rounds of firing. Previously, the straps failed after 400 to 500 rounds of firing in the engineering test. The technical characteristics required that the launcher be capable of firing 1000 rounds without the occurrence of broken or unserviceable parts; the heat-treated tiedown straps were serviceable after 1500 rounds of use.

b. Modification of the follower assembly, with increased diameter guide rods and larger diameter springs (with increased spring rate), eliminated breakage of the assembly and the occurrence of the failures of the follower to override the cocking lever in 6000 rounds of firings, 1500 rounds in each of four launchers.

c. Additionally, the correction of the enlongation and breakage of the tiedown strap also was considered to have corrected the shortcoming relative to breakage of the barrel release latch which occurred with the reliability test and adverse conditions test launchers.

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
Purpose:			
The launcher shall be suitable primarily for attachment to the following point-fire weapons: a. Rifle, 5.56-mm, M16/M16A1. b. Submachine gun, 5.56-mm, XM177/XM177E2.	A.1	The XM203 grenade launcher was readily attachable to the M16/M16A1 rifle. Attachment to the XM177E2 submachine gun required removal of the front sight and flash suppressor from the submachine gun.	2.1
It is desired that consideration be given to launcher designs which could, without major modification, be attached and used effectively with other shoulder	A.2	Not within the scope of the engineering test.	

[a]The requirements are the technical characteristics for 40-mm grenade launcher attachment for rifles which are technical characteristics stated in terms of the Army Approved Small Development Requirement (SDR) for a 40-MM Detachable Grenade Launcher for Individual Weapons. The technical characteristics are approved by the minutes of formal in-process review meeting of 18 October 1967 on the Grenade Launcher Attachment for Rifles Program held at AMCPM-RS.

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
weapons such as the M14 rifle, M2 carbine, or shoulder weapons of developmental type. This consideration is secondary, and is not to interfere with the primary purpose of providing an effective grenade - launcher attachment for the M16/M16A1 rifle and the XM177/XM177E2 submachine gun.			
Ammunition Type Utilized:			
It is required that the launcher be suitable for safe and effective firing of the various types of 40-mm ammunition, listed below, and to any other rounds having exterior configuration and interior ballistic properties	B.1	The launcher was suitable for safe and effective firing of the various types of 40-mm ammunitions.	2.3

interior ballistic properties

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
substantially the same as any of these current types: a. Cartridge, HE, 40-mm, M406. b. Cartridge, practice, 40-mm, M407. c. Cartridge, proof, 40-mm, XM387E3. d. Cartridge, multiple-projectile, 40-mm, XM576. e. Cartridge, white-star cluster, 40-mm, XM585. f. Cartridge, white-star parachute, 40-mm, XM583.			

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
The launcher shall provide sufficient firing-pin energy to assure reliable functioning of the primer in the aforementioned types of ammunition.	B.2	The firing-pin energy requirement was believed to be marginally met, in that, during test the occurrence of three failures to fire with light firing pin indents were experienced. The originally proposed requirements specified a minimum energy level of 30.0 in.-oz. The energy level of the three launchers which experienced the failures to fire were 23.5, 24.3, and 26.0 in.-oz.	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
It is required that the launcher be so designed as to prevent the inadvertent chambering and firing of 40-mm high-velocity ammunition, such as the M384, which is intended for use in the M75 or other high-velocity 40-mm launchers.	B.3	The 40-mm high-velocity ammunition could not be chambered and fired in the XM203 grenade launcher.	2.3
Type of Operation:			
A multishot, semiautomatic launcher is desired, provided that characteristics of weight, bulk, complexity, reliability of operation, and ease	C.1	Not within the scope of the engineering test.	-

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
of maintenance are not seriously compromised by the capability of semiautomatic fire. A launcher of multishot design must be capable of being loaded, carried, and fired as a single-shot weapon when the cartridge magazine is detached.			
A single-shot launcher will be acceptable, provided the stated performance requirements are met.	C.2	The launcher was single-shot in design and was determined to be acceptable.	2.2
Recoil:			
The firing of the launcher, when attached to the point-fire weapons to which it is adapted,	D	The recoil energy of the XM203 launcher when attached to the rifle or submachine gun was less than that produced by	2.3

it is adapted,

gun was less than
that produced by

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
shall not produce a free-recoil energy greater than that produced by the M79 launcher when firing the same types of ammunition. The configuration of the launcher shall be such as to permit firing from any of the standard firing positions without excessive discomfort and without risk of injury to the firer in consequence of recoil.		the M79 launcher. In the opinion of the riflemen, the configuration was such to permit firing without excessive discomfort or injury to the firer in consequence of recoil.	
Range, Accuracy, and Lethality:			
The average effective range of the launcher shall be at least 95	E	The effective range of the XM203 launcher was	2.4 2.5

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
per cent of that obtained with the M79 launcher firing the same type and lot of ammunition. The launcher shall, with aimed fire using the M406 cartridge, have such accuracy at all useable ranges up to 200 meters that one range probable error shall be less than 14 feet and one deflection probable error shall be less than three feet. The delivered projectile shall produce the same lethal effect as a similar projectile fired from the M79 launcher.		equivalent to the M79 launcher and the accuracy was such that one range probable error was less than 14 feet (4.3 meters) and one deflection probable error was less than three feet (0.9 meter). The ammunition used in XM203 launcher was the same ammunition used in the M79; therefore, the delivered projectile from the XM203 would produce the same lethal effect as those fired from the M79 launcher.	
Reaction Time and Rate of Fire:			
The average time required to fire the first grenade round,	F.1	Not within the scope of the engineering test.	

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
required to fire the first grenade round.		Not within the scope of the engineering test.	
beginning with the loaded launcher-equipped weapon in any safe carrying position, shall not exceed by more than one second the time required to fire the first round from the M79 launcher in a comparable manner.			
The sequence of operation for reloading and firing the launcher shall not require appreciable greater dexterity, or more training to perform, than the comparable operations for the M79 launcher. The average time to load, measured in a series of five rounds each,	F.2	Not within the scope of the engineering test.	

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
shall be no more than 110% of the time to load the M79 launcher, and the average sustained rate of fire (both pointed and aimed) measured in series of five rounds each, shall be least 90 per cent of the average rate achieved with the M79 launcher, by operators of comparable proficiency, firing the same type of ammunition, from any and all of the standard firing positions (prone, sitting, squatting, kneeling, standing, and foxhole-supported).			
Simplicity of Design and Maintenance:			
The launcher shall be as simple as possible	G.1	The launcher was simple in design and	2.2 and 2.7 thru 2.17

as simple as possible | G.1 | The launcher was simple in design and | 2.2 and 2.1 thru 2.1.5

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
in design and construction, consistent with meeting the other stated requirements. The operations required for care and maintenance shall be in general not more difficult or time-consuming than the comparable operations required by the M79. The launcher and launcher sight assembled to the rifle shall be compatible with cleaning and maintenance requirements of the rifle.		construction and the operations for care and maintenance were not more difficult nor time-consuming than comparable operations for the M79 launcher. The launcher and sight which assembled to the launcher were compatible with the cleaning and maintenance requirements of the rifle.	
It is desired that the number of parts in the launcher and sight combined be not more than 50	G.2	The total number of parts was 110, of which 28 were contained in the primary sight, 22	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
per cent of the number in the M79 launcher with sight. It is required that the number of parts in the launcher and sight combined not exceed the number in the M79 launcher with sight.		in the cover assembly and the remainder in the receiver. The total number of parts in the M79 launcher was 106.	
It is desired that no special tools be required for the assembly and/or disassembly associated with operator maintenance. It is mandatory that no more than one special tool be required for operator maintenance, and that this tool weigh not more than	G.3	No special tools other than the cleaning equipment for the M79 launcher were required for operator maintenance and no special tools were required for attachment or removal, and organizational maintenance of the launcher.	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
0.25 pound. It is required that not more than one additional special tool be required by armorer-type personnel at orgainizational level for the attachment, removal, and orgainizational maintenance of the launcher.			
Maximum use of standard parts shall be made throughout the design to minimize maintenance.	G.4	Not within he scope of the engineering test.	
Size, Configuration, and Effect on Point-Fire Zeroing:			
The launcher shall be of minimum length consistent with meeting other requirements. It is required that the	H.1	The launcher was of such length that the over-all length of the assembled rifle/ launcher combination did not exceed the	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
over-all length of the assembled weapon/launcher combination, with launcher loaded and prepared for firing, not exceed the length of the M16A1 and the XM177E2; it is desired that the length not exceed the XM177.		over-all length of the M16/M16A1 rifle or the XM177E2 and M177 submachine guns.	
The configuration of the launcher shall be such that, when mounted on the point-fire weapon, it does not interfere with assuming or firing from the normal standard positions of prone, kneeling, squatting, sitting, standing, or foxhole-supported.	H.2	Not within the scope of the engineering test.	
The configuration and mounting arrangements of the	H.3	No tests were conducted in the engineering test to	2.2

engine[illegible]ng test to

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
launcher and sights shall be such as to minimize catching in brush, vines, other vegetation, equipment, or clothing when the weapon - launcher combination is carried and used in a normal manner, by normally clothed and combat-equipped soldiers, operating in terrain where heavy vegetation prevails. The handlability of the weapon - launcher combination will be such as to maximize ease of loading, operation, and transportability by the individual soldier.		determine if the design of the launcher was such to minimize catching on brush or vines; however, it was found that the primary sight was susceptible to catching on clothes and equipment.	
The attachment of the launcher to the point-fire weapon and	H.4	The attachment of the launcher to the M16A1 rifle and the	2.6 2.7

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
the subsequent firing thereof, shall not cause a shift in the center of impact of the point-fire weapon which exceeds two mils in deflection and/or two mils in elevation, when the weapon is fired either from the prone position with elbows supported, or from a foxhole position with the weapon supported.		subsequent firing did not cause a shift in the center of impact of the M16A1 rifle which exceeded two mils in deflection or two mils in elevation.	
Weight:			
The weight of the assembled weapon - launcher combination (without ammunition), including the launcher sight, shall not exceed the weight of the empty point-fire weapon alone by more than three pounds.	I	The attachment of the launcher to the M16A1 rifle increased the over-all weight of the weapon 2.9 lbs.	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
Firing Mechanism, Safety and Sights:			
The firing mechanism shall be so located as to provide for convenient operation in any firing position. In particular it must permit firing the launcher from a prone position with both elbows supported on the ground.	J.1	Not within the scope of the engineering test.	-
The weapon shall be secure against accidental discharge by inadvertent pressure on the trigger and/or by rough handling when carried loaded and in SAFE position. The firing mechanism may be of a type which is carried uncocked (as in a double-action	J.2	The launcher was secure against accidential discharge by inadvertent pressure on the trigger or rough handling when carried loaded and with the safety in the ON position. The safety was the type that blocked movement of the trigger which, in turn, blocked the	2.3

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
handgun) in which case the safety may be of a type which positively blocks movement of either the trigger and/or the sear, and/or the hammer, and/or the firing pin. If the firing mechanism employed is a type which is carried in cocked position, then the safety shall be of a type which positively blocks movement of the hammer and/or the firing pin so as to prevent accidental discharge by pressure on the trigger or by a blow struck on the weapon, when the safety is engaged.		forward movement of the firing pin.	
The safety (or safeties) shall be so designed and located as	J.3	The safety was designed and located to be easily identifiable, quickly and	2.3 2.8

quick and

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
to be easily identifiable, quickly and conveniently disengaged at will, and reasonably secure against accidental disengagement. The operation shall be so arranged that the SAFE and FIRE positions of the safety can be quickly and easily distinguished, both by sight and by touch while using necessary protective clothing to include temperate winter clothing.		conveniently engaged, and was reasonably secure against accidential disengagement. The SAFE and FIRE positions of the safety were easily distinguished both by sight and touch.	
The weapon shall be secure against accidental discharge by a firer assuming any of the standard firing positions rapidly, with the	J.4	Based on the results of dropping the weapon butt downward from a height of 5 feet, the weapon was judged to be secure	2.3

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
weapon loaded and the safety disengaged (in FIRE position). This condition shall be considered to be met if the launcher withstands, without firing, a vertical free drop of the weapon-launcher assembly butt-downward, from a height of five feet, impacting on a surface of hard-packed earth.		against accidental discharge by a firer assuming any of the standard firing positions rapidly with the weapon loaded and the safety disengaged.	
Sighting System:			
It is required that the launcher be accompanied by a fully adjustable sight (or sights) incorporating the following features:	K.1		

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
a. Permits convenient firing of the launcher at all ranges from 30 meters to approximately 400 meters from any of the standard firing positions (prone, sitting, squatting, kneeling, standing or foxhole-supported).		Not within the scope of the engineering test.	
b. Permits zeroing of the launcher in both elevation and deflection, independently of the scale for adjustment of range.		The primary sight permitted zeroing of the launcher in both elevation and deflection, independent of the scale for adjustment of range.	2.2
c. Provides precision and accuracy of adjustment		The precision and accuracy of the adjustments on the sight was not equal	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
substantially equal to that of the sights on the M79 launcher.		to that of the sights on the M79 launcher.	
d. Attaches to and detaches from either the launcher or the point-fire weapon for convenient carrying, and is conveniently attachable, detachable, and adjustable for range by an operator wearing protective clothing, to include temperate-zone winter clothing.		The sight conventiently attached and detached from the carrying handle of M16A1 rifle and could be adjusted for range by an operator wearing protective clothing.	2.2 2.8
e. Provides a configuration and mounting arrangement which		The configuration of the sight was such that it would catch on clothing and	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
risk of catching on brush, vines grass, clothing, or items of equipment normally carried by the combat-equipped soldier.			
f. Withstands rough handling to the maximum degree which is consistent with meeting the other requirements.		The sight withstood the impact of the weapon being dropped from a 3-foot height onto hard-packed earth.	2.16
g. Does not change adjustment in elevation or deflection in consequence of recoil from firing either the launcher or the point-fire weapon to which it is attached.		The sight did not change adjustment in elevation or deflection with the recoil from firing the launcher or rifle to which it was attached.	2.2 2.7 2.8 2.9

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
It is desired that the launcher sighting system also incorporate the following features:	K.2		
a. Permit convenient aiming and firing of the weapon from either the left shoulder or the right shoulder at the firer's option, using the principal sight.		Not within the scope of the engineering test.	-
b. Provide a "battle sight" for the launcher, centrally located atop the point-fire weapon, so designed and constructed as to cause no significant		A battle sight was provided which mounted on top of the cover for the launcher. The battle sight was semipermanently attached with two screws and was no inconvenience to	2.2 2.5

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
inconvenience if left in place at all times when the launcher is assembled to the point-fire weapon. The "battle sight" shall provide for firing elevations up to approximately 16 degrees so as to permit accurate aiming for ranges of 50, 100, 150, 200, and 250 meters, when firing the 40-mm M406 cartridge. The battle sight may be semipermanently attached to the point-fire weapon at the same time as the grenade launcher, and left in place until the launcher is removed. It is,		the employment of the rifle, if left in position at all times. The battle sight was graduated in 50-meter increments out to 250-meters range and provided reasonable accurate aiming at all ranges, except 250 meters. The center of impact of the grenades when using the 250-meter graduation was 230 meters and if the elevation of the weapon was increased to impact the grenades at 250 meters, the muzzle suppressor on the rifle blocked the line of sight.	

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
therefore, imparative that the design, configuration, and method of attaching the "battle sight" be such as not to interfere with the normal carrying or operation of the point-fire weapon. It is desirable that no modification whatsoever be required on the point-fire weapon for attachment of the battle sight, and it is mandatory that no part be modified or replaced except the handguard of the point-fire weapon. The object of the "battle sight" is to provide constantly and immediately available means of			

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
aiming the launcher, with reasonable accuracy, over the ranges at which the launcher is most commonly employed. The range, precision, and fineness of adjustment required are less than those of the principal launcher sight, but shall be as good as practicable, consistent with the other characteristics desired.			
Method of Attachment:			
It is required that the launcher be conveniently attachable to (and detachable from) the point-fire weapon by armorer-type personnel at	L.1	The launcher was conveniently attached and detached from the the M16A1 rifle; however, similar operations with the XM177E2 submachine	2.2

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
orgainizational level. It is not desired that the launcher be detachable by the individual soldier-operator in the field.		gun required removal of the front sight and flash suppressor which is above organizational level maintenance.	
It is required that the attaching members be so designed and constructed as to provide an adequate, thermal barrier between the point-fire weapon and the launcher. The temperature of the chamber area on the launcher must remain safely below the cook-off temperature of the 40-mm M406 cartridge when a complement of 400	L.2	The firing of 400 rounds from the M16A1 rifle in a 4-minute period did not produce temperatures in the chamber of the launcher which would be above the safe level with reguard to cook-off of an M406 cartridge.	2.3

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
rounds of 5.56-mm point-fire ammunition is fired within a 4-minute period in the M16/ M16A1 rifle to which the launcher is attached.			
Transportability and Ruggedness:			
The unloaded launcher, when attached to the point-fire weapon, shall withstand dropping on hard-packed earth from a height of three feet, so that the weapon - launcher combination impacts muzzle downward, or butt-downward, or on	M.1	The launcher could be safely fired after being dropped in each of the six positions:	2.16

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
either side, or on the top or bottom. After one drop in each of these six positions, the launcher and its attaching memebers shall be capable of being safely fired.			
The sighting system for the launcher, when attached to the weapon - launcher combination, shall withstand the impact of dropping the weapon butt-downward from a height of three feet on hard-packed earth. The sights and their attaching members shall remain in serviceable condition after three such	M.2	The sight system for the launcher withstood the impact of the weapon being dropped butt-downward and remained in a serviceable condition.	2.16

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
drops, so that the range and deflection obtained in firing correspond correctly to the respective range and deflection settings which are applied to the sight.			
System Reliability:			
It is required that the launcher have a probability of at least 0.95 of completing a firing mission. In this context, a firing mission consists of the expenditure of ten rounds of M406 or M407 grenade ammunition, fired within a two-minute period, by a trained operator,	N.1	Not within the scope of the engineering test.	-

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
beginning with the weapon loaded and locked. In event a mission fails to be completed because of misfires or other such malfunctions which might be either weapon-induced or ammunition-induced, careful investigation will be made to assure that the cause of the malfunction is correctly assigned. Ammunition-induced malfunctions will not be charged against the reliability record of the launcher. Failure of high-explosive or pyrotechnic projectiles to function in the intended manner after launching shall not be ascribed to the launcher.			

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
It is desired that the launcher have a probability of at 0.99 of completing a firing mission, as defined and described above.	N.2	Not within the scope of the engineering test.	-
It is desired that the reliability of the launcher after limited and/or extended storage be equal to the reliability of the point-fire weapon to which the launcher is attached, after comparable periods and conditions of storage. Such degradation of reliability as may result from limited storage or extended storage must be correctable by orgainizational maintenance respectively.	N.3	The reliability of the launcher after limited storage as encountered in the reliability, high and low temperature, and salt-water immersion tests were judged equal to that of the M16A1 rifle.	2.7 2.8 2.9 2.15

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
It is required that the launcher be typically capable of firing at least 1000 rounds, under normal temperate environmental conditions without incurring broken or unserviceable parts.	N.4	Deformed tiedown straps occurred with all three launchers fired in the reliability test and two retainer screws for the tiedown strap were broken. Additionally, a broken barrel release latch were experienced with one of the reliability test launchers. However, in the additional firings conducted by the developer, four modified XM203 launchers were fired 1500 rounds each without the occurrence of a broken or unserviceable part.	2.7 2.18
It is required that the launcher be capable of being operated and maintained under Warm-Wet Climatic	N.5	The launcher could be operated and maintained under the conditions of the high-temperature test (+155°F) and the	2.9 2.15

Warm-Wet Climatic

high-temperature test (+155°F) and the

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
Conditions, as described in AR 705-15, Pars. 7.b and 7.c respectively (Change 1 dated 14 October 1963).		high-humidity conditions of the salt-water immersion test.	
It is desired that the launcher be capable of being operated and maintained under Cold Climatic Conditions, as described in AR 705-15, Par. 7.d, provided that other desirable characteristics are not compromised thereby.	N.6	The launcher was capable of being operated and maintained under the conditions of the low-temperature test (-25 and -65°F).	2.8

Requirements[a]	Source, Technical Characteristics Par. No.	Finding	Test Par. No.
It is desired that the launcher provide the highest possible degree of functioning reliability, consistent with meeting other requirements, under exposure to adverse environmental conditions of dust, mud, heavy rain, and water-immersion.	N.7	The launcher was capable of being operated under exposure to adverse environmental conditions of dust, mud, heavy simulated rain, and water-immersion.	2.10 2.11 2.12 2.13 2.15

APPENDIX III - DEFICIENCIES AND SHORTCOMINGS

1. Deficiencies

None

2. Shortcomings

Shortcoming	Suggested Correction Action	Remarks
1. On two occasions the pivot pin for the barrel-release latch broke.	Replace the present pin with a less brittle pin.	
2. The retainers on the front end of the cover for the launcher which engage the handguard cap on the M16A1 rifle broke on one of the launchers during removal of the cover from the rifle.	This can be corrected by decreasing the width of the lower edge of the retainer 0.2 inch so it will not contact the tiedown strap during disassembly.	
3. The glue that adheres the handgrip to the barrel broke loose on two of the launchers during the low-temperature test (-65°F). This in turn caused the cartridge retainer springs to fail to hold the cartridge in the barrel during the loading operation. Also, insect repellent dissolved the glue during the lubricants and solvents compatibility test.	Use a compound that will withstand low temperatures and is impervious to insect repellent.	

Shortcomings	Suggested Correction Action	Remarks
4. The primary sight was not correctly graduated at the 350 meters range for the velocity level produced by the launchers with the test lot of ammunition.	Manufacture the launcher barrels within dimensions to incrase the velocity or change the graduations on the sight.	The sights on the launchers tested in the engineer design test (ref 1c) were correctly graduated; however, the launchers in the ED Test fired the same lot of grenades at 10 feet per second greater velocity. A comparison of the bore measurements disclosed the groove diameter in the ET launchers was approximately 0.002 inch greater than in the ED launchers, which would increase gas blowby. Also, the land diameter was approximately 0.002 inch less in the ET launchers, which would increase the friction of lands engraving and consequently decrease the velocity of the grenade.
5. The battle sight was not correctly graduated at the 250-meter range for the velocity level produced by the launchers with the test lot of ammunition.	Same comment as with Shortcoming No. 4.	

Shortcomings	Suggested Correction Action	Remarks
6. The screws that assembled the battle sight to the cover loosened during firings.	Apply locktight to the screws during the initial assembly of the sight to the cover or use rivets rather than screws.	
7. The breech plug in the modified launchers loosened during tests at low temperature.	Apply locktight to the breech plug or manufacture the breech plug with a Ny-lock insert.	
8. The extractor in the modified launcher reduced the headspace to the point that the rims of fired cases lodged between the extractor and the breech face which caused failures to eject.	Return the headspace to 0.089 - 0.005 inch rather than 0.080 to 0.084 inch which was recorded on the modified launchers.	
9. The greande launcher attachment cannot readily be assembled to the XM177E2 submachine gun without removal of the handguard cap which entails removal of the front sight and flash suppressor from the submachine gun.	This can be corrected by cutting deeper relief cuts in the receiver of the launcher or notching the handguard cap on the submachine gun.	
10. The stop on the sight base prevented the range selector latch from moving into the locked position on the 400-meter setting.	Remove material from the side of the stop to provide clearance for the latch.	

3. Corrected Deficiencies - Shortcomings

Deficiency - Shortcoming	Suggested Corrective Action	Remarks
1. During the firing of the launcher, the safety moved from the OFF position to the ON position with the recoil of the weapon. The design of the trigger mechanism was such that the barrel could not be moved forward to extract the fired case and open the breech to load the next round with the safety in the ON position Consequently, the shooter had to manually move the safety before cycling the launcher.	The trigger was modified by the addition of material in the area forward of the sear. The added material contacted the bottom edge of the firing pin when the firing pin moved forward to fire the cartridge. This in turn held the trigger in the REAR position, which prevented movement of the safety to the ON position. The modification made to the trigger is shown in Figure 2.7-I.	
2. Occasionally, the follower failed to override the cocking lever. When this occurred, the cocking lever protruded between the barrel extension and the follower and prevented closure of the barrel.	The 1/16-inch diameter follower return springs were replaced with 1/8-inch diameter springs to increase the energy of the follower. Also, a flat surface was ground on the front edge of the cocking lever to replace the curved surface.	
3. The tiedown straps which assembled the launcher to the rifle deformed and, in some instances, broke. The deformation allowed the mounting screws to loosen and, in three instances, during the 1000-	The tiedown strap was heat-treated for additional strength and the flat-head mounting screws were replaced with fillister-head screws. Also, the heads of the fillister screws were drilled to provide for a safety wire for added	

Deficiency - Shortcoming	Suggested Corrective Action	Remarks
round reliability test one of the two mounting screws sheared.	prevention against the screw loosening during firing.	
4. On three launchers a small piece was broken from the corner of the barrel-release latch, which in turn wears away the contact edge of the barrel extension. When this occurred the barrel failed to remain in the latched position and moved forward with the firing of a round.	The breakage of the barrel-release latch was believed to be directly related to the failure of the tiedown strap in that, when the tie-down strap stretched and deformed, the launcher moved rearward relative to the rifle during recoil. This rearward movement partially released the barrel latch due to the inertia of the latch. In the additional firings by the developer, in which the deficiency of the tiedown straps was corrected, no occurrences of failure of the barrel latch were experienced in 6000 rounds of firing.	As a further assurance of the failure of the latch, the present return spring for the barrel-release latch should be replaced with a spring of higher spring rate.
5. During the low-temperature test punch-outs and partial punch-outs of the primer occurred and the primer fragments collected in the firing-pin well. This restricted movement of the firing pin and caused failures to fire.	Four modifications were made as follows: a. A modified breech plug was installed which reduced firing-pin protrusion. b. The stainless-steel firing-pin spring was replaced with a cadmium-plated music wire spring which reduced firing-pin energy.	Problems were encountered with the modified extractors, in that, reduction in headspace caused failures to eject.

Deficiency - Shortcoming	Suggested Corrective Action	Remarks
	c. A modified extractor was installed which which reduced headspace.	
	d. A spring-loaded plunger was installed in the barrel extension which adjusted headspace.	

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

S: 3 Feb 69
1 Aug 69

AMSTE-BC

11 DEC 1968

SUBJECT: Test Directive for Engineering and Service Test of Launcher, Grenade, 40mm, XM203, Attachment for Rifles, RDT&E Project No. 1X542703D311, USATECOM Project Nos. 8-9-0240-13, 14, 15

✓Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-CO-P
Commanding Officer, US Army Arctic Test Center, ATTN: STEAC-IN
President, US Army Infantry Board, ATTN: STEBC-SA

1. References:

a. Letter, AMCPM-RS, 1 May 68, Subject: Engineering Design Test 40mm Grenade Launcher Attachment for Rifles.

b. Letter, APG (STEAP-MT-TI), 18 Oct 68, Subject: Final Report on Engineer Design Test of M16/M16A1 Rifle (GLAD). USATECOM Project No. 8-8-0240-09.

c. Letter, USAIB, Aug 68, Subject: Final Report on Engineer Design Test of 40mm Grenade Launcher Attachment for M16A1 Rifle. USATECOM Project No. 8-8-0240-10.

d. Letter, 5 Sep 68, Subject: Minutes of In-Process Review of 18 July 68 on the Grenade Launcher Attachment for Rifles Program.

e. Letter, 13 Jun 67, Subject: Department of the Army Approved Small Development Requirement for 40mm Detachable Grenade Launcher for Individual Weapons.

f. Letter, 25 Sep 68, Subject: Establishment of a Consolidated Item Security Check List for the Grenade Launcher Attachment for Rifles, inclosure 1.

g. USATECOM Regulation 705-4.

h. USATECOM Regulation 750-15.

i. USATECOM Regulation 385-6.

SUBJECT: Test Directive for Engineering and Service Test of Launcher, Grenade, 40mm, XM203, Attachment for Rifles, RDT&E Project No. 1X542703D311, USATECOM Project Nos. 8-9-0240-13, 14, 15

j. USATECOM Regulation 385-7.

k. AMC Regulation 385-12.

l. USATECOM Regulation 705-2.

2. Background:

a. In June 1967 a proposed Small Development Requirement for a 40mm detachable grenade launcher for rifles (GLAD) was approved by ACSFOR. The purpose of the requirement was to provide squad grenadiers with the capability of engaging point as well as area targets, thereby adding, in effect, two riflemen to the current squad.

b. Engineering Design Tests were conducted at APG and Ft Benning in Aug 68. References 1b and c forwarded test results. An Engineering-Service Test is to be conducted beginning in April 1969.

3. Description of Materiel: The XM203 launcher is a single shot, pump actuated weapon capable of being shoulder fired. The launcher is loaded by inserting the round in the open breech and pulling the barrel rearward to the locked position. The pump-operated mechanism moves forward on a T-shaped track assembled to the underside of the launched housing. This weapon is capable of firing all standard 40mm ammunition associated with the M79 launcher. Additional detailed information is contained in references 1b and 1c.

4. Test Objectives:

a. The test objectives for engineering tests are to generate data for the purpose of evaluating:

(1) Launcher safety for shoulder fire.

(2) Physical and technical characteristics.

(3) Launcher performance under temperate and adverse climatic conditions.

b. The test objectives for temperate service tests are to evaluate:

(1) Launcher performance under actual or simulated field conditions to determine the degree that the launchers perform their intended mission.

(2) Suitability of the launcher for US Army use.

c. Test objectives for Arctic Service tests are to evaluate:

(1) The degree to which the launchers perform their intended mission under Arctic environmental conditions.

(2) Suitability of the launchers for US Army use in Arctic environments.

5. Responsibilities:

a. CO, APG is responsible for preparation of test plan, execution and final reporting of the engineering test.

b. Pres, USAIB is responsible for preparation of test plan, execution and final reporting of the temperate service test.

c. CO, USAATC is responsible for preparation of test plan, execution and final reporting of the service test under arctic environmental conditions.

6. Coordination: The test agencies will coordinate test plans as follows:

COORDINATING AGENCY	Test Agencies APG	USAIB	USAATC
CG USAMC ATTN: AMCPM-RS	X	X	X
CO PA ATTN: SMUPA-DW5	X	X	X
CO CDCIA ATTN: LTC Oltman	X	X	X
CO USACDCMA ATTN: CDCMA-E	X	X	X
CO USAIS ATTN: AJIIS-M	X	X	X
CO APG ATTN: STEAP-MT-TI		X	X
CO USAATC ATTN: STEAC-IN	X	X	
Pres USAIB ATTN: STEBC-SA	X		X

7. Special Instructions:

a. Delivery of test materiel is anticipated by 1 April 1969. Tests are to be initiated immediately upon receipt of materiel. It should be noted by reference 1d that the development program for temperate testing and reporting is three months. A Service Test Review (STR) is scheduled for early July. Temperate test agencies will maintain an up-to-date data analysis during testing so as to be prepared for the STR. In the event that reports are not available for the STR, copies of proposed presentations will be provided this headquarters at least three days in

advance of the scheduled STR.

b. Arctic tests will be conducted during the CY 69-70 environmental test season. Previous tests in the Arctic have revealed some degradation of fuze functioning in various depths of snow. Capabilities of the launcher to perform its intended mission should be considered separately from the terminal ballistic performance of fuzed ammunition.

c. Materiel and cost estimates will be provided this headquarters by APG and USAIB not later than 6 January 1969. Materiel estimates will be submitted this headquarters by ATC not later than 1 June 1969.

d. Development of the test launcher is authorized by DA Project No. 1X542703D311. Funding is authorized by AMCMS code 5542.12.46603.

e. This is a category I activity and is subject to requirements of TECR 705-2, ref 1l. USATECOM Priority 3, SEA related 02, is assigned. Any conflict with other programs of higher priority which precludes initiation of this test by 1 April 1969 will be brought to the attention of this command. Submit a list of the conflicting programs by title, project no. and scheduled initiation and/or completion date.

f. Maintainability and reliability will be specifically addressed throughout the test program by all addressees. A summary statement regarding the maintenance/maintainability characteristics of the test item will be included in the test reports in accordance with ref 1h. The exact format for submission of supporting data in this area is left to the best judgment of the addressees but where possible and applicable should be in summary chart form.

g. USATECOM Project Nos. are assigned as follows:

(1) APG - 8-9-0240-13

(2) USAIB - 8-9-0240-14

(3) USAATC - 8-9-0240-15

8. Test Plans and Reports:

a. Plan of Test

(1) Test plans will be prepared in accordance with reference 1l

and coordinated as specified in paragraph 6. If coordination is not complete prior to submission deadline, submit the plans followed by coordination comments and accommodations thereto. Test plans are desired by the following dates:

(a) Engineering Test Plan - 3 Feb 69.

(b) Service Test Plan (USAIB) - 3 Feb 69.

(c) Service Test Plan (Arctic) - 1 Aug 69.

(2) The referenced SDR will be utilized as criteria for conduct of each subtest. If subtests are required for which there is no specific criteria cited in reference 1e, justification for the test together with a statement on the planned utilization of the data and a rationale to support presumed or self-generated criteria is required.

b. Test Reports:

(1) Test reports will be published in accordance with reference 1l and forwarded this command for approval. Distribution will be in accordance with inclosure 2. Submission dates are as follows:

(a) Engineering Test Report - 30 June 69.

(b) Service Test Report (USAIB) - 30 June 69.

(c) Service Test Report (Arctic) - 30 April 70.

(2) Equipment Performance Reports (EPR's) will be submitted in accordance with reference 1g. Final reports will cite the EPR within the applicable subtest and state if any corrective action has been exercised in accordance with paragraph 4a(2) of reference 1g.

9. Safety:

a. As stated in paragraph 5, safety responsibilities are assigned CO, APG and will be executed in accordance with references 1i, j and k. Structural integrity of the launchers has been demonstrated as evidenced by issuance of safety release on 10 May 1968. The release was based on

AMSTE-BC

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11 DEC 1968

results of Engineer Design Tests (EDT) reported by references 1b and c. Based on results of the EDT, it is not anticipated that weapons scheduled for delivery in April 1969 will incorporate any major design modification. Recommendations for safety release should be provided this headquarters within five days after receipt of hardware. Expeditious release is required to minimize delay for initiation of test at the Infantry Board.

10. Security: Test plans and final reports will be classified CONFIDENTIAL. It should be noted that the inclosed security check list pertains only to the launcher. The SDR previously provided all agencies remains CONFIDENTIAL.

FOR THE COMMANDER:

GOODWIN MORROW
Dep Dir
Mat Test Dir

4 Incls w/d
1. Security Check List
2. TSMS
3. Dist List
4. LMR (USAATC only)

Copies furnished: (w/o incls)
CG USAMC ATTN: AMCPM-RS
CG USACDC ATTN: USATECOM LO
USMC LO

APPENDX V - REFERENCES

1. Technical Characteristics for 40-MM Grenade Launcher Attachments for Rifles as Approved in the Minutes of Formal In-Process Review Meeting, 18 October 1967, USAMC.

2. Keele, E., Final Report on Engineer Design Test of 40-MM Grenade Launcher Attachments for M16A1 Rifle (GLAD) (U). USATECOM Project No. 8-8-0240-09. Report No. DPS-2929, October 1968. Aberdeen Proving Ground. Confidential. (Distribution Controlled by US Army Weapons Command, ATTN: AMCPM-RS.)

3. Minutes of In-Process Review Meeting, 24 June 1969, Held at USAWECOM by Project Manager's Office, Rifles.

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Security Classification

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UTHOR(S) *(First name, middle initial, last name)*
ric Keele

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. DISTRIBUTION STATEMENT

This document may be further distributed by any holder only with specific prior approval of Project Manager, Rifles, ATTN: AMCPM-RS.

1. SUPPLEMENTARY NOTES None	12. SPONSORING MILITARY ACTIVITY Proj Mgr, Rifles

3. ABSTRACT

The purpose of the test was to evaluate the performance characteristics of the XM203 grenade-launcher attachment and determine compliance with the technical characteristics. Testing was initiated the latter part of April 1969 and was completed 31 July 1969. The launchers were examined for potential safety hazards, fired for velocity, accuracy, and reliability, and were subjected to adverse conditions, ruggedness, and lubricants and solvents compatibility tests. Deficiencies were experienced with the launcher in several areas: the safety inadvertently moved to the ON position with recoil of the launcher; punctured primers occurred in the low-temperature test; tiedown straps deformed and broke after 400 to 500 rounds of firing; and, occasionally, the follower failed to override the cocking lever. Subsequently, modifications were made to the launcher to correct the deficiencies and additional firings were conducted to test the modifications. At the completion of the engineering test and the additional firings, no uncorrected deficiencies existed. Within the scope of the engineering test, the XM203 grenade launcher complied with the requirements of the technical characteristics with the exception of exceeding the total number of parts stipulated; parts broke and became unserviceable in the reliability test; and the precision and accuracy of adjustment of the primary sight was not equal to that of the M79 launcher. Recommendations were made to correct the shortcomings of the launcher and to insure that the final design be tested sufficiently to verify the adequacy of the corrections.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Attachment, grenade-launcher, XM203 Safety Performance characteristics Adverse conditions Modification						