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U.S. ARMY TEST & EVALUATION COMMAND

FINAL REPORT ON

OPERATIONAL RELIABILITY STUDY

OF

M16A1 RIFLE

BY

ALLAN WILSON

OCTOBER 1969

ABERDEEN PROVING GROUND

ABERDEEN PROVING GROUND, MARYLAND

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

Mr. Morrow/nm/4476

AMSTE-BC

17 NOV 1969

SUBJECT: Report on Operational Reliability Study of M16A1 Rifle, USATECOM Project No. 8-WE-600-016-001

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

1. Subject report is approved and is forwarded for your information and action as appropriate.

2. The study was directed by your office as an outgrowth of concern with the nature and interpretation of M16 Rifle malfunctions and the need to express them in more meaningful terms. To this end, measures of down time associated with specific malfunctions were accumulated in exercises with 64 combat experienced and 40 Infantry soldiers without combat experience at Fort Benning, Georgia. Each of 7 malfunction types was imposed 104 times in each of 4 firing positions during both day and night for a total of 832 exposures per malfunction, and the results were analyzed for significance. Although attempts were made to impose realism, the data accumulation procedures limited the degree to which it could be accommodated. The relative data is valid but absolute values might change in a true combat environment.

3. A statement is made in Results, para 1.4g, which may be misinterpreted. The statement does not mean that no relationship exists between combat experience and light condition and malfunction type etc., and this is explained in detail in para 1.4.1. What is meant is, that on an average, the difference is not significant between combat and noncombat experienced troops per se, daylight and darkness per se, and position per se, these being considered separately.

4. For the first time, the concept of down time can provide the basis for trade-off of specific rifle malfunctions for acceptance criteria or when limited by design capability. For example, if a change in cyclic rate is required to minimize the failure of a bolt to stay rearward, such rate change may be accompanied by an increase in failures to eject; the trade-off in numbers of each type which may be permitted can then be considered in terms of down time in the tactical environment. Also, in comparing two weapons for reliability, down time rate rather than malfunction rate can be examined.

17 NOV 1969

AMSTE-BC
SUBJECT: Report on Operational Reliability Study of M16A1 Rifle, USATECOM Project No. 8-WE-600-016-001

5. The results of this study should be of interest to users, developers and testers in areas of requirements, training, quality assurance and testing. New training approaches are suggested, together with changes to technical manuals and to purchase criteria.

6. The techniques used in this study are pertinent to all individual weapons, however, specific exercises would have to be generated on a case-by-case basis for weapons other than the M16 Rifle.

FOR THE COMMANDER:

V. Kovalevsky

V. KOVALEVSKY
Colonel, GS
Dir, Inf Mat Test Dir

1 Incl (5 cys)
APG-MT Rept, subject
as above, Oct 69

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OPERATIONAL RELIABILITY STUDY OF M16A1 RIFLE

FINAL REPORT

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OCTOBER 1969

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND
21005

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ABSTRACT

A study of the operational reliability characteristics of the M16A1 rifle was conducted at Aberdeen Proving Ground and at Fort Benning, Georgia from July 1968 through July 1969. Modifications to the M16A1 rifle and M193 ammunition, which would cause specific malfunctions to occur on a scheduled basis, were developed at Aberdeen Proving Ground and limited firing tests were conducted with experienced civilian firers. Troop tests were then conducted by the US Army Infantry Board at Fort Benning employing rifles and ammunition modified by Aberdeen Proving Ground. As a result of the study, recommendations were made to change the present limitations on malfunctions in M16A1 rifle acceptance tests, to amend technical publications with changes to the weapon loading technique and also to the immediate-action instructions, and to incorporate a more useful rifle training procedure in the present program of instruction for the M16A1 rifle. In addition to this report, a Pamphlet on Definitions and Identifications of Malfunctions for 5.56-MM Weapons was published by Aberdeen Proving Ground.

FOREWORD

The Materiel Test Directorate at Aberdeen Proving Ground had over-all responsibility for the study, including analysis and reporting, and the US Army Infantry Board at Fort Benning, Georgia had responsibility for developing a plan of test and for conducting troop tests to determine the times required for test subjects to clear malfunctions in the M16A1 rifle.

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 8-WE-600-016-001

FINAL REPORT ON OPERATIONAL RELIABILITY STUDY OF M16A1 RIFLE

JULY 1968 THROUGH JULY 1969

SECTION 1. INTRODUCTION

1.1 BACKGROUND

On 13 March 1968, US Army Test and Evaluation Command (USATECOM) directed that a study of the operational reliability characteristics of the M16A1 rifle be conducted. The USATECOM directive (Appendix II) defined operational reliability as "The probability of achieving system operation, measured in terms of down-time when a stoppage or inability to accomplish a task occurs, in relation to specific malfunctions or inherent limitations (i.e., magazine change times)."

1.2 OBJECTIVES

The primary objective of the study was to determine an accurate and tactically realistic weighting factor for various malfunctions which would aid in assessing the acceptability of production rifles as well as future product improvements to the rifle.

In addition, as a preliminary objective, the study was also expected to generate a uniform and clearly defined listing of malfunctions common to the M16A1 rifle.

1.3 PROCEDURES

The study was divided into a number of progressive phases and each phase was completed prior to initiation of the next phase. These phases were as follows:

a. Phase I. From July through September 1968, information was gathered and edited at Aberdeen Proving Ground (APG) which provided a set of uniform definitions for the malfunctions common to the M16AI rifle. Following approval by USATECOM, this material, together with illustrations of the various types of malfunctions, was published in pamphlet form (Reference 1).

b. Phase II. During November and December 1968, STEAP–MT–TI at APG explored various methods of modifying certain rifle components and 5.56-mm ammunition in such a manner that seven different malfunctions could be programmed to occur at specified intervals during firing. Every effort was made to provide modifications that would not only result in the occurrence of a desired malfunction but which could also be overcome by a normal clearing action on the part of the firer.

c. Phase III. A limited firing exercise was then conducted at APG employing one modified rifle and three experienced civilian firers. The times required for each firer to clear each malfunction were measured. Due to the experience level of these firers with the M16A1 rifle, the recorded times were anticipated to provide an optimum base line against which the results of subsequent troop tests could be evaluated.

d. Phase IV. With the technical problems associated with inducing malfunctions in the M16A1 rifle resolved and satisfactorily demonstrated, STEBC–SA at US Army Infantry Board (USAIB) developed a plan of test which would employ 64 test soldiers. Each test soldier was to experience each of the seven basic malfunctions under conditions of both daylight and darkness and while firing from four different firing positions (prone, kneeling, standing, and from a foxhole position). The time required to change magazines was also to be measured during each test condition. The instrumented COMBATEST firing range at Fort Benning, Georgia, was selected as the test site, and modified rifles and ammunition were supplied by APG.

   These firings were conducted in January and February 1969. However, as all of the 64 test soldiers were Viet Nam returnees, an additional test was conducted in March 1969 with 40 soldiers who had no previous combat experience but who had completed basic and advanced individual training and had been selected for attendance at the Noncommissioned Officers Candidate Course.

e. Phase V. The final phase of the study was completed when the USAIB data were forwarded to APG for statistical analysis and final reporting.

1.4 RESULTS

The results of the study are summarized as follows:

a. The M16A1 rifle and M193 ammunition can be modified in such a manner to provide malfunctions in seven different categories, the occurrence of the malfunctions is highly predictable, and the malfunctions can be cleared in a normal manner.

b. During efforts to develop the above modifications it was noted that the M16A1 rifle was not sensitive to relatively minor modifications in the particular areas which were explored, except when magazine spring force was reduced.

c. Experienced civilian firers at APG required, on the average, from 3.1 to 6.7 seconds to clear most malfunctions and 14.5 and 17.2 seconds to clear feeding failures of the bolt override type and to clear failures to extract respectively.

d. During troop exercises at USAIB, the grand average time for all subjects, under all conditions, to clear all malfunctions was 14.0 seconds.

e. The average clearing times per malfunction type were as shown in Table 1.4-I.

Table 1.4-I. Average Clearing Times per Malfunction Type

Malfunction	Time, sec
Failure to eject (FJ)	13.1
Failure to fire (FFR)	7.5
Failure to extract (FX)	32.9
Failure to feed (FF)	11.4
Failure of the bolt to remain rearward (FBR)	[a]10.8
Failure to feed the first round (FF1)	13.4
Time required to change magazines (MCT)	8.9

[a]Includes normal magazine change time.

f. The average time to clear all malfunctions, all test conditions, for combat-experienced troops was 13.8 seconds and 14.2 seconds for noncombat-experienced troops.

g. Statistical analysis of the USAIB test data showed that on the average, no significant differences existed between the combat- and noncombat-experienced troops, nor between the two light levels of daylight and darkness, nor between any of the four firing positions examined.

h. There was, however, a significant difference at the 5% significance level between malfunction types as follows:

1) FX down times were significantly higher than all other malfunctions.

2) FF1 down times were significantly higher than for FFR, FBR, and MCT.

3) FJ down times were significantly higher than for FFR, FBR, and MCT.

4) FF down times were significantly higher than for FFR and MCT.

5) FBR down times were significantly higher than for FFR.

i. The average time of 32.9 seconds to clear the FX does not take into account that in 14% of all occurrences of FX the rifle was rendered temporarily unserviceable due to the severely jammed mechanism (the rifle could not be cleared within approximately 1-1/2 minutes), nor could a time of 32.9 seconds be attained for the less difficult to clear FX's without the aid of a readily accessible and quickly usable extraction tool or other device.

j. The mean "true" FBR time, which is defined as the penalty imposed on the firer when this malfunction occurs by extending the normal magazine change time, was estimated to be within 1.5 to 2.3 seconds (80% 2-sided confidence limit).

k. However, other statistical analysis plus pertinent test observations cast doubt on the concept of the FBR as a penalty-producing malfunction. It was clearly demonstrated that some firers were not penalized due to the occurrence of an FBR because of the weapon loading technique employed by these firers.

l. Statistical interaction effects of first, second, and third order (2-, 3-, and 4-factor effects) were examined with the following results:

1) Training Level versus Light Condition. The performance of noncombat-experienced troops was adversely affected by nighttime operations in comparison to combat troops.

2) Training Level versus Malfunction Type. Among individual malfunction types, the noncombat troops were significantly less able to clear the FFR malfunction, in comparison to combat troops, but were apparently more proficient in clearing the FX malfunction. This latter difference was considered to be influenced in part by the fact that noncombat-experienced troops tended to "give up" on the more difficult to clear FX's approximately twice as often as the combat-experienced soldiers, thus providing fewer clearing times of long duration.

3) Light Condition versus Malfunction Type. Considering individual malfunction types, the ability to clear the FX malfunction was significantly degraded by a nighttime operation.

4) Training Level versus Light Condition versus Malfunction Type. Significant differences existed in this 3-factor analysis due principally to the key role played by the FX malfunction. In essence, the interaction caused by the FX malfunction was greater than the average interaction between training level and light condition, and this analysis served again to emphasize the seriousness of this malfunction.

5) General. No other significant differences were detected among the various interactions not discussed above.

m. Important observations concerning human factors and training problems and their effect on the operational reliability levels of a personal, hand-held weapon system were made by USAIB personnel. While these comments do not lend themselves well to summarization here, recommendations and conclusions based on these comments are included in the subsequent paragraphs. The detailed observations are contained in paragraph 2.5.3.7.

1.5 CONCLUSIONS

It is concluded by APG that:

a. The present schedule of permissible malfunctions which determines rifle acceptability is not consistent with down time weighting factors as determined in this study (ref par. 2.5.3.6).

b. Even if the FBR malfunction results in a down time penalty to the firer, and there is some doubt that it does, it is not considered to be a tactically significant malfunction (ref par. 2.5.3.2).

c. Magazine change time (8.9 seconds each 20 rounds) represents a greater down time penalty to the firer than any type of malfunction except:

1) Those that become repititious in nature at a high consecutive incidence as a FJ often does.

2) Those that are likely to result in a firmly jammed and difficult to clear rifle as may happen with the FX, FF1, and some types of FF (ref par. 2.5.3.2).

d. It is simple and economical to fabricate certain modifications to the M16A1 rifle and M193 ammunition to deliberately program specific malfunctions of the weapon - ammunition combination (ref par. 2.2.2).

The following conclusions are based on comments offered by the USAIB personnel who conducted the troop test exercises in this report:

a. The existing doctrine for the M16A1 rifle (FM 23-9, with Change 1, 2 February 1968) is not satisfactory and does not fully recognize the sophistication and peculiarities of the M16A1 weapons system.

b. Current programs of instruction (POI) for immediate action/remedial action do not allocate sufficient time during basic training for meaningful instruction which will remain with the soldier. There is no comprehensive attempt at immediate action drills or practical work exercises which would reinforce the procedure taught.

c. Additional testing is necessary to further develop a preferred method of clearing the weapon and a best time for each malfunction which can be taught as a training standard or objective.

1.6 RECOMMENDATIONS

The following recommendations are made by APG:

a. The present schedule of permissible malfunctions which determines rifle acceptability be changed to reflect, as nearly as possible, relative malfunction values as determined in this study. The following is offered for consideration:

"Malfunctions Permitted in 6000-Round Endurance Test.

a. No more than one FX or FF1, or FF/BOB is to be permitted.

b. No more than nine FFR, or FJ, or FF, or FBR, or any combination of these not exceeding nine, are to be permitted.

c. No more than one unspecified malfunction is to be permitted except that if one FX, or FF1, or FF/BOB also occurs during test then the unspecified malfunction shall not be permitted if clearing action requires more than a single exercise of the charging handle, or bolt assist device, or trigger.

d. No more than nine malfunctions of any type or subtype shall be permitted."

The suitability of these criteria are discussed at greater length in paragraph 2.5.3.6.

b. The Field Manual for the M16A1 Rifle (FM 23.9), and any other pertinent manuals, should contain the following instructions on loading procedures:

1) Insert a fully-loaded magazine.

2) Tap on the bottom of the magazine to insure that it is locked in position.

3) Pull the charging handle sharply rearward and release it at the rearmost position.

4) Tap once on the bolt-assist device.

5) The bolt-catch lever is to be used only on those occasions when it is desired to manually lock the bolt to the rear. (Note: This may have been the primary original design intent of the bolt catch; i.e., to serve as a bolt lock, not as a bolt release.)

It is anticipated that the above procedures would automatically clear all FBR malfunctions and probably some FF1 malfunctions with no delay to the firer and without the firer being aware that the malfunctions had occurred.

c. The following immediate-action technique for clearing malfunctions is proposed for inclusion in FM 23-9 and other pertinent manuals:

1) Rapidly withdraw the charging handle and lock the bolt rearward with the bolt catch.

2) Remove and discard the magazine.

3) Roll the rifle to the right to permit a loose cartridge or fired case to fall out.

4) Insert a new magazine, tap the bottom of the magazine, and release the bolt by withdrawing and quickly releasing the charging handle. Tap once on the bolt assist device and attempt to fire. While the proposed technique will not clear all types of malfunctions, notably the FX, it should clear the majority of malfunctions quickly and without any requirement on the part of the firer to first analyze the problem or to consider alternative actions.

The following recommendations are made by the USAIB:

a. FM 23-9 and appropriate TM's be modified to describe a more realistic method of immediate action/remedial action for clearing malfunctions.

b. Current POI's be modified to incorporate a more extensive practical exercise sequence of instruction designed to reinforce soldier learning in a manner directly related to its intended use in action.

c. Additional testing be planned to refine a preferred method of immediate action/remedial action and a set of best times to clear malfunctions.

SECTION 2. DETAILS OF STUDY

2.1 PHASE I, MALFUNCTION PAMPHLET

The previously mentioned USATECOM pamphlet concerning the definitions of malfunctions associated with the M16A1 rifle comprised phase I of the study. The pamphlet is identified in Reference 1.

The pamphlet fulfilled an initial and important objective of the study by categorizing malfunctions into seven major types (six basic and one miscellaneous), 23 related subtypes, and eight less commonly encountered malfunctions. Pages from the pamphlet which identify and illustrate the particular malfunctions which were investigated in the subsequent phases of this study are extracted from the manual and are contained in Appendix I.

2.2 PHASE II, WEAPON AND AMMUNITION MODIFICATION

2.2.1 Introduction

As a result of the work performed in the initial phase of the study it was determined that down-time data should be collected on the six basic types of malfunctions as listed in the malfunction pamphlet. These types were as follows:

a. FJ = Failure to eject.

b. FFR = Failure to fire.

c. FX = Failure to extract.

d. FF = Failure to feed.

e. FBR = Failure of the bolt to remain to the rear after the last round in a magazine is fired.

f. FF1 = Failure to strip and feed the first round from a magazine.

As previous tests with the M16A1 rifle had often indicated that feeding failures were one of the most commonly encountered malfunctions, this basic category (FF) was further divided into two subtypes; the first being a failure with the bolt overriding the base of the round and the second a failure with the bolt remaining behind the base of the round (see Appendix I). These subtypes were abbreviated FF/BOB and FF/BB respectively, and were substituted in the original list in place of FF.

The study directive also established the requirement to obtain down-time data for the time required to change magazines. This information was expected to be useful in future evaluations of magazines which might contain more than the 20 rounds of the standard magazine. Magazine change-time data were added to the requirements of the above list (abbreviated as MCT), making a total of eight down-time data categories. The complete list was then FJ, FFR, FX, FF/BOB, FF/BB, FBR, FF1, and MCT.

After the malfunction list had been established, rifle and ammunition modifications were undertaken to determine if each of the malfunctions could be individually programmed to occur whenever desired, in as realistic a manner as possible and with a normal clearing action required in order to resume firing. It should be noted that a number of obvious and reasonably simple solutions were subsequently deemed not acceptable for the purposes of this study.

For example, an FBR will result on every final round in a magazine if the bolt catch is removed from the rifle. However, normal clearing of the malfunction requires that the firer manually retract the bolt which is then usually successfully engaged by the bolt catch and the malfunction is cleared. Without a bolt catch, normal clearing action cannot be performed. Somewhat similarly, an ejection failure (FJ) will occur if the ejector is removed from the bolt, and while normal clearing action can be accomplished and firing resumed, a failure to eject occurs on every round with a rifle altered in this manner. Under this condition, a test subject would encounter the FJ malfunction on every round fired and the malfunction could not be programmed to occur at a later point in an otherwise normal firing cycle.

2.2.2 Results

The following paragraphs summarize the modification work that was performed to develop each malfunction in as realistic a manner as possible.

2.2.2.1 FJ Malfunction. This malfunction was induced by removing four full-working coils from the ejector spring in the bolt; the original spring contains 27 coils of which 25 are full-working coils. This alteration resulted in ejection failures during firing and usually caused more than one failure in a 20-round magazine. However, as initial rounds could be fired successfully before a failure occurred, it was judged that this problem would not affect test results particularly if the recorded down time was confined to each firer's first encounter with the malfunction.

It was also noted that different rifles had to be "tuned" to the occurrence of this malfunction. Removing no more than 3-1/2 coils from the ejector spring in some rifles produced the desired effect while other rifles required removal of nearly five coils if successful firing of at least several rounds followed by the malfunction was to be obtained. The fact that ejection failures usually did not occur on first-fired rounds was judged to be a factor of the cyclic velocity of the bolt and bolt carrier. Slowly or marginally ejected cartridge cases, which resulted from shortening the ejector spring, were successfully cleared from the ejection port until bolt carrier velocities increased sufficiently to catch and jam the fired case.

2.2.2.2 FFR Malfunction. This malfunction was induced by loading a dummy round in the magazine. The effect was exactly the same as a normally encountered FFR and the required clearing action was the same; i.e., extracting and ejecting the round which had failed to fire and loading a fresh round.

2.2.2.3 FX Malfunction. This malfunction was induced by loading a specially modified round in the magazine. The modification consisted of removing nearly all of the existing rim of the cartridge case; the normal rim depth of 0.025 inch was reduced to 0.005. Firing of the modified round realistically simulated the occurrence of a full rim shear. The bolt would recoil rearward and, on the counterrecoil stroke, the next live round was fed and jammed into the base of the FX case which had remained in the chamber.

Clearing action was normal and time-consuming, first requiring removal of the jammed live round and then, with the aid of the extraction tool, removing the fired case from the chamber. However, limited firing exercises indicated that the modified cartridge must be fired as the first to third round from the magazine or else an FJ would occur instead of an FX. The reason for this was unknown, but the fired case appeared to be blown rearward out of the chamber if the round was fired beyond third position in an automatic burst.

It was also noted that the special extraction tool (illustrated in Appendix I) could not be operated in the exact manner intended, as very little cartridge case rim surface remained on the modified cartridges for engagement by the tool. While this did not present a problem in subsequent firings at APG, the test subjects at Fort Benning occasionally found the tool not completely effective in removing a fired case from the chamber. However, this was not considered to present a serious limitation in test data accumulation and should not be construed as a design shortcoming of the extraction tool.

2.2.2.4 FF/BOB and FF/BB Malfunctions. Many attempts were made to induce feeding malfunctions in the rifle but none of the attempts were entirely successful from the standpoint of study objectives. It was considered desirable that both the BOB and the BB subtype of the feeding malfunction be evaluated as the required clearing action in each case was entirely different (see Appendix I). It was also considered desirable that the malfunction not occur on the first several rounds fired from the magazine and that the malfunction subtypes be predictable in advance so that one or the other of the subtypes would occur on a programmed basis.

Following a number of trial-and-error efforts, it was determined that by removing 3-1/2 full-working coils from the magazine spring a feeding failure of either the FF/BB or FF/BOB subtype would result after several rounds had been successfully fired. The required clearing action was normal for either subtype of the malfunction and the down time required to clear the first encountered failure of each subtype was judged to be entirely valid although repetitive failures would usually follow the first occurrence in any single magazine.

The only limitation that was not overcome was an inability to be able to predict which of the subtypes, BOB or BB, would occur. In consultation with USAIB, it was decided that each test subject would be monitored by a test support noncommisioned officer and the monitor would attempt to note which malfunction subtype had occurred.

2.2.2.5 FBR Malfunction. This malfunction was induced by inserting a cylindrical metal disk in the rear of the action-spring tube after first removing the action spring and buffer. The disk was machined to provide a friction fit with the inside diameter (1.00 inch) of the action tube to preclude the possibility of the disk tilting inside the action tube during firing. It was found that proper disk height varied from rifle to rifle and the problem was to select a height which would permit the bolt to recoil far enough to clear the bolt catch but not far enough to permit the catch sufficient time to elevate before the bolt moved forward again in counterrecoil. This technique was important as the resulting FBR could then be cleared normally by manually retracting the bolt (manual retraction would allow sufficient time for the catch to rise to the engagement position).

Due to rifle-to-rifle variation, disks were fabricated at APG of a number of different heights which, in a stacked combination, provided the correct over-all height for each rifle used in the USAIB test. The use of several thinner disks, rather than a single disk, created the possibility that one of the disks might tip in the action tube during firing and damage the buffer on recoil impact. However, this problem did not occur in the USAIB tests and it is now presumed that the action spring provides constant tension against the disks and maintains the disks in an upright position.

2.2.2.6 FF1 Malfunction. This malfunction was induced by inserting three standard magazine springs in the magazine which substantially increased the force required to strip the cartridge. Upon inserting such a magazine (which can only be loaded with 16 rounds) and releasing the bolt-stop mechanism, complete closure of the bolt does not occur, but the malfunction may then be cleared normally by either depressing the bolt-assist mechanism several times or by manipulating the charging handle. The rifle can then be fired automatically in a normal manner without malfunctions despite the increased stripping force required.

2.2.3 Discussion

An important observation concerning the sensitivity of design of the M16A1 rifle was noted repeatedly throughout this test phase; however, it must be emphasized that this observation was made while modifying and test firing only one rifle. This observation concerned the degree of modification that was usually required to insure that a particular malfunction would occur. While only a few design parameters were investigated, in almost none of these areas were malfunctions easily or subtly introduced. In addition to the modifications discussed in the preceding paragraph, changes were made to the action spring and to the gas port and while these efforts were not regarded as satisfactory in terms of the objectives of the study, it was observed that modifications in these areas also needed to be substantial in order to produce weapon failures.

The only exception to this desirable insensitivity was observed during efforts to reduce the magazine spring force, where it was noted that feeding failures would occasionally occur on the last or the next to the last round by removing only 1 to 1-1/2 coils of the magazine spring. However, few observations were made at this point as it was considered desirable to have the stoppage occur within fewer rounds fired which then required a substantial change to the spring.

2.3 PHASE III, APG FIRING TEST

2.3.1 Introduction

Phase III comprised a limited firing test which was conducted at APG with three experienced civilian firers employing one M16A1 rifle and ammunition modified as previously described. The firing was intended to serve as a pilot study prior to troop exercises at USAIB and to provide a set of data obtained from firers whose experience level with the M16A1 rifle, in terms of number of rounds fired and exposure to malfunctions, was expected to far exceed the experience level of the test subjects at USAIB.

The APG subjects fired during daylight, from the standing and from the prone positions, and one firer repeated the exercises in a completely darkened range firing from the standing position. In most instances, each firer experienced each malfunction (magazine clearing times were not measured at APG) at least three times and as many as 25 to 30 times in certain trials.

The down-time data, or malfunction clearing times, were measured by an observer using a stop watch. A cyclic-rate-of-fire recorder was also employed, and times were measured between the firing of the round prior to the malfunction and the firing of the next round indicating that the rifle was restored to action.

2.3.2 Results

Table 2.3-I summarizes the data obtained at APG for three firers and detailed data are contained in Appendix I. The data for the firing by one subject in a darkened range are included only in Appendix I.

Table 2.3-I. Summary of Malfunction Clearing Times Recorded at APG

	Standing; Daylight			Prone; Daylight		
Mal-Function Type	Avg for all Data	Avg for First Three Malfunctions for Each Firer	Avg for First-Encountered Malfunction, All Firers	Avg for all Data	Avg for First Three Malfunctions for Each Firer	Avg for First-Encountered Malfunction, All Firers
FJ	4.3 (4.0)	4.6	5.3	5.1 (4.6)	7.8	7.5
FFR	3.5	3.5	3.8	3.4	3.4	3.7
FX	15.7	15.6	17.2	16.3	16.3	17.4
FF/BOB	8.6 (5.9)	8.8	14.5	8.6 (7.0)	8.6	6.6
FF/BB	4.2 (3.6)	[c]3.6	6.7	3.6	[c]4.0	4.4
FBR	2.7 (2.0)	2.8	3.1	1.6	1.6	1.8
FF1	7.6 (4.7)	7.6	6.1	5.0	5.0	5.2

[a]Numbers in parenthesis are averages obtained by excluding certain extreme measurements as follows: 11.7, 12.6, and 10.3 seconds for FJ; 18.1 and 20.3 seconds for FF/BOB; 11.7 seconds for FF/BB; 9.6 seconds for FBR; and 30.6 seconds for FF1.
[b]Numbers in parenthesis are averages obtained by excluding extreme measurements as follows: 11.7, 16.6, and 15.7 seconds for FJ; and 21.5 seconds for FF/BOB.
[c]Data were averaged for two firers as only one time (11.7 seconds) was obtained for the third firer during standing and only two record times during prone (4.2 and 3.3 seconds).

Note: Averages are times, in seconds, to clear the various malfunctions.

2.3.3 Discussion

As will be noted later, the comparable down times reported in phase IV for the USAIB troop tests were greater than the APG times by approximately a factor of 2. With some justification, these differences can be said to represent a valid estimate of the improvement in average down times that might be obtained by subjects after exposure to the ultimate in training with the M16A1 rifle. However, it should be pointed out that each of the APG firers had previously fired in excess of an estimated 100,000 rounds with many different rifles and each had repeatedly encountered the full spectrum of malfunctions common to the rifle. In many cases, these firings were accomplished under severe environmental conditions (+155°F, -65°F, high humidity, simulated rain, etc.) and in a number of exercises, such as sustained fire tests, under potentially hazardous conditions with a high degree of personal stress imposed.

Considering this level of experience, the APG data should be considered as "ultimate" data and probably attainable by only a few individuals even if exposed to specific malfunction clearing exercises during training. It is therefore suggested that any changes in basic training that might be contemplated as a result of this comparison should first be confined within relatively narrow parameters where the potential gain might be greatest; i.e., requiring trainees to clear rifles which are truly "jammed" (FX, FF/BOB, etc.) rather than diluting the training effort over the spectrum of malfunctions where in some instances even the maximum theoretical gain would be small.

2.4 PHASE IV, USAIB TROOP TEST

2.4.1 Introduction

With the previous phases of the study completed, APG fabricated a sufficient quantity of action tube disks, modified magazine and ejector springs, and modified ammunition to permit large scale troop tests to be initiated at USAIB.

A plan of test was developed by USAIB (Reference 2) and a pilot exercise was conducted in January 1969 to determine the feasibility of the plan. As a result of the pilot exercise the following test procedures were followed:

a. A total of 64 enlisted personnel, all Viet Nam returnees, was used as test firers, and an additional eight noncommissioned officers served as test monitors.

b. Each test soldier fired from four different positions during both day and night (kneeling, prone, standing, and standing supported or foxhole positions). All firing was conducted in the automatic mode and each test soldier received three magazines in each firing sequence. Each of the test soldiers was exposed once to each type malfunction in each firing position during both day and night exercises.

c. The COMBATEST range was used as the test site and instrumentation already installed at the range was utilized for data recording purposes. Audio pickups were installed at each of eight firing positions and a multichannel recorder was used to provide records by which times between rounds fired at each of the firing positions were measured.

d. Each test monitor also timed the duration of the malfunction clearing operation with the aid of a stop watch and these data were entered on individual monitor worksheets. The monitor's worksheets were also used to determine if the extended time between rounds was for a magazine change or for a malfunction and the data were correlated with the data obtained on the multichannel recorder. (Note: The FF1 malfunction was timed by stop watch only and the data recorded on the worksheet.)

e. Malfunctions were programmed so that the firers were unable to anticipate the occurrence of a malfunction. This was accomplished by positioning each test soldier at a stationary firing point and rotating the monitors with the test weapons and magazines in a random pattern through the firing points. Additionally, malfunctions were randomly programmed to appear in one of the three magazines provided so that the test soldier did not know at which point in the firing sequence the malfunction would occur.

f. Prior to firing, the test soldiers were subjected to fatigue conditioning by strenuous exercises involving running, jumping, and crawling.

g. At the conclusion of the tests with the combat-experienced subjects, an additional 40 subjects who had no previous combat experience were made available and the tests described above were then repeated with the noncombat troops.

2.4.2 Results

Test results from USAIB are summarized in the following tables and the individual data are contained in Appendix I.

Table 2.4-I summarizes the over-all results of tests at USAIB for all test subjects, and Tables 2.4-II and 2.4-III show how these data were divided between the combat-experienced and the noncombat-experienced subjects.

Table 2.4-I. Summary of USAIB Down Time Data for All Test Subjects, All Test Conditions

A. Average Time in Seconds by Malfunction Type, Firing Position, and Day versus Night

Malfunction Type	Firing Position: Standing Day	Standing Night	Kneeling Day	Kneeling Night	Foxhole Day	Foxhole Night	Prone Day	Prone Night	Grand Average per Malfunction Type
FJ	12.4	14.1	11.9	13.5	12.3	13.5	12.1	14.9	13.1
FFR	6.6	8.3	6.8	8.2	6.7	7.4	8.2	7.7	7.5
FX	33.7	34.6	34.9	34.3	25.6	32.6	32.2	35.3	32.9
FF	12.6	12.6	10.8	10.7	10.8	10.4	12.1	11.3	11.4
FBR	11.7	12.0	10.4	9.9	10.2	10.2	11.4	10.6	10.8
FFI	13.6	13.5	14.3	12.5	14.8	12.8	13.7	11.6	13.4
MCT	9.4	9.3	8.3	8.4	8.2	9.4	8.7	9.2	8.9
Average	14.3	14.9	13.9	13.9	12.6	13.7	14.1	14.4	14.0
Grand Average per Firing Position	14.6		13.9		13.2		14.2		

B. Average Time in Seconds by Malfunction Type, Day versus Night

	Malfunction Type: FJ	FFR	FX	FF	FBR	FFI	MCT	Grand Average per Light Condition
Day	12.2	7.1	31.6	11.6	10.9	14.1	8.6	13.7
Night	14.0	7.9	34.2	11.2	10.7	12.6	9.1	14.2

Over-All Grand Average 14.0 Seconds.

Table 2.4-II. Summary of USAIB Down Time Data for Combat-Experienced Subjects

A. Average Time in Seconds by Malfunction Type, Firing Position, and Day versus Night

Malfunction Type	Firing Position: Standing		Kneeling		Foxhole		Prone		Grand Average per Malfunction Type
	Day	Night	Day	Night	Day	Night	Day	Night	
FJ	12.6	11.9	11.7	15.1	11.3	13.4	11.6	16.2	13.0
FFR	5.2	7.2	6.1	6.4	5.8	6.3	6.0	6.6	6.2
FX	37.3	31.7	39.0	30.5	28.0	33.6	36.2	36.2	34.0
FF	11.5	11.2	9.8	10.0	9.9	10.2	11.3	11.1	10.6
FBR	11.6	11.4	10.0	9.6	10.0	10.6	11.0	11.4	10.7
FFI	14.8	13.6	15.9	12.6	16.0	12.7	14.2	11.4	13.9
MCT	9.3	9.1	7.6	8.0	7.5	8.6	8.4	8.8	8.4
Average	14.6	13.7	14.3	13.2	12.6	13.6	14.1	14.5	13.8
Grand Average per Firing Position	14.2		13.7		13.1		14.3		

B. Average Time in Seconds by Malfunction Type, Day versus Night

	Malfunction Type: FJ	FFR	FX	FF	FBR	FFI	MCT	Grand Average per Light Condition
Day	11.8	5.8	35.1	10.6	10.6	15.2	8.2	13.9
Night	14.2	6.6	33.0	10.6	10.7	12.6	8.6	13.8

Over-All Grand Average for Combat-Experienced Subjects: 13.8 Seconds.

Table 2.4-III. Summary of USAIB Down Time Data for Noncombat-Experienced Subjects

A. Average Time in Seconds by Malfunction Type, Firing Position, and Day versus Night

Malfunction Type	Firing Position: Standing Day	Standing Night	Kneeling Day	Kneeling Night	Foxhole Day	Foxhole Night	Prone Day	Prone Night	Grand Average per Malfunction Type
FJ	12.1	17.6	12.2	10.9	13.9	13.9	13.0	12.9	13.3
FFR	9.0	10.0	8.0	10.9	8.1	9.2	11.7	9.3	9.5
FX	27.9	39.2	28.3	40.4	22.0	31.1	25.9	34.1	31.1
FF	14.5	14.8	12.3	11.7	12.2	10.7	13.3	11.6	12.6
FBR	11.8	12.9	11.0	10.3	10.6	9.6	12.0	9.3	10.9
FFI	11.7	13.3	11.8	12.3	12.8	13.0	13.0	11.9	12.5
MCT	9.6	9.7	9.3	9.1	9.3	10.6	9.2	10.0	9.6
Average	13.8	16.8	13.3	15.1	12.7	14.0	14.0	14.2	14.2
Grand Average per Firing Position	15.3		14.2		13.3		14.1		

B. Average Time in Seconds by Malfunction Type, Day versus Night

	Malfunction Type: FJ	FFR	FX	FF	FBR	FFI	MCT	Grand Average per Light Condition
Day	12.8	9.2	26.0	13.1	11.4	12.3	9.3	13.4
Night	13.8	9.9	36.2	12.2	10.5	12.6	9.8	15.0

Over-All Grand Average for Noncombat-Experienced Subjects: 14.2 Seconds.

The data appearing in the tables as reported for the FBR malfunction also include the time for the test subjects to change a magazine. As this malfunction only occurs following the firing of a last round in the magazine, if timing of the malfunction depends on the firing of a subsequent round then the total elapsed time must also include the time to change magazines. The FBR and MCT categories of data are therefore defined as follows:

a. MCT is the average time to change magazines as recorded when firers were attempting to change magazines as rapidly as possible.

b. FBR is the very same event except that the bolt had failed to remain rearward following the firing of the last round in the previous magazine.

It must be emphasized that all other references to FBR are to the event just described and not to a true FBR time. This latter subject is discussed in detail in paragraph 2.5.3.2c.

Note also that only one category of feeding failures is reported instead of a breakdown into categories of FF/BOB and FF/BB as previously intended. This limitation in data collection occurred because the test monitors could not consistently determine visually which subtype of the malfunction had occurred. The limitation had not been apparent in the pilot studies that were previously conducted but did occur in the full-scale test where, in many instances, it was found that the test subjects inadvertently but effectively obscured the monitor's view of the rifle ejection port while attempting to clear the malfunctions as quickly as possible.

For this reason, only a single category for feeding failures is listed although an estimate of subtype values can be made based on the APG firings. This estimate would indicate that the FF/BOB down time at USAIB (standing, daylight) was approximately 17 seconds while the FF/BB was approximately 8 seconds. The estimate is made by doubling the average USAIB value of 11.6 seconds and assigning 68% of this as FF/BOB time and 32% as FF/BB time. Similar estimates can be made for FF data reported under other test conditions. It should be pointed out that the estimate presumes an equal likelihood of either subtype occurring; i.e., the USAIB data for FF is not overloaded with one or the other of the subtypes. This presumption appears valid although it cannot be confirmed.

2.4.3 Discussion

The USAIB test results were forwarded to APG for statistical analysis and this analysis plus other comments are given in paragraph 2.5.

2.5 PHASE V, DATA ANALYSIS

Data from the USAIB tests are discussed and the results of statistical analysis are given in the following paragraphs.

2.5.1 Introduction

As explained previously, 64 combat-experienced and 40 noncombat-experienced troops were subjected to the various firing tests at USAIB. Utilizing eight firing positions, tests were conducted with groups of eight subjects at a time through each of four firing positions during both daylight and darkness. The usual practice was to complete both the daylight and darkness exercises on the same date with one group of eight firers. This method resulted in eight recorded down times (occasionally less) for each of seven malfunction categories (counting magazine change time as a malfunction category) for each of four firing positions for each of the two light conditions. In order to reduce the total data to a more workable amount for the analysis, it was decided to average the times for each 8-man group which provided 56 average down times per group (seven malfunction categories times four positions times two light conditions).

An analysis of variance technique was then employed to make comparisons of the clearing times within, as well as in combination, for the four factors of the study; training level (combat versus noncombat), light condition, firing position, and malfunction type. The design comprised a 4-factor fixed-effect factorial with replications. The model includes main effects and all possible interactions. The technique consists of partitioning the total variation of individual times about a grand mean into variations due to differences between levels of the four factors as well as for differences due to various interactions of the factors. Whenever significant effects were found by the statistical tests, an attempt was then made to find which differences were the major causes of significance.

2.5.2 Results

The results of these initial statistical tests are summarized in Table 2.5-I. By reference to statistical tables, and considering the appropriate degrees of freedom, the computed "F" ratios were examined to determine if significant effects existed. Footnotes in Table 2.5-I, F-ratio column, designate the statistical significance level (10%, 5%, and 1%) as well as identifying where significant effects or differences were detected.

Table 2.5-I. Analysis of Variance Results

Source	Degrees of Freedom	Mean Square	F-Ratio
T = Training level (combat versus noncombat)	1	27.12	1.06
L = Light condition	1	47.57	1.86
P = Firing position	3	63.85	2.50
M = Malfunction type	6	7709.96	[a]302.20
T x L interaction	1	125.96	[b] 4.94
T x P interaction	3	13.57	0.53
T x M interaction	6	107.88	[a] 4.23
L x P interaction	3	10.05	3.94
L x M interaction	6	50.59	[c] 1.98
P x M interaction	18	26.98	1.06
T x L x P interaction	3	43.44	1.70
T x L x M interaction	6	146.50	[a] 5.74
T x P x M interaction	18	12.81	0.50
L x P x M interaction	18	13.05	0.51
T x L x P x M interaction	18	18.30	0.72
Within (error)	616	25.51	
Total	727		

[a]Significant at 1% level.
[b]Significant at 5% level.
[c]Significant at 10% level.

2.5.3 Discussion

2.5.3.1 Discussion of Prime Factors. The data in Table 2.5-I show that significant differences exist within the prime factor of malfunctions but not within any of the remaining three prime factors. This analysis is intuitively supported by the data previously presented in Tables 2.4-I through 2.4-III where the magnitude of differences of means within prime factors is extremely samll for three of the four factors. Between night and day firing the mean difference was 0.5 second (Table 2.4-I, 14.2 - 13.7 seconds), between firing positions the difference was 1.4 seconds (Table 2.4-I, 14.6 - 13.2 seconds), and between training levels the difference was 0.4 second (Tables 2.4-II and -III, 14.2 - 13.8 seconds). On the other hand, the magnitude of difference between malfunctions was 25.4 seconds (Table 2.4-I, 32.9 - 7.5 seconds).

The statistical analysis of the prime factors does not rule out the possibility that significant differences exist as a result of interaction effects where, for example, a significant difference may exist between the time to clear an FX during daylight as compared to darkness. The important distinction is that statements about prime factors are statements of over-all effects and that it is not a contradiction to find exceptions among interaction effects which deal directly with specific segments of the data. The analysis of interaction effects is discussed in subsequent paragraphs (2.5.3.3 through 2.5.3.5).

2.5.3.2 Discussion of Differences within Malfunctions. As significant differences were detected only within the prime factor of malfunctions it is worthwhile to pursue the analysis further to detect where these differences occur.

For this purpose, a statistical multiple comparison test was employed (Scheffe's method was selected), but prior to that the data in Table 2.4-I were first examined. From the table it can be seen that the magnitude of differences between the mean time for the FX and any other malfunction is substantially greater than for any other pair of malfunctions and, as might be expected, the subsequent statistical analysis showed that there was a significant difference between the FX and all other malfunctions.

Listed below are the results of comparing average times. It is pointed out that by the multiple comparison test one selects the principal contributions to the over-all differences. One cannot necessarily conclude that no other significant differences exist although it can be inferred that it would be a smaller difference than any of those listed.

a. FX is significantly higher than all other types.

b. FF1 is significantly higher than FFR, FBR, and MCT.

c. FJ is significantly higher than FFR, FBR, and MCT.

d. FF is significantly higher than FFR, and MCT.

e. FBR is significantly higher than FFR.

Best estimates of the magnitude of the significant differences cited above can be obtained from Table 2.4-I by subtracting mean values. For example, a significant difference is claimed to exist between FF (feeding failure) and MCT (magazine change time). Table 2.4-I shows that the best estimate of this difference is 2.5 seconds. Note that this is a statistically significant difference, as are all the cited differences, and that without further analysis it should not be presumed that these differences also exist as tactically meaningful differences. Further comments on this subject follow, and it is emphasized that these comments are the opinions of the engineering test agency and may or may not coincide with opinions based on the experience of user agencies.

a. FX Malfunction. This malfunction is unquestionably the most serious malfunction among those investigated in this study and, prior to test, was fully expected to rank well above all other malfunctions with regard to the required down time to clear the stoppage. It is the opinion of the test agency that the statistically significant differences that exist between the FX and all other malfunctions are also significant from a tactical standpoint. In addition, there are two important factors which do not appear in the tabulated data or in the statistical analysis for the FX which place this malfunction in an even more serious category.

The first factor is the use of the special extraction tool illustrated in Appendix I which all test firers used (both APG and USAIB) as an aid in clearing the FX case from the chamber. It was anticipated at the time of test that this tool would eventually become a standard issue item. The future of the extraction tool is unknown by the test agency but there is no doubt that if the test subjects had been required to assemble cleaning rods prior to clearing the malfunction, or permitted to use the bayonet as an extraction tool, the times to clear FX malfunctions would have been greatly increased over those reported in this study. This opinion is considered valid even though the special extraction tool could not always be employed to its full design potential by the test subjects due to the specially modified FX cartridges (see paragraph 2.2.2).

The second factor regarding the seriousness of the FX was observed during USAIB tests where it was noted that many firers were unable to clear the FX malfunction and the exercise was terminated without a recorded time. These instances were attributed to the inherently difficult nature of the FX malfunction and not to limitations of the extraction tool. Test subjects were permitted approximately 1-1/2 minutes to clear the malfunction and 115 FX trials were not completed within this time. This represents approximately 14% of all attempts to clear the FX at USAIB and this observation is not reflected in the summarized data.

It therefore appears reasonable to estimate that when an FX occurs, approximately 14% of the occasions will effectively render the rifle unserviceable and the remainder of occurrences will require, on the average, 33 seconds to clear, providing that an extraction tool or other device is readily accessible and quickly usable.

b. Magazine Change Time (MCT). As the infantry rifle is often called on to provide a relatively brief but intensive sustained-fire capability, any delay in maintaining fire may be equally undesirable regardless of whether it is an anticipated interruption, as is MCT, or whether it is an unexpected interruption, as are the various malfunctions. If it is assumed that down time, regardless of source, is equally undesirable then it appears that MCT is a significant factor in the operational reliability characteristics of the rifle system, an MCT delay averaging 8 to 9 seconds occurs 50 times for each 1000 rounds fired. Because of this inherent down time characteristic of the M16A1 rifle and magazine, and because it apparently is acceptable or at least is accommodated, it is the opinion of the test agency that malfunctions in the M16A1 rifle only become tactically significant if they fall into any one of the following categories:

1) Require average clearing times greater than 15 seconds, as the FX does.

2) Become repetitious in nature with a high consecutive incidence, as an FJ often does.

3) Are likely to result in a firmly jammed and difficult to clear rifle as may happen with the FX, FF1, and the FF malfunctions. (Note: All of these malfunctions remained unclearable more than 10% of the time after approximately 1-1/2 minutes in the USAIB tests. It is probable that many of the FF malfunctions were of the FF/BOB subtype although data are not available to confirm this.)

While every effort should be made to eliminate all malfunctions from the rifle system, it is unlikely that easily cleared (15 seconds or less), randomly encountered malfunctions (as on the order of 2 per 1000 rounds fired) can be considered tactically significant when the total down time per 1000 rounds fired would be 30 seconds as compared to a total down time of 450 seconds to accomplish magazine exchanges in the same interval.

Although the 15-second clearing time cited in the previous paragraphs is somewhat arbitrarily chosen, it appears logical within the context of the discussion of MCT and it divides all relatively easy to clear malfunctions from the usually catastrophic FX category.

c. FBR Malfunction. The purpose of this paragraph is to provide an estimate of the true FBR time and to comment on a number of observations that were made during test concerning this malfunction.

True FBR time is defined as the penalty imposed on the firer when this malfunction occurs by extending the normal MCT. Two factors are highly relevant here; one factor is that the statistical multiple comparison tests indicated that there was probably no significant difference between average MCT times and FBR times (keeping in mind that the recorded FBR times presumably included normal MCT times) and the second factor was detected during test when it was noted that some firers were completely unaware that an FBR had occurred. It should also be noted that in some exercises (foxhole and prone positions, night firing, Table 2.4-III) that the average FBR time was less than the MCT.

It was observed during the pilot exercise at USAIB that some firers, after inserting a loaded magazine, released the bolt from the bolt catch by rapidly pulling rearward and then quickly releasing the charging handle, rather than depressing the bolt catch and thus releasing the bolt. Either method is suggested in TM 9-1005-249-12 (Operator and Organizational Maintenance Manual for M16A1 Rifle) depending upon whether the bolt was initially in the closed or open position. However, the charging handle procedure is successful irrespective of the bolt position and it is suspected that many firers adopt this method for this reason for all magazine loadings.

Firers which were accustomed to employing the charging handle method, upon receiving the "signal" that the rifle was out of ammunition, withdrew the empty magazine, inserted a loaded magazine, exercised the charging handle, and resumed firing. They often did not notice, or did not appear to notice, the position of the bolt. If an FBR occurred, it apparently was ignored and presented no difficulty or delay to the firer.

In considering the significance of this malfunction, it also appeared important that the out-of-ammunition signal usually came not from visual observation of the rifle (bolt rearward, magazine empty) but from an intuitive sense of how many rounds had been fired combined with a physical signal transmitted by the trigger; the trigger was pulled and the rifle failed to fire. A magazine exchange then took place with little difficulty irrespective of the position of the bolt.

As slight differences in mean values in Table 2.4-I through 2.4-III favor the FBR down time as slightly longer than the MCT values, a statistical analysis of the range of probable mean value of true FBR time was computed (mean FBR time minus mean MCT equals true mean FBR time).

This analysis does not necessarily present a contradiction to the previous statistical analysis which failed to find a significant difference between FBR and MCT mean values, as the question now being asked is, if a difference does exist, what is the range of this difference. The question is logical and the answer is important as it suggests what the consequences would be when claiming that no difference between FBR and MCT exists if, in fact, a difference does exist. Furthermore, if the examined difference can be judged to be of little or no tactical significance then it can be stated that for practical purposes one no longer need be concerned with the possibility of an error in the original comparison.

The statistical analysis showed the range of true mean FBR time to be as follows while applying an 80%, 2-sided confidence limit:

1) Between 1.9 and 2.7 seconds for combat-experienced troops.

2) Between 0.6 and 2.2 seconds for noncombat-experienced troops.

3) Between 1.6 and 2.8 seconds during daylight exercises for all troops.

4) Between 1.0 and 2.2 seconds during nighttime exercises for all troops.

5) And for all tests, all conditions, between 1.5 and 2.3 seconds.

NOTE: Values for 90%, 1-sided confidence limits may be obtained by using only one of the two limits in each instance.

Considering the above data in conjunction with the observations made during the test, it is the opinion of the test agency that, on the average, the FBR malfunction is not tactically significant in terms of down time penalty to the firer.

2.5.3.3 Discussion of First Order (2-Factor) Interaction Effects. In Table 2.5-I the six 2-factor interactions were examined for significant effects and significant differences were found to exist in three of these. Each of these interactions is discussed in the following paragraphs.

a. Training Level versus Light Condition. The significant differences in this interaction show that the combat-experienced troops responded differently when encountering a malfunction, if the factor of light condition is considered, than did the noncombat-experienced subjects. While the combat troops were not significantly affected by a nighttime operation, the noncombat troops were, and the best estimate of the increased down time penalty is obtained from Tables 2.4-II and 2.4-III by subtracting mean values. For convenience, these values are listed in Table 2.5-II.

Table 2.5-II. Mean Values, Training Versus Light Condition

	Down Time, sec		
	Day	Night	Average
Combat troops	13.9	13.8	13.8
Noncombat troops	13.4	15.0	14.2
Average	13.6	14.4	14.0
Absolute difference	0.5	1.2	0.4

While these data suggest that nighttime operations during basic training might be increased to improve operational reliability of the M16A1 rifle, it is not known to what extent this would have to be applied to approach or equal the on-the-job training experience of the combat veterans. Furthermore, the 1.2 second longer average down time may not be a tactically significant difference between combat- and noncombat-experienced troops.

b. Training Level versus Malfunction Type. Again, in this interaction, combat troops responded differently to "certain" malfunctions than did noncombat-experienced troops. The mean values from Tables 2.4-II and 2.4-III are given in Table 2.5-III.

Table 2.5-III. Mean Values, Training Versus Malfunction Type

	Down Time, sec							
	FJ	FFR	FX	FF	FBR	FFI	MCT	Avg
Combat troops	13.0	6.2	34.0	10.6	10.7	13.9	8.4	13.8
Noncombat troops	13.3	9.5	31.1	12.6	10.9	12.5	9.6	14.2
Average	13.2	7.8	32.6	11.6	10.8	13.2	9.0	14.0
Absolute Difference	0.3	3.3	2.9	2.0	0.2	1.4	1.2	0.4

The statistical analysis, showed that the key malfunctions, those that evidenced a statistically significant difference in this phase of the study, were the FFR and FX malfunctions. Combat troops were unable to clear the FX malfunction as readily as were the noncombat troops but the combat troops cleared the FFR malfunction in less time than did the noncombat-experienced subjects. However, an inspection of individual monitor worksheets disclosed that the noncombat-experienced troops were apparently not as proficient in clearing the more difficult FX malfunctions and, in comparison to the combat troops, they were twice as likely to fail entirely to clear a difficult FX. This factor is judged to be much more significant, tactically, than is the difference between 34.0 and 31.1 seconds which were the average times recorded for clearable FX malfunctions between the combat- and the noncombat-experienced troops respectively.

c. Light Condition versus Malfunction Type. The statistical comparison test applied to this interaction indicated that significant differences existed in the ability of the subjects to clear certain malfunctions, depending upon the light condition. A summary of the mean differences is listed in Table 2.5-IV.

Table 2.5-IV. Mean Values, Light Condition Versus Malfunction Type

	Down Time, sec							
	FJ	FFR	FX	FF	FBR	FFI	MCT	Avg
Day	12.2	7.1	31.6	11.6	10.9	14.1	8.6	13.7
Night	14.0	7.9	34.2	11.2	10.7	12.6	9.1	14.2
Average	13.1	7.5	32.9	11.4	10.8	13.4	8.8	14.0
Absolute Difference	1.8	0.8	2.6	0.4	0.2	1.5	0.5	0.5

As might be deduced from the data above, the significant value concerns the FX malfunction. The average mean difference of 2.6 seconds between day and night firing, however, may not be a tactically significant difference when it comes "on top of" an average time of approximately 30 seconds which is required to clear this serious malfunction in either daylight or darkness.

2.5.3.4 Discussion of Second Order (3-Factor) Interaction Effects. Information obtained from an analysis of second order effects in this study had the potential of indicating very specific problem areas which might be correctable, at least to some extent, by concentrating on these specific conditions during training. This potential is due to the nature of the questions asked and answered by this analysis. For example, given that no significant over-all difference exists between combat and noncombat troops, and further, that no significant over-all difference exists between combat troops during daylight only and noncombat troops during daylight only, are there then any significant differences between combat troops in daylight and noncombat troops in daylight that are a function of one or more of the four firing positions? If the answer is yes, then it could be directed that the "difficult" positions be the only ones employed during malfunction clearing operations in the training cycle.

However, by reference to Table 2.5-I it can be seen that the only significant difference in the second order interactions occurs when one examines the individual malfunctions as a function of training level and light condition. And, as previous analysis has so often indicated, the major contributing factor to these differences is the failure-to-extract malfunction. Unfortunately, the data do not reveal a meaningful pattern except to re-emphasize the seriousness of the FX malfunction.

2.5.3.5 Discussion of Third Order (4-Factor) Interaction Effects. With all of the previous stages of the analysis completed, the sensitivities and characteristics of the data are presumably well defined, at least from the statistical aspect. The only remaining question is to consider all of the individual cells of the data and to examine them to determine if, through some unique arrangement of factors alone, the data in any one cell are statistically different from other cells. To cite a hypothetical example, is there any 4-factor combination which, due only to the particular combination of factors, provides FX data on the order of 5 seconds? The answer to the hypothetical question is "no," and the answer also is negative for the actual results of the third order interaction analysis. None of the 4-factor combinations provide data statistically different from the pattern of differences already detected.

2.5.3.6 Relation of Test Results to Rifle Acceptance Criteria. Present acceptance test criteria for a single rifle, as established in Small Arms Purchase Description (SAPD) 253F (22 November 1968), permit the malfunctions shown in Table 2.5-V to occur in a 6000-round endurance test.

Table 2.5-V. Rifle Acceptance Criteria

Malfunction	Number Permitted
Failure of bolt to lock	2
Failure to fire	2
Failure to feed from magazine	4
Failure to eject	2
Failure to chamber	3
Failure to extract	1
Bolt fails/hold rear	3
All other malfunctions	0
Total - above malfunctions combined	9

As failure of bolt to lock, failure to chamber, and failure to feed from the magazine are all subtypes of the FF malfunction (although the SAPD does not clearly explain the difference between the first two subtypes), the criteria also can be written as shown in Table 2.5-VI using the malfunction abbreviations of this report.

Table 2.5-VI. Rifle Acceptance Criteria (Grouped)

Malfunction	Number Permitted
FF	9
FFR	2
FJ	2
FX	1
FBR	3
Other	0
Total - above malfunctions combined	9

By reference to the average down time values in Table 2.4-I, it can be seen that if down time is considered as a measure of acceptability then a rifle could experience six FF, two FJ, and one FX for a maximum possible down time of 135.5 seconds, and still be rated as acceptable. This total presumes the worst combination of malfunctions, six FF, two FJ, and one FX, and that four of the FF malfunctions are of the FF1 type at a value of 13.4 seconds each (the FF1 presumably is scored as a magazine feeding failure during acceptance tests).

If no more than nine malfunctions should be permitted in 6000 rounds and if the total down time should not exceed 136 seconds, it would then appear, with regard to the results of this study, that the acceptance criteria could be more realistically stated as follows:

a. In order to restrict the potentially unclearable malfunctions, no more than one FX, or FF1, or FF/BOB is permitted.

b. In order not to reject rifles on low down times only, no more than nine FFR, or FJ, or FF, or FBR, or any combination of these not exceeding nine, are permitted.

c. In order to include an unspecified malfunction, no more than one unspecified malfunction is permitted, except that if one FX, or FF1, or FF/BOB also occurs during test, then the unspecified malfunction shall not be permitted if clearing action requires more than a single exercise of the charging handle, the bolt device, or the trigger.

d. In order to maintain the maximum limit of nine, no more than nine malfunctions of any type or subtype shall be permitted.

These criteria maintain the present 9-malfunction limit within a maximum down time of 138 seconds but would tend to restrict the more serious malfunctions, in comparison to the present criteria, while not rejecting rifles with low down time totals. Note that the present criteria excludes rifles which experience more than three FBRs, or approximately 6 seconds of total down time (true FBR time being approximately 2 seconds).

2.5.3.7 Comments by USAIB. In a letter (Reference 3) transmitting the USAIB test data to Hq, USATECOM, there also were contained several paragraphs of comments by USAIB test personnel relative to observations made during the USAIB tests. These comments appear particularly applicable to some of the key human factors problems which are closely related to the operational reliability level of a personal, hand-held weapon system. The USAIB comments were followed by several recommendations and conclusions and the comments, recommendations, and conclusions are extracted from the letter and presented here, at the request of Hq, USATECOM, as follows:

a. Comments (USAIB).

"(1) Combat experienced test soldiers euphemistically characterized all malfunctions as "jams" and appeared to have evolved their own method of immediate action based on a combination of current doctrine and personal experience. They did not exhibit any pronounced confidence in the approved method of reducing malfunctions, and remembered little of previous training. Some of these test soldiers were unaware of the existence of an approved method and could not remember ever having been so taught. Those test firers who had just completed basic training were aware of the approved procedure but exhibited little confidence because of the brief time alloted to this subject during basic training. The ability of this second group of test soldiers to clear a malfunction seemed to be based to a considerable degree on a method of trial and error accumulated in firing the M16A1 during basic training.

"(2) It was apparent that considerable misinformation existed among the test soldiers as to exactly what they were supposed to do in clearing a malfunction. No test soldier could adequately describe more than two malfunctions, the most common of these being failure to fire, failure to extract, and failure to feed. During daily orientation it became evident that most test soldiers felt the first step in immediate action for any malfunction was to replace the magazine with a new magazine. Additionally, many test soldiers believed that a cleaning rod had to be used to clear a failure to extract malfunction. The majority said they cleared a failure to fire malfunction by simply tapping the bottom of the magazine and functioning the charging handle. It was apparent that there was considerable variation among the test soldiers as to the correct method to clear a malfunction.

"(3) Current procedures for reducing stoppages as outlined in Change 1 to FM 23-9 for the M16A1 rifle, dated 2 Feb 68, explain that the firer, to clear a malfunction "strikes the forward assist assembly to assure that the extractor has engaged the round (current USAIS teaching deletes this phrase), tapping up on the bottom of the magazine to insure it is fully seated, pulls the charging handle to the rear and observes for the ejection of a cartridge or case." Depending on whether or not the ejection occurs, the firer then either completes the charging cycle, strikes the forward assist assembly to assure bolt closure and attempts to fire or inspects the weapon to determine the cause of malfunction and appropriate further action. This procedure while appropriate for some malfunctions, tended to complicate four of the programmed malfunctions. In the case of these four malfunctions (failure to extract, failure to strip first round, failure to feed, and failure to eject) it was observed that this procedure only lengthened the time to clear the malfunction.

"(4) During each firing sequence, the noise of firing and the activity to his immediate left and right on the firing line distracted the test soldier and he usually charged his bolt without noticing whether or not a round, or expended cartridge case, had ejected. As a result the test soldier then often unknowingly fed a second round into an already obstructed chamber or receiver. Under the strain of combat and during the hours of darkness it is likely that the soldier would have neither the opportunity nor the ability to observe whether or not a round had been ejected. Under current doctrine ejection is important to immediate action. As stated, test soldiers tended to ignore current doctrine and usually only charged the bolt and/or changed magazines and attempted to continue firing. Observers on the firing line indicated the following variations in procedures: some soldiers looked in the chamber or receiver as they charged the bolt, some did not unless the weapon failed to fire after charging; some soldiers used the forward bolt assist either before or after charging the bolt handle, and some did not use the forward bolt assist at all. There was no discernible pattern to the manner in which the individual soldier attempted to clear his malfunctions and this was as true of the recently trained NCOC's as it was of combat veterans.

"(5) The "down times" posted as a result of the evaluation show only a very brief average time needed to clear a malfunction and return the weapon to action. These average times indicated a considerable degree of ability on the part of the test soldier in handling his weapon. This appears to be the result of a combination of factors, e.g., the test soldier's desire to do well within the semicompetitive frame of the special study, and his own past experience. This ability could not be clearly traced to any standardized military instruction. While the special study was adequate for its intended purpose, it did not sufficiently address certain training aspects, e.g., further refinement of a preferred system of clearing malfunctions and a "time to clear" stated as a training objective.

"(6) An added factor which makes diagnosis and correction of malfunctions more difficult with the M16A1 rifle, as compared to the M1 and M14 rifles, is that it has a closed receiver. Whether or not a cartridge case is ejected in the firing cycle, the position of the bolt, or the presence of obstruction, when a malfunction occurs, are not as readily apparent to the firer of the closed receiver rifle as they are with the open receiver rifles. The removal of an obstruction, such as occurs during a double feed or bolt override is more difficult to clear from the closed receiver rifle than from an open receiver one."

b. Conclusions (USAIB).

"(1) The existing doctrine (FM 23-9 w/Ch 1, 2 Feb 68) is not satisfactory and does not fully recognize the sophistication and peculiarities of the M16A1 weapons system.

"(2) Current Programs of Instruction (POI) for immediate action/remedial action do not allocate sufficient time during basic training for meaningful instruction which will remain with the soldier. There is no comprehensive attempt at immediate action drills or practical work exercises which would reinforce the procedure taught.

"(3) Additional testing is necessary to further develop a preferred method of clearing the weapon and a best time for each malfunction which can be taught as a training standard or objective."

c. Recommendations (USAIB).

"(1) FM 23-9 and appropriate TM's be modified to describe a more realistic method of immediate action/remedial action for clearing malfunctions.

"(2) Current POI's be modified to incorporate a more extensive practical exercise sequence of instruction designed to reinforce soldier learning in a manner directly related to its intended use in action.

"(3) Additional testing be planned to refine a preferred method of immediate action/remedial action and a set of best times to clear malfunctions.

"(4) The above be brought to the attention of the US Continental Army Command and other commands and agencies concerned with training and use of the M16A1 rifle."

SECTION 3. APPENDICES

APPENDIX I - TEST DATA

Definitions and Identifications of Malfunctions

Pages I-2 through I-16 are extracted from USATECOM Pamphlet on Definitions and Identifications of Malfunctions for 5.56-MM Weapons, November 1968. Copies of the complete pamphlet are available from Commanding General, US Army Test and Evaluation Command, ATTN: AMSTE-BC, Aberdeen Proving Ground, Maryland 21005.

Designation: FF1 - Failure to feed and chamber the first round from the magazine.

Description: This failure occurs when the bolt is manually released by depressing the bolt catch and the bolt and bolt carrier fail to move fully forward to feed and chamber the first round from a fully loaded magazine.

Probable Cause: This malfunction is usually the result of an accumulation of dirt or fouling in and around the bolt and bolt carrier, although it can occur as a result of a defective magazine, an improperly inserted or improperly loaded magazine, or a damaged (dented or bulged) round. In the case of an improperly loaded magazine, the projectile end of the top round in the magazine becomes inadvertently tipped down and the cartridge cannot clear the front of the magazine; this is often referred to as a "stubbed" round when describing the resultant malfunction.

Corrective Action: Use of the bolt-assist device will often overcome the malfunction by completing closure of the bolt. However, the carrier should not be forced home; if resistance is encountered, as may occur with a "stubbed" round, the bolt should be retracted and held to the rear while the magazine is removed and the malfunction cleared.

While repetitive occurrences of this malfunction may be temporarily overcome by lubricating the bolt carrier without disassembly, the weapon should be field-stripped, cleaned, and lubricated at the earliest opportunity.

Malfunction Subtypes: The malfunction subtypes, as listed on the FRR (Section II), depend upon the severity of the malfunction and are identified by the degree to which the carrier has failed to close. The various subtypes listed on the FRR are shown in Figures I-1 and I-2.

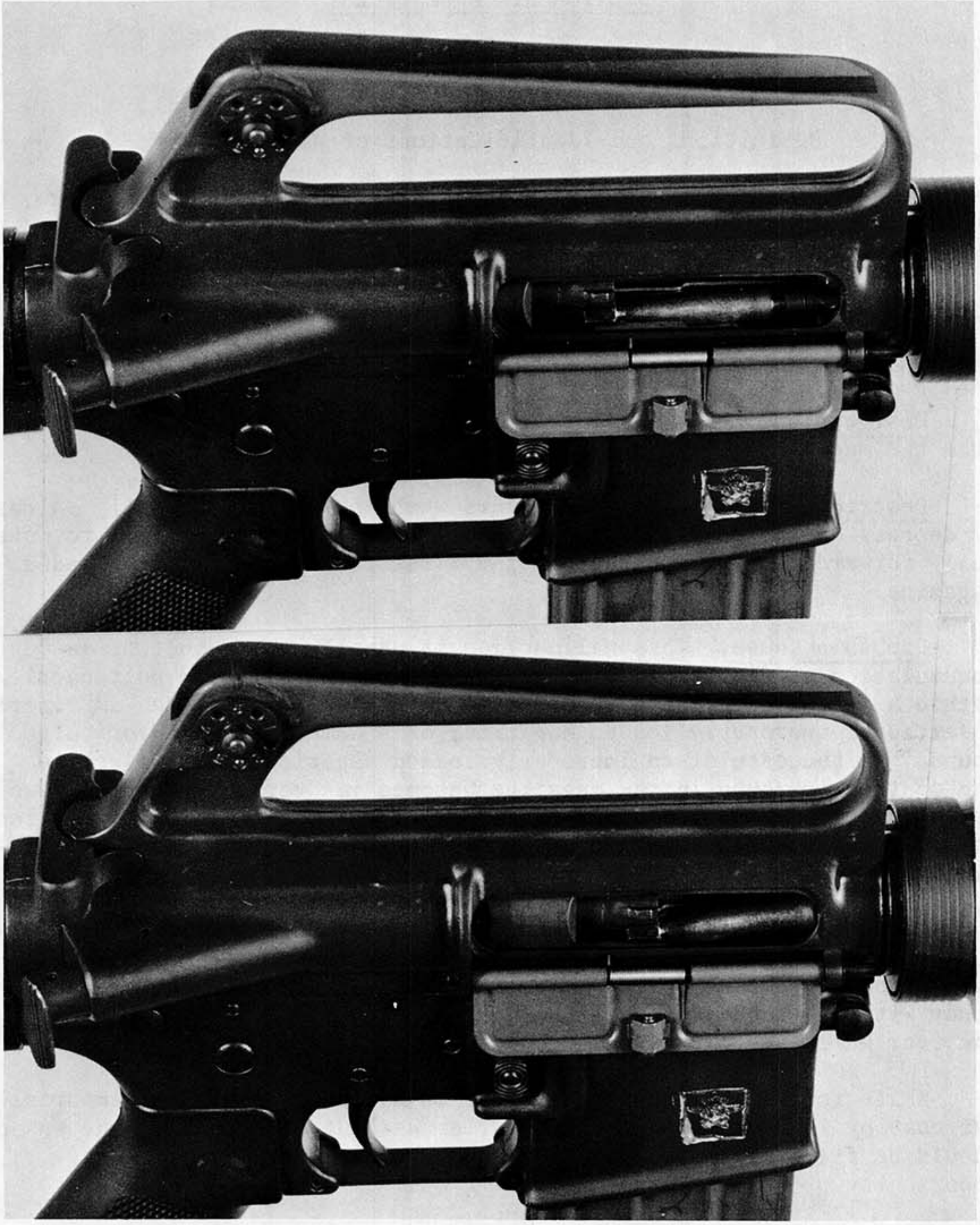

Figure I-1: Failures to Feed the First Round from the Magazine (FF1); Cartridge Fully Visible, Top and Partially Visible, Bottom.

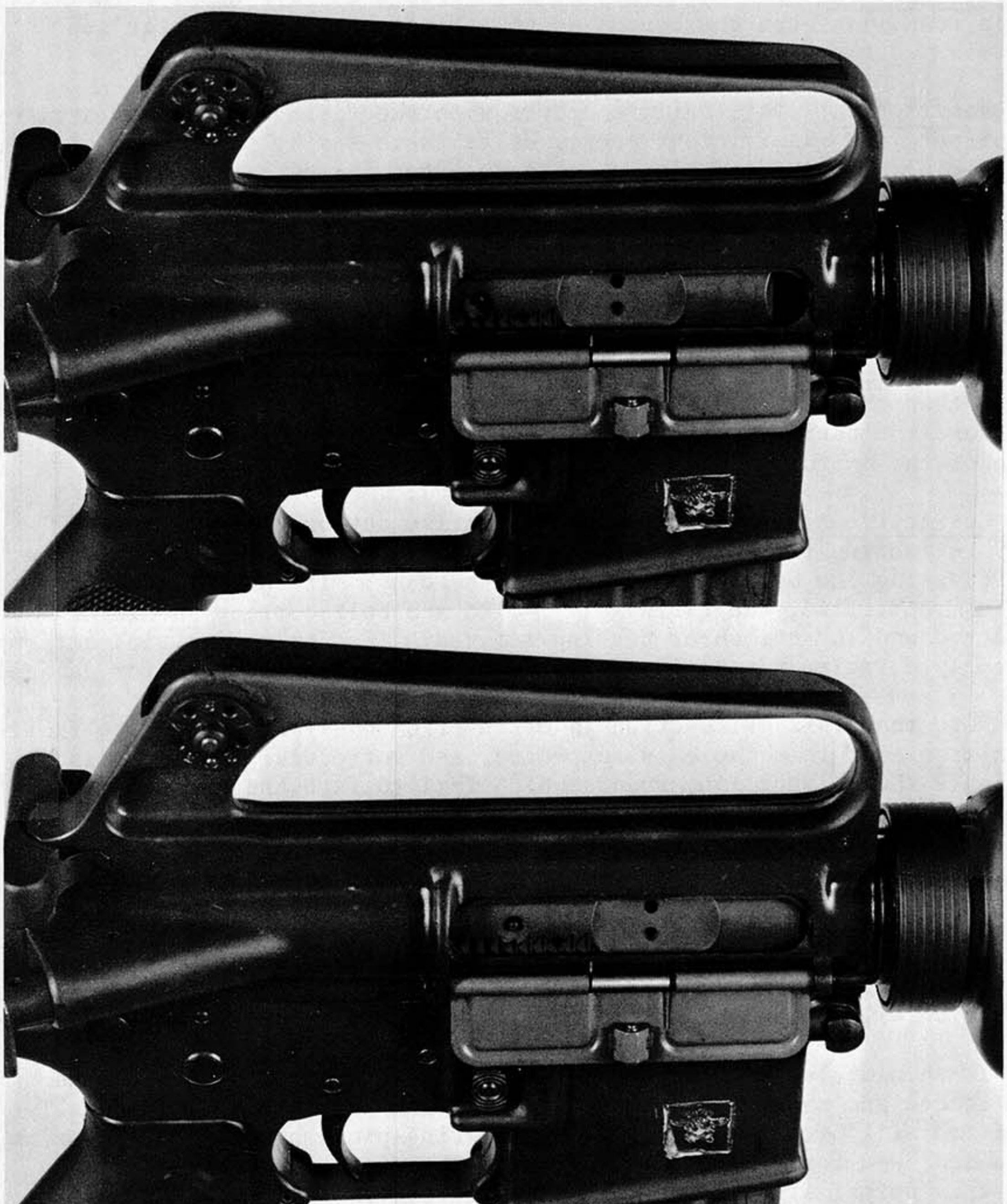

Figure I-2: A Failure to Feed the First Round from the Magazine (FF1) with the Bolt Carrier Not Fully Closed Is Shown at Top; Bottom View Shows the Bolt Carrier in a Normal and Fully Closed Position.

Designation: FFR - Failure of a cartridge to fire despite the fact that a round has been chambered and the trigger or the automatic sear has released the hammer.

Description: This failure occurs when the firing pin either strikes the primer with insufficient energy or fails to strike the primer at all. Superficial visual inspection usually does not indicate the nature of the malfunction and the weapon appears normal with the bolt carrier closed.

Probable Cause: Carbon or fouling accumulation on the firing pin, as shown in Figure I-3, is often the cause, and the full forward travel of the firing pin is restricted. This malfunction also occurs when the bolt carrier fails to fully close and the hammer strikes the carrier rather than the firing pin. However, the hammer striking the carrier may cause the carrier to move fully forward and, on inspection, the cause of the malfunction is not then apparent.

Corrective Action: Immediate corrective action can be taken by fully retracting the bolt, permitting the chambered round to be ejected, and releasing the bolt to chamber a fresh round. If this malfunction becomes repetitive, the firing pin, bolt, and bolt carrier should be inspected and any carbon or fouling removed. The firing-pin tip, although extremely durable in normal service, should also be inspected for damage.

Note that this malfunction is often erroneously attributed to faulty ammunition. If this cause is suspected, and corrective action fails to eliminate the malfunction, rounds which fail to fire and exhibit a normal firing-pin indent should be identified and stored and the responsible ammunition agency notified at once.

Malfunction Subtypes: Four subtypes of this malfunction are listed on the FRR (Section II) with three of the subtypes distinguished by the degree of firing-pin indent. These subtypes are illustrated in Figure I-4. The fourth subtype, carrier not fully closed, on initial visual inspection will appear to be the same as shown in Figure I-2.

It should also be noted that the primer of a cartridge which has been loaded and chambered during automatic gun action but intentionally not fired will often show a very light firing-pin imprint. This imprint is caused by a forward movement of the relatively free-floating firing pin; this normal signature effect may be quite indistinct with some weapons.

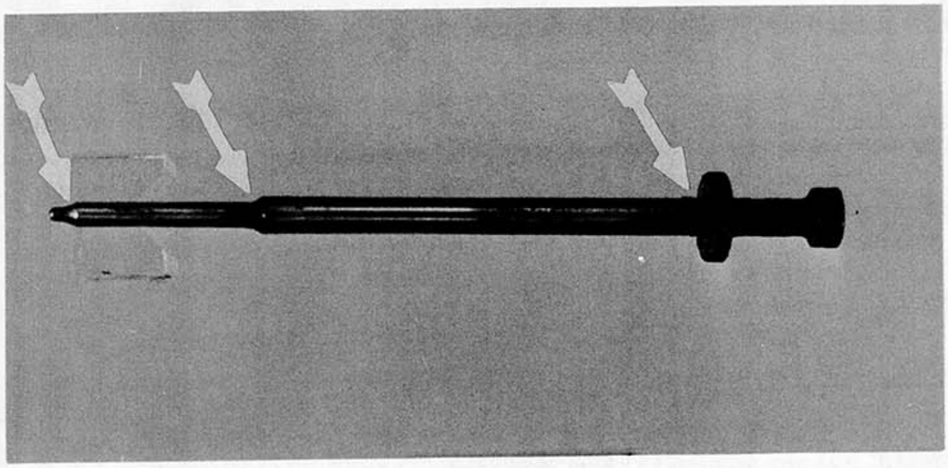

Figure I-3: Arrows Indicate Critical Areas Where Fouling Accumulation May Cause Failures to Fire (FFR).

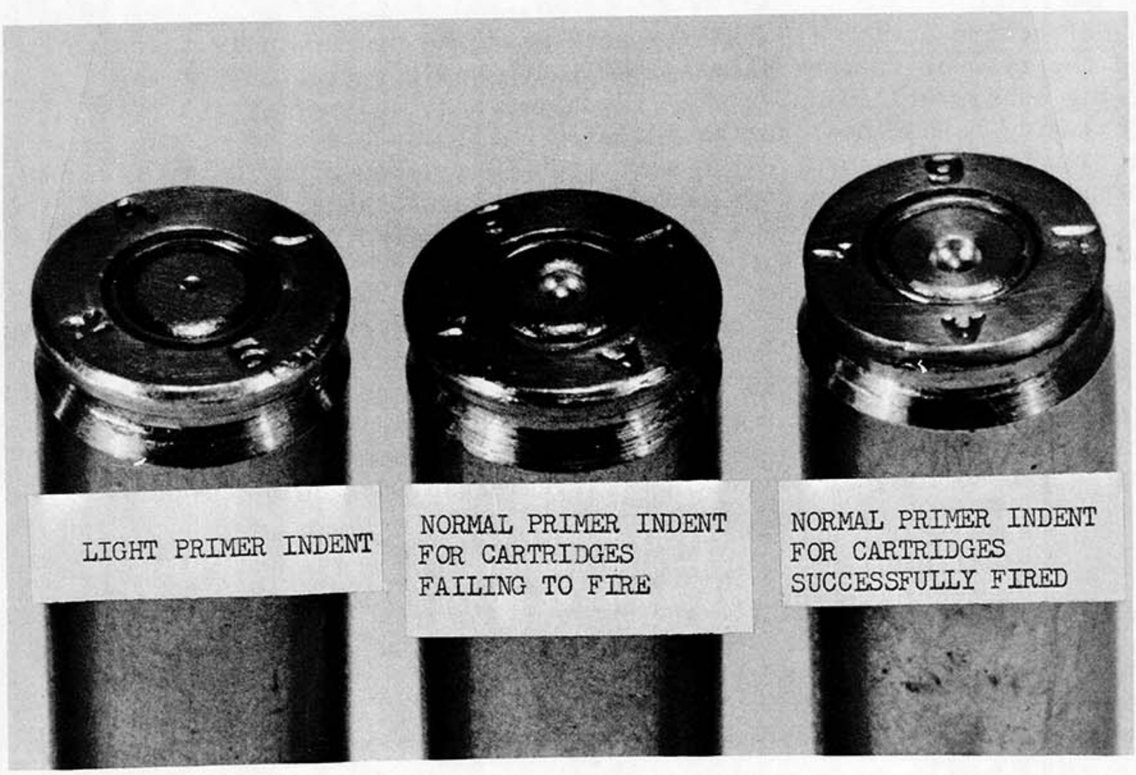

Figure I-4: Various Degrees of Primer Indent on 5.56-MM Cartridges. (Note that for cartridges successfully fired, the primer, and particularly the circumference of the primer indent, show a distinct flattening of the primer surface as a result of normal propellant pressure.)

Designation: FJ - Failure of a fired case to be completely ejected from the gun.

Description: Ejection of a fired case is a function of automatic gun action regardless of the mode of fire. A malfunction occurs when the fired case is not successfully cleared through the ejection port and becomes jammed in the mechanism as the bolt closes. On some occasions, the fired case, while initially clearing the gun, may strike an outside surface and bounce back into the path of the bolt. This is usually referred to as spin-back.

Probable Cause: Ejection failures are difficult to diagnose, but are often related to a weak or damaged extractor spring and, much less commonly, to a weak or damaged ejector spring. Failures to eject can also be caused by an accumulation of carbon or fouling on the ejector spring, on the extractor, and from short recoil. Short recoil is usually due to an accumulation of fouling in the mechanism[1] which may result in any of a number of failures including a failure to eject. Difficult extraction from a fouled or corroded chamber can also cause ejection failures.

Corrective Action: Immediate action should be carefully taken to avoid the risk of further jamming the gun. While retraction of the charging handle will usually free the fired case and permit its removal, the charging handle must not be released until the position of the next live round is determined. If a live round has been sufficiently stripped from the magazine, or in some cases completely stripped from the magazine, then the magazine and all live rounds may also require removal before the charging handle should be released.

If repetitive malfunctions occur and are not corrected by cleaning and lubricating, it is recommended that the ejector spring, the extractor spring, and the extractor be replaced even if damage is not apparent. The ejector itself does not often require replacement. Note that the extractor spring cannot be easily removed from the extractor without damaging the spring, although a new extractor spring can be properly installed, if care is exercised.

Malfunction Subtypes: The four subtypes of failure to eject listed on the FRR (Section II) are shown in Figures I-5 and I-6. On rare occasions a fifth subtype may be encountered where the fired case, which has not been successfully ejected, is found to be completely rechambered and the bolt is fully closed and locked. This should not be confused with a failure-to-extract (FX) which is discussed on page I-13.

[1]Short recoil may also be caused by a fouled or obstructed gas tube. This problem is discussed in the paragraph on miscellaneous malfunctions (MISC).

The determining factor in deciding whether a failure-to-eject or a failure-to-extract has occurred is the nature of the clearing action required to overcome the malfunction. If the fired case can be cleared by simply retracting the charging handle, a failure-to-eject has occurred; if difficulty is encountered to the extent that repeated charging handle cycles are required or if tools (cleaning rod, bayonet, special extractor tool) are required to clear the malfunction then a failure-to-extract has occurred.

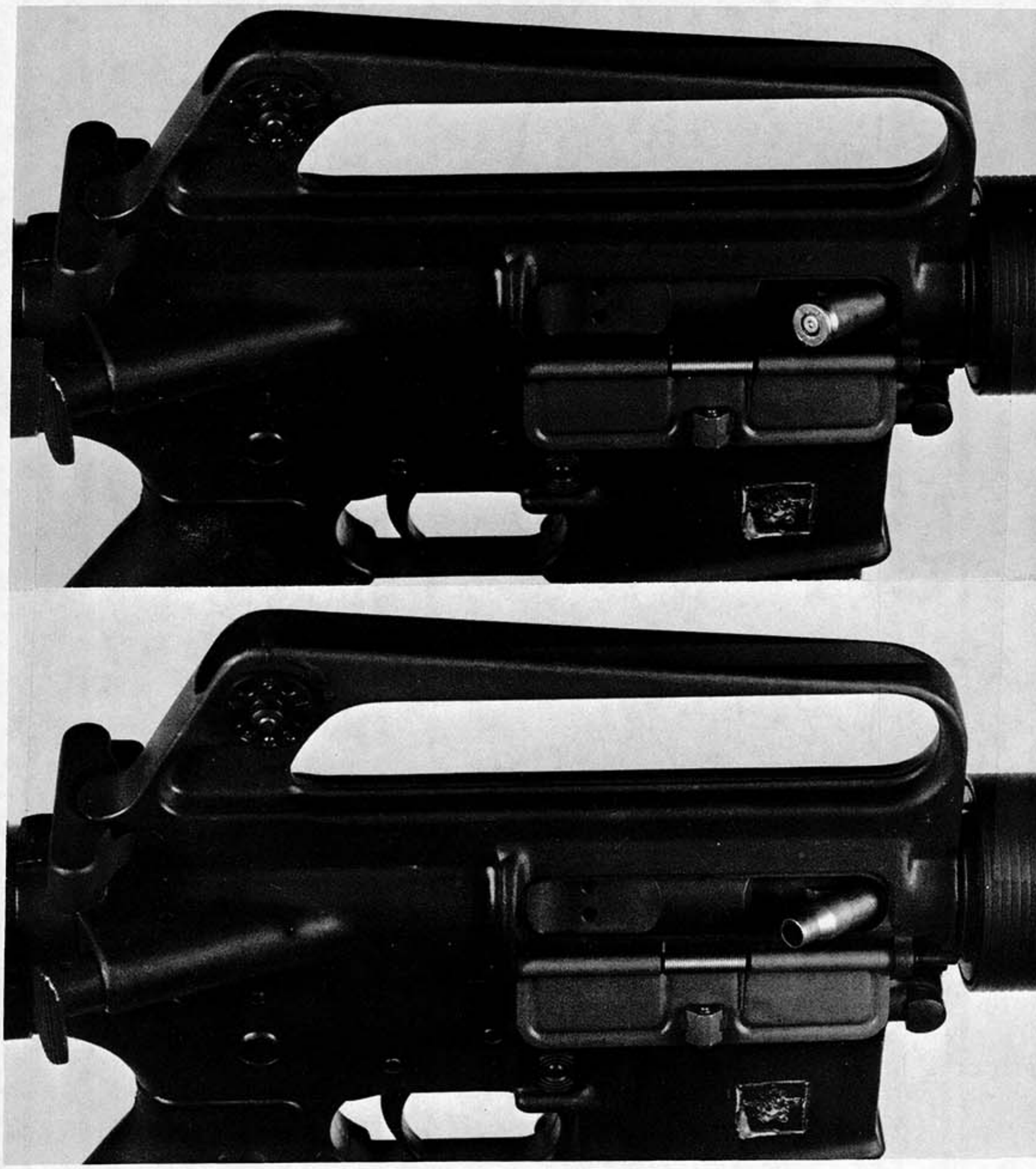

Figure I-5: Two Subtypes of Failure to Eject (FJ) Are Shown; Failure to Eject the Fired Case, Base Exposed, Top, and with the Fired Case, Mouth Exposed, Bottom.

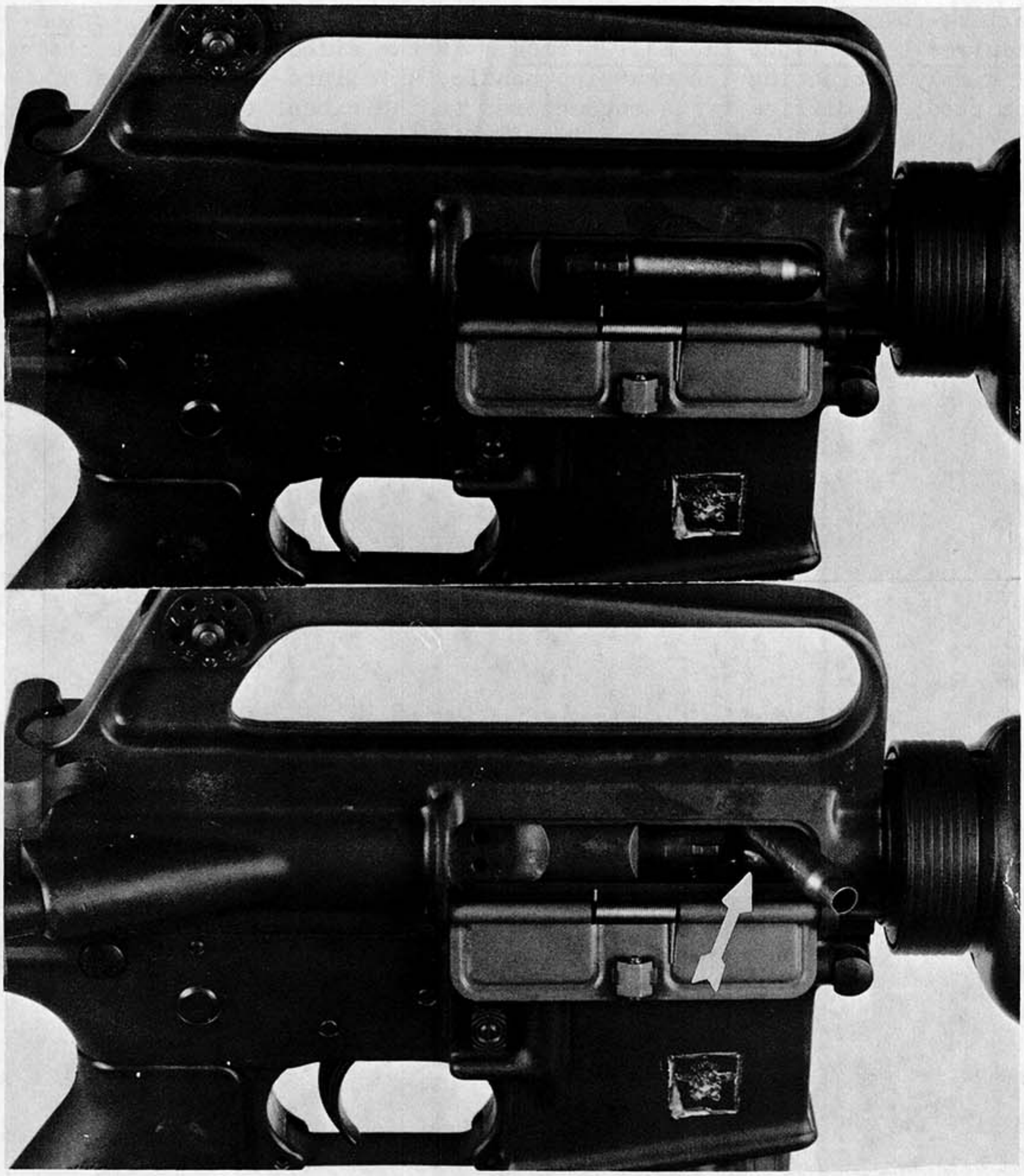

Figure I-6: Two Subtypes of Failure to Eject (FJ) Are Shown; Failure to Eject with No Portion of the Fired Case Outside the Ejection Port, Top, and Failure to Eject with a Live Round Also Jammed (Arrow Indicates Live Round).

Designation: FX - Failure of a fired case to be successfully extracted from the rifle chamber.

Description: A failure to extract results when the fired case remains in the rifle chamber.[1] While the bolt and bolt carrier may move rearward only a very short distance, more commonly the bolt and carrier recoil fully to the rear, leaving the fired case in the chamber. A live round is then forced into the base of the fired case as the bolt returns in counterrecoil. This malfunction is considered to be one of the most difficult to clear.

Probable Cause: Short recoil cycles or fouled or corroded rifle chambers are the most common causes of failures to extract. A damaged extractor or a weak or broken extractor spring can also cause this malfunction.

Corrective Action: The severity in nature of a failure to extract determines the corrective action procedures which will be successful. If the bolt has moved rearward sufficiently to engage a live round, the magazine and all live rounds must be removed prior to attempting to extract the fired case. A cleaning rod must then be inserted in the bore, or a special extractor tool used (Figure I-8), in order to remove the fired case. While the gun must be completely unloaded and the bolt and carrier retracted prior to insertion of the cleaning rod, the extractor tool can usually be used successfully and safely without magazine removal.

Where cleaning and inspection of the mechanism and the chamber reveal no deficiencies in these areas, and failures to extract persist, the extractor and extractor spring should be replaced. If the chamber surface is damaged, the entire barrel must be replaced.

Malfunction Subtypes: Various degrees of cartridge-case rim damage are shown in Figure I-7 and illustrate, together with Figures I-9 and I-10, the five subtypes of failure to extract listed on the FRR (Section II).

[1] The distinction between certain failures-to-eject (FJ) and a failure-to-extract (FX) is determined by the nature of the clearing action required to overcome the malfunction. This has been previously discussed in the section on the FJ malfunction. As the FX malfunction is considered to be an extremely serious malfunction, one that requires the use of tools to clear, it is essential that it be properly identified and reported. Relatively easy-to-clear failures-to-eject must not be incorrectly reported as extraction failures.

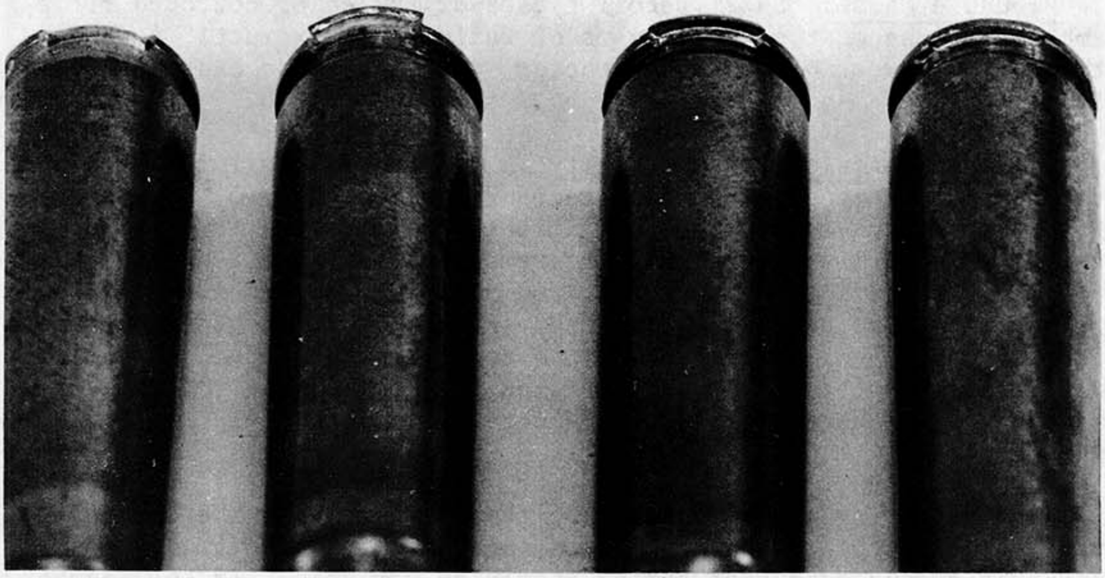

Figure I-7: Various Degrees of Rim Damage Which May Occur as a Result of a Failure to Extract (FX) Are Shown. (Cartridge rim at left is completely sheared, center two cartridges illustrate partial rim shears, while cartridge rim at right shows evidence of hard extraction. A normal extraction leaves only a faint and indistinct extractor mark on the cartridge case rim.)

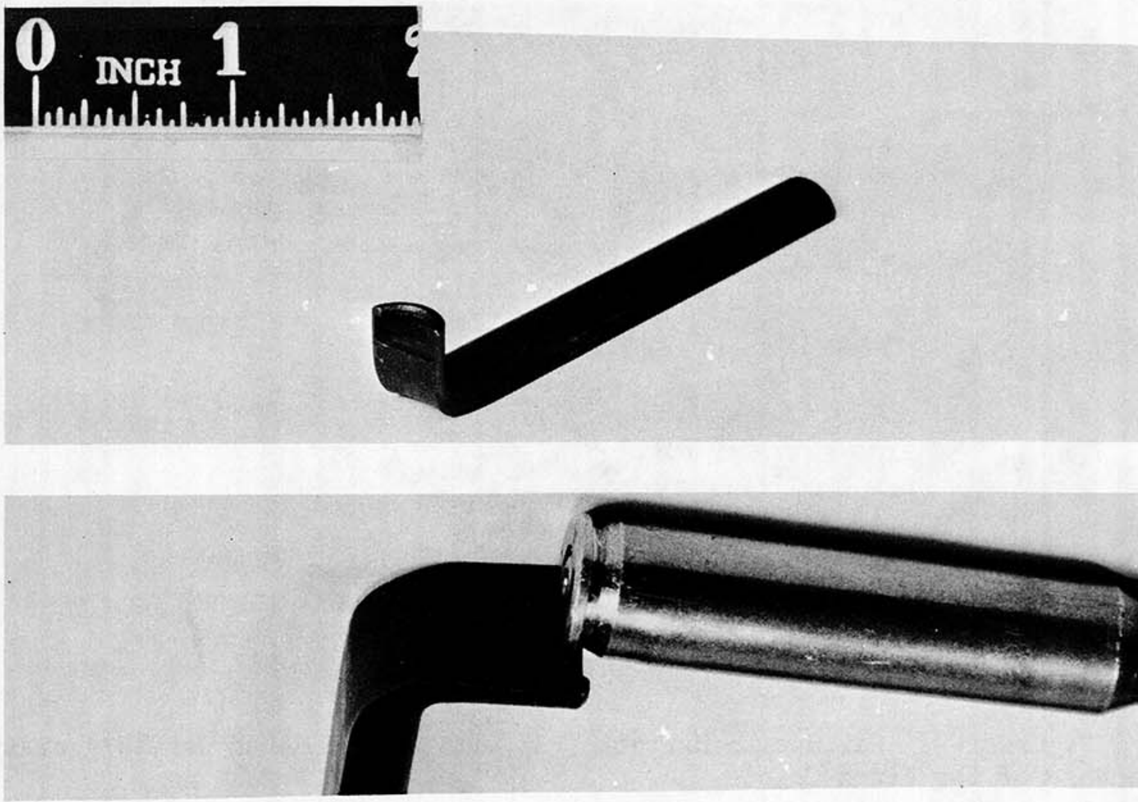

Figure I-8: The Special Extractor Tool, Top View Is Designed to be Inserted Through the Ejection Port Where the Curved Lip of the Tool Can be Positioned to Engage the Cartridge Rim, Bottom View. Force Exerted Through the Extractor Tool Is Usually Sufficient to Remove a Cartridge Case Which Has Failed to Extract after Being Fired.

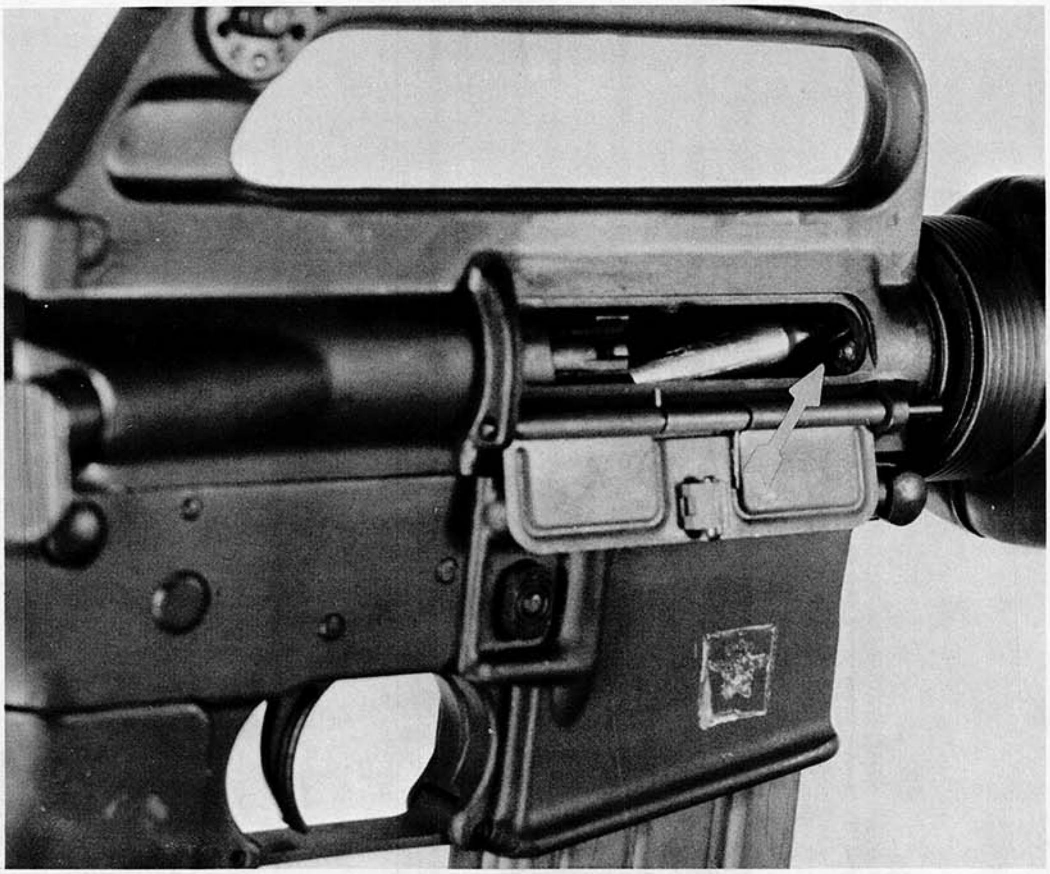

Figure I-9: Failure to Extract (FX) with a Live Round Jammed Against the Base of the Fired Case.

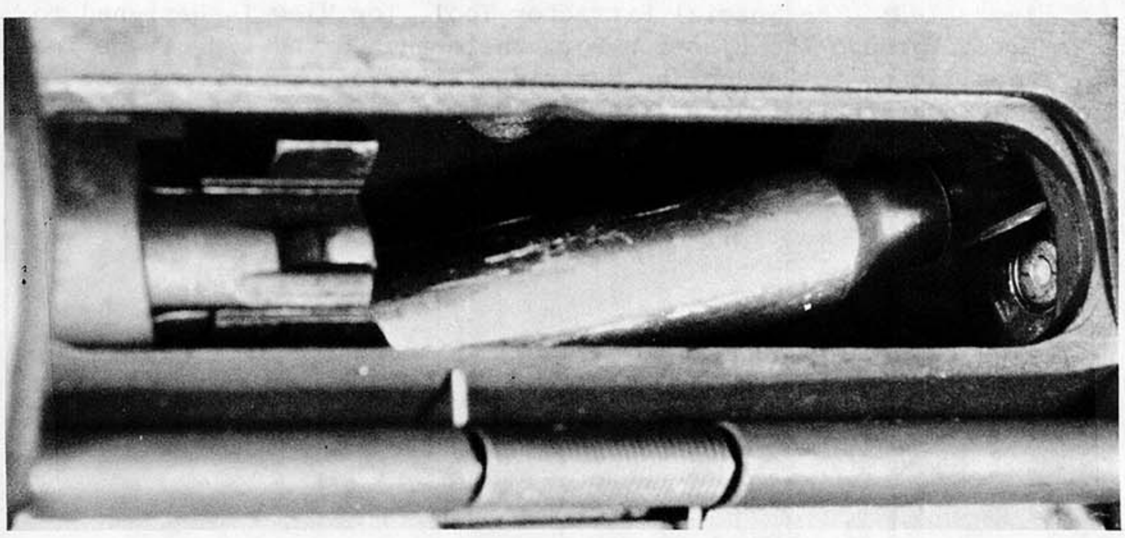

Figure I-10: An Enlarged View of the Above Figure Is Shown.

Designation: FF - Failure of a live round to be successfully stripped from the magazine and fully chambered.

Description: This malfunction occurs during a firing sequence, as opposed to the previously discussed FF1 which occurs only after manual bolt release following insertion of a loaded magazine. Feeding failures can be divided into five basic types as listed on the FRR (Section II).

Probable Cause: The majority of feeding failures are due to one of two causes; short recoil or a defective magazine. In short recoil, the bolt lacks sufficient energy to move fully rearward to engage the cartridge base, or, with the base engaged, lacks sufficient energy to complete the feeding operation. As previously discussed, short recoil is usually due to an accumulation of fouling or dirt in the mechanism. The problem of defective magazines is discussed in the paragraph dealing with miscellaneous malfunctions.

Corrective Action: Immediate action should be carefully taken to avoid the risk of further jamming the gun. Where only one round is involved and the bolt is behind the base of the round to be fed, the bolt-assist device may be used to complete the feeding action. However, if resistance is encountered, the bolt should be retracted and held to the rear while the magazine is removed and the malfunction cleared.

In instances where the bolt has overridden the base of the next round to be fed, or where the bolt has closed on an empty chamber, the bolt should first be retracted with the charging handle. Inspection of the position of the round will then indicate if the bolt can be released in an attempt to complete feeding under action-spring force or whether the magazine must be removed to clear the malfunction. Magazine removal is usually required to clear a double feed.

Malfunction Subtypes: Various feeding failure subtypes, as listed on the FRR (Section II), are shown in Figures I-11 and I-12. Due to the relative frequency of feeding failures, the subtypes are often identified by the following abbreviations:

- BB - Bolt behind the cartridge base.
- BOB - Bolt override of the cartridge base.
- COEC - Bolt closes on an empty chamber.
- DF - Double feed of two cartridges.

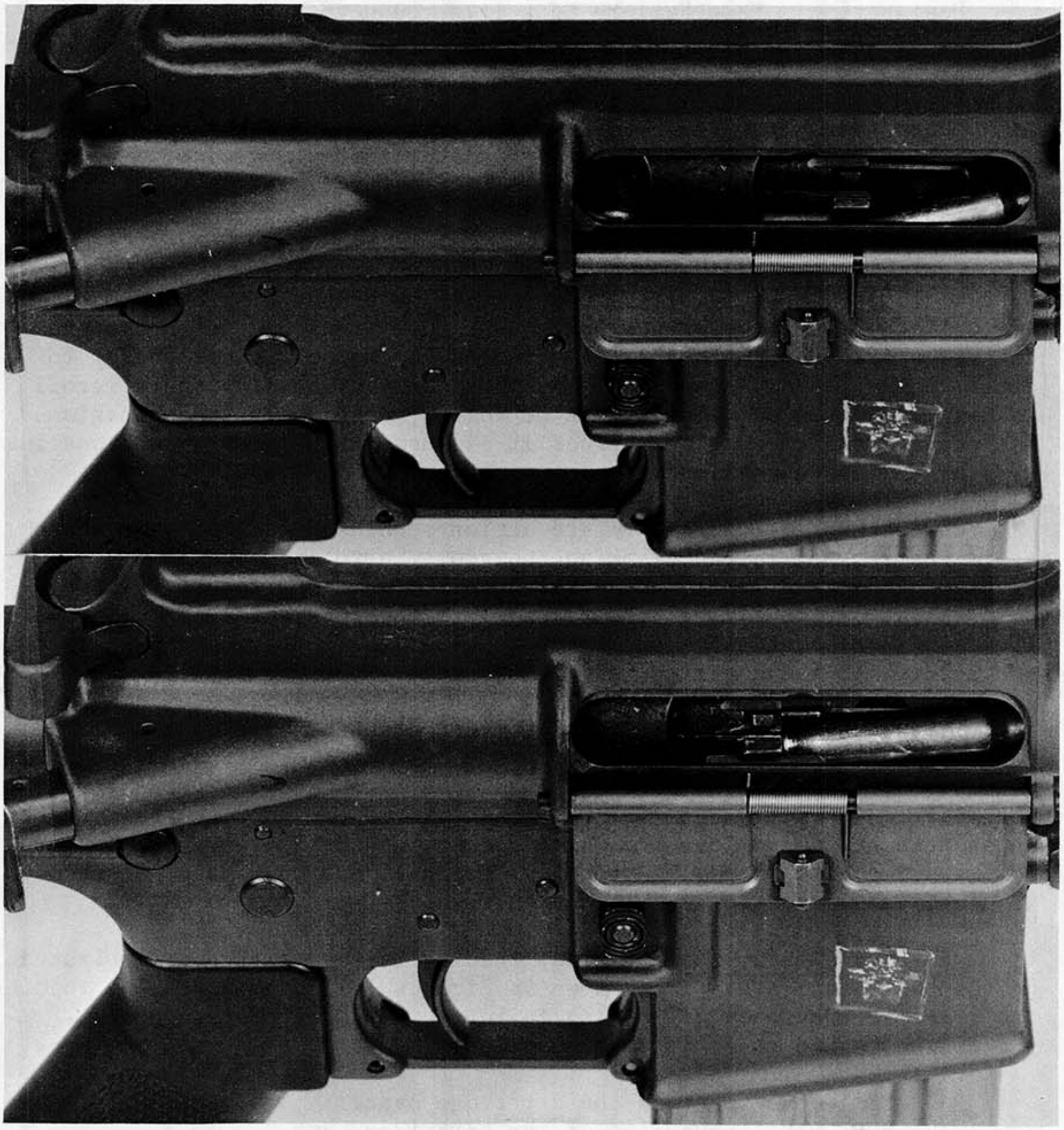

Figure I-11: Two Subtypes of Feeding Failures (FF) Are Shown; Top, Bolt Override of the Base (BOB), and Bolt Behind the Base (BB) of the Cartridge.

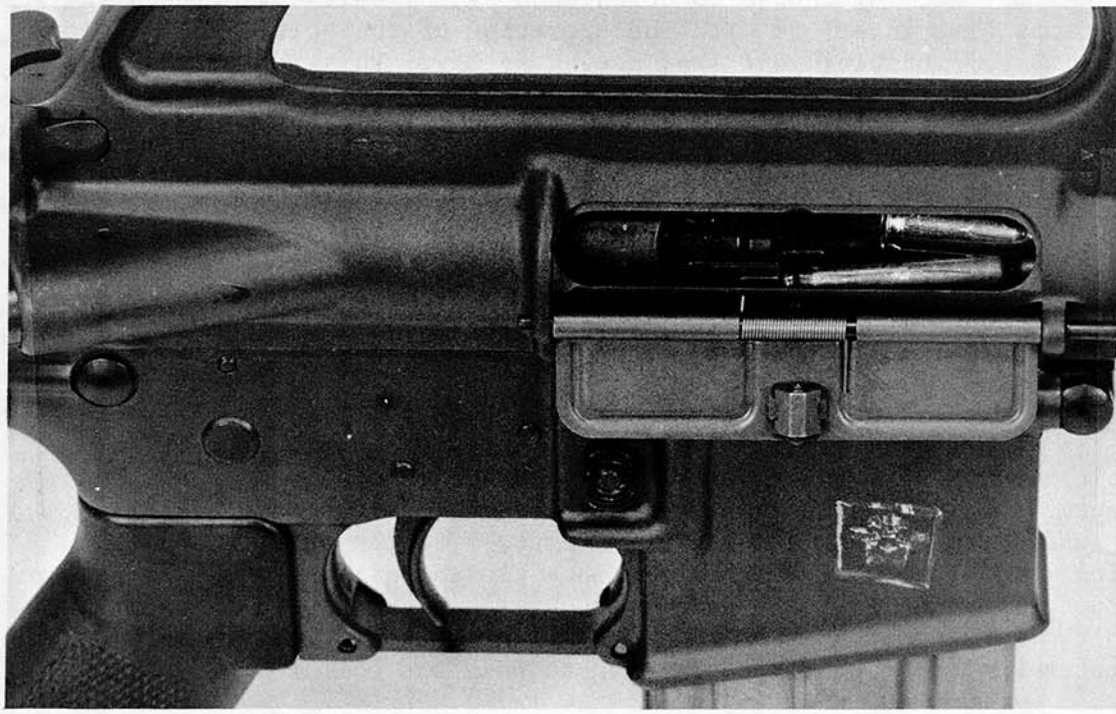

Figure I-12: A Double Feed (DF) of Two Live Rounds Is Shown.

Designation: FBR - Failure of the bolt to remain in a rearward position, engaged by the bolt catch, after the last round has been fired.

Description: When this failure occurs, the gunner has no immediate visual check to determine if a malfunction has interrupted firing or whether the last round has been fired. The weapon appears to be in a normal, bolt-closed position.

Probable Causes: The malfunction is most commonly due to short recoil where the bolt recoils far enough to complete all other firing operations but not far enough to be engaged by the bolt catch. Fouling and dirt may also interfere with the operation of the bolt catch itself, restricting or prohibiting it from moving freely. This failure is also occasionally due to a high cyclic rate of fire where the bolt catch does not have sufficient time to move into position to arrest the bolt after the last round is fired. The high cyclic rates of fire necessary to induce this malfunction occur only with certain lots of ammunition and should not be confused with a firing rate controlled by the gunner; i.e., the number of trigger pulls per second, the length of the burst, time between bursts, etc. It should be noted that special instrumentation is required in order to determine if high cyclic rates of fire are the cause of this malfunction.

Corrective Action: Immediate corrective action is accomplished by using the charging handle to fully retract the bolt and bolt carrier. The bolt catch will then usually engage and hold the bolt rearward and the empty magazine can be removed and a loaded magazine inserted. A fully loaded magazine should not be inserted with the bolt in a closed position. Note that, if the bolt is in a closed position when a magazine is removed from the gun, the bolt catch will not automatically engage the bolt, if the bolt is then retracted. Under these conditions the bolt catch must be manually positioned to hold the bolt to the rear.

Cleaning, inspection, and lubrication of the mechanism, including the bolt catch assembly, should be accomplished where repetitive failures occur; in the event of continued failure, the bolt catch and bolt-catch spring should be replaced.

Malfunction Clearing Times Recorded During APG Firings

Firer	Trial No.	Time, sec	Remarks
Test Condition: Firer in standing position			
			FF1 Malfunctions
A	1	6.2	Bolt assist device used twice to complete feeding.
	2	4.3	Bolt assist device used once to complete feeding; bolt was nearly fully closed prior to corrective action.
	3	30.6	Repeated use of bolt assist device increased severity of malfunction; charging handle was then tried but was ineffective. Magazine was removed and first round discarded.
Avg		13.7	
B	1	7.2	Bolt assist device used unsuccessfully; charging handle retracted and released to complete feeding.
	2	3.6	Bolt assist device used successfully.
	3	3.9	Same as B2.
Avg		4.9	
C	1	4.9	Bolt assist device used repeatedly to complete feeding.
	2	3.3	Same as C1.
	3	4.5	Same as C1.
Avg		4.2	

Avg all trials: 7.6 sec
Avg all trials, but excluding A3: 4.7 sec.

Firer	Trial No.	Time, sec	Remarks
Test Condition: Firer in prone position.			
A	1	8.0	Bolt assist device used repeatedly to complete feeding
	2	7.6	Same as A1.
	3	7.4	Same as A1.
Avg		7.7	
B	1	2.2	Same as A1.
	2	3.9	Same as A1.
	3	4.1	Same as A1.
Avg		3.4	

Firer	Trial No.	Time, sec	Remarks
C	1	5.4	Same as A1.
	2	4.3	Same as A1.
	3	2.3	Same as A1.
Avg		4.0	

Avg, all trials: 5.0 sec.

Test Condition: Firer in standing position in a completely darkened range.

Firer	Trial No.	Time, sec	Remarks
A	1	2.6	Firer sensed by sound the correct identity of the malfunction. The bolt assist device was used to complete feeding.
	2	3.3	Same as A1.
	3	41.3	Same as A1 except use of the bolt assist device jammed the first round instead of clearing it. The malfunction eventually required magazine removal in order to clear.

FFR Malfunctions

Test Condition: Firer in standing position

Firer	Trial No.	Time, sec	Remarks
A	1	5.8	Charging handle used to clear FFR.
	2	4.9	Same as A1.
	3	3.8	Same as A1.
Avg		4.8	
B	1	2.9	Charging handle used to clear FFR.
	2	4.3	Same as B1.
	3	2.5	Same as B1.
Avg		3.2	
C	1	2.8	Charging handle used to clear FFR.
	2	2.6	Same as C1.
	3	1.8	Same as C1.
Avg		2.4	

Avg, all trials: 3.5 sec.

Test Condition: Firer in prone position

Firer	Trial No.	Time, sec	Remarks
A	1	4.3	Charging handle used to clear FFR.
	2	4.2	Same as A1.
	3	4.4	Same as A1.
Avg		4.3	

Firer	Trial No.	Time, sec	Remarks
B	1	3.8	Same as A1.
	2	3.0	Same as A1.
	3	2.8	Same as A1.
Avg		3.2	
C	1	3.0	Same as A1.
	2	2.5	Same as A1.
	3	2.3	Same as A1.
Avg		2.6	

Avg, all trials: 3.4 sec.

Test Condition: Firer in standing position in a completely darkened range.

A	1	19.7	Malfunction occurred near the end of a 20-round magazine; by touch with his fingers, firer assumed it was an FBR and he changed magazines. FFR was cleared when firer retracted charging handle.
	2	11.5	Firer sensed by touch the correct identity of the malfunction. The charging handle was retracted and the FFR cleared.
	3	6.3	Same as A2.

FJ Malfunction

Test Condition: Firer in standing position.

A	1	5.3	Fired case jammed in the mechanism, no portion exposed outside the ejection port. Charging handle retracted part-way and gun rolled to the right permitting fired case to fall out.
	2	5.4	Mouth of fired case exposed. Charging handle retracted part-way and case fell out.
	3	4.6	Same as A2.
	4	5.0	Same as A1.
	5	3.8	Same as A2.
	6	4.2	Same as A1.
	7	3.4	Same as A2.
	8	11.7	Mouth of fired case exposed and a live round also jammed. Use of charging handle was ineffective and magazine removal was required.
	9	3.7	Same as A1.
	10	7.3	Same as A8.
	11	3.5	Same as A2.

Firer	Trial No.	Time, sec	Remarks
	12	8.2	Fired case jammed in the mechansim, no portion exposed outside the ejection port and a live round also jammed. Charging handle retracted, magazine removed to clear.
Avg		5.5	
B	1	4.9	Fired cased jammed in the mechanism, no portion exposed outside the ejection port. Charging handle retracted, fired case removed by grasping with the fingers.
	2	4.3	Same as B1.
	3	4.1	Fired case jammed, mouth exposed, charging handle retracted, fired case removed by grasping with fingers. Bolt assist device required to complete feeding of next live round.
	4	3.5	Mouth of fired case exposed and cleared by grasping with fingers.
	5	2.8	Same as B4 except charging handle also used.
	6	4.1	Same as B3.
	7	6.2	Same as B5 but firer's fingers were burned on hot case.
	8	3.0	Same as B1 except bolt assist device was required to complete feeding of next live round.
	9	6.6	Same as B4.
	10	3.6	Same as B5.
	11	3.3	Same as B1.
	12	3.3	Same as B5.
	13	3.4	Same as B5.
	14	12.6	Same as B3 except bolt assist device was employed unsuccessfully to load next round. It was then necessary to use charging handle to remove the round and the next round was successfully loaded.
	15	3.0	Same as B5.
	16	3.9	Same as B3.
	17	4.2	Same as B1.
	18	2.8	Same as B1.
	19	3.1	Same as B1.
	20	5.8	Fired case jammed in the mechanism, no portion exposed outside the ejection port. Charging handle retracted part-way and gun was rolled to the right permitting fired case to fall out. However, bolt closed on an empty chamber and it was necessary to recharge the gun.
	21	3.3	Same as B1.
	22	4.0	Same as B1.
	23	3.3	Same as B1.
	24	3.4	Same as B1.
	25	2.8	Same as B1.

Firer	Trial No.	Time, sec	Remarks
	26	3.0	Same as B1.
	27	4.1	Same as B1 except case was too hot to grasp with fingers; gun was rolled to the right to free the case.
Avg		4.2	
C	1	5.7	Fired case jammed in the mechanism, no portion exposed outside the ejection port. Charging handle retracted, fired case removed by grasping with the fingers.
	2	4.2	Same as C1.
	3	3.3	Same as C1.
	4	3.0	Same as C1.
	5	4.2	Same as C1.
	6	3.9	Same as C1 except case mouth exposed.
	7	4.4	Same as C6 but bolt assist required to complete feeding of next live round.
	8	3.9	Same as C1.
	9	3.1	Same as C6.
	10	3.4	Same as C1.
	11	3.0	Same as C1.
	12	3.1	Same as C1.
	13	3.8	Same as C1.
	14	3.8	Same as C1.
	15	3.5	Same as C1.
	16	3.3	Same as C6.
	17	3.1	Same as C6.
	18	10.3	Same as C1 except that the next two live rounds were inadvertently freed from the magazine and it was necessary to remove the magazine.
	19	2.5	Same as C6.
	20	4.3	Same as C6. Firer's fingers were burned by hot case.
	21	3.8	Same as C6.
	22	5.6	Same as C7.
	23	3.1	Same as C1.
	24	4.4	Same as C6.
	25	4.1	Same as C6.
	26	4.4	Same as C1.
	27	3.5	Same as C1.
	28	3.3	Same as C1.
	29	3.3	Same as C1.
	30	3.0	Same as C1.
Avg		3.9	

Avg, all trials: 4.3 sec.
Avg, all trials but excluding A8 (11.7), B14 (12.6 and C18 (10.3): 4.0 sec.

Firer	Trial No.	Time, sec	Remarks
Test Condition:	Firer in prone position		
A	1	11.7	Fired case jammed in the mechanism with mouth exposed; firer dropped the gun while attempting to clear the malfunction.
	2	7.5	Fired case jammed in the mechanism with no portion of the case exposed outside the ejection port. Firer retracted the charging handle and removed the fired case by grasping with the fingers.
	3	3.8	Same as A2 except fired case was jammed with case mouth exposed.
	4	3.8	Same as A2.
	5	3.2	Same as A3.
	6	2.6	Same as A4.
	7	16.6	Same as A4 except in removing the fired case, the next live round was released and a double-feed resulted.
	8	8.1	Same as A7
	9	3.9	Same as A4.
	10	3.7	Same as A3.
	11	2.7	Same as A4.
	12	3.1	Same as A4.
	13	6.3	Same as A3.
	14	3.1	Same as A3.
	15	3.3	Same as A4.
	16	3.6	Same as A4.
Avg		5.4	
B	1	6.1	Same as A3 except base of the fired case was exposed. The bolt assist device was required to assist feeding of the next round.
	2	6.1	Same as A4.
	3	7.8	Same as A4.
	4	4.0	Same as A4.
	5.	3.8	Same as A4.
	6	4.5	Same as A4.
	7	9.6	Same as A4 except that a live round was also jammed.
	8	5.1	Same as A4 except that the bolt assist device was required to assist feeding of the next live round.
	9	3.0	Same as A3.
	10	2.4	Same as A3.
	11	3.9	Same as A4.
	12	7.8	Same as A4.
	13	3.0	Same as A3.
	14	7.0	Same as A4.
	15	5.2	Same as A4.
	16	3.4	Same as A4.

Firer	Trial No.	Time, sec	Remarks
	17	3.9	Same as A4.
	18	3.3	Same as A3.
	19	5.2	Same as A3 except fired case was too hot to readily grasp with the fingers.
	20	1.8	Same as A3.
	21	2.4	Same as A4.
	22	1.7	Same as A4.
	23	4.2	Same as A3.
	24	3.1	Same as A3.
	25	3.6	Same as A3.
	26	4.4	Same as A3.
	27	7.2	Same as A4 except the case could not be cleared until the magazine was removed.
	28	3.0	Same as A3.
	29	3.0	Same as A3.
Avg		4.5	
C	1	4.8	Same as A3.
	2	15.7	The firer attempted to roll the gun to the right to clear the fired case after retracting the charging handle. This was unsuccessful and in grasping the case with the fingers the next live round was partially freed from the magazine and a bolt override occurred.
	3	6.6	The firer was successful in rolling the gun to to the right and clearing the fired case.
	4	6.1	Same as A4.
	5	6.7	Same as A4.
	6	7.3	Same as A3.
	7	3.6	Same as A3.
	8	5.6	Same as A4 except the case was too hot to be readily grasped with the fingers.
	9	5.5	Same as A3.
	10	6.2	Same as A4.
	11	4.7	Same as A4.
	12	4.1	Same as A4.
	13	4.1	Same as A4.
	14	3.6	Same as A3.
Avg		6.0	

Avg, all trials: 5.1 sec.

Avg, all trials, except A1 (11.7), A7 (16.6) and C2 (15.7): 4.6

Firer	Trial No.	Time, sec	Remarks
Test Condition:			Firer in standing position in a completely darkened range.
A	1	8.1	The fired case was jammed in the mechanism with the mouth exposed on three occasions and with no portion exposed outside the ejection port on seven occasions (as estimated by the firer). The firer retracted the charging handle and removed the fired case with his fingers.
	2	6.7	
	3	3.9	
	4	10.6	
	5	23.3	
	6	6.5	
	7	5.8	
	8	5.6	
	9	6.0	
	10	4.5	

FX Malfunction

Firer	Trial No.	Time, sec	Remarks
Test Condition:			Firer in standing position.
A	1	14.8	A live round was jammed into the base of the FX case. The charging handle was held to the rear, the magazine removed and the bolt manually latched to the rear. The jammed live round fell out and the special extraction tool was used to remove the FX.
	2	19.0	Same as A1.
	3	23.7	With the charging handle held to the rear, the extraction tool was used in an unsuccessful attempt to clear the jammed live round. Remaining procedure was then the same as A1.
	4	16.3	Same as A3.
Avg		18.4	
B	1	21.1	Same as A3.
	2	11.4	Same as A1.
	3	11.5	Same as A1.
Avg		14.7	
C	1	15.6	Same as A1.
	2	10.2	Same as A1.
	3	13.5	Same as A1.
Avg		13.1	

Avg, all trials: 15.7 sec

Firer	Trial No.	Time, sec	Remarks
Test Condition:	Firer in prone position.		
A	1	25.3	A live round was jammed into the base of the FX case. The extraction tool was used in an unsuccessful attempt to clear the live round. The magazine was then removed, the live round cleared and the tool successfully used to clear the FX.
	2	18.9	Same as A1 except that the magazine was removed as a first step.
	3	18.5	Same as A2.
Avg		20.9	
B	1	14.7	Same as A2.
	2	16.4	Same as A2.
	3	12.9	Same as A2.
Avg		14.7	
C	1	12.1	Same as A2.
	2	12.8	Same as A2.
	3	14.9	Same as A2.
Avg		13.3	
Avg, all trials:	16.3 sec.		
Test Condition:	Firer in standing position in a completely darkened range.		
A	1	54.2	A live round was jammed into the base of the FX. The firer judged the jammed live round to be a feeding failure and after clearing the live round he recharged the gun. This duplicates the original malfunction, ie, a live round jammed into the base of the FX. The firer then correctly sensed the identity of the malfunction and cleared the stoppage using the extraction tool.
	2	27.2	The firer correctly identified the stoppage by touch with his fingers. The extraction tool was used to remove the FX.
	3	31.5	The FX occurred on the last round and the firer assumed an FBR had occurred. When a new magazine was inserted a live round was fed into the base of the FX. The malfunction was then correctly identified and the extraction tool was used.

Firer	Trial No.	Time, sec	Remarks
Test Condition: Firer in standing position			
			The following feeding malfunctions are of the bolt-override type (BOB)
A	1	18.1	Charging handle retracted and jammed round was removed; when charging handle was released a second BOB occurred. It was then necessary to remove the magazine.
	2	7.8	Jammed round was repositioned by hand after retracting charging handle.
	3	7.8	Same as A2.
	4	6.6	Same as A2 except bolt assist device was required to complete loading.
Avg		10.1	
B	1	5.2	When the charging handle was retracted two live rounds were released from the magazine. The rounds were cleared by rolling the gun to the right.
	2	4.9	The charging handle was retracted part way and then released.
	3	5.1	Same as B2.
Avg		5.1	
C	1	20.3	Same as A1 except bolt assist device was required to complete loading.
	2	4.6	Charging handle retracted and then released; the bolt assist device was required to complete loading.
	3	5.5	Same as C2.
Avg		10.1	

Avg, all trials: 8.6 sec.
Avg, all trials, but excluding A1(18.1) and C1 (20.3): 5.9 sec.

Firer	Trial No.	Time, sec	Remarks
			The following feeding malfunctions are of the bolt-behind-base-of-the-round type (BB)
A	1	11.7	Charging handle retracted and released three times but round would not feed. It was necessary to remove the magazine and clear the jammed round.
B	1	3.4	Bolt was almost fully closed. The charging handle was retracted and the live round ejected.

Firer	Trial No.	Time,sec	Remarks
	2	3.0	Same as B1.
	3	2.3	Bolt almost fully closed and the bolt assist device used to complete feeding.
	4	2.4	Same as B3.
	5	4.2	Same as B3, however, hammer had fallen and it was necessary to eject the round and reload using the charging handle.
	6	5.0	Same as B5.
Avg		3.4	
C	1	5.0	Same as B3.
	2	2.6	Same as B3.
	3	5.0	Bolt had moved forward only a short distance, repeated use of the bolt assist device completed feeding.
	4	3.1	Same as B3.
	5	5.0	Same as C3.
	6	2.6	Same as B3.
	7	2.7	Same as B3.
	8	4.4	Same as C3.
Avg		3.8	

Avg, all trials: 4.2 sec.
Avg, all trials, except A1 (11.7): 3.6 sec.

The following feeding malfunctions are of the bolt-override type (BOB)

Test Condition: Firer in prone position

Firer	Trial No.	Time,sec	Remarks
A	1	5.3	Charging handle was retracted and released; the bolt assist device was then used to complete feeding.
	2	4.8	Same as A1.
	3	21.5	Same as A1 except use of the bolt assist device increased the severity of the malfunction. It became necessary to remove the magazine and clear the jammed round.
Avg		10.5	
B	1	6.8	Same as A1.
	2	5.8	Same as A1.
	3	11.0	Same as A3
Avg		7.9	

Firer	Trial No.	Time, sec	Remarks
C	1	7.7	Same as A1.
	2	6.9	Same as A3.
	3	7.7	Same as A3.
Avg		7.4	

Avg, all trials: 8.6 sec.
Avg, all trials, except A3 (21.5): 7.0 sec.

The following feeding malfunctions are of the bolt-behind-the-base-of-round type (BB)

Test Condition: Firer in prone position.

Firer	Trial No.	Time, sec	Remarks
A	1	4.2	The bolt assist device was used to complete feeding.
	2	3.3	Same as A1.
B	1	2.4	Same as A1.
	2	3.8	Same as A1.
	3	3.0	Same as A1.
	4	2.8	Same as A1.
Avg		3.0	
C	1	6.7	Same as A1 except repeated use of the bolt assist devices was required.
	2	2.3	Same as A1.
	3	6.0	The bolt was almost fully closed and the hammer had been released. The bolt assist device was used to complete feeding but the weapon required recocking in order to be fired.
	4	4.1	Same as A1.
	5	3.6	Same as A1.
	6	2.3	Same as A1.
	7	4.0	Same as A1.
	8	6.2	Same as A1.
	9	3.1	Same as A1.
	10	2.3	Same as A1.
	11	6.2	Same as A1.
	12	2.4	Same as A1.
	13	2.0	Same as A1.
	14	2.3	Same as A1.
Avg		3.8	

Avg, all trials: 3.6 sec.

Firer	Trial No.	Time,sec	Remarks
Test Condition:	Firer in standing position in a completely darkened range.		
A	1	18.8	The feeding failure was of the BB type. The firer sensed the malfunction by touch with his fingers. The bolt assist device was used to overcome the malfunction.
	2	6.2	Same as A1.
	3	-	The firer mistakenly sensed by touch that an FX had occurred and spent 90 seconds attempting to clear the non-existent fired case with the extractor tool.
	4	20.1	Same as A1.
	5	7.8	Same as A1 except the failure was of the BOB type and by use of both the charging handle and the bolt assist device, the malfunction was cleared.

FBR Malfunction

Firer	Trial No.	Time,sec	Remarks
Test Condition:	Firer in standing position.		
A	1	5.8	The charging handle was retracted part-way and the weapon inspected. When the malfunction was correctly diagnosed, the charging handle was fully retracted.
	2	9.6	Same as A1.
	3	1.8	Charging handle fully retracted and weapon then inspected.
	4	2.3	Same as A3.
	5	2.3	Same as A3.
Avg		4.4	
B	1	1.2	Same as A3.
	2	1.1	Same as A3.
	3	0.8	Same as A3.
Avg		1.0	
C	1	2.3	Same as A3.
	2	1.3	Same as A3.
	3	1.4	Same as A3.
Avg		1.7	

Avg, all trials: 2.7 sec.
Avg, all trials, except A2 (9.6): 2.0 sec.

Firer	Trial No.	Time, sec	Remarks
Test Condition:		Firer in prone position	
A	1	2.1	The firer retracted the charging handle and cleared the malfunction.
	2	2.2	Same as A1.
	3	2.1	Same as A1.
Avg		2.1	
B	1	1.8	Same as A1.
	2	0.9	Same as A1.
	3	1.2	Same as A1.
Avg		1.3	
C	1	1.5	Same as A1.
	2	1.3	Same as A1.
	3	1.4	Same as A1.
Avg		1.4	
Avg, all trials:		1.6	
Test Condition:		Firer in standing position in a completely darkened range.	
A	1	12.4	The firer judged the malfunction to be an FX and attempted to clear the non-existent FX case with the extractor tool. On two other trials the firer ignored or failed to recognize the FBR and replaced magazines without first clearing the FBR.

USAIB TEST DATA

The first 64 data pages (I-32 through I-95) are for the combat-experienced troops and the final 40 pages (I-96 through I-135) are for the noncombat-experienced troops. The abbreviation "MF" is to be read as MCT, magazine change time. The entries labelled "MNC" and "MNI" were originally intended to denote that a malfunction was not cleared or where a planned malfunction did not occur respectively. However, the USAIB test officer has advised that these terms were used interchangeable and that where either term is noted, and a time is also given, this is to indicate that the time is a stop watch time and that a time was not recorded via the range instrumentation. Where either "MNI" or "MNC"appear with no recorded time, or a zero, this is to indicate that the test subject was unable to clear the malfunction.

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	8.24	6.44	22.71	5.6 MNC	6.0 MNC	9.0 MNI	2 MNI	18.6	
2	25.19	8.61	13 MNC	26.4 MNC	30.0 MNC	12.51	2 MNC	15.4	
3	24.86	6.86	22.24	17.2 MNC	8.0 MNC	2.29	25.42	9.26	
4	10.67	6.91	77.9	13.6 MNC	34.0 MNC	12.03	9.21	10.32	
5	14.74	4.41	105.13	15.0 MNC	24.0 MNC	7.6	11.06	15.07	
6	12.0 MNC	8.8	16.87	13.6 MNC	5.0 MNC	13.74	12.60	11.59	
7	29.0 MNC	10.84	105.04	13.2 MNC	9.0 MNI	15.83	12.46	9.49	
8	13.57	12.24	78.21	12.8 MNC	7.0 ~~34.55~~	16.46	19.05	6.39	
TOTAL TIME TO CLEAR	138.32	64.31	441.59	117.4	123.0	94.46	93.80	96.12	
NUMBER CLEARED	8	8	8	8	8	8	8	8	
AVG TIME TO CLEAR	17.29	8.04	55.20	14.68	15.38	11.81	11.72	[illegible]	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 20 Jan 69 (Day) Night

Exercise Number 1

Firing Position Prone

STEBC-CT Form 6 (OT)
23 Jan 69

[illegible]

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	7.1	6.1	71.4	MNC	14.9	9.2	12.4	12.0	
2	16.5	5.1	29.4	MNC	11.0	11.6	24.1	4.9	
3	MNI	6.3	77.0	5.6	MNC	16.7	14.2	8.4	
4	9.2	7.9	73.2	MNC	9.5	15.2	14.7	7.1	
5	6.7	3.1	70.1	9.4	25.2	13.0	11.1	9.4	
6	16.6	8.8	82.4	MNC	MNC	10.0	13.2	7.0	
7	18.6	3.2	MNC	13.7	MNC	9.5	18.5	6.3	
8	11.5	5.1	64.6	MNC	13.9	15.5	8.6	6.9	
TOTAL TIME TO CLEAR	86.2	55.6	468.1	28.7	74.5	100.7	116.8	62.0	
NUMBER CLEARED	7	8	7	3	5	8	8	8	
AVG TIME TO CLEAR	12.3	6.9	66.9	9.6	14.9	12.6	14.6	7.8	

LEGEND:
FO - Firing Order
MNC - Malfunction Not Cleared
MNI - Malfunction Not Indicated
Time is given in seconds.

Date 20 Jan 69 Day Night

Exercise Number 2

Firing Position Kneeling

[illegible]-CT Form 6 (OT)
[illegible] 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	26.4 MNC	3.74	50.85	7.9 MNC	17.0 MNC	6.78	6.0 MNC	9.5	
2	10.88	3.52	52.0 MNC	8.41	12.39	11.1	3.5 MNC	4.62	
3	5.97	3.68	27.84	4.74	5.0 MNC	10.34	9.38	8.77	
4	14.45	10.4	57.74	6.0 MNC	11.0 MNC	10.02	18.77	9.1	
5	49.2	2.8	0 MNI	9.1 MNC	5.0 MNC	11.71	19.64	7.28	
6	6.1	20.9	41.0 MNC	15.4 MNC	8.0 MNC	6.37	8.07	13.00	
7	10.0 MNI	8.95	67.0 MNC	18.4 MNC	15.0 MNC	6.51	17.49	5.85	
8	10.5	5.16	87.0 MNC	3.35	17.0 MNC	12.13	7.95	17.05	
TOTAL TIME TO CLEAR	133.5	59.5	383.43	73.30	95.39	74.96	90.80	75.17	
NUMBER CLEARED	8	8	7	8	8	8	8	8	
AVG TIME TO CLEAR	16.69	7.39	54.78	9.16	11.92	9.37	11.35	9.4	

LEGEND:

- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 20 to 21 Jan 69 (Day) Night

Exercise Number 3

Firing Position STANDING

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	15.65	1.5	29.0 MNI	15.9 MNC	7.85	0 MNI	40.25	7.83	
2	7.17	3.8	55.0 MNC	14.9 MNC	11.0 MNC	0 MNI	9.0 MNC	10.45	
3	21.57	4.7	53.0 MNC	3.8 MNC	7.0 MNC	0 MNI	37.2	7.42	
4	[illegible]8	15.18	46.0 MNC	11.0 MNC	14.55	16.35	18.95	5.74	
5	59.5	1.88	19.10	8.9 MNC	21.0 MNC	9.14	22.35	6.31	
6	5.6	4.51	0 MNI	4.75	5.59	9.15	22.05	9.8	
7	6.2	12.5	25.22	5.7	11.55	5.5	42.3	3.72	
8	14.0 MNC	4.8	0 MNI	10.1 MNC	14.0 MNC	20.23	6.55	11.8	
TOTAL TIME TO CLEAR	144.09	23.69	227.32	75.05	92.54	60.37	198.65	63.09	
NUMBER CLEARED	8	8	6	8	8	5	8	8	
AVG TIME TO CLEAR	18.01	2.96	37.89	9.38	11.57	12.07	24.83	[illegible]	

LEGEND:
FO - Firing Order
MNC - Malfunction Not Cleared
MNI - Malfunction Not Indicated
Time is given in seconds.

Date 21 Jan 61 (Day) Night

Exercise Number 4

Firing Position Foxhole supported

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	17.1	4.15	40.9	6.05	22.36	11.45	26.0 MNC	8.45	
2	15.0	3.9	71.0 MNC	18.9 MNC	3.5	13.1	9.0 MNC	8.05	
3	10.49	3.85	80.0 MNC	6.0 MNC	22.0 MNI	11.9	11.0 MNI	8.4	
4	56.0 MNC	29.89	54.0 MNC	21.0 MNC	10.1	10.25	26.35	5.9	
5	23.6	1.95	48.0 MNC	8.4 MNC	10.0 MNC	13.2	18.1	19.8	
6	22.55	12.9	67.0 MNC	15.3 MNC	13.34	16.55	5.2 MNC	8.15	
7	32.7	26.35	43.75	15.0 MNC	12.5	7.80	22.5	8.4	
8	7.55	4.3	33.0 MNC	23.31	4.72	15.0 MNC	7.0 MNC	12.0	
TOTAL TIME TO CLEAR	184.99	87.29	437.65	113.96	98.52	99.25	125.15	79.15	
NUMBER CLEARED	8	8	8	8	8	8	8	8	
AVG TIME TO CLEAR	23.12	10.91	54.71	14.24	12.32	12.41	15.64	9.89	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 21 Jan 69 Day (Night)

Exercise Number #1

Firing Position Prone

STEBC-CT Form 6 (OT)
23 Jan 69

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FFL	8 [illegible]
1	13.1	18.0	22.7	4.4 MNC	21.0 MNC	6.7	19.0 MNI	11.9
2	15.2	12.0	38.1	7.1 MNC	0 MNC	20.0 MNI	4.2 MNI	9.3
3	8.9	4.2	0 MNC	8.4 MNC	0 MNI	10.1	7.0 MNI	12.1
4	28.0 MNC	6.1	0 MNI	17.2 MNI	11.0 MNI	8.7	0 MNI	5.1
5	13.4	1.9	0 MNI	11.6 MNC	10.5	9.0	9.1	9.9
6	13.1	17.2 MNI	65.0 MNC	9.8	7.0 MNC	13.5 MNC	16.7	11.6
7	29.4	3.5	45.0 MNC	4.0 MNC	5.0 MNC	7.1	24.8	7.0
8	58.0 MNC	15.8	4.6	10.6 MNC	15.0 MNI	13.0 MNI	9.3	9.8
TOTAL TIME TO CLEAR	179.1	78.7	175.4	73.10	69.5	88.10	90.1	76.70
NUMBER CLEARED	8	8	5	8	6	8	7	8
AVE. TIME TO CLEAR	22.39	9.84	35.08	9.14	11.58	11.01	12.87	9.59

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared
MNI- " " INDICATED
Time is given in seconds.

Date 21 Jan 68 Day (Night)

Exercise Number 2

Firing Position Kneeling

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF
1	7.7	3.9	28.0 MNC	4.4 MNC	14.2	11.2	19.0 MNC	16.88
2	36.0 MNC	9.0	0 MNC	8.1 MNC	9.6	16.5	0 MNC	8.7
3	6.0	3.55	44.0 MNC	12.4 MNC	9.0	10.0 MNC	15.0 MNC	6.51
4	15.05	6.14	0 MNC	41.0 MNC	11.3	10.8	12.0 MNC	14.88
5	24.49	2.49	0 MNC	11.24	41.0 MNC	15.9	33.89	7.68
6	7.05	2.0 MNC	53.0 MNC	13.1 MNC	10	14.7	15.95	13.21
7	8.15	4.7	0 MNC	14.8 MNC	21.0 MNC	12.9	24.0	4.35
8	35.0 MNC	35.0	48.0 MNC	10.6	6.8	14.7	8.0 MNC	10.8
TOTAL TIME TO CLEAR	338.09	66.78	173.0	115.64	85.9	106.7	127.84	83.01
NUMBER CLEARED	8	8	4	8	8	8	7	8
AVE. TIME TO CLEAR	42.26	8.35	43.25	14.45	10.74	13.34	18.26	10.38

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared

Time is given in seconds.

Date 21 Jan 69 Day Night

Exercise Number 3

Firing Position Standing

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FLR	7 FF1	8 MF
1	17.23	13.4	0 MNC	4.0 MNC	17.0 MNC	5.5	21.0 MNC	11.54
2	31.0 MNC	16.68	25.0 MNC	5.0 MNC	4.00	8.45	0 MNC	7.57
3	8.93	3.85	0 MNC	7.4 MNC	10.6	23.5	7.69	11.94
4	14.75	18.18	33.0 MNC	9.8 MNC	8.01	6.65	6.3	5.99
5	32.49	2.05	45.0 MNC	11.2 MNC	5.00	11.94	25.81	6.69
6	16.6	15.8	0 MNC	11.95	18.95	4.05	6.0 MNC	7.98
7	7.65	8.9	47.0 MNC	3.2 MNC	9.4	13.11	9.0 MNC	4.8
8	16.5	5.4	59.0 MNC	3.3 MNC	5.8	10.2	14.13	14.38
TOTAL TIME TO CLEAR	264.35	84.26	199.0	55.85	78.76	83.4	79.93	70.89
NUMBER CLEARED	8	8	5	8	8	8	7	8
AVE. TIME TO CLEAR	33.04	10.53	39.8	6.98	9.84	10.43	11.42	8.86

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared

Time is given in seconds.

Date 21 JAN 69 Day (Night)

Exercise Number 4

Firing Position FOX HOLE

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	15.10	17.40	29.60	11.6 MNC	4.0 MNC	13.60	14.75	7.20	
2	18.80	10.95	85.0 MNC	14.2 MNC	5.0 MNC	13.40	7.60	12.35	
3	18.25	5.70	70.0 MNC	15.0 MNC	4.0 MNC	6.95	20.60	13.80	
4	7.45	4.70	63.0 MNC	10.1 MNC	14.0 MNC	11.40	1.0 MNC	7.25	
5	25.20	4.40	80.0 MNC	10.2 MNC	14.10	18.50	14.80	6.60	
6	7.0 MNC	4.05	57.0 MNC	10.6 MNC	14.80	13.70	13.85	8.80	
7	17.20	4.00	75.0 MNC	8.1 MNI	13.05	15.20	13.95	5.35	
8	7.4 MNC	9.80	55.0 MNC	18.8 MNC	5.0 MNC	12.60	10.80	15.90	
TOTAL TIME TO CLEAR	116.40	61.00	514.60	98.60	73.95	105.35	97.35	77.25	
NUMBER CLEARED	8	8	8	8	8	8	8	8	
AVG TIME TO CLEAR	14.55	7.62	64.32	12.33	9.24	13.17	12.17	9.66	

Date 22 JAN 69 (Day) Night

Exercise Number 1

Firing Position PRONE

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	10.70	6.40	65.0 MNC	17.8 MNC	5.0 MNC	9.10	25.70	7.10	
2	9.20	7.60	53.0 MNC	11.6 MNC	4.0 MNC	14.40	9.0 MNC	7.30	
3	10.25	5.00	18.70	12.8 MNC	6.0 MNC	12.40	14.35	9.60	
4	21.80	5.50	66.0 MNC	8.4 MNC	7.0 MNI	13.70	37.80	7.25	
5	26.50	3.50	63.0 MNC	9.6 MNC	9.0 MNC	12.00	23.25	6.20	
6	7.30	5.55	21.45	10.0 MNC	7.0 MNC	14.60	29.85	8.80	
7	11.55	5.15	65.0 MNC	9.4 MNC	13.70	9.95	12.65	5.70	
8	8.35	11.25	50.0 MNC	10.90	14.0 MNC	11.20	12.20	7.10	
TOTAL TIME TO CLEAR	105.65	49.95	396.1	90.50	58.70	97.35	164.80	59.05	
NUMBER CLEARED	8	8	8	8	8	8	8	8	
AVG TIME TO CLEAR	13.21	6.24	49.52	11.31	7.34	12.17	20.60	7.38	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 22 JAN69 (Day) Night

Exercise Number 2

Firing Position KNEELING

STEBC-CT Form 6 (OT)
23 Jan 69

[illegible] RELIABILITY STUDY DATA REDUCTION [illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	21.3	5.3	MNC	4.9	MNC	14.5	MNC	10.3	
2	22.5	6.7	43.2	MNC	MNC	13.0	14.1	7.4	
3	8.1	5.5	32.9	9.3	MNI	9.9	14.2	7.3	
4	7.1	4.5	28.6	MNC	22.9	13.6	MNC	9.1	
5	12.4	3.9	MNC	MNC	MNC	15.4	21.6	9.3	
6	14.0	4.8	61.9	MNC	18.4	17.9	10.8	9.8	
7	13.5	4.1	MNC	MNC	MNC	15.6	19.5	7.6	
8	MNC	9.6	41.7	8.5	MNC	11.0	15.6	9.4	
TOTAL TIME TO CLEAR	98.9	44.4	208.3	22.7	41.3	110.9	95.8	70.2	
NUMBER CLEARED	7	8	5	3	2	8	6	8	
AVG TIME TO CLEAR									

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated

Time is given in seconds.

Date 22 Jan 69 Day Night

Exercise Number 3

Firing Position Standing

[illegible] Form 6 [illegible]

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FFL	8 [illegible]	[illegible]
1	23.35	6.30	36.55	6.00	8.0 MNC	9.20	19.80	6.50	
* PAPER HEAT OFF — LOST DATA 2	10.0	6.40	16.0	0 MNC	12.0 MNC	6.0	3.0	5.0	
3	13.40	4.20	18.80	9.6 MNC	6.0 MNC	10.15	27.10	7.95	
4	7.2 MNC	3.50	0 MNC	5.50	8.0 MNC	11.20	12.60	9.00	
5	10.60	3.0 MNC	37.0 MNC	9.30	9.0 MNC	10.40	19.25	6.10	
6	11.40	2.95	20.35	10.2 MNC	11.0 MNC	12.85	9.65	8.00	
7	9.80	4.15	40.0 MNC	7.9 NMI	9.0 MNC	8.35	9.40	4.55	
8	15.60	10.45	21.0 MNC	8.45	15.80	9.60	16.0 MNC	5.40	
TOTAL TIME TO CLEAR	101.35	40.95	189.65	56.95	85.92	77.75	116.80	52.50	
NUMBER CLEARED	8	8	7	7	8	8	8	8	
AVE. TIME TO CLEAR	12.67	5.12	27.09	8.14	10.74	9.72	14.60	6.56	

LEGEND:
- FO- Firing Order
- MNC- Malfunction Not Cleared
- NMI - NO MALFUNCTION INDICATED
- Time is given in seconds.

Date 22 JAN 69 (Day) Night

Exercise Number 4

Firing Position FOXHOLE

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF
1	26.30	4.00	16.80	4.3 MNI	4.0 MNC	11.0 MNI	18.65	7.80
2	3.75	4.20	56.0 MNC	3.3 MNC	14.0 MNC	13.20	15.60	19.40
3	14.10	3.60	60.0 MNC	0 MNC	6.0 MNC	9.70	13.60	10.20
4	27.30	2.70	12.45	6.4 MNC	No fire 9.0	12.5 MNI	18.10	12.80
5	10.75	9.05	55.0 MNC	0 MNC	12.0 MNC	17.10	26.07	16.90
6	10.50	4.15	0 MNC	21.6 MNC	11.0 MNC	22.55	23.83	14.35
7	20.0 MNC	3.50	58.0 MNC	12.0 MNC	9.0 MNC	9.40	11.05	6.10
8	13.95	8.65	43.0 MNC	17.2 MNC	7.0 MNC	12.95	13.75	10.10
TOTAL TIME TO CLEAR	126.65	39.85	239.25	59.80	72.00	108.40	140.65	97.65
NUMBER CLEARED	8	8	7	6	8	8	8	8
AVE. TIME TO CLEAR	15.83	4.98	34.18	9.97	9.00	13.55	17.58	12.21

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared
MNI- " " INDICATED
Time is given in seconds.

Date 22 JAN 69 Day (Night)

Exercise Number 1

Firing Position STANDING

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 [illegible]	[illegible]
1	15.0 MNC	4.30	7.10	4.2 MNC	10.0 MNC	9.90	16.50	8.35	
2	20.0 MNC	5.60	4.00	2.2 MNC	11.0 MNC	7.60	24.28	10.60	
3	13.80	3.40	53.0 MNC	13.4 MNC	9.0 MNC	9.72	No fire	15.60	
4	30.53	1.70	4.0 MNC	4.2 MNC	10.0 MNC	11.80	6.2 MNC	11.05	
5	24.45	6.40	63.0 MNC	10.95	8.0 MNC	9.78	18.33	9.55	
6	4.42	3.00	41.0 MNC	14.2 MNC	10.43	8.62	11.50	10.25	
7	26.90	3.70	32.0 MNC	4.2 MNC	7.15	7.43	0 MNC	6.00	
8	25.0 MNC	13.15	45.0 MNC	4.6 MNC	23.60	7.55	4.2 MNC	9.90	
TOTAL TIME TO CLEAR	160.10	41.25	249.1	57.95 ~~59.34~~	89.18	72.40	81.01	81.30	
NUMBER CLEARED	8	8	8	8	8	8	6	8	
AVE. TIME TO CLEAR	20.02	5.16	31.13	7.24 ~~11.14~~	11.15	9.05	13.50	10.16	

LEGEND:

FO- Firing Order

MNC- Malfunction Not Cleared

MNI= " " INDICATED

Time is given in seconds.

Date 22 JAN 69 Day (Night)

Exercise Number 2

Firing Position KNEELING

[illegible]

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF
1	11.0 MNI	3.75	7.10	3.4 MNC	13.0 MNC	7.90	0 MNC	9.65
2	14.0 MNC	5.50	32.0 MNC	20.0 MNC	8.40	6.95	7.0 MNC	18.20
3	46.0 MNC	3.50	3.0 MNC	13.70	8.83	10.5 MNC	-0- MNC	12.30
4	13.90	2.22	30.95	11.0 MNC	6.0 MNC	13.72	37.85	8.90
5	12.27	3.92	29.20	11.1 MNC	No 9.0 malfunction	16.73	16.42	9.10
6	6.81	2.70	25.0 MNC	4.9 MNC	5.0 MNC	15.67	14.75	7.90
7	14.50	4.30	28.0 MNC	5.0 MNC	7.0 MNI	15.35	10.23	5.00
8	12.05	11.60	45.0 MNC	14.1 MNC	4.0 MNC	12.60	13.10	5.90
TOTAL TIME TO CLEAR	130.53	37.49	200.25	83.20	61.23	99.42	99.35	76.95
NUMBER CLEARED	8	8	8	8	8	8	6	8
AVE. TIME TO CLEAR	16.31	4.69	25.03	10.40	7.66	12.43	16.56	9.62

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared
MNI- " " Indicated
Time is given in seconds.

Date 22 JAN 69 Day Night

Exercise Number 3

Firing Position FOXHOLE

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 [illegible]
1	15.0 MNC	4.20	50.0 MNI	13.3 MNC	8.0 MNC	7.82	10.23	9.75
2	10.0 MNC	0 MNC	No Fire 30.0	13.5 MNC	9.16	7.0 MNC	7.65	19.15
3	15.91	4.55	25.0 MNC	6.0 MNC	6.40	8.95	4.0 MNC	11.80
4	8.97	1.96	73.0 MNC	0 MNC	6.0 MNC	15.90	18.55	8.80
5	8.52	3.00	29.83	6.1 MNC	11.0 MNC	11.12	20.65	9.40
6	8.03	2.92	33.0 MNI	21.62	3.0 MNC	9.70	19.95	9.0
7	16.45	5.10	0 MNC	3.0 MNC	12.0 MNC	11.15	0 MNC	4.45
8	9.22	20.50	0 MNC	14.2 MNC	9.0 MNC	9.52	11.55	4.70
TOTAL TIME TO CLEAR	92.10	42.23	186.10	77.72	64.56	81.98	92.58	77.05
NUMBER CLEARED	8	7	6	7	8	8	7	8
AVE. TIME TO CLEAR	11.51	6.03	31.01	11.10	8.07	10.25	13.23	9.63

LEGEND:
FO- Firing Order
MNC- Malfunction Not Cleared
MNI- " " Indicated
Time is given in seconds.

Date 22 JAN 69 Day (Night)

Exercise Number 4

Firing Position PRONE

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	39.0 MNI	4.1	8.0	13.5	20.0 MNI	4.4	18.3	6.6	
2	11.0 MNC	8.5	20.6	16.3	12.3 MNC	7.5	34.5	15.7	
3	10.3	3.3	25.7	5.0 MNC	13.0 MNC	9.1	0 MNI	6.3	
4	14.1	4.7	80.0 MNC	9.0	17.1	13.5	11.4	10.4	
5	8.3	2.2	35.6	45.0 MNC	8.9	13.3	25.5	7.3	
6	17.2	2.1	38.1	0 MNC	41.0 MNC	11.2	11.3	8.5	
7	3.7	3.6	60.0 MNC	5.0 MNC	18.5	11.9	16.5	3.0	
8	6.9	5.0	30.1	0 MNC	17.0 MNC	7.6	7.4	6.3	
TOTAL TIME TO CLEAR	110.5	33.5	298.1	93.8	110.8	78.5	124.9	64.1	
NUMBER CLEARED	8	8	8	6	8	8	7	8	
AVG TIME TO CLEAR	13.81	4.19	37.26	15.63	13.85	9.81	17.84	8.01	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 (Day) Night

Exercise Number 1

Firing Position STANDING

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	6.4	4.0	33.0	11.0 MNC	4.0 MNC	4.8	17.6	7.7	
2	11.0	8.9	30.1	0 MNC	9.9	4.9	25.3	10.2	
3	12.5	4.0	43.0 MNC	9.8	5.9	10.0	20.5	7.9	
4	11.9	5.2	0 MNC	9.5	6.0 MNC	9.5 MNI	12.6	6.6	
5	6.9	2.5	50.0 MNC	15.4 MNC	6.0 MNC	6.5	14.3	5.7	
6	11.4	4.1	32.2	0 MNC	5.0 MNC	6.9	10.4	5.0	
7	5.5	19.0	75.0 MNC	7.8 MNC	11.0 MNC	4.6	17.3	2.7	
8	18.2	5.5	22.3	0 MNC	11.0 MNC	6.4	20.8	5.9	
TOTAL TIME TO CLEAR	83.8	53.2	285.6	53.50	58.8	53.60	138.8	51.70	
NUMBER CLEARED	8	8	7	5	8	8	8	8	
AVG TIME TO CLEAR	10.48	6.65	40.80	10.70	7.35	6.70	17.35	6.46	

LEGEND:
FO - Firing Order
MNC - Malfunction Not Cleared
MNI - Malfunction Not Indicated
Time is given in seconds.

Date 23 JAN 69 (Day) Night

Exercise Number 2

Firing Position KNEELING

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	6.6	4.0	19.3	19.6	10.7	4.3	0 MNC	9.0	
2	13.1	8.6	26.3	7.9 MNC	5.0 MNC	5.1	34.8	7.4	
3	9.0	3.8	57.0 MNC	8.4 MNC	12.5	6.9	26.5	7.1	
4	8.9	2.9	0 MNI	6.2 MNC	9.0 MNC	7.4	15.0	8.1	
5	5.3	2.0	25.4	13.2 MNC	14.0 MNC	5.7	17.8	6.1	
6	5.8	2.4	20.7	15.4 MNC	7.1	14.8	10.5	11.7	
7	5.7	4.4	18.0	4.4 MNC	8.0 MNC	10.1	11.3	2.4	
8	5.6	7.2	15.0 MNC	15.0	6.0 MNC	7.7	23.8	4.6	
TOTAL TIME TO CLEAR	60.0	35.3	163.70	90.10	72.3	62.00	139.7	56.4	
NUMBER CLEARED	8	8	7	8	8	8	7	8	
AVG TIME TO CLEAR	7.50	4.41	23.39	11.26	9.04	7.75	19.96	7.05	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 (Day) Night

Exercise Number 3

Firing Position FOXHOLE

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	5.0	4.9	25.3	12.6 MNC	5.0 MNC	5.0	0 MNC	9.6	
2	10.9	6.3	29.7	27.8 MNC	27.0	6.1	21.4	7.8	
3	9.9	4.9	0 MNI	4.7 MNC	7.8	7.4	16.6	8.7	
4	7.9	3.7	57.3	10.6	9.0 MNC	8.7	11.8	7.5	
5	5.7	4.4	58.4	4.7 MNC	5.0 MNC	7.3	22.0	14.4	
6	3.8	4.2	43.7	21.1	13.9	12.5	11.1	5.7	
7	7.1	3.4	58.7	3.4 MNC	6.0 MNC	12.8	10.5	2.3	
8	32.6	5.8	20.1	8.7 MNC	16.0 MNC	7.2	14.7	5.3	
TOTAL TIME TO CLEAR	82.9	37.6	293.20	93.6	89.7	67.60	108.1	61.30	
NUMBER CLEARED	8	8	7	8	8	8	7	8	
AVG TIME TO CLEAR	10.36	7.78	41.88	11.70	11.21	8.38	15.44	7.66	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 (Day) Night

Exercise Number 4

Firing Position PRONE

MTEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	26.3	3.2	25.5	13.8	13.0 MNC	3.8	11.0 MNC	8.6	
2	8.5	20.0 MNC	29.0	6.4	5.7	6.2	31.3	10.5	
3	10.5	3.3	49.2	0 MNC	5.0 MNC	11.8	8.0 MNC	9.0	
4	9.2	4.1	50.0 MNC	10.6 MNC	10.0 MNC	6.5	12.4	11.3	
5	22.2	2.2	50.0 MNC	4.6	75.0 MNC	10.4	12.6	6.8	
6	6.1	2.1	55.0 MNC	23.3	6.0 MNC	11.5	9.2	6.5	
7	9.3	3.3	30.1	3.9 MNC	5.0 MNC	13.7	11.0	3.3	
8	13.8	5.6	31.9	0 MNC	3.1	6.9	15.0	5.2	
TOTAL TIME TO CLEAR	105.9	43.8	320.7	62.6	62.8	70.8	110.5	61.2	
NUMBER CLEARED	8	8	8	6	8	8	8	8	
AVG TIME TO CLEAR	13.24	5.47	40.09	10.43	7.85	8.85	13.81	7.65	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 Day (Night)

Exercise Number 1

Firing Position STANDING

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	17.1	0	15.7	3.1	10.0 MNC	3.0	35.6	11.5	
2	7.5	11.2	62.5	0 MNC	10.5	5.3	25.3	14.5	
3	11.3	2.6	54.5	7.0 MNC	7.0 MNC	22.2	3.0 MNC	6	
4	2.7	2.7	47.3	2.7	3.0 MNC	19.6	2.4 MNC	8.9	
5	34.1	3.2	45.3	14.0 MNC	12.0 MNC	6.7	16.5	6.4	
6	5.5	2.1	30.3	7.8 MNC	10.0 MNC	5.9	17.6	4.8	
7	13.6	2.2	7.1	4.9 MNI	9.0 MNC	7.0 MNC	13.1	2.6	
8	18.7	4.2	29.5	20.0 MNC	11.0 MNC	8.6	9.8	4.8	
TOTAL TIME TO CLEAR	110.5	28.2	292.2	59.50	72.50	78.3	123.3	59.50	
NUMBER CLEARED	8	7	8	7	8	8	6	8	
AVG TIME TO CLEAR	13.81	4.03	36.52	8.50	9.06	9.79	15.41	7.44	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 Day (Night)

Exercise Number 2

Firing Position KNEELING

STEBC-CT Form 6 (OT)
23 Jan 69

M16A1 RELIABILITY STUDY DATA REDUCTION SHEET

FIRING POINTS

FO NUMBER	1 FJ	2 FFR	3 FX	4 FF	5 FF	6 FBR	7 FF1	8 MF	MALFUNCTION
1	12.6	6.1	31.1	11.0	15.0	6.3	19.0	9.2	
2	83.1	7.8	62.4	5.4 MNC	10.5	4.7	20.3	22.0	
3	8.0	3.1	48.5	6.4	11.0 MNC	10.0	22.4	11.2	
4	14.1	2.3	48.1	7.8 MNC	13.5	13.6	0 MNC	33.2	
5	6.0	1.7	75.5	6.8	x 7.0 MNC	7.7	18.3	11.0	
6	4.4	2.2	72.1	21.0 MNC	8.0 MNC	7.4	15.6	5.0	
7	6.8	3.1	55.7	3.4 MNC	13.0 MNC	11.1	11.3	7.9	
8	5.6	x 6.5	43.0 MNI	0 MNC	15.0 MNC	8.3	12.1	5.0	
TOTAL TIME TO CLEAR	80.6	32.8	436.4	61.8	93.00	69.1	119.0	104.5	
NUMBER CLEARED	8	8	8	7	8	8	7	8	
AVG TIME TO CLEAR	10.08	4.10	54.55	8.82	11.62	8.64	17.0	13.06	

LEGEND:
- FO - Firing Order
- MNC - Malfunction Not Cleared
- MNI - Malfunction Not Indicated
- Time is given in seconds.

Date 23 JAN 69 Day (Night)

Exercise Number 3

Firing Position FOXHOLE

STEBC-CT Form 6 (OT)
23 Jan 69