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Test Report

PROTOTYPE QUALIFICATION TEST - GOVERNMENT OF CONUS-PRODUCED SAW AMMUNITION (M855/M856)

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The functioning performance data recorded for information only during the belt-pull test, are presented in Table 5.2-3.

TABLE 5.2-3. FUNCTIONING PERFORMANCE DATA FROM BELT PULL TESTING

Wpn Identification Serial No.	Test No.	Bbl No.	Total Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
001240	1	1	66	5	0	2	0	0	0	7	All Stoppages caused by the testing, but the types of stoppages were similar to those which occurred as a result of a belt hang-up in the plastic 200-round magazine.
		S1	61	4	0	2	0	0	0	6	
002279	2	2	94	8	0	0	0	0	0	8	
		S2	71	8	0	0	0	0	0	8	
002305	3	3	114	8	0	3	0	0	0	11	
		S3	75	6	1	2	0	0	0	9	
002437	4	4	114	9	0	0	0	0	0	9	
		S4	94	4	0	3	0	0	0	7	
002594	5	5	40	1	0	5	0	0	0	6	
		S5	43	1	0	5	0	0	0	6	
014229	6	6	79	3	0	3	0	0	0	6	
		S6	86	6	0	1	0	0	0	7	
014230	7	7	105	9	0	0	0	0	0	9	
		S7	81	7	0	0	0	0	0	7	
014231	8	8	89	4	0	4	0	0	0	8	
		S8	82	7	0	0	0	0	0	7	
Total	8	16	1240	90	1	30	0	0	0	121	

Note: Abbreviation definitions can be found in Appendix E.

The initial accuracy and dispersion firings were done with eight weapons and both original and spare barrels. Three 10-round targets were fired from each of the guns with each of the barrels, using the NORMAL gas regulator setting. The summary of that data is presented in Table 5.2-4. Velocity and cyclic rate information recorded during the targeting exercise are also presented.

TABLE 5.2-4. INITIAL TARGETING RESULTS (50-METER RANGE)

Wpn Identification Serial No.	Test No.	Bbl No.	Average CR[a]	Average Vel[b]	HCI	Target Measurements, inches[c] VCI	HSD	VSD	EHS	EVS	ES	MR
001240	1	1	914	2932	-5.65	3.72	1.64	2.27	5.13	6.68	7.55	2.47
		S1	854	2911	-1.86	-0.83	1.92	1.64	5.87	4.97	6.93	2.18
002279	2	2	751	2949	-8.34	0.86	1.50	1.50	4.61	4.72	5.10	1.88
		S2	824	2908	-2.07	-1.91	1.58	2.05	4.99	5.95	7.23	2.19
002305	3	3	890	2959	-7.20	3.57	2.51	3.06	7.87	8.85	10.99	3.54
		S3	832	2954	-3.21	2.06	2.68	1.62	8.29	5.08	8.81	2.73
002437	4	4	886	2946	0.25	8.22	3.07	2.69	9.29	8.22	11.03	3.53
		S4	810	2966	1.84	9.12	2.10	1.54	6.91	4.52	7.83	2.28
002594	5	5	743	2953	-4.59	4.95	1.69	2.44	5.12	7.53	8.03	2.57
		S5	697	2956	-5.97	6.06	1.39	1.80	4.47	5.98	6.17	1.93
014229	6	6	749	2915	-6.94	-1.04	1.19	1.66	4.15	5.22	5.75	1.77
		S6	699	2959	-1.69	-2.41	1.21	1.48	4.13	4.74	5.44	1.62
014230	7	7	779	2947	-1.61	-10.34	1.62	1.30	5.19	4.65	6.28	1.73
		S7	771	2927	0.42	9.22	1.47	1.20	4.79	3.57	5.07	1.64
014231	8	8	731	2933	-5.36	5.49	1.42	2.19	4.86	6.94	8.04	2.18
		S8	697	2935	-6.97	4.80	1.44	1.46	4.81	5.10	5.99	1.67

[a] Cyclic rate limits for the gun with NORMAL setting was 700 to 850 spm.

[b] These average velocities are the basis of first velocity measurements used during endurance and reliability testing to determine barrel serviceability.

[c] The sum of the extreme horizontal and vertical spreads must not exceed 15.75 inches (40cm) for 9 out of 10 shots per target. All barrels met this requirement for all targets with 10 rounds, except target No. 2 from barrel No. 3 (9 rounds= 20.75 inches). Targets 1 and 2 from barrel No. 4 did not meet the requirements with 10 rounds, but did meet it with 9 rounds (target 1= 15.04 inches and target No. 2= 15.12 inches).

Note: Abbreviation definitions can be found in Appendix E.

The functioning performance information from the accuracy/dispersion firings are listed in Table 5.2-5.

TABLE 5.2-5. FUNCTIONING PERFORMANCE DATA FROM ACCURACY/DISPERSION

Wpn Identification Serial No.	Test No.	Bbl No.	Total Rd Fired	No. Malfunctions, by type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
001240	1	1	90	0	0	0	0	0	0	0	
		S1	60	0	0	0	0	0	1	1	Round No. 31, loose flash suppressor.
002279	2	2	30	0	0	0	0	0	0	0	
		S2	30	0	0	0	0	0	0	0	
002305	3	3	30	0	0	0	0	0	0	0	
		S3	30	0	0	0	0	0	0	0	
002437	4	4	30	0	0	0	0	0	0	0	
		S4	30	0	0	0	0	0	0	0	
002594	5	5	30	0	0	0	0	0	0	0	
		S5	30	0	0	0	0	0	0	0	
014229	6	6	30	0	0	0	0	0	0	0	
		S6	30	0	0	0	0	0	0	0	
014230	7	7	30	0	0	0	0	0	0	0	
		S7	30	0	0	0	0	0	1	1	Round No. 0, loose flash suppressor.
014231	8	8	30	0	0	0	0	0	0	0	
		S8	30	0	0	0	0	0	1	1	Round No. 0, loose flash suppressor.
Total	8	16	330	0	0	0	0	0	3	3	

Note: Abbreviation definitions can be found in Appendix E.

The eight weapons were each fired 110-rounds. The firing schedule consisted of firing the first 80-rounds from a 200-round plastic magazine. The 80-round belt of ammunition was linked all ball, with dummy rounds positioned in the belt after every 20th live round (i.e., rounds No. 21, 42, and 63). The first 20 rounds were fired in 5-round bursts. The second 20 rounds were fired as a continuous burst. Both were at the NORMAL gas regulator setting. The gas setting was changed to HIGH for the next 20 rounds, which were fired in a continuous burst. The final 20 rounds of the belt were fired in 5-round bursts again at the NORMAL setting. Thirty rounds were then fired in 5-round bursts from the 30-round M16A2-rifle magazine. The gas regulator setting was unchanged. The result of these firings are presented in Table 5.2-6. Cyclic rate data are in Table 5.2-7.

TABLE 5.2-6 FUNCTIONING PERFORMANCE DATA FROM INITIAL FUNCTION-CHECK TESTING

Wpn Identification Serial No.	Test No.	Bbl No.	Total Rd Fired	No. Malfunctions, by type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
001240	1	1	110	0	0	1	0	0	0	1	Case deformed.
		S1	0	-	-	-	-	-	-	0	
002279	2	2	110	0	0	0	0	0	0	0	
		S2	0	-	-	-	-	-	-	0	
002305	3	3	110	0	0	0	0	0	0	0	
		S3	0	-	-	-	-	-	-	0	
002437	4	4	110	0	0	0	0	0	0	0	
		S4	0	-	-	-	-	-	-	0	
002594	5	5	110	0	0	0	0	0	0	0	
		S5	0	-	-	-	-	-	-	0	
014229	6	6	109	0	0	1	0	0	0	1	Link in buffer.
		S6	0	-	-	-	-	-	-	0	
014230	7	7	110	0	0	0	0	0	0	0	
		S7	0	-	-	-	-	-	-	0	
014231	8	8	110	0	0	0	0	0	0	0	
		S8	0	-	-	-	-	-	-	0	
Total	8	16	330	0	0	2	0	0	0	2	

Note: Abbreviation definitions can be found in Appendix E.

TABLE 5.2-7. CYCLIC RATE RECORDED DURING INITIAL FUNCTION CHECK TEST

Wpn Identification			Cyclic Rate, spm, by Mag Type, Mode of Fire, Gas Setting, and Sequence of Fire					
			SAW	200-Rd Magazine Linked			M16A2 Mag	
			N-SB	N-FA	H-FA	N-SB	N-SB	
Serial No.	Test No.	Bbl No.	1 to 20	21 to 40	41 to 60	61 to 80	81 to 110	Avg
001240	1	1	-	-	-	-	-	-
002279	2	2	742	685	985	762	844	804
002305	3	3	801	847	1056	903	977	917
002437	4	4	804	812	1049	850	934	890
002594	5	5	682	728	986	804	872	814
014229	6	6	699	711	996	800	858	813
014230	7	7	698	732	1042	827	905	841
014231	8	8	695	696	952	722	801	773
Avg	-	-	732	744	1009	810	884	836

N= NORMAL gas regulator setting.
SB= Short burst of approximately 5 rounds.
FA= Fully automatic (continuous) burst.

Inspection of the ammunition before firing revealed no prefiring defects. Fired case inspections found a few minor defects which are tabulated in Table 5.2-8 for the combined initial inspection firings.

TABLE 5.2-8. FIRED CASE INSPECTION (TEST AMMUNITION)

Lot No.	Ammo Type	Total Inspected	No. Defects, By Zone		
			I	S	Total
LC85D300S339	M855	2503	17	4	21

Note: Refer to Figure 3.2-1 for an explanation of the defect zone locations.

5.2.5 Technical Assessment

a. The M249 SAW provided for use in the ammunition assessment met the requirements of the inspection test.

b. The weapons, fired with the test ammunition, provided no safety-related problems.

c. The weapon and ammunition as a system were compatible.

d. The use of barrels which were not of the "plugged" type was representative of current issue items and, therefore, not a bar to their use, even though barrel life may be less than barrels of the other, later production type.

e. Although failure to properly weld the left hand rail in the receiver was a deviation from accepted manufacturing practice, this defect did not adversely affect either functioning or durability of the weapon.

f. The weapons were acceptable for use in assessing the CONUS-production ammunition and the criterion was therefore met.

5.3 ENDURANCE AND RELIABILITY

5.3.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56mm Ball, M855; and Tracer, M856?

e. Other issue. Are all the test item's RAM requirements met?

5.3.2 Criteria

a. The cartridge shall function without casualty at ambient temperature and under the temperature conditions of +125°F and -65°F (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridge shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 18 and 19, respectively).

d. The M249 SAW weapons must collectively exhibit the following minimum mean rounds between failure (MRBF) over a receiver service life of 50,000 rounds.

Failure Class	MRBF
I and II	3,333
II	6,250
III	15,000

(Para. 3.4.10 of PD-QAF-1) (Ref. 28).

e. The barrel shall exhibit a minimum service life of 10,000-rounds. A barrel is considered unserviceable if, during the endurance test, the velocity drops more than 61-m/s, or more than 20% of the rounds fired exhibit yaw in excess of 15° (Para. 3.4.8.3 of PD-QAF-1) (Ref. 28).

Note: The underlined portion was not addressed.

5.3.3 Test Procedure

The basic guidance for conduct of this test is found in paragraph 6.2.8 of TOP 3-2-045 (Ref. 36). Specific test procedures relating to activities peculiar to the test item are given in the following paragraphs:

a. The test sequence for firing 25,000-rounds of CONUS-produced M855 and M856 cartridges, linked in M27 links in the ratio of 4 ball to 1 tracer, is given in Tables 5.3-1 and 5.3-2. These schedules were fired with three weapons.

TABLE 5.3-1. BASIC FIRING SEQUENCE FOR M249 SAW FIRED FOR ENDURANCE AND RELIABILITY[a]

Firing Order	Firing Position	No. Rd Fired[b]
1	Bipod	600
2	Underarm/assault	600
3	Tripod (M122)	600
4	Test stand	[c] 200
	Total	2000

[a]Repeated the sequence until 25,000-rounds were fired from each gun. Completely cleaned, inspected, then lubricated with MIL-L-63460A after each 2000-rounds were fired.
[b]Fire in 5-round burst at 85 spm rate (approximately one burst every 3 seconds). One barrel per gun was used. Each weapon was cooled after firing each 200-rounds.
[c]The first 180-rounds were fired for projectile yaw which was monitored on a rolling paper target at 25 meters range. All firing was in 5-round bursts, 3 seconds between bursts. Velocity was recorded for all shots. All targets were inspected for signs of metal parts integrity failures.

TABLE 5.3-2. ATTITUDES FIRING SEQUENCE FOR M249 SAW FIRED DURING ENDURANCE AND RELIABILITY TEST[a]

Firing Order	No. Rd Fired[b]	How Held	Orientation	Elev. deg
1	100	Normal	Right side up	0
2	100	Normal	Left side up	0
3	100	Normal	Top side up	+80
4	100	Loose	Top side up	+80
5	100	Normal	Top side up	-80
6	100	Loose	Top side up	-80

[a]The 600-rounds per gun were fired at the beginning of the second 2000-round sequence.
[b]Firing was in 5-round bursts at intervals of about 3 seconds (85 spm).

b. After firing the 600-round attitudes test cycle, the remaining 1400 rounds were divided as follows: 400-rounds each from bipod, underarm/assault, and tripod. The test stand firing remained at 200-rounds in order to maintain uniformity of yaw, velocity, and dis persion data collection. The first 100-rounds fired during the underarm/assault position (after attitudes) was done with a loosely held weapon. The resultant performance was annotated in the data presentation.

c. The unservicability of M249 gun barrels was defined as a decrease in the velocity between new cold-barrel velocity and subsequent hot barrel velocity which exceeded 200 fps (61m/s). If more than 20% of the projectiles from the first 180-rounds in the yaw test (firing order No. 4) exhibited yaw of more than 15°, the barrel was considered unserviceable, even though a velocity drop failure may not have occurred.

d. Belt pull measurements were recorded (three trials) as part of initial inspection and during endurance/reliability testing at 4000-round intervals, starting at 6000-rounds per weapon. A final belt pull test was done at the completion of all firing. In the event that barrel failure occurred prior to 25,000-rounds, belt pull was measured using the replacement barrel.

e. Barrel bore and chamber measurements were recorded during initial inspection and again at 2000-round intervals, starting at 6,000-rounds, during the endurance/reliability test. Final barrel measurements were made either after completion of 25,000-rounds, or when a barrel was declared unserviceable.

f. Barrel changes were evaluated at each 2000-round maintenance interval. Immediately upon completion of the targeting exercise, the hot barrel was removed and a spare (unfired) barrel was installed. In the event that fouling prevented easy removal, barrel change testing was done during each 200-round cooling interval.

g. Parts of the SAW were not replaced until unserviceable, which was defined as causing malfunctions or stoppages of the weapon. The only exception to this rule was in the case of potential category I or II saftey hazards. Under those circumstances, any gun component that was safety was replaced.

h. Observation of daylight tracer functioning was made to detect proper functioning and visibility (information only). Various background contrasts were used to determine visibility characteristics of the tracer ammunition.

5.3.4 Test Findings

The results of this subtest are reported in Tables 5.3-3 and 5.3-4 (functioning performance), 5.3-5 (barrel life), 5.3-6 (barrel life/tracer ammunition performance), 5.3-7 (belt pull), and 5.3-8 (ammunition/fired case inspection results).

TABLE 5.3-3 FUNCTIONING PERFORMANCE: M249 SAW
FIRED WITH CONUS-PRODUCED AMMUNITION

Weapon ID No.			Average[a]		Rd	No. Malfunctions, by Type							
Receiver SN	Test	Bbl	CR	Vel	Fired	FFD	FTC	FFR	FEX	FEJ	OTH	Tot.	Remarks
					Phase I								
001240	1	1	076	na	1,999	2	0	0	0	0	1	3	OTH=FRA
002279	2	2	882	2,914	2,000	2	0	0	0	0	0	2	(mag.)
002305	3	3	960	2,933	1,998	2	0	1	0	1	1	5	OTH=FRM.
Subtotal					5,997	6	0	1	0	1	2	10	
					Phase II								
001240	1	1	980	2,911	1,991	9	0	1	0	0	2	12	OTH=FRA, LFB
002279	2	2	946	2,877	2,000	2	0	0	0	0	1	3	OTH=LFB.
002305	3	3	1,007	2,891	1,999	3	1	0	0	0	1	5	OTH=FIL.
Subtotal					5,990	14	1	1	0	0	4	20	
					Phase III								
001240	1	1	998	2,869	1,999	8	0	0	0	0	0	8	
002279	2	2	967	2,837	1,998	3	0	0	0	0	1	4	OTH=LCF.
002305	3	3	1,043	2,855	1,997	2	1	0	0	0	0	3	
Subtotal					5,994	13	1	0	0	0	1	15	

See footnotes at end of Table.

TABLE 5.3-3 (CONTINUED)

Weapon ID No. Receiver SN	Test	Bbl	Average[a] CR	Vel	Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Tot.	Remarks
					Phase IV								
014229	6	1	963	2,878	2,000	0	0	0	0	0	0	0	Rec rd=2334.
002279	2	2	930	2,848	2,000	1	0	0	0	0	0	1	
002305	3	3	1,015	2,854	2,040	1	0	0	0	0	0	1	40 extra tgt rounds.
Subtotal					6,040	2	0	0	0	0	0	2	
					Phase V								
014229	6	1	954	2,852	1,999	0	0	1	0	0	0	1	
002279	2	2	912	2,817	1,999	0	0	1	0	0	0	1	
002305	3	3	1,027	2,824	1,999	0	0	1	0	0	1	2	OTH=LJC.
Subtotal					5,997	0	0	3	0	0	1	4	
					Phase VI								
014229	6	1	970	2,825	2,140	0	0	0	0	0	0	0	140 rd bltpl.
002279	2	2	915	2,763	2,077	0	0	0	0	0	0	0	77 rd bltpl.
002305	3	3	982	2,796	2,050	0	0	0	0	0	0	0	50 rd bltpl.
Subtotal					6,267	0	0	0	0	0	0	0	
					Phase VII								
014229	6	1	868	2,828	2,000	0	0	0	0	0	0	0	155 rd bltpl.
002279	2	2	934	2,747	2,000	0	0	0	0	0	0	0	101 rd bltpl.
002305	3	3	974	2,790	2,000	0	0	0	0	[b]1	0	1	95 rd bltpl.
Subtotal					6,000	0	0	0	0	1	0	1	
					Phase VIII								
014229	6	1	943	2,797	2,000	0	0	0	0	0	0	0	
002279	2	[c]S2	958	2,884	2,000	0	0	1	0	0	0	1	
002305	3	3	962	2,763	2,000	0	0	1	0	0	0	1	
Subtotal					6,000	0	0	2	0	0	0	2	
					Phase IX								
014229	6	1	880	2,769	2,000	0	0	0	0	0	0	0	
002279	2	S2	866	2,853	2,000	0	0	0	0	1	0	1	
002305	3	3	910	2,730	2,000	0	0	0	0	0	0	0	
Subtotal					6,000	0	0	0	0	1	0	1	

See footnotes at end of Table.

TABLE 5.3-3 (CONTINUED)

Weapon ID No. Receiver SN	Test	Bbl	Average[a] CR	Vel	Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Tot.	Remarks
					Phase X								
014229	6	1	942	2,798	2,000	0	0	0	0	0	0	0	154 rd bltpl.
002279	2	S2	990	2,843	2,000	0	0	0	0	0	0	0	90 rd bltpl.
002395	3	[c]S3	980	2,919	2,000	0	0	0	0	0	0	0	80 rd bltpl.
Subtotal					6,000	0	0	0	0	0	0	0	
					Phase XI								
014229	6	1	847	2,772	2,000	0	0	1	0	0	0	1	
002279	2	S2	881	2,833	2,000	0	0	0	0	0	0	0	
002395	3	S3	978	2,895	2,000	0	0	0	[b]1	0	0	1	
Subtotal					5,999	0	0	1	1	0	0	2	
					Phase XII								
014229	6	[c]S1	885	2,899	2,000	1	0	1	2	0	0	4	146 rd bltpl.
002279	2	S2	944	2,826	2,000	0	0	0	0	0	0	0	95 rd bltpl.
002305	3	S3	971	2,879	2,000	0	0	0	0	0	0	0	125 rd bltpl.
Subtotal					6,000	1	0	1	2	0	0	4	
					Phase XIII								
014229	6	S1	910	2,883	1,122	0	0	0	0	3	0	3	122 rd bltpl.
002279	2	S2	904	2,788	1,074	0	0	0	0	0	0	0	74 rd bltpl.
002305	3	S3	957	2,865	1,103	0	0	0	0	0	0	0	105 rd bltpl.
Subtotal					3,299	0	0	0	0	3	0	3	
Grand Total					[d]75,584	36	2	9	3	6	8	64	1,609 rd bltpl.

[a]The averages were for rounds fired during the last 20-rounds of each 2000-round phase. Cyclic rates were averages of the 16 ball and 4 tracer rounds. Velocity averages were only for the 16 ball rounds.
[b]Chipped extractor lip. Part replaced during the test phase indicated.
[c]Barrel replaced after completion of previous test phase due to velocity loss and/or projectile yaw.
[d]A total of 73,975-rounds was used in computation of reliability (excluded belt pull test rounds shown in Table 5.3-4).

bltpl = Belt Pull.

Note: Refer to Appendix E for definition of the abbreviations used in this table.

Most of the feeding stoppages which occurred during the first three test phases were due to problems experienced with the CONUS-produced, 200-round-capacity, plastic magazine for the linked ammunition. The link tab of this magazine assembly differed from that of the Belgian-produced part. The link ejection port cover of the weapon caught on the CONUS-produced part whenever the feed cover was slowly closed during loading of a new magazine of linked ammunition. A bolt underride of the first round occurred. This situation did not occur if the feed cover was slammed closed. The inertia was sufficient to prevent catching of the two parts. Training the gunners reduced the frequency of this type of stoppage in the remaining phases of this subtest.

TABLE 5.3-4. FUNCTIONING PERFORMANCE DATA FROM BELT PULL TESTING

Wpn Identification Serial No.	Test No.	Bbl No.	Tot Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
014229	6	1	449	18	0	3	0	0	0	21	16-BS
		S1	268	8	0	0	0	0	0	8	8-BS
002279	2	2	77	4	0	0	0	0	0	4	4-BS
		S2	360	3	0	0	0	0	0	3	2-BS
002305	3	3	145	3	0	0	0	0	0	3	3-BS
		S3	310	5	0	0	0	0	0	5	5-BS
Total----------			1,609	41	0	3	0	0	0	44	38-BS

BS = Belt separation (classified as FFD malfunctions).

Note: Abbreviation definition can be found in Appendix E.

The extreme spread measurements taken during the targeting portion of this subtest are reported as part of the barrel life information contained in Table 5.3-5. Detailed barrel bore measurements are contained in Appendix B.

TABLE 5.3-5. M249 SAW BARREL PERFORMANCE
FIRED WITH CONUS-PRODUCED AMMUNITION

Bbl No.	Vel Level, fps Initial	Reject at	Rejection Cause	Vel, fps, at Rejection	Extreme Spread in., at 100 yd[a]	Barrel Life, Rd
1	2932	2732	Yaw	2772	[b] -	22,515
S1	2911	2711	-	-	14.1	[c]3,122
2	2949	2749	Velocity	2747	18.1	14,409
S2	2908	2708	-	-	[b]19.1	[c]11,074
3	2959	2759	Velocity	2730	[d]17.3	18,442
S3	2954	2754	-	-	21.7	[c]7,103

See footnotes on following page.

[a]Target size used was 4 by 4 feet, with aiming point centered.
[b]Rounds missed target area.
[c]Rounds on barrel at time of test completion. Barrel was still serviceable.
[d]Measurment of ball rounds only. Tracer rounds yawed off target.

Notes: Targeting consisted of 16 ball and 4 tracer rounds fired in a 4 and 1 ball to tracer mix.
Velocity data were only for the ball rounds. Refer to Table 5.3-6 for tracer velocity change information.
Ball ammunition velocity at time of acceptance test was 3000 ± 40 fps from a Mann barrel.

TABLE 5.3-6 M249 SAW BARREL PERFORMANCE RELATIVE TO CHANGES IN TRACER AMMUNITION VELOCITY, DISPERSION, AND YAW

Bbl No.	Bbl Life Rounds	Tracer Velocity fps	Ext Spread, in., at 100 yd by Ammo Type Ball	Ext Spread, in., at 100 yd by Ammo Type Tracer	No. Yawed Tracer, Proj On Target	No. Yawed Tracer, Proj Off Target
1	12,515	2673	26.6	8.3	-	-
	14,515	2684	18.2	10.9	-	-
	16,515	2654	19.8	13.6	1	0
	18,515	2636	19.0	12.3	3	0
	20,515	2584 (3)	-	-	0	4
	[a]22,515	2680 (2)	-	-	0	[b]4
S1	2,000	2778	14.4	9.7	-	-
	[c]3,122	2730	13.6	12.6	-	-
2	12,332	2647	15.8	11.0	-	-
	[d]14,409	2608	18.1	6.9	3	0
S2	2,000	2758	21.3	11.1	-	-
	4,000	2736	12.7	9.5	-	-
	6,000	2688	23.6	5.8	-	-
	8,000	2694	16.6	11.6	-	-
	10,000	2676	19.3	22.4	3	0
	[c]11,074	2656 (3)	19.1	-	0	4
3	12,392	2659	13.4	12.3	2	0
	14,442	2647 (3)	17.5	23.1	3	1
	16,442	- (0)	17.8	-	0	4
	[d]18,442	2597	17.3	-	0	4
S3	2,000	2751	16.1	10.0	-	-
	4,000	2758	17.1	14.9	-	-
	6,000	2765	13.3	8.2	-	-
	[c]7,103	2722	21.7	8.9	-	-

See footnotes on following page.

[a]Number of rounds at time of barrel replacement due to excessive ball/tracer yaw.
[b]Four tracer rounds plus 16 ball rounds off target due to yaw.
[c]Barrel considered serviceable at time of test completion.
[d]Barrel replaced due to velocity loss of the ball rounds.

Notes: Number in () after velocity is the number of rounds in the average; all other are 4-round averages.
A "-" indicates no data entry due to performance of the ammunition.
Tracer velocity at time of acceptance test was 2860 ± 40 fps from a Mann barrel.

Belt pull was monitored throughout the test and is reported in Table 5.3-7. The weight of a 200-round free-hanging belt of ammunition was 13.7 pounds. The machine gun must be able to pull a weight equivalent to that much ammunition in the belt pull test; or in a retest if the first test failed, the equivalent weight of 150 rounds. The actual force required to either stall the gun operation or cause a belt separation was measured.

TABLE 5.3-7 M249 SAW BELT PULL DATA RECORDED DURING ENDURANCE/RELIABILITY TESTING

Wpn Identification			Test Interval, Rd		Belt Pull Force, N	
Serial No.	Test No.	Bbl No.	Receiver	Barrel	Normal	High
001240	[a]1	1	0	0	79.6	74.6
014229	[a]6	6	0	0	102.1	106.1
	6	1	3xxx	10xxx	77.4	-
	6	1	7xxx	14xxx	75.6	85.0
	6	1	11xxx	18xxx	90.3	88.5
	6	S1	15xxx	1xx	84.1	78.7
	6	S1	18xxx	3xxx	78.7	116.1
002279	[a]2	2	0	0	85.6	93.8
	2	2	10xxx	10xxx	75.2	81.0
	2	S2	14xxx	1xx	83.6	64.9
	2	S2	18xxx	4xxx	77.0	84.1
	2	S2	22xxx	8xxx	75.2	107.6
	2	S2	25xxx	11xxx	63.6	60.9
002305	[a]3	3	0	0	84.7	87.4
	3	3	10xxx	10xxx	73.4	75.6
	3	3	14xxx	14xxx	72.5	63.2
	3	3	18xxx	1xx	68.9	70.3
	3	S3	22xxx	4xxx	129.4	104.5
	3	S3	25xxx	7xxx	62.3	78.3

[a]Data taken from initial belt pull test results (Table 5.2-2).

Note: To convert belt pull force from N to lb-f, divide by 4.448. The minimum acceptable belt pull was 61 N (13.71 lb-f).

Test interval is in even thousands of rounds. Additonal rounds above the interval were fired but not computed; they are represented by xxx.

Several M249 SAW component parts failed during this subtest. Examples of broken extractors, an extractor spring, and handguard mounting tab of the receiver are shown in Figures 5.3-1 through 5.3-8. Metallurgical analyses of these failures were reported in Laboratory Report No. 86-M-74 (Extractor Spring and Extractors) and 86-M-78 (Receiver Assembly- Handguard Mounting Tab Failures). The results of these laboratory investigations are summarized in the following paragraphs.

Examination of the failed extractor spring, Figures 5.3-1 and 5.3-2, revealed that it was a fatigue failure. The fracture initiation site was located along the horizontal axis of the inside of the first coil from one end. Scanning Electron Microscope (SEM) examination revealed no evidence of material imperfections or manufacturing defects that would contribute to a fatigue initiation.

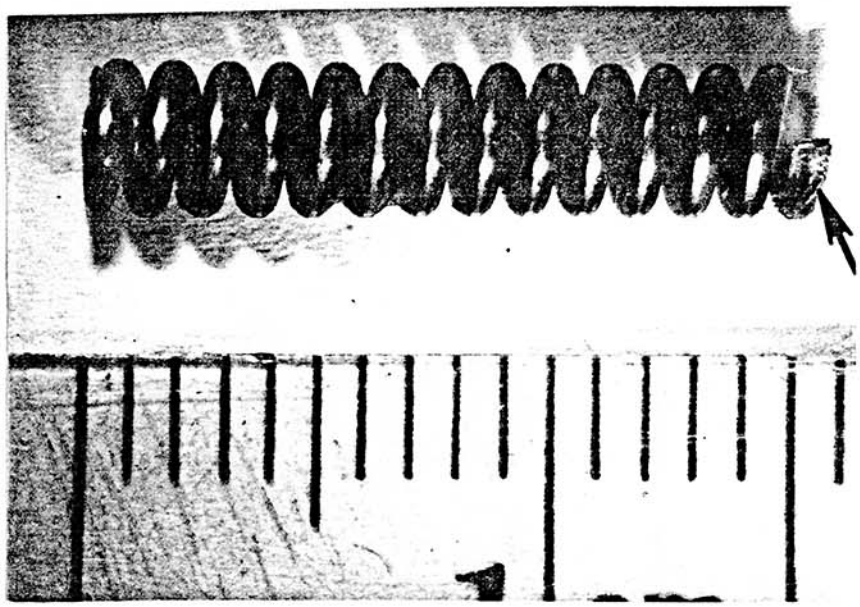


Figure 5.3-1. Photograph (enlarged) of failed extractor spring which shows the location of the fracture (arrow).

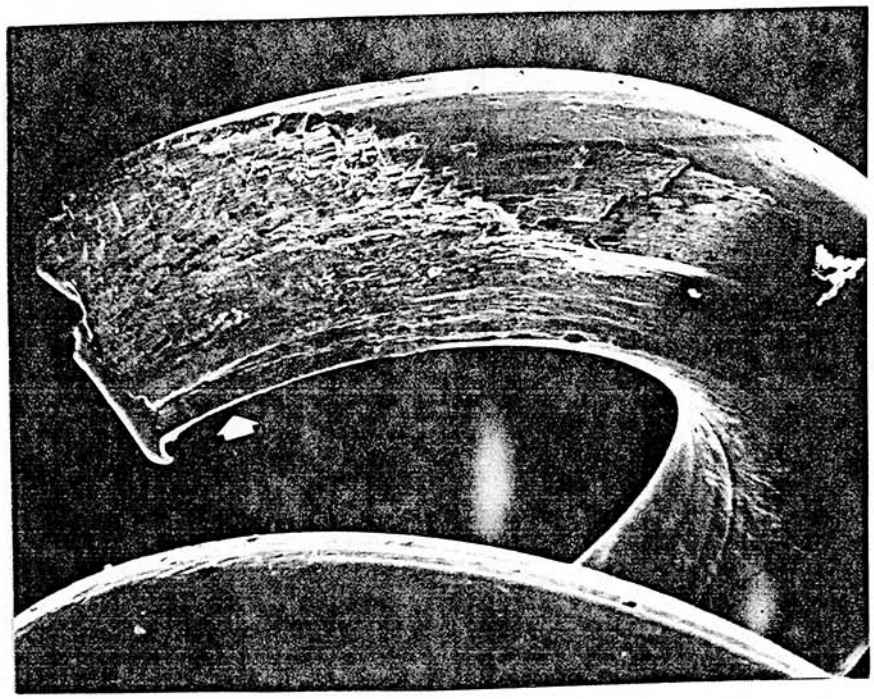


Figure 5.3-2. Closeup of the extractor spring fracture surface. Fracture initiated along the inner edge of the spring coil in the area identified by the arrow. Magnification, 80X.

Examination of the failed extractors, Figures 5.3-3 to 5.3-8, shows that they were exposed to a compressive load during chambering of the cartridge and a tensile load during extraction and ejection of the fired case. Macroscopic examination of the fracture surfaces revealed a fracture zone with beach marks on the edge of the fracture zone. Metallurgically, the extractors have a case hardened zone with martensitric microstructure. Beneath this zone, the extractors have a microstructure of mixed transformation products. The extractor hardness was HRC 41, with a case hardened zone depth of 0.14 mm. The material used in the extractor was identified as 34xx-series nickel-chromium steel. No carbon determination was made because of insufficient sample quantities available. The hardness specified for the extractor (Drawing No. 390 04 41-003) was above the 86 HR15N minimum required. The case-hardened zone of 0.10 to 0.15 mm was also within specification. The microstructure of the extractors was sound, indicating that material imperfections were not a contributing factor in the failures. The extractors failed in fatigue initiated by tensile loading applied during extraction and ejection of fired cases.

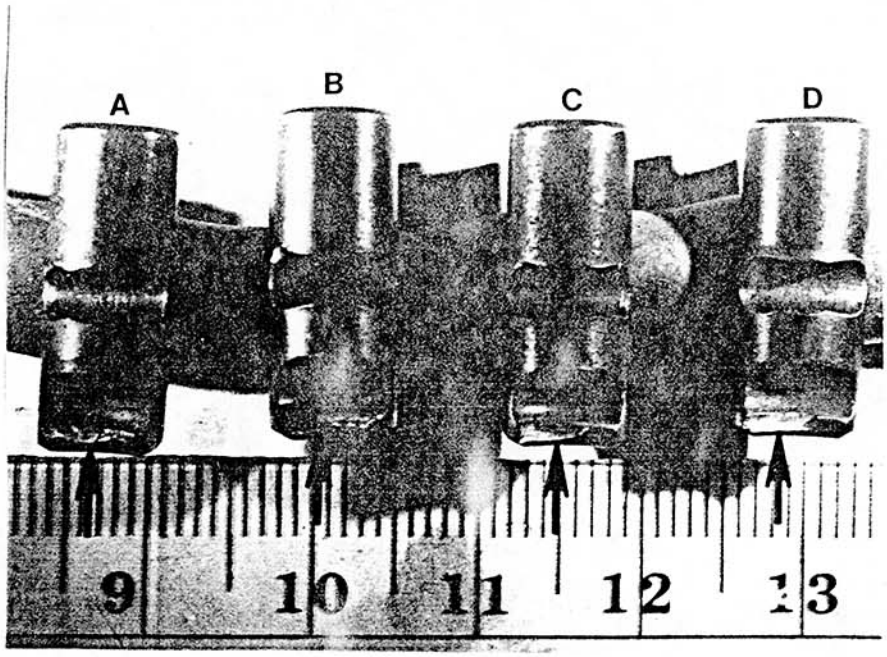


Figure 5.3-3. Photograph of the four broken extractors submitted for analysis. Note the location of fracture (arrows).

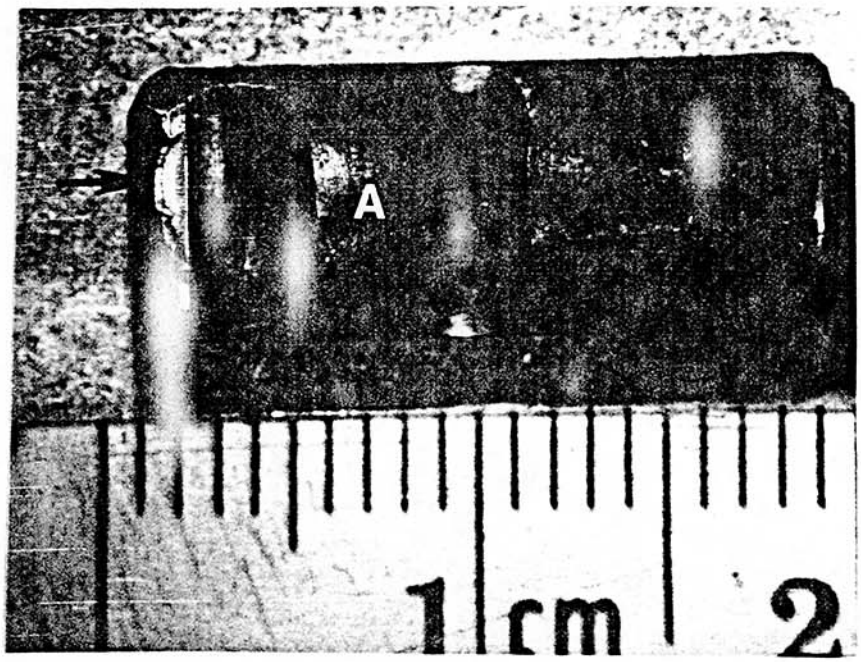


Figure 5.3-4. Top view of extractor A showing fractured lip (arrow).

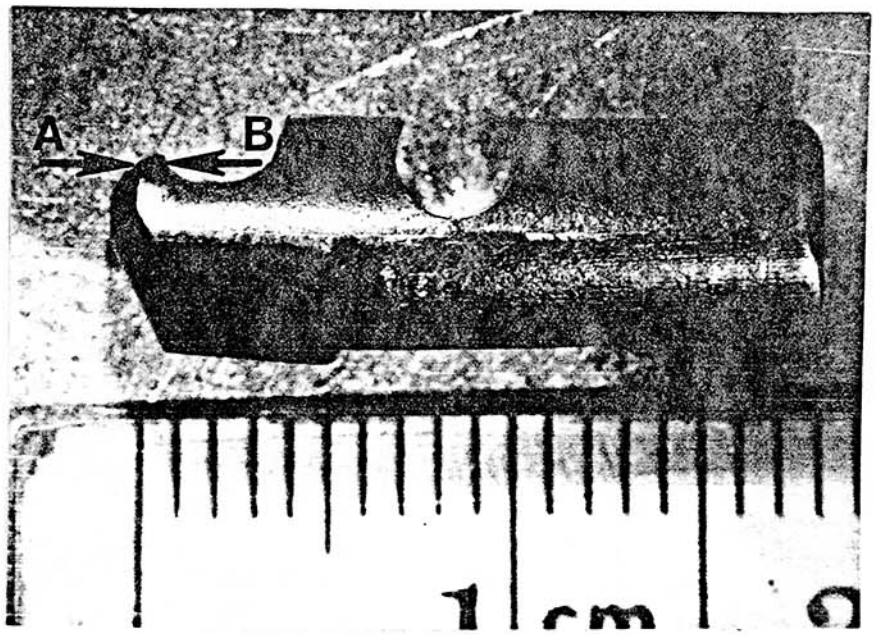


Figure 5.3-5. Profile view of extractor with the direction of both applied loads identified. A - compressive impact load, B - tensile load.

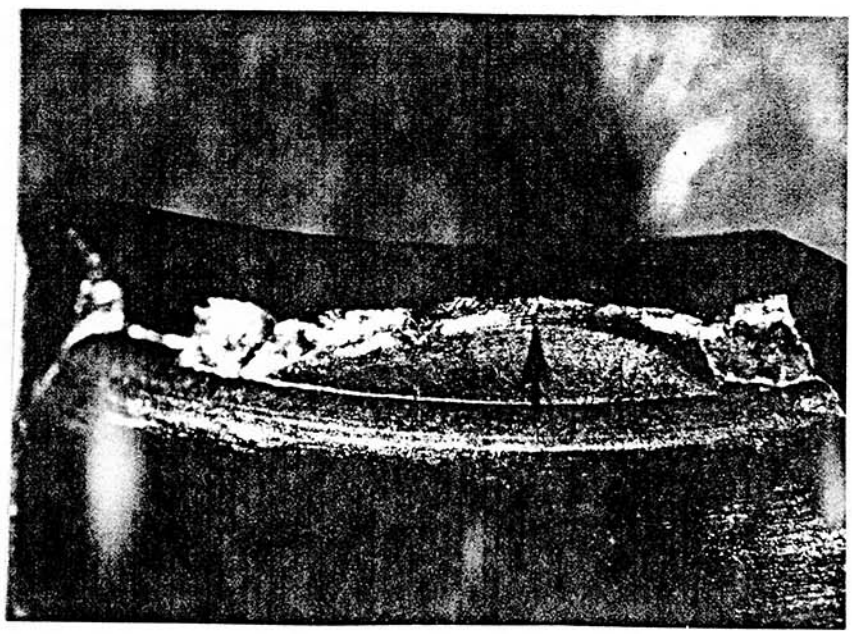


Figure 5.3-6. Closeup of fracture surface showing fatigue fracture surface with beach marks on the leading edge (arrow). Magnification: 20.X.

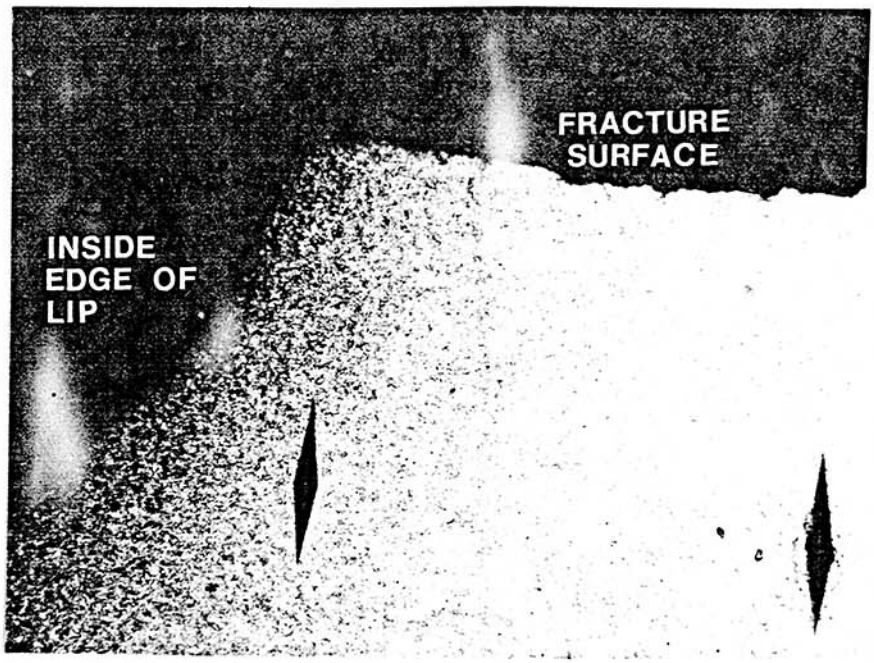


Figure 5.3-7. Micrograph of extractor where the fracture surface intersects the inside edge of the lip. This is a case hardened zone with a martensitic microstructure with the remainder having a microstructure of mixed transformation products. Magnification: 200 X.

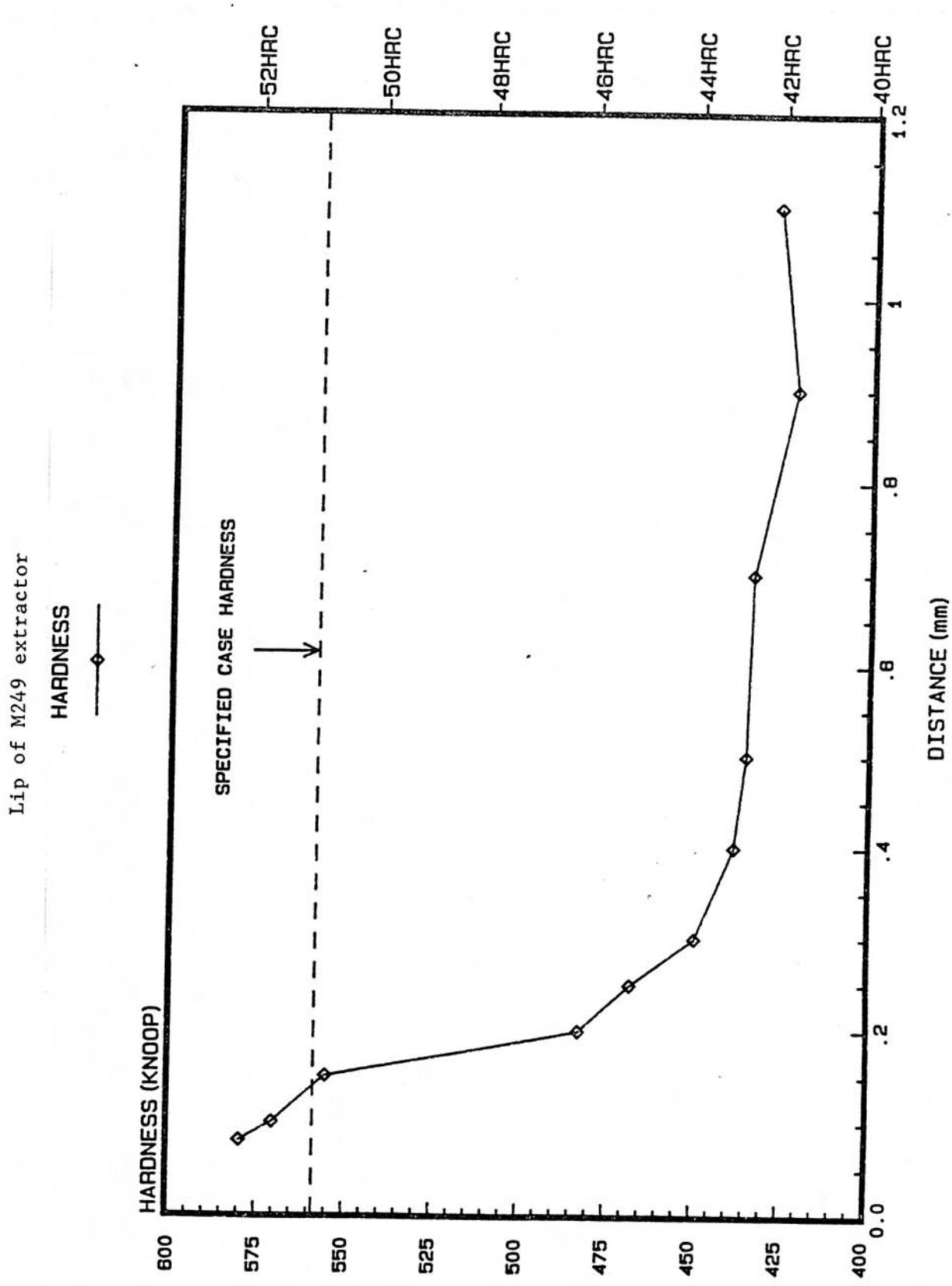


Figure 5.3-8. Microhardness traverse.

Two of the three M249 receivers experienced breakage of the metal boss which was the mounting location of the handguard. The macroscopic appearance of the fracture was typical of a fatigue failure in a cold-rolled steel. The ferritic grains were elongated and defects and inclusions were oriented in the rolling direction. Since cracks propagate more rapidly through defects and inclusions, the fracture surface had a layered appearance. The fracture surface was more heavily damaged at the rear end (narrow end of the retainer boss), indicating that the fatigue crack propagated from that direction. The least damaged portions of the failure surface showed ductile fracture characteristics, although the existing damage made it difficult to characterize the fracture. The part hardness, HRB 73, corresponded to a tensile strength of approximately 65 kpsi. The micrograph of the longitudinal section showed elongation of ferritic grains due to cold rolling reductions of between 40 and 50%. There were also sulfide stringer inclusions. Examination of an unetched polished section showed that the inclusions were minimal and too small to be characterized by ASTM standards. The material used in the receiver was identified as a high-strength low-alloy (HSLA) steel, SAE 950x grade. The microstructure indicated that the material had a low carbon content.

Part hardness and the microstructure indicated uniform material strength. The surface cracks noted (Fig. 5.3-10) acted as stress risers. The cracks were part of the manufacturing process, since the protective coating applied to the receiver was also applied to the crack surfaces before occurrence of the failures. Figures 5.3-9 through 5.3-14 show various views of the failed parts.

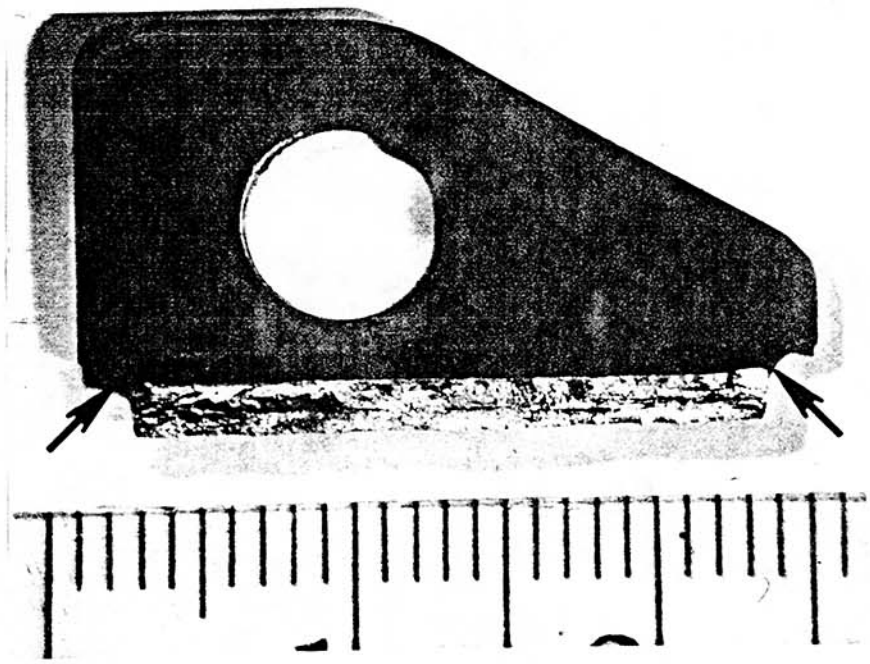


Figure 5.3-9. Right side view of failed retainer boss showing fracture surface with punched stress-relief holes on each and (arrow) (rear end at right).

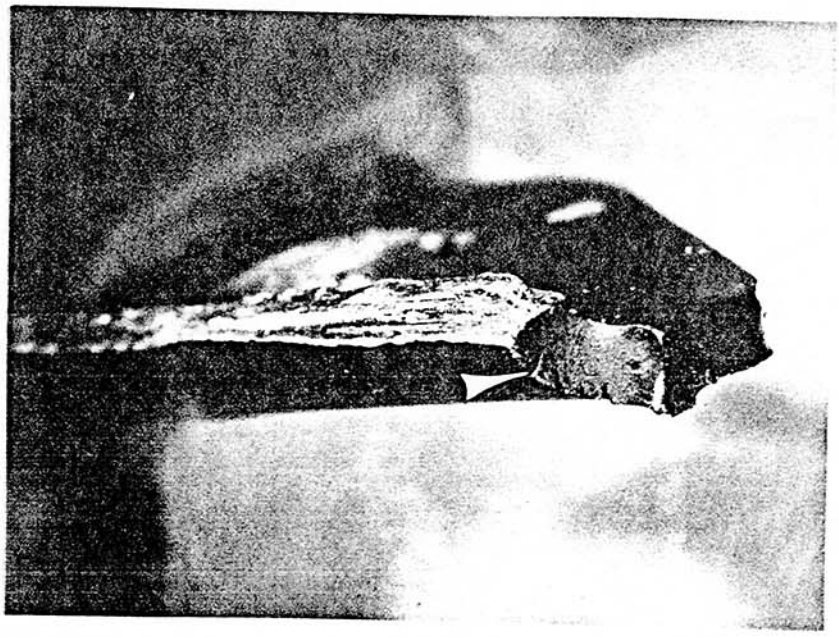


Figure 5.3-10. Rear end view closeup of retainer boss showing cracks on outside edge of stress-relief hole. Magnification: 6 X.

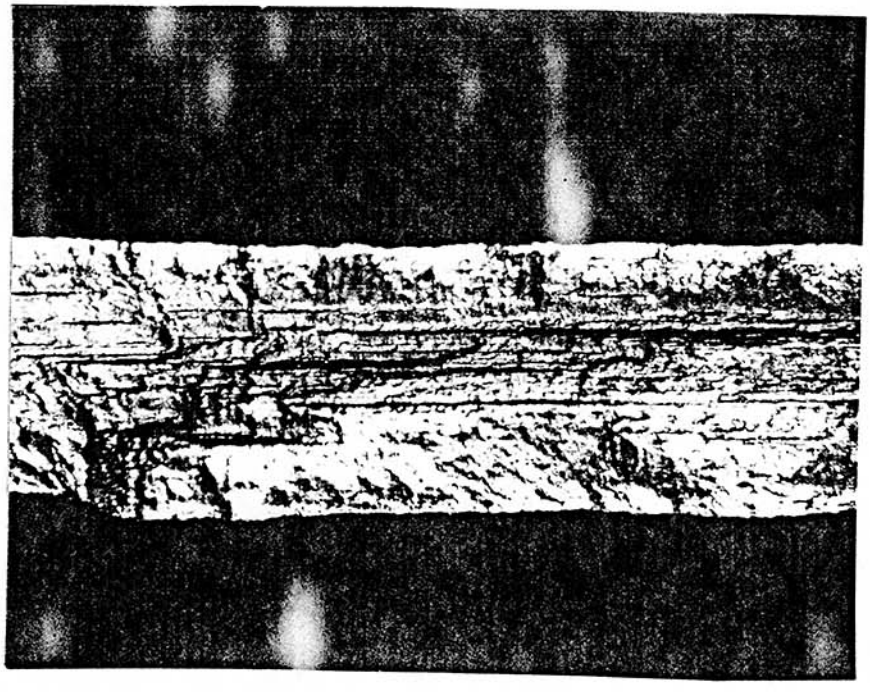


Figure 5.3-11. Closeup of fracture surface showing layered effect due to preferential cracking. Magnification: 20 X.

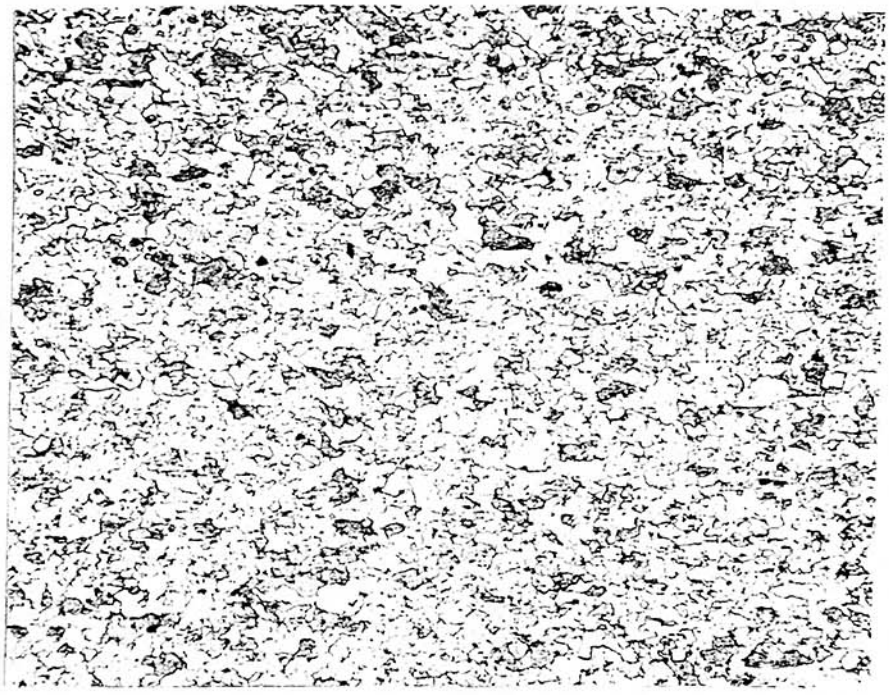


Figure 5.3-12. Micrograph of transverse section showing ferritic microstructure. Magnification: 200 X.

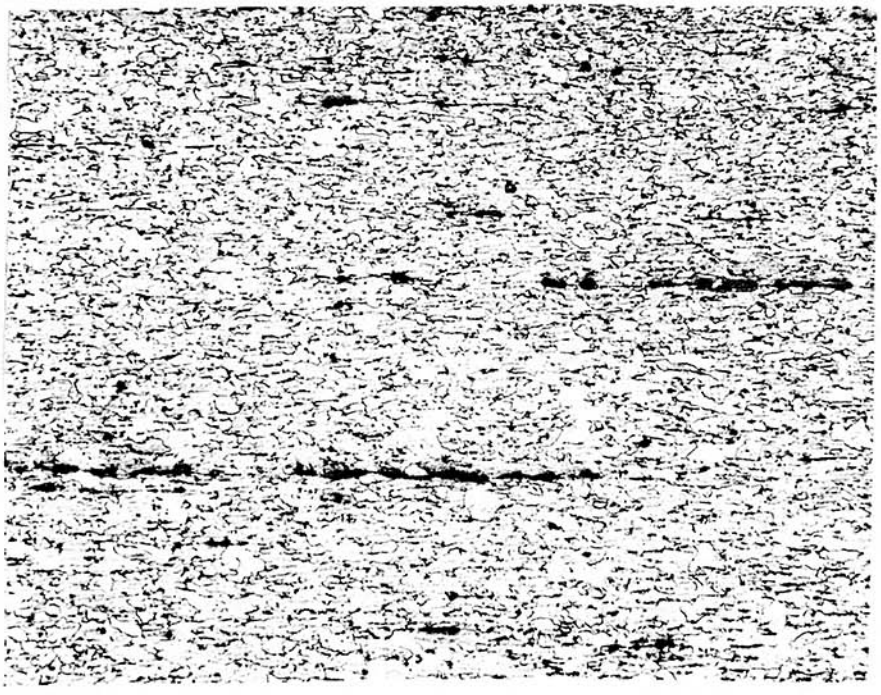


Figure 5.3-13. Micrograph of longitudinal section showing elongation of ferritic grains in direction of cold rolling and sulfide inclusions. Magnification: 200 X.

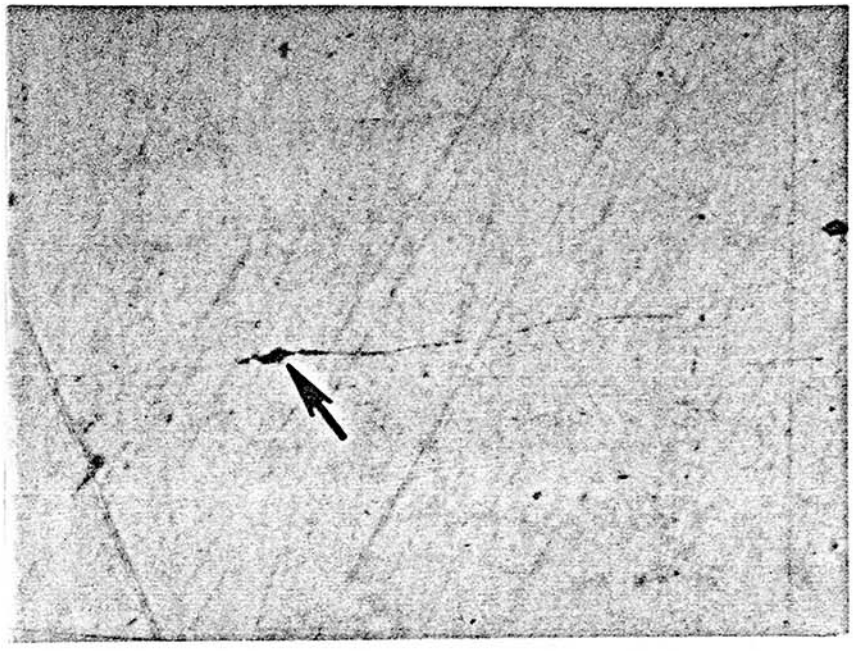


Figure 5.3-14. Micrograph of unetched longitudinal section showing sulfide stringer inclusions (arrow). Magnification: 800 X

The final documentation of this subtest relates to inspection of the ammunition and fired cases. Figure 5.3-15 shows an incorrect cartridge case on a round of M855 Ball ammunition. Figure 5.3-16 depicts a typical case mouth tear. Folds in the neck of the cartridge case, caused during manufacture, are shown in Figure 5.3-17. These folds could result in splits when the round was fired (Fig. 5.3-18). Another type of case fold in the area of the case shoulder is shown in Figure 5.3-19. A representative example of a pierced primer is displayed in Figure 5.3-20. Table 5.3-8 summarizes the ammunition and fired case inspection performed during this subtest.

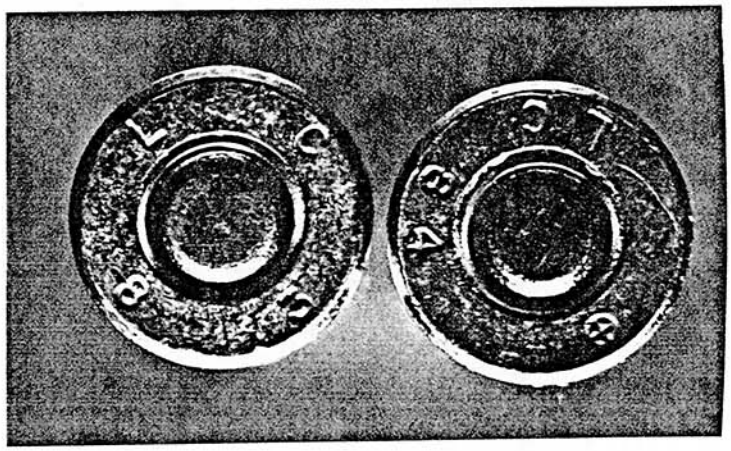


Figure 5.3-15. Wrong cartridge (left) discovered during pre-firing inspection.

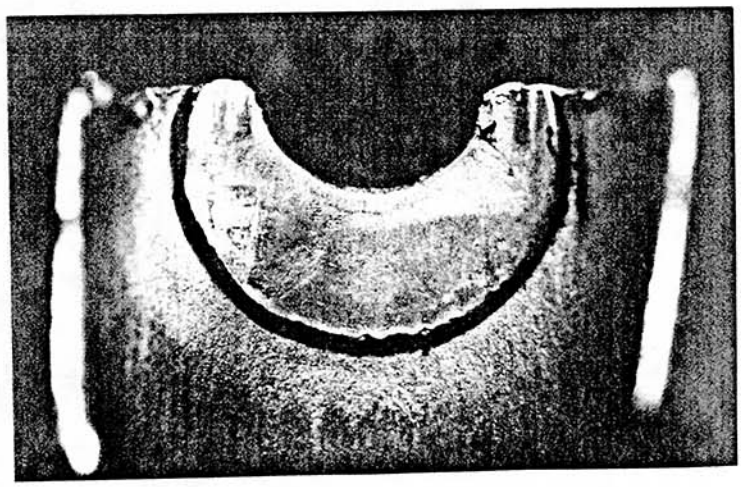
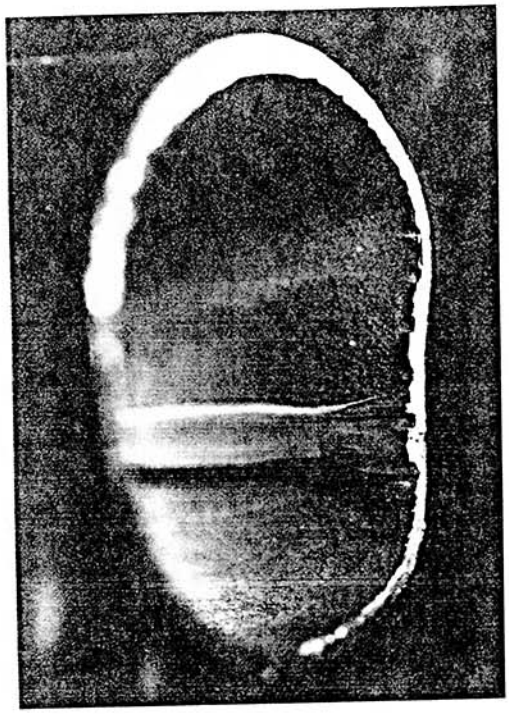
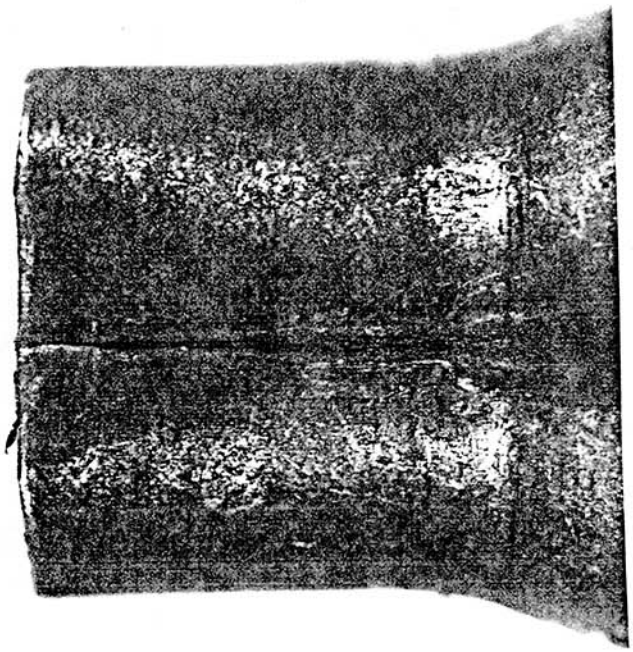


Figure 5.3-16. Inside view of case mouth deformation (typical).



Inside veiw



Outside view

Figure 5.3-17. Showing a typical fold in the case neck.

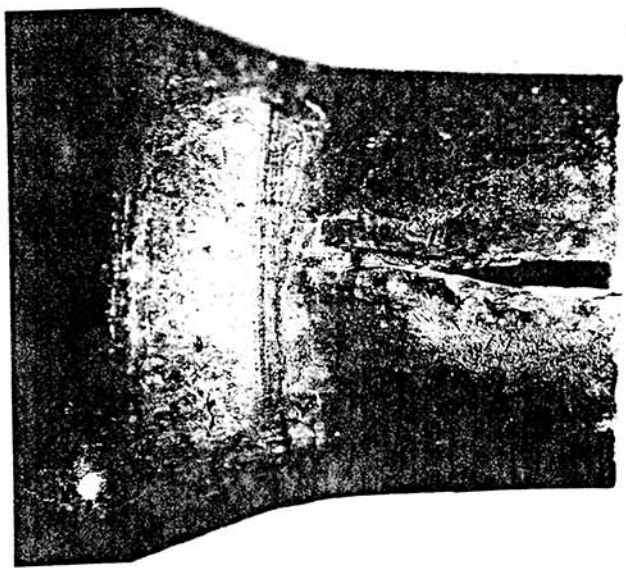


Figure 5.3-18. Typical case split.

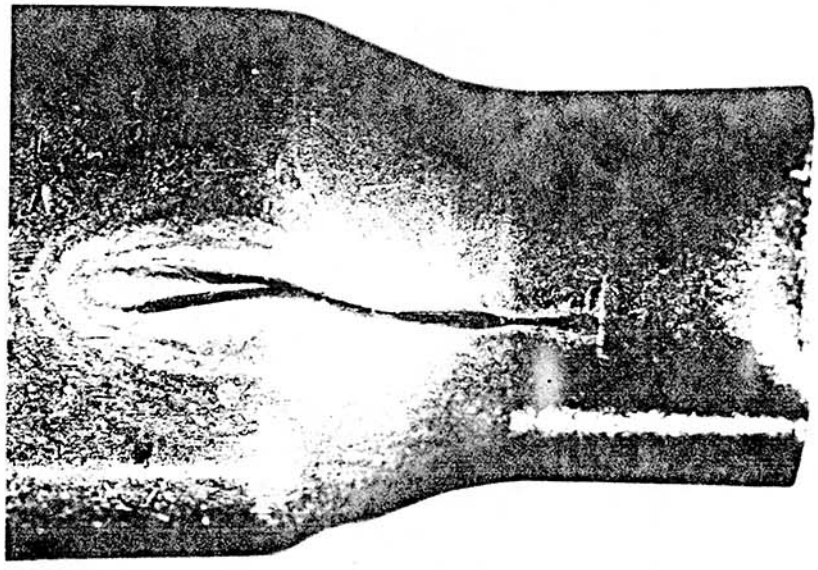


Figure 5.3-19. Typical should fold.

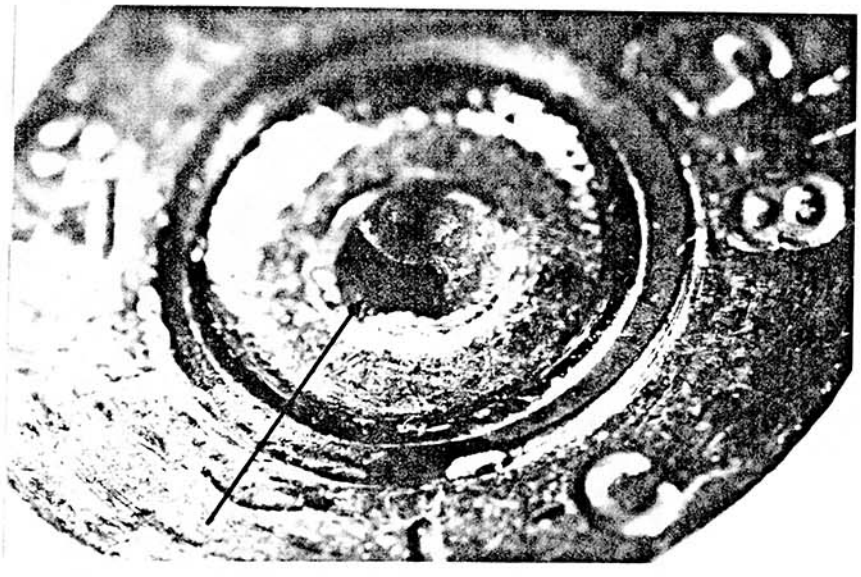


Figure 5.3-20. Typcial pierced primer (arrow).

TABLE 5.3-8. AMMUNITION/FIRED CASE INSPECTION FROM ENDURANCE/RELIABILITY SUBTEST

Defect Type	Zone	No. Casualties, by Ammo Type: M855 Ball	M856 Tracer	Total
Neck split	I	54	4	58
Neck and shoulder split	I and S	11	1	12
Case mouth fold	I	90	0	90
Shoulder split	S	0	2	2
Shoulder fold	S	7	0	7
Case mouth tear	I	16	0	16
Pierced primer	-	21	0	21
Incorrect cartridge[a]	-	2	0	2

[a]Cartridge lot No. LC85D300S339 contained two M855 ball rounds without green color coding on the bullet nose. These rounds were headstamped LC 83. All other ball rounds in this lot were headstamped LC 84 O.

5.3.5 Technical Assessment

a. Assessment of the mean rounds between stoppages (MRBS) values were based on 73,975 rounds testing. Part life figures (including barrel life) use actual rounds fired, which was slightly different (75,584). The MRBS tabulation is based on values shown in Table 5.3-9.

TABLE 5.3-9. ENDURANNCE/RELIABILITY TEST MRBF VALUES FOR FIRING OF CONUS PRODUCED M855 BALL AND M856 TRACER AMMUNITION FIRED FROM M249 SAW

Failure Class	No. of Stoppages, by Ammo Type and Cause: M855 Ball Ammo	M855 Ball Wpn	M855 Ball Magazine	M856 Tracer Ammo	M856 Tracer Wpn	M856 Tracer Magazine	Total
I	0	[a]14	4	0	0	0	18
II	0	[b]20	18	0	1	0	39
III	0	[c] 7	0	0	0	0	7
Total	0	41	22	0	1	0	64

[a]Excluded two repetitive stoppages.
[b]Excluded two repetitive stoppages.
[c]Excluded three barrel replacements which were not the cause of stoppages.

b. Taking the information from Table 5.3-9 and applying it to the requirements of paragraph 5.3.2d produced the following profile of system performance. Required MRBF for failure Class I and II combined = 3333-rounds minimum; the demonstrated MRBF was 1299-rounds. Required MRBF for failure Class II = 6250-rounds minimum; the demonstrated MRBF was 1897-rounds. Required MRBF for failure Class III = 15,000 minimum; the demonstrated MRBF was 10,568-rounds.

c. Since there were no ammunition caused failures during this subtest, the ammunition posed no adverse influence on system performance.

d. The general failure of the weapons to satisfy the minimum failure rates could be categorized into two major groups: (1) magazine-caused problems and (2) weapon-caused problems.

(1) The 200-round plastic magazine of current CONUS production tended to cause an increase in belt pull force when it was used in conjunction with the M122 tripod. The linked ammunition was bound on the antifallback tab of the magazine. Another problem area was the pull tab that was attached to the first round in the fully loaded magazine. This tab interfered with the link ejection port cover of the weapon. This problem had been officially resolved by elimination of the cover from the weapon (done to prevent hand injury during stoppage clearing actions by the gunner).

(2) Design of the weapon allowed link fallback to occur whenever the M249 was fired in the right-side-up position. The links entered through the case ejection port. Another means for the links to become trapped in the weapon mechanism was during reloading of the weapon after firing out of the previous load of belted ammunition. The links remaining in the feed tray fell back into the mechanism as soon as the bolt was retracted and the cover opened. A third means of causing gun stoppages was created by fired cases failing to eject. These rounds could be trapped in the 30-round magazine well (also could contain expended links). These fired cases and/or links then were randomly expelled into the path of the piston assembly where they caused a stoppage that was difficult to clear.

e. All class III failures were caused by part failures. They were predominantly breakage of the extractor lip. Since the criteria were based on aggregate weapon performance over a life of 50,000-rounds, and testing of the ammunition was done over a nominal interval of 25,000-rounds per weapon, the true performance could only be estimated. Extractor life ranged from a low of 6979-rounds to a high of 22,350-rounds. The average was 14,607-rounds. The one weapon that was replaced during the test (No. 1) was done at the direction of the SAW program manager, with the concurrence of the test sponsor. This weapon produced a high frequency of feeding stoppages. Individual weapon performance compared to the requirements is shown in Table 5.3-10. This comparison excluded all failures except those attributed to the malfunctioning of the basic weapon.

TABLE 5.3-10. RECOMPUTATION OF MRBF VALUES BY WEAPON FOR WEAPON CAUSED FAILURES

Wpn No.	No. Failures by Type I	II	III	MRBF, by Failure Class I and II	II	III	No. Rd
1	5	4	1	665	1497	5,989	5,989
6	4	2	1	3091	9272	18,544	18,544
2	2	6	2	3089	4118	12,356	24,711
3	3	9	3	2061	2748	8,244	24,731
Criteria				3,333	6,250	15,000	

f. The CONUS-produced M855 and M856 ammunition was safe to use.

g. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW.

h. The Military Specification requirements concerning the ammunition defects and fired case casualties were satisfied.

i. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition or its handling, storage, or maintenance.

j. The CONUS- produced M855 Ball and M856 Tracer ammunition did not contribute to the exhibited level of performance of the weapons when fired with the test rounds; therefore, the ammunition is considered to have satisfied the test criteria.

5.4 HIGH TEMPERATURE (+155 °F)

5.4.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball M855; and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.4.2 Criteria

a. The cartridge shall function without casualty <u>at ambient temperature and under the temperature conditions of +125°F and -65°F</u> (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

d. The M249 SAW weapons must collectively exhibit the following minimum mean rounds between failure (MRBF) over a receiver service life of 50,000 rounds.

Failure Class	MRBF
I and II	3,333
II	6,250
III	15,000

(Para. 3.4.10 of PD-QAF-1) (Ref. 28)

Note: The underlined portion was not addressed.

e. The barrel shall exhibit a minimum service life of 10,000-rounds. A barrel is considered unserviceable if, during the endurance test, the velocity drops of more than 61-m/s, or more than 20% of the rounds fired exhibit yaw in excess of 15° (Para. 3.4.8.3 of PD-QAF-1) (Ref. 28).

f. The system must function reliably, provided necessary precautions are taken commensurate with hot, basic cold, severe cold climate criteria IAW change 1 to AR 70-38 and appropriate maintenance (Para. 5b (2) of JSOR (Ref. 48).

Note: The underlined portion was not addressed.

5.4.3 Test Procedure

Basic procedures for high temperature testing are given in TOP 3-2-045 (Ref. 36). Detailed procedures, applicable to this test are given in the following paragraphs:

a. The two M249 weapons and 15,000-rounds of test ammunition, linked 4 ball to 1 tracer, were placed in an environmental test chamber. The room temperature was then elevated to +155 °F (+68°c). The temperature of the weapons and ammunition was stabilized at the test temperature for a minimum of 12 hours before firing the first round.

b. Firing was divided into 200-round cycles, with 1-hour minimum cooling time between cycles for each weapon. The firing rate was 85 spm, fired in 5-round bursts. All firing was with bipod supported weapons.

c. Each weapon was cleaned, inspected, and lubricated after firing ten cycles (2000-rounds). The last maintenance interval was only 1500-rounds (end of test), at which time both weapons were disassembled in detail, cleaned, inspected (including magnetic particle inspection), and then prepared for low temperature testing.

d. All scheduled maintenance during this test was done within the environmental facility, at temperature. CLP (MIL-L-63460A) was used exclusively as a lubricant and cleaner. If any unscheduled maintenance required removal of the weapon from the test chamber, that weapon was completely cleaned and lubricated and reconditioned for 12 hours at temperature before resumption of testing.

e. Cyclic rate of fire was recorded throughout the test.

f. After completion of the test, the two weapons were fired for dispersion at 100-meters. Firing was from a test stand, at ambient range temperature. Three targets consisting of four 5-round bursts were fired from each barrel. Only the M855 test ammunition was used in this dispersion check. After completion of the dispersion test with the barrels used during high temperature, the two new barrels to be used during low temperature testing were fired for dispersion. Velocity was measured at 78 feet (23.7m) for all shots fired.

5.4.4 Test Findings

The functioning performance data of this subtest are reported in Table 5.4-1. The cyclic rate information is contained in Table 5.4-2. Targeting and velocity data, recorded at the completion of this subtest, are presented in Table 5.4-3. Table 5.4-4 is for the ammunition/fired case inspection data.

TABLE 5.4-1 FUNCTIONING PERFORMANCE: M249 SAW FIRED WITH CONUS PRODUCED AMMUNITION AT HIGH TEMPERATURE

Wpn Identification Serial No.	Test No.	Bbl No.	Total Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
				Phase I							
002437	4	4	1,992	2	3	0	0	0	1	6	A
002594	5	5	2,000	0	0	0	0	0	0	0	
				Phase II							
002437	4	4	2,000	0	0	1	0	0	1	2	B
002594	5	5	2,000	0	0	0	0	0	0	0	
				Phase III							
002437	4	4	2,000	0	2	0	0	1	0	3	C
002594	5	5	2,000	0	0	0	0	0	0	0	
				Phase IV							
002437	4	4	1,499	0	1	0	0	0	0	1	D
002594	5	5	1,499	0	0	1	0	0	0	1	E
Total----------			14,990	2	6	2	0	1	2	13	F

A= One round removed from test because of manufacturing defect (OTH). FTC caused by blown primer (1), manufacturing defect in cartridge (1). and one cartridge cook-off in an unlocked breech gun due to unknown cause (ammunition suspected).

B= Light indent on FFR round. Fired on second attempt. Firing pin retaining pin moved out of position (OTH). This failure to remain in assembly was found during scheduled maintenance (no stoppages) and the pin repositioned.

C= All stoppages caused by link fall-back.

D= The FTC caused by round damage during manufacture.

E= The FFR caused by light strikes of the primer.

F= 15,000 rounds attempted to be fired. That figure used to compute MRBS. The figure of 14,990 rounds fired was used to compute barrel and other part life.

Note: Abbreviation definitions can be found in Appendix E.

TABLE 5.4-2. HIGH TEMPERATURE TEST CYCLIC RATE (CR) DATA FOR M249 SAW

Cycle No.	CR, by Wpn No. and Rd Interval in Magazine							
	SN 002437 (test No. 4)				SN 002594 (test No. 5)			
	10	100	200	Avg	10	100	200	Avg
				Phase I				
1	-	947	949	948	692	899	961	851
2	856	940	966	921	755	893	947	865
3	872	931	996	933	-	-	-	-
4	843	937	980	920	845	923	943	904
5	838	951	990	926	849	911	962	907
6	737	857	999	864	859	938	971	923
7	877	959	1033	956	862	918	978	919
8	902	983	1045	977	883	935	960	926
9	849	1005	1018	957	872	949	968	930
10	890	1000	1053	981	830	934	957	907
Avg	851	951	1003	938	827	922	961	904
				Phase II				
1	900	1011	1028	980	857	958	976	930
2	912	1018	1046	992	795	934	982	904
3	952	1017	1047	1006	885	930	977	931
4	948	1021	1060	1010	870	849	987	935
5	947	1005	1055	1002	870	942	994	935
6	923	1010	1059	997	865	949	984	933
7	959	998	1025	994	882	955	963	933
8	935	1020	1043	999	871	940	1011	941
9	974	1010	1042	1009	869	932	980	927
10	986	1018	1068	1024	880	948	981	936
Avg	944	1013	1047	1001	864	944	984	930
				Phase III				
1	946	1008	1035	996	861	927	963	917
2	963	1006	1046	1005	859	958	962	926
3	925	1017	1047	996	896	966	983	948
4	962	1002	1024	996	882	951	984	939
5	851	1023	1033	969	896	909	990	932
6	936	999	1053	996	863	937	968	923
7	944	1001	1060	1002	878	957	997	944
8	904	982	1039	975	853	922	964	913
9	928	984	986	966	872	925	966	921
10	928	979	987	965	826	925	948	900
Avg	928	1000	1031	987	869	938	972	926

TABLE 5.4-2 (CONT'D)

Cycle No.	CR, by Wpn No. and Rd Interval in Magazine: SN 002437 (test No. 4) 10	100	200	Avg	SN 002594 (test No. 5) 10	100	200	Avg
				Phase IV				
1	910	996	1026	997	804	924	971	900
2	916	952	1007	958	864	921	979	921
3	909	994	1022	975	881	940	962	928
4	907	1001	1017	975	840	949	978	922
5	920	1000	1021	980	894	941	991	942
6	910	1001	1007	973	881	965	973	940
7	907	1007	1015	976	901	957	986	948
8	903	986	-	944	872	928	-	900
9	-	-	-		-	-	-	
10	-	-	-		-	-	-	
Avg	910	992	1016	970	867	941	977	925

TABLE 5.4-3. M249 SAW TARGETING AND VELOCITY DATA RECORDED AFTER COMPLETION OF HIGH TEMPERATURE TESTING[a]

Wpn ID: Serial No.	Test No.	Bbl No.	Cyclic Rate, spm	Rd Fired, Wpn	Rd Fired, Bbl	Vel, fps	Target Measurements, inches: HSD	VSD	EVS	EHS	ES	MR
002437	4	4	905	7969	7969	2874	5.63	6.06	19.13	22.49	25.29	7.39
		S4	917	7989	184	2949	2.98	4.62	12.06	17.58	18.41	4.61
002594	5	5	892	7852	7852	2866	8.81	7.53	29.53	29.03	36.46	10.35
		S5	842	7872	133	2950	3.01	3.93	10.36	14.67	16.99	4.19

[a]Barrels No. 4 and 5 fired in the high temperature environment. Barrels No. S4 and S5 fired in preparation for use in the low temperature environment which followed high temperature testing. All barrels/weapons fired outside of the environmental facility at ambient range temperature. Round counts are total cumulative rounds fired.

Note: Abbreviation definitions can be found in Appendix E.

TABLE 5.4-4. AMMUNITION/FIRED CASE INSPECTION FROM HIGH TEMPERATURE (+155°f) SUBTEST

Defect Type	No. Casualties, by Ammo Type: M855 Ball	M856 Tracer	Total
Neck split (zone I).	11	4	15
CMT (zone I).	1	0	1
Blown primer.	3	0	3
Prefiring (Mfg) damage to cartridge case.(Fig. 5.4-1)	1	2	3
Total	16	6	22

Note: The ammunition satisfied the defect limit requirements. Refer to paragraph 3.2 for detailed discussion.

Inspection of the SAWs after the high temperature test revealed that there was no change in existing crack patterns found during initial inspection. The components showing major damage from the cookoff in gun, SN 002437 (Test No. 4) are shown in Figures 5.4-2 and 5.4-3. These parts were replaced before continuing the test. Other components replaced were the bolt, extractor, extractor spring, extractor pin, and feed tray. No damage occurred to the receiver or barrel of this gun. No personnel injury occurred. The primer of the cartridge case that cooked off was securely retained by its crimp. The case showed signs of a lack of support (unlocked breech) (refer to Fig. 5.4-4). Figure 5.4-5 compares the case heads from the cook-off round, a normal fired case, and a case with a blown primer. The increased firing pin indentation in the cook-off primer was due to the setback damage created when the weapon fired while unlocked.

There was no indication of projectile breakup or other metal parts separation during this test, although there was evidence in the metal parts integrity test that jacket rupturing occurred (Refer to Para. 5.10).

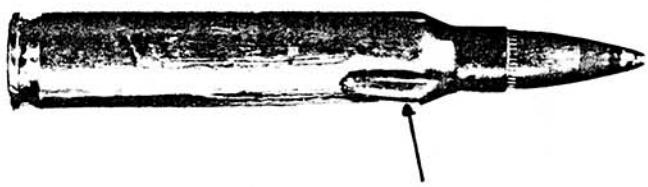
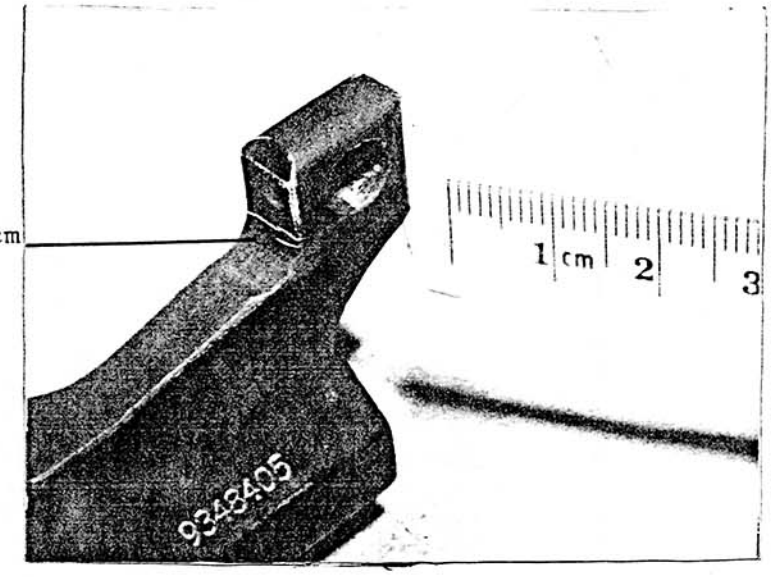


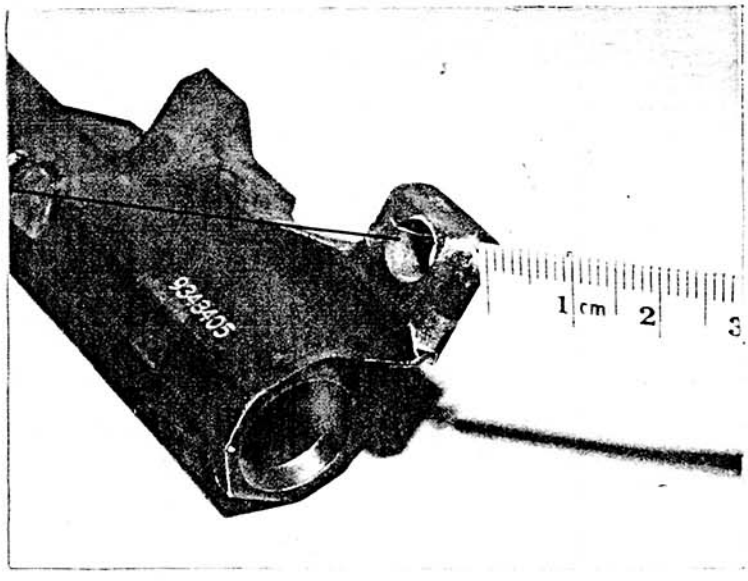
Figure 5.4-1. Ammunition damage caused during manufacturing (arrow).

Crack patterns
(0.7- and 0.3-cm
length)



Muzzle End

Crack patterns
(0.8- and 0.4-cm
length)



Breech End

Figure 5.4-2. Piston assembly from M249 SAW, SN 002437. Magnetic particle crack pattern noted after cartridge cookoff in high temperature (+155 °F) environment.

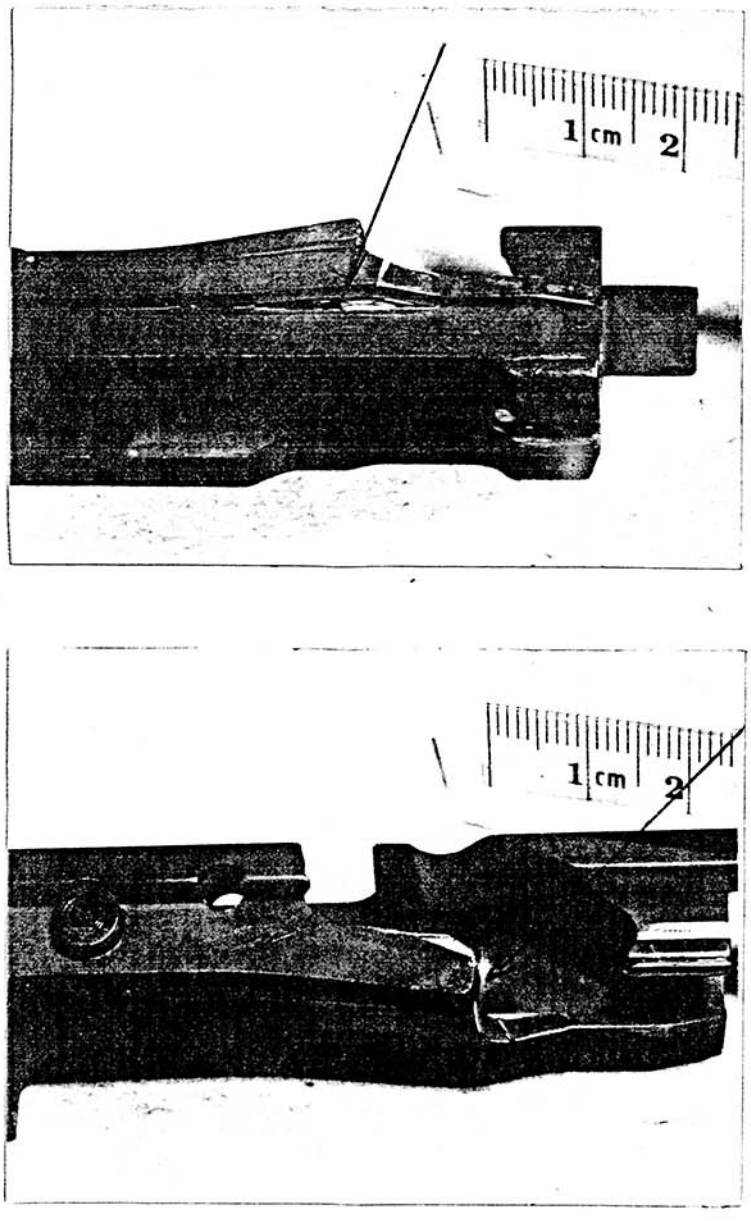


Figure 5.4-3. Bolt carrier from M249 SAW, SN 002437. Through crack noted after cartridge cookoff in high temperature (+155 °F) environment.

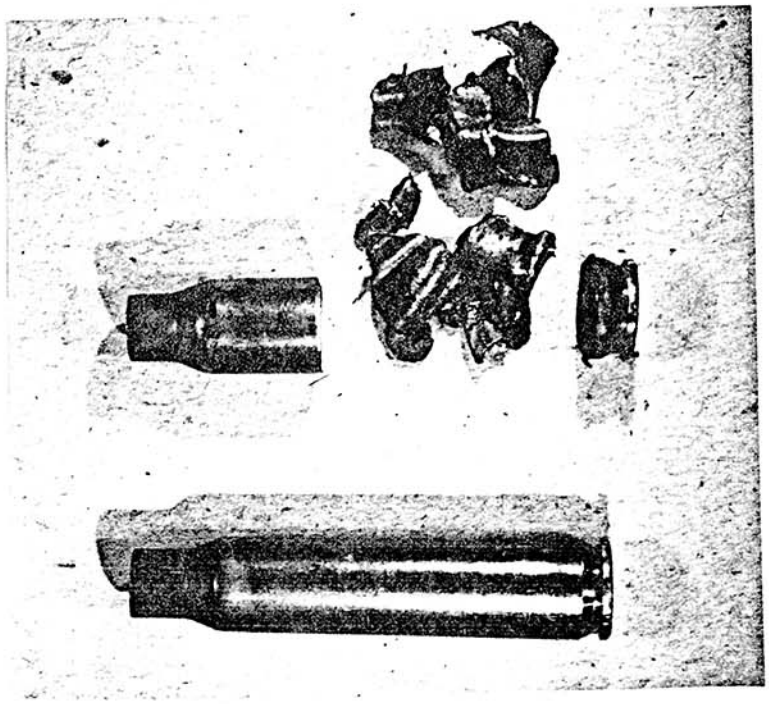


Figure 5.4-4. Cook-off case (top) from the high temperature test compared to an undamaged, fired case (bottom).

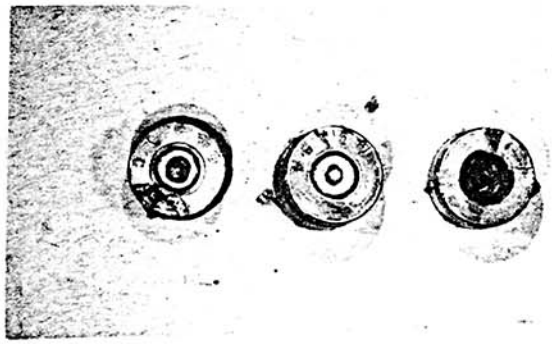


Figure 5.4-5. View of case head from high temperature test cook off (left), normal fired case (center), and blown primer (right).

Fouling of the weapon was normal for the number of rounds fired. The malfunctions which occurred were not caused by the fouling of the weapon.

5.4.5 Technical Assessment

a. The suspected cause of the damage to the weapon due to cookoff (damage to the cartridge during its manufacture) could not be proven. The damage found on other rounds, during prefiring inspection, was indicative of damage created during the machine linking operation. Another type of damage that could occur was related to feeding failure, wherein the cartridge case bent and then partially chambered. In either instance, the result was the same if the weapon barrel temperature was in the cookoff range. Cartridge case destruction prevented identification of any previous case damage prior to cookoff. Personnel injury did not occur because the damage was contained within the receiver of the weapon. Any case fragments were ejected from the weapon through the case ejection port.

b. Failures to chamber (FTC) due to link fall-back occurred as a result of opening the feed cover with the bolt forward after firing the last round from the magazine. The two links, which usually remained in the feed tray, could fall back into the weapon mechanism when the bolt was retracted. They either fell into the 30-round magazine well or onto the piston assembly. In the latter case, the next round fired after reloading resulted in a failure to chamber if the link did not fall out through the ejection port. If the links were trapped in the magazine well, the FTC stoppage would occur any time the links moved into the path of the piston assembly during firing. Neither of these conditions prevailed during the FTC/cookoff experienced in this subtest. Application of immediate action prevented the possible recurrence of cookoff during the other FTC stoppages where this condition prevailed.

c. The expulsion of the primer cup into the path of the piston assembly, as a result of a blown primer, could cause an FTC stoppage. This was demonstrated by its occurrence in this subtest. Cookoff did not occur since immediate action was applied to remove the unfired round from the chamber. There was no evidence of this condition having initiated the cookoff during this subtest as the primer was fully intact in the case head after case rupture occurred.

d. Assessment of the MRBF values were based upon 15,000-rounds testing. Part-life figures (including barrel life) use actual rounds fired which was slightly different (14,990). The MRBF tabulation is shown in Table 5.4-5.

TABLE 5.4-5. HIGH TEMPERATURE TEST MRBF VALUES FOR FIRINGS OF CONUS-PRODUCED M855 BALL AND M856 TRACER AMMUNITION, FROM M249 SAW

Failure Class	Number of Stoppages, by Ammo Type and Cause						
	M855 Ball			M856 Tracer			
	Ammo	Wpn	Magazine	Ammo	Wpn	Unknown	Total
I	1	4	0	2	0	0	7
II	[c]1	2	0	0	0	0	3
III	0	0	0	0	0	[d]1	1
Total	2	6	0	2	0	1	[a]11

[a]Did not count one round with manufacturing defect (deformed case) which was removed from test during prefiring inspection. One malfunction of gun was not a stoppage.
[b]Counted one stoppage caused by a previous stoppage (link fall-back).
[c]Counted one stoppage created by another stoppage (blown primer).
[d]Suspected to have been caused by ammunition (deformation during manufacture).

e. Taking the information from Table 5.4-5 and applying it to the requirements of paragraph 5.4.2d produced the following profile of system performance: Required MRBF for failure Class I and II, combined = 3333-rounds minimum; the demonstrated MRBF was 1500-rounds. Required MRBF for failure Category II = 6250-rounds minimum; the demonstration MRBF was 7500-rounds. The required, and demonstrated MRBF for failure Class III, was 15,000-rounds.

f. Excluding the three Type I and one Type II failures charged to ammunition only raised the MRBF for the combined Category I and II to 2500-rounds. This indicated that the ammunition was not a primary contributor of the weapon failing to attain the required level of performance.

g. The CONUS-produced M855 and M856 ammunition was safe to fire at high temperature.

h. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW at high temperature.

i. The Military Specification requirements concerning ammunition defects and fired case casualties were satisfied, except for the blown primer occurrence.

j. The CONUS-produced ammunition did not increase the RAM requirements relative to the storage or handling of the ammunition. Maintenance of the weapon was not meaningfully increased, although the unscheduled maintenance action to clear the malfunction caused by the blown primer was not desirable.

k. The CONUS-produced M855 and M856 ammunition generally performs in accordance with the criteria requirements. In those instances where irregularities occurred, they were caused by quality-control problems, not the basic design of the ammunition. The criteria were partially met.

5.5 LOW TEMPERATURE (-50 °F)

5.5.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball; and Tracer M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.5.2 Criteria

a. The cartridge shall function without casualty <u>at ambient temperature and</u> under the temperature conditions of <u>+125 °F</u> and -65 °F (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 18 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para.3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIl-C-63990A) (Ref. 15 and 19, respectively).

d. The M249 SAW weapons must collectively exhibit the following minimum mean rounds between failure (MRBF) over a receiver service life of 50,000 rounds.

Failure Class	MRBF
I and II	3,333
II	6,250
III	15,000

(Para. 3.4.10 of PD-QAF-1) (Ref. 28).

Note: The underlined portion was not addressed.

e. The barrel shall exhibit a minimum service life of 10,000-rounds. A barrel is considered unservice4able if, during the endurance test, the velocity drop of more than 61-m/s, or more than 20% of the rounds fired exhibit yaw in excess of 15c (Para. 3.4.8.3 of PD-Qaf-1) (Ref. 28).

f. The system must function reliably, provided necessary precautions are taken commensurate with hot, basic cold, severe cold climatic criteria IAW change 1 to AR 70-38 and appropriate maintenance (Para. 5b (2) of JSOR (Ref. 48).

Note: The underlined portion was not addressed.

5.5.3 Test Procedure

Basic procedures for the low temperature testing are given in TOP 3-2-045 (Ref. 36). Detailed procedures, applicable specifically to this test, are given in the following paragraphs.

a. The two M249 weapons previously used at high temperature, and the two new barrels fired for velocity and dispersion after completion of the high temperature firing, were prepared for this test. Maintenance consisted of lubrication with MIL-L-63460A.

b. The firing schedule and maintenance intervals used for high temperature testing were repeated during this test (see Para. 5.4.3c and 5.4.3e).

c. Cyclic rate of fire data were collected throughout this test.

5.5.4 Test Findings

The functioning performance data are summarized in Table 5.5-1. Cyclic rate data and targeting and velocity data are presented in Tables 5.5-2 and 5.5-3, respectively.

TABLE 5.5-1. FUNCTIONING PERFORMANCE: M249 SAW FIRED WITH CONUS-PRODUCED AMMUNITION AT LOW TEMPERATURE

Wpn Identification			Total	No. Malfunctions, by Type							
Serial No.	Test No.	Bbl No.	Rd Fired	FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
				Phase I							
002437	4	S4	1,999	5	0	1	0	0	0	6	A
002594	5	S5	1,999	3	1	2	0	1	0	7	
				Phase II							
002437	4	S4	1,996	2	23	4	0	0	0	29	B
002594	5	S5	1,989	9	0	6	1	4	0	20	C

See footnotes at end of Table.

TABLE 5.5-1 (CONT'D)

Wpn Identification Serial No.	Test No.	Bbl No.	Total Rd Fired	No. Malfunctions, by Type FFD	FTC	FFR	FEX	FEJ	OTH	Total	Remarks
				Phase III							
002437	4	S4	1,997	1	0	3	0	0	0	4	
002594	5	S5	1,996	3	0	4	0	0	0	7	
				Phase IV							
002437	4	S4	1,497	2	0	3	0	0	0	5	
002594	5	S5	1,498	0	0	2	0	0	0	2	
Total----------			14,971	25	24	25	1	5	0	80	

A = Normal firing pin indent in primer of the misfired round.
B = Broken feed pawl spring replaced.
C = Two fired cases found in 30-round magazine well. Worn extractor replaced.
D = 15,000 rounds attempted to be fired. That figure used to compute MRBS. A figure of 14,971-rounds fired was used to compute barrel and other parts life.

TABLE 5.5-2 LOW TEMPERATURE TEST CYCLIC RATE DATA FOR M249 SAW

Cyclic No.	Cyclic Rate by Wpn No. and Rd Interval in Magazine: SN 002437 (test No.4) 10	100	200	Avg	SN 002594 (test No. 5) 10	100	200	Avg
				Phase I				
1	-	842	938	890	746	724	867	779
2	778	769	899	835	704	679	784	722
3	721	808	956	828	661	[a]921	[a]954	845
4	671	[a]993	[a]1045	903	[a]879	[a]848	[a]929	885
[a]5	957	954	1049	987	653	879	1012	848
[a]6	[b]961	954	1064	999	815	926	983	908
[a]7	960	1000	1058	1006	834	915	995	915
[a]8	941	1001	1058	1000	833	913	999	915
[a]9	954	998	1041	998	880	947	1008	945
[a]10	909	985	1063	986	873	947	1029	950
Avg	872	932	1017	941	788	870	956	871
				Phase II				
1	677	882	939	833	640	677	863	727
2	[c]722	796	956	825	652	728	808	729
3	665	781	[a]989	812	653	761	873	762
4	901	837	907	882	656	681	833	723
5	707	838	[b]976	840	685	749	842	759
6	662	817	916	798	651	661	805	706
7	681	819	875	792	662	676	762	700
8	655	820	905	793	679	701	814	731
9	647	827	896	790	680	663	729	691
10	702	825	920	816	681	[a]893	[a]984	853
Avg	702	824	928	818	664	719	831	738

TABLE 5.5-2 (CONT'D)

Cyclic No.	Cyclic Rate by Wpn No. and Rd Interval in Magazine: SN 002437 (test No.4) 10	100	200	Avg	SN 002594 (test No. 5) 10	100	200	Avg
				Phase III				
1	668	857	933	819	621	691	816	709
2	767	863	957	862	672	[a]1001	1042	905
3	752	795	927	825	[a]917	[a]982	[a]1027	975
4	730	872	917	840	[a]886	[a]998	[a]1019	968
5	756	826	969	850	[a]901	[a]998	[a]1054	984
6	746	817	902	822	[a]929	[a]1009	[a]1049	996
7	647	856	900	801	[a]930	[a]995	[a]1012	979
8	680	766	911	786	[a]906	[a]938	[a]1021	955
9	661	835	934	810	[a]887	[a]965	[a]1027	960
10	713	830	901	815	[a]946	[a]1011	[a]1033	997
Avg	712	832	925	823	860	959	1010	943
				Phase IV				
1	[f]622	908	962	831	643	737	876	752
2	672	920	949	843	661	780	901	781
3	739	908	938	862	669	777	900	782
4	728	876	[d]981	862	676	803	894	791
5	708	885	955	849	664	804	881	783
6	752	925	976	884	685	843	916	815
7	716	902	971	863	702	823	885	803
8	752	914	-	833	669	807	-	738
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Avg	711	905	962	853	671	797	893	781

[a]High rate gas regulator setting.
[b]First two-round burst was 178 spm.
[c]First three-round burst was 245 spm.
[d]Last two-round burst in magazine.
[e]First three-round burst was 224 spm.
[f]First two-round burst was 413 spm.

Note: CONUS-produced 200-round plastic magazine used throughout subtest. Barrel No. S4 and S5 used in weapons No. 4 and 5, respectively. High rate setting applied to eliminate stoppages due to sluggish operation of gun and/or binding of rounds in magazine. Cyclic rates were measured at the beginning, middle, and end of each magazine (i.e., rounds 1-10, 90-100, and 190-200).

TABLE 5.5-3. M249 SAW TARGETING AND VELOCITY DATA RECORDED AFTER COMPLETION OF LOW TEMPERATURE TESTING[a]

Wpn ID			Cyclic				Target Measurements, inches					
Serial No.	Test No.	Bbl No.	Rate, spm	Rd Fired, Wpn	Rd Fired, Bbl	Vel, fps	HSD	VSD	EVS	EHS	ES	MR
002437	4	S4	928	15,543	7678	2913	3.10	4.48	10.91	17.35	18.48	4.76
002594	5	S5	876	15,414	7615	2885	4.07	4.10	15.37	15.80	18.68	4.93

[a]All barrels/weapons were fired outside of the environmental facility at ambient range temperature. Round counts were total cumulative rounds fired.

Inspections of the ammunition and fired cases subjected to low temperature testing revealed no defects, either before firing or after firing.

There was no indication of projectile break-up or other metal parts separation during this test, or during the low temperature phase of the metal parts integrity test (Refer to Para. 5.10).

Fouling of the weapon was normal for the number of rounds fired. The malfunctions, which occurred as a result of mechanism fouling, were corrected by changing the gas regulator setting from normal to high. Increasing the operation power to the weapon (see cyclic rate data, Table 5.5-2) is the approved means of correcting power shortages in adverse and extreme environmental situations.

5.5.5 Technical Assessment

a. Assessment of the MRBF values was based on 15,000 rounds testing. Part life figures (including barrel life) used actual rounds fired which was slightly different (14,971). The MRBF tabulation is shown in Table 5.5-4.

TABLE 5.5-4. LOW TEMPERATURE TEST MRBF VALUES FOR FIRING OF CONUS-PRODUCED M855 BALL AND M856 TRACER AMMUNITION FIRED FROM M249 SAW

	No. of Stoppages, by Ammo Type and Cause						
Failure	M855 Ball				M856 Tracer		
Class	Ammo	Mag	Wpn	Pers	Ammo	Wpn	Tot.
I	0	12	[a]59	0	0	3	74
II	0	4	0	2	0	0	6
III	0	0	0	0	0	0	0
Total	0	16	59	2	0	3	80

[a]Thirty-three were repetitive stoppages caused by two part failures.

b. Taking the information from Table 5.5-4 and applying it to the requirements of paragraph 5.5.2d produced the following profile of system performance. Required MRBF for failure Class I and II combined = 3333 rounds minimum; the demonstrated MRBF was 188 rounds. Required MRBF for failure Category II = 6250 rounds minimum; the demonstrated MRBF was 625 rounds. The required, and demonstrated MRBF for failure class III was 15,000 rounds.

c. Since all failures were not chargeable to ammunition, the performance demonstrated was not influenced by the use of test rounds. The CONUS-produced 200-round plastic magazines contributed to the feeding problems by increasing the amount of belt pull necessary to remove belted rounds from the magazine during firing. This was caused by the antifallback tab at the exit port of the magazine becoming inflexible at low temperature. Misfires of the ammunition were caused by sluggish action of the gun mechanism at the beginning of the 200-round cycles where the -50°F temperature had solidified fouling/lubricant (CLP) build-up. Based on the poor performance of CLP at low temperature when used in other weapon types, the lubricant was suspect rather than the fouling generated by the ammunition.

d. The CONUS-produced M855 and M856 ammunition was safe to use at low temperature.

e. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW at low temperature.

f. The Military Specification requirements concerning ammunition defects and fired-case casualties were satisfied (no defects or casualties).

g. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition, or its handling, storage, or maintenance.

h. The CONUS-produced M855 and M856 ammunition performs in accordance with the test criteria.

i. The plastic magazine, which packages the test ammunition, is the largest contributor to the general decrease in performance experienced by the M249 SAW at low temperature.

5.6 TEMPERATURE AND HUMIDITY

5.6.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. Safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball M855; and Tracer, M856?

e. Other issue. Are all of the item's RAM requirements met?

5.6.2 Criteria

a. The cartridge shall function without casualty at ambient temperature <u>and under the temperature conditions of +125 °F and -65 °F</u> (Para. 12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridge shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

Note: The underlined portion was not addressed.

5.6.3 Test Procedure

Basic procedures for conduct of the 10-day temperature-humidity test are given in paragraph 34 of TOP 4-2-016 (Ref. 43). Specific procedures governing this test are given below:

a. Two hundred rounds each of the CONUS-produced M855 Ball and M856 Tracer ammunition were linked in 100-round belts. One belt of each ammunition type was subjected to environmental stress. The other two belts of ammunition were used as unconditioned (control) ammunition.

b. The belted ammunition was placed in the test chamber, the temperature and relative humidity stabilized at 48.8 °C and 30 ± 10% for 24 hours. This was followed by changing the temperature to +22.8 ± 1.7 °C and relative humidity to 50 ± 10% and restabilized for another 24 hours. After this interval, the ammunition was exposed to ten, 24-hour cycles as shown in Table 5.6-1.

TABLE 5.6-1. HIGH HUMIDITY-TEMPERATURE DIURNAL CYCLE

Phase	Temperature, °C	Relative Humidity, %	Duration, hr
1	Gradually increase to 40.6 ± 1.7 and...	90 ± 5	2
2	Maintain at 40.6 ± 1.7 and...	90 ± 5	16
3	Gradually decrease to 21.2 ± 1.7 and...	95 ± 5	2
4	Maintain at 21.1 ± 1.7 and...	95 ± 5	4

d. Following the 240 hour storage period, the ammunition was removed from the environment and immediately fired in a M249 gun equipped with a new barrel. The firing sequence is shown in Table 5.6-2.

TABLE 5.6-2. FIRING SEQUENCE FOR TEMPERATURE-HUMIDITY TEST

Firing Order	Ammo Type	Environmental Treatment	No. Rd[a]
1	M855	Temp-Humidity	100
2	M855	Control	100
3	M856	Temp-Humidity	100
4	M856	Control	100

[a]Fired in 5-round bursts at 85 spm. Cooled and cleaned the gun barrel after each 100 rounds fired. Recorded velocity and cyclic rate.

5.6.4 Test Findings

M249 SN 014229 (Test No. 6) was fired using new barrel No. 5. There were no stoppages or other malfunctions during the test. Average velocity and cyclic rate of fire data are shown in Table 5.6-3. Inspection of the ammunition before firing, and the fired cases after firing, revealed no defects or casualties.

TABLE 5.6-3. TEMPERATURE/HUMIDITY TEST RESULTS FROM FIRING CONUS PRODUCED M855 BALL AND M856 TRACER AMMUNITION FROM M249 SAW

Test Indices	Test Results, by Ammo Type and Environmental Condition			
	M855 Ball		M856 Tracer	
	Conditioned	Unconditioned	Conditioned	Unconditioned
Vel, fps	2938	2939	2771	2775
CR, spm	951	957	918	927

5.6.5 Technical Analysis

a. The CONUS-produced M855 and M856 ammunition was safe to fire in the M249 SAW under conditions of a temperature/humidity environment.

b. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW in a temperature/humidity environment.

c. The Military Specification requirements concerning ammunition defects and fired case casualties were satisfied (no defects or casualties).

d. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition, or its handling, storage, and maintenance.

e. The CONUS-produced M855 and M856 ammunition performs in accordance with the test criteria.

5.7 SMOKE AND FLASH

5.7.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56mm: Ball M855; and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.7.2 Criteria

a. The cartridge shall function without casualty at ambient temperature <u>and under the temperature conditions of +125 °F anf -65 °F</u> (Para. 3.12.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A0 (Ref. 15 and 19, respectively).

d. The smoke and flash produced by firing CONUS-produced M855 and M856 cartridges in a 4:1 mix, shall not be greater than that produced by firing the Belgian produced M855 and M856 ammunition (SS-109 and L110 types, respectively) under the same conditions (Test Agency devised, TECOM approved).

Note: Underlined portion was not addressed in this subtest.

5.7.3 Test Procedure

The basic test procedures for flash and smoke testing are found in Paragraph 4.9 and 4.10 of TOP 3-2-045 (Ref. 36). Specific procedures relating to this test are given below.

a. Flash. One M249 was fired using both a new barrel and an old (7,500 or more rounds) barrel. The firing sequence for each barrel consisted of one 20-round group, fired in 5-round bursts at 85 spm and one 20-round continuous burst. All firing was done from a test stand in a darkened (enclosed) range. Visual observation of this firing was also made. The effectiveness of the flash suppressor was monitored by repeating the test with the suppressor removed.

b. Smoke. The smoke and dust cloud accumulated at the gun position during burst firing was assessed for target obscuration when viewed from directly behind the gun and position disclosure when viewed from a position forward of the weapon muzzle. The firings were conducted in an open area where visibility was suitable for obtaining a sharply defined photograph under nonfiring conditions. The barrels used in the flash test were used in the smoke test.

   For target obscuration effects, 5-,10-, and 20-round bursts were fired from the new barrel in an attempt to establish boundaries for target obscuration. To judge the size and density of the smoke and dust cloud, and the degree of obscuration, a checkerboard target 2.4-meters square with 0.3-meter black and white squares, was placed in line with the gun at a range of 100 meters. The gun was elevated to fire slightly over the target. The camera was placed behind and as near as practicable to the weapon in the position assumed by the gunner during firing. A photograph of the target under nonfiring conditions was made for comparison to determine the degree of target obscuration caused by the firing. For the position disclosure effects, the checkerboard was placed behind the gun with the camera positioned 30-meters forward of the gun muzzle and 4 meters to the right of the line-of-fire. A 20-round burst was fired. For both of these test conditions, a 35-mm camera with a remotely operated motor drive, set for four frames per second, was used to record the test data. Air temperature and relative humidity information were also recorded during the time of firing. Table 5.7-1 summarizes the firings spelled out in paragraphs 5.7.3a and 5.7.3b.

TABLE 5.7-1. SMOKE AND FLASH TEST FIRING SCHEDULE

Ammo Type	No. Rd. Fired by Burst Size Rd 5	10	20	Remarks
				Flash test[a]
M855	20	-	20	CONUS produced ammo.
M855	20	-	20	Belgian produced ammo (SS-109).
M856	20	-	20	CONUS produced ammo.
M856	20	-	20	Belgian produced ammo (L110).
Mix	20	-	20	CONUS produced M855/M856 in a 4:1 mix.
Mix	20	-	20	Belgian produced M855/M856 in a 4:1 mix.
				Smoke test[b]
Mix	5	10	20	CONUS produced M855/M856 in a 4:1 mix.
Mix	5	10	20	Belgian produced M855/M856 in a 4:1 mix.

[a]Four 5-round bursts fired at a rate of 85spm. Fired with both old and new barrels, with and without flash suppressor.
[b]Three trials were fired for each condition. Only the new barrels were used.

5.7.4 Test Findings

The test results are depicted in Figures 5.7-1 through 5.7-9 for the muzzle flash and Figures 5.7-10 thru 5.7-14 for the smoke obscuration and detection portion of this subtest. Barrel No. S1 (no previous rounds) and barrel No. 1 (10,461 previous rounds) were used in gun SN 014230 (test No. 7). A total of 1020 rounds was fired on this gun; 720 rounds with barrel No. S1, and 300 rounds with Barrel No. 1.

-MUZZLE FLASH TEST-
(M249 Machine Gun)

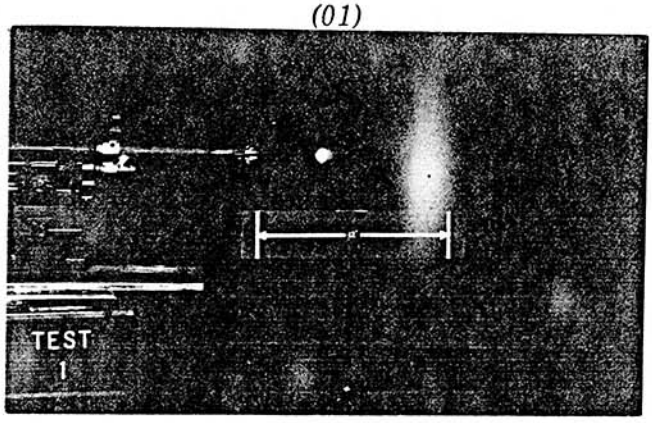
NEW BARREL-5 ROUNDS WITH FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339).

Control Ammunition
(FNB84F001L019)

M855 Ball

(01)



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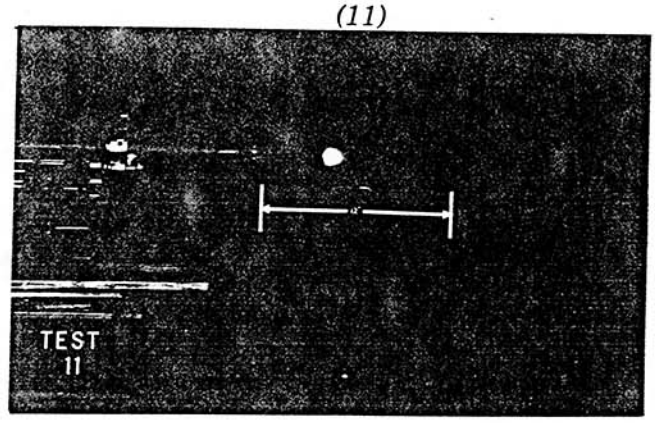
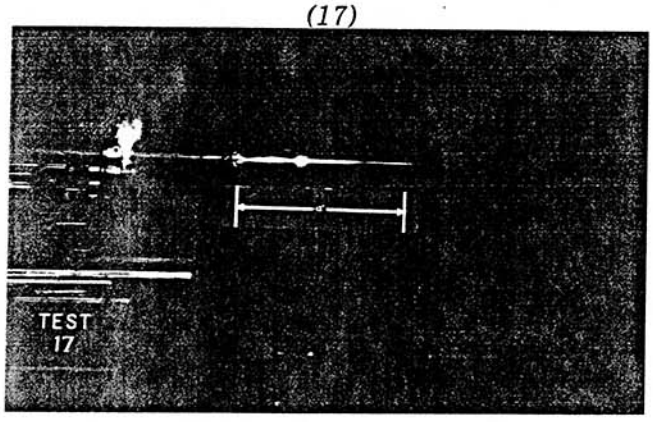


M856 Tracer

(17)



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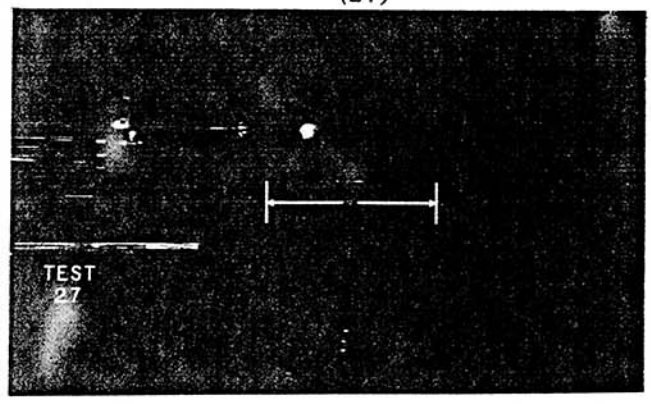
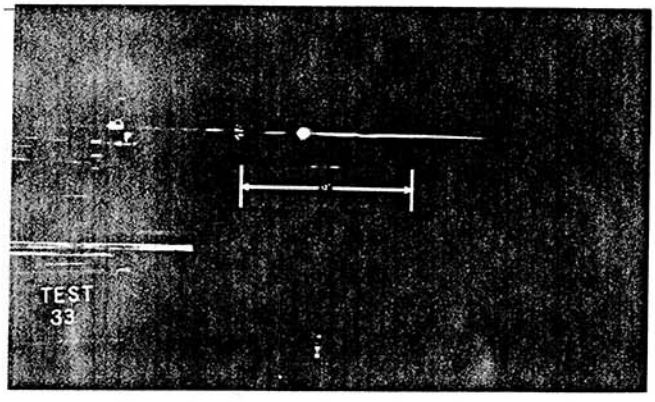


M855/M856 Ball/Tracer Mix (4:1)

(33)



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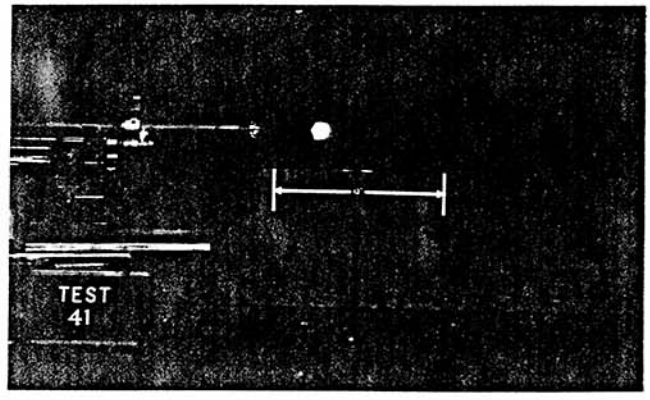


Figure 5.7-1.

-MUZZLE FLASH TEST-
(M249 Machine Gun)

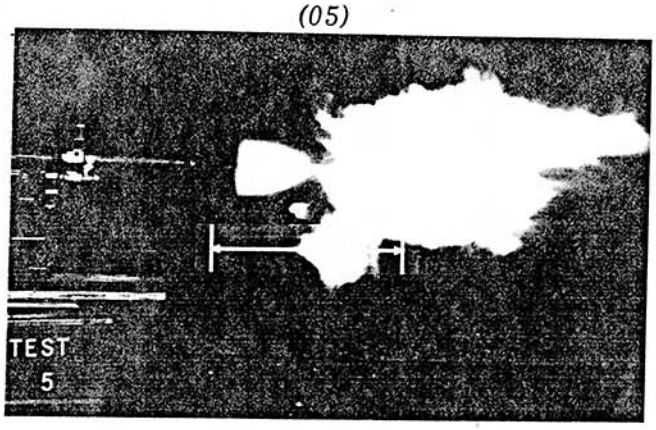
NEW BARREL -5ROUNDS WITHOUT FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

Control Ammunition
(FNB84F001L019)

M855 Ball

(05)



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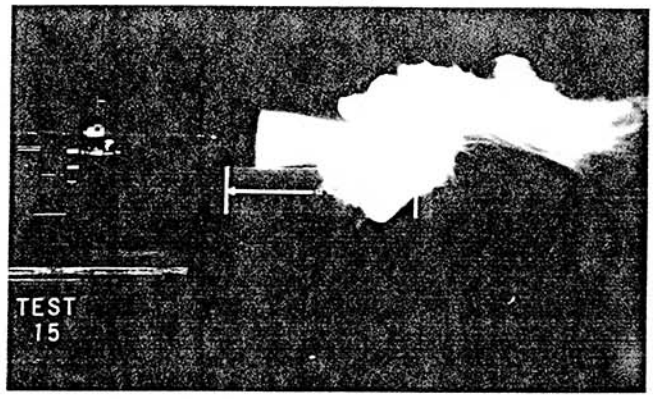
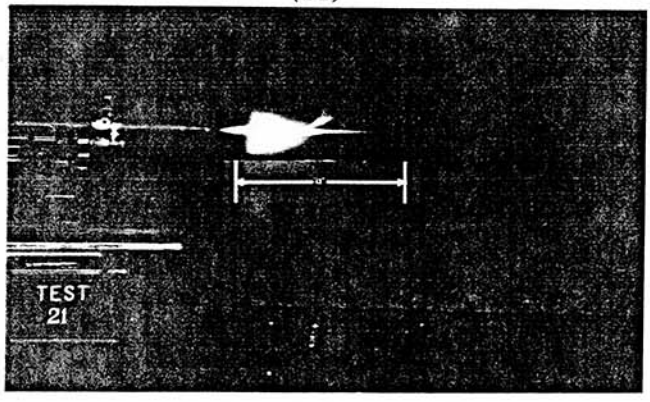


M856 Tracer

(21)



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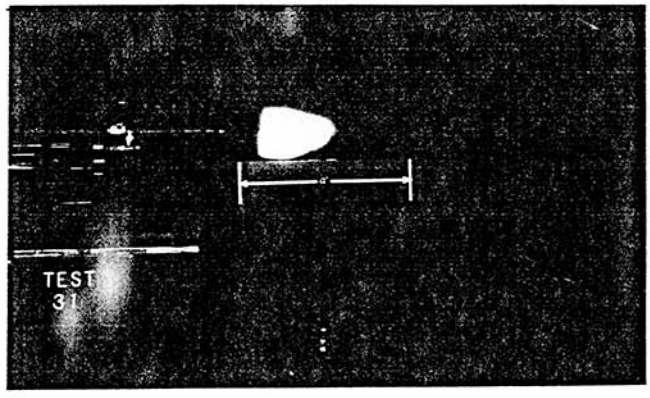
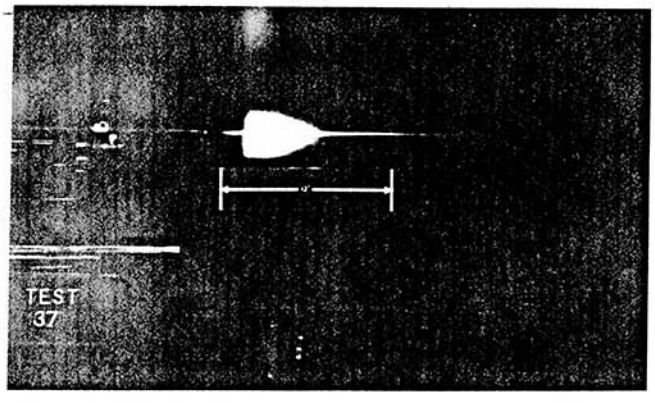


M855/M856 Ball/Tracer Mix (4:1)

(37)



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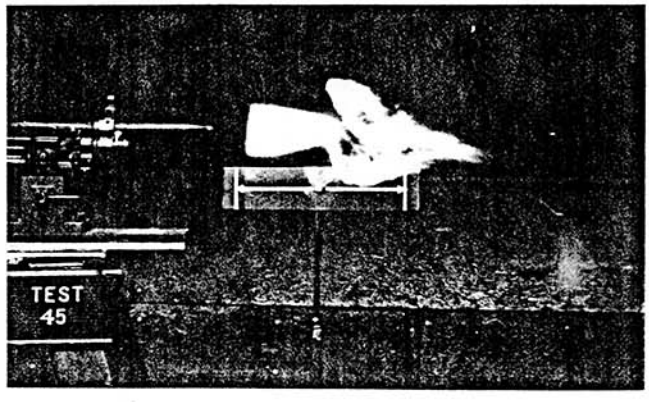


Figure 5.7-2.

-MUZZLE FLASH TEST-
(M249 Machine Gun)

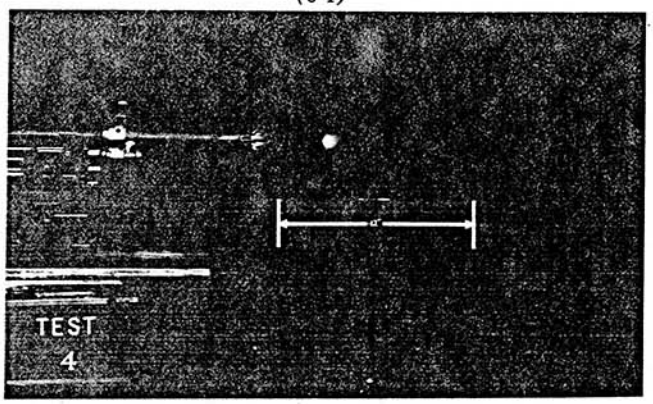
NEW BARREL-20 ROUNDS WITH FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

Control Ammunition
(FNB84F001L019)

M855 Ball

(04)



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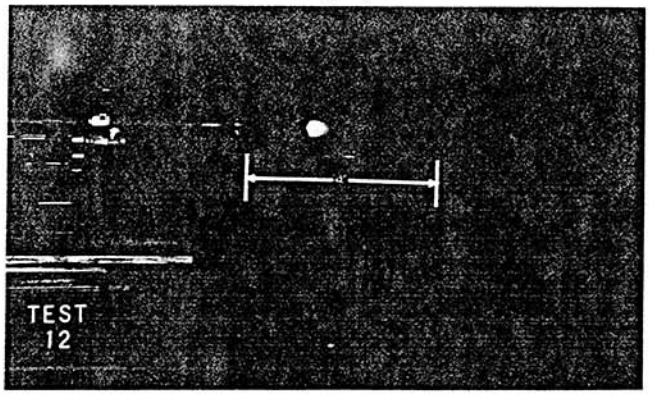
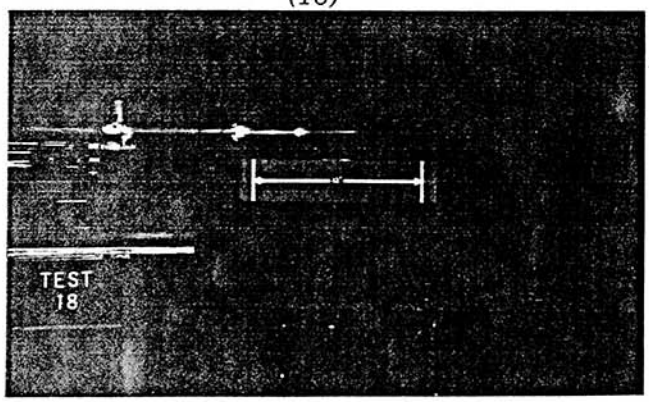


M856 Tracer

(18)



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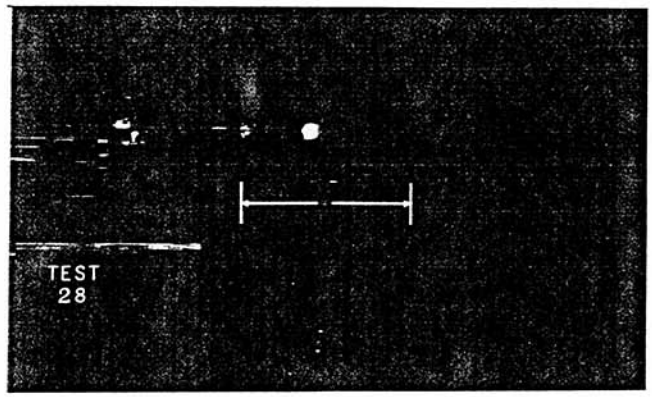
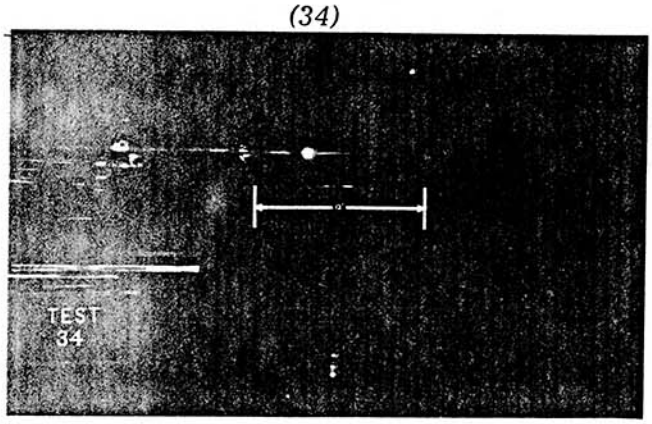


M855/M856 Ball/Tracer Mix (4:1)

(34)



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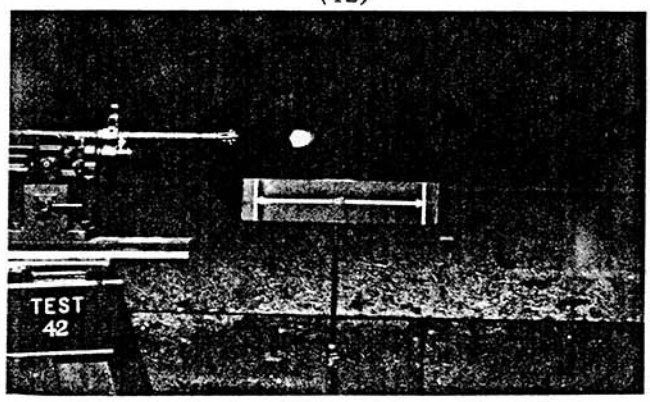


Figure 5.7-3.

(M249 Machine Gun)

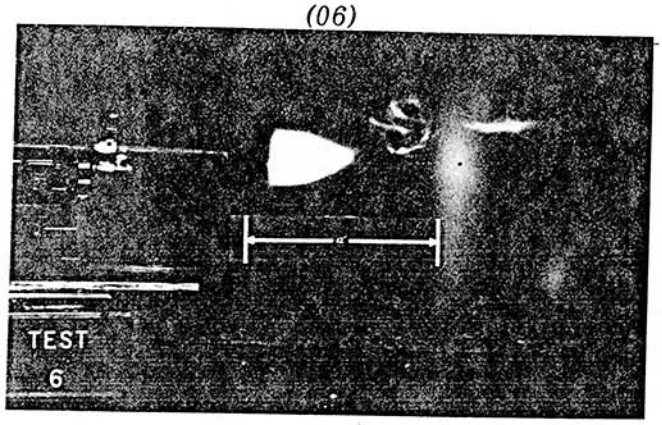
NEW BARREL-20 ROUNDS WITHOUT FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

Control Ammunition
(FNB84F001L019)

M855 Ball

(06)



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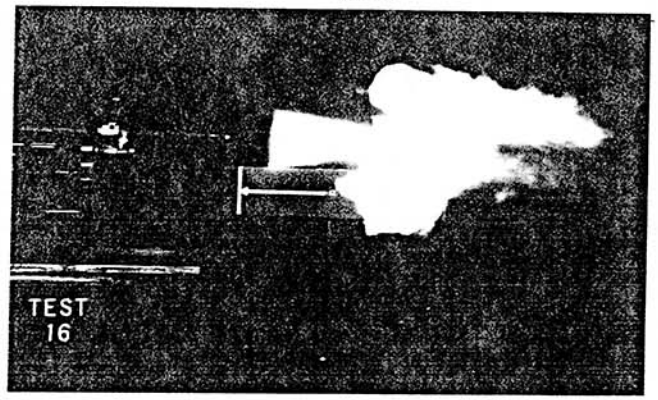
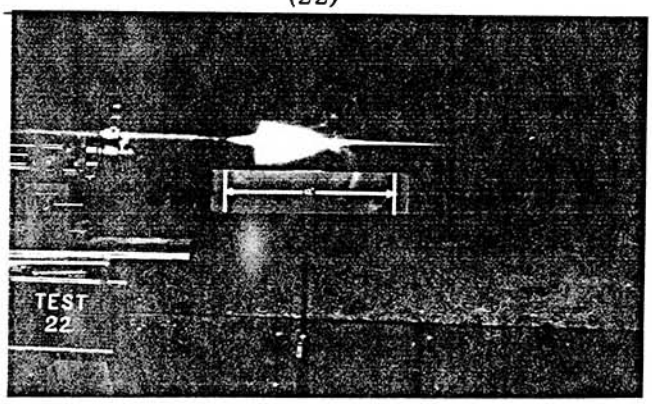
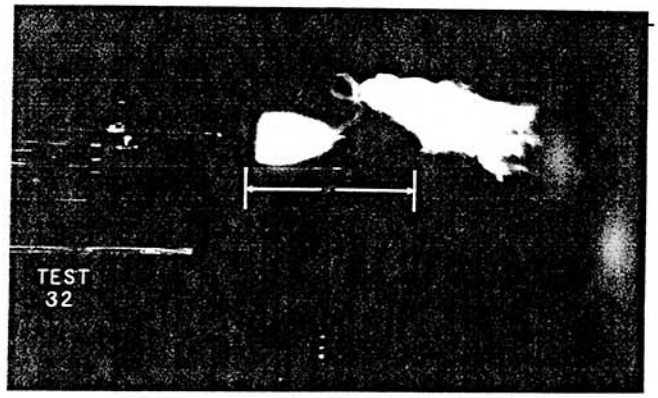


M856 Tracer

(22)

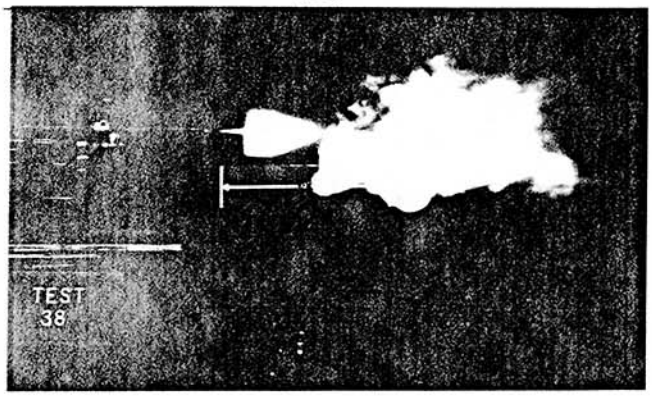


(32)



M855/M856 Ball/Tracer Mix (4:1)

(38)



(46)

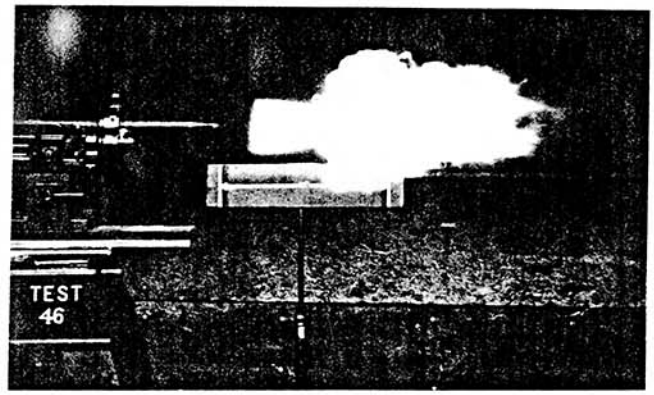


Figure 5.7-4.

-MUZZLE FLASH TEST-
(M249 Machine Gun)

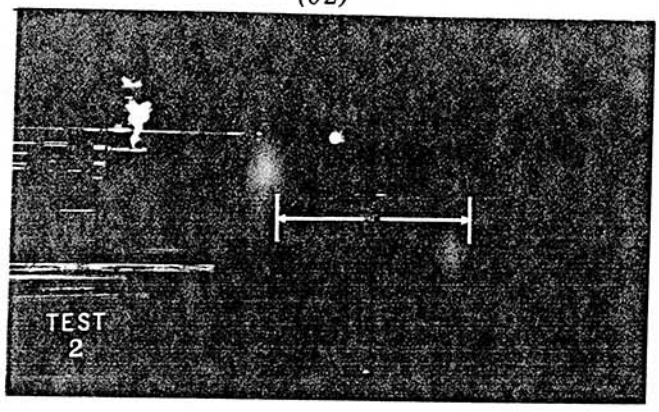
OLD BARREL-5 ROUNDS WITH FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

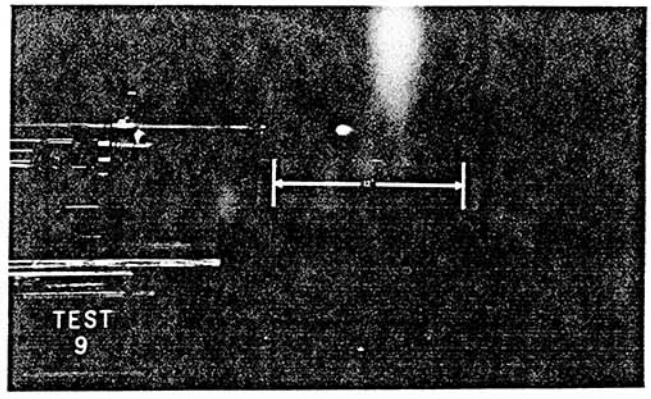
Control Ammunition
(FNB84F001L019)

M855 Ball

(02)

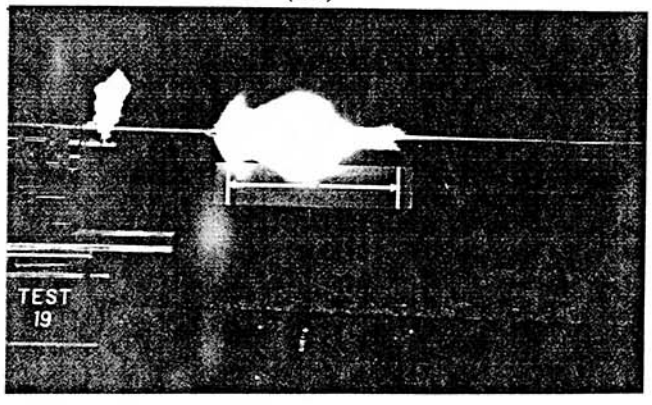


(09)

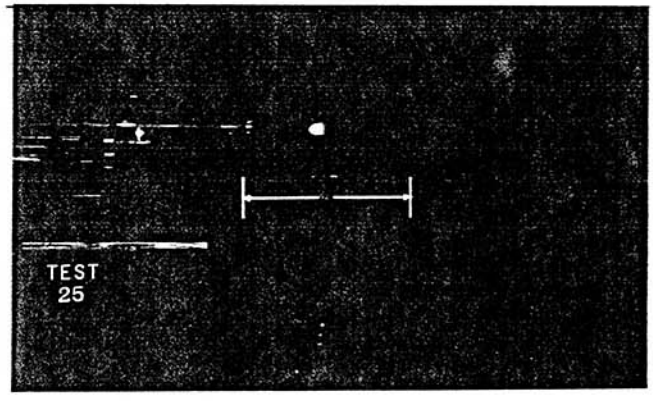


M856 Tracer

(19)

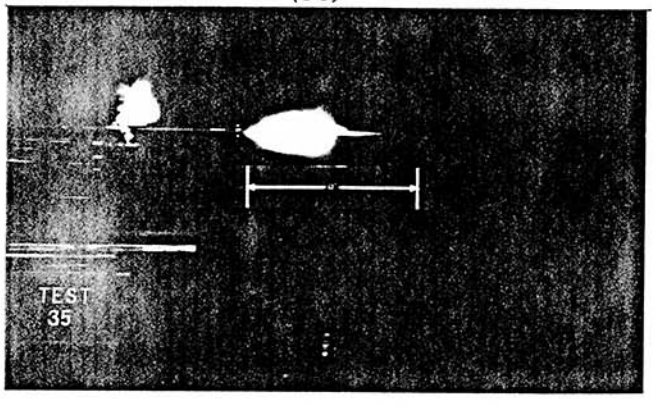


(25)



M855/M856 Ball/Tracer Mix (4:1)

(35)



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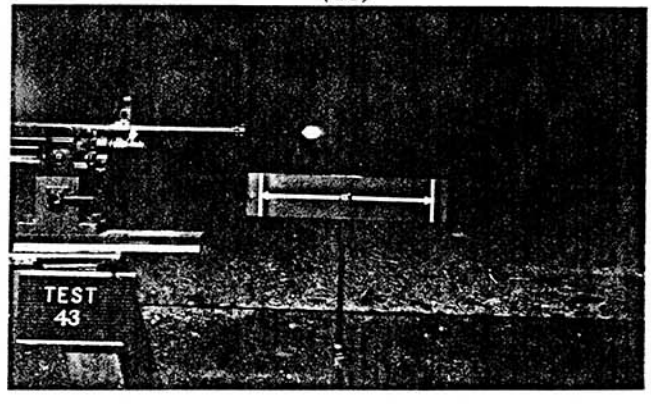


Figure 5.7-5.

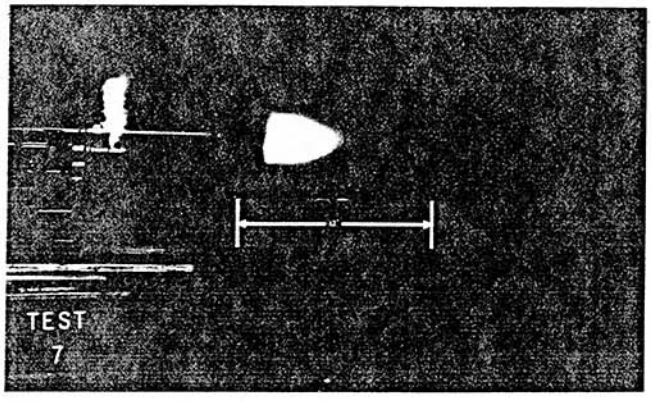
OLD BARREL-5 ROUNDS WITHOUT FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

Control Ammunition
(FNB84F001L019)

M855 Ball

(07)



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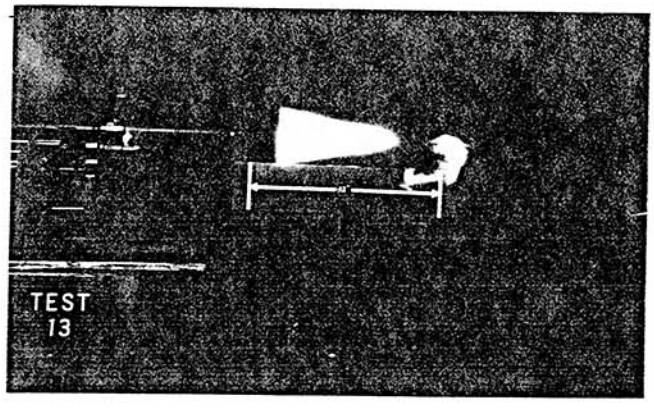
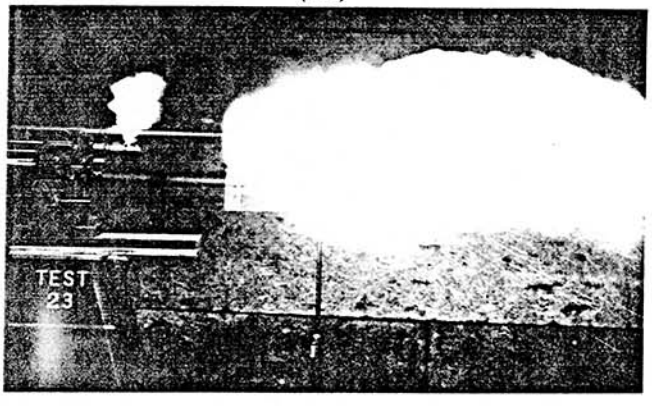


M856 Tracer

(23)



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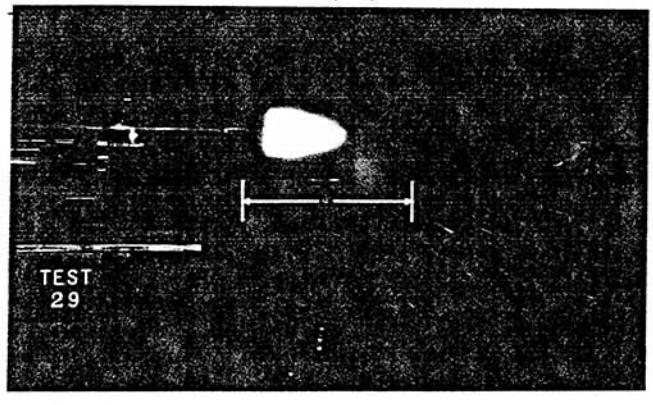
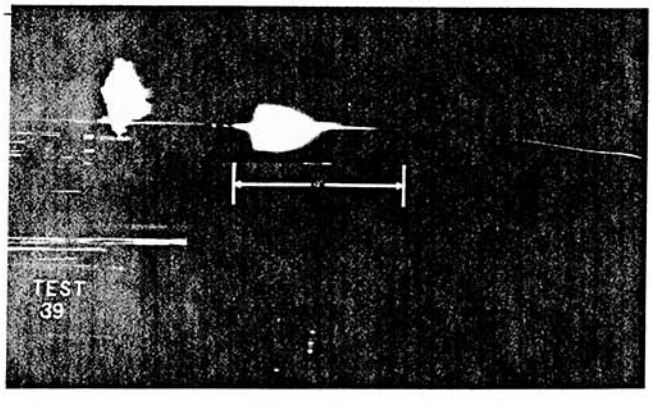


M855/M856 Ball/Tracer Mix (4:1)

(39)



(47)

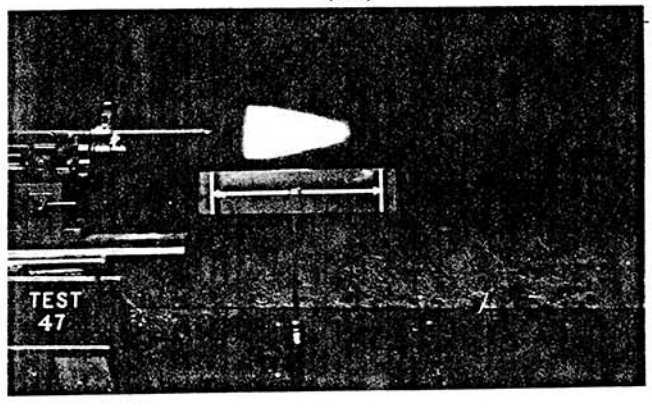


Figure 5.7-6.

-MUZZLE FLASH TEST-
(M249 Machine Gun)

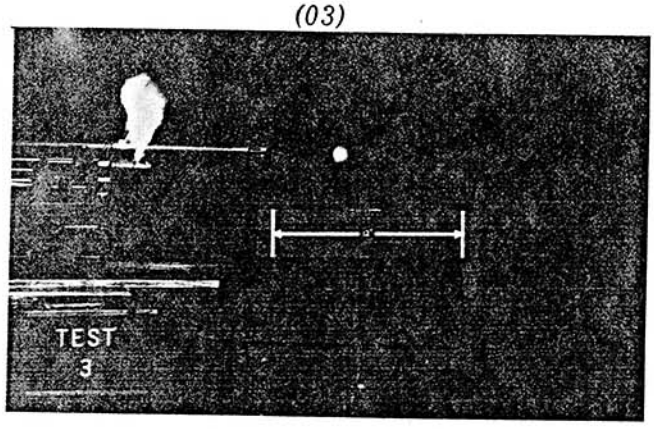
OLD BARREL-20 ROUNDS WITH FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

Control Ammunition
(FNB84F001L019)

M855 Ball

(03)



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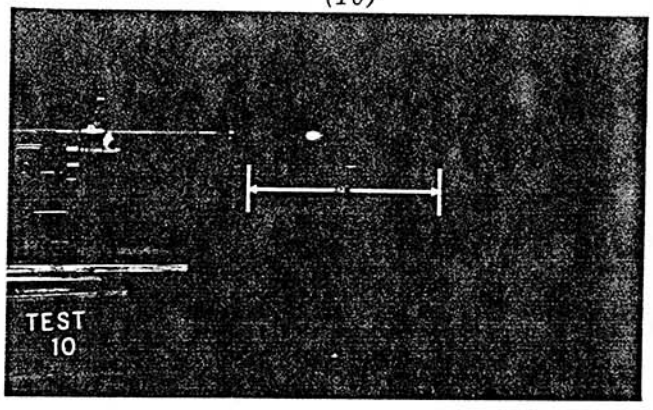
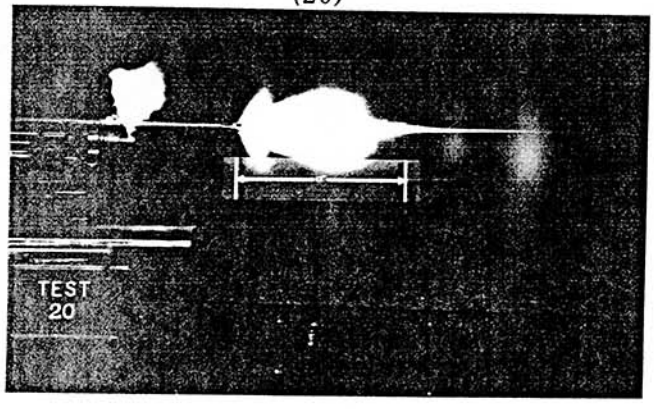


M856 Tracer

(20)



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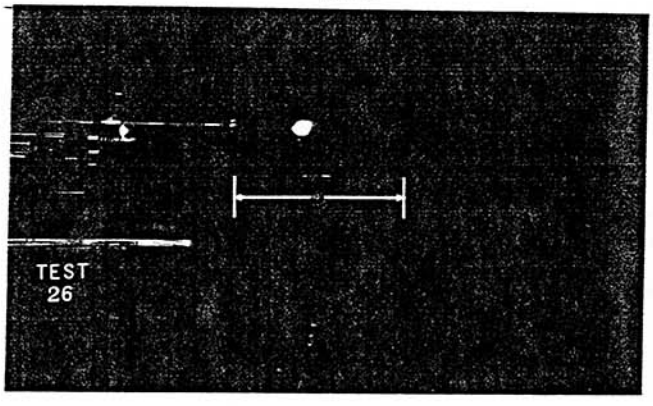
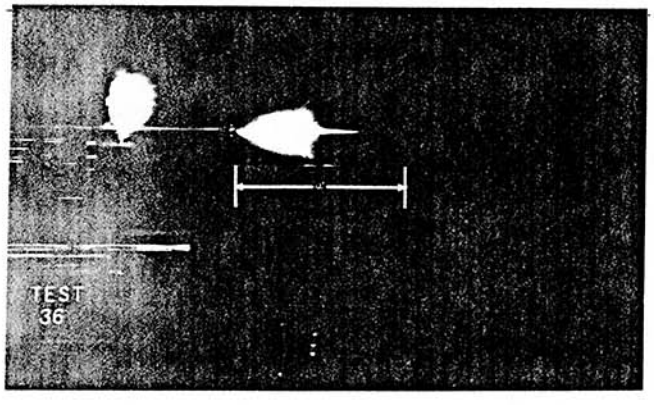


M855/M856 Ball/Tracer Mix (4:1)

(36)



(44)

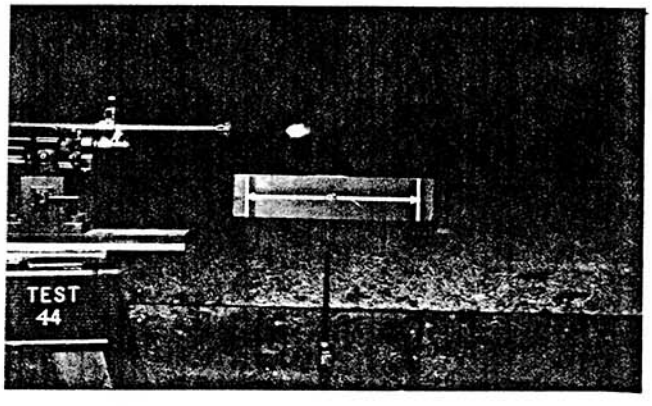


Figure 5.7-7.

MUZZLE FLASH TEST-
(M249 Machine Gun)

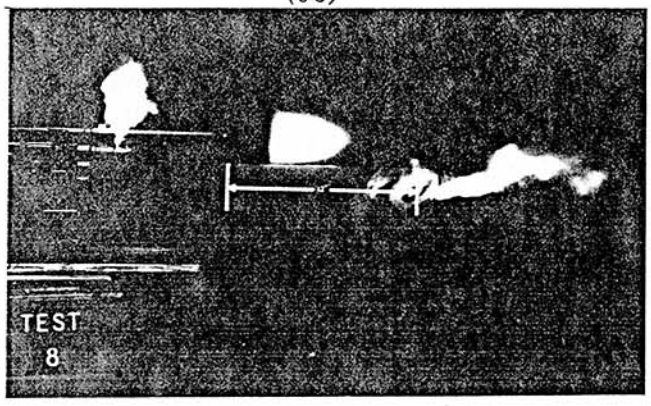
OLD BARREL-20 ROUNDS WITHOUT FLASH SUPPRESSOR

Test Ammunition
(LC85D300S339)

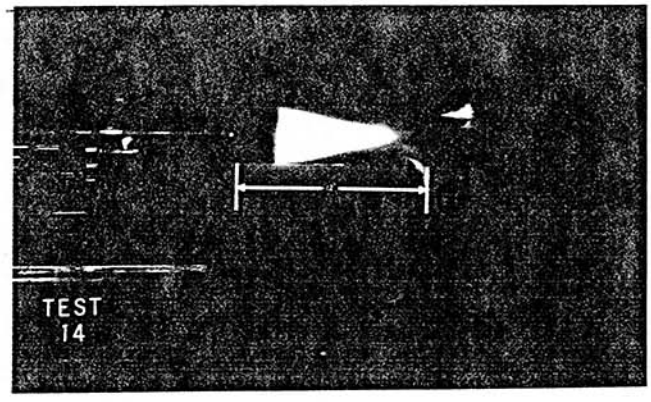
Control Ammunition
(FNB84F001L019)

M855 Ball

(06)

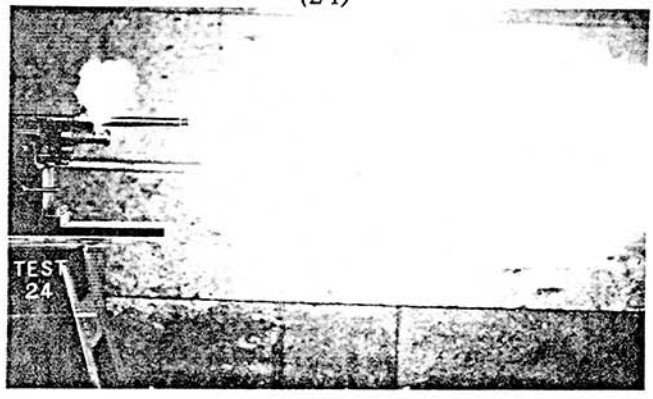


(14)



M856 Tracer

(24)



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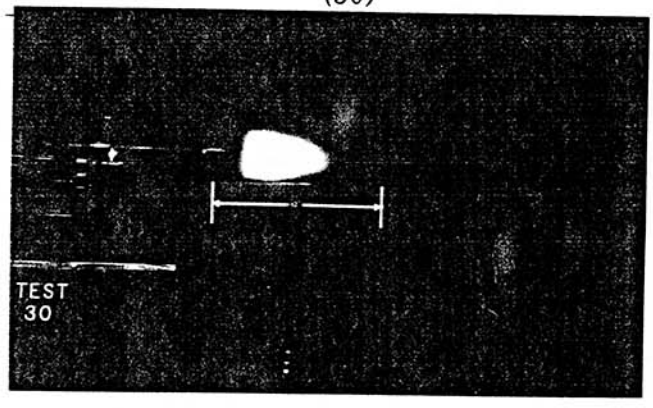
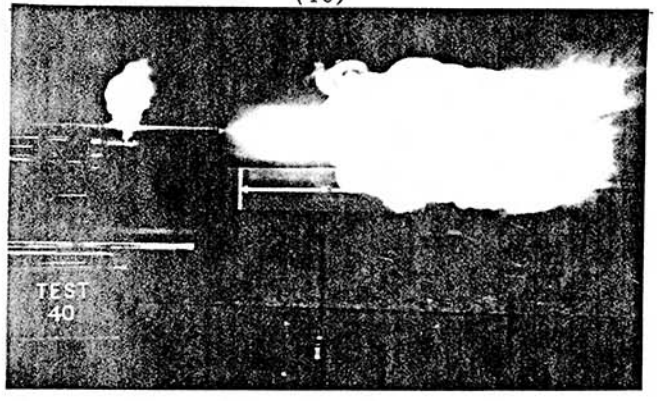


M855/M856 Ball/Tracer Mix (4:1)

(40)



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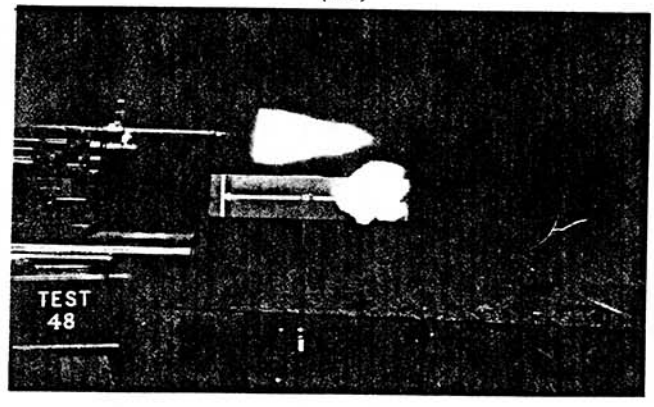


Figure 5.7-8.

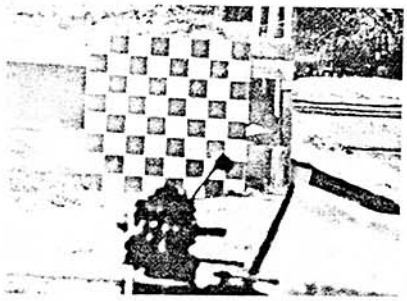
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM SHOOTERS POSITION-

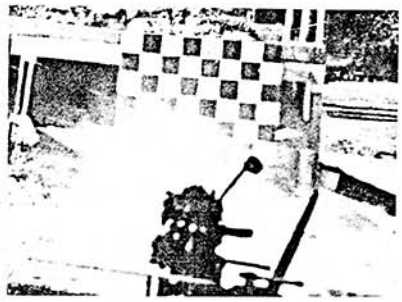
5-ROUND BURSTS

Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

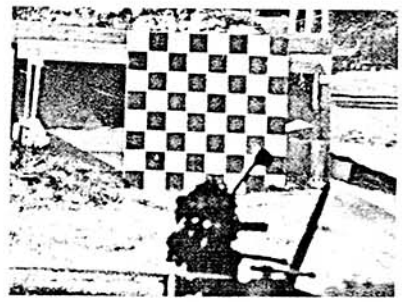
Test 01

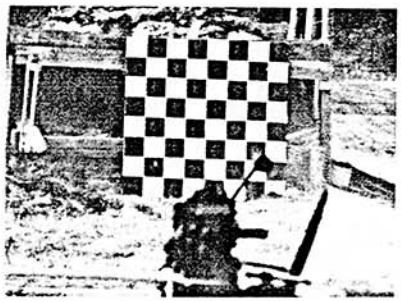


Test 02

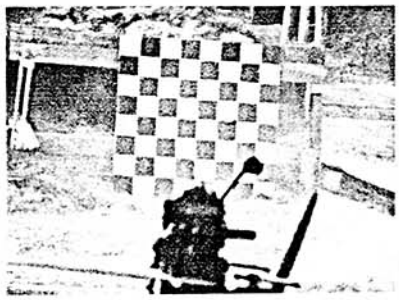


Test 03

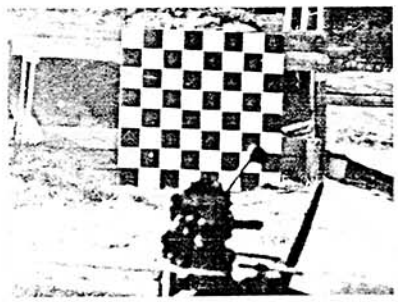




Test 10



Test 11



Test 12

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-9.

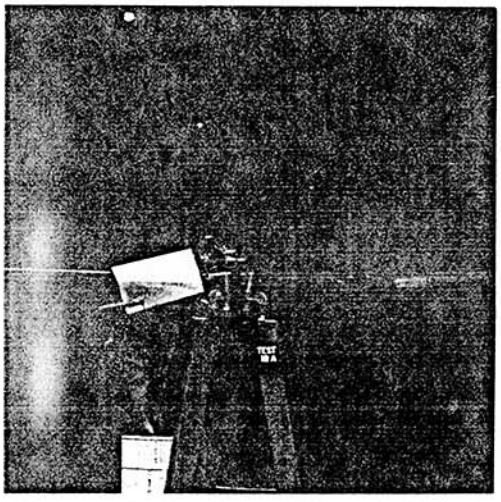
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM DOWN RANGE POSITION-

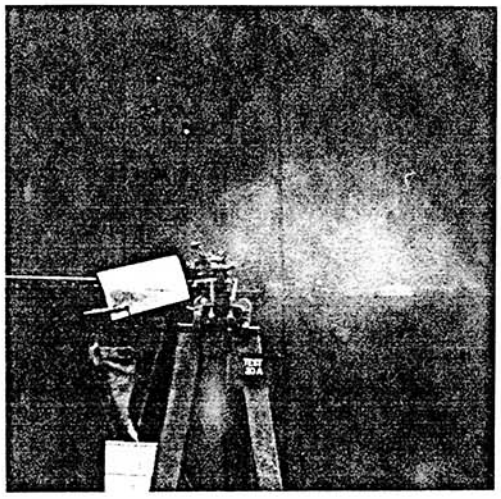
5-ROUND BURST

Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

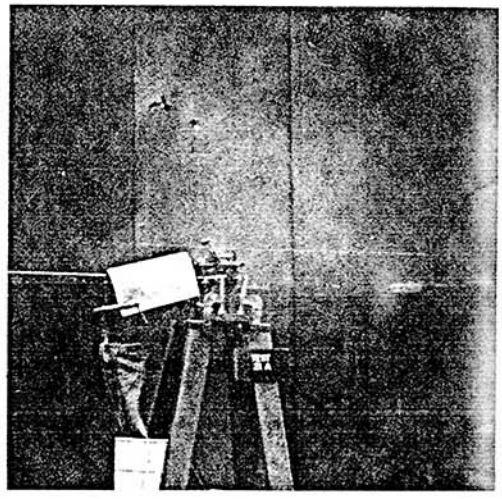
Test 19

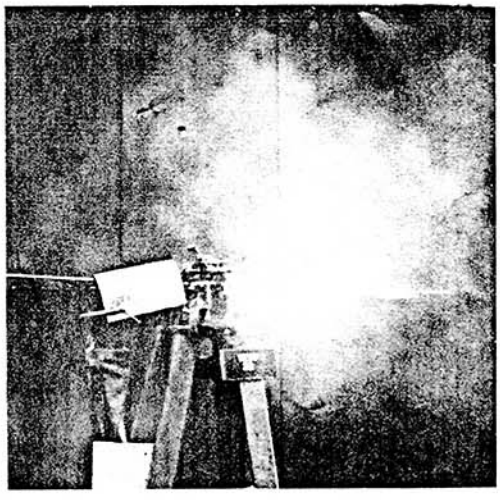


Test 20

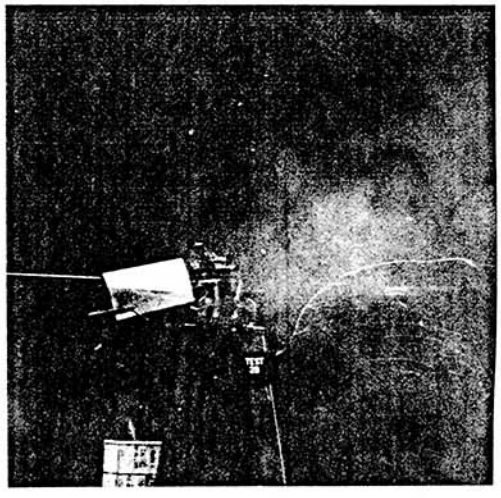


Test 21

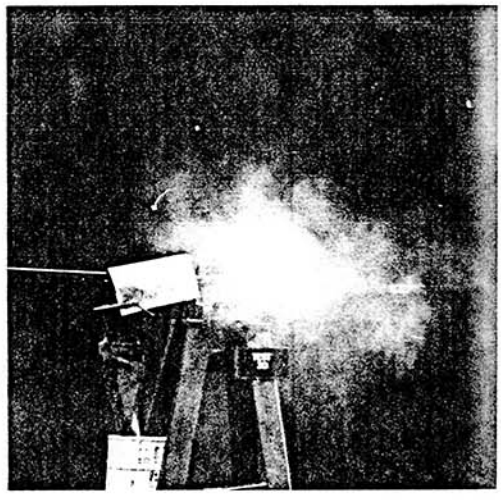




Test 28



Test 29



Test 30

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-10.

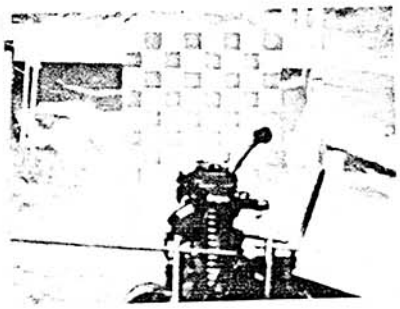
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM SHOOTERS POSITION-

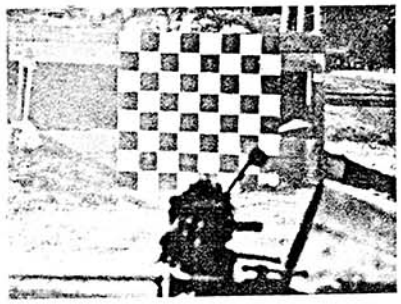
10-ROUND BURST

Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

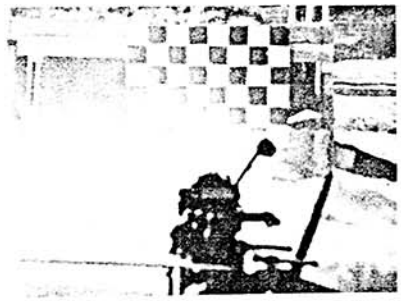
Test 04

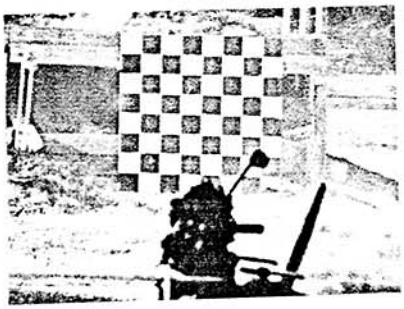


Test 05

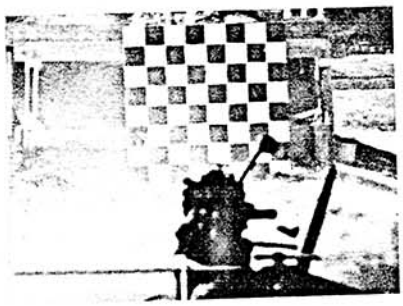


Test 06

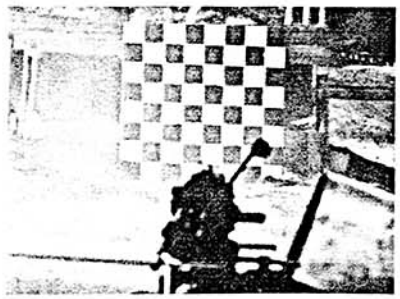




Test 13



Test 14



Test 15

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-11.

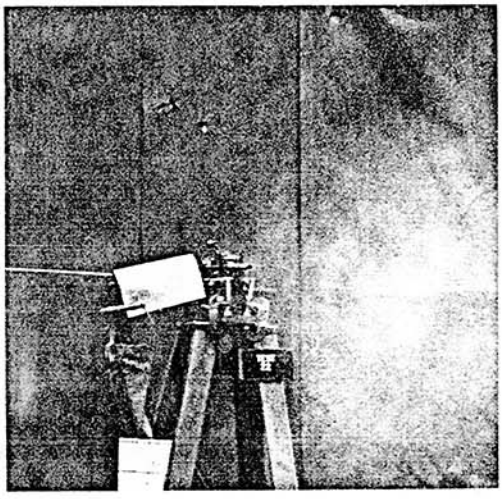
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM DOWN RANGE POSITION-

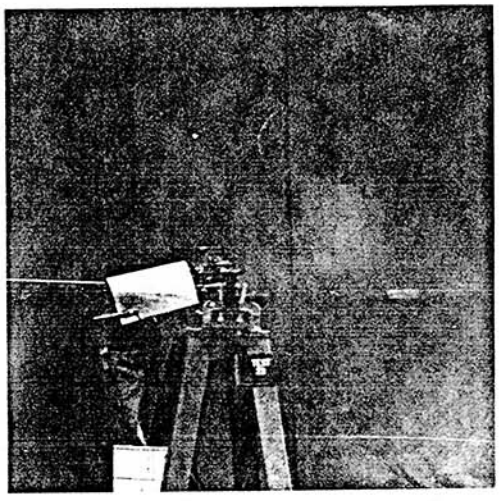
10-ROUND BURST

Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

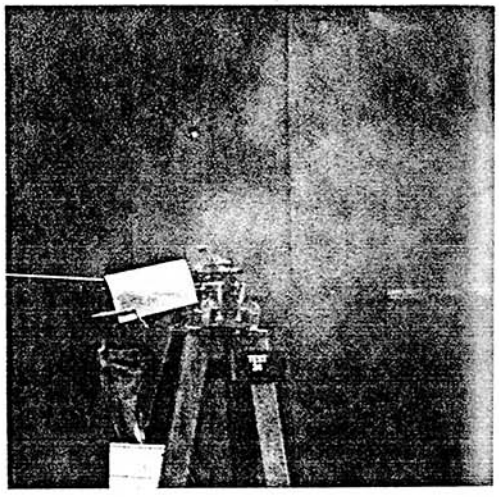
Test 22

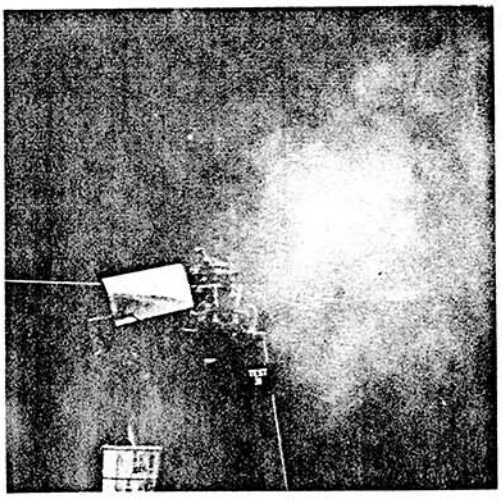


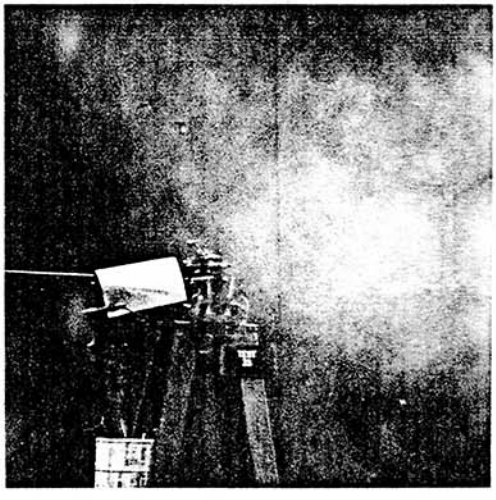
Test 23



Test 24







Test 31

Test 32

Test 33

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-12.

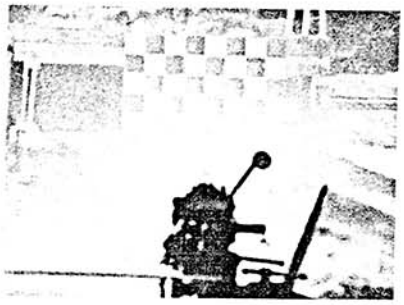
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM SHOOTERS POSITION-

20-ROUND BURST

Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

Test 07



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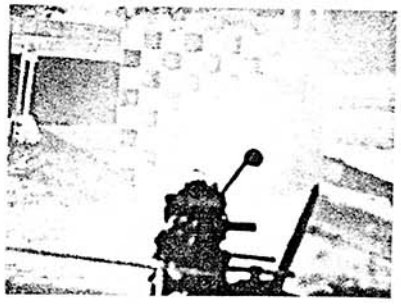

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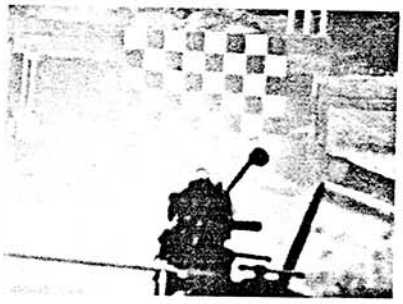

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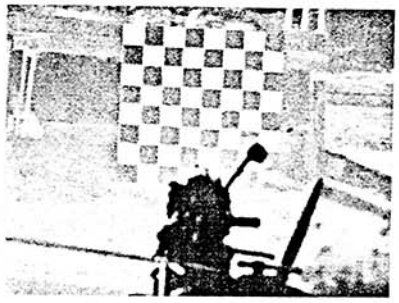

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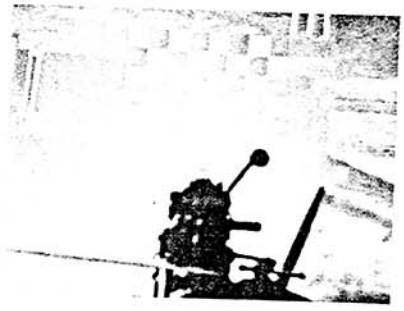


Test 18

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-13.

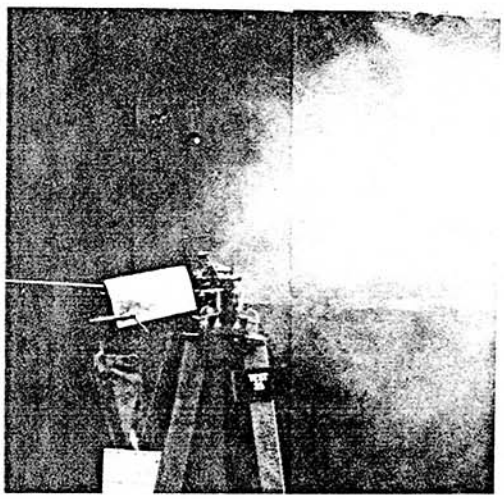
-SMOKE TEST-
(M249 Machine Gun)

-VIEWED FROM DOWN RANGE POSITION-

20-ROUND BURST

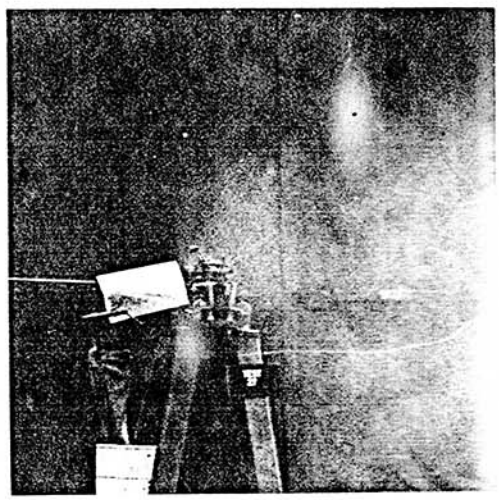
Test Ammunition - M855/M856 (4:1 mix) - LC85D300S339

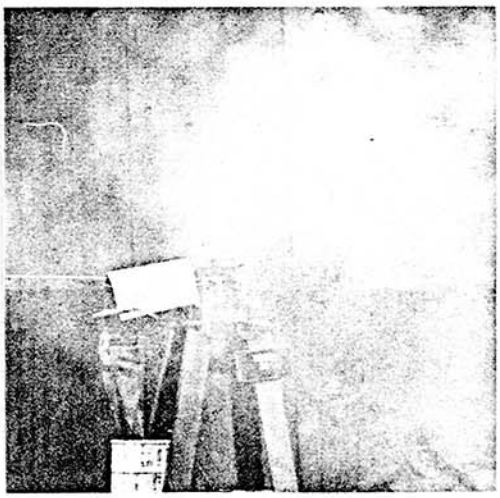
Test 25

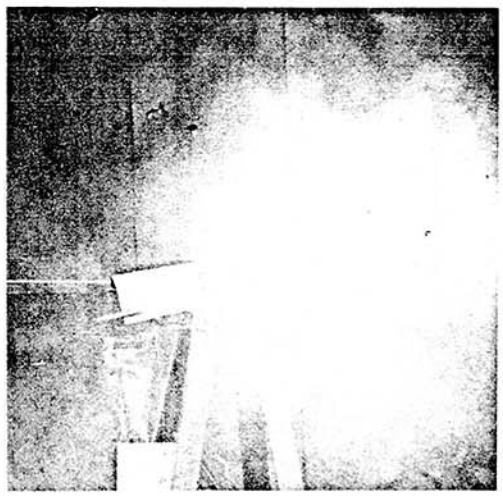


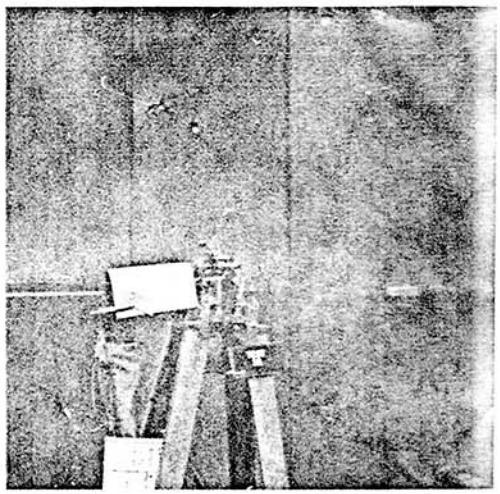
Test 26

Test 27









Test 34

Test 35

Test 36

Control Ammunition - M855/M856 (4:1 mix) - FNB84F001L019

Figure 5.7-14.

5.7.5 Technical Assessment

a. The muzzle flash produced by new barrels was less than that produced with barrels with high round counts. Although the test and control ammunition generated approximately the same comparative level of flash when fired from new barrels, the Belgian-produced rounds did not exhibit as much flash when fired from a well worn bore. When the unsuppressed flash photographs were compared, the reason became apparent - there was a greater amount of flash to be suppressed. In either a new or an old barrel, there was a greater amount of gas escape visible in the area of the gas regulator vent.

b. The smoke cloud produced by firing was approximately equal for test and control ammunition in terms of target obscuration and detection.

c. The CONUS-produced M855 and M856 ammunition was safe to fire.

d. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW.

e. The Military Specification requirements concerning ammunition defects and fired case casualties were satisfied (no defects or casualties).

f. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition, or its handling, storage, or maintenance.

g. The CONUS-produced M855 and M856 ammunition generally performs in accordance with the criteria requirements.

h. The smoke obscuration and detection, and flash in a new barrel are satisfactory, but performance from a well worn barrel (beyond 10,000 round life) is not. This latter condition is not considered a shortcoming since barrel life is only required to be 10,000 rounds (minimum life).

5.8. COOK-OFF

5.8.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball M855; and Tracer M856?

e. Other issue. Are all the test item's RAM requirements met?

5.8.2 Criteria

a. The cartridge shall function without casualty at ambient temperature <u>and under the temperature conditions of +125°F and -65°F</u> (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para.3.13 of MIL-C-63989A and MIL-C-63990A) (Ref.15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

d. The demonstrated cook-off level, when fired at a sustained rate of 85 spm, shall be at least 200-rounds without cook-off (Test Agency devised, TECOM approved).

Note: The underlined portion was not addressed in this subtest.

5.8.3 Test Procedure

The basic procedures used in the conduct of the cook-off test are found in paragraph 6.2.7 of TOP 3-2-045 (Ref. 36). Specific procedures governing this test are given below:

a. One new M249 weapon was fired with the test ammunition linked in the standard ratio of 4 ball to 1 tracer. The weapon was mounted in a test stand and fired in 5-round bursts at the rate of 85 spm. The cook-off rounds have desensitized primers made by slow indentation of the primer beyond the normal depth of firing pin indentation of the gun.

b. In order to establish cook-off levels for both ball and tracer ammunition, two gun barrels were used; one for the ball cook-off rounds, and the other for the tracer cookoff rounds. Initial firings were done at 350-rounds for both ammunition types and was thereafter, changed in 20-round increments as test results dictated. Five confirmatory trials of no cook-off were made for each cartridge type.

c. The test conditions were controlled to the extent that the ambient range temperature and temperature of the weapon and ammunition at the start of testing was consistent throughout the test.

5.8.4 Test Findings

The results of firing 5030-rounds from M249 SAW SN 012431 (Test No. 8) (3081 M855 Ball rounds from Barrel No. 8 and 1949 M856 Tracer rounds from Barrel No. S12 are reported in Table 5.8-1. Ammunition from lot No. LC85D300-S339 was used throughout the subtest. Both barrels were new at the start of testing. The weapon had a total of 341 prior rounds.

A representative example of a cookoff round fired case is shown in Figure 5.8-1. The case head and primer deformation did not represent a safety hazard. It was not normal to fire the SAW in this manner.

TABLE 5.8-1. COOKOFF DATA FOR M249 SAW FIRED WITH 4:1 MIX OF CONUS-PRODUCED M855 BALL AND M856 TRACER AMMUNITION

	Test Results, by Ammo Type			
	Cookoff		No Cookoff	
Test Parameters	M855	M856	M855	M856
Number of rounds fired	270	310	250	290
Rate of fire, spm	96	86	96	97
Firing time, sec	170	216	150	171
Time of Cookoff, sec	48	77	-	-
Temperature, °F:				
Range ambient	60	47	61	57
Barrel chamber	715	720	700	710
Barrel gas port	660	760	645	750

Note: Minimum number of rounds fired without cook-off must be at least 200.

Rate of fire based on firing in short bursts (5 to 7 rounds) at inter vals of 2 to 3 seconds to produce at least 85 spm, when the weapon's gas regulator is set at NORMAL.

Five trials were fired at the no-cook-off round count to validate that number. The temperature given for no cook-off are maximum attained values. Some individual trials produced lower values.

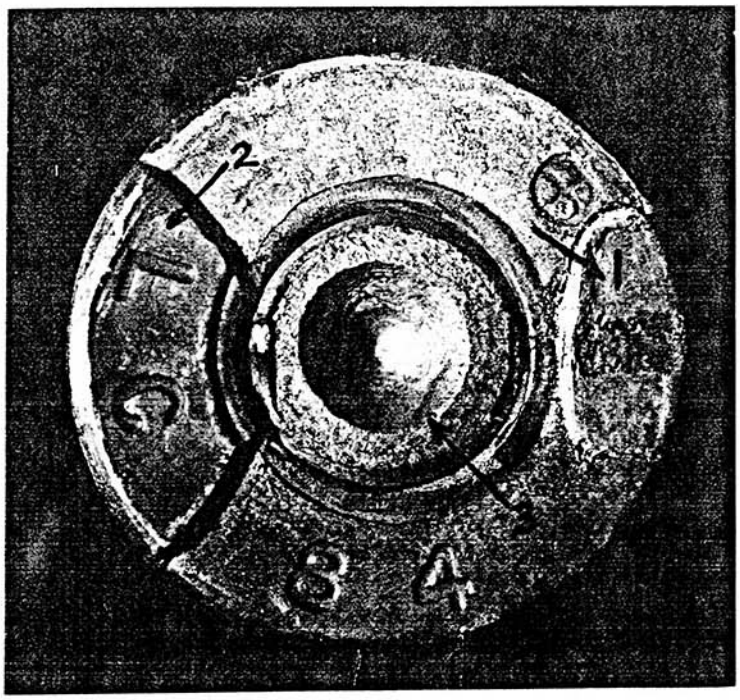


Figure 5.8-1. Typical cook-off round fired case from an M249 SAW showing heavy set back into bolt face (arrow 1 and 2) and protruding primer (arrow 3).

5.8.5 Technical Assessment

a. The CONUS-produced ammunition was safe to fire and did not produce hazardous conditions as a result of having a cook-off.

b. The number of rounds fired without the occurrence of a cook-off was above the minimum 200-round requirement.

c. The Military Specification requirements concerning ammunition defects and fired cases casualties were satisfied (no defects or casualties).

d. The CONUS-produced M855 and M856 ammunition performs in accordance with the test criteria.

5.9 SALT-FOG

5.9.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball; and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.9.2 Criteria

a. The cartridge shall function without casualty at ambient temperature <u>and under the temperature conditions of +125°F</u> (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridge shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19 respectively).

Note: The underlined portion was not addressed in this subtest.

5.9.3 Test Procedure

Basic procedures for doing a salt-fog test are given in paragraph 33 of TOP 4-2-016 (Ref. 43). Specific procedures relating to this subtest are given below and in Method 509.2 of MIL-STD-810D (Ref. 49).

a. Only the ammunition (100-rounds each of CONUS-produced M855 Ball and M856 Tracer, linked in 50-round belts) was subjected to the salt-fog 4-day test cycle. The ammunition was preconditioned for 16 hours at +35 °C temperature, then conditioned for 48 hours in the saltwater fog environment. The ammunition was then removed from the test environment and one-half of the sample was immediately fired for functioning . The remaining 50-rounds of each type were stored in a sheltered storage area for an additional 48 hours and then fired. The weapon was cleaned and lubricated between test firings. One barrel was used for all firings.

5.9.4 Test Findings

M249 SAW SN 014229 (test No. 6) and new a barrel (No. 8) were used in this subtest. There were no weapon malfunctions or stoppages, there were no defects found in the ammunition used in this test, and there were no fired case casualties. There was moderate rusting of the links and some corrosion on the cartridge cases and projectiles. Average cyclic-rate-of-fire for the ball ammunition was 947 spm after the first 48 hour salt-fog interval and 939 spm after the second 48 hour storage interval. Rates of fire for the same time intervals when firing the tracer ammunition were 915 and 910 spm, respectively.

5.9.5 Technical Assessment

a. The CONUS-produced ammunition was safe to fire from the M249 SAW.

b. The CONUS-produced ammunition was compatible with the M249 SAW.

c. The Military Specification requirements concerning ammunition defects and fired case casualties were satisfied (no defects or casualties).

d. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition, or its handling, storage, or maintenance.

e. The CONUS-produced M855 and M856 ammunition performs in accordance with the test criteria.

5.10 METAL PARTS INTEGRITY

5.10.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball; and Tracer, M856?

e. Other issue. Are all of the test item's requirements met?

5.10.2 Criteria

a. The cartridge shall function without Casualty at ambient temperature and under the temperature conditions of +125°F and -65°F (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 18 and 19, respectively).

5.10.3 Test Procedure

The basic procedures used in the conduct of the metal parts integrity test are found in Paragraph 17 of TOP 4-2-016 (Ref. 43). Specific procedures governing this test are given below:

a. Firing was done in 50-round continuous bursts, with complete weapon cooling after every 100- rounds. A total of 400-rounds was fired at each of three temperatures: +155, 70, and -65°F (+68, +21, and -51 °C). Two hundred-ball and 200-tracer rounds were fired at each temperature. The ammunition was temperature conditioned for at least 12 hours prior to firing in the M249. The weapon was not temperature conditioned. The two gun barrels used (one for each ammunition type) were new at the start of the test. Firing was initiated immediately upon removal of the ammunition from the temperature conditioning box.

b. The test site layout consisted of a test stand mount for the weapon, velocity sensors, yaw target, and fragment recovery targets. The velocity sensors were located at ranges of 5 and 15-meters from the weapon muzzle. The yaw target was at 25-meters. The fragment recovery targets were at 3-, 10-, 30-, and 60-meter ranges. A hole was cut in each of these targets on the line of fire so that all projectiles would pass through the holes without touching.

c. Cyclic rate of fire was recorded.

d. Since the normal dispersion at short range precluded viewing of individual shots fired on a fixed target, a rolling kraft paper yaw target was used. Any resultant yaw was measured with the yaw gauge.

e. The NORMAL gas regulator setting was used on the gun. Gun maintenance was performed after each temperature phase of testing. Barrel gauging was done at the end of all testing.

5.10.4 Test Findings

a. The results of firing CONUS ammunition through the M249 SAW is reported in Table 5.10-1. Weapon SN 014230 (Test No. 7) was used with Barrel No. S9 for M855 rounds and barrel No. S10 for M856 rounds. Weapon round count at start of testing was 1865. Both barrels were previously fired 0 rounds.

TABLE 5.10.1. METAL PARTS INTEGRITY OF CONUS PRODUCED M855 BALL AND M856 TRACER AMMUNITION FIRED FROM M249 SAW

Temp, °F	No. Rd Fired	Vel, fps	CR, spm	No. Particles by Range, Meters 3	10	30	60
			M855 Ball				
70	200	2921	866	2	0	0	0
155	200	3032	836	0	0	0	0
-65	200	2944	842	3	0	0	0
Total	600	----------		5	0	0	0
Avg	---	2966	848	----------			
			M856 Tracer				
70	200	2792	882	12	0	0	0
155	200	2918	819	64	0	0	0
-65	200	2735	887	22	0	0	0
Total	600	----------		98	0	0	0
Avg	---	2815	863	----------			

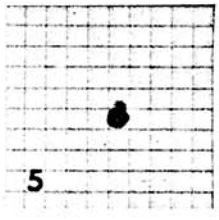
Notes: No projectile yaw in excess of 15° was noted.
Possible bullet jacket separation noted on yaw target with M855 Ball ammunition during high temperature testing. Refer to Figure 5.10-1.

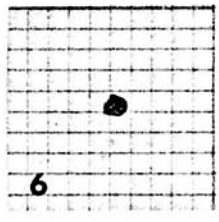
Figure 5.10-1. Bullet signature at high temperature (+155°F). View 1 = rd No. 51; view 2 = rd No. 113, and view 3 = rd No. 187 of the 200-round series. Dark colored semicircular smear (arrows) on the paper target were created during passage of the projectile through the kraft paper target.

Ambient temperature

Low temperature (- °F)

High temperature (+155 °F)





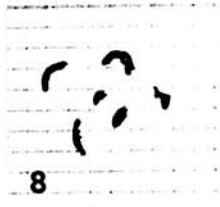


Figure 5.10-2. Recovered particles ejected from CONUS produced M856 tracer projectiles during firing at 10-meter range. Note: Grid scale = 0.1 inch.

b. The small metal parts expelled from the M856 Tracer projectiles (Figure 5.10-1) (estimated to be from more than four projectiles) did not constitute a safety hazard. These particles, weighing 3 grains or less, were recovered from the first witness screen, which was constructed of kraft-paper-covered plywood. The dispersion of the particles was random about the line of fire, in a circular pattern approximately 2 feet (0.61 meter) in diameter.

c. The single small particle recovered from firings of the M855 rounds was within the accepted limits of the ammunition specification.

5.10.5 Technical Assessment

a. The CONUS-produced M855 and M856 ammunition was safe to fire and was compatible with the M249 SAW.

b. The CONUS-produced M855 Ball ammunition met the Military Specification requirements for metal parts integrity, but the CONUS-produced M856 Tracer ammunition did not.

c. Functioning of the M249 SAW was not adversely affected by the fouling produced by firing of either type of test ammunition.

d. The CONUS-produced M855 Ball ammunition performs in accordance with the test criteria.

e. The CONUS-produced M856 Tracer ammunition, while not meeting the letter of the test criteria, substantially satisfies all three of them. The adverse performance of the tracer ammunition should not be considered a bar to its use, since there is no evidence of catastrophic failure of the projectile.

5.11 SECURED CARGO AND ROUGH HANDLING

5.11.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm: Ball M855; and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.11.2 Criteria

a. The cartridge shall function without casualty at ambient temperature and under the temperature conditions of +125°F and -65°F (Para. 3.12 of MIL-C-63989A and MIL-C-63990A) (Ref.15 and 19, respectively).

b. The fouling accumulated in the weapon during firing of the sample cartridges shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A and MIL-C-63990A) (Ref. 15 and 19, respectively).

d. There shall be no significant change (5% level of significance) in weapon performance (i.e. dispersion and functioning) as a result of using ammunition that has been subjected to rough handling (Test Agency devised, TECOM approved).

5.11.3 Test Procedure

Basic procedures for conduct of secured cargo and rough handling tests are contained in TOP 4-2-602 and 1-2-601 (Ref. 50 and 51, respectively). Specific procedures governing this test are given below:

a. All ammunition and packaging was inspected before testing.

b. The testing was started with 57,600-rounds being subjected to a secured cargo vibration test at +68°C. Another identical sample was also tested at -46°C temperature.

c. Another 57,600-round sample at each of the same two temperatures was subjected to sequential rough handling in the order of 2.1-meter pelletized drop; loosely stowed cargo, and 1.5-meter packaged drop.

d. One pallet (57,600-rounds) was subjected to a 12-meter drop without being temperature-conditioned.

e. 6,400-rounds of low temperature conditioned rounds were selected from the tests in b and c for firing at that temperature. The same quantity of rounds was selected from the high temperature tests for firing at that temperature.

f. These procedures superceded those originally proposed in the test plan. Refer to Report No. USACSTA-6421 (Ref. 25) if complete procedures are required.

5.11.4 Test Findings

This subtest was devised prior to development of standard packaging for M249 SAW ammunition magazines. A packaging test, conducted under TECOM Project No. 2-MU-023-SAW-001, was completed in August 1986 and reported in Report No. USACSTA-6421 (Ref. 25). TECOM approved the use of the results of that test as the basis for establishing suitability of the ammunition and its packaging.

A total of 172,800-rounds of linked, CONUS-produced ammunition, was tested. All rounds were linked in the ratio of 4-Ball M855 to 1-Tracer M856 cartridge. The ammunition was equally divided among three temperatures: (1) Ambient, (2) -50 °F, and (3) +155 °F. Firing of samples of the ammunition was done after completion of the transportation vibration and drop tests, and visual inspections. Sixty-four hundred rounds from each of the two extreme temperatures were fired from an M249 SAW. Table 5.11-1 detailed the results.

TABLE 5.11-1. SUMMARY OF SECURED CARGO AND ROUGH HANDLING AMMUNITION TEST FIRED FROM THE M249 SAW

200-Rd Cycle No.	Rd Fired	Vel, fps	CR, spm	No. Malfunctions, by Type						
				FFD	FTC	FER	FEX	FEJ	OTH	Total
Low Temperature (-50 °F)										
1	199	2750	818	0	0	[a]1	0	0	0	1
2	200	2776	696	0	0	0	0	0	0	0
3	200	2766	785	0	0	0	0	0	0	0
4	200	-	-	0	0	0	0	0	[b]1	1
5	200	2817	732	0	0	0	0	0	0	0
6	200	2795	780	0	0	0	0	0	0	0
7	199	-	-	0	0	[a]1	0	0	0	1
[c]8	198	2871	961	0	[a]1	[a]1	0	0	0	2

See footnotes at end of Table.

TABLE 5.11-1. (CONT'D)

200-Rd Cycle No.	Rd Fired	Vel, fps	CR, spm	No. Malfunctions, by Type FFD	FTC	FER	FEX	FEJ	OTH	Total
[c]9	199	-	-	0	[a]1	0	0	0	0	1
[c]10	200	2794	1011	0	0	0	0	0	0	0
Total	1995	----------		0	2	3	0	0	1	6
Avg	-----	2796	826	----------						
[c]11	198	2789	977	0	[a]2	0	0	0	0	2
[c]12	199	-	1106	0	[a]1	0	0	0	0	1
[c]13	200	2731	999	0	0	0	0	0	0	0
[c]14	197	2834	940	0	[a]1	[a]2	0	0	0	3
[c]15	200	2810	964	0	0	0	0	0	0	0
[c]16	200	2813	768	0	0	0	0	0	0	0
17	197	2828	690	0	[a]2	[a]1	0	0	0	3
18	200	2825	768	0	0	0	0	0	0	0
19	198	2782	-	0	[a]1	[a]1	0	0	0	2
20	198	2817	766	0	[a]2	0	0	0	0	2
21	200	2809	831	0	0	0	0	0	0	0
Total	2187	----------		0	9	4	0	0	0	13
Avg	----	2804	881	----------						
22	199	2802	863	0	0	[a]1	0	0	0	1
23	200	2825	791	0	0	0	0	0	0	0
24	200	2815	840	0	0	0	0	0	0	0
25	199	2813	782	0	0	[a]1	0	0	0	1
26	199	2837	684	0	[a]1	0	0	0	0	1
27	199	2833	838	0	0	[a]1	0	0	0	1
28	200	2804	824	0	0	0	0	0	0	0
29	198	-	-	1	0	0	0	2	0	3
[c]30	199	-	-	0	0	1	0	1	0	2
[c]31	200	-	-	0	0	0	0	0	0	0
[c]32	200	-	-	0	0	0	0	0	0	0
Total	2193	----------		1	1	4	0	3	0	9
Avg	----	2818	803	----------						
High Temperature (+155°F)										
1	199	-	947	0	0	0	0	1	0	1
2	187	-	905	1	0	0	0	0	0	1
3	200	-	912	0	0	0	0	0	0	0
4	200	-	956	1	0	0	0	0	0	1
5	200	-	986	1	0	0	0	0	0	1
6	200	-	912	0	0	0	0	0	[d]1	1
7	199	-	942	1	0	0	0	0	0	1
8	198	-	873	2	0	0	0	0	2	2

See footnotes at end of Table.

TABLE 5.11-1. (CONT'D)

200-Rd Cycle No.	Rd Fired	Vel, fps	CR, spm	No. Malfunctions, by Type FFD	FTC	FER	FEX	FEJ	OTH	Total
9	198	-	869	2	0	0	0	0	0	2
10	200	-	912	0	0	0	0	0	0	0
Total	1981	----------		8	0	0	0	1	1	10
Avg	----	-	921	----------						
11	199	-	816	1	0	0	0	0	0	1
12	199	-	837	1	0	0	0	0	0	1
13	199	-	905	1	0	0	0	0	0	1
14	198	-	815	2	0	0	0	0	0	2
15	197	-	830	3	0	0	0	0	0	3
16	198	-	939	1	0	1	0	0	0	2
17	200	-	903	0	0	0	0	0	0	0
18	196	-	885	4	0	0	0	0	0	4
19	200	-	942	0	0	0	0	0	0	0
20	192	-	884	3	0	0	0	0	0	3
21	197	-	952	3	0	0	0	0	0	3
Total	2175	----------		19	0	1	0	0	0	20
Avg	----	-	882	----------						
22	200	-	1001	0	0	0	0	0	0	0
23	194	-	886	6	0	0	0	0	0	6
24	198	-	902	2	0	0	0	0	0	2
25	200	-	933	0	0	0	0	0	0	0
26	198	-	925	2	0	0	0	0	0	2
27	198	-	969	2	0	0	0	0	0	2
28	198	-	927	2	0	0	0	0	0	2
29	199	-	914	1	0	0	0	0	0	1
30	199	-	959	1	0	0	0	0	0	1
31	197	-	1036	3	0	0	0	0	0	3
32	199	-	891	1	0	0	0	0	0	1
Total	2180	----------		20	0	0	0	0	0	20
Avg	----	-	940	----------						

[a]Round not fired.
[b]Pull tab failed to remain in assembly with the cartridge.
[c]Maximum (adverse) gas regulator setting-all others set on normal.
[d]200-round magazine box did not latch on gun.

Notes: Velocity data were unavailable due to instrumentation failure. Abbreviation definitions can be found in Appendix E.

5.11.5 Technical Assessment

a. The CONUS-produced M855 and M856 ammunition was safe to fire in the M249 SAW. No indication of projectile metal parts failure occurred during firing. Although the ammunition was not fired for dispersion, the damage sustained as a result of testing should not affect performance relative to dispersion.

b. The CONUS-produced M855 and M856 ammunition was compatible with the M249 SAW.

c. The Military Specification requirements concerning ammunition defects and fired case casualties were satisfied (no defects or casualties).

d. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition or its handling, storage, or maintenance.

e. The CONUS-produced M855 and M856 ammunition performs in accordance with the criteria requirements.

5.12 NOISE

5.12.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm, Ball, M855 and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.12.2 Criterion

The peak sound pressure and B-duration level of the CONUS-produced M855 and M856 ammunition must not exceed the peak and B-duration levels generated by the Belgian-produced M855 and M856 cartridges when tested under the same conditions (Test Agency devised, TECOM approved).

5.12.3 Test Procedure

The basic procedure used is found in TOP 1-2-608 (Ref. 52). Specific details are given below:

a. In order to duplicate results from previous tests, the firing done during the DT-1A of the M249 SAW was repeated (refer to Table 2.7-1 of Report No. APG-MT-5372 (Ref. 53).

b. One weapon, fired from the prone bipod-supported position, was fired five single rounds of each type of the test ammunition. This was followed by five single rounds of each of the control rounds.

c. Data were recorded at three locations: prone shooter's ear (left ear, SAW fired right handed), standing person, 5-meters to the right; and standing person 5-meters to the rear. With the exception of the shooter's ear position, all distance measurements were from the weapon muzzle, aligned either on, or perpendicular to the line-of-fire. Height above ground for the two standing person locations was 5-feet (1.5-meters).

5.12.4 Test Findings

The peak noise (dB) and B-duration of that noise are summarized in Table 5.12-1.

TABLE 5.12-1. SUMMARY OF NOISE LEVEL MEASUREMENTS FROM CONUS PRODUCED M855 BALL AND M856 TRACER AMMUNITION FIRED FROM THE M249 SAW

		Noise Level, by Ammunition Type			
		Control		Test	
Measurement Location	Ammo Type	Peak, dB	Duration, ms	Peak dB	Duration ms
Right-hand shooter's left ear	M855	155	7.3	155	7.6
	M856	154	6.9	156	6.6
5 meters right of muzzle	M855	145	3.0	143	2.9
	M856	144	3.0	143	2.9
5 meters behind muzzle	M855	137	5.2	138	5.1
	M856	137	5.1	137	5.1

5.12.5 Technical Assessment

a. The CONUS-produced ammunition was considered safe, since it did not increase the noise hazard in the M249 SAW, when compared to the noise hazard produced by the Belgian made rounds fired under the same conditions. Both types of ammunition require hearing protection either plugs or muffs, since both fall within curve X of MIL-STD-1474B (Ref. 35).

b. The ammunition was compatible with the M249 SAW.

c. The Military Specification requirements concerning ammunition defects and fired-case casualties were satisfied (no defects or casualties).

d. The CONUS-produced ammunition did not increase the RAM requirements relative to the use of this ammunition, or its handling, storage, or maintenance.

e. The CONUS-produced M855 and M856 ammunition met the criterion.

5.13 WATER SPRAY

5.13.1 Objective and Issues

a. Test objective. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M249 SAW, demonstrated compatibility with the weapon to the extent that all test criteria were met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. Safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the SAW?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the Military Specification for Cartridge, 5.56-mm, Ball, M855 and Tracer, M856?

e. Other issue. Are all of the test item's RAM requirements met?

5.13.2 Criterion

a. The cartridge shall function without casualty at ambient temperature <u>and under the temperature conditions of +125°F and -65°F</u> (Para 3.12.12 of MIL-C-63989A and MIL-C-63990A) (Ref. 18 and 19, respectively).

NOTE: The underlined portion was not addressed in this subtest.

5.13.3 Test Procedure

The basic test procedure governing simulated rain testing is in Paragraph 4.5.4 of TOP 3-2-045 (Ref. 36). Specific procedures are detailed below:

a. One weapon and 600-rounds of the CONUS-produced M855 and M856 ammunition (linked 4 ball to 1 tracer) was used in this test.

b. The weapon was maintained with CLP (MIL-L-63460A) at the start of testing and after 600-rounds firing. The firing schedule is listed in Table 5.13-1.

TABLE 5.13-1. WATER SPRAY TEST CONDITIONS[a]

Step Number	Test Condition Description
1	Weapon horizontal, bolt closed, chamber empty, half loaded (200 rounds).
2	Bolt seared, weapon fully loaded (200-rounds).
3	Fire 100-rounds.
4	Bolt closed on dummy round, half loaded (100-rounds).

TABLE 5.13-1 (CONTINUED)

Step Number	Test Condition Description
5	Charge out dummy round, bolt seared, weapon fully loaded (100-rounds).
6	Fire 100-rounds. Change magazine.
7	Weapon muzzle up, bolt closed on empty chamber, half loaded (200-rounds).
8	Bolt seared, weapon fully loaded (200-rounds).
9	Fire 100-rounds (horizontal).
10	Bolt closed on dummy round, half loaded (100-rounds).
11	Charge out dummy round, bolt seared, weapon fully loaded (100-rounds).
12	Fire 100-rounds (horizontal), change magazine.
13	Weapon muzzle down, bolt closed, chamber empty, half loaded (200-rounds).
14	Bolt seared, weapon fully loaded (200-rounds).
15	Fire 100-rounds (horizontal).
16	Bolt closed on dummy round, half loaded (100-rounds).
17	Charge out dummy round, bolt seared, weapon fully loaded (100-rounds).
18	Fire 100-rounds (horizontal). End of test.

[a]Steps No. 3, 6, 9, 12, 15 and 18 each encompassed 4 minute intervals. All other intervening steps encompassed 5 minute intervals. Rainfall rate was 0.4 inch/min (1.02 cm/min). Weapon was conditioned (i.e., exposed to water spray) as specified in steps No. 1, 7 and 13. All firing was from a bipod supported position from bench rest.

5.13.4 Test Findings

This subtest was fired with M249 SAW SN 014231 (Test No. 8) and barrel No. 8. Both had previously been fired 341-rounds. Ammunition from lot No. LC85D300S339 was used. Firing of the 600-rounds of 4:1 mix linked rounds was spread over a period of 120 minutes at an average rainfall of 24 in/hr.

There were no weapon malfunctions or ammunition/fired case defects noted during this subtest. Weapon cyclic rate data were unavailable because of instrumentation problems. The gun was fired with the NORMAL gas regulator setting and the rates did not sound erratic or abnormal.

5.13.5 Technical Assessment

a. The lack of ammunition and weapon malfunctions/defects as a result of being fired in a simulated rain environment showed that the ammunition was safe to use and was compatible with the M249 SAW. The ammunition met the Military Specification requirements to the extent applicable to this subtest. The ammunition's RAM requirements have been satisfied, there being no malfunctions of the weapon due to ammunition; no special maintenance of the weapon due to use of the ammunition, and no maintenance of the ammunition because off the adverse environment.

b. The CONUS-produced M855 and M856 ammunition met the criterion.

6.1 TEST PART IV -INTRODUCTION

a. Part IV of the test program evaluated performance of the test ammunition when fired from the M16A2 rifle. Nine subtests were used in this assessment. They were: inspection, endurance and reliability, high and low temperatures, cook-off, noise, water spray, and metal parts integrity and three-temperature tracer assessment.

b. Input from these subtests also addressed logistic supportability, safety, human factors and ammunition reliability. These four subjects are definitively covered in Section 2, Part I of this report.

TABLE 6.1-1 INDEX OF SUBTESTS

Para. No.	Subtest Description	Page No.
6.1	Introduction	6-1
6.2	Inspection	6-2
6.3	Endurance and Reliability	6-19
6.4	High Temperature	6-62
6.5	Low Temperature	6-68
6.6	Tracer	6-76
6.7	Cook-Off	6-112
6.8	Noise	6-126
6.9	Water Spray	6-130
6.10	Metal Parts Integrity	6-134

6.2 INSPECTIONS

6.2.1 Objective and Issues

a. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M16A2 Rifle, demonstrates compatibility with the weapon to the extent that all test criteria are met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the M16A2 Rifle?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the military specification for cartridge; 5.56-mm, Ball M855 and Tracer M856?

e. Other issue: Are all of the test item's RAM requirements met?

6.2.2 Criteria

a. The cartridge shall function without casualty at ambient temperature and under the temperature conditions of 51.8°C and -53.9°C (+125°F and -65°F) (Para. 3.12 of MIL-C-63989A for cartridge, 5.56-mm, Ball: M855 and Para. 3.12 of MIL-C-63990A for cartridge, Trace: M856 (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during the firing of the sample cartridge shall not cause failure of the weapon to function (Para. 3.13 of MIL-C-63989A for cartridge, 5.56-mm, Ball: M855 and Para. 3.13 of MIL-C-63990A for cartridge, Tracer: M856 (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para. 3.14 of MIL-C-63989A for cartridge; 5.56-mm, Tracer: M856 (Ref. 15 and 19, respectively).

d. The condition of all M16A1 and M16A2 Rifles before test use must conform to applicable drawings and specifications for the manufacture and acceptance of those weapons (Test Agency devised, TECOM approved).

6.2.3 Test Procedure

a. Basic test procedure guidance is given in TOP 3-2-045 (Ref. 36), Paragraph 3.2; Paragraph 5 of TOP-3-2-807 (Ref. 37); Paragraph 3 of MIL-R-45587A (Ref. 26); and Paragraph 3 of MIL-R-63997(AR) (Ref. 27). Specific guidance for this test is given in Paragraphs 6.2.3b thru 6.2.3h.

b. Barrel bore measurements were taken at 2.5-cm intervals, starting at the origin of rifling and ending at the muzzle at the point of last full rifling. During borescope inspection of the overall condition of the rifling, photographs of the gas port orifice were taken. The condition of the origin of rifling was also photographed.

c. Barrel chamber measurements were made at the locations specified in Figure 6.2-1.

d. Headspace was measured with plug-type gauges. Graduated gauges were available, so the exact (within 0.025-mm length) headspace was determined.

e. Firing pin protrusion was measured with a dial indicating height gauge, accurate to ± 0.013-mm (± 0.0005 in.).

f. Firing pin indent was measured in copper cylinders of known length (three trials each rifle). The weapon was in the vertical muzzle-down position with the muzzle end supported. The cylinder, in its holder, was placed in the weapon chamber and the bolt slowly closed and locked. The trigger was then pulled. After careful removal of the cylinder from its holder, the cylinder was remeasured using a dial-indicating depth micrometer. Total indent depth was determined by subtracting the post-test cylinder length (measured from the bottom of the indent to the opposite end) from the pretest length of the cylinder.

g. Magnetic particle inspection was done on the bolt, bolt carrier, and bolt cam pin. Black light photographs were taken of any observed discontinuities.

h. After completion of the physical examination of the M16A1 and M16A2 Rifles, they were reassembled, lubricated with MIL-L-63460A and test fired 150-rounds each. All firing was from a bench rest. The schedules are shown in Tables 6.2-1 and 6.2-2. The data recorded were velocity, cyclic rate, dispersion and functioning performance (includes ejection patterns for semiautomatic and burst firing).

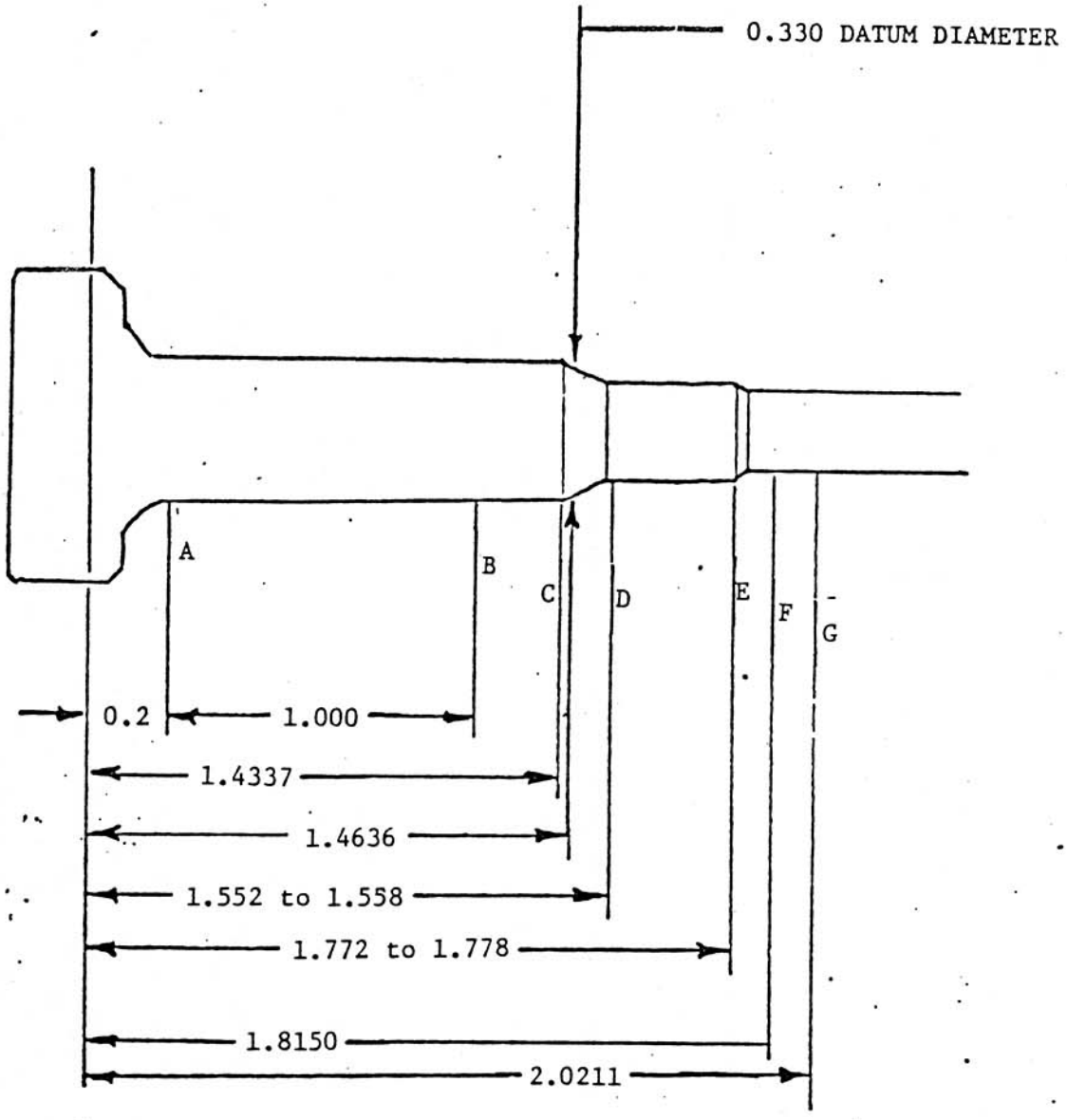


Figure 6.2-1. M16A1 rifle chamber diameter dimension locations; all measurements generated from nominal breech face, located 1.4636 inches from datum diameter reference point.

TABLE 6.2-1. INSPECTION FIRING SCHEDULE FOR M16A2 RIFLES, FIRED WITH CONUS-PRODUCED M855 AMMUNITION[a]

Order of Test	Type Test	Mode of Fire	No. Rd.	Remarks
1	91.4m dispersion and accuracy	SA	30	Sight setting at 200m. Establish initial sight setting in accordance with Paragraph 3.4.6 of MIL-R-63997. Three 10-round targets each. Record velocity at 23.8m.
2A	Function check	CB	30	Ten 3-round bursts.
B		CB	30	Ten 3-round bursts. Record cyclic rate.
C		SA	30	
D		SA	30	Repeat 2C.

[a]Cartridge Lot No. LC84E300S286.
SA = Semi-automatic
CB = Controlled burst

TABLE 6.2-2. INSPECTION FIRING SCHEDULE FOR M16A1 RIFLES, FIRED WITH M193 AMMUNITION[a]

Order of Test	Type Test	Mode of Fire	No. Rd.	Remarks
1	91.4m dispersion and accuracy	SA	30	Combat (short range) sight setting. Three 10-round targets each. Record velocity at 23.8m. Use M193 Ball ammunition with a mean radius dispersion between 1.2 and 1.4 inch at time of acceptance.
2A	Function check	FA	30	5-round bursts.
B		FA	30	Record cyclic rate.
C		SA	30	Fire at a rate of one shot every 3 seconds.
D		SA	30	Fire at a rate of one shot every 3 seconds.

[a]Cartridge Lot No. LC-4-161
SA = Semi-automatic
FA = Full-automatic

6.2.4 Test Findings

Inspection of the rifles listed in Table 6.2-3 was performed in general accordance with the procedures of the test plan. One additional inspection, not in the original plan, was determination of gas leakage between the bolt carrier and carrier key. The method used and results are discussed later in this section of the report.

TABLE 6.2-3 LIST OF RIFLES

Test Agency Assigned No.			
Receiver	Barrel	Rifle SN	Remarks
1A	1A	6001685	
2A	RA2	6001708	
3A	RA3	6001860	
4A	4A	6001870	
5A	5A	6002054	
6A	6A	6002210	Cold, Hot
7A	RA7	6002289	Cold, Hot
8A	8A	6002918	Cold, Hot
9A	9A	6002922	Cold, Hot
10A	RA10	6002927	Cold, Hot
11A	11A	6002933	
12A	RA12	6002947	
13A	13A	6003305	
14A	14A	669428	
15A	15A	1892038	
16A	16A	1903863	

Measurements of headspace, firing pin protrusion and firing pin indent were taken initially and are reported in Table 2.6-4.

TABLE 6.2-4 INITIAL INSPECTION MEASUREMENTS

Weapon ID Test No.		Measurements, in.			
				Firing Pin Indent	
Receiver	Barrel	Headspace	Firing Pin Protrusion	Inertia	Hammer
1A	1A	1.4656	0.033	0.004	0.018
2A	RA2	1.4646	.033	.006	.022
3A	RA3	1.4646	.033	.006	.021
4A	4A	1.4646	.033	.005	.022
5A	5A	1.4666	.033	.005	.021
6A	6A	1.4646	.032	.006	.020
7A	RA7	1.4656	.033	.005	.020
8A	8A	1.4646	.034	.005	.020
9A	9A	1.4666	.034	.005	.020
10A	RA10	1.4646	.034	.005	.022
11A	11A	1.4656	.034	.006	.022

TABLE 6.2-4 (CONTINUED)

Weapon ID Test No.		Measurements, in.			
				Firing Pin Indent	
Receiver	Barrel	Headspace	Firing Pin Protrusion	Inertia	Hammer
12A	RA12	1.4646	0.032	0.005	0.021
13A	13A	1.4666	.034	.005	.022
14A	14A	1.4706	.032	.006	.022
15A	15A	1.4696	.031	.006	.023
16A	16A	1.4676	.034	.005	.022

Magnetic particle inspection of the bolt, bolt carrier and key assembly and bolt cam pin were made prior to firing. All parts were free of cracks. Final inspection measurements are in Table 6.2-5.

TABLE 6.2-5. FINAL INSPECTION MEASUREMENTS

Weapon ID Test No.		Measurements, in.			
				Firing Pin Indent	
Receiver	Barrel	Headspace	Firing Pin Protrusion	Inertia	Hammer
1A	1A	1.4666	0.033	0.005	0.020
2A	RA2	1.4656	.033	.006	.020
3A	RA3	1.4666	.033	.006	.022
4A	4A	1.4666	.034	.006	.021
5A	5A	1.4666	.034	.006	.021
6A	6A				
7A	7A				
8A	8A				
9A	9A				
10A	10A				
11A	11A				
12A	12A				
13A	13A				
14A	14A				
15A	15A				
16A	16A				

NOTE: No final measurements obtained for 6A thru 16A.

Inspection of the buffer assembly of each rifle showed that the spring pin which retains the buffer bumper was improperly installed. The pin opening (side profile) must be facing forward or be within ±90° of that orientation. All pins were found to be facing toward the rear. All buffer assemblies were replaced by the factory prior to startng the test.

Inspection of the barrel bore of the rifles revealed large-scale defective areas (pitting and scaling of the chrome plating and tool marks) in some bores. Table 6.2-6 lists the barrels with and without defects. All defective barrels were replaced by the rifle manufacturer prior to staring the test.

TABLE 6.2-6. BARREL INSPECTION

Rifle	Original Assigned Test No.	Inspection Results Accept	Inspection Results Reject	Replacement Assigned Test No.	Reject Cause Comments
1A	1A	x			
2A	2A		x	RA2	a -
3A	3A		x	RA3	
4A	4A	x			
5A	5A	x			
6A	6A	x			
7A	7A		x	RA7	b -
8A	8A	x			
9A	9A	x			
10A	10A		x	RA10	a -
11A	11A	x			
12A	12A		x	RA12	c -
13A	13A	x			
	S-1		x	RS-1	
	S-2		x	RS-2	
	S-3		x	RS-3	
	S-4		x	RS-4	
	S-5		x	RS-5	

aPitting underneath plating.
bTorn lands.
cScaling of plating.

Measurements of the wear at the breech end of the barrel bore for the M16A2 rifles were taken using wear gauge No. 8448496 (NSN 5220-01-014-8183). Gauge No. 7799792 (FSN 4933-912-3409) was used for M16A1 rifles. The results are displayed in Table 6.2-7.

Airflow measurements through the gas tube of each rifle are reported in Table 6.2-8. A plug was placed in the barrel chamber, while the regulated 5-psi airflow was forced into the barrel and out through the gas tube. The higher the reading, the greater amount of constriction of airflow (a completely closed gas system would produce a 5 psi reading).

The trigger pull of each rifle was measured for both semi-automatic and controlled burst or automatic settings. The average pull for three trials at each setting are shown in Table 6.2-9.

TABLE 6.2-7. BARREL BREECH EROSION MEASURMENTS, MM

Barrel Test No.	Init Insp	After Amb Temp,	After Low Temp,	After Hot Temp,	After Cookoff	During Ambient Temp. Endurance, by No. Rounds Fired								
						2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000
1A	11					10	8	6	4	3	2	0.5	0.0	-1.5
RA2	11					9.5	8	7	6	5	4.5	1.0	0.0	-1.5
RA3	11					10.5	9.5	8.5	7	6.5	6	4.5	3.5	2.5
4A	11					9.5	8.5	7	5	4	3	2.0	0.5	-2.0
5A	11					9.0	7.5	5.5	3.5	2.5	1	0.0	-1.5	-4.0
6A	11		12	11										
RA7	11		11	11										
8A	11		11	10.5										
9A	11		10.5	10.5										
RA10	11		11.5	10.5										
11A	11	10.5	10.0	4.5										
RA12	11	11.0	10.0	-2.0										
13A	11	10.5	9.0	-8.0										
14A	6													
15A	5													
16A	6													
RS-1	11				11.5									
RS-2	11													
RS-3	11													
RS-4	11													
RS-5	11													

Init Insp = Initial Inspection

Amb = Ambient range

TABLE 6.2-8. AIRFLOW MEASURMENTS OF GAS TUBE, PSI

Barrel Test No.	Init Insp	After First Amb. Temp,	After Low Temp,	After Hot Temp,	After Cookoff	After Last amb. Temp,	During Ambient Temp. Endurance, by No. Rounds fired								
							2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000
1A	2.25						1.84	1.88	1.88	1.88	1.81	1.81	1.84	1.81	1.81
RA2	1.69						1.84	1.88	1.84	1.81	1.81	1.81	1.81	1.81	1.81
RA3	1.94						1.88	1.88	1.88	1.88	1.84	1.88	1.88	1.88	1.88
4A	1.81						1.88	1.94	1.88	1.88	1.88	1.88	1.88	1.91	1.88
5A	1.75						1.69	1.75	1.69	1.69	1.69	1.69	1.72	1.69	1.69
6A	1.62			1.75											
RA7	1.88			1.81											
8A	1.62			1.75											
9A	1.56			1.84											
RA10	1.88			1.81											
11A	1.88	1.88	1.84	1.81		1.88									
RA12	1.88	1.81	1.88	1.81		1.88									
13A	1.88	1.84	1.81	3.25		1.81									
14A				1.94											
15A				1.75											
16A				1.94											
RS-1	1.81				1.81										
RS-2															
RS-3															
RS-4															
RS-5															

Init Insp = Initial Inspection

Amb = Ambient range

TABLE 6.2-9. TRIGGER PULL WEIGHT

Weapon ID Receiver Test No.	Pull Weight, lb. by Selector Setting: Semi-automatic Initial	Semi-automatic Final	Burst/ Automatic Initial	Burst/ Automatic Final
1A	11.3	9.5	12.5	11.0
2A	9.8	8.8	11.0	10.7
3A	10.2	10.0	12.5	11.8
4A	10.5	10.7	11.8	12.0
5A	9.2	9.8	11.0	12.2
6A	10.0		11.8	
7A	10.2		12.3	
8A	9.3		11.2	
9A	10.7		11.8	
10A	9.3		11.7	
11A	11.0		12.8	
12A	10.2		11.5	
13A	9.0		11.0	
14A	6.8		7.8	
15A	8.2		9.8	
16A	7.2		9.2	

NOTE: No final measurements obtained for 6A thru 16A.

Initial inspection of the bolt carrier assembly from each rifle was made in order to determine if there was any gas leakage between the carrier key and the body of the carrier. A special plug was fabricated which sealed off the openings in the carrier body. Air was then forced through the carrier key at 25-psi pressure, while the assembly was immersed in water. The relative size and frequency of air bubbles escaping into the water was then recorded. The results are given in Table 6.2-10.

All M16A2 bolt carrier assemblies were produced by Colt. All carrier key screws were retained by double side-staking the head of each screw. The three M16A1 Rifles (Anniston Army Depot rebuild in 1979) used single top staking of each screw head.

After completion of the initial inspection by measuring, gauging and visual inspection, the rifles were fired for dispersion and function check. The functioning performance is presented in Tables 6.2-11 and 6.2-12. Sequential round counts are given in Table 6.2-13. It should be noted that during the machine-rest accuracy test, only one lower receiver assembly was used. All upper receiver and barrel assemblies were fired from this one assembly in order to more closely control the test by reducing the number of variables that could affect machine rest-fired dispersion.

TABLE 6.2-10 AIRFLOW MEASUREMENTS OF BOLT CARRIER ASSEMBLY

Wpn Test No.	Wpn Type	Constant Bubble Stream Large	Constant Bubble Stream Medium	Constant Bubble Stream Small	Min Inter.
1A	M16A2	x			
2A	M16A2	x			
3A	M16A2		x		
4A	M16A2		x		
5A	M16A2		x		
6A	M16A2			x	
7A	M16A2	x			
8A	M16A2		x		
9A	M16A2			x	
10A	M16A2			x	
11A	M16A2		x		
12A	M16A2			x	
13A	M16A2	x			
14A	M16A1				x
15A	M16A1				x
16A	M16A1				x

Min Inter = Minimum size with intermittant emissions.

TABLE 6.2-11 FUNCTIONING PERFORMANCE DATA FOR INITIAL INSPECTION ACCURACY AND DISPERSION TEST

Weapon I.D. Receiver Test No.	Weapon I.D. Barrel Test No.	Malf Quantity By Type/Cause FFD	Malf Quantity By Type/Cause FTC	Remarks
1A	All 13 M16A2			No malfunctions. All rounds fired from one 20-round magazine.

NOTES: Total number rounds = 589.
Total number malfunctions = 0.
Mean rounds between stoppages (MRBS) = NA
Malf. rate/1000 rd. = NA

TABLE 6.2-12 FUNCTIONING PERFORMANCE DATA FOR INITIAL INSPECTION (120 ROUND) FUNCTIONING TEST

Weapon I.D.		Malf Quantity By Type/Cause		
Receiver Test No.	Barrel Test No.	FFD	FTC	Remarks
1A	1A			
2A	RA2			
3A	RA3	1/M		Mag No. 4 (partial strip).
4A	RA4	1/M		Mag No. 4 (bolt override).
5A	5A			
6A	6A			
7A	RA7	3/M		Mag No. 4 (stub), magazine replaced.
8A	8A		1/M	
9A	9A			
10A	RA10			
11A	11A			
12A	RA12			
13A	13A			

NOTES: Total number rounds = 1560.
Total number malfunctions = 6.
MRBS = 260.
Malf rate/1000 rd = 3.85.
Mag = magazine

TABLE 6.2-13. ROUND COUNT TABULATIONS FOR M16A1 AND M16A2 RIFLES

Date Fired		Reciever		Barrel	Reciever			Barrel		
					Subtest		Comulative	Subtest		Comulative
From	To	SN	Test No.	Test No.	Start	End	Total	Start	End	Total
				Initial Accuracy/Dispersion						
12 Jun 84	15 Jun 84		1A	1A	0	36	36	0	36	36
			1A	RA2	36	75	75	0	39	39
			1A	RA3	75	117	117	0	42	42
			1A	RA4	117	179	179	0	62	62
			1A	5A	179	248	248	0	69	69
			1A	6A	248	293	293	0	45	45
			1A	RA7	293	335	335	0	42	42
			1A	8A	335	384	384	0	49	49
			1A	9A	384	423	423	0	39	39
			1A	RA10	423	462	462	0	39	39
			1A	11A	462	511	511	0	49	49
			1A	RA12	511	544	544	0	33	33
			1A	13A	544	589	589	0	45	45
	Ttoal					589	589		589	589
				Initial Inspection-Function Check						
15 Jun 84	18 Jun 84		1A	1A	0	709	709	0	36	156
			2A	RA2	0	120	120	0	39	159
			3A	RA3	0	120	120	0	42	162
			4A	RA4	0	120	120	0	62	182
			5A	5A	0	120	120	0	69	189
			6A	6A	0	120	120	0	45	165
			7A	RA7	0	120	120	0	42	162
			8A	8A	0	120	120	0	49	169
			9A	9A	0	120	120	0	39	159
			10A	RA10	0	120	120	0	39	159
			11A	11A	0	120	120	0	49	169
			12A	RA12	0	120	120	0	33	153
			13A	13A	0	120	120	0	45	165
	Round count total					1560	2149		1560	2149

The cyclic rate of fire was recorded during the functioning check which followed the dispersion firing. Each rifle used its assigned upper receiver and barrel assembly and was fired from bench rest with the rifles being hand-held and shoulder fired. Table 6.2-14 presents these data.

TABLE 6.2-14 CYCLIC RATE DATA FOR INITIAL INSPECTION FUNCTION CHECK

Weapon I.D. Test No.		Cyclic Rate, spm, Rounds 1 to 30				Cyclic Rate, spm, Rounds 31 to 60			
Receiver	Barrel	Avg	Max	Min	Rg	Avg	Max	Min	Rg
1A	1A	773	818	722	96	828	857	800	57
2A	RA2	700	732	662	70	741	791	698	93
3A	RA3	731	771	672	88	768	809	724	85
4A	4A	751	792	703	89	798	834	753	81
5A	5A	781	820	744	76	821	861	776	85
6A	6A	768	818	705	113	804	837	768	69
7A	RA7	725	746	711	35	735	760	720	40
8A	8A	798	815	772	43	824	861	786	75
9A	9A	790	822	739	83	814	857	783	74
10A	RA10	728	768	669	99	765	808	723	85
11A	11A	754	793	720	73	793	841	737	104
12A	RA12	733	775	649	126	771	817	719	98
13A	13A	790	836	732	104	811	850	753	97

Rg=Range

Dispersion and velocity data recorded during the targeting phase of the initial inspection are summarized in Table 6.2-15. All firing was done from the machine rest using one lower receiver with each upper receiver and barrel assembly being installed and fired.

TABLE 6.2-15 SUMMARY OF INITIAL INSPECTION VELOCITY AND DISPERSION DATA

Target No.	Measurement, cm (10 rd. targets) HSD	VSD	ES	MR	Average Velocity[a] fps	No. Rd	Test No. Weapon No	Barrel No.
1	3.1	2.4	9.3	3.4	2983	9	1A	1A
2	1.8	2.3	8.5	2.5	2996	10		
3	2.3	2.2	6.8	3.0	2999	10		
Mean	2.4	2.3	8.2	3.0	2993			
4	1.2	1.3	4.6	1.5	2976	10	2A	RA2
5	1.7	2.1	7.8	2.3	2986	10		
6	3.1	1.9	9.9	3.2	2988	9		
Mean	2.0	1.8	7.4	2.3	2983			
7	3.1	2.4	10.7	3.2	2965	8	3A	RA3
8	3.0	2.2	11.2	2.9	2964	8		
9	3.2	2.0	10.2	3.0	2975	9		
Mean	3.1	2.2	10.7	3.0	2968			
10	2.6	2.6	9.5	3.2	2993	10	4A	4A
11	2.1	2.6	10.6	2.7	2996	9		
12	3.7	2.0	11.2	3.7	2988	6		
Mean	2.8	2.4	10.4	3.2	2992			
13	2.7	1.9	8.1	2.9	2992	8	5A	5A
14	4.6	3.9	17.9	5.1	2980	9		
15	2.8	2.1	8.9	3.2	2978	8		
Mean	3.4	2.6	11.7	3.7	2983			
16	2.0	3.7	12.4	3.6	2977	10	6A	6A
17	2.1	2.4	8.0	2.8	2974	10		
18	2.0	1.5	7.9	1.9	2986	10		
Mean	2.0	2.5	9.4	2.8	2979			
19	1.5	2.7	8.1	2.7	2965	10	7A	RA7
20	1.8	2.9	9.2	2.8	2960	9		
21	1.1	2.3	6.9	2.2	2987	8		
Mean	1.5	2.6	8.1	2.6	2971			
22	2.0	1.2	7.8	1.8	2984	10	8A	8A
23	2.6	3.6	13.6	3.5	2975	10		
24	1.6	2.5	6.7	2.6	2989	10		
Mean	2.1	2.4	9.4	2.6	2983			
25	2.5	2.5	10.3	3.0	2989	10	9A	9A
26	2.2	3.8	11.9	3.9	2990	8		
27	2.9	4.1	12.9	4.5	3000	10		
Mean	2.5	3.5	11.7	3.8	2993			

TABLE 6.2-15 (CONTINUED)

Target No.	Measurement, cm (10 rd. targets) HSD	VSD	ES	MR	Average Velocity[a] fps	No. Rd.	Test No. Weapon No.	Barrel No.
28	2.9	2.7	10.5	3.6	2989	10	10A	RA10
29	2.2	1.9	7.4	2.5	2994	10		
30	2.7	2.5	8.8	3.2	3007	10		
Mean	2.6	2.4	8.9	3.1	2997			
31	2.3	2.0	8.1	2.8	2962	7	11A	11A
32	2.5	2.6	9.8	3.0	2970	2		
33	2.2	2.0	7.6	2.5	2950	8		
Mean	2.3	2.2	8.5	2.8	2961			
34	3.3	2.6	11.5	3.3	2969	10	12A	RA12
35	1.5	1.8	5.9	2.1	2968	10		
36	2.0	2.6	9.1	3.0	2960	10		
Mean	2.3	2.3	8.8	2.8	2966			
37	2.7	3.0	11.2	3.4	2970	10	13A	13A
38	1.9	2.1	7.3	2.4	2946	10		
39	2.5	2.6	10.6	3.0	2963	10		
Mean	2.4	2.6	9.7	2.9	2960			

[a]Problems with instrumentation caused loss of some velocity data.

HSD = Horizontal standard deviation.
VSD = Vertical standard deviation.
ES = Extreme spread.
MR = Mean radius.

NOTES: Range from rifle to target was 91.4-meters.
Distance from rifle to first velocity sensor was 15.81-meters with 15.25-meters between the first and second sensors.

6.2.5 Technical Assessment

a. Initial inspection: cartridge casualties - the criterion 6.2.2a and the casualties found during firing of 2149-rounds of ammunition (no casualties) were compared and found to be within acceptable limits.

b. Criterion 6.2.2b and the weapon gas system fouling was compared and found to be acceptable. Due to the empirical nature of the airflow measurement value, only approximate safe limits can be established. Airflow constriction greater than 3 psi is usually required before "short recoil" feeding stoppages occur. Since there were none of these stoppages and the pressure ranged between 1.56 (low) and 2.25 (high) psi, there was no indication of the presence of gas tube fouling. Disassembly and visual inspection of the gas tubes confirmed this.

c. Criterion 6.2.2c was compared against performance from the metal parts integrity test. The CONUS-produced M855 Ball cartridge produced no failures throughout the complete temperature range of testing (i.e. +68°C, +21°C and -51°C). The CONUS-produced M856 Tracer cartridge expelled tracer closure discs throughout the same temperature range. These small gilding metal foil particles do not pose a threat to health and safety.

d. The M16A1 Rifle was found to be in conformance with its manufacturing drawings and specification as received. The M16A2 Rifles, after replacement of defective barrels, also conformed to their respective drawings and specifications.

e. The test criterion have been met.

6..3 ENDURANCE AND RELIABILITY

6.3.1 Objective and Issues

a. The overall objective was to determine if the observed performance of the test ammunition, when fired in the M16A2 Rifle, demonstrates compatibility with the weapon to the extent that all test criteria are met.

b. Critical issue. Has the CONUS-produced M855 and M856 ammunition met U.S. safety requirements?

c. Critical issue. Is the CONUS-produced M855 and M856 ammunition compatible with the M16A2 Rifle?

d. Critical issue. Does the CONUS-produced M855 and M856 ammunition meet the requirements set forth in the military specification for cartridge, 5.56-mm, Ball M855 and Tracer M856?

e. Other issue. Are all of the test item's RAM requirements met?

6.3.2 Criteria

a. The cartridge shall function without casualty at ambient temperature and under the temperature conditions of 51.5°C and -53.9°C (+125 °F and -65°F) (Para. 3.12 of MIL-C-63989A for cartridge, 5.56-mm, Ball: M855 and Para. 3.12 of MIL-C-63990A for cartridge, Tracer: M856) (Ref. 15 and 19, respectively).

b. The fouling accumulated in the weapon during the firing of the sample cartridge shall not cause failure of the weapon to function (Para 3.13 of MIL-C-63989A for cartridge, 5.56-mm, Ball: M855 and Para. 3.13 of MIL-C-63990A for cartridge, Tracer: M856) (Ref. 15 and 19, respectively).

c. The bullet of the cartridge shall not burst either in its passage through the barrel or in flight; neither shall the jacket of the bullet nor any part thereof strip from the other bullet components when the cartridge is fired (Para 3.14 of MIL-C-63989A for cartridge; 5.56-mm, Ball: M855 and Para. 3.14 of MIL-C-63990A for cartridge; 5.56-mm, Tracer: M856) (Ref. 15 and 19, respectively).

d. As a minimum, the M16A2 Rifle, fired with M855 Ball or M856 Tracer ammunition, should have a component part life at least equal to that of the M16A1E1 Rifle fired with M855 Ball ammunition, based on Table I of MIL-R-63997 (Ref. 27) (Test Agency devised, TECOM approved).

e As a minimum, the M16A2 Rifle, fired with M855 Ball or M856 Tracer ammunition, should have a malfunction rate at least equal to that of the M16AE1 Rifle fired with M855 Ball ammunition, based on Table I of MIL-R-63997 (Ref. 27) (Test Agency devised, TECOM approved).

f. The test ammunition shall be ballistically matched to the weapon sight elevation adjustments, throughout the range of that adjustment (Test Agency devised, TECOM approved).

g. Barrel life of the M16A2 Rifle, when firing either M855 Ball or M856 Tracer ammunition shall be at least 6000-rounds (required) with a desired minimum life of 12,000-rounds. Barrel serviceability is determined as follows (Test Agency devised, TECOM approved).

(1) Projectile yaw is less than 15 degrees for 80% of all rounds fired in a group (measured at 25-meters range).

(2) Projectile velocity from a hot barrel shall remain within 182.8 m/s of initial new hot barrel velocity throughout testing.

(3) Extreme spread of any semiautomatically fired 10 shot group at 91.4-meters range is 17.8 cm or less.

(4) Failure to meet one or more of these serviceability criteria at any given measurement interval during testing constitutes barrel unserviceability.

6.3.3 Test Procedure

a. Basic test procedures are specified in Paragraph 4.3 of TOP 3-2-045 (Ref. 36).

b. The test schedule is shown in Table 6.3-1 and the firing cycle schedule in Table 6.3-2.

c. Five M16A2 Rifles (APG No. 1 through 5) were used. Each weapon was assigned four 30-round magazines which were used until unserviceable They were then replaced with new magazines.

d. The cyclic rate of fire was measured for all bursts (rounds 1 to 60 in each cycle).

e. All accuracy/dispersion firing was done from handheld rifles and fired from a bench rest. Firing was in the semiautomatic mode in groups of 10-rounds. Three targets were fired per rifle (Table 6.3-1). The operator's manual for the M16A2 Rifle (Ref. 38) was used to initially zero the rifles at a 25-meter range for battle sight zero. All 91-meter (100-yd) range firings were done with the short range sight setting. All other ranges coincide with the battle sight setting's marked on the rifle sight (e.g., 600-meter sight setting fired at 600-meter range). The target/aiming point specified in reference 38 was used only for 25-meter firings. Firings at 91.4 meters used the target specified in Figure 1 of MIL-R-63997 for rifle acceptance testing. Most other targets were standard military bull's eyes (A, B or C sizes); "A" targets were used at ranges of 200 through 400-meters, "B" targets from 500 to 700-meters and "C"

targets at 800-meters range. A center hold on all bull's eye targets was used as the aiming point. Wind velocity during all outdoor targeting exercises did not exceed 16 km/hr (10 mph) with a maximum variation of that velocity not exceeding 8 km/hr (5 mph). All firing was done during daylight hours. Day-to-day variations in ambient light levels due to changes in sky condition (i.e., cloudy, bright sunlight, snow, etc.) were noted. The time and temperature at the firing site was recorded for each target fired.

TABLE 6.3-1 TEST SCHEDULE FOR M16A2 RIFLE ENDURANCE AND RELIABILITY USING M855 BALL AMMUNITION

Maintenance Interval	Sequential Rd. No.	Inspection By Type				Accuracy/ Disp. Fired at Range, m		Velocity	
		MPI	BG	CIL	AFM	ALL[a]	91.4[b]	Cold[c]	Hot[d]
0	0	x	x	x	x			x	x
1	1 to 1200		x	x	x	x		x	x
2	1201 to 2400		x	x	x			x	x
3	2401 to 3600		x	x	x			x	x
4	3601 to 4800		x	x	x		x	x	x
5	4801 to 6000	x	x	x	x			x	x
6	6001 to 7200		x	x	x		x	x	x
7	7201 to 8400		x	x	x		x	x	x
8	8401 to 9600		x	x	x		x	x	x
9	9601 to 10800		x	x	x		x	x	x
10	10801 to 12030	x	x	x	x		x	x	x

[a] Zero rifles at 25-meters, then fire at 91.4 through 800-meters range using only graduated sight settings provided on the rifle. This was done at start of test cycle: three 10-round targets at each range. All firings from bench rest in semiautomatic mode.

[b] Three 10-round targets were fired at the beginning of each maintenance cycle with CONUS-produced M855 ammunition. Sights were set on the 200-meter setting.

[c] Instrumental velocity at 23.8-meters (15.24-meter baseline) recorded during the accuracy/dispersion firings (cold barrel) at the start of each cycle.

[d] Instrumental velocity at 23.8-meters (15.24-meter baseline) recorded during firing of the last 30-rounds in each cycle (hot barrel). Projectile yaw was determined on a rolling paper target at 25-meters, concurrent with the hot barrel velocity test.

MPI= Magnetic particle inspection before start of test and after maintenance intervals 5 to 10.

BG = Bore gauge before start of test and at each 1200-round maintenance interval. Includes land and groove diameter measurements and bore erosion gauge measurement.

CIL= Clean, inspect and lubricate with MIL-L-43460A, before test and after each 1200-rounds.

AFM= Airflow measurement through the rifle's gas system, before test and after each cycle (part of CIL procedures).

TABLE 6.3-2. FIRING CYCLE SCHEDULE FOR M16A2 RIFLE ENDURANCE AND RELIABILITY TEST

Rd. No. in Cycle	Mode of Fire
1 to 30	Ten (3-rd. controlled) bursts.
31 to 60	Ten (3-rd. controlled) bursts.
61 to 90	Semiautomatic, 60 to 90 spm.
91 to 120	Semiautomatic, 10 to 30 spm.

f. The ammunition was inspected as it was being loaded into the magazines and again after firing.

g. The functioning performance of the rifles and ammunition was reported throughout the test.

h. Weapon maintenance and inspection were recorded at prescribed (scheduled) intervals and at other times whenever unscheduled actions occurred.

i. All maintenance, safety, health and human factors data collected during this subtest were reported in part II of the final report (i.e., common tests).

j. Bore-erosion measurements were taken after every 1200-rounds fired, using gauge No. 8448496 (NSN 5520-01-014-8183) by measuring the amount of the gauge protrusion from the back of the upper receiver.

TABLE 6.3-3. UNSERVICEABLE PARTS PERMITTED IN 6000 ROUNDS

Unserviceable Part[a]	Min Life Rd[b]	Four Rifles Comb[c]
Ejector spring	3000	2
Extractor spring	2000	2
Other parts[d]	3000	1
Total unserviceable parts, above unserviceable parts comb.		3

a All unserviceable parts occurring during the test were recorded and properly identified regardless of whether they were chargeable to the rifle. Components determined unserviceable after meeting minimum life round requirements may be replaced and not charged against the rifle.

TABLE 6.3-3 (CONTINUED)

b Minimum life rounds were defined as the minimum service life of an individual part, whether it was the original part or a replacement part, expressed in the number of weapon rounds fired with the part assembled in the weapon. For example, an extractor spring which failed prior to firing 2000-rounds on a new rifle, would not meet the minimum life rounds; the failure was recorded and was cause for test failure.

c The allowable number of unserviceable parts shown for four rifles combined applies only to parts failing after the minimum life rounds were fired on the weapon. For example, ejector springs failing at 3500-rounds on one rifle, and at 4100-rounds on a second rifle, would fall within the allowable limits of two unserviceable parts on four rifles combined; however, failure of an ejector spring on a third rifle after firing 3000-rounds (which exceeded the allowance) would be cause for test failure.

d Other parts were limited to trigger spring, disconnect spring, hammer spring, extractor pin, and extractor.

Comb. = Combined.
Min = Minimum.

6.3.4 Test Findings

Five M16A2 Rifles were initially zeroed from a machine rest in preparation for firing at longer ranges. Although dispersion from the mount was satisfactory, the rifles could not be reinstalled in the mount with repeatable accuracy. The zeroing process was repeated with all weapons being handheld and shoulder fired from a bench rest supported position. One shooter was used throughout the test.

Loss of the rear sight indexing set screw from Rifle No. 1A during the 300-meter range firing resulted in the screw from another M16A2 Rifle being installed and the entire test refired. The cause of the loss is discussed in depth in Section I, Paragraph 3.2.4). Table 6.3-4 shows the test schedule. Tables 6.3-5 and 6.3-6 give the results of the all-range accuracy and dispersion firings and the barrel endurance accuracy, respectively.

TABLE 6.3-4. ACCURACY/DISPERSION SCHEDULE

Date 1984	Range m	No. Rd. Fired, by Wpn No. 1A	2A	3A	4A	5A	Total Rd. Fired	Remarks
22 Jun	25	123	0	0	0	123	123	Initial zeroing fired
25 Jun	25	0	36	51	0	87	87	from machine rest
26 Jun	25	0	0	0	75	264	339	Test subsequently refired from bench rest.
27 Jun	25	40	40	4	40	70	230	Fired from bench rest.

TABLE 6.3-4. (CONTINUED)

Date 1984	Range m	No. Rd. Fired, by Wpn No. 1A	2A	3A	4A	5A	Total Rd. Fired	Remarks
27 Jun	91.4	40	40	30	30	30	170	
28 Jun	200	40	30	30	30	30	160	
28 Jun	300	25	0	0	0	0	25	Rear sight failed to maintain elevation; repaired rear sight of No. 1A Rifle.
2 Jul	300	20	30	30	30	30	140	
3 Jul	25	30	0	0	0	0	30	Refired test after repair of rear sight.
	91.4	30	0	0	0	0	30	
	200	30	0	0	0	0	30	
	300	30	0	0	0	0	30	
6 Jul	400	30	30	30	30	30	150	
9 Jul	500	30	30	30	30	30	150	
11 Jul	600	30	30	30	30	0	120	
12 Jul	700	30	30	30	30	30	150	
13 Jul	800	30	30	30	0	0	90	
14 Jul	800	0	0	0	40	30	70	
Total		558	326	331	365	574	2154	

TABLE 6.3-5. TARGET DATA FOR M16A2 RIFLE/CONUS-PRODUCED M855 BALL AMMUNITION COMPATIBILITY

CM= 2 mils	Range m	Measurements, cm[a] HSD	VSD	ES	MR	CI H	CI V	Rear Sight Aperture Size Large	Small
				Rifle Test No. 1A					
5	25	0.9	0.8	3.2	1.0	-0.3	+0.7		x
18	91.4	6.4	6.2	23.5	7.7	-11.2	-2.5	x	
40	200	9.0	10.4	40.9	11.9	-19.3	-21.3	x	
60	300	9.2	8.3	34.8	10.6	-4.3	23.1		x
80	400	14.8	13.8	65.4	17.4	+2.0	+1.5		x
100	500	15.8	26.0	79.8	26.0	-1.3	+14.8		x
120	600	17.3	17.4	69.5	21.4	-0.1	+18.0		x
140	700	18.4	26.9	99.8	26.8	+21.0	-16.7		x
160	800	23.3	43.5	145.0	39.3	-3.3	+29.4		x

TABLE 6.3-5. (CONTINUED)

CM= 2 mils	Range m	Measurements, cm[a] HSD	VSD	ES	MR	CI H	CI V	Rear Sight Aperture Size Large	Small
				Rifle Test No. 2A					
5	25	0.6	0.7	2.4	0.8	-0.4	+0.3		x
18	91.4	4.8	4.4	16.9	5.4	-10.6	-4.9	x	
40	200	11.0	10.4	38.5	13.0	-18.1	-30.4	x	
60	300	8.7	11.3	38.4	12.3	-0.6	3.5		x
80	400	13.5	14.1	54.1	16.8	+1.3	-12.0		x
100	500	13.5	20.0	73.6	19.8	-8.4	-15.7		x
120	600	18.9	18.5	71.5	24.3	+7.5	-9.1		x
140	700	22.5	24.5	82.5	29.4	-12.0	10.0		x
160	800	30.0	32.8	111.7	36.5	+21.0	1.4		x
				Rifle Test No. 3A					
5	25	0.8	0.6	2.6	0.8	-0.5	+4.1		x
18	91.4	4.4	5.3	20.5	6.0	-9.5	+4.1	x	
40	200	10.2	10.7	40.7	13.1	-13.8	-27.2	x	
60	300	8.7	13.2	41.1	13.7	-3.2	+11.4		x
80	400	11.4	11.3	44.1	13.6	-1.8	+4.0		x
100	500	13.2	16.6	53.8	19.2	-11.0	-13.7		x
120	600	13.4	21.1	69.2	21.1	+6.5	+7.3		x
140	700	18.0	25.7	82.0	27.3	-14.5	+25.8		x
160	800	27.6	35.9	128.0	38.3	+26.0	+11.1		x
				Rifle Test No. 4A					
5	25	0.9	0.8	3.4	1.0	+0.1	+0.5		x
18	91.4	6.5	6.1	25.7	7.5	-7.1	+1.4	x	
40	200	12.5	12.7	45.4	15.3	-16.8	-7.6	x	
60	300	8.1	9.5	37.4	10.5	+2.9	+17.5		x
80	400	12.9	13.7	51.6	16.0	+11.3	+12.7		x
100	500	20.1	19.1	[b]84.8	22.8	+10.6	-7.2		x
120	600	16.2	26.4	89.9	26.0	-5.1	-14.0		x
140	700	19.4	25.3	83.4	27.5	+12.4	+30.5		x
160	800	22.8	31.6	113.6	32.0	+39.6	+27.6		x
				Rifle Test No. 5A					
5	25	0.9	0.8	3.9	1.0	+0.1	-0.5		x
18	91.4	6.5	4.8	21.3	6.9	-6.4	-4.9	x	
40	200	11.9	12.9	47.7	15.0	-2.0	-6.5	x	
60	300	11.0	10.0	37.8	13.1	+11.4	+7.0		x
80	400	11.0	15.8	55.3	16.5	+18.7	+7.9		x
100	500	14.5	18.7	61.4	20.4	+21.2	-7.9		x
120	600	18.8	16.9	57.4	22.4	+20.4	-17.9		x
140	700	25.2	20.6	83.3	28.3	+25.8	+10.0		x
160	800	20.4	31.7	114.3	31.6	+49.2	+10.6		x

TABLE 6.3-5 (CONTINUED)

[a]Average of three 10-round targets per range.
[b]One round (Shot No. 3, Target No. 12) out of group. Average ES with this one round removed is 63.8 cm.

CI = Center of impact
ES = Extreme spread
H = Horizontal
HSD = Horizontal standard deviation
MR = Mean radius
V = Vertical
VSD = Vertical standard deviation

After completion of the all-range accuracy and dispersion firings, the five rifles were subjected to a 12,000-round endurance and reliability test, using the CONUS-produced M855 Ball ammunition from lot No. LC84E300S286. Test results are presented in the tables which follow. The 91.4-meter range bench rest accuracy and dispersion data are contained in Table 6.3-6. Both the cold-barrel and hot-barrel velocity information are also given in this table. The breech bore wear measurement results are given in Table 6.2-7.

TABLE 6.3-6. 91.4 METER RANGE BENCH REST FIRED ACCURACY AND DISPERSION DATA FOR CONUS PRODUCED M855 BALL AMMUNITION FIRED FROM M16A2 RIFLE

Target Code	1200 Rd Phase No.	Target Measurements, cm HSD	VSD	ES	MR	CI H	CI V	Cold Barrel Vel fps	Hot Barrel Vel fps
				Rifle Test No. 1A					
-	[a] 0	6.4	6.2	23.5	7.7	-11.2	-2.5	-	-
A	[a] 1	5.8	5.1	24.4	6.5	3.0	-8.1	3017	3024
B	[a] 2	5.0	5.9	22.1	6.6	-1.3	-5.9	3025	3023
C	[a] 3	5.7	7.8	26.8	8.5	-7.6	-9.1	3004	3007
D	[b] 4	3.2	3.9	12.9	4.4	-9.3	-3.8	3019	2990
E	[b] 5	2.7	3.1	11.2	3.7	-9.7	4.1	2993	2984
F	[b] 6	5.0	5.0	21.0	6.2	[c]-17.0	-1.7	3001	2975
G	[b] 7	3.6	3.7	15.5	4.4	[d]-12.2	1.7	2956	2951
H	[a] 8	6.8	6.1	23.3	8.1	-2.3	-16.0	2951	2960
I	[b] 9	6.6	6.1	24.9	7.7	-13.3	0.8	2954	2928
J	[b]10	5.3	6.6	22.1	7.5	-25.4	4.8	2905	2908
K	[b]11	7.7	8.6	33.2	9.5	-24.2	1.6	2950	-
	Avg.	5.3	5.7	21.7	6.7	-10.9	-2.8	2980	2975
	Max.	7.7	8.6	33.2	9.5	-24.3	4.8	3025	3024
	Min.	2.7	3.1	11.2	3.7	3.0	-16.0	2905	2908
	ES	5.0	5.5	22.0	5.8	27.3	20.8	120	116

TABLE 6.3-6 (CONTINUED)

Target Code	1200 Rd Phase No.	Target Measurements, cm HSD	VSD	ES	MR	CI H	CI V	Cold Barrel Vel fps	Hot Barrel Vel fps
				Rifle Test No. 2A					
-	[a] 0	4.8	4.4	16.9	5.4	-10.6	-4.9	-	-
A	[a] 1	6.0	6.5	26.4	7.3	-2.3	-9.4	3003	3016
B	[a] 2	6.2	5.9	21.7	7.6	2.5	-12.3	3000	3020
C	[a] 3	5.7	6.4	22.0	7.7	-2.8	-11.5	2990	2994
D	[b] 4	3.1	4.2	14.9	4.4	-5.8	[c]10.8	3016	3003
E	[b] 5	3.0	3.0	11.4	3.7	-4.0	5.4	2992	2982
F	[b] 6	3.3	3.6	12.9	4.3	-10.8	9.8	2990	2980
G	[b] 7	3.0	3.3	12.6	3.7	-6.4	6.6	2954	2957
H	[a] 8	4.0	6.6	21.8	6.6	0.7	4.3	2948	2968
I	[b] 9	4.2	3.7	16.7	4.6	-4.3	10.4	2967	2943
J	[b]10	4.0	3.8	14.4	4.8	-10.4	14.3	2907	2944
K	[b]11	4.4	4.2	17.8	5.2	-6.4	9.7	2952	-
	Avg.	4.3	4.6	17.5	5.4	-5.1	+2.8	2975	2981
	Max.	6.2	6.6	26.4	7.7	-10.8	+14.3	3003	3020
	Min.	3.0	3.0	11.4	3.7	+2.5	-12.3	2907	2943
	ES	3.2	3.3	15.0	3.0	13.3	[e]2.76	96	77
				Rifle Test No. 3A					
-	[a] 0	4.4	5.3	20.5	6.0	-9.5	4.1	-	-
A	[a] 1	4.6	4.3	16.1	5.6	-4.5	-4.6	2999	2997
B	[a] 2	6.4	5.7	24.6	7.0	-0.8	-1.3	3007	3005
C	[a] 3	4.9	4.3	17.9	5.5	-1.5	-10.9	3000	3008
D	[a] 4	4.7	2.9	15.3	5.0	-5.8	-3.6	2998	3019
E	[b] 5	4.7	4.8	20.4	5.7	-6.7	3.8	2984	2981
F	[b] 6	3.4	2.4	11.4	3.5	-7.7	1.7	2998	2988
G	[b] 7	3.0	2.9	11.4	3.5	-4.0	8.6	2976	2984
H	[a] 8	5.9	6.0	21.3	7.3	-3.8	7.8	2970	2960
I	[b] 9	2.7	4.0	13.6	4.1	-8.3	13.3	2951	2968
J	[b]10	4.1	3.4	15.6	4.5	-9.3	15.4	2923	2969
K	[b]11	3.1	3.7	11.4	4.4	-11.8	8.2	2971	-
	Avg.	4.3	4.1	16.6	5.2	-6.1	3.5	2980	2988
	Max.	6.4	6.0	24.6	7.3	-11.8	15.4	3007	3019
	Min.	2.7	2.4	11.4	3.5	-0.8	-10.9	2923	2960
	ES	3.7	3.6	13.2	3.8	11.0	26.3	84	59

TABLE 6.3-6 (CONTINUED)

Target Code	1200 Rd Phase No.	Target Measurements, cm HSD	VSD	ES	MR	CI H	CI V	Cold Barrel Vel fps	Hot Barrel Vel fps
				Rifle Test No. 4A					
-	[a] 0	6.5	6.1	25.7	7.5	-7.1	1.4	-	-
A	[a] 1	4.3	5.7	18.5	6.3	0.6	-0.7	2994	3000
B	[a] 2	4.7	5.5	20.1	6.3	-2.6	0.1	3014	3005
C	[a] 3	5.8	3.9	18.4	6.0	-4.5	-10.9	3007	2998
D	[b] 4	3.3	3.3	13.4	4.0	-5.5	2.7	2993	3012
E	[b] 5	3.5	3.5	12.7	4.3	-4.3	7.6	2974	2975
F	[b] 6	3.6	3.6	11.7	4.0	-9.5	0.7	2989	2989
G	[b] 7	3.3	3.3	11.8	4.1	-7.1	5.6	2956	2958
H	[b] 8	2.6	3.2	11.4	3.7	-9.9	13.4	2960	2949
I	[b] 9	3.3	3.7	13.0	4.3	-8.5	13.3	2943	2956
J	[b] 10	3.5	3.6	15.1	4.4	-6.0	18.8	2919	2953
K	[b] 11	6.8	5.5	22.8	7.7	-6.5	8.8	2970	-
	Avg.	4.3	4.2	16.2	5.2	-5.9	5.1	2974	2980
	Max.	6.5	6.1	25.7	7.7	-9.9	18.8	3014	3012
	Min.	2.6	3.2	11.4	3.7	+0.6	-10.9	2919	2953
	ES	3.9	2.9	14.3	4.0	10.5	29.7	95	59
				Rifle Test No. 5A					
-	[a] 0	6.5	4.8	21.3	6.9	-6.4	-4.9	-	-
A	[a] 1	4.6	4.0	17.3	5.2	6.5	-5.2	2992	2982
B	[a] 2	3.8	5.4	20.1	5.5	3.2	-4.6	3004	2971
C	[a] 3	5.2	5.1	21.4	6.0	-5.2	-12.1	3000	2979
D	[b] 4	3.9	3.5	14.2	4.5	-5.9	-1.6	2989	3001
E	[b] 5	2.8	3.1	11.3	3.6	-1.0	-3.3	2964	2959
F	[b] 6	2.9	2.9	11.3	3.5	-9.9	0.6	2984	2969
G	[b] 7	3.8	3.6	17.0	4.4	-7.3	-5.0	2969	2941
H	[b] 8	2.8	3.7	11.7	4.1	-9.3	1.9	2953	2940
I	[b] 9	3.2	3.4	12.4	3.9	-11.4	5.9	2929	2941
J	[b] 10	4.3	3.6	15.5	4.8	-7.0	9.9	2908	2937
K	[b] 11	5.0	4.8	19.3	5.9	-7.1	3.1	2958	-
	Avg.	4.1	3.9	16.1	4.9	-5.1	-1.3	2968	2962
	Max.	6.5	5.4	21.4	6.9	-11.4	+9.9	3004	3001
	Min.	2.8	2.9	11.3	3.5	+6.5	-12.1	2908	2937
	ES	3.7	2.5	10.1	3.4	17.9	22.0	96	64

[a]Marksman No. 1.
[b]Marksman No. 2.
[c]Sight inadvertently moved one click left prior to firing.
[d]Move sight one click right, prior to firing.
[e]Front sight ejected from sight base. The part was replaced from Barrel No. RS2 (rain test damaged barrel) prior to firing Phase 4 targets

TABLE 6.3-6 (CONTINUED)

CI = Center of impact.
ES = Extreme spread.
H = Horizontal.
HSD = Horizontal standard deviation.
MR = Mean radius.
V = Vertical
VSD = Vertical standard deviation.

NOTE: Initial 91.4-meter rifle zero data taken from long-range accuracy test.

Weapon functioning performance is tabulated for each of the five rifles in Tables 6.3-7 through 6.3-11.

Weapon cyclic rate of fire data are presented in Tables 6.3-12 through 6.3-16. Pre-firing and fired-case inspection data are contained in Table 6.3-17.