B-349 JK 20-2

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

Mr.Crider/nm/3608

AMSTE-BC

12 MAR 1970

SUBJECT: Monthly Inspection Comparison Test of M16A1 Rifle, USATECOM Project No. 8-WE-600-016-003 (formerly 8-8-0230-05)

Commanding General
US Army Weapons Command
ATTN: AMSWE-QA
Rock Island, Illinois 61201

1. References:

a. Letter, AMSWE-QA, HQ, USAWECOM, dated 15 Jan 70, subject: USATECOM M16A1 Rifle Endurance Test, USATECOM Project No. 8-8-0230-05.

b. Letter, AMSTE-BC, HQ, USATECOM, dated 18 Nov 69, subject: Report on Operational Reliability Study of M16A1 Rifle, USATECOM Project No. 8-WE-600-016-001.

c. Pamphlet on Definitions and Identification of Malfunctions for 5.56mm Weapons, M16A1/XM177E2, dated Nov 68, USATECOM Project No. 8-8-0070-05.

d. Small Arms Purchase Description (SAPD) 253F, dated Nov 68.

2. As requested by paragraph 9 of reference 1a, comments of this command are as follows:

a. Statistical approach is correct.

b. Input data are suitable.

c. Malfunction limits of Inclosure 6 to reference 1a are acceptable and are in consonance with reference 1b, and should be identified accordingly.

3. With regard to Inclosure 2 of reference 1a, this headquarters does not accept the viewpoint that conflicting nomenclature is used. The malfunction of FF1 (failure to feed and chamber the first round from a magazine) was specified as a "failure of bolt to lock" only so as to be in consonance with SAPD 253F, reference 1d. Regardless of the terms

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for these malfunctions, operation of the bolt assist, normally will restore operability. "Failure of bolt to lock" is a concomitant condition of a FF1 and not inconsistent with current classifications and identifications of malfunctions. FF1 is also a specific type of "failure to feed" (FF) malfunction and can be so committed in an analysis of feed type malfunctions.

4. Notwithstanding the acceptability of the malfunction limits and in view of the above, consolidation of malfunction types for endurance tests appears warranted, reference 1d, page 10. Review of references 1b (pg 31) and 1d with respect to format and definition of malfunctions is suggested. Appropriate notations may be necessary to further identify specific malfunctions, i.e., major heading "failure to feed" (FF), subheadings "failure to lock" (FTL), "failure to chamber" (FTC), "failure to feed first round from magazine" (FF1), etc.

5. It is recognized that a table of permissable malfunctions for all possible instances is extremely difficult. A continued effort toward improvement in definition of malfunction limits for determining acceptance of weapons is a worthy objective.

FOR THE COMMANDER:

GOODWIN MORROW
Acting Director
Inf Mat Test Dir

Copy furnished:
CO APG, ATTN: STEAP-MT-TI

S: 17 Feb 70 JA 20-1

AMSTE-BC (15 Jan 69) 1st Ind Mr. Crider/sr/3608
SUBJECT: USATECOM M16A1 Rifle Endurance Test - USATECOM Project No. 8-8-0230-05

DA, Headquarters, US Army Test and Evaluation Command, Aberdeen Proving Ground, Md 21005 5 FEB 1970

TO: Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-D

1. References:

a. Letter, AMSTE-BC, HQ USATECOM, 12 June 69, subject: Report of Combined Initial Production and Inspection Comparison Test of M16A1 Rifles, USATECOM Project Nos. 8-9-0200-25 and 27.

b. Small Arms Purchase Description 253F, 22 Nov 68, subject: Rifles, 5.56mm: M16 and M16A1.

2. Basic letter, specifically paragraph 9a, b, and d, is forwarded for review and comment thru this command. It is requested that the reply be received at this command by 17 Feb 70. Comment relative to paragraph 9c is not pertinent; evaluation of monthly QA test results by this command is not required. Direct contact with Mr. Rivard is authorized.

3. With regard to Inclosure 2 of basic letter, this headquarters does not accept the viewpoint that conflicting nomenclature is used. The malfunction of FF1 (failure to feed and chamber the first round from a magazine) was specified as a "failure of bolt to lock" (ref 1a) only, so as to be in consonance with SAPD 253F (ref 1b). Regardless of the terms for these malfunctions, operation of the bolt assist, normally will restore operability. "Failure of bolt to lock" is a concomitant condition of a FF1 and not inconsistent with current classifications and identifications of malfunctions. FF1 is also a specific type of "failure to feed" (FF) malfunction and can be so committed in an analysis of feed type malfunctions.

FOR THE COMMANDER:

Goodwin Morrow

6 Incls
nc

GOODWIN MORROW
Act Dir
Inf Mat Test

BC
30Jan

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY WEAPONS COMMAND
ROCK ISLAND, ILLINOIS 61201

S - 2 Feb 70

AMSWE-QA

JAN 15 1969

SUBJECT: USATECOM M16A1 Rifle Endurance Test - USATECOM Project No 8-8-0230-5

Commanding General
U. S. Army Test and Evaluation Command
ATTN: AMSTE-BC
Aberdeen Proving Ground, Maryland 21005

1. References:

a. Colonel A. C. Isaacs's (AMCPM-RS) briefing to General Chesarek on 29 March 1969 which included "USATECOM Conclusions and Recommendations".

b. AMCPM-RS Teletype No 8229 dated 2 April 1969 to AMSTE-BC, subject: M16A1 Rifle Endurance (Reliability) Test, USATECOM Project No 8-8-0230-5.

2. In accordance with SAPD-253F, endurance testing for acceptance purposes is conducted using a firing fixture. Various testing programs, however, are conducted with the rifle fired from the shoulder (e.g., the USATECOM Monthly Endurance Test). As a result, a revised table of allowable malfunctions and unserviceable parts for shoulder fired weapons has been developed per your recommendation (see reference 1a).

3. It is essential that standards for evaluation reflect the expectancy of malfunctions determined by weapons of the current design configuration. The usage of data from only certain tests and/or production months is an attempt to preclude the interaction that certain design changes to the weapon may cause. With this as a prerequisite, data from the following shoulder-fired endurance tests were analyzed (see Incl 1) as described in paragraphs 3 and 4:

a. IPT-ICT Endurance Retest - Only Colt's and GM data were used; H&R weapons were tested with the unmodified bolt catch. Each of the 24 rifles were fired 6000 rounds; malfunction data was obtained from the "Final Report on Combined Initial Production and Inspection Comparison Test of M16A1 Rifles" dated May 1969.

b. USATECOM Monthly Endurance - Results as reported by your Command for the production months of Aug, Sep, and Oct 69 were used.

c. Comparison Test conducted by GE - Seven rifles from each producer were endurance tested in a free-standing shoulder firing position in accordance with CT Plan dated 9 May 1969. Three weapons (one from each producer) were excluded during subsequent data review due to the unrepresentative and excessive number of malfunctions experienced. Subsequent calculations, therefore, were based on data obtained during the initial 6000 rounds on each of the remaining 18 weapons.

4. A lower one-sided 95% confidence limit for θ was calculated for each malfunction type utilizing the following expression:

$$\theta \text{ Lower} = \frac{2T}{\chi^2;\ 2r+2}$$

where θ = mean round between stoppage for the malfunction categories per α confidence.

T = total test time (rounds)
r = number of malfunctions cited
α = level of confidence (equals .05 for 95% one-sided confidence)
χ^2 = representative of a chi-square distribution

5. The underlying distribution of malfunction occurrence was determined by graphical means, to best approximate the exponential. Since the occurrence of a specific malfunction type follows the Poisson process, probabilities were generated using the Poisson probability density function:

$$f(n) = \frac{(\lambda X)^n \exp(-\lambda X)}{n!}$$

where $f(n)$ = probability of n malfunctions occurring in x rounds

$\lambda = \frac{1}{\theta}$ = constant failure rate

X = test duration in rounds

6. The probabilities of occurrence associated with each malfunction type for each of the tests cited in paragraph 3 are shown on the Inclosures as follows:

a. Incl 2 - IPT-ICT Retest

b. Incl 3 - TECOM Monthly Endurance Test

c. Incl 4 - CT at GE

JAN 15 1969

AMSWE-QA
SUBJECT: USATECOM M16A1 Rifle Endurance Test - USATECOM Project No 8-8-0230-5

7. Inclosure 5 cites the probabilities derived by combining data from the three previously mentioned tests. Comments concerning the limits of Table I, SAPD-253F and the probabilities of Inclosure 5 are as follows:

a. Inclosure 5 represents analysis of data obtained on 58 rifles. Table I of SAPD-253F was developed by a similar analysis utilizing data obtained on 52 rifles. The allowable malfunction limit for Table I of the Purchase Description (PD) was obtained by choosing a cumulative probability near .995 as the cut-off value.

b. Comparison of the PD limits with those in Inclosure 5 (considering the same cut-off cumulative probabilities) shows a marked decrease in all malfunction categories except F/T Hold Rear and F/T Feed (from magazine). This comparison is assumed reasonable based on the similarity in number of rifles fired for generation of the PD limits and those probabilities of Inclosure 5.

c. Comparison of the F/T Hold Rear and the F/T Feed cumulative probabilities of occurrence for each of the three tests as well as the combination of these tests indicated that the malfunction rates (λ's) obtained are relatively constant for these malfunction types. This fact directly supports usage of the Poisson probability density function for computation.

d. Due to the infrequent occurrence of the other malfunction types, it is difficult to make a similar comparison between the malfunction rates for one test and the rates for another. The results cited in Inclosure 5 were obtained by combining data from the three tests. These results are deemed representative of the current configuration test weapons and are comparable to the limits specified in the PD by reasons stated in paragraphs 7a and 7b above.

8. Consistent with the observations of paragraph 7, a table of malfunctions and unserviceable parts which is comparable to Table I of SAPD-253F was generated and is provided in Inclosure 6. This table suggests standards for evaluation of M16A1 Rifles fired from the shoulder; these standards should not, however, be construed as acceptance criteria. Future design changes may significantly affect the expectancy of certain malfunction types, thus necessitating re-analysis of rifle performance.

9. Therefore, in coordination with your Command, it is requested that a review of the Inclosures be made and comments supplied this Command as to the:

JAN 15 1969

AMSWE-QA
SUBJECT: USATECOM M16A1 Rifle Endurance Test - USATECOM Project No 8-8-0230-5

a. Correctness of approach.

b. Suitability of data.

c. Findings of your evaluation thus far. QA normally

d. Acceptableness of malfunction limits as suggested on Incl 6.

10. Point of contact at this Command for coordination is Mr. George Rivard, AMSWE-QAT, AUTOVON 551-1380, Extension 6021. Request reply by COB 2 Feb 70.

FOR THE COMMANDER:

6 Incl
as

B. C. GERKE
Director, Quality Assurance

CF:
CG, U. S. Army Materiel Command
ATTN: AMCQA, Mr. Lorber w/incl

JAN 15 1969

	[1] TECOM MONTHLY END	[2] IPT RETEST	[3] CT	TOTAL
F/T Lock	3	0	2	5
F/T Fire	0	0	0	0
F/T Feed	30	28	27	85
F/T Eject	1	1	0	2
F/T Chamber	0	0	3	3
F/T Extract	0	0	0	0
F/T Hold Rear	23	48	27	98
All Other	0	0	0	0
TOTAL	57	77	59	193
Rds Fired	96,416	144,000	108,000	348,416

[1] Data reflects tests on rifles from the production months of Aug, Sep and Oct 69.

[2] Data excludes H&R weapons (all had unmodified bolt catches).

[3] Three rifles (1 from each producer) excluded due to unrepresentative and excessive number of malfunctions.

Encl 1

IPT ENDURANCE - RETEST

Twelve rifles from each producer were endurance tested 6000 rounds each during the IPT with some weapons having the modified bolt catch installed. The breakdown is as follows:

GM - All Modified
H&R - Original
COLT - All Modified

The results obtained from rifles of the modified configuration are as follows:

	FBRs	FEJ	*FF-1	F/T FEED	TOTAL
GM	21	1	6	7	35
Colt	27	0	8	7	42
	48	1	14	14	77

*"Pamphlet on Definitions and Identification of Malfunctions for 5.56mm Weapons, M16A1/XM177E2" dated Nov 68 written by Aberdeen Proving Ground defines an FF-1 as "Failure to feed and chamber the first round from the magazine." Subject retest (see page 143 of Final Report on Combined IP and ICT of M16A1 Rifles dated May 69, paragraph 2.9.5.3, a, 2, reads as follows: "Due to excessive failures of the bolt to lock (no more than 2 per 6000 rounds permitted; scored as FF-1's in Table 2.9-1)... . Apparently conflicting nomenclature is used by USATECOM in this instance. Since past tests as well as current testing show no prevalence of the "Bolt failing to lock, the FF-1 during the retest was counted, for calculations below, as a F/T Feed type malfunction. Furthermore, a F/T Lock would necessarily occur due to a F/T Feed or Chamber but should not be counted as a "lock" malfunction.

Therefore, the probabilities associated with each malfunction, assuming FF-1 as a Feed type malfunction, are as follows:

F/BOLT TO LOCK OR F/T FIRE

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 600 Rds]
0	.8827	.8827
1	.1101	.9928
3	.0069	.9997

Incl 2

RETEST

F/T FEED

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 6000 Rds]
0	.2019	.2019
1	.3230	.5249
2	.2584	.7833
3	.1378	.9211
4	.0551	.9762
5	.0176	.9938
6	.0047	.9985
7	.0011	.9996
8	.0002	.9998

F/T EJECT

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 6000 Rds]
0	.8187	.8187
1	.1637	.9824
2	.0164	.9988
3	.0011	.9999

F/T CHAMBER OR F/T EXTRACT

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 6000 Rds]
0	.8827	.8827
1	.1101	.9928
2	.0069	.9997

BOLT FAILS/T HOLD

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 6000 Rds]
0	.0821	.0821
1	.2052	.2873
2	.2565	.5438
3	.2138	.7576
4	.1336	.8912
5	.0668	.9580
6	.0278	.9858
7	.0099	.9957
8	.0031	.9989
9	.0009	.9998

ALL OTHER

"n" Malfunctions	P ["n" in 6000 Rds]	P ["n" or less in 6000 Rds]
0	.8827	.8827
1	.1101	.9928
2	.0069	.9997

MONTHLY ENDURANCE TEST - TECOM

TECOM conducts a monthly Endurance Test of M16A1 Rifles representative of specific production months. The period examined is the production months of Aug 69, Sep 69, and Oct 69. During these months, 10 Colt rifles and 6 GM rifles were endurance fired 6026 rounds each in a bench rest position (NOTE: H&R weapons were not available during the period). The following probabilities are associated with data generated during the above testing:

F/BOLT TO LOCK

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.6703	.6703
1	.2681	.9384
2	.0536	.9920
3	.0072	.9992
4	.0007	.9999

F/T FIRE

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8187	.8187
1	.1637	.9824
2	.0164	.9988
3	.0011	.9999

F/T FEED

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.0821	.0821
1	.2052	.2873
2	.2565	.5438
3	.2138	.7576
4	.1336	.8912
5	.0668	.9580
6	.0278	.9858
7	.0099	.9957
8	.0031	.9988
9	.0009	.9997
10	.0002	.9999

TECOM

F/T EJECT

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.7118	.7118
1	.2420	.9538
2	.0411	.9949
3	.0047	.9996

F/T CHAMBER

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8187	.8187
1	.1637	.9824
2	.0164	.9988
3	.0011	.9999

F/T EXTRACT

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8187	.8187
1	.1637	.9824
2	.0164	.9988
3	.0011	.9999

BOLT FAILS/T HOLD REAR

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.1353	.1353
1	.2707	.4060
2	.2707	.6767
3	.1804	.8571
4	.0902	.9473
5	.0361	.9834
6	.0120	.9954
7	.0034	.9988
8	.0009	.9997
9	.0002	.9999

OTHER MALFUNCTIONS

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8187	.8187
1	.1637	.9824
2	.0164	.9988
3	.0011	.9999

COMPARISON TEST - GENERAL ELECTRIC

F/BOLT TO LOCK

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.7047	.7047
1	.2466	.9513
2	.0432	.9945
3	.0050	.9995
4	.0004	.9999

F/T FIRE

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8437	.8437
1	.1434	.9871
2	.0122	.9993
3	.00069	.99999

F/T FEED

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.1275	.1275
1	.2626	.3901
2	.2703	.6604
3	.1853	.8457
4	.0954	.9411
5.	.0390	.9801
6	.0145	.9946
7	.0045	.9991

F/T EJECT

"n" Malfunctions	P { "n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8437	.8437
1	.1434	.9871
2	.0122	.9993
3	.00069	.99999

Incl 4

F/T CHAMBER

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.6505	.6505
1	.2797	.9302
2	.0086	.9989
3	.0009	.9998

F/T EXTRACT

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.8437	.8437
1	.1434	.9871
2	.0122	.9993
3	.00069	.99999

BOLT FAILS/T HOLD REAR

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.1275	.1275
1	.2626	.3901
2	.2703	.6604
3	.1853	.8457
4	.0954	.9411
5	.0390	.9801
6	.0145	.9946
7	.0045	.9991

OTHER MALFUNCTIONS

"n" Malfunctions	P { "n" in 6000 Rds}	P { "n" or less in 6000 Rds}
0	.8437	.8437
1	.1434	.9871
2	.0122	.9993
3	.00069	.99999

IPT (RETEST); TECOM MONTHLY ENDURANCE; COMPARISON TEST

(All Data Combined)

F/T LOCK

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8353	.8353
1	.1503	.9856
2	.0135	.9991

F/T FIRE

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.9512	.9512
1	.0476	.9988

F/T FEED

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.1653	.1653
1	.2975	.4628
2	.2678	.7306
3	.1607	.8913
4	.0723	.9636
5	.0260	.9896
6	.0078	.9974
7	.0020	.9994
8	.0005	.9999
9	.0001	—

F/T EJECT

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8958	.8958
1	.0985	.9943
2	.0054	.9997

F/T CHAMBER

"n" Malfuctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.8781	.8781
1	.1142	.9923
2	.0074	.9999

Pg 5

COMBINED

F/T EXTRACT

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.9512	.9512
1	.0476	.9988

BOLT F/T HOLD REARWARD

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.1353	.1353
1	.2707	.4060
2	.2707	.6767
3	.1804	.8571
4	.0902	.9473
5	.0361	.9834
6	.0120	.9954
7	.0034	.9988

ALL OTHER

"n" Malfunctions	P {"n" in 6000 Rds}	P {"n" or less in 6000 Rds}
0	.9512	.9512
1	.0476	.9988

TABLE OF MALFUNCTIONS AND UNSERVICEABLE PARTS
(6000 ROUND ENDURANCE TEST - SHOULDER FIRING)

Malfunctions[1]	Single Rifle
Failure of bolt to lock[2]	2
Failure to fire	1
Failure to Feed (from magazine)	6
Failure to eject	1
Failure to chamber	1
Failure to extract	1
Bolt fails/hold rear	6
All other malfunctions[3]	1
Total - above malfunctions combined	9

Unserviceable Parts	Minimum Life (Rds)[4]
Magazine Assembly	250 (1)
Ejector Spring	3000 (1)
Extractor Spring	2000 (2)
Other Parts[5]	3000 (1)
Total unserviceable parts - above unserviceable parts combined	(2)

[1] When malfunctions are traceable to particular parts, it is permissible to replace such parts and record them as unserviceable, subject to the limitations of the above table. When verified by the Government representative that previously recorded malfunctions are attributable to an unserviceable part, such malfunctions shall not be counted against the rifle being tested provided that they occurred not more than 200 rounds prior to replacement of the unserviceable part. These 200 rounds shall have been fired with the unserviceable part. However, such malfunctions shall remain recorded and properly identified. Malfunctions attributable solely to ammunition defects, as verified by the Government representative, shall not be counted against the rifle; however, such malfunctions shall be recorded.

[2] In the event of any failure of bolt to lock malfunction, the forward assist assembly shall be operated. Failure of the forward assist assembly to remain engaged with the bolt carrier assembly during manual attempt to lock bolt shall be considered an additional malfunction in the category of "other malfunction."

[3] Other malfunctions include but are not limited to: occurrence of doubling (two shots fired with a single trigger pull) during semi-automatic firing, failure to immediately stop firing when the trigger is released (uncontrolled fire) during burst firing, and failure of forward bolt assist assembly to remain engaged with bolt carrier assembly during manual attempt to lock the bolt, etc.

[4] Minimum life rounds is the minimum allowable life of an individual part, whether it is the original part or a replacement part, expressed in the number of weapon rounds fired prior to failure. For example, an extractor spring failing prior to firing 2000 rounds on a new rifle has not met the minimum life rounds. The failure shall be recorded and shall be cause for test failure. Numbers in parentheses indicate the number of unserviceable parts allowed per 6000 round test. The numbers outside of the parentheses indicate the minimum number of rounds the part must successfully complete before a failure occurs.

[5] Other parts shall be limited to trigger spring, disconnect spring, hammer spring, extractor pin, and extractor.