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EFFECT ON THE M16A1 RIFLE OF FIRING .22
CALIBER AMMUNITION

Ronald E. Elbe, et al

Army Armament Command
Rock Island, Illinois

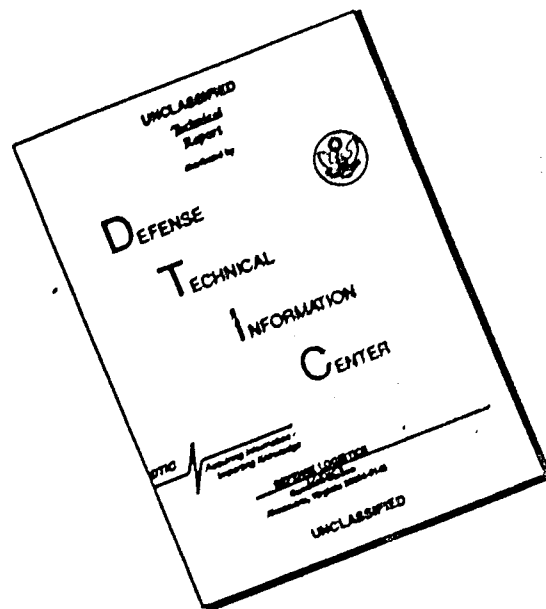
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EFFECT ON THE M16A1 RIFLE
OF FIRING .22 CALIBER RIMFIRE AMMUNITION

NOVEMBER 1973

Ronald E. Elbe

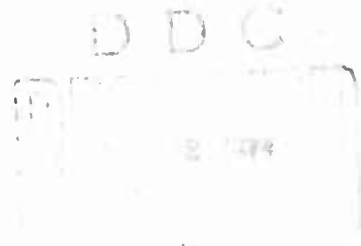
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REPORT NO: R-RE-S-5-85-73

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ABSTRACT

A 25,000 round test program was conducted to determine the effects on the M16A1 Rifle of firing up to 10,000 rounds of .22 caliber rimfire ammunition through it. No significant, permanent degradation of the rifle was found.

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BACKGROUND

Earlier this year a Training Device Requirement for a .22 Caliber Rimfire Adapter for the M16A1 Rifle was approved. In anticipation of the adoption of a rimfire adapter, the M16A1 Rifle Team saw a need to determine the effects on the M16A1 Rifle of firing large quantities of .22 long rifle ammunition. This Technical Report results from the test program conducted to satisfy that need.

PROGRAM OBJECTIVES

The objective of the test program was to determine the effect on the M16A1 Rifle of firing large quantities of .22 long rifle ammunition through it. More specifically, the interior of the upper receivers and barrels were visually observed, flow meter readings were taken, the gas tubes were x-rayed, and accuracy data was taken to determine the extent of lead and fouling build-up.

SCOPE

A total of approximately 25,000 rounds of .22 cal long rifle ammunition were fired through three M16A1 Rifles. Testing was conducted 21 Aug through 24 Sep 73 by the Weapons Test Division, SARRI-LE-T, at Bldg 25, Rock Island Arsenal. The details of the test plan are given in Appendix A. The only major variation from the test plan was that only 5,000 rounds of high velocity ammunition were fired through the second weapon due to an ammunition shortage.

As detailed in the test plan, the three rifles and their test conditions differed in significant ways. Rifle #1 (S/N 4401482) was essentially a new rifle. Five thousand rounds of standard velocity .22 long rifle ammunition from each of two commercial producers were fired through it. Both the rifle and the rimfire adapter were cleaned every 500 rounds. Rifle #1 then represented relatively optimum test conditions; that is, a variety of ammunition (to preclude the possibility of a bad lot) fired in a new weapon with adequate maintenance.

Rifle #2 (S/N 4402653) was a new rifle fired 5,000 rounds of high velocity .22 long rifle ammunition. It, too, was cleaned every 500 rounds.

In contrast, Rifle #3 (S/N 3296250) was a well-used, but still serviceable, rifle typical of what one could expect to find in the field. It was fired 10,000 rounds of standard velocity .22 long rifle ammunition procured through the Army's supply system. At no time during the test was Rifle #3 cleaned. Thus, the test of Rifle #3 represented, to some extent, field conditions.

Thus, among the three rifles, a variety of conditions were tested.

SUMMARY OF RESULTS

I. Accuracy Data

A summary of the accuracy data for the .22 rimfire ammunition is graphically depicted in Figure I. The #193 ball accuracy data is summarized in Table I. Degradation of the bore, if any, should be reflected in a significant increase in extreme spread as shown in Figure I and Table I.

NOTE: More detailed accuracy data may be found in Appendix B.

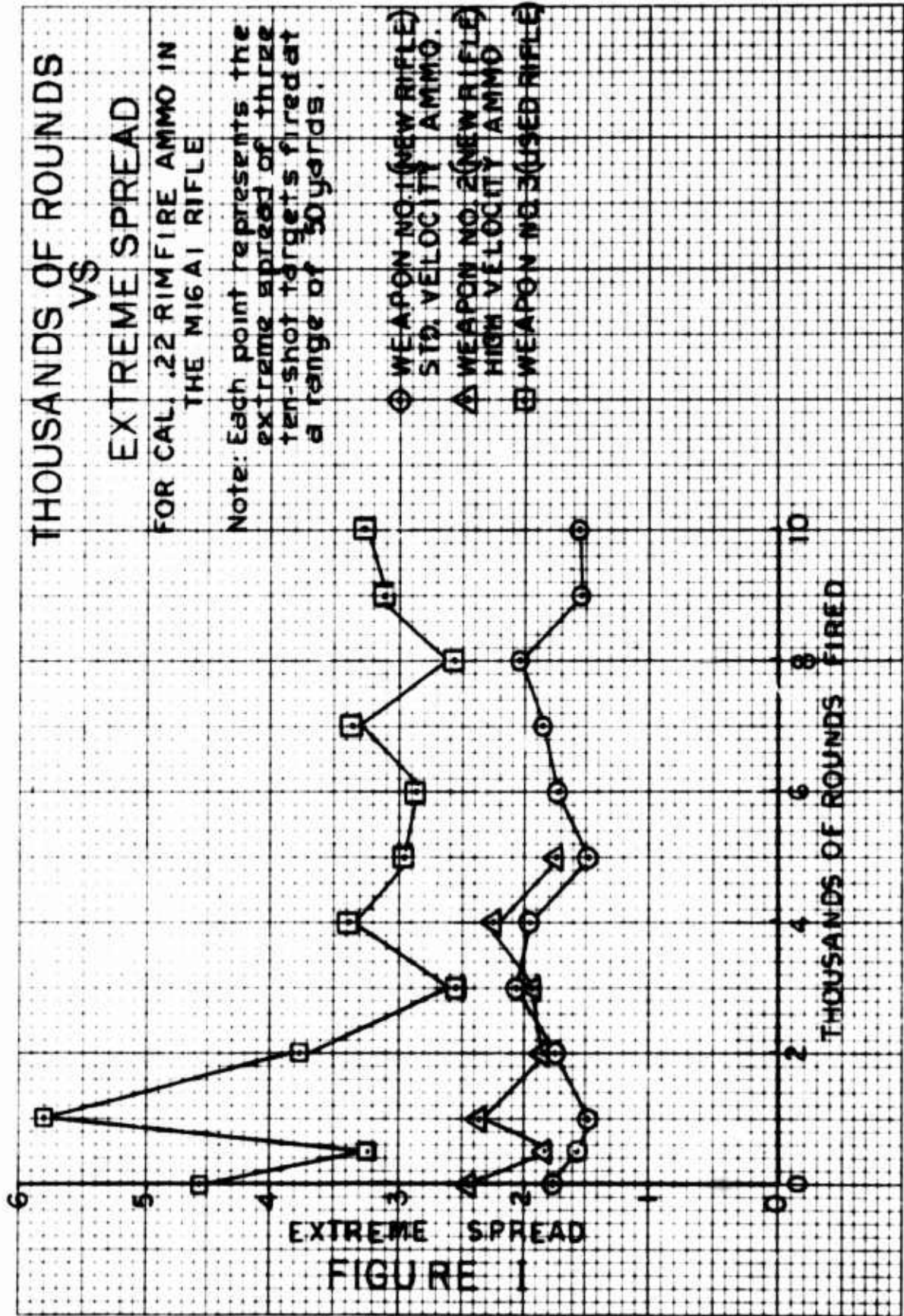


TABLE I
M193 RAIL. ACCURACY DATA

NUMBER OF ROUNDS OF .22 CAL RIMFIRE FIRED	WEAPON NUMBER		
	1	2	3
0	3.5	3.6	4.3
5,000	---	4.1	---
10,000	3.8	---	5.4

NOTE: Each data point represents the average extreme spread in inches of three ten-shot targets fired at a range of 100 yards.

II. Flow Meter Data

The design of the flow meter is such that air, at a constant input pressure flows through the meter, bore, gas port, front sight, and gas tube in series. Restriction of the passage in the gas tube and/or front sight and/or gas port causes an increase in the pressure upstream in the meter.

A graphical presentation of the flow meter readings is presented in Figure II; while, the data is tabulated in Appendix B.

III. Borescope Data

A complete enumeration of the borescope data can be found in Appendix B. However, that data is briefly summarized below:

- Rifle #1 - initially smooth, clean, uniform bore;
- by 4,000 rounds, slight lead build-up in gas port;
 - by 7,000 rounds, intermittent areas of heavy lead build-up in bore; gas port 90% covered with lead;
 - by 10,000 rounds, areas of heavy lead build-up in bore, gas port 95% covered;
 - after 10,000 rounds + 75 rounds of 5.56mm ball, black surface deposits in bore, gas port clear.
- Rifle #2 - initially smooth, clean, uniform bore;
- after 5,000 rounds, bore condition good, gas port 30% covered with lead;
 - after 5,000 rounds + 75 rounds of 5.56mm ball, dark surface deposits in bore, gas port clear.
- Rifle #3 - initially typical of used weapon, pitting, heat checking, and surface cracks in bore;
- after 1,000 rounds, gas port 30% covered;
 - after 2,000 rounds, gas port 100% covered;
 - after 10,000 rounds, considerable lead in bore, gas port 100% covered;
 - after 10,000 rounds + 75 rounds of 5.56mm ball, considerable lead in bore, gas port clear.

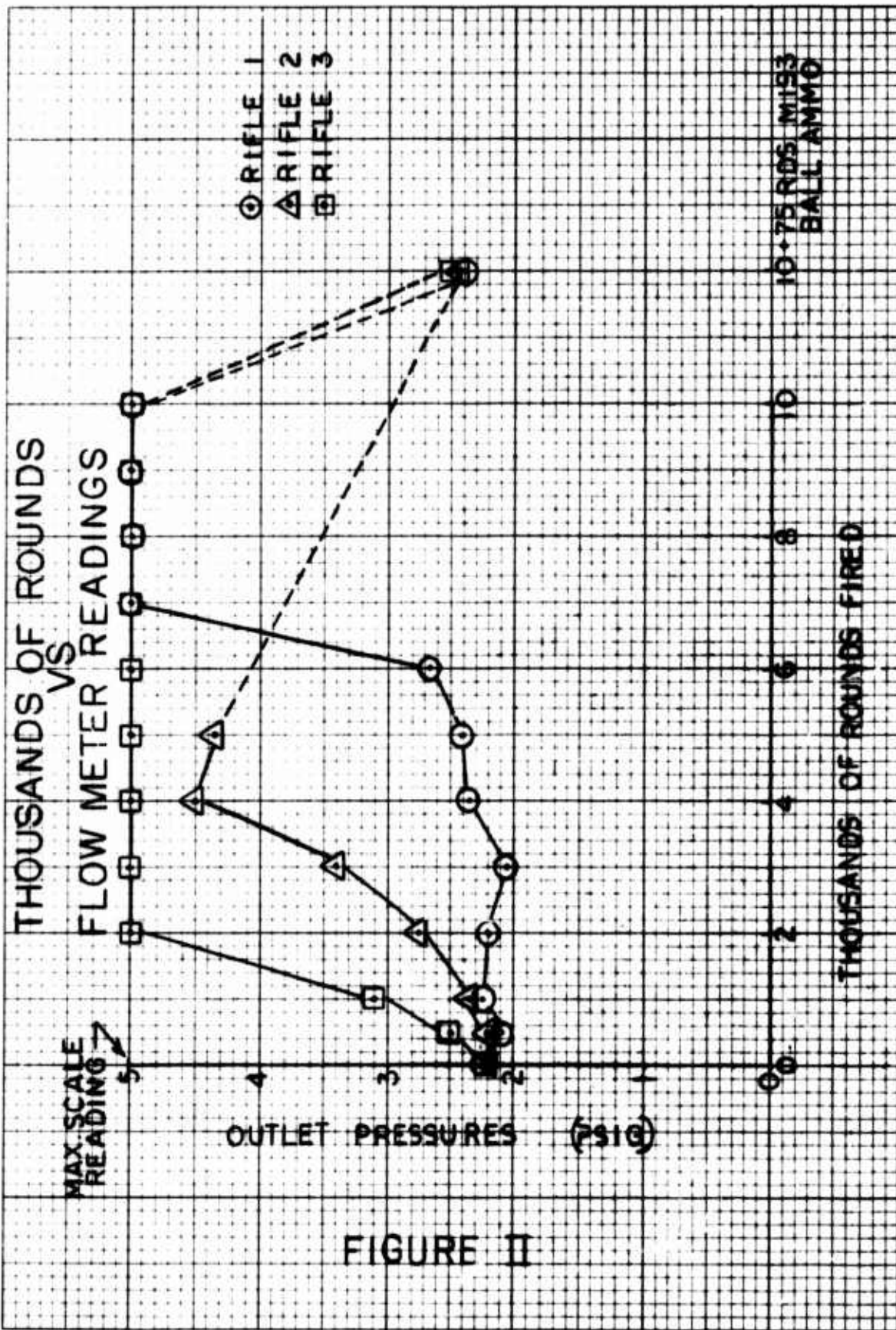


FIGURE II

IV. Gas Tube X-Rays

X-rays of the gas tubes at the test's conclusion (after firing the 5.56mm rounds) revealed no significant lead or fouling build-up in the portions of the tubes that carry the gas flow. However, the "dead space" forward of the gas port in the gas tube from Rifle #3 was full of lead and/or fouling at the test's conclusion.

V. Miscellaneous Results

A. No evidence of lead or fouling was found in the upper receivers, bolts, or bolt carriers of any of the weapons after firing the M193 ball rounds at the test's conclusion.

B. All weapons functioned normally when fired with M193 ball at the test's conclusion.

CONCLUSIONS

I. Accuracy of .22 caliber rimfire or M193 ball ammunition is not significantly degraded by the firing of 10,000 rounds of .22 caliber long rifle ammunition.

II. Although leading of the bore may occur, little, if any, degradation of the bore surface accompanies the firing of up to 10,000 rounds of .22 long rifle ammunition.

III. Significant, even complete closure of the gas port due to leading can be expected in as little as 2,000 rounds of .22 long rifle firing.

IV. Firing one M193 ball round clears the leading from the gas port and functions the weapon with no adverse affects.

APPENDIX A

TEST OF SYSTEM EFFECTS OF FIRING .22 LONG RIFLE CARTRIDGES THROUGH A RIMFIRE ADAPTER IN THE M16A1 RIFLE**1. Material For Test:**

1.1 Two M16A1 Rifles with new Replacement-Barrel-and-Front-Sight Assemblies and Gas Tube installed.

1.2 One M16A1 Rifle from a 6,000 round contractor endurance test with a new gas tube installed.

1.3 10,000 rounds of standard velocity .22 long rifle ammunition (5,000 rounds from each of two producers).

1.4 10,000 rounds of high velocity .22 long rifle ammunition (5,000 rounds from each of two producers).

1.5 10,000 rounds of A086 .22 long rifle ball ammunition procured through the supply system.

1.6 1,000 rounds of M193 ball.

1.7 Miscellaneous test fixtures and inspection equipment as required.

1.8 Three rimfire adapters and 12 .22 rimfire magazines.

2. Test Program Request Number: TPR-SAL-73-P-021**3. Test Installation: SARRI-LE-T**

4. Purpose: The purpose of this test plan is to determine the effect on the M16A1 Rifle of firing .22 caliber rimfire ammunition through it. In particular, the chamber, throat, origin of rifling, rifling, gas port, gas tube, and upper receiver will be observed to determine the extent of lead and fouling build-up.

5. Test Program:**5.1 Test Preparation & Maintenance:**

5.1.1 All weapons shall be cleaned and lubricated per SAPD-253F and the rimfire adapters' operation and maintenance manual before the initiation of the test and at all other points indicated in the test plan.

5.1.2 Necessary maintenance shall be performed by the testing agency in accordance with applicable TM's and instructions stated herein.

5.1.3 The testing agency is authorized to use standard instrumentation or other suitable means to define test conditions and results, analyze shortcomings, deficiencies, breakages, malfunctions, and other unusual conditions.

5.1.4 All hardware, including that which is damaged, broken, or rendered unserviceable during testing shall be returned to this group at the conclusion of testing.

5.1.5 The use of photography by the testing agency is encouraged to define test conditions and results, breakages, malfunctions, and other unusual occurrences.

5.1.6 All test equipment shall be initially inspected by the testing agency to determine its completeness and suitability for the test.

5.2 Data To Be Recorded:

5.2.1 Time (date and hour).

5.2.2 Test title.

5.2.3 Identification of weapons and number of rounds on each.

5.2.4 Identification of gunner(s) and all other participants.

5.2.5 All stoppages, malfunctions, or other irregularities in the test schedule regardless of their causes.

5.2.6 Cause of each stoppage, malfunction, or other irregularity.

5.2.7 Accuracy data to be recorded are: extreme spread, extreme vertical spread, extreme horizontal spread, mean radius, and center of impact (horizontal and vertical distance from point of aim to center of impact).

5.2.8 All other data as required in the test schedule (borescope, flow meter, x-ray, etc.).

5.2.9 The data listed above shall be included in the testing agency's final report, but shall not in any way exclude items and data normally provided in the report.

5.3 Miscellaneous Requirements:

5.3.1 All accuracy firing shall be conducted at a range of 50 yards except as noted in the test schedule.

5.3.2 No deviation from this test plan is authorized without the approval of SARRI-LS-P.

5.3.3 Forced air cooling may be applied to the weapons as needed.

5.3.4 When firing in the semi-automatic mode, rate of fire shall not exceed 20 rounds per minute.

5.3.5 Remington ammunition shall be used for the first 5,000 rounds and Winchester-Western for the next 5,000 rounds of the 10,000 rounds on the first weapon.

5.3.6 The same brand of ammunition shall be used for the accuracy firing that has just previously been used for function firing.

5.4 Test Schedule:

5.4.1 One M16A1 Rifle with a new barrel and front sight assembly and gas tube shall be tested as follows:

5.4.1.1 Three sighting rounds shall be followed by three ten-shot targets of M193 ball fired for accuracy at a range of 100 yards. Velocity of the rounds shall also be recorded at this time.

5.4.1.2 Two twenty-round bursts of M193 ball shall be fired and the rates of fire recorded.

5.4.1.3 The weapon and its associated rimfire adapter shall be cleaned and lubricated normally after which the adapter shall be installed in the rifle.

5.4.1.4 A flow meter reading of the gas tube shall be taken.

5.4.1.5 The chamber throat, origin of rifling, rifling, and gas port shall be borescoped.

5.4.1.6 Three ten-shot targets shall be fired at a range of 50 yards using .22 rimfire ammunition as specified in 5.3.5 and 5.3.6.

5.4.1.7 500 rounds of standard velocity ammunition shall be fired.

5.4.1.8 Sections 5.4.1.3, 5.4.1.4, 5.4.1.5, and 5.4.1.6 shall be repeated.

5.4.1.9 500 rounds of standard velocity ammunition shall be fired.

5.4.1.10 Sections 5.4.1.3, 5.4.1.4, 5.4.1.5, and 5.4.1.6 shall be repeated.

5.4.1.11 Section 5.4.1.3 shall be repeated at 500 round intervals throughout the duration of the test.

5.4.1.12 Sections 5.4.1.4, 5.4.1.5, and 5.4.1.6 shall be repeated at 1,000 round intervals throughout the duration of the test.

5.4.1.13 After the 10,000 rounds have been fired and Sections 5.4.1.3, 5.4.1.4, 5.4.1.5, and 5.4.1.6 accomplished, Section 5.4.1.1 and 5.4.1.2 shall be repeated.

5.4.1.14 The gas tube shall be removed and x-rayed to determine the presence of lead or fouling build-up.

5.4.2 The test scheduled for the second new rifle shall be the same as that outlined in 5.4.1 except that high velocity .22 long rifle ammunition shall be used throughout.

5.4.3 The test schedule for the endurance rifle shall be the same as that outlined in 5.4.1 except that the bore and chamber of the weapon shall not be cleaned throughout the test's duration and that only .22 long rifle ammunition procured through the Army's supply system and designated as A086 in SC 1305/30-II shall be used.

APPENDIX B

TABLE I
ACCURACY DATA
(Inches)

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tst. No.	Extreme Dispersion		Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.		X	Y	
*** 5.56 mm Accuracy 100 Yards ***									
1	TW 18396	0	1	3.65	2.22	1.15	0.14	3.63	3185
			2	2.51	1.96	0.90	0.26	3.76	3177
			3	2.99	1.70	0.95	0.39	2.62	3220
			AVG.	3.05	1.96	1.00	0.27	3.34	3194
*** .22 Cal. IR Accuracy 50 Yards ***									
1	Rem Std Vel	0	4	2.03	0.61	0.43	0.86	-1.32	
			7	1.20	0.93	0.42	0.90	-1.20	
			8	0.91	1.92	0.43	0.93	-0.74	
			AVG.	1.36	1.12	0.43	0.92	-1.22	
		100	7	1.22	2.14	0.69	0.69	-1.71	
			8	0.59	0.95	0.34	-0.27	-0.98	
			9	1.51	0.87	0.42	-0.02	-1.06	
			AVG.	1.10	1.32	0.46	0.13	-1.25	
		100	10	1.02	1.21	0.52	0.91	-1.71	
			11	1.27	1.15	0.41	0.05	-1.76	
			12	1.46	1.07	0.51	0.35	-1.02	
			AVG.	1.25	1.14	0.46	0.44	-1.50	

Wpn. No.	Ammunition	•22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion		Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.		Spread	X	
1	Rem Std Vel	2000	13	2.33	1.56	2.37	0.72	1.19	-1.14
			14	1.00	0.97	1.26	0.38	-0.52	-0.64
			15	1.07	1.24	1.59	0.45	-0.56	-0.08
			Avs.	1.46	1.25	1.74	0.52	0.04	-0.62
10	3000	3000	16	1.09	2.03	2.52	0.77	0.44	-2.57
			17	1.35	1.13	1.40	0.40	0.34	-1.54
			18	1.90	1.85	2.29	0.66	0.27	-0.97
			Avs.	1.72	1.67	2.07	0.64	0.35	-1.69
19	4000	4000	19	1.15	1.81	2.03	0.54	1.72	-2.59
			20	1.73	1.17	1.74	0.59	0.61	-1.67
			21	1.20	1.0	2.11	0.37	-1.10	-0.97
			Avs.	1.36	1.59	1.96	0.50	0.30	-1.74
22	5000	5000	22	1.96	1.83	2.20	0.60	1.79	-1.54
			23	1.25	0.76	1.27	0.36	-0.36	-0.68
			24	0.84	0.67	0.92	0.34	0.22	-1.27
			Avs.	1.3	1.15	1.49	0.45	0.54	-1.16
1	Western Std Vel	6000	25	1.53	2.75	2.52	0.54	-1.37	-1.10
			26	0.70	1.07	1.00	0.37	1.04	-0.96
			27	1.00	1.13	1.22	0.51	0.59	-0.22
			Avs.	1.11	1.65	1.71	0.57	0.09	-0.78

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion			Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.	Spread		X	Y	
1	Wes Std Vel	7000	28	1.97	1.28	2.27	0.63	1.83	-0.28	
			29	1.20	1.58	1.58	0.49	0.75	-0.12	
			30	1.33	1.49	1.75	0.55	-0.61	0.64	
			Avs.	1.50	1.45	1.67	0.56	0.65	0.06	
		7000	31	1.56	3.17	3.26	0.98	0.59	-1.36	
			32	1.37	1.41	1.73	0.57	1.13	-1.14	
			33	0.57	1.06	1.09	0.30	1.32	-1.15	
			Avs.	1.18	1.86	2.03	0.62	1.01	-1.22	
		7000	34	1.42	1.26	2.32	0.55	-0.40	-0.27	
			35	0.85	0.92	1.03	0.38	-0.91	0.26	
			36	1.13	1.17	1.27	0.40	-0.29	0.05	
			Avs.	1.13	1.35	1.54	0.44	-0.53	0.01	
		10000	37	1.60	1.92	1.93	0.71	0.45	-3.16	
			38	1.12	1.00	1.12	0.36	1.05	-1.64	
			39	1.16	1.26	1.64	0.46	0.35	-1.16	
			Avs.	1.36	1.40	1.56	0.51	0.62	-1.99	
			***	5.56 mm Accuracy 100 Yards			***			
1	TW 18396	10000	40	3.49	1.81	3.52	1.09	-0.13	0.39	3168
			41	3.99	1.60	4.12	1.07	0.92	1.07	3181
			42	3.54	3.43	3.75	1.66	0.25	0.78	3197
			Avs.	3.67	2.28	3.80	1.27	0.35	0.75	3162

TABLE II
ACCURACY DATA
(Inches)

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion			Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.	Spread		X	Y	
			***	5.56 mm Accuracy 100 Yards ***						
2	TW 1830f	0	1	3.13	3.37	3.61	1.48	-0.93	4.12	315f
			2	3.66	1.97	3.77	1.06	-1.55	4.00	3187
			3	3.27	1.55	3.27	0.91	-1.10	4.25	3185
			Avg.	3.35	2.30	3.62	1.16	-1.19	4.13	3178
			***	.22 Cal. LR Accuracy 50 Yards ***						
2	Rem Hi Vel	0	4	2.85	2.20	2.86	0.94	0.03	0.16	
			5	2.54	0.77	2.55	0.53	0.05	0.50	
			6	1.94	0.92	1.94	0.63	-0.95	0.63	
			Avg.	2.44	1.30	2.46	0.70	-0.29	0.44	
		500	7	1.12	1.03	1.25	0.46	-1.56	0.01	
			8	2.71	0.96	2.77	0.74	-1.27	-0.39	
			9	1.35	0.99	1.40	0.41	-1.64	0.26	
			Avg.	1.73	0.99	1.81	0.54	-1.49	-0.04	
		1000	10	1.34	2.37	2.42	0.65	-0.05	-0.67	
			11	1.99	1.06	2.16	0.66	0.29	-0.05	
			12	2.23	1.39	2.52	0.63	-0.20	-0.19	
			Avg.	1.85	1.61	2.38	0.64	0.01	-0.30	

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion			Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.	Spread		X	Y	
2	Rem Hi Vel	2000	13	1.76	1.30	2.03	0.64	0.16	-0.78	
			14	1.57	1.06	1.58	0.56	-0.05	-0.56	
			15	1.91	1.36	1.92	0.56	-1.70	-0.36	
			AVG.	1.75	1.24	1.84	0.58	-0.53	-0.57	
		3000	16	1.49	1.39	2.04	0.53	0.02	0.19	
			17	1.54	1.83	1.83	0.54	-0.67	-0.69	
			18	1.72	1.23	1.92	0.57	-0.47	-0.38	
			AVG.	1.58	1.48	1.93	0.55	-0.37	-0.29	
		4000	19	2.48	1.96	3.02	0.80	0.62	-1.14	
			20	2.08	0.80	2.16	0.54	0.06	-0.82	
			21	1.55	0.75	1.56	0.51	0.32	-1.15	
			AVG.	2.04	1.17	2.25	0.62	0.33	-1.04	
		5000	22	1.61	2.43	2.68	0.85	-0.55	-0.37	
			23	1.00	1.13	1.29	0.40	0.62	-0.09	
			24	0.74	1.06	1.19	0.37	-1.25	-0.45	
			AVG.	1.12	1.54	1.72	0.54	-0.39	-0.30	
*** 5.56 mm Accuracy 100 Yards ***										
2	TW 18396	5000	25	3.43	0.97	3.48	1.03	-1.20	6.69	
			26	2.56	3.41	3.65	1.41	-1.33	7.20	
			27	4.87	3.16	5.28	1.53	-0.61	4.93	
			AVG.	3.62	2.51	4.14	1.32	-1.05	6.27	
*** 3161 3175 3221 3186										

TABLE III
ACCURACY DATA
(Inches)

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	5.56 mm Accuracy 100 Yards			Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Extrem. Dispersion Horiz.	Spread		X	Y	
3	TW 18396	0	***	***			***			
			1	3.44	2.61	3.60	1.28	0.06	2.09	3154
			2	3.86	3.46	4.10	1.41	1.00	0.71	3208
			3	5.11	3.43	5.12	1.78	1.33	2.14	3198
			AVG.	4.14	3.17	4.27	1.49	0.80	1.65	3187
3	MCC-6485	0	***	.22 Cal LR Accuracy 50 Yards			***			
			4	3.49	7.50	7.52	1.04	2.26	-1.31	
			5	2.23	2.78	2.79	0.98	1.36	-1.21	
			6	3.39	1.75	3.40	1.09	1.29	-0.65	
			AVG.	3.04	4.01	4.57	1.24	1.63	-1.06	
		500	7	3.87	3.10	4.47	1.33	2.17	0.33	
			8	1.61	2.87	2.94	0.64	2.74	-0.31	
			9	1.56	2.11	2.25	0.69	2.72	0.24	
			AVG.	2.35	2.69	3.22	0.88	2.54	0.09	
		1000	10	9.57	9.07	10.83	2.55	2.94	-0.61	
			11	4.14	2.31	4.61	1.03	1.93	1.43	
			12	1.94	1.42	1.96	0.72	1.89	0.97	
			AVG.	5.22	4.27	5.80	1.44	2.26	0.60	

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion			Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft./Sec)
				Vert.	Horiz.	Spread		X	Y	
3	WCC-6485	2000	13	6.96	4.94	7.07	2.23	2.97	0.25	
			14	2.11	1.70	2.43	0.75	3.59	1.61	
			15	1.72	1.08	1.76	0.54	1.46	0.69	
			Avg.	3.59	2.57	3.76	1.17	2.67	0.85	
		3000	16	3.17	3.62	4.37	1.24	-0.41	0.53	
			17	1.10	1.61	1.62	0.60	2.56	1.21	
			18	1.65	0.92	1.60	0.54	0.85	0.31	
			Avg.	1.97	2.05	2.56	0.79	1.00	0.78	
		4000	19	4.03	4.06	4.95	1.67	3.70	-1.11	
			20	2.44	1.25	2.47	0.66	2.05	0.76	
			21	2.33	1.48	2.76	0.95	1.87	-0.38	
			Avg.	2.93	2.26	3.39	1.10	2.54	-0.24	
		5000	22	2.68	4.09	4.09	1.24	2.58	0.31	
			23	1.47	2.47	2.75	0.57	3.00	-0.00	
			24	1.94	0.99	2.05	0.65	2.80	0.04	
			Avg.	2.03	2.51	2.96	0.82	2.79	0.11	
		6000	25	3.44	2.66	3.91	1.01	2.07	-0.13	
			26	1.50	1.52	1.68	0.64	3.06	0.33	
			27	2.56	1.78	2.97	0.85	1.00	-0.51	
			Avg.	2.50	1.99	2.85	0.83	2.05	-0.10	

Wpn. No.	Ammunition	.22 Cal. Rds. Fired	Tgt. No.	Extreme Dispersion		Mean Radius	Center of Impact Relative to POA		Velocity @15' (Ft/Sec)
				Vert.	Horiz.		Spread	X	
3	WCC-6485	7000	26	3.92	3.13	5.02	2.07	-0.83	
			29	0.91	1.70	1.87	2.07	-0.39	
			30	3.14	1.27	3.17	-0.19	-0.17	
			Avg.	2.66	2.03	3.35	1.32	-0.46	
		8000	31	2.67	1.22	2.77	2.55	2.22	
			32	2.69	1.87	2.99	-0.70	-0.59	
			33	1.62	1.48	1.97	-0.30	-0.06	
			Avg.	2.32	1.52	2.58	0.51	0.52	
		9000	34	4.90	3.02	5.70	-0.35	0.47	
			35	2.26	1.74	2.39	-1.10	-0.18	
			36	1.23	1.06	1.23	-0.48	-0.52	
			Avg.	2.80	1.97	3.11	-0.64	-0.08	
		10000	37	4.75	3.27	5.01	1.49	-0.01	
			38	1.88	1.48	2.39	1.06	0.62	
			39	2.06	1.57	2.44	0.60	0.14	
			Avg.	2.90	2.10	3.28	1.05	0.25	
				*** 5.56 mm Accuracy 100 Yards ***					
3	TW 18396	10000	40	2.78	5.41	5.47	-0.59	2.34	3157
			41	3.17	5.67	5.93	-1.35	3.29	3171
			42	3.34	3.61	4.92	-0.51	2.76	3176
			Avg.	3.10	4.90	5.44	-0.82	2.79	3168

.22 CAL. RFA/M16A1 RIFLE

FLOW METER READINGS

(INLET PRESSURE 4 PSIG)

.22 CAL. ROUNDS FIRED	WEAPON AND (AMMO) IDENTIFICATION		
	S/N 4401482 #1 (STD VEL)	S/N 4402653 #2 (HI VEL)	S/N 3296250 #3 (GOVT ISSUE)
0	2.25	2.15	2.20
500	2.10	2.20	2.50
1000	2.25	2.35	3.10
2000	2.20	2.75	OS
3000	2.05	3.40	OS
4000	2.35	4.50	OS
5000	2.40	4.35	OS
6000	2.65		OS
7000	OS		OS
8000	OS		OS
9000	OS		OS
10000	OS		OS
*	2.40	2.45	2.50

* Final reading taken after firing approximately 75 5.56mm rounds at conclusion of test.

OS = Off Scale (Over 5.0)

.22 CAL. RFA/M16A1 RIFLE

BORESCOPE DATA *

Weapon #1 (S/N 4.01482) - STD VEI AMMO *

0 Rounds *

1. Chamber Throat *
 - a. Light scratch marks throughout.
 - b. Rings (tool marks) in chamber area.
 - c. Several circumferential scrapes at end of throat approx 1/8" in.
2. Origin of Rifling
 - a. Smooth and uniform.
3. Rifling
 - a. Light carbon deposits on surface, mainly in grooves.
 - b. Lands and grooves smooth and well defined.
4. Gas Port
 - a. Sharp corner all around except for very light erosion, muzzle edge.

500 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling
 - a. Becoming shiny.
3. Rifling
 - a. Very slight traces of lead or carbon (black).
 - b. Surfaces becoming shiny, very light gold in color.
4. Gas Port - N/C

* See notes, last page.

1000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling
 - a. Black deposits gone.
 - b. Surfaces shinier.
4. Gas Port - N/C

2000 Rounds

1. Chamber Throat
 - a. Black deposits building up in scrape marks, approx first 1/2" of chamber.
2. Origin of Rifling
 - a. Very slight wear.
3. Rifling - N/C
4. Gas Port - N/C

3000 Rounds

1. Chamber Throat
 - a. Black deposits forming at M16/RFA chamber interface.
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

4000 Rounds

1. Chamber Throat
 - a. Increased black deposits in scratches, scrapes and tool marks. Surface dark, dull.
 - b. Slight increase in deposits in chamber interface.

2. Origin of Rifling - N/C

3. Rifling - N/C

4. Gas Port

a. Slight lead build up (dark grey in color) at muzzle end of port, below bore surface.

5000 Rounds

1. Chamber Throat

a. Increased build up (black).

2. Origin of Rifling - N/C

3. Rifling

a. Slight leading and wear in corners of lands and grooves.

b. Some lead deposits in grooves.

c. Deposits are light gold, shiny.

4. Gas Port - N/C

6000 Rounds

1. Chamber Throat - N/C

2. Origin of Rifling - N/C

3. Rifling - N/C

4. Gas Port - N/C

7000 Rounds

1. Chamber Throat

a. Several smooth and shiny areas throughout.

2. Origin of Rifling - N/C

3. Rifling

a. Increased lead build up in lands, grooves and corners.

b. Several areas of heavy build up mainly in grooves and corners, approx 1/3 of the way down from breech end.

4. Gas Port

a. Approx 90% filled up with deposits.

8000 Rounds

1. Chamber Throat
 - a. Increased numbers of shiny areas.
2. Origin of Rifling
 - a. Slight build up in corners at origin of lands.
3. Rifling
 - a. Increased build up on lands.
4. Gas Port
 - a. Approx 95% filled up (role at rear edge).

9000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

10,000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling
 - a. Increase in lead deposits, lands and grooves.
 - b. Deposits appear almost as areas of plating.
4. Gas Port - N/C

After Firing 5.56mm Ball Rounds

1. M16 Chamber
 - a. Smooth and shiny
2. Rifling
 - a. Black surface deposits throughout.
 - b. Light gold color shininess diminished.
3. Gas Port - Clear

Weapon #2 (S/N 4402653) - High Velocity Ammo

0 Rounds

1. Chamber Throat
 - a. Light scratch marks throughout.
 - b. Several circumferential scrapes (tool marks).
2. Origin of Rifling
 - a. Smooth and uniform.
 - b. Several circumferential scrapes (tool marks).
3. Rifling
 - a. Fairly smooth and uniform.
 - b. Light carbon deposits, mainly in grooves.
 - c. Slight coppering just forward of gas port.
4. Gas Port
 - a. Sharp, well defined corner.
 - b. Very slight erosion, muzzle edge.

500 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling
 - a. Surfaces appear shiny.
4. Gas Port - N/C

1000 Rounds

1. Chamber Throat
 - a. Traces of black deposits in scratches and scrapes.
2. Origin of Rifling - N/C
3. Rifling
 - a. Traces of black deposits, mainly in muzzle half of bore at corners of lands and grooves.
 - b. Remainder shiny, light gold in color.
4. Gas Port - N/C

2000 Rounds

1. Chamber Throat
 - a. Increase black deposits in scratch and scrape marks.
 - b. Surface appears dull, grey.
2. Origin of Rifling - N/C
3. Rifling
 - a. Ver, slight wear on corners of some lands.
4. Gas Port - N/C

3000 Rounds

1. Chamber Throat
 - a. Black deposits (lead ?) building up at RFA/M16 chamber interface.
 - b. Front end of RFA chamber shows wear.
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port
 - a. Slight wear developing at corner, breech end.

4000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling
 - a. Shiny deposits building up at corners of lands and grooves.
 - b. Slight wear marks at corners.
4. Gas Port
 - a. Deposits cover approx 30% of gas port area.
 - b. Build up is from muzzle edge rearward.

5000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

After Firing 5.56mm Ball Rounds

1. M16 Chamber
 - a. Surface smooth and shiny.
2. Rifling
 - a. Dark surface deposits (carbon ?) throughout.
3. Gas Port - Clear

Weapon #3 (S/N 3296250) - Government Issue Ammo

0 Rounds

1. Chamber Throat
 - a. Scratch marks throughout.
 - b. Scattered circumferential scrapes.
2. Origin of Rifling
 - a. Rough, pitted.
 - b. Lands washed away, several places.
3. Rifling
 - a. Heavy to medium pitting/heat checking, first several inches.
 - b. Surface cracks, first several inches.
 - c. Light to medium carbon and coppering, first half of bore.
 - d. Last (muzzle) half of bore fairly smooth and uniform; lands and grooves well defined.
 - e. Plating cracked approx 1/2" forward of gas port.
4. Gas Port
 - a. Slight erosion muzzle edge.
 - b. Otherwise, sharp corner all around.

500 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling
 - a. Black deposits noticeable in washed out areas.
3. Rifling
 - a. Forward portion of bore shinier.
4. Gas Port
 - a. Lead (dark grey) deposits at muzzle end, just below corner.

1000 Rounds

1. Chamber Throat
 - a. Black deposits forming in scrape marks.
2. Origin of Rifling - N/C

3. Rifling
 - a. Copper fouling not present.
 - b. Pitting contains black deposits, first half of bore (breach end).
4. Gas Port
 - a. Deposits cover approx 30% of area.

2000 Rounds

1. Chamber Throat
 - a. Increase in black deposits.
2. Origin of Rifling - N/C
3. Rifling
 - a. Increased deposits in rough areas.
 - b. Slight black deposits in some corners, muzzle half.
4. Gas Port
 - a. Completely filled up.

3000 Rounds

1. Chamber Throat
 - a. Surface appears dark, dull.
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

4000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

5000 Rounds

1. Chamber Throat
 - a. Increased black deposits.
 - b. Increased dullness.
 - c. Circumferential scrapes showing wear.

2. Origin of Rifling
 - a. Increased build up, mainly in crevices of eroded portions.
3. Rifling
 - a. Increased dark deposits in rough areas, first 6" of bore.
 - b. Last half still fairly smooth, slightly shinier.
4. Gas Port
 - a. Lead building up in erosion at muzzle corner.

6000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

7000 Rounds

1. Chamber Throat
 - a. Several scattered shiny areas.
2. Origin of Rifling - N/C
3. Rifling
 - a. Several small, spherical black deposits throughout.
4. Gas Port - N/C

8000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

9000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling
 - a. Increase in black deposits, first 6", collecting at surface irregularities.
4. Gas Port - N/C

10,000 Rounds

1. Chamber Throat - N/C
2. Origin of Rifling - N/C
3. Rifling - N/C
4. Gas Port - N/C

After Firing 5.56mm Ball Rounds

1. M16 Chamber
 - a. Considerable lead build up throughout.
2. Rifling
 - a. Same, except for generally duller surfaces, muzzle half.
3. Gas Port - Clear

Notes on Borescope Data

1. Barrel assemblies were borescoped after cleaning with RFA's installed. (Except barrel from Weapon #3 which was not cleaned throughout the test).
2. Rounds refer to .22 Cal. rounds fired, this test.
3. Chamber throat was assumed to include the RFA chamber, the smooth bore area of the RFA, and RFA/M16 chamber interface.
4. Notes after "O" rounds reflect observed changes in visual conditions. N/C implies no change noticed from previous inspection.