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Report No. DPS-2662



FINAL REPORT ON  
PRODUCT IMPROVEMENT TEST  
OF  
REDESIGNED BUFFER FOR M16A1 RIFLE  
BY  
LLOYD STALEY  
JANUARY 1968

ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND

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DEPARTMENT OF THE ARMY  
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AMSTE-BC

31 JAN 1968

SUBJECT: Transmittal of Final Report on Product Improvement Test of Redesigned Buffer for M16A1 Rifle, USATECOM Project No. 8-7-0230-04

TO: Commanding General, US Army Materiel Command, ATTN: AMCPM-SO-RS  
Commanding General, US Army Materiel Command, ATTN: AMCPM-RS  
Commanding General, US Army Combat Developments Command, ATTN: USACDC Liaison Officer, USATECOM

1. References:

a. Aberdeen Proving Ground Final Report, subject as above, January 1968.

b. Aberdeen Proving Ground Letter Report, Initial Production Test of Chrome Plated Chambers for M16A1 Rifle, USATECOM Project No. 8-8-0200-07, 19 January 1968.

2. Subject report should not be evaluated without considering other tests, completed or in process, which have involved use of the new buffer and which give weight and emphasis to the findings and conclusions expressed herein. Additional tests just beginning are expected to provide further enlightenment and confirmation as follows:

a. Arctic Test Center tests of M16A1 Rifle with IMR and Ball propellant cartridges and both standard and non-standard lubrication approaches; USATECOM Project No. 8-8-0060-03.

b. Quality Assurance Tests of Chrome-Chambered M16A1 Rifles with IMR propellant loaded cartridges as a companion effort to reference 1b above, scheduled to begin 1 February 1968, USATECOM Project No. 8-7-0211-03.

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3. Major findings are summarized as follows:

a. The redesigned buffer has acted to reduce significantly the incidence of failures to fire at the expense of increasing the incidence of failures to feed (Ref Tables 1.4-II, Pgs 12, 13). These two types of malfunctions cannot be equated, the latter being considered of a much more serious nature. The relative degree of seriousness requires weighting considering operational modes and judgment.

b. Specific attention is invited to Tables 1.4-II, Pg 13, 2.9-II, Pg 114 and Analysis Pgs 119, 120 in which a test of the effects of firing at rifle attitudes of  $\pm 80^\circ$  by ammunition lot is shown. This type of test had never been imposed before on M16A1 Rifles, although it is routinely used for machine guns. Results demonstrate the sensitivity of the system to an impressive degree. Not only does it clearly show the difference in malfunction rate and category between the buffers and the separate effect of H.R and Ball propellant, but it shows very significant differences related to mode of fire. These results are not included in the bar chart of "Malfunctions per 1000 Rounds Fired" on Pg 15 for the following reasons:

(1) Cyclic rates were not recorded while the weapons were at  $\pm 80^\circ$  attitude.

(2) The operational frequency and weighting of such extreme attitudes could not be resolved.

(3) Firings were conducted late in the test at round numbers of approximately 8000 when cyclic rates were high (Ref is made to Ref 1b, above, in which cyclic rates are shown to increase at a relatively fast level after firing in excess of 6500 rounds).

c. Over the spectrum of tests imposed, using the two types of propellants, the new buffer has shifted cyclic rates downward (Ref Fig 1.4-1 thru 1.4-6, Pgs 4-9). Using H.R 8208 propellant at  $70^\circ\text{F}$ , approximately 30% of the cyclic rates observed will fall below 650 rounds per minute (Ref Table 1.4-I, Pg 10). Cyclic rates of this order are accompanied by a significant increase in over-all malfunction rates of the order of 4 to 1 with ball projectiles, primarily in the failures to feed category (Table 1.4-III, Pg 14). With the new buffer no increase in malfunctions was noted with cyclic rates above 850 rounds per minute.

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d. With either buffer, the variability in cyclic rates rifle-to-rifle and lot-to-lot of ammunition does not permit staying within the "design" limits of 650 to 850 rounds per minute or permit optimum levels of reliability. For example, the variation in cyclic rate due to propellant type alone, is approximately 100 rounds per minute.

e. Reliability criteria in use for acceptance of rifles based on non-adverse conditions are not indicative of, or proportional to reliability during various actual use environments.

f. Weapon quality control or design omissions were in evidence with respect to durability of anodized finishes, unsatisfactory performance of one new individual weapon during initial firing tests, and failures of extractor springs.

g. There is an unexplained but significant discrepancy in port pressure in 3 out of 4 ammunition test lots measured in this test when compared to acceptance reports (Ref Pgs 146, 147).

h. When tracer projectiles are utilized in an all-tracer mode, only IMR propellant provides an overall operational capability; current tracer bullets w/Ball propellant break up under certain conditions. In this test, relative to weapon malfunctions, there was no difference between tracer cartridges, regardless of propellant, until tests at weapon attitudes and dynamic dust were imposed in which event, IMR loading yielded significantly higher failure to feed malfunctions (Ref Table 1.4-11, Pg 13).

4. It is concluded that the M16A1 Rifle with redesigned buffer:

a. Demonstrated an improved overall level of reliability when used with ball projectiles and Ball propellant loaded cartridges.

b. The proper mix of tracer and ball cartridge, to include propellant type, which will not result in projectile break up or high malfunction rate has not been determined.

c. With IMR propellant loaded cartridges, the system is not kinematically "tuned" to either consistently meet specification requirements of 650 to 850 rounds per minute or to provide maximum levels of functioning reliability in realistic use environments over its intended life.

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d. The weapon with new buffer cannot be expected to function without excessive feeding failures at low temperatures with either IMR or Ball propellant loaded cartridges. IMR is worse than Ball propellant in this respect. The condition prevails with both propellants at  $-65^{\circ}\text{F}$  and up to some higher temperature. Based on 1966-67 Arctic tests, satisfactory functioning was obtained with the old buffer and Ball propellant cartridges (the new buffer in the Arctic is scheduled for 1967-68).

e. High cyclic rates beyond 850 rounds per minute were not productive of malfunctions to any degree comparable to malfunctions associated with cyclic rates below 650 rounds per minute. These rates must be examined by single magazines and not by averages. Further confirmation is provided in reference 1b. Therein, as firings progress in a continuing schedule, cyclic rates advance in the order of 100 rounds per minute between the first and last magazine in a 100 round cycle, with Ball projectiles and Ball propellant. As the weapon is fired over its life, its cyclic rate drops so that individual magazines have been recorded at 525 rounds per minute after 6600 rounds have been expended at  $70^{\circ}\text{F}$ , non-adverse conditions. As subject report indicates, adverse conditions further decrease the rate. With IMR propellant this could be expected to occur earlier in the weapons life.

f. Once an acceptable level of system reliability is established, any change imposed, should be with extensive caution. Any changes should be preceded by exploring the spectrum envelope of weapons and ammunition involved.

5. Addressees are cautioned to consider the conclusions of subject report both in context and implication in reasoned perspective. For example, a malfunction rate of 2 per 1000 rounds consisting of failures to fire or of the bolt to stay to the rear cannot, as the report states, be clearly equated with more serious failure to feed although the exact weighting of one category against the other is not easily established. What is establishable is that the frequency with which failures to feed occur is related to class of ammunition combined with cyclic rate. An optimum combination can probably minimize failures to feed, perhaps at the expense of occasional increases in such minor failures as the bolt failing to stay to the rear after the last round in a magazine. Regardless of the level, type, or trade-off of malfunctions one is willing to accept over the use life of a weapon, if the weapon has a technical potential for improvement in reliability with either or both types of

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for M16A1 Rifle, USATECOM Project No. 8-7-0230-04

propellant, this objective should be pursued. What has become increasingly apparent is that IMR propellant with the present buffer design demonstrates a generally lower reliability than does Ball propellant. This performance is contrary to what has been inferred or what may have been considered true with the original buffer design. If the weapon system were to be optimally "tuned" for IMR propellant, its theoretical potential may be realized to the extent of achieving maximum reliability. However, this is conjecture and may be impractical.

6. It is recommended that:

a. The redesigned buffer be considered an acceptable replacement for the original design for use with ball ammunition loaded with Ball propellant and tracer ammunition loaded with IMR propellant pending determination of suitability of a ball and tracer mix.

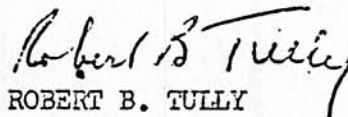
b. The use of IMR propellant in 5.56mm ammunition be limited to tracer cartridges, pending the results and analysis of current tests which will permit more comprehensive comparison of the respective characteristics of Ball and IMR propellant.

c. The current kinematic analysis be expanded to determine whether improvements can be made to increase reliability of the system by simple retrofit adjustments of the buffer, and also by more sophisticated adjustments, as the gas port and/or action spring.

d. A comprehensive analysis be instituted of all testing done to date with the M16 series of Rifles prior to proceeding with any changes in the weapon or ammunition system.

e. Immediate action be instituted to redefine specifications and criteria for acceptability.

FOR THE COMMANDER:



ROBERT B. TULLY  
Colonel, GS  
Dir, Inf Mat Test

1 Incl  
APG Rept, subj as above,  
Jan 68 (AMCPM-RS, 10 cys;  
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USATECOM PROJECT NO. 8-7-0230-04

PRODUCT IMPROVEMENT TEST OF  
REDESIGNED BUFFER FOR M16A1 RIFLE

FINAL REPORT

BY

LLOYD STALEY

JANUARY 1968

ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND  
21005

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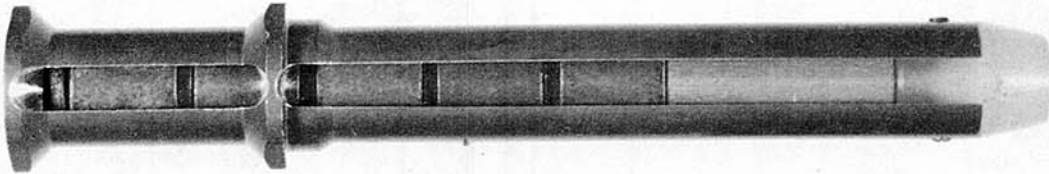
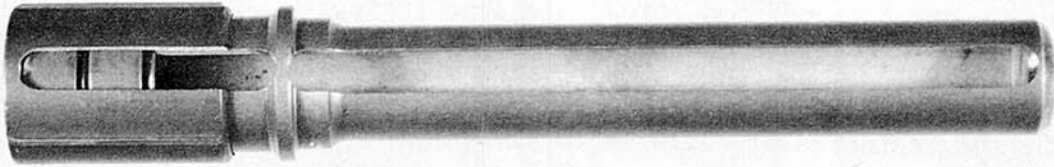
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## ABSTRACT

At the request of US Army Weapons Command, a product-improvement test of a redesigned buffer for the M16A1 rifle was conducted at Aberdeen Proving Ground, Maryland, between 7 September 1967 and 15 January 1968. Twelve M16A1 rifles were fired under a variety of adverse conditions employing both the redesigned and the standard buffer. Four lots of ammunition were also tested to investigate the relationship of certain ammunition variables to weapon performance. The redesigned buffer was developed as a substitute for the standard buffer with the objective of lowering cyclic rate of fire and reducing the incidence of failures to fire in the M16A1 rifle. Test results confirmed that both design objectives were accomplished, but there was an undesirable increase in other types of weapon malfunctions, particularly in cartridge feeding failures.

## FOREWORD

Aberdeen Proving Ground was responsible for preparing the test plan, conducting the test, and preparing the test report.



Frontispiece: Cutaway Views of Standard (Top) and Redesigned Buffers for the M16A1 Rifle.

ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 8-7-0230-04

FINAL REPORT ON PRODUCT IMPROVEMENT TEST OF  
REDESIGNED BUFFER FOR M16A1 RIFLE

7 SEPTEMBER 1967 THROUGH 15 JANUARY 1968

SECTION 1. INTRODUCTION

1.1 BACKGROUND

During the progressive development and production of the AR-15 rifle to the present configuration and designation as the standard M16A1 rifle, the cyclic rate of fire of the weapon steadily increased from approximately 750 rounds per minute to rates in excess of 900 rounds per minute. The higher cyclic rates of fire were often, although not always, associated with an increase in malfunction rate and a decrease in parts life. Functioning tests indicated a relationship between the higher cyclic rates of fire and certain types of cartridge propellant, particularly ball propellant.

A joint effort between Frankford Arsenal, Springfield Armory, and Colt Firearms was initiated in 1966 to develop a new buffer mechanism which would accommodate the variations in cartridge propellant type while maintaining a cyclic rate of fire between 650 and 850 rounds per minute. The joint effort resulted in a redesigned buffer which was introduced into production of M16A1 rifles in 1967 as a product-improved item. Concurrently with the introduction of the redesigned buffer, cartridge production was expanded to include a number of new cartridge producers as well as several new propellant-projectile combinations of ammunition.

In order to confirm that the redesigned buffer would be suitable for field issue and compatible with four basic types of ammunition, USATECOM directed that a product-improvement test of the redesigned buffer, reported herein, be conducted at Aberdeen Proving Ground.

1.2 DESCRIPTION OF MATERIEL

The redesigned buffer, referred to in the technical manual as the action spring guide assembly, is composed of a one-piece cylindrical alloy body within which are assembled an alloy spacer and five cylindrical steel weights (275 grains each) separated by thin buna rubber pads. The spacer and weights are retained in the buffer by a solid polyurethane shock absorbing end cap and a split pin. The external configuration of the

redesigned buffer is similar to the standard buffer, and retrofit is accomplished without modification to the rifle; the original action spring and lower receiver extension accept both the redesigned and standard buffer.

The buffer absorbs the energy of the recoiling bolt carrier through inertia of the buffer assembly and by compression of the action spring which incloses the buffer. The internal assembly of the redesigned buffer provides a delayed forward impulse to the bolt carrier at the moment of bolt carrier closure. The internal buffer weights are in a rearward position as the buffer moves forward, after recoil, and the weights move forward approximately 0.1 inch when the bolt carrier and buffer stop.

### 1.3 TEST OBJECTIVES

The test objectives are:

- a. To compare cyclic rates of fire using the old and new buffers.
- b. To compare bolt rebound upon closing, using the old and new buffers.
- c. To permit a comprehensive evaluation of the old and new buffers in the M16A1 rifle.

The test objectives were accomplished firing four different types of 5.56-mm ammunition, both extruded grain and ball propellant with both tracer and ball projectiles.

### 1.4 SUMMARY OF RESULTS

#### 1.4.1 Cyclic Rate of Fire

Cyclic rate of fire results in the majority of subtests were evaluated against the following criterion:

"The cyclic rate of fire for each 20-round burst shall be within 650 to 850 rounds per minute (par. 10.2.1, Reference 3)."

Figures 1.4-1 through 1.4-4 summarize the range and average cyclic rate-of-fire data for the four lots of ammunition with both redesigned and standard buffers. These data were obtained only at normal ambient conditions and immediately following a cleaning period. In each figure, the average cyclic rate of fire shown is for the average of nine guns at various stages from 0 to 8500 rounds of firing in the "life" of each weapon, except at 8500 rounds where only six of

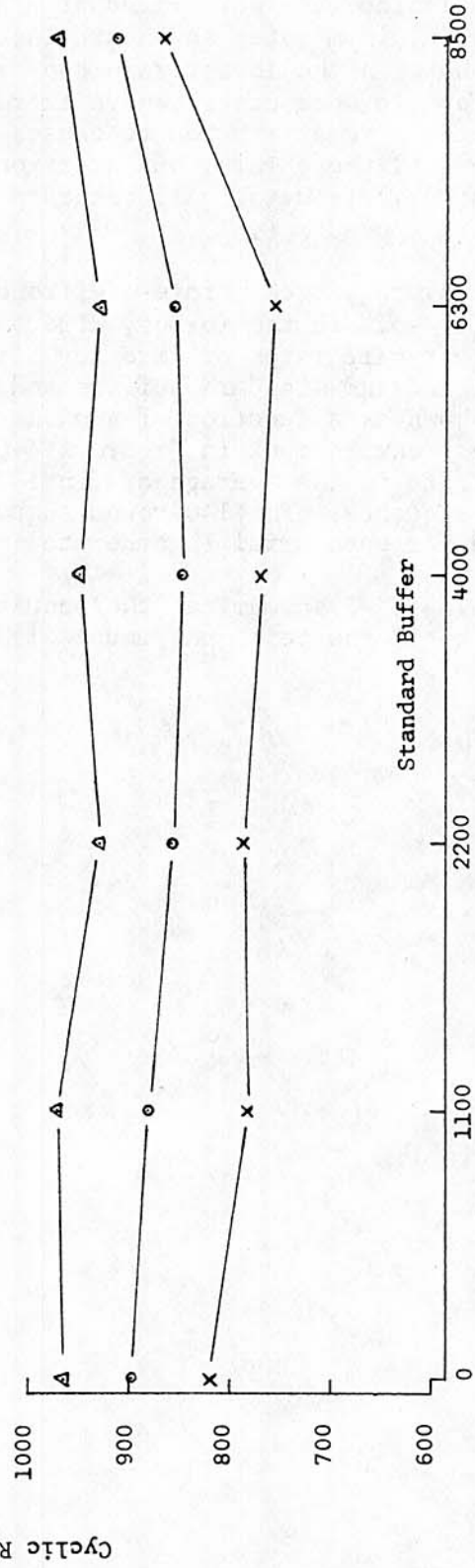
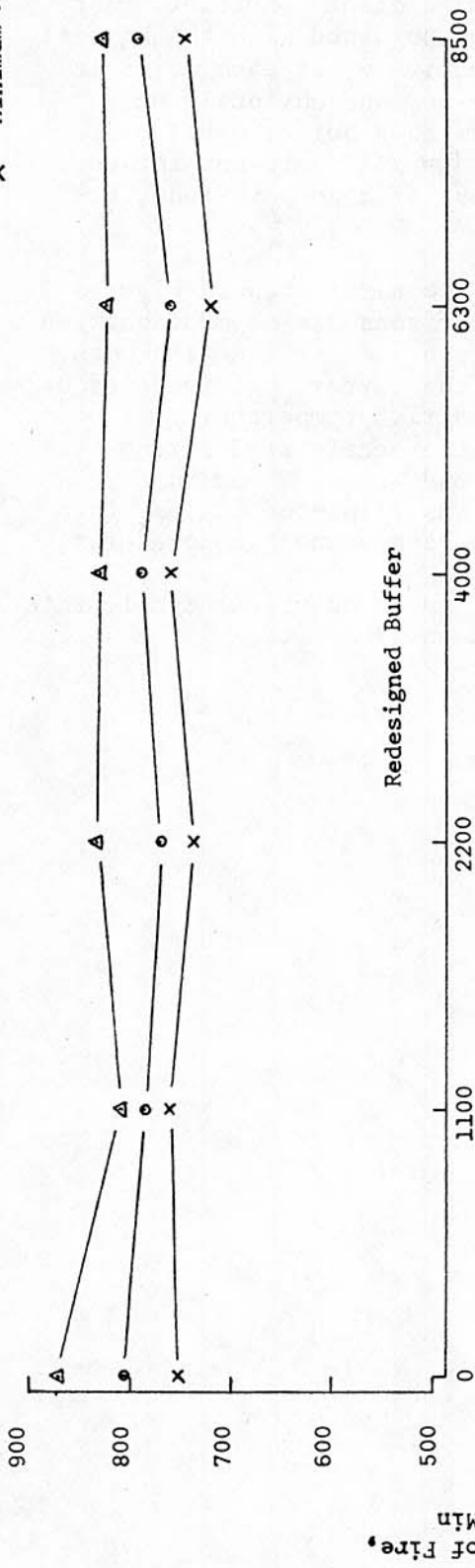
the original nine guns were fired at a normal ambient condition. The maximum and minimum rates shown are the rates obtained with the highest rate gun and with the lowest rate gun, respectively, at each point in weapon life. In some cases, where extremely low and obviously non-typical rates were attributed to causes other than buffer model or ammunition lot, these rare, but occasional, low rates are not included in the minimum-rate data. All recorded rates, with no omissions, are contained in Appendix I.

The average cyclic rate-of-fire data are also shown in Figures 1.4-5 and 1.4-6. In the former, direct comparisons can be made between the average cyclic rates of fire for all lots of ammunition with both the redesigned and standard buffers and, in the latter, cyclic rates of fire are shown as a function of gun and ammunition temperature. The initial test environment in Figure 1.4-6 is the accelerated firing test where the rate is the average of final 20-round bursts fired in a 140-round sequence. The 140-round sequence was completed in less than one minute for each trial in order to induce high weapon temperatures.

Table 1.4-I summarizes the results of 1916 individual cyclic rate trials with all the test guns under all test environments.

Legend

- △- Maximum Rate
- Mean Rate
- X- Minimum Rate



Weapon Life by Number of Rounds Fired

Figure 1.4-1: Average and Range of Cyclic Rate of Fire of Nine M16A1 Rifles As a Function of Weapon Life. Ammunition Lot LC12177 (Ball Projectile, WC 546 Propellant).

Legend  
 -△- Maximum Rate  
 -○- Mean Rate  
 -x- Minimum Rate

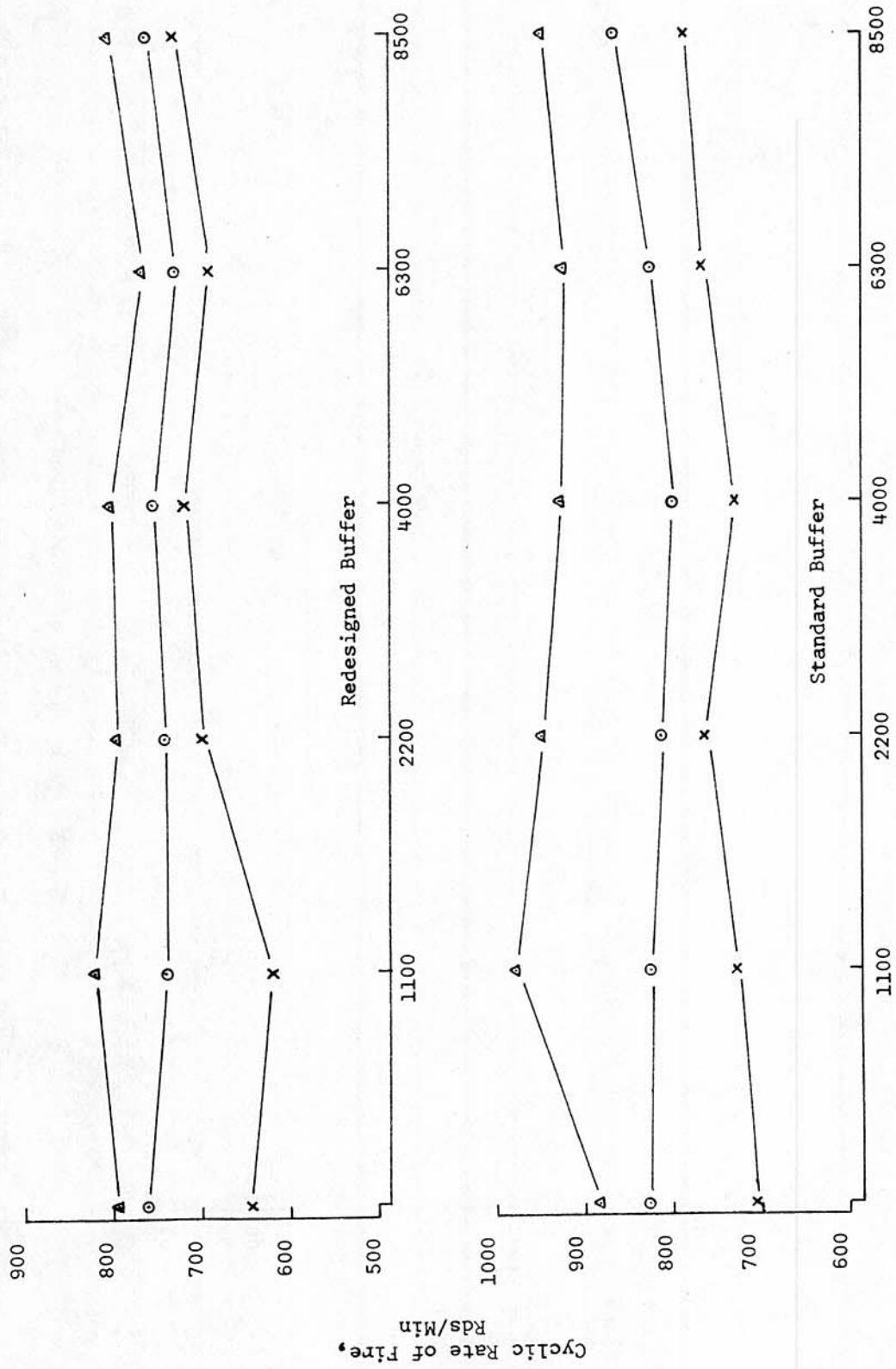
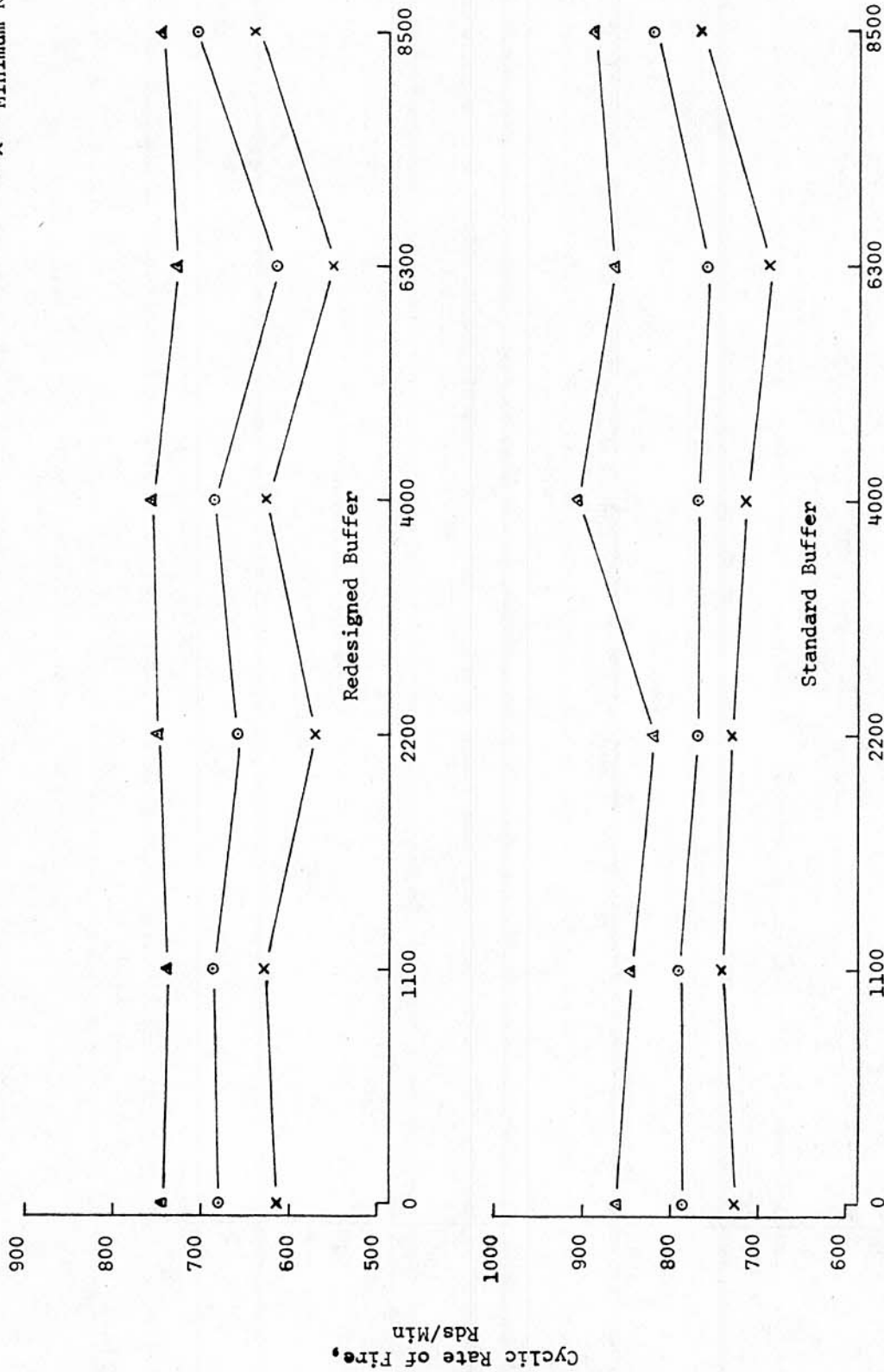


Figure 1.4-2: Average and Range of Cyclic Rate of Fire of Nine M16A1 Rifles As a Function of Weapon Life. Ammunition Lot LC12081 (Tracer Projectile, WC 846 Propellant).

-Δ- Maximum Rate  
 -○- Mean Rate  
 -X- Minimum Rate



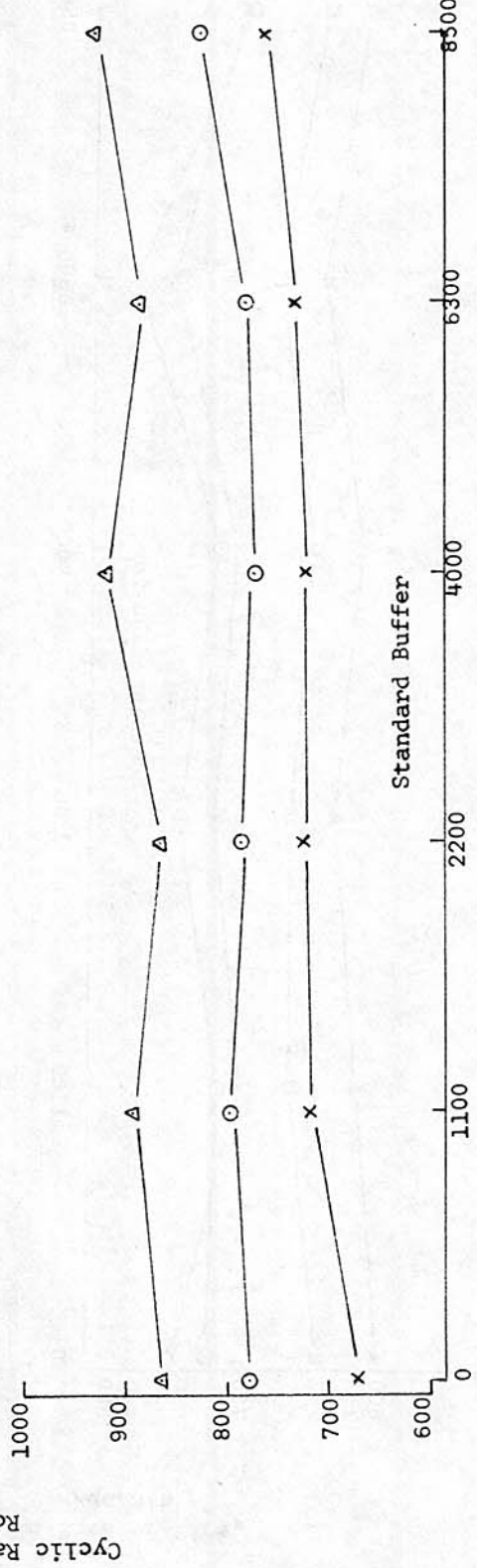
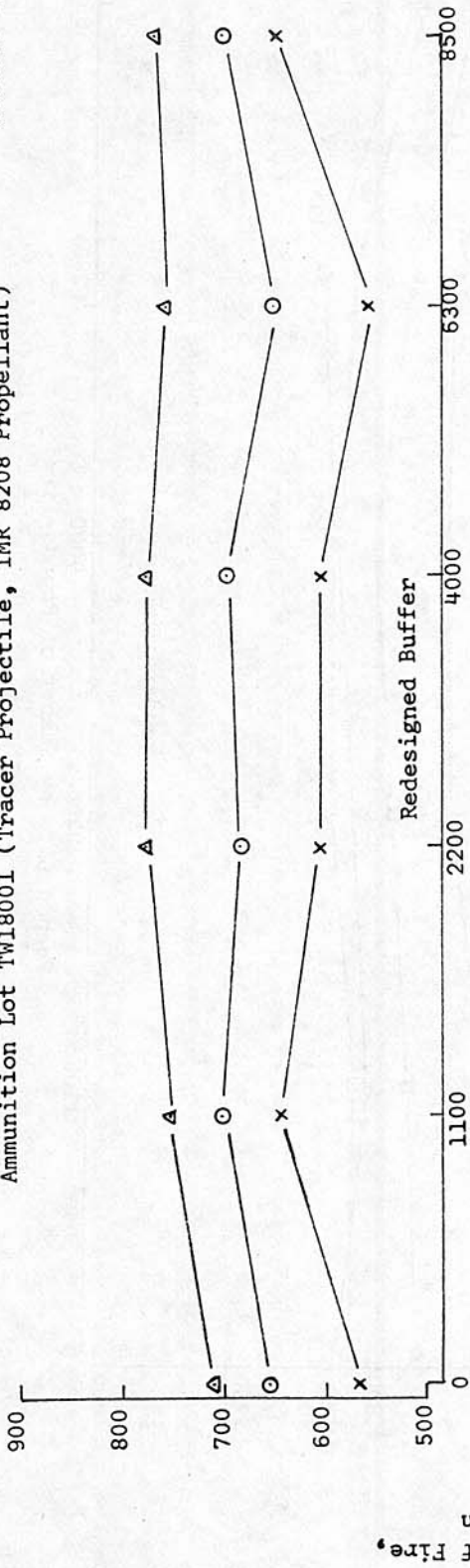
Weapon Life by Number of Rounds Fired

Figure 1.4-3: Average and Range of Cyclic Rate of Fire of Nine M16A1 Rifles As a Function of Weapon Life. Ammunition Lot TW18166 (Ball Projectile, IMR 8208 Propellant).

Average and Range of Cyclic Rate of Fire of Nine M16A1 Rifles  
As a Function of Weapon Life

Ammunition Lot TW18001 (Tracer Projectile, IMR 8208 Propellant)

Legend  
 -Δ- Maximum Rate  
 -○- Mean Rate  
 -X- Minimum Rate



Weapon Life by Number of Rounds Fired

Figure 1.4-4: Average and Range of Cyclic Rate of Fire of Nine M16A1 Rifles As a Function of Weapon Life. Ammunition Lot TW18001 (Tracer Projectile, IMR 8208 Propellant).

M193, WC846    -△- Lot LC 12177  
 M196, WC846    -□- Lot LC 12081  
 M193, IMR        -○- Lot TW 18166  
 M196, IMR        -x- Lot TW 18001

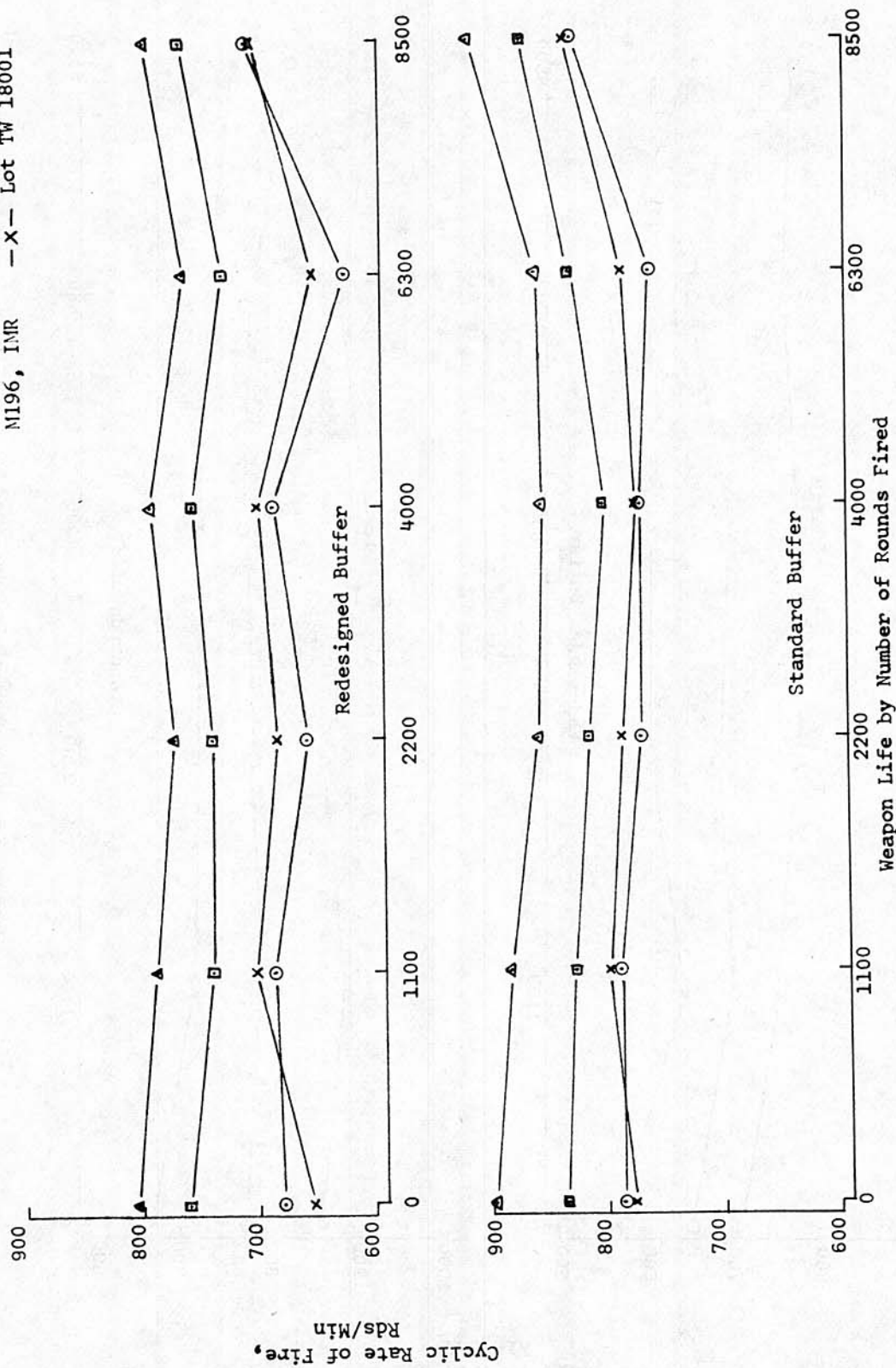


Figure 1.4-5: Average Cyclic Rate of Fire for Four Lots of Ammunition As a Function of Weapon Life in M16A1 Rifles.

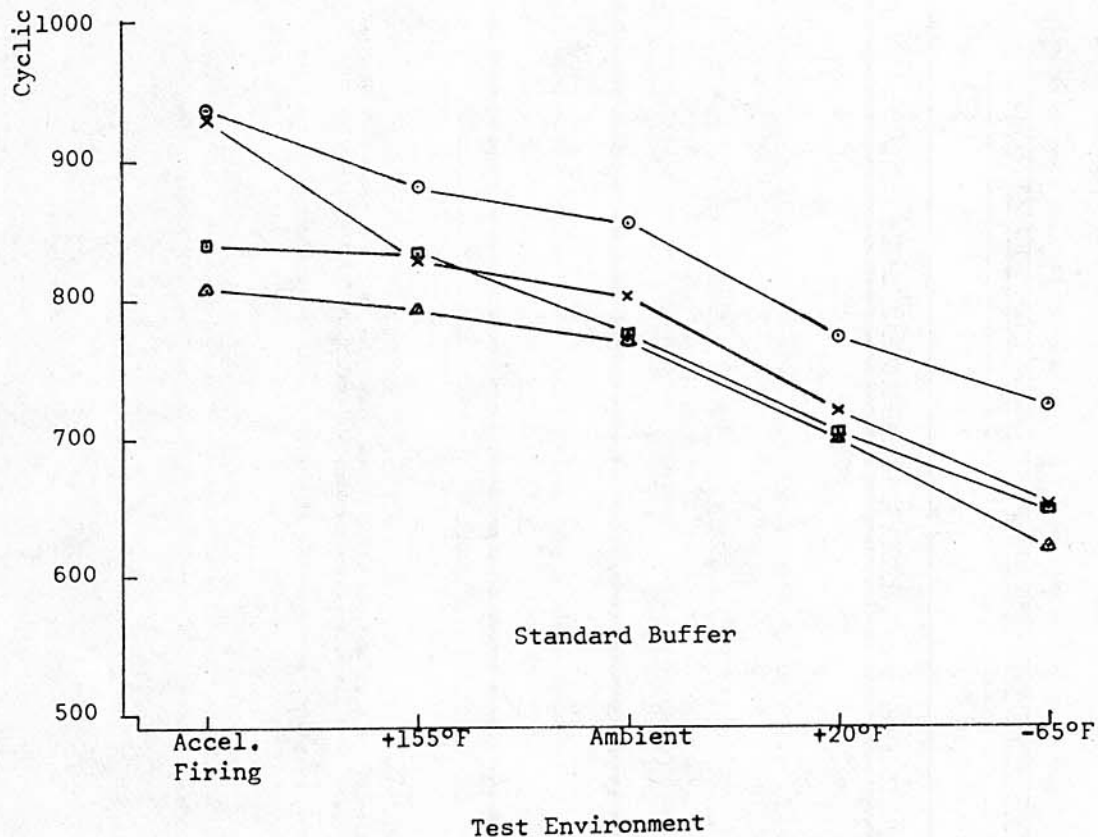
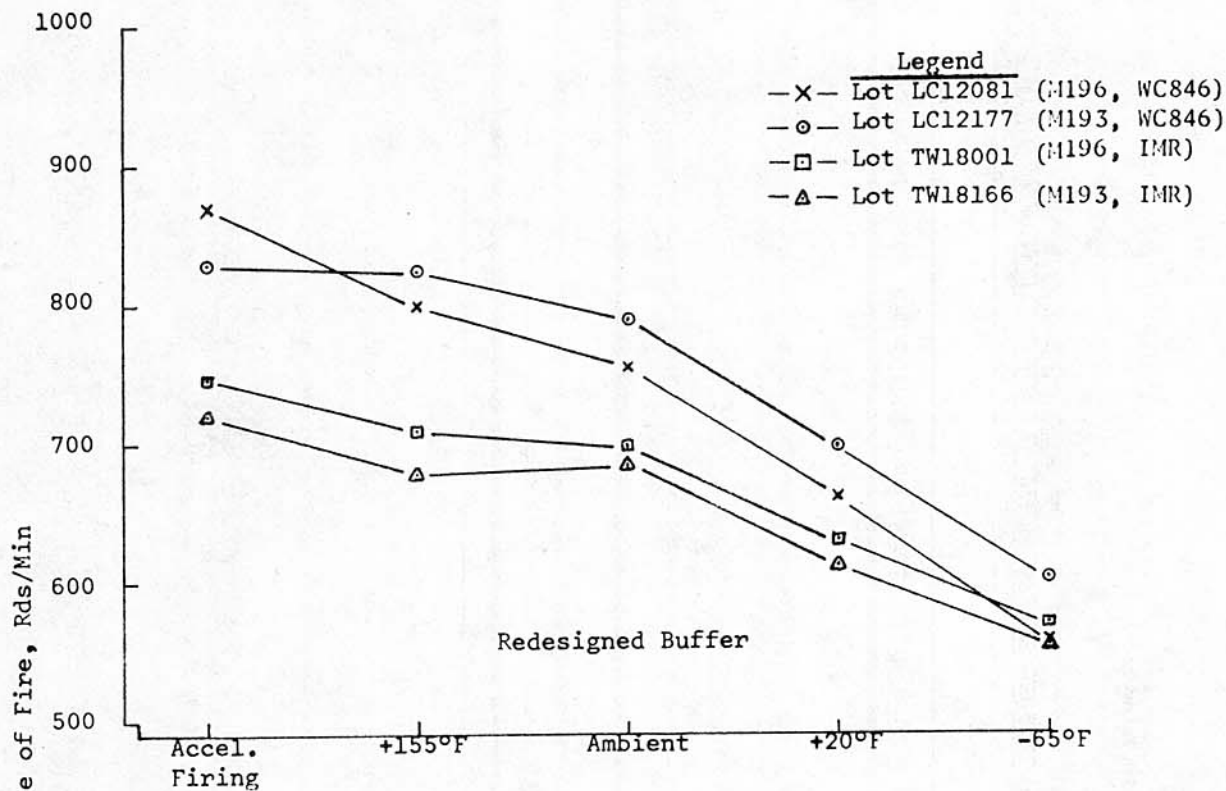


Figure 1.4-6: Average Cyclic Rate of Fire for Four Lots of Ammunition As a Function of Test Environment.

Table 1.4-I. Summary of Cyclic Rate of Fire Data which Failed to Meet Rate Criteria Limits

Test Environment	Standard Buffer			Redesigned Buffer		
	No. of Trials above 850 rds/min		No. of Trials below 650 rds/min	No. of Trials above 850 rds/min		No. of Trials below 650 rds/min
	LC12177	TW18166	LC12081	LC12177	TW18166	LC12081
Normal ambient	56	10	28	11	105	0
High humidity	19	8	9	3	39	0
High temperature	16	5	9	8	38	0
Fouling test (+20°F)	5	0	0	5	2	8
Low temperature	1	0	0	1	4	22
perature	19	1	21	2	43	0
Accel firing	4	2	7	3	16	0
Dust			Not fired			
Salt-water immersion						
Total by lot	120	26	74	27	6	33
					21	23
Total by buffer	943	247	83	973	25	273

<sup>a</sup> With the exception of the dust test and the salt-water-immersion test, all rates were obtained by firing a continuous 20-round burst. Due to stoppages in these tests some dust test rates and salt-water-immersion test rates are for the first 10 rounds of an attempted 20-round burst.

Lot LC12177 (ML93, WC846).  
 Lot TW18166 (ML93, IMR).  
 Lot LC12081 (ML96, WC846).  
 Lot TW18001 (ML96, IMR).

#### 1.4.2 Reliability

The reliability data for all firings are summarized in Table 1.4-II and malfunctions rates are computed in Table 1.4-III. Firings in the salt-water-immersion test were conducted by employing three weapons with each of the four lots of ammunition, which was considered to be the minimum acceptable sample size. As the severity of the 10-day test precluded repeating the exercise with the same weapons, only the redesigned buffer was evaluated.

The reliability of the M16A1 rifle in the majority of subtests was evaluated against the following criterion:

"The total number of malfunctions and unserviceable parts for all subtests (except pars. 2.11 and 2.12) shall not exceed the specifications of Table I in par. 10.3, Reference 3."

A copy of the referenced Table I, which explains in some detail the type and number of malfunctions permitted, is contained in Appendix I of this report. Basically, it permits a malfunction rate of approximately two per 1000 rounds fired during a 6000-round evaluation. As this criterion also defines the performance level which must be met in weapon acceptance tests, it can be expected that this level of performance may not be reached in some extreme environmental exercises. However, if weapon acceptance test results are to have any useful meaning beyond fulfillment of a contractual obligation, then they must also offer assurance that the same levels of performance will be closely approached during actual use in various environments.

Figure 1.4-7 illustrates the incidence of malfunctions as a function of test environment by employing the same test environment data base as was used in Figure 1.4-6 to plot cyclic rate of fire as a function of environment. In Figure 1.4-7, only feeding failures and failures to fire are considered, with the former including failures to feed the first round (FF-1), bolt overrides (BOB), bolt closing on an empty chamber (COEC), double feed (DF), and failures to feed (FF) where the bolt stops short of full closure or locking. The malfunctions are defined in detail in par. 2.1.

Approx No. of Rounds Fired per Lot, per Buffer Type	Ammuni- tion Lot No.	Malfunctions by Buffer Type <sup>a</sup> (Standard and Redesigned)												Total per Test Condition Std Red.								
		FFR		FBR		BOB		FF		COEC		FF-1			FJB		FXB		DF		FIR	
		Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.		Std	Red.	Std	Red.	Std	Red.	Std	Red.

Test: Initial rate test.  
No. of Guns Fired: Twelve.

240	LC12177																						0
240	TW18166																						0
240	LC12081																						0
240	TW18001																						0
	Total	20	1	3	4	0	0	14	3	1	0	3	0	0	0	0	0	0	0	0	0	0	0

One gun was replaced in test (ref par. 2.5.4), but no other malfunctions occurred.

Test: High humidity<sup>c</sup>.  
No. of Guns Fired: Twelve.

1680	LC12177	6	1																				7
1680	TW18166	1	-																				1
1680	LC12081	12	1	1	2	2																15	
1680	TW18001	1	4	1	12	1	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	
	Total	20	1	3	4	0	4	3	1	0	3	0	0	0	0	0	0	0	0	0	0	0	26
																							49

Test: High temperature (+155°F).  
No. of Guns Fired: Twelve.

1700	LC12177	5	6																				12
1700	TW18166	4	0							1	4												4
1700	LC12081	14	7	2	3																	22	
1700	TW18001	8	1																			9	
	Total	31	0	14	2	2	0	3	0	0	1	4	0	0	1	5	0	1	0	0	0	0	47
																							62

Test: Fouling test (+20°F).  
No. of Guns Fired: Twelve.

2730	LC12177	7	2																				19
2730	TW18166	15	1							2	5	10	7	15	9								35
2730	LC12081	17	1																			29	
2730	TW18001	37	1	1	2	1	2	13	10	1	13	10	1	20	9							37	
	Total	76	2	2	1	0	2	6	22	0	7	58	39	1	0	0	0	1	0	0	0	0	52
																							143
																							217

Test: Low temperature (-65°F).  
No. of Guns Fired: Twelve.

3350	LC12177	9	4																				44
3350	TW18166	28	9	1	2	6	35	13	19	15	46	18	27									81	
3350	LC12081	45	8																			110	
3350	TW18001	44	1	3	2	18	24	13	18	33	44	10	17	1	6	3						122	
	Total	126	22	4	9	37	104	61	76	73	146	55	88	1	10	5	0	0	0	0	0	0	357
																							460
																							817

<sup>a</sup>Malfunction abbreviations are identified in par. 2.1. In the majority of subtests some firing was done under a normal ambient condition to obtain comparison cyclic rate of fire data. Any malfunctions which were recorded during these firings are included under the subtest where they occurred.

<sup>b</sup>In some instances, FJ's and FX's were not recorded in this table when they were definitely attributed to a broken or damaged extractor spring. They are recorded in the individual tables in Section 2.

<sup>c</sup>A total of 38 malfunctions occurred with one gun; ref par. 2.5.

Table 1.4-II (Cont'd)

Approx No. of Rounds Fired per Lot, Per Buffer Type	Ammunition Lot No.	Malfunctions by Buffer Type <sup>a</sup> (Standard and Redesigned)												Total per Test Ammunition Lot Condition Std	Red.			
		FPR	FBR	BOB	FF	COEC	FF-1	F10	F10	FXD	DF	F1R						
		Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	
Test: Extreme attitude functioning test.																		
No. of Guns Fired: Six.																		
1570	LC12177	173	3	1	3												179	1
1570	TW18166	43	2	10	17			3									43	33
1570	LC12081	34	1	1	5				1	2							41	9
1570	TW18001	25	3	3	15					4							25	22
Total		275	1	3	3	1	14	8	37	0	3	1	7	0	0	0	288	65
																	353	

Test: Accelerated firing test.  
No. of Guns Fired: Six.

420	LC12177	2																3	0
420	TW18166			1	2					1								1	2
420	LC12081	1																1	0
420	TW18001																	0	0
Total		3	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	5	2

Test: Dynamic dust.  
No. of Guns Fired: Six.

780	LC12177																		7	9
780	TW18166																		16	19
675	LC12081	1																	14	13
675	TW18001																		15	18
Total		0	0	1	0	5	8	0	19	0	0	32	29	4	1	1	2	0	52	59
																	111			

Test: Salt-water immersion<sup>d</sup>.  
No. of Guns Fired: Twelve.

d 900	LC12177	1																		6	51																		
d 900	TW18166	2	1	1	23															d	35																		
d 900	LC12081	1																		d	23																		
d 900	TW18001	2	5	2	37															2	46																		
Total		d-5	d-2	d-2	d-114	d-8	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16	d-16																		
																	531	26	27	19	44	147	87	155	74	163	147	163	7	16	1	8	0	1	0	0	e918	698	
																	557		46	191	242	237	310	23	9	1	0	0	0	0	0	0	0	0	0	0	0	0	e1616

<sup>a</sup>Malfunction abbreviations are identified in par. 2.1. In the majority of subtests some firing was done under a normal ambient condition to obtain comparison cyclic rate of fire data. Any malfunctions which were recorded during these firings are included under the subtest where they occurred.

<sup>b</sup>In some instances, F1's and FX's were not recorded in this table when they were definitely attributed to a broken or damaged extractor spring. They are recorded in the individual tables in Section 2.

<sup>c</sup>The standard buffer was not tested. Malfunctions in this table are not included beyond the fifth day of firing (ref par. 2.12).

<sup>d</sup>Totals do not include malfunctions from the salt-water-immersion test.

Note: Lot LC12177 (M193, WC846); lot TW18166 (M193, EMR); lot LC12081 (M196, WC846); lot TW18001 (M196, EMR).

Table 1.4-III. Summary of Malfunction Rates per 1000 Rounds Fired

Approx No. of Rounds Fired per Lot, per Buffer Type	Standard Buffer Ammunition Lot No. <sup>a</sup>		Redesigned Buffer Ammunition Lot No. <sup>a</sup>	
	LC12177 TW18166	LC12081 TW18001	LC12177 TW18166	LC12081 TW18001
12470	21.7	14.5	4.6	18.2
-	4980	18.4	18.1	15.1
			14.0	
9120	24.9	11.0	2.4	6.1
-	36480	15.4	9.5	8.0
			6.5	

All test conditions except salt-water immersion<sup>b</sup>

All test conditions except salt-water immersion and -65°F<sup>b</sup>

<sup>a</sup>Lot LC12177 (M193, WC846).  
 Lot TW18166 (M193, IMR).  
 Lot LC12081 (M196, WC846).  
 Lot TW18001 (M196, IMR).

<sup>b</sup>Redesigned buffer malfunctions occurring in the salt-water-immersion test are not included as no comparable standard buffer performance data were obtained.

Legend

- A - Lot LC12177 (Ball Proj., Ball Prop.)
- B - Lot TW18166 (Ball Proj., IMR Prop.)
- C - Lot LC12081 (Tracer Proj., Ball Prop.)
- D - Lot TW18001 (Tracer Proj., IMR Prop.)

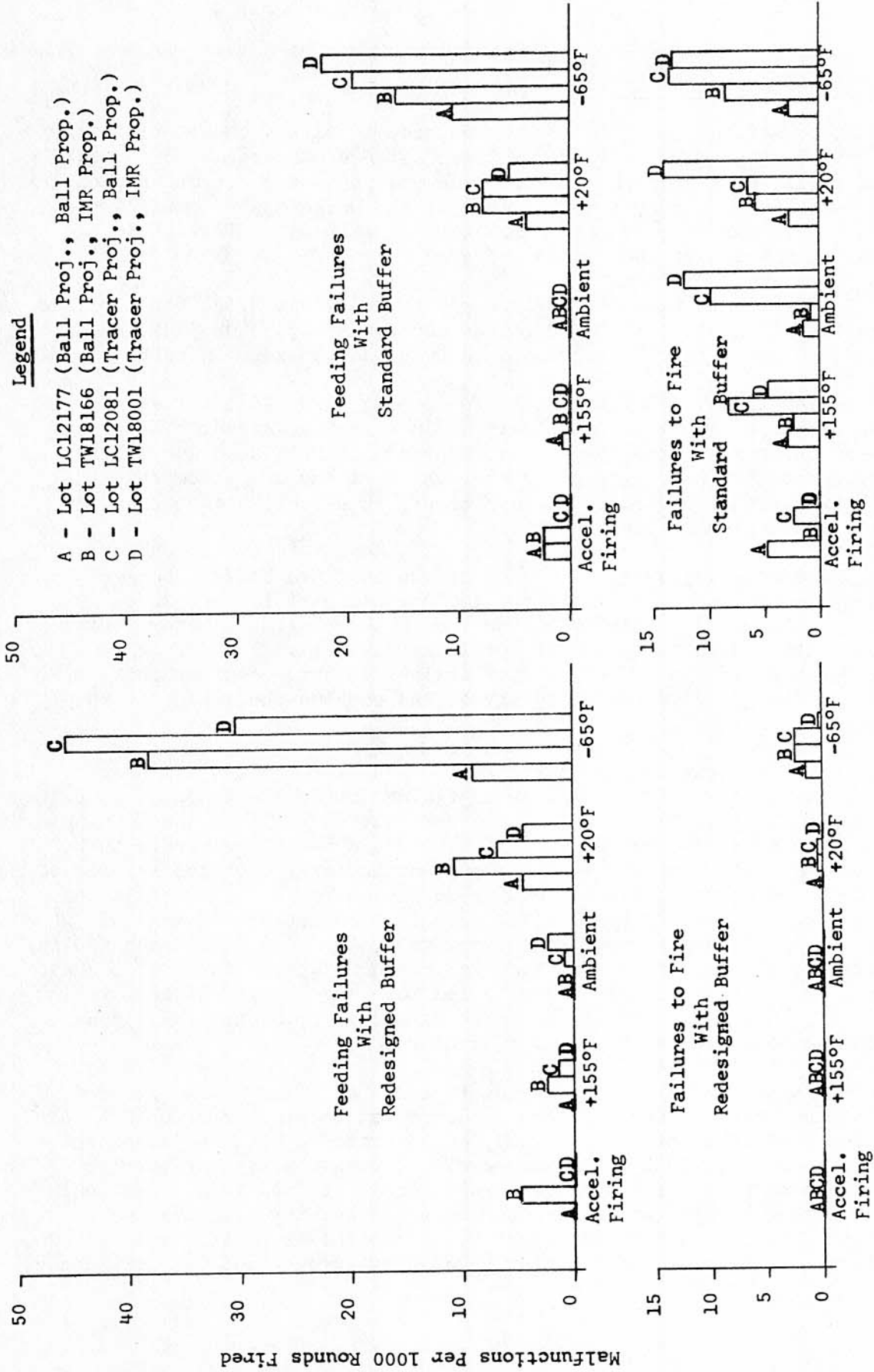


Figure 1.4-7: Incidence of Malfunctions in M16A1 Rifles with Four Lots of Ammunition As a Function of Environment.

### 1.4.3 Specific Subtest Results

There were no deficiencies encountered in either the initial or final inspections (par. 2.2) of the 12 redesigned buffers although, in final inspection, two of the polyurethane end caps were cut or cracked at the point where the cylindrical edge of the buffer body contacts the end cap; there was no evidence of moisture or salt water leakage in the interior of any of the redesigned buffers.

During the initial firing tests (par. 2.3), one M16A1 rifle became inoperative within the first 120 rounds fired. The gas tube, gas key, and standard buffer were damaged and the gun was replaced in test.

During the high humidity test (par. 2.5), one M16A1 rifle was charged with the majority of the malfunctions that occurred. The rifle had been previously fired 160 rounds. The problem was associated with the upper receiver-barrel assembly and, while it was suspected that the gas tube was either obstructed or deficient, this could not be confirmed by X-ray inspection of the gas tube.

The bevel-ring springs in many of the standard buffers became jammed or locked together during the +20°F fouling test (par. 2.7). While it was usually possible to free them by tapping the buffer, this problem continued to occur in the remaining subtests. The effect on gun performance of jammed buffer ring springs is not known but the ability of the standard buffer to arrest and cushion the impact of the bolt carrier in recoil is obviously diminished.

Complete cleaning and maintenance of the test rifles was done after approximately each 600 rounds of firing in the low temperature test (par. 2.8). Despite this maintenance, very little reliable functioning was possible after 300 rounds of firing. This appeared primarily to be a function of extreme low rates of fire, particularly with the redesigned buffer, and an accumulation of fouling in the mechanism of the bolt and bolt carrier. As all 12 test rifles were divided between firings of projectile type and not propellant type, no analysis of propellant fouling was possible although there was some indication that the three test guns firing only tracer ammunition were fouled more severely than the three guns firing only ball projectiles. The sample size, however, was considered too small to permit a clear distinction.

The extraordinary frequency of failures to fire, which occurred when the test rifles were elevated or depressed to plus or minus 80° in the extreme attitude test (par. 2.9), demonstrated a hitherto unsuspected sensitivity of the M16A1 rifle when equipped with the standard buffer. The precise nature of the deficiency was not identified in a subsequent limited firing investigation although several theories are advanced in paragraph 2.9.5. The most important result of this subtest was the capability of the redesigned buffer to completely overcome the deficiency.

While the rifles equipped with redesigned buffers met the test plan criterion of equal performance in the dynamic dust test, equal to that of the standard buffer (par. 2.11), there appears to be only slightly more than a 50% chance that a 140-round firing mission can be completed in a severe dust environment. Stoppages that were difficult to clear were common and the time to clear stoppages in this environment is extremely important; the more time involved the less likely it becomes that firing can be resumed due to ingestion of dust in the mechanism.

The malfunction data in the salt-water-immersion test (par. 2.12) show that there is very little likelihood that any firing mission can be successfully completed without malfunctions unless some type of cleaning of ammunition, magazines and rifle is performed within a matter of hours after salt-water immersion. The use of a cloth and water from a canteen proved extremely effective as a field expediency measure. This is discussed in detail in paragraph 2.12.5.

The finish on the upper receiver of one M16A1 rifle had progressively deteriorated during previous subtest firings until it became totally unserviceable following salt-water immersion. The resulting corrosion made it necessary to remove the rifle from test (Figure 2.12-1).

Five stainless steel dust covers for the M16A1 rifle were also tested and compared to standard steel covers (Figure 2.12-3). The stainless steel covers were somewhat more impervious to rust and corrosion than were the standard covers and appeared at least equal in durability and reliability.

All four test lots of ammunition were judged to have met the standards of acceptance test criteria for chamber pressure at +70°F (par. 2.13) although IMR 8208 propellant-loaded lots were significantly higher in chamber pressure than were the WC846 propellant-loaded lots. Only lot LC12081 was judged to have met the port pressure criteria with the remaining lots falling below the minimum acceptable level.

Based on observations in all subtests relative to the appropriate immediate action which should be taken to clear stoppages, a reported forthcoming change to FM 23-9 (Reference 8) appeared less desirable than the presently prescribed steps for immediate action. This is discussed further in paragraph 2.1.

## 1.5 CONCLUSIONS

### 1.5.1 Reliability

To support a conclusion that would state without qualification which of the two buffer models provides the most effective weapon reliability level, some set of values must first be assigned to various

types of malfunctions. Some of the difficulty in attempting to do this is discussed in paragraph 2.1 where it can be seen that many complex human factors problems are inherently associated in clearing of malfunctions in the M16A1 rifle. The incidence of the failure-to-fire malfunction for example, while obviously undesirable, is not a difficult malfunction to immediately clear and is rarely a cause of further problems even if incorrect action is first taken. On the other hand, feeding failures are usually much more difficult to clear, as are failures to extract and eject, and will often lead to further jamming of the rifle, if the nature of the malfunction is misjudged and an improper, but not illogical, clearing action is attempted.

The relationship between these two basic types of malfunctions suggests that the combat effectiveness of the M16A1 rifle may be degraded significantly more by the incidence of a feeding failure than by a failure to fire. If, in a numerical sense, this relationship should be on a two-to-one basis then the elimination of somewhat more than 500 failures to fire, which was accomplished in the 50,000 rounds of redesigned buffer firings, is not a net gain considering that there was also an increase in feeding failures of approximately 275.

To further evaluate this trade-off of malfunctions, a value-analysis model was employed within which the malfunction totals and rates in Tables 1.4-II and 1.4-III were examined. The types of malfunctions were divided into two categories: those which can be cleared quickly and simply with little likelihood of further jamming the weapon, and those which usually require a more complex clearing action and where further jamming may result, if incorrect action is taken. The first category includes failures to fire (FFR), failures of the bolt to remain to the rear (FBR), and the bolt closing on an empty chamber (COEC). All other malfunctions were included in the second category. The totals for each category were then computed and the hypothesis of the value analysis model is stated as follows:

Assigning a value of unity to all quickly cleared malfunctions, what value must then be assigned to the remaining malfunctions to reject the unweighted numerical advantages claimed for the redesigned buffer in Tables 1.4-II and 1.4-III; i.e., when does the trade-off of simple versus difficult-to-clear malfunctions become unacceptable? The rejection value was determined as follows, first considering all test conditions except salt-water immersion.

	<u>Redesigned Buffer</u>	<u>Standard Buffer</u>
FFR	26	531
FBR	19	27
COEC	163	74
Total	208	632
All other malfunctions	490	286

$$M_{R1} + R_V \cdot M_{R2} \geq M_{S1} + R_V \cdot M_{S2}$$

$$208 + R_V(490) \geq 632 + R_V(286)$$

$$R_V(490-286) \geq 424$$

$$R_V \geq 2.1$$

$M_{R1}$  = Number of easy-to-clear malfunctions for redesigned buffer.

$R_V$  = Rejection value.

$M_{R2}$  = Number of difficult-to-clear malfunctions for redesigned buffer.

$M_{S1}$  = Number of easy-to-clear malfunctions for standard buffer.

$M_{S2}$  = Number of difficult-to-clear malfunctions for standard buffer.

The rejection value was also determined for all test conditions but excluding both salt-water immersion and -65°F firings.

	<u>Redesigned Buffer</u>	<u>Standard Buffer</u>
FFR	4	405
FBR	10	23
COEC	17	1
Total	31	429
All other malfunctions	207	132

$$M_{R1} + R_V \cdot M_{R2} \geq M_{S1} + R_V \cdot M_{S2}$$

$$31 + R_V(207) \geq 429 + R_V(132)$$

$$R_V \geq 5.3$$

From the rejection values determined above, the following conclusion is made:

If the incidence of a difficult-to-clear malfunction reduces the combat effectiveness of the M16A1 rifle by no more than a factor of 2.1, when compared to the effectiveness loss of each easy-to-clear malfunction, then the redesigned buffer is acceptable for world-wide use as a replacement for the standard buffer; if the effectiveness ratio between the two basic types of malfunctions exceeds 2.1 but does not exceed 5.3, then the redesigned buffer is an acceptable replacement, but for temperate zone use only.

### 1.5.2 Malfunction Rate

The malfunction rate criteria permitting approximately two malfunctions per 1000 rounds fired was met only during redesigned buffer firings with lot LC12177 (salt-water immersion and -65°F firings excluded). Lot LC12177 was a ball propellant-loaded lot of ball cartridges and provided substantially higher cyclic rates of fire in all guns and with both buffers than did any of the other three test lots of ammunition. In a similar manner, lot LC12177 provided equally reliable and acceptable performance when used with the standard buffer with the single exception of the high number of failures to fire which occurred with this combination.

In summation, it can be concluded that ball propellant-loaded lots of ball cartridges, with characteristics similar to those of lot LC12177, will provide reliable performance with the M16A1 rifle equipped with the redesigned buffer, and that even with the standard buffer, the only significant functioning deficiency encountered will be principally confined to the failure to fire malfunction.

As an added consideration, serious concern must be expressed in view of the fact that this agency is not aware that the failure-to-fire malfunction has been reported as a significant failure in SEA operations. If this low incidence of failure-to-fire in combat use is true, it can be at least partially explained by the fact that it rarely occurs in semiautomatic fire, and even in short automatic bursts it rarely occurs on the first round of each burst (which, in fact, is a semiautomatically fired round). To make a hypothetical case, if one-half of the rounds in every magazine in combat are fired semiautomatically and the remaining rounds fired in three-round bursts, the likelihood of a failure-to-fire occurring has been reduced 70% in comparison to firings conducted fully automatically. There exists a very real possibility that the redesigned buffer has eliminated a malfunction which occurs in combat less often than presumed and at the same time has increased the incidence of the "jamming" type malfunction; and the latter malfunction has been cited, correctly or incorrectly, as the major deficiency of the M16A1 rifle in SEA.

### 1.5.3 Cyclic Rate of Fire

Cyclic rate of fire measurements in all tests with both models of buffers failed to remain within the specified limits of 650 to 850 rounds per minute on 630 occasions during 1916 trials. Firings with the redesigned buffer which failed to meet the specification were predominately below the lower limit (273 occasions) while the standard buffer failures were predominately above the upper limit (274 occasions).

If it is considered desirable to lower the level of cyclic rate of fire of the standard buffer-equipped M16A1 rifle to a range more nearly in line with the "design" rate of 650 to 850 rounds per minute, then it must be concluded that the redesigned buffer has overcorrected high-rate characteristics and it comes no closer to meeting the requirement than does the standard buffer, considering the spectrum of all test conditions. Only at temperatures of approximately +70°F, employing recently cleaned and lubricated weapons, will rates of fire with the redesigned buffer remain reasonably confined within the specified rates. Even under these conditions, approximately 30% of the firings with IMR 8208 propellant-loaded cartridges will fall below 650 rounds per minute.

The results of this test also cast serious doubt on the validity of the specified "design" limits of 650 to 850 rounds per minute. While a significant increase in over-all malfunction rates appears to be closely associated with rates somewhat below the lower limit, there does not appear to be a similar phenomenon associated with malfunction rates during cyclic rates of fire as high as 950 rounds per minute. On the basis of the results in this test, it is concluded that the presently specified rate range under which weapons are accepted should be shifted in the direction of higher rates.

This recommended change in rate-of-fire criteria would also require a change in the characteristics of the redesigned buffer if a maximum number of rifles are to be accepted and if the optimum limits of cyclic rate of fire are to be established.

It is also concluded that, if two propellants are to be used in cartridges for M16A1 rifles, then the cyclic rate-of-fire characteristics of each propellant cannot be permitted to be 100 rounds per minute apart, particularly when small samples of M16A1 rifles also evidence 100 rounds per minute and more differences in rate with all test conditions including the cartridge lot identical. The likelihood is then too great that eventually low-rate-of-fire guns will be fired with low-rate ammunition, and vice versa, with adverse effects on the functioning performance of the weapons.

## 1.6 RECOMMENDATIONS

It is recommended that:

- a. Due to the different characteristics of the malfunctions associated with the standard buffer versus the redesigned buffer, it is essential to resolve with the utmost urgency the significance of these characteristics particularly in view of the unexpected trade-off of malfunctions which occurred in this test. The engineering personnel most intimately involved with testing of the M16A1 rifle can contribute to this evaluation and the expertise of human factors engineers is also required, but the judgement and analysis of experienced military personnel is felt to be essential. The resolution of this very difficult problem should provide a most significant advance in the analysis of the performance levels of the M16A1 rifle.
- b. It is considered possible that by minor modification of the redesigned buffer through a change in mass, that an absolute reduction in malfunctions may be obtained without the undesirable characteristics of a trade-off. While a kinematic evaluation is currently underway to determine if this potential exists, it is recommended that a much more extensive design investigation be undertaken.

## SECTION 2. DETAILS OF TEST

### 2.1 INTRODUCTION

#### 2.1.1 Ammunition

Four projectile-propellant combinations of 5.56-mm cartridges were fired in approximately equal numbers throughout test (some exceptions are noted in certain subtests). The cartridge types are as follows:

- a. M193 cartridge, ball projectile and ball propellant, lot LC12177.
- b. M193 cartridge, ball projectile and IMR 8208M propellant, lot TW18166.
- c. M196 cartridge, tracer projectile and ball propellant, lot LC12081.
- d. M196 cartridge, tracer projectile and IMR 8208M propellant, lot TW18001.

#### 2.1.2 Maintenance

Each weapon was disassembled, cleaned, and lubricated following the instructions in TM 9-1005-249-14 (Reference 1) after approximately each 600 rounds of firing as well as prior to the initiation of any subtest, with the exception of the extended firing in paragraphs 2.5, 2.6, and 2.7. MIL-L-46000A semifluid oil was used in all tests except in paragraphs 2.7 and 2.8 where MIL-L-14107A oil was used (Reference 7).

Prior to the final rate test in paragraphs 2.5 through 2.8, each weapon was cleaned by wiping the bolt and carrier, lubricating with MIL-L-46000A, and each rifle bore was wire-brushed. The final rate tests were then conducted under normal ambient conditions.

#### 2.1.3 Firing Schedules

Various firing schedules in this test were designed to permit an evaluation of the effects of firing four types of ammunition while employing standard and redesigned buffers in twelve M16A1 rifles of current production. Six of the weapons were fired with approximately equal amounts of all four types of ammunition while three weapons

were fired only with ball-projectile ammunition and the remaining three weapons were fired only with tracer-projectile ammunition. All firings with each weapon were divided equally as nearly as possible, between standard and redesigned buffers. Each weapon was assigned one standard and one redesigned buffer and the buffers were numbered to insure that the same pair of buffers remained with the same rifle throughout all subtests. Detailed firing schedules are shown in each subtest.

#### 2.1.4 Modes of Fire

All cyclic rate-of-fire tests were conducted by measuring on each occasion, unless otherwise noted, an uninterrupted 20-round burst. All other firings were conducted by firing approximately equal numbers of rounds in the semiautomatic mode and in 3- to 5-round automatic bursts, except during the accelerated firing test which was fired only in the full automatic mode.

#### 2.1.5 Malfunctions

A description of malfunctions is contained in Table 2.1-I. The purpose of the table is to define in some detail the more common malfunctions as they occurred in this test. However, the undetermined significance of human factors problems precludes any numerical weighting of the malfunctions and the intent is not to rank malfunctions by degree of severity or to categorically identify them as unclearable, immediately clearable, etc.

The following paragraph is extracted from FM 23-9 (Reference 8) and identifies the current training instructions for clearing of malfunctions in the M16A1 rifle:

### "SECTION IV. STOPPAGES AND IMMEDIATE ACTION

#### 14. STOPPAGES

A stoppage is any unintentional interruption in the cycle of operation. Immediate action must be taken to clear the stoppage.

#### 15. IMMEDIATE ACTION

Immediate action is the unhesitating application of a probable remedy to reduce a stoppage without investigating the cause. Immediate action when clearing a stoppage in the XM16E1 consists of the following steps:

- a. Strike upward on the bottom of the magazine to insure that it is fully seated.

- b. Pull the charging handle fully to the rear and release it.
- c. Strike the forward assist assembly to insure that the bolt is fully seated.
- d. Attempt to fire the weapon."

With regard to the preceding paragraph, Development and Proof Services has been unofficially advised that a significant change in the instructions for immediate action is now being proposed for inclusion in FM 23.9. This change would instruct the firer to use the bolt-assist device as a first corrective action prior to retracting the charging handle.

This change in procedure is viewed with some concern as observations throughout this test indicate that many malfunctions may become much more difficult to clear if use of the bolt-assist device becomes an arbitrary "first action." Table 2.1-I discusses in detail some of the complications that may arise if an incorrect clearing action is first attempted.

Table 2.1-1. Identification and Description of M16A1 Rifle Malfunctions

Abbrevia- tion	Identification	Description	Required Clearing Action and Related Problems <sup>a</sup>
BOB	Bolt overrides the base of the round.	<p style="text-align: center;">Feeding Failures</p> <p>The base of the round to be fed is not presented in a fully elevated position in front of the forward moving bolt. This may be caused by an underpowered or short recoil of the bolt and carrier, or by a failure of the cartridge follower in the magazine to fully elevate the dual cartridge columns. The jammed and damaged cartridge is most often only partially stripped from the magazine.</p>	<p>Clearing of this malfunction can rarely be done quickly and if the bolt assist device is used as a first corrective action the degree of severity of the malfunction is greatly increased. Clearing of the stoppage requires retracting the charging handle only far enough to permit the base of the round to move upward in front of the bolt and then releasing the charging handle. Pulling the charging handle fully to the rear may cause a double feed.</p>
			<p>In some instances of this malfunction the round to be fed has been driven forward into the chamber after impact by the bolt and a second round partially stripped forward from the magazine jamming the bolt in an "override" position. In order to clear the weapon, the bolt must be retracted and held rearward while the magazine is removed. Usually some force is needed to withdraw the magazine due to the partially stripped round and this force may be sufficient to spread or damage the lips of the magazine.<sup>b</sup></p>

<sup>a</sup>As most malfunctions cannot be sensed by the shooter until after he has pulled the trigger, and consequently released the hammer, those immediate actions which may clear a malfunction by manually completing bolt closure do not permit a resumption of firing until the rifle is also recocked.

<sup>b</sup>As noted in the table, a number of the cited methods to clear malfunctions may inadvertently damage the magazine. While these methods might be necessary under combat conditions, tools were used during all tests (except the dust test) to facilitate clearing of jammed rounds without damage to the magazines.

Table 2.1-1 (Cont'd)

Abbreviation	Identification	Description	Required Clearing Action and Related Problems <sup>a</sup>
COEC	Bolt closes on an empty chamber	Occurs either as a result of a failure of the cartridge follower to fully elevate the round to be fed, or as a result of short recoil of the bolt and carrier. The malfunction is closely related to a bolt override although the consequences of a COEC are much less than those of a BOB.	The malfunction is not difficult to clear and firing can be resumed quickly by fully retracting and then releasing the charging handle. If the bolt assist device is inadvertently used instead of the charging handle, the error only delays but does not further increase the difficulty of correctly clearing the malfunction.
DF	Double feed	The distinction between a double feed and a bolt override of a second round, as discussed above under BOB, is that in the case of a DF the bolt is behind both the cartridge to be fed and the next round and both rounds are simultaneously being forced into the chamber.	Clearing of this malfunction requires fully retracting the bolt and removal of the magazine. The removal of the magazine may unavoidably result in damage to the lips of the magazine.  Inadvertent use of the bolt assist device to clear the weapon will greatly increase the degree of severity of the malfunction and may make necessary the use of tools to accomplish clearing.
FF	Failure to feed	Occurs as a result of insufficient energy of the bolt and carrier to successfully carry through the feeding and chambering operations. The round is in front of the bolt but usually not in a jammed position.	The malfunction can usually be quickly cleared by use of either the bolt assist device or the charging handle providing that if the latter is used only a partial rearward retraction is employed. Full retraction and release of the charging handle may cause a double feed.

<sup>a</sup>As most malfunctions cannot be sensed by the shooter until after he has pulled the trigger, and consequently released the hammer, those immediate actions which may clear a malfunction by manually completing bolt closure do not permit a resumption of firing until the rifle is also recocked.

Abbreviation	Identification	Description	Required Clearing Action and Related Problems <sup>a</sup>
FF-1	Failure to feed the first round of a fully loaded magazine	Occurs when the bolt, after being released by depressing the bolt stop release lever, lacks sufficient energy to feed and chamber the first round of a fully loaded magazine.	The malfunction can usually be quickly cleared either by use of the bolt assist device or by retracting the charging handle. However, use of the charging handle may occasionally cause a double feed.
Ejection and Extraction Failures			
FJ	Failure to eject	Occurs when a fired case fails to clear the ejection port causing the bolt to stop in its forward motion. The next live round to be fed is often in the chamber but usually not in a jammed position.	Corrective action must be limited to proper manipulation of the charging handle, as fully retracting the charging handle may result in a double feed. Use of the bolt assist device will only increase the severity of the stoppage.
Repetitive Failures			
28		Repetitive failures are often due to a broken or damaged extractor (not ejector) spring.	In some instances the fired case, if it is sufficiently exposed, can be manually removed and the weapon cleared without use of the charging handle.
FX	Failure to extract	A broken or damaged extractor or extractor spring, or the occurrence of a sheared cartridge rim, will result in a failure to extract. On some occasions, particularly with a fouled chamber, the extractor may be forced over the rim of the case without causing a complete rim shear. A live round is often fed into the base of the case which failed to extract.	In the event of a sheared rim or broken extractor the malfunction cannot be immediately cleared. A cleaning rod may be required to remove the fired case. Where the cartridge rim is still intact and the extractor undamaged, the fired case can usually be successfully extracted by manually cycling the bolt providing that the gun is first cleared of all live rounds. Inadvertent use of the bolt assist device as a first corrective action may cause a live round to be forced against the base of the fired case, firmly jamming the fired case in the chamber.

<sup>a</sup>As most malfunctions cannot be sensed by the shooter until after he has pulled the trigger, and consequently released the hammer, those immediate actions which may clear a malfunction by manually completing bolt closure do not permit a resumption of firing until the rifle is also recocked.

Table 2.1-I (Cont'd)

Abbreviation	Identification	Description	Required Clearing Action and Related Problems <sup>a</sup>
FBR	Failure of the bolt to remain to the rear after the last round is fired	<p style="text-align: center;">Other Failures</p> <p>Usually attributed to the failure of the bolt catch to engage the bolt at very high cyclic rates of fire.</p>	<p>Presumably the only problem associated with this malfunction would be some initial uncertainty on the part of the gunner in diagnosing whether or not a firing stoppage had occurred. However, if the empty magazine is removed prior to fully retracting the charging handle, the bolt cannot easily be latched rearward. Attempting then to insert a fully loaded magazine against the pressure of the bolt carrier becomes difficult and in some instances may cause damage to the magazine lips.</p>
FFR	Failure to fire	<p>This malfunction is usually associated with a light firing pin indent on the primer. While it may be caused by a weak hammer spring, or by a dirt-laden or fouled firing pin, it is most often attributed to the bolt carrier being somewhat out of "battery position," i.e., not fully forward at the time the hammer falls. This permits the hammer to strike the carrier rather than to directly impact the firing pin.</p>	<p>The malfunction is not difficult to clear and firing can be resumed quickly by fully retracting and then releasing the charging handle. If the bolt assist device is inadvertently used instead of the charging handle, the error only delays but does not further increase the difficulty of correctly clearing the malfunction.</p>
F2R	Firing two rounds on a single trigger pull in semiautomatic fire mode	<p>Usually caused by the trigger pin moving out of position.</p>	<p>Cannot be overcome quickly; requires manipulation of the trigger and the trigger pin to correct. Disassembly of the gun is not necessary.</p>

<sup>a</sup>As most malfunctions cannot be sensed by the shooter until after he has pulled the trigger, and consequently released the hammer, those immediate actions which may clear a malfunction by manually completing bolt closure do not permit a resumption of firing until the rifle is also recocked.

## 2.2 INSPECTION

### 2.2.1 Objectives

To determine that the test weapons have been received in proper condition for test and to determine the physical characteristics of the standard and redesigned buffers.

### 2.2.2 Criteria

The test items shall be suitable for test and free of apparent defects.

### 2.2.3 Method

The weapons are disassembled, cleaned and lubricated as specified in TM 9-1005-249-14. Rifle bores are inspected and measured, head space and firing pin protrusion determined, and the chambers tested for chrome plating. Weights and measurements of the standard and redesigned buffers are recorded. At the conclusion of all firing tests all buffers are disassembled and inspected.

### 2.2.4 Results

The inspection results are summarized in Table 2.2-I and the following figures. Bore dimensions are contained in Appendix I. None of the rifle chambers were chromeplated.

Figure 2.2-1 shows disassembled views of the redesigned and standard buffers. The buffers were X-rayed prior to the salt-water immersion test and no damage from previous firings (7500 to 8500 rounds per gun; 3750 to 4450 rounds per buffer) could be detected.

The buffers were then disassembled and inspected at the conclusion of all firing. Two of the polyurethane end caps from the redesigned buffers were slightly split or cracked, but no other damage or wear was noted.

It was also noted that the rifle buttstocks on ten of the 12 rifles were cracked at the conclusion of all firing. However, with the exception of two of the cracked stocks, the damage was not severe enough to require stock replacement. The damage was caused during -65°F and salt-water immersion firings by bumping the buttstock on a firm surface while simultaneously attempting to retract the charging handle in instances where the bolt could not be retracted in a normal manner.

Table 2.2-1. Physical Characteristics

	Gun No.												
	735086	737114	737142	737641	737993	738329	739498	745075	745214	748046	749967	762573	168486 <sup>a</sup>
Lead space, in.	1.4656	1.4666	1.4656	1.4666	1.4646	1.4646	1.4646	1.4656	1.4666	1.4666	1.4656	1.4666	1.4656
Firing-pin protrusion, in.	0.034	0.035	0.032	0.032	0.034	0.034	0.034	0.032	0.032	0.035	0.034	0.033	0.030
Standard buffer, bearing surface diameter, in.	0.986	0.986	0.986	0.986	0.987	0.987	0.986	0.986	0.985	0.987	0.986	0.987	-
Redesigned buffer bearing surface diameter <sup>b</sup> , in.	0.982	0.981	0.982	0.981	0.977	0.978	0.977	0.978	0.981	0.980	0.978	0.977	0.978
Standard buffer length, in.	5.859	5.859	5.853	5.864	5.850	5.860	5.865	5.856	5.854	5.873	5.860	5.870	-
Redesigned buffer length, in.	5.917	5.925	5.930	5.914	5.921	5.918	5.914	5.924	5.917	5.925	5.918	5.932	-
Standard buffer weight, lb	0.128	0.126	0.126	0.126	0.126	0.126	0.128	0.126	0.126	0.128	0.126	0.126	-
Redesigned buffer weight, lb	0.328	0.328	0.330	0.328	0.328	0.328	0.328	0.328	0.330	0.328	0.328	0.328	-

<sup>a</sup>Gun No. 168486 replaced gun No. 762573 in test (ref par. 2.3).

<sup>b</sup>F = forward bearing ring; R = rear bearing ring.

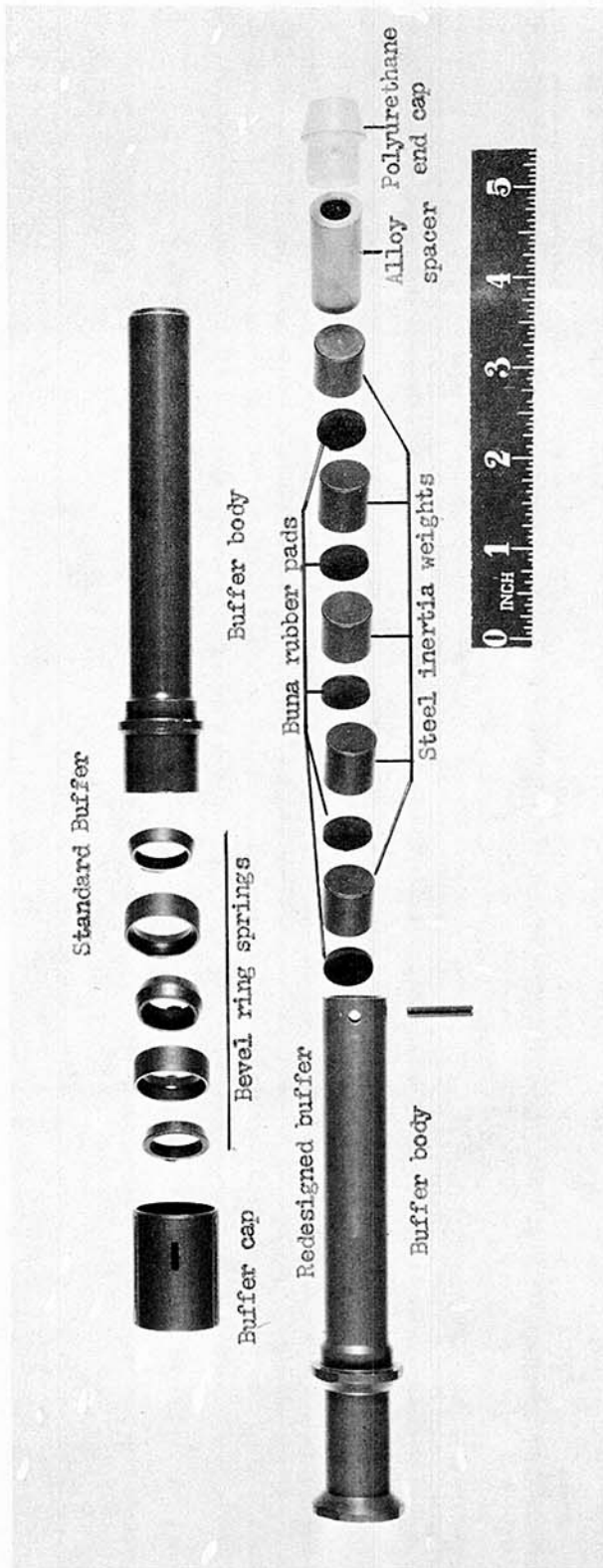


Figure 2.2-1: Disassembled Views of the Standard and Redesigned Buffers.

### 2.2.5 Analysis

The redesigned buffers demonstrated a significant improvement in durability compared to the standard buffer. Jammed or stuck buffer ring springs were noted with all of the standard buffers. This problem is discussed further in other subtests.

## 2.3 CYCLIC RATE OF FIRE TEST

### 2.3.1 Objective

To measure the cyclic rate of fire of the test weapons during normal ambient conditions.

### 2.3.2 Criteria

The cyclic rate of fire for each 20-round burst shall be within 650 to 850 rounds per minute (par. 10.2.1, Reference 3).

### 2.3.3 Method

Wherever cyclic rates of fire are required, either initially in this subtest or during the firing in any other subtest (except pars. 2.10, 2.11, and 2.12) the schedule in Table 2.3-I is followed.

Table 2.3-I. Cyclic Rate Schedule

Each trial is a 20-round continuous burst.

Trial No. <sup>b</sup>	Buffer	Ammunition Type <sup>a</sup>			
		Guns			
		1 to 3	4 to 6	7 to 9	10 to 12
1	Std	A	D	A	C
2	Red.	A	D	A	C
3	Std	B	C	B	D
4	Red.	B	C	B	D
5	Std	C	B	A	C
6	Red.	C	B	A	C
7	Std	D	A	B	D
8	Red.	D	A	B	D

<sup>a</sup>Ammunition Type: A - M193 with ball propellant, lot LC12177.  
B - M193 with 8208 propellant, lot TW18166.  
C - M196 with ball propellant, lot LC12081.  
D - M196 with 8208 propellant, lot TW18001.

<sup>b</sup>A minimum cooling time of 15 minutes is observed between each trial.

#### 2.3.4 Results

The cyclic rate-of-fire data are summarized and graphically presented in Figures 2.3-1 through 2.3-4. The individual cyclic rate data are contained in Appendix I.

During the conduct of the cyclic rate of fire test a total of 1760 rounds was fired in 11 of the test guns following the schedule in Table 2.3-I. No malfunctions occurred.

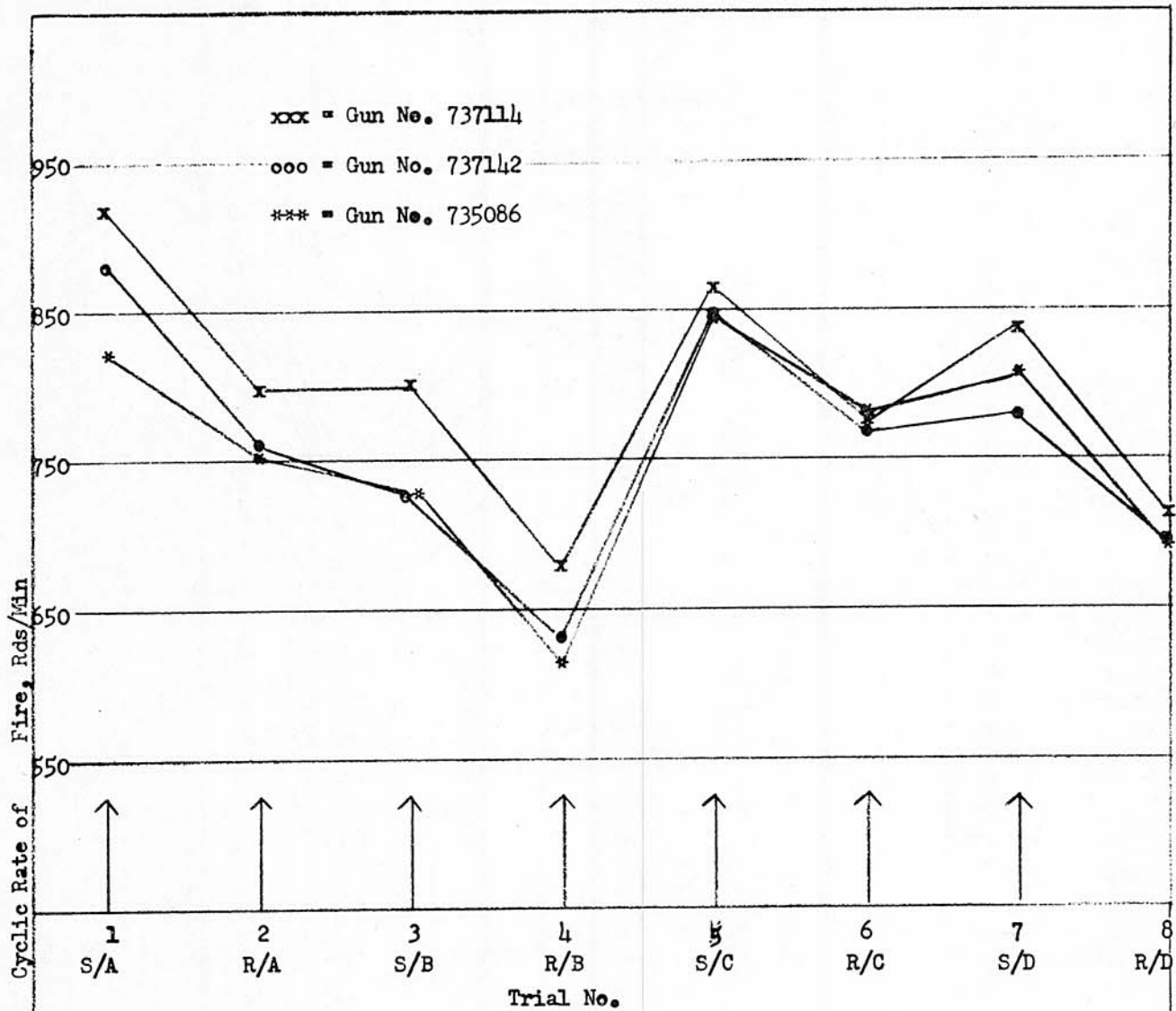
However, during firing of the sixth magazine (lot LC12081) with the twelfth test gun, No. 762573, a failure of the bolt carrier to close occurred. Inspection revealed that the gas-exit end of the gas tube and the gas-entrance end of the bolt carrier key were damaged. The tube and the key were both replaced and it was assumed that one or both components may have been incorrectly aligned in the gun as received for test.

The eight trials of the cyclic rate-of-fire test were then re-initiated and completed firing only tracer ammunition as specified in Table 2.3-I. Subsequently, in comparing these eight cyclic-rate trials, the rate of fire with the redesigned buffer, with one exception, was seen to be higher or approximately the same as rates obtained with the standard buffer. As this was a complete reversal of rate comparison data obtained with standard and redesigned buffers in the other 11 test guns, further investigatory firings were conducted.

An XM16E1 rifle was selected and component parts were exchanged between the XM16E1 and gun No. 762573 until it was possible to induce the same rate reversal phenomena in the XM16E1 rifle. As the only component part that remained associated with the rate reversal throughout the trials was the standard buffer from gun No. 762573, the buffer was disassembled and inspected. Four of the five bevel ring springs were found firmly pressed together. In this condition, the springs are not free to act as an energy-absorbing device.

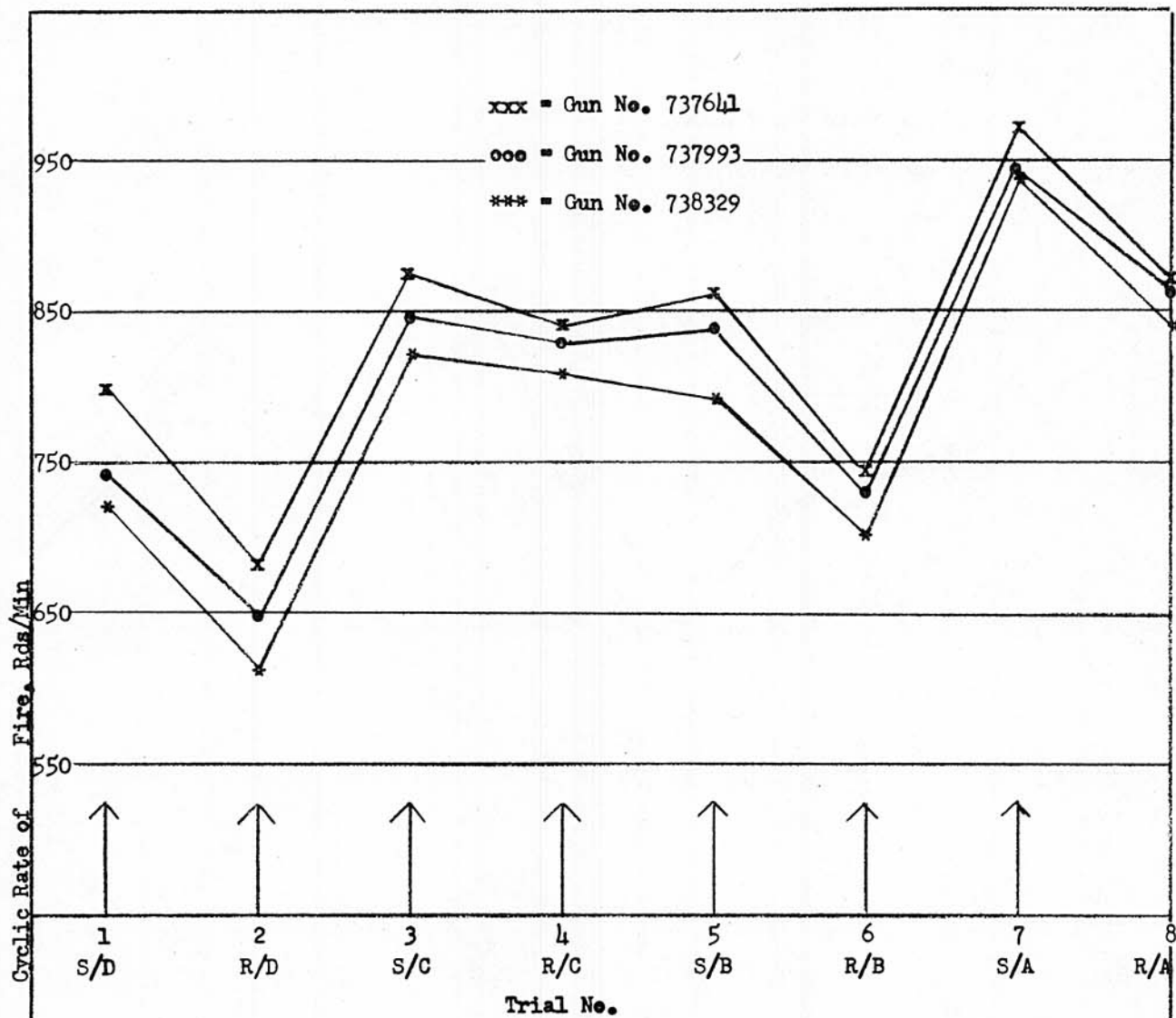
As a significant number of rounds had been fired in gun No. 762573 before the standard buffer deficiency was identified, the gun was replaced in test with a new XM16E1 rifle, No. 168486 (fired 30 rounds previously). The XM16E1 rifle was equipped by Development and Proof Services with the latest design bolt assembly and bolt carrier and key, and a new standard and a new redesigned buffer were assigned to the rifle.

The cyclic rate-of-fire test was then conducted with rifle No. 168486 and the rates are shown in Figure 2.3-4.



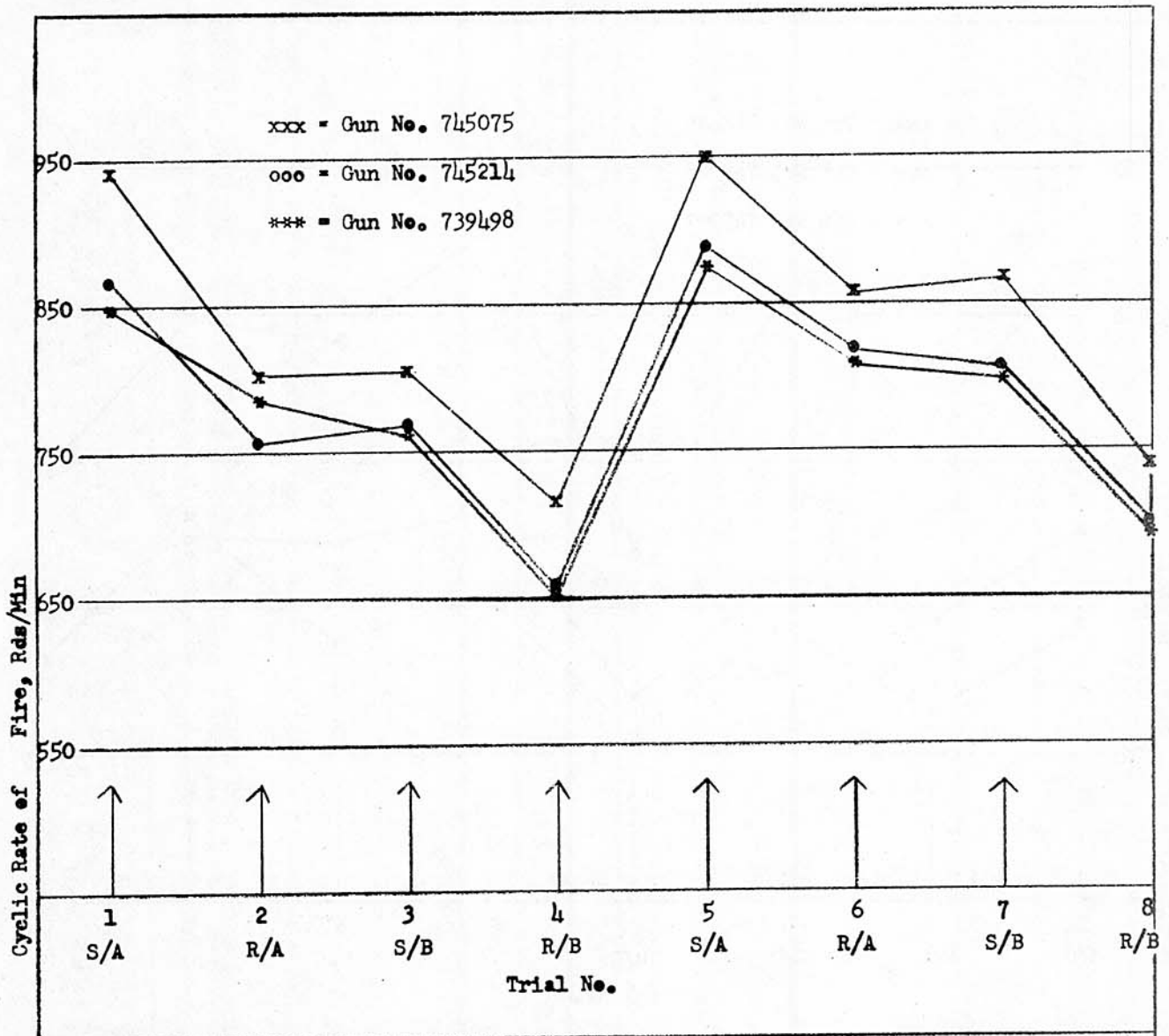
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.3-1. Cyclic Rate of Fire Test for Three M16A1 Rifles in New Condition.



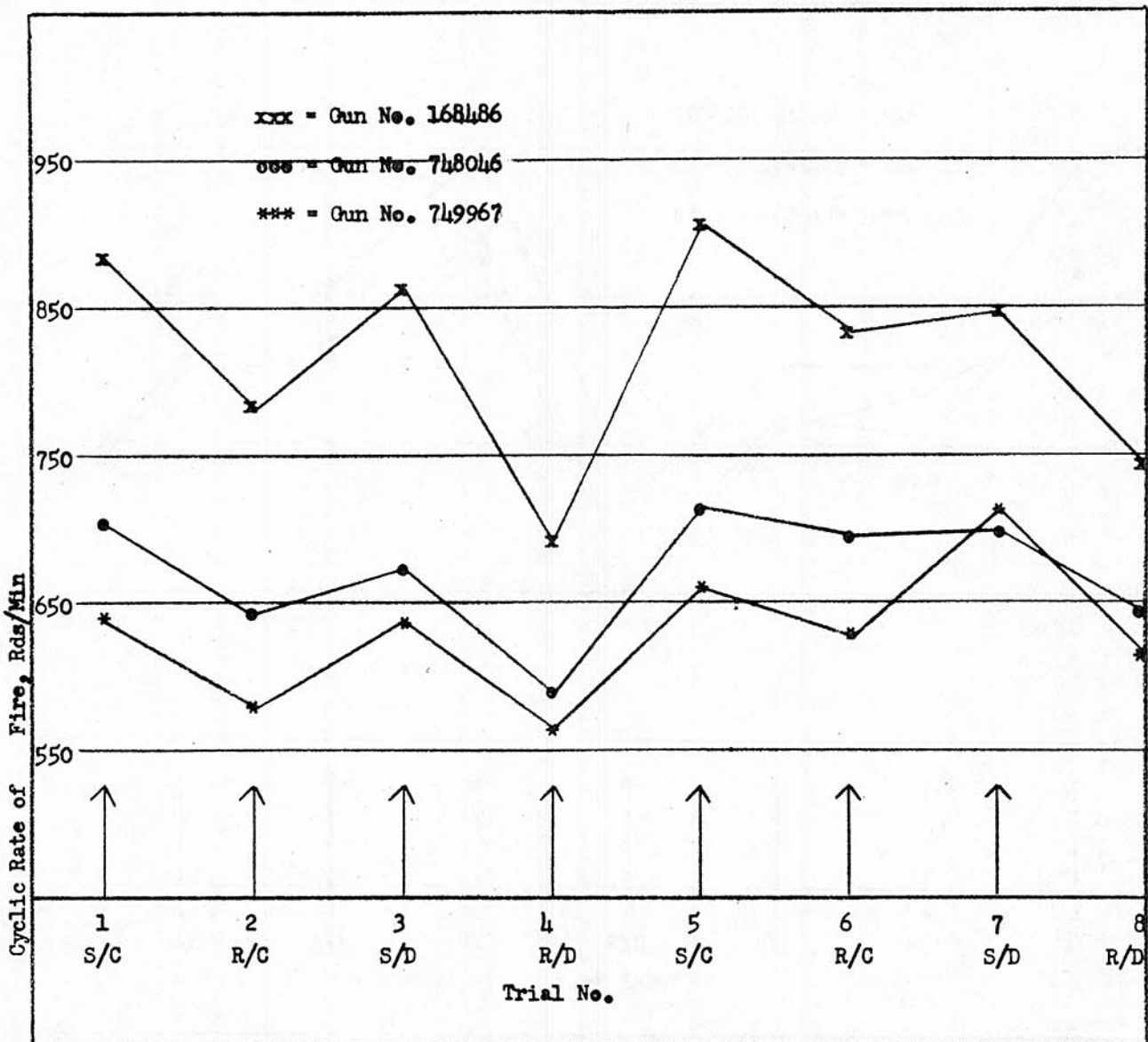
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.  
 S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
 S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.3-2. Cyclic Rate of Fire Test for Three M16A1 Rifles in New Condition.



S/A = Standard buffer while firing M193, ball propellant.  
 R/A = Redesigned buffer while firing M193, ball propellant.  
 S/B = Standard buffer while firing M193, 8208M propellant.  
 R/B = Redesigned buffer while firing M193, 8208M propellant.

Figure 2.3-3. Cyclic Rate of Fire Test for Three M16A1 Rifles in New Condition.



S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.3-4. Cyclic Rate of Fire Test for Three M16A1 Rifles in New Condition.

### 2.3.5 Analysis

The cyclic rate-of-fire data illustrated in Figures 2.3-1 through 2.3-4 show that, in each case, regardless of individual gun characteristics or the lot of ammunition fired, the redesigned buffer provided lower rates than comparable firings with the standard buffer. While a reduction in rate of fire is one of the design intents of the redesigned buffer, it should be pointed out that of the 48 trials firing the redesigned buffer, 11 trials were below the minimum permitted rate of 650 rounds per minute while three trials exceeded 850 rounds per minute. The record for the standard buffer was two trials below the minimum rate and 17 trials exceeding the upper rate.

During the conduct of the majority of other subtests cyclic rate of fire trials were conducted at normal ambient conditions immediately after cleaning. The record for 357 trials with the redesigned buffer, including the trials in the initial rate test, was 63 trials below 650 rounds per minute and 5 trials above 850 rounds per minute. The record for the standard buffer was 3 trials below the minimum rate and 105 trials exceeding the upper rate.

## 2.4 SPECIAL FIRING TEST

### 2.4.1 Objective

To provide Hq, USAMC with three M16A1 rifles, each fired 1000 rounds without cleaning, for the purpose of examination of the nature and extent of bore-fouling by Hq, USAMC personnel.

### 2.4.2 Criteria

Not applicable.

### 2.4.3 Method

The test was directed as a supplement to the M16A1 rifle firings specified in the test plan. The supplemental directive with an explanation of the method of test is contained in Appendix II.

### 2.4.4 Results

Three M16A1 rifles and four lots of ammunition were fired. The test rifles were not used in any other tests in this report. The rifles and ammunition lots are identified below:

Gun Nos.: 728523, 737413, and 741244.

Ammunition Lot Nos.: LC12194 (M193, ball propellant).  
TW18191 (M193, 8208M propellant).  
LC121081 (M196, ball propellant).  
TW18007 (M196, 8208M propellant).

Three failures occurred during the firing of 1140 rounds with gun No. 728523; two failures to eject and one failure of the trigger to return. The failures occurred while firing lot LC12194. Cyclic rates of fire averaged 666 rounds per minute with lot TW18191 and 792 rounds per minute with lot LC12194.

One failure to feed, a double feed, occurred during the firing of 1160 rounds with gun No. 737413 and with lot TW18191. Cyclic rates of fire averaged 700 rounds per minute with lot TW18191 and 789 rounds per minute with lot LC12194.

Two failures to feed, both double feed, occurred during the firing of 1110 rounds with gun No. 741244; one failure occurred with lot LC12194 and the other with lot LC12081. Cyclic rates of fire averaged 677 rounds per minute with lot TW18191 and 816 rounds per minute with lot LC12194.

The weapons were hand-carried to HQ, USAMC on 21 August for examination and inspection.

#### 2.4.5 Analysis

Not applicable.

## 2.5 HIGH HUMIDITY

### 2.5.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a re-designed buffer when firing various types of ammunition during high-humidity conditions.
- b. To compare the above performance with similar firing employing the standard buffer.

### 2.5.2 Criteria

- a. The cyclic rate of fire for each 20-round burst shall be within 650 to 850 rounds per minute (par. 10.2.1, Reference 3).
- b. The total number of malfunctions and unserviceable parts for all subtests except par. 2.11 and 2.12 shall not exceed the specifications of Table 1 in par. 10.3, Reference 3.

### 2.5.3 Method

The method of test is described in par. 3.3.1c, Interim Pamphlet 20-20, TECP 700-700, 11 April 1966.

The firing schedule in Table 2.5-I is followed.

Table 2.5-I. High Humidity Schedule

Trial No.	Buffer	Rds Fired Per Gun <sup>b</sup>	Ammunition Type <sup>a</sup>		
			Guns Nos.		
			1 to 6	7 to 9	10 to 12
<sup>c</sup> 1	Std and Red.	160	Repeat cyclic rate of fire test.		
<sup>c</sup> 2	Std	80	A	A	C
<sup>d</sup> 3	Red.	80	B	A	C
<sup>d</sup> 4	Std	80	C	B	D
<sup>d</sup> 5	Red.	80	D	B	D

<sup>a</sup>See explanation, Table 2.3-1.

<sup>b</sup>Except for trials No. 1, 10, and 11, each trial is divided equally into automatic (3-round bursts) and semiautomatic firing.

<sup>c</sup>After 48 hours of conditioning.

<sup>d</sup>After 96 hours of conditioning.

Table 2.5-1 (Cont'd)

Trial No.	Buffer	Rds Fired Per Gun <sup>b</sup>	Ammunition Type <sup>a</sup>		
			Guns Nos.		
			1 to 6	7 to 9	10 to 12
<sup>e</sup> 6	Std	80	D	A	C
<sup>e</sup> 7	Red.	80	C	A	C
<sup>e</sup> 8	Std	80	B	B	D
<sup>f</sup> 9	Red.	80	A	B	D
<sup>f</sup> 10	Std and Red.	160	Repeat cyclic rate of fire test.		
<sup>g</sup> 11	Std and Red.	160	Repeat cyclic rate of fire test.		

<sup>a</sup> See explanation, Table 2.3-1.

<sup>b</sup> Except for trials No. 1, 10, and 11, each trial is divided equally into automatic (3-round bursts) and semiautomatic firing.

<sup>e</sup> After 168 hours of conditioning.

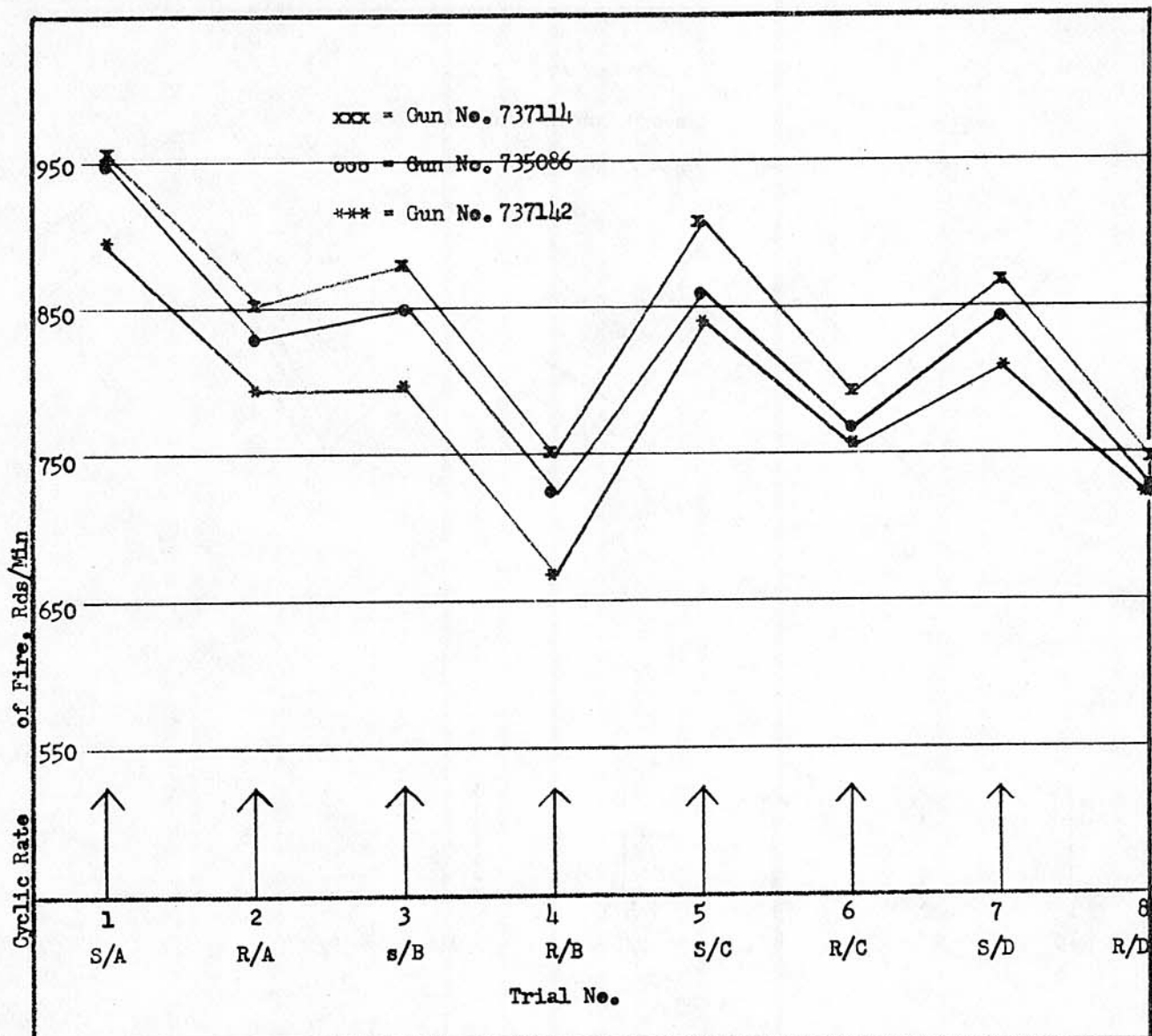
<sup>f</sup> After 216 hours of conditioning.

<sup>g</sup> Fired under normal ambient conditions following cleaning and lubrication.

#### 2.5.4 Results

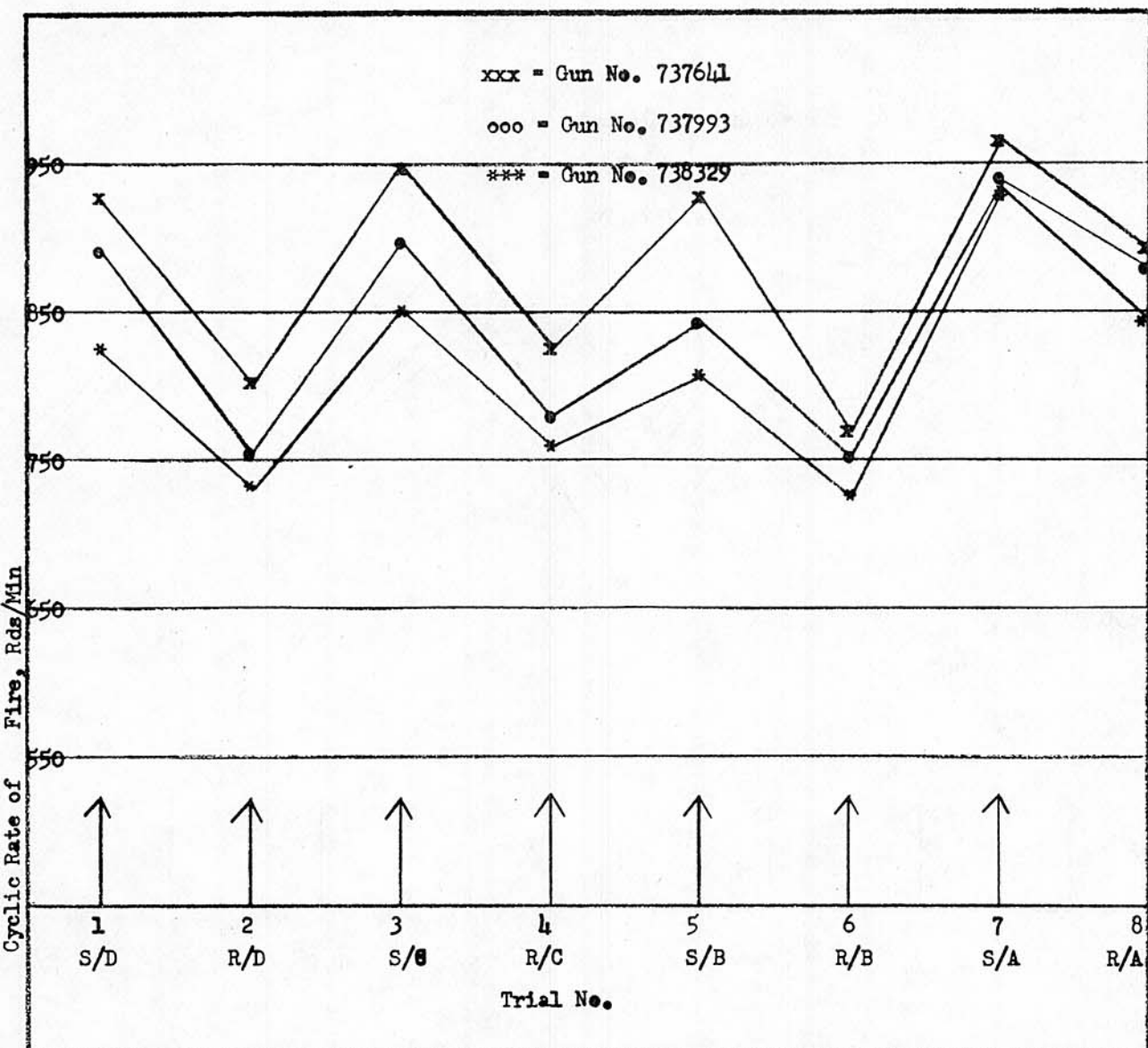
The results of the three cyclic rate of fire tests are summarized in Figure 2.5-1 through 2.5-12. The individual cyclic rate-of-fire data are contained in Appendix I.

The functioning data are summarized in Table 2.5-II.



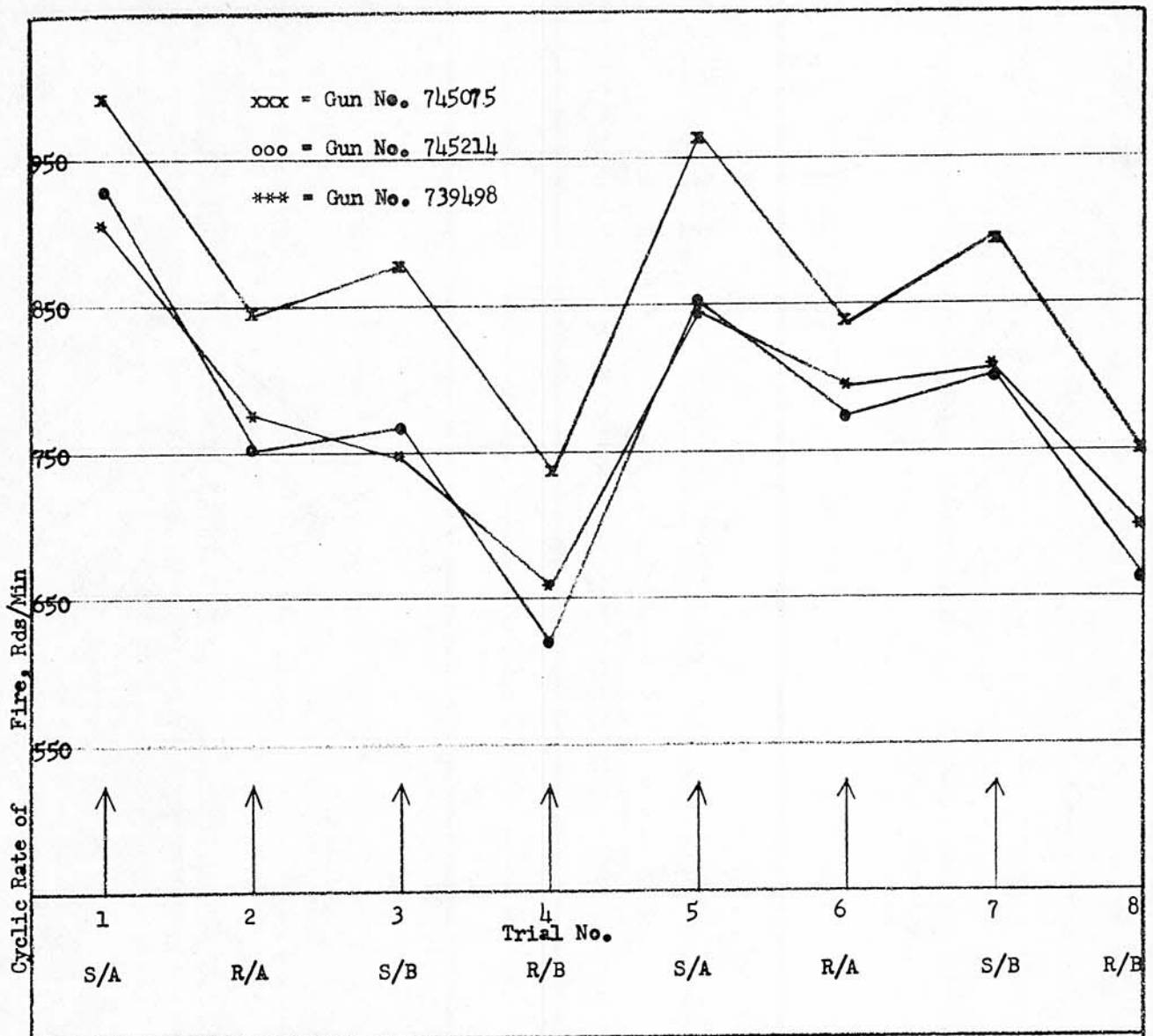
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.5-1. Cyclic Rate of Fire Test During Initial Phase of High Humidity Test for Three M16A1 Rifles.



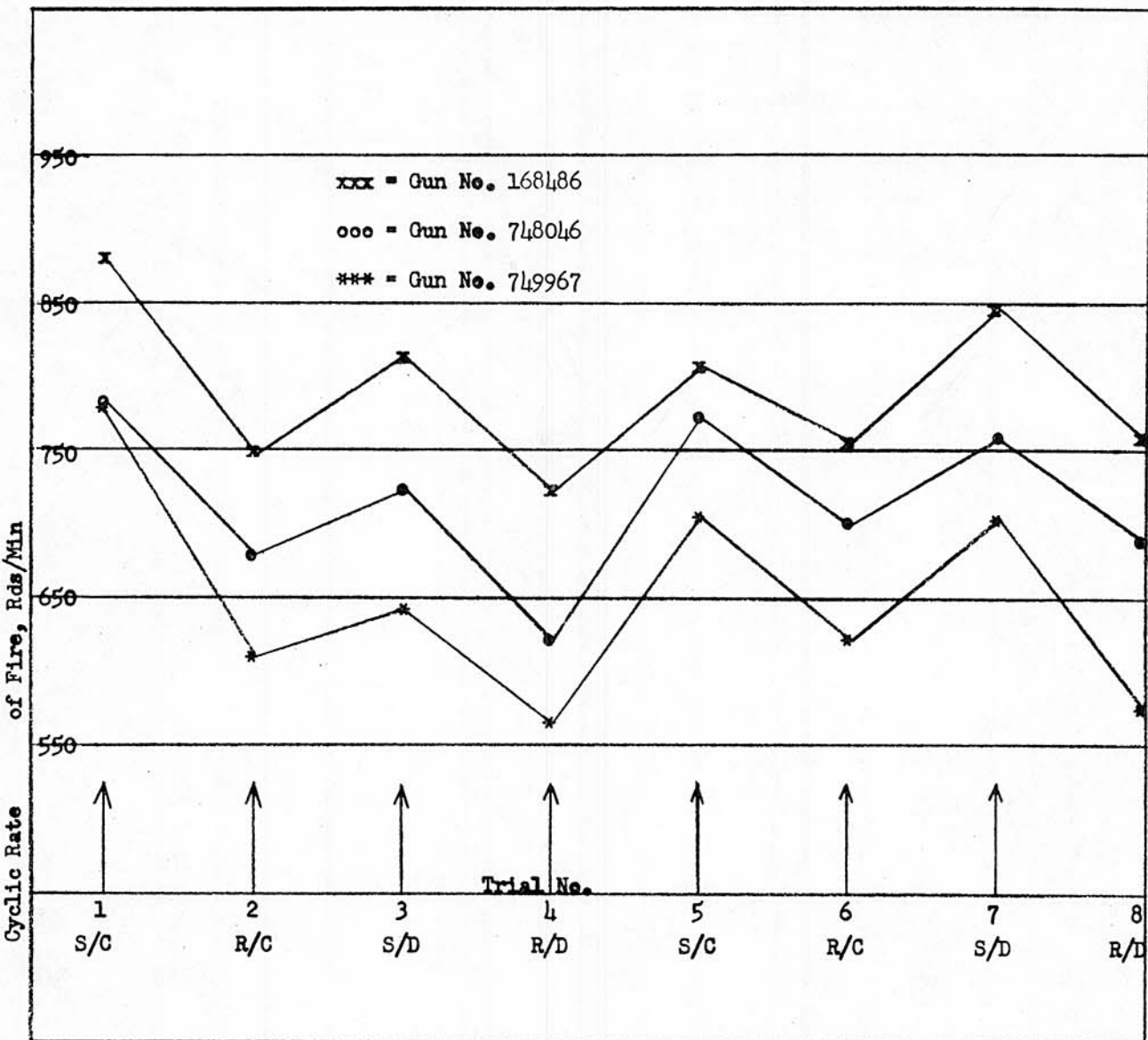
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition,
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.5-2. Cyclic Rate of Fire Test During Initial Phase of High Humidity Test for Three M16A1 Rifles.



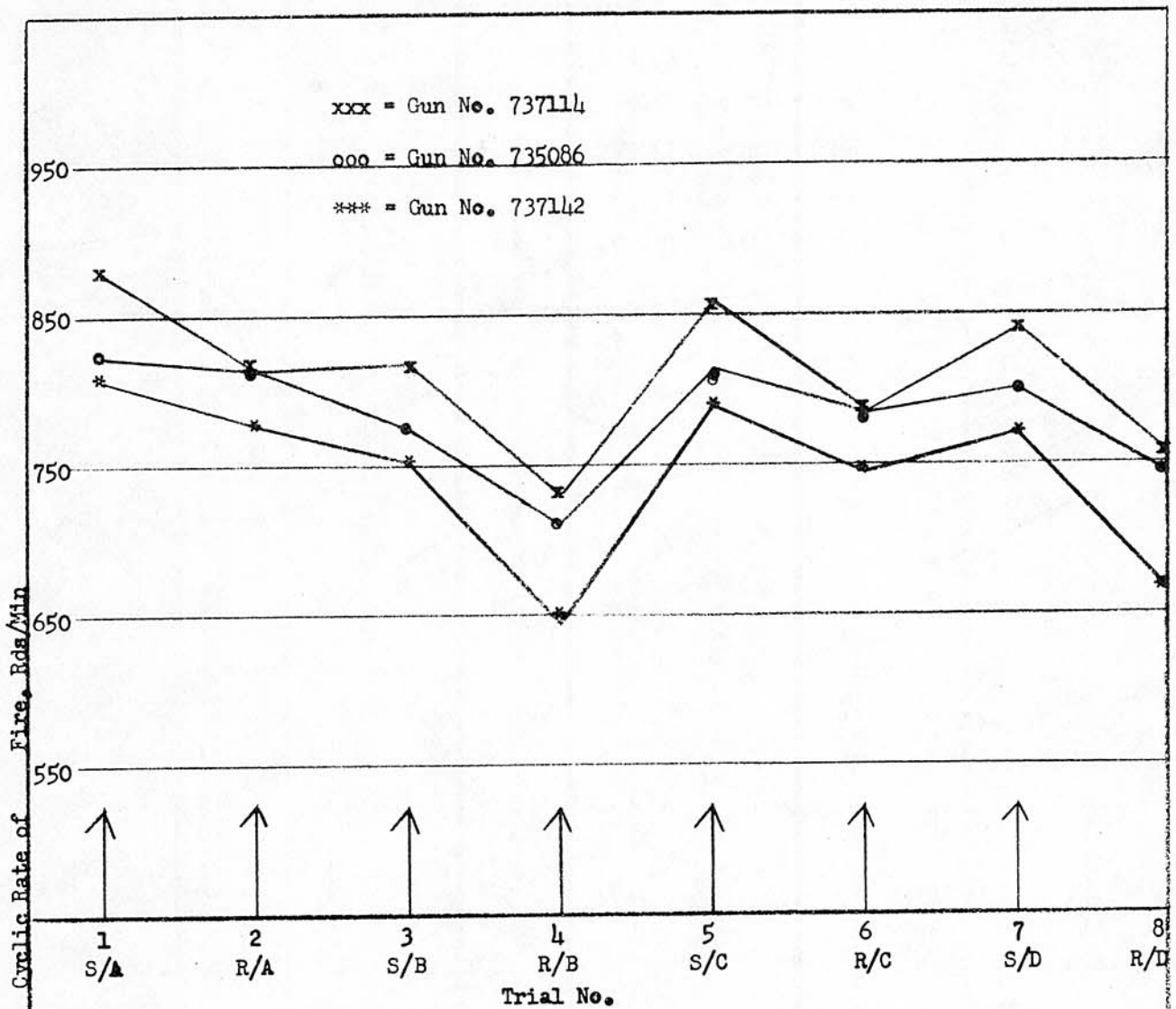
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.5-3. Cyclic Rate of Fire Test During Initial Phase of High Humidity Test for Three M16A1 Rifles.



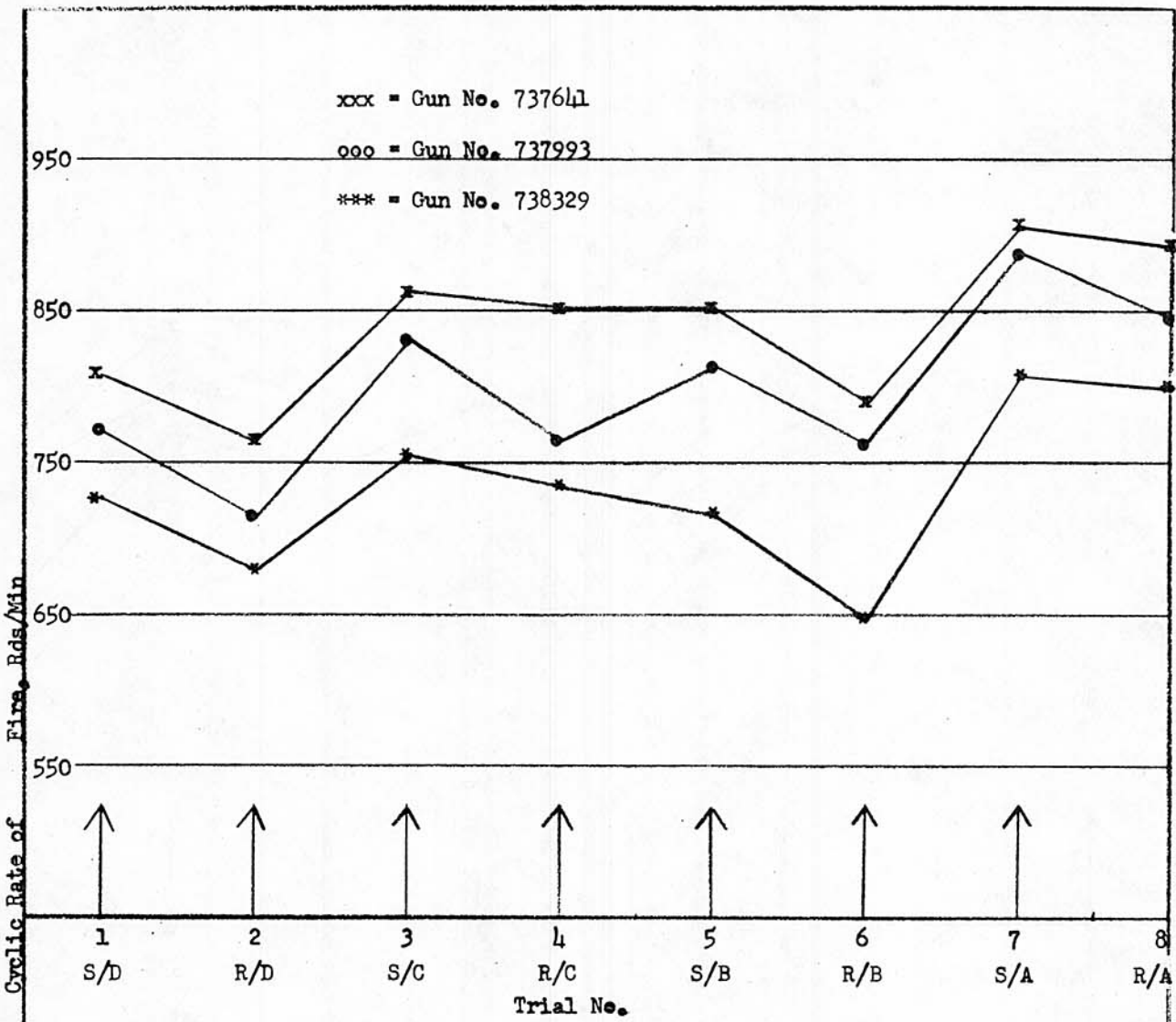
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.5-4. Cyclic Rate of Fire Test During Initial Phase of High Humidity Test for Three M16A1 Rifles.



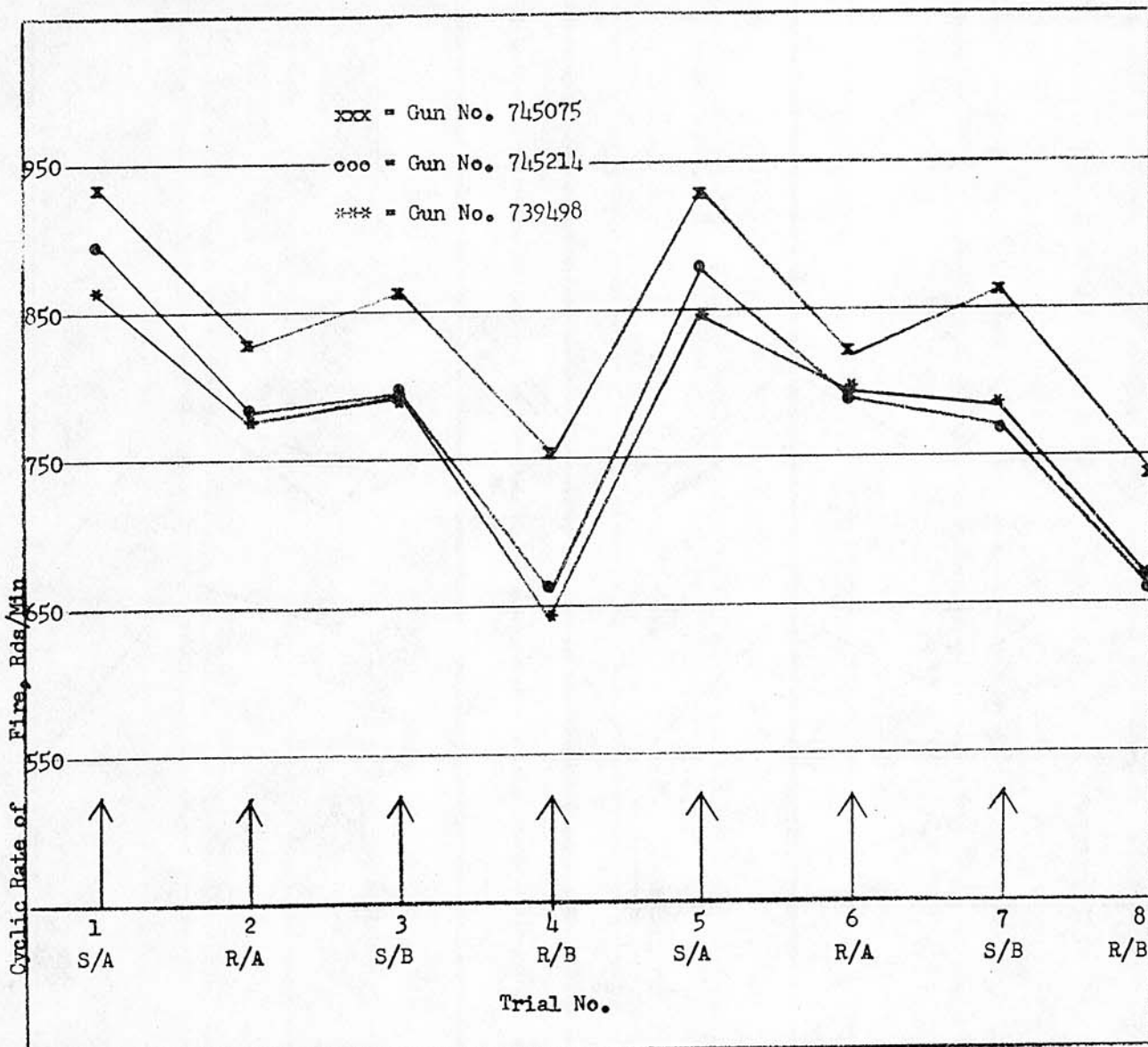
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.5-5. Cyclic Rate of Fire Test During Final Phase of High Humidity Test for Three M16A1 Rifles.



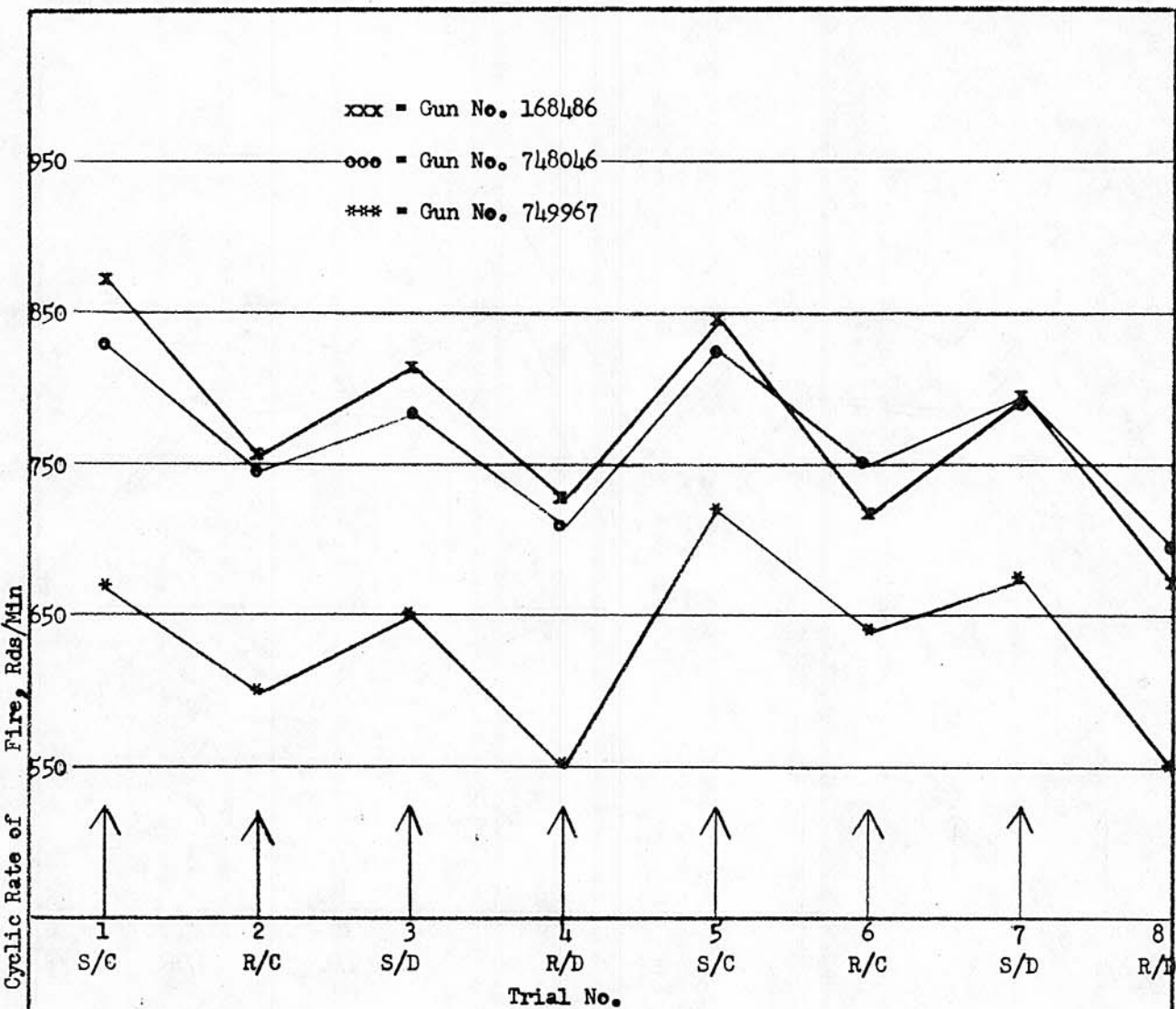
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.5-6. Cyclic Rate of Fire Test During Final Phase of High Humidity Test for Three M16A1 Rifles.



- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing ,193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.5-7. Cyclic Rate of Fire Test During Final Phase of High Humidity Test for Three M16A1 Rifles.



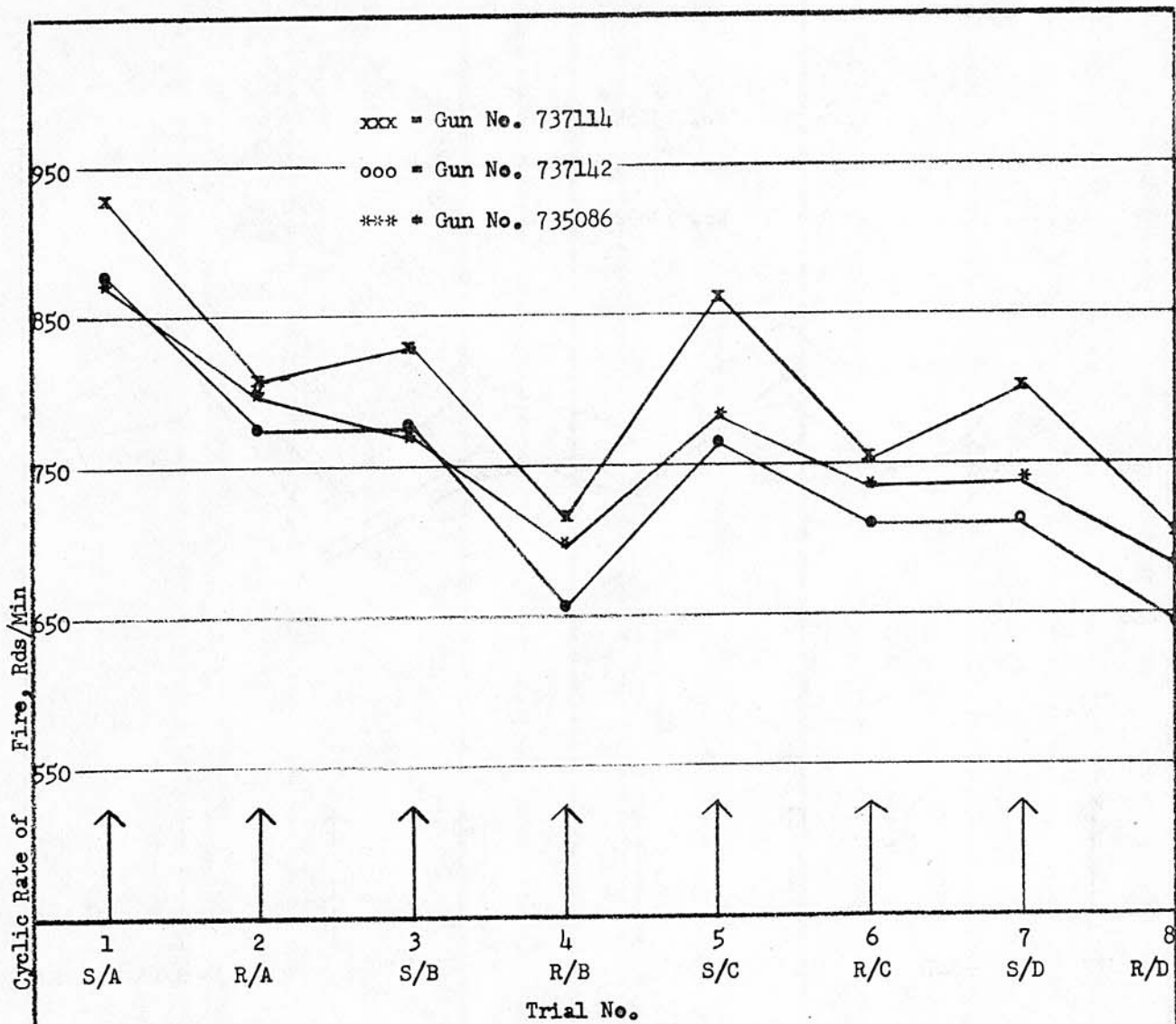
S/C = Standard buffer while firing M196, ball propellant ammunition.

R/C = Redesigned buffer while firing M196, ball propellant ammunition.

S/D = Standard buffer while firing M196, 8208M propellant ammunition.

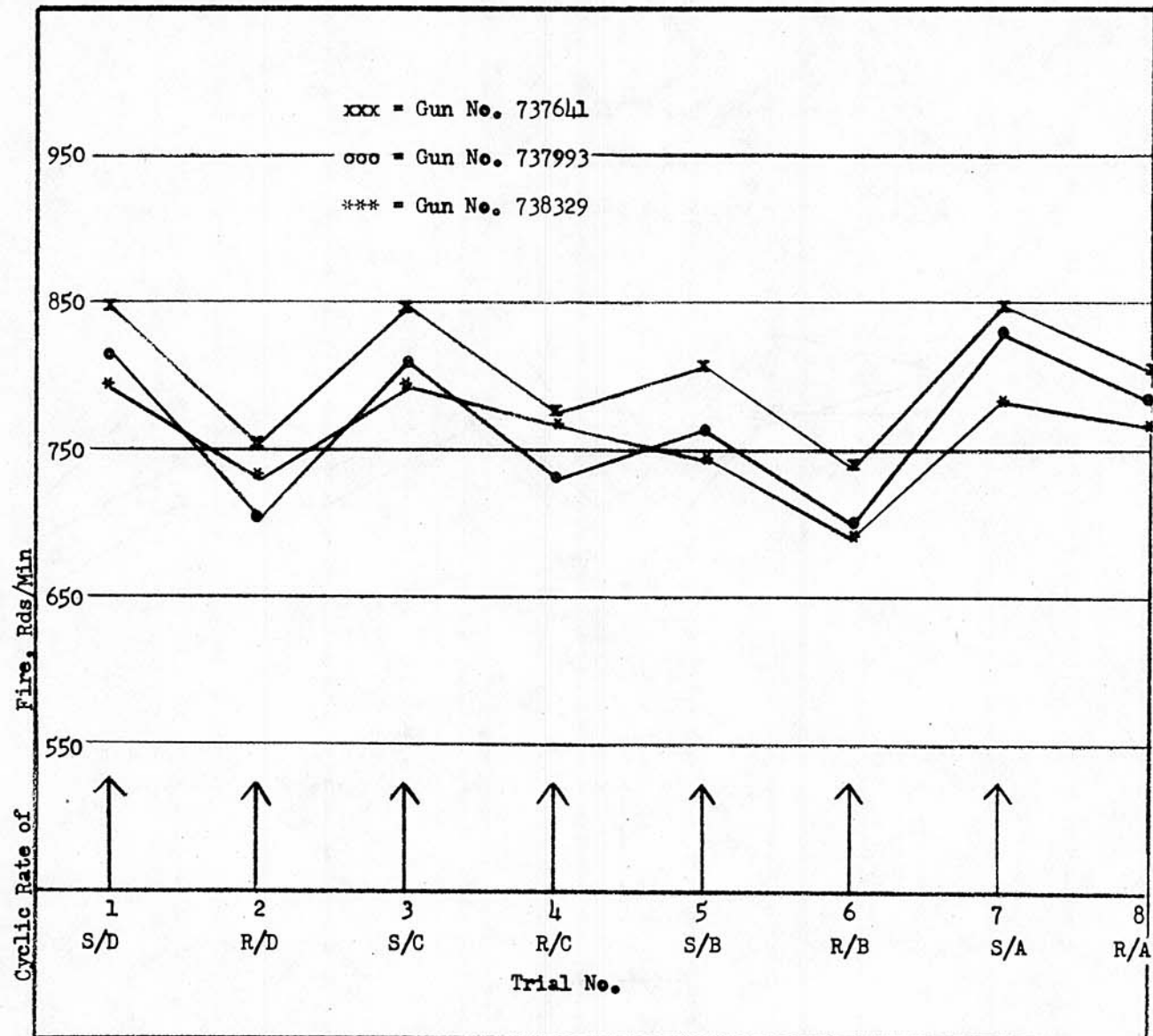
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.5-8. Cyclic Rate of Fire Test During Final Phase of High Humidity Test for Three M16A1 Rifles.



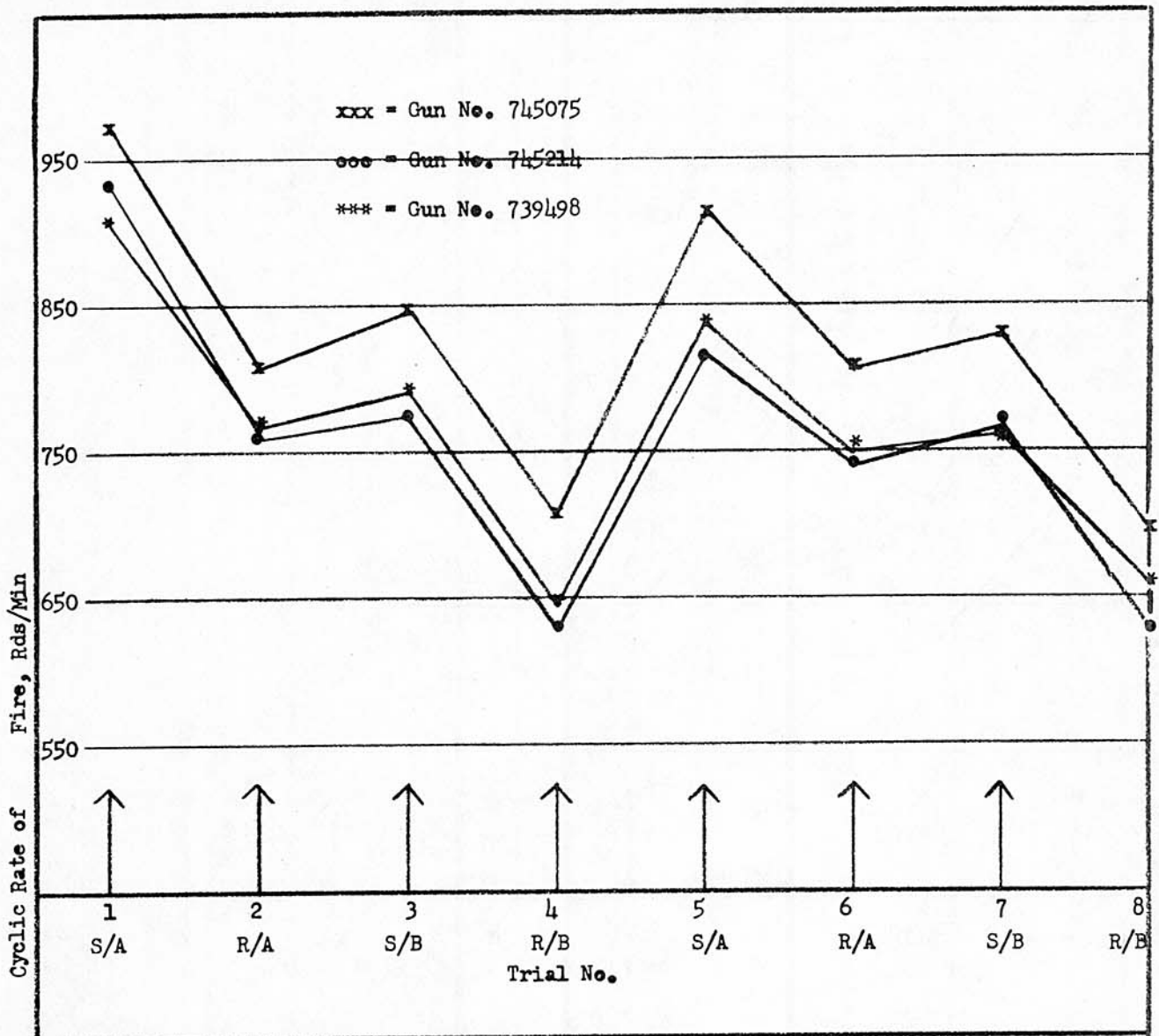
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.5-9. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Humidity Test for Three M16A1 Rifles.



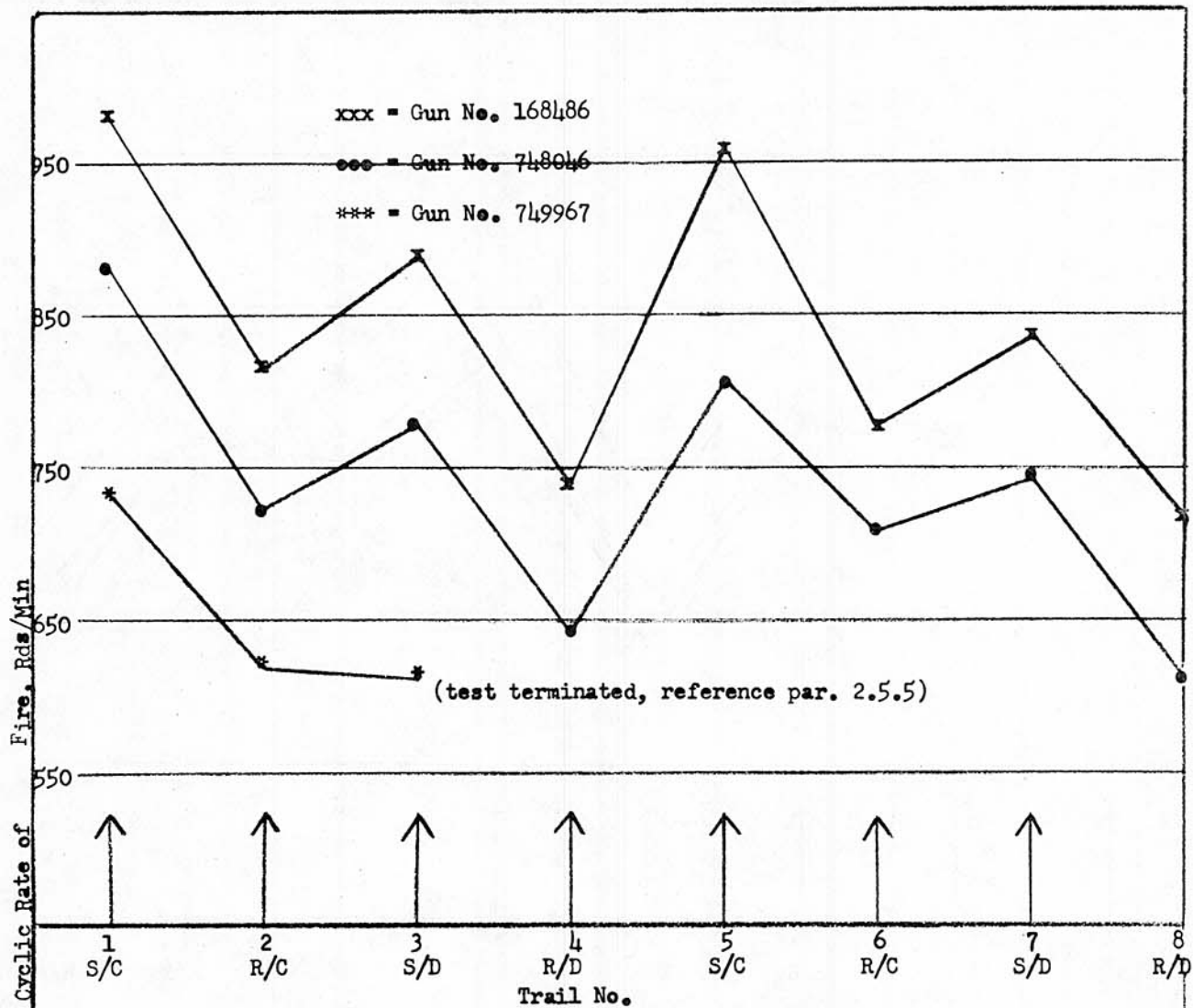
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.5-10. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Humidity Test for Three M16A1 Rifles.



S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.5-11. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Humidity Test for Three M16A1 Rifles.



- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2,5-12. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Humidity Test for Three M16A1 Rifles.

Table 2.5-II. Summary of Malfunction Data for High-Humidity Test

Gun No.	Ammunition Lot No.	Total Rds Fired	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic; A = Automatic)												Total Malfunctions						
			FFR			FBR			BOB			FF				COEC					
			Std	Red.	SA	Std	Red.	SA	Std	Red.	SA	Std	Red.	SA		Std	Red.	SA			
735086	LC12177	280															0				
	TW18166	280															0				
	LC12081	280															0				
	TW18001	280															0				
737114	LC12177	280															0				
	TW18166	280															0				
	LC12081	280															0				
737142	TW18001	280	1														1				
	LC12177	280															0				
	TW18166	280															0				
	LC12081	280															0				
737641	TW18001	280	4														4				
	LC12177	280	1														1				
	TW18166	280															0				
	LC12081	280															0				
737993	TW18001	280	1														1				
	LC12177	280															0				
	TW18166	280															0				
	LC12081	280															0				
738329	TW18001	280		1													1				
	LC12177	280															0				
	TW18166	280															0				
	LC12081	280															0				
739498	TW18001	280		1													1				
	LC12177	560															0				
	TW18166	560															0				
745075	LC12177	560															0				
	TW18166	560															0				
745214	LC12177	560															0				
	TW18166	560															0				
748046	LC12081	560															0				
	TW18001	560		1													1				
749967	LC12081	579	1	11	1												17				
	TW18001	533				2											21				
168486	LC12081	560				12											0				
	TW18001	560				1											0				
Totals		13432	1	19	0	1	2	1	2	2	0	0	0	14	0	3	0	0	0	3	49
	Semiautomatic		1	1	0	1	4	2	2	0	0	0	0	0	0	0	0	0	0	0	5
	Automatic		20	19	1	3	1	2	2	3	14	14	14	14	4	4	3	3	3	3	44
			21	20	1	7	7	7	7	7	14	14	14	14	4	4	3	3	3	3	49

a First number in parentheses indicates standard buffer malfunctions, second number indicates redesigned buffer malfunctions.

LC12177, standard buffer: 7 } 7  
 LC12177, redesigned buffer: 0 }  
 TW18166, standard buffer: 1 } 1  
 TW18166, redesigned buffer: 0 }  
 LC12081, standard buffer: 15 } 18  
 LC12081, redesigned buffer: 3 } 3  
 TW18001, standard buffer: 3 } 23  
 TW18001, redesigned buffer: 20 } 49

### 2.5.5 Analysis

The cyclic rate of fire data illustrated in Figures 2.5-1 through 2.5-12 show, as in the initial cyclic rate of fire test, that the redesigned buffer, in comparison to the standard buffer, consistently provided reduced rates during the ten days of the high-humidity test regardless of the lot of ammunition or the characteristics of the individual weapon. However, of 96 cyclic rate trials with the redesigned buffer conducted under high-humidity conditions, 13 trials were below the minimum permitted rate of 650 rds/min while five trials exceeded 850 rds/min. The record for the standard buffer was one trial below the minimum rate and 39 trials exceeding the upper rate.

The data in Table 2.5-II show that the majority of malfunctions, 38 out of 49, occurred with gun No. 749967. As the cause of the malfunctions was not readily apparent, various component parts of gun No. 749967 were checked-fired in an XM16E1 rifle not included among the test rifles. These firings indicated, although not conclusively, that the problem was associated with the upper receiver and barrel assembly of gun No. 749967.

The gas tube of the test gun was removed and a new tube was installed and the gun then fired in the high temperature test (par. 2.6). X-ray photographs of the used gas tube from gun No. 749967 were compared to X-rays of a new tube. No defects could be seen and no evidence of fouling accumulation was detected in the X-rays. While 16 failures to fire subsequently occurred early in the high temperature test with this gun the remainder of high temperature firings were conducted with relatively few malfunctions.

The reliability criteria referenced in par. 2.5.2 are evaluated in section 1, pars. 1.4.2 and 1.5.2 of this report.

## 2.6 HIGH TEMPERATURE (+155°F)

### 2.6.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a redesigned buffer when firing various types of ammunition during high-temperature conditions.
- b. To compare the above performance with similar firings employing the standard buffer.

### 2.6.2 Criteria

Same as par. 2.5.2.

### 2.6.3 Method

The method of test is described in par. 3.3.1 Interim Pamphlet, 20-20, TECP 700-700, 11 April 1966, except that the high temperature is +155°F and daily firing is conducted only after at least four hours of continuous high-temperature conditioning.

The firing schedule in Table 2.6-I is followed.

Table 2.6-I. High Temperature (+155°F)

Trial No.	Buffer	Rds Fired Per Gun <sup>b</sup>	Ammunition Type <sup>a</sup>		
			Guns		
			1 to 6	7 to 9	10 to 12
<sup>c</sup> 1	Std and Red.	160	Repeat cyclic rate of fire test.		
<sup>d</sup> 2	Std	80	A	A	C
<sup>d</sup> 3	Red.	80	B	A	C
<sup>d</sup> 4	Std	80	C	B	D
<sup>d</sup> 5	Red.	80	D	B	D
<sup>e</sup> 6	Std	80	D	A	C
<sup>e</sup> 7	Red.	80	C	A	C
<sup>e</sup> 8	Std	80	B	B	D
<sup>e</sup> 9	Red.	80	A	B	D
<sup>f</sup> 10	Std and Red.	160	Repeat cyclic rate of fire test.		
<sup>g</sup> 11	Std and Red.	160	Repeat cyclic rate of fire test.		

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>Except for trials No. 1, 10, and 11, each trial is divided equally into automatic (3-round bursts) and semiautomatic firing.

<sup>c</sup>After 48 hours of conditioning.

<sup>d</sup>After 72 hours of conditioning.

<sup>e</sup>After 96 hours of conditioning.

<sup>f</sup>After 120 hours of conditioning.

<sup>g</sup>Fired under normal ambient conditions following cleaning and lubrication.

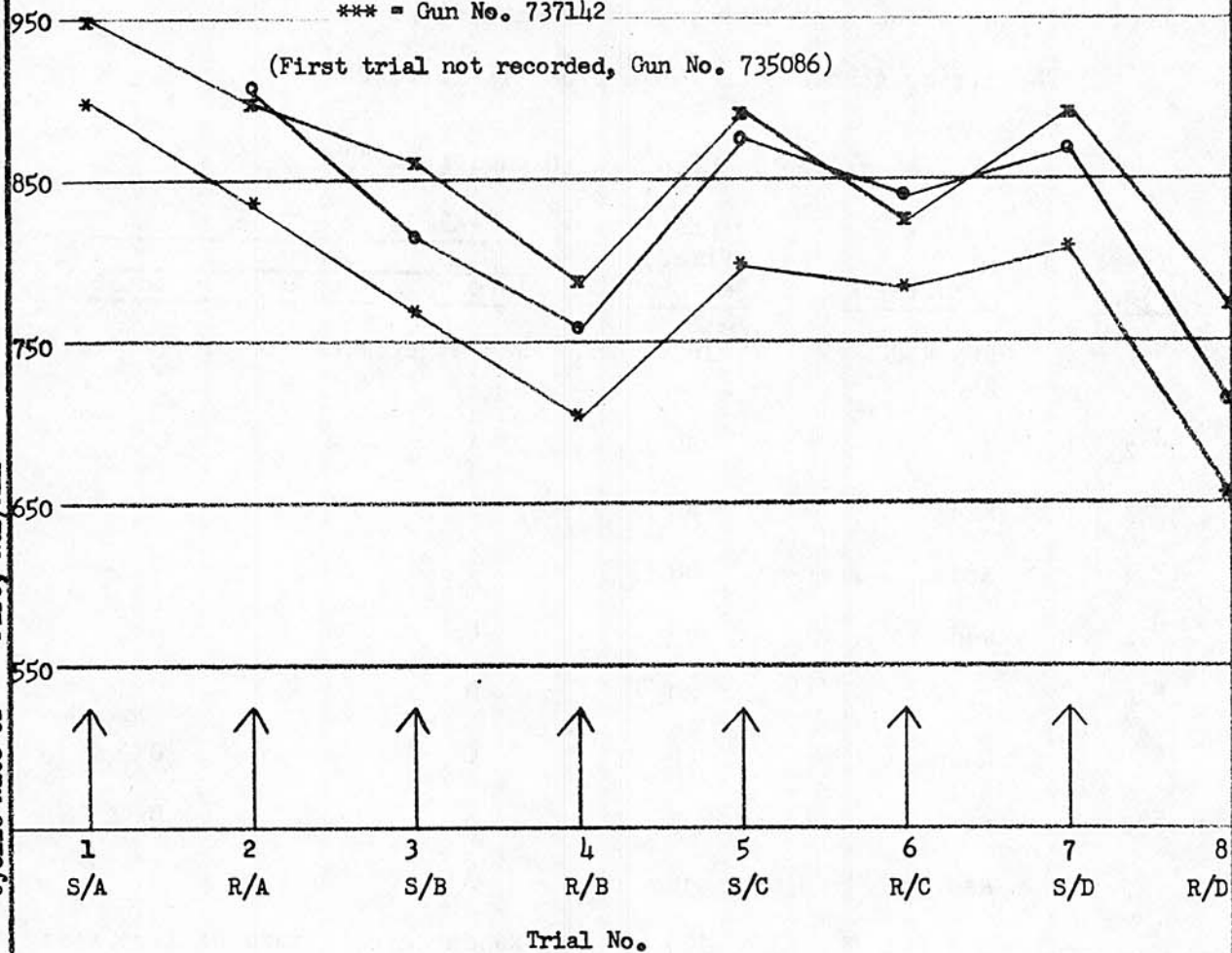
xxx = Gun No. 737114

ooo = Gun No. 735086

\*\*\* = Gun No. 737142

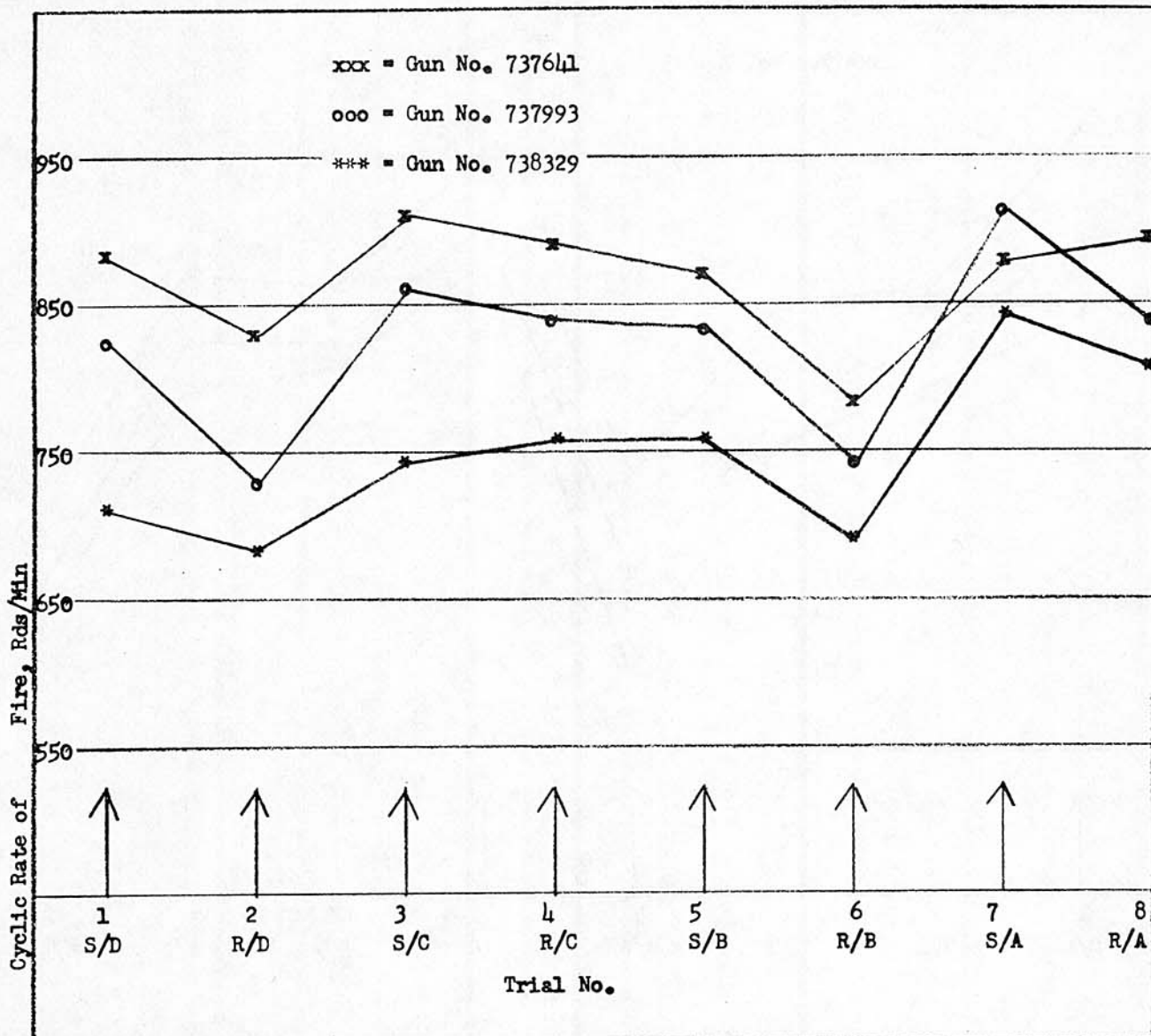
(First trial not recorded, Gun No. 735086)

Cyclic Rate of Fire, Rds/Min



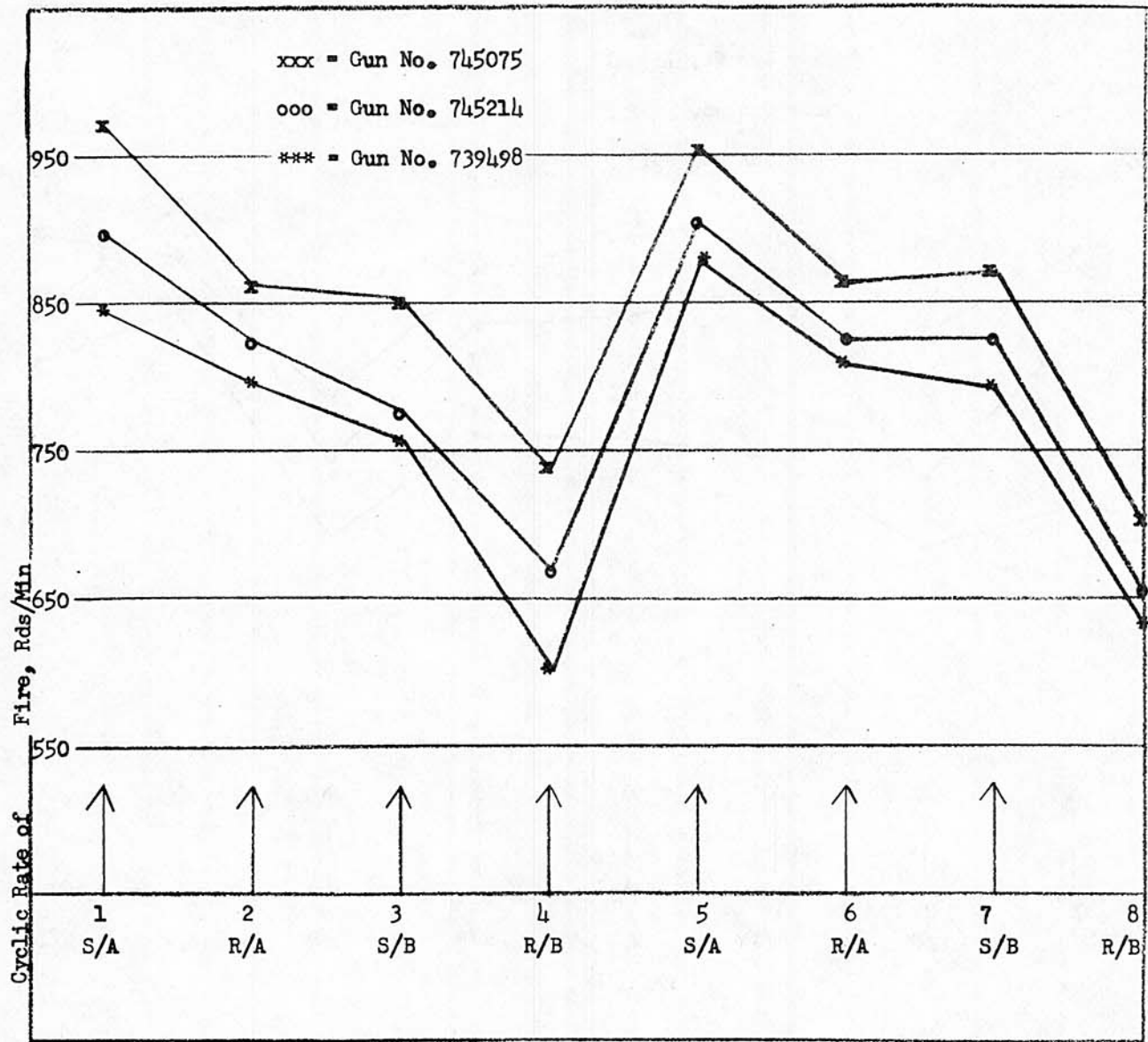
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-1. Cyclic Rate of Fire Test During Initial Phase of High Temperature Test for Three M16A1 Rifles.



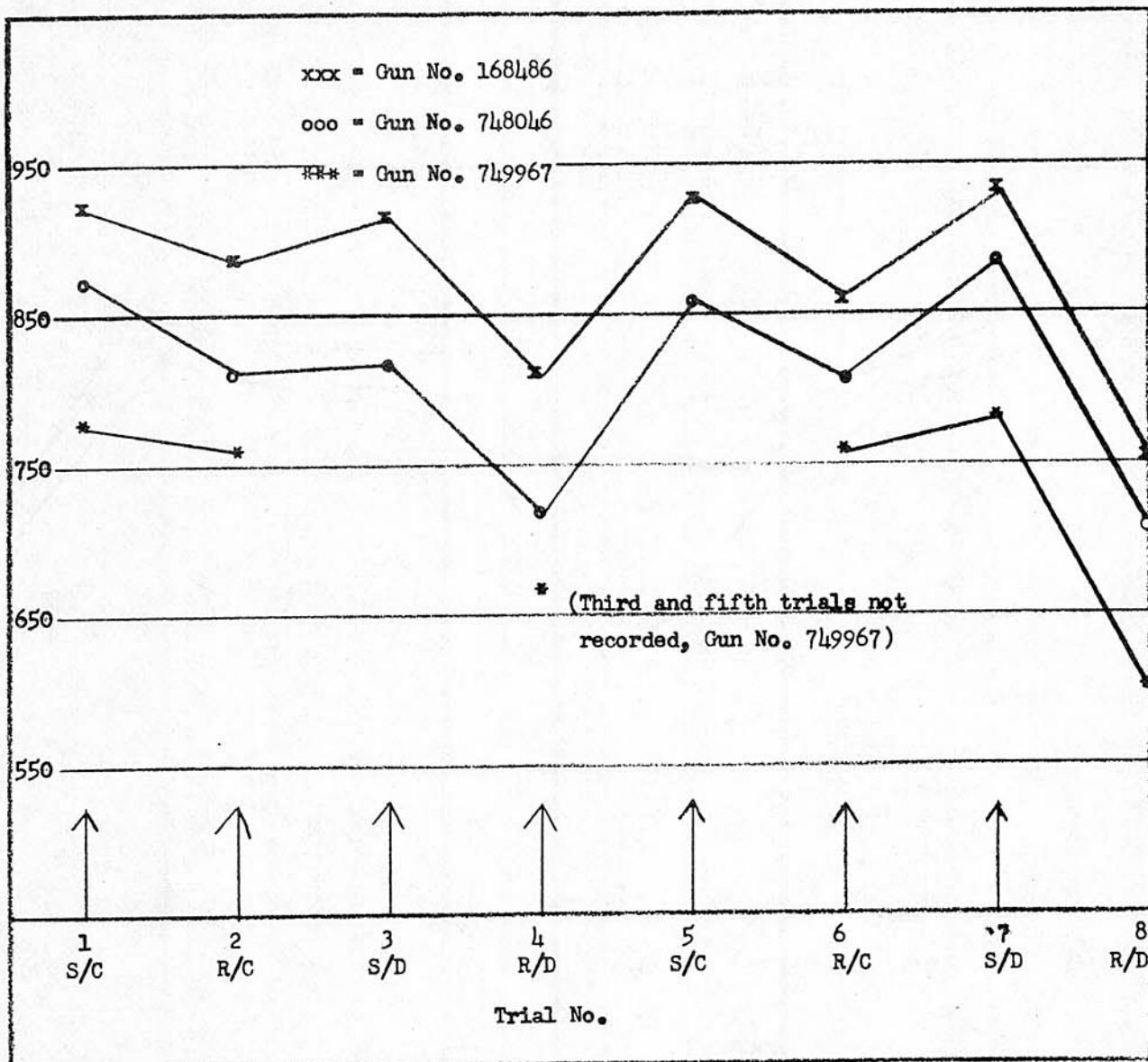
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.  
 S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
 S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.6-2. Cyclic Rate of Fire Test During Initial Phase of High Temperature Test for Three M16A1 Rifles.



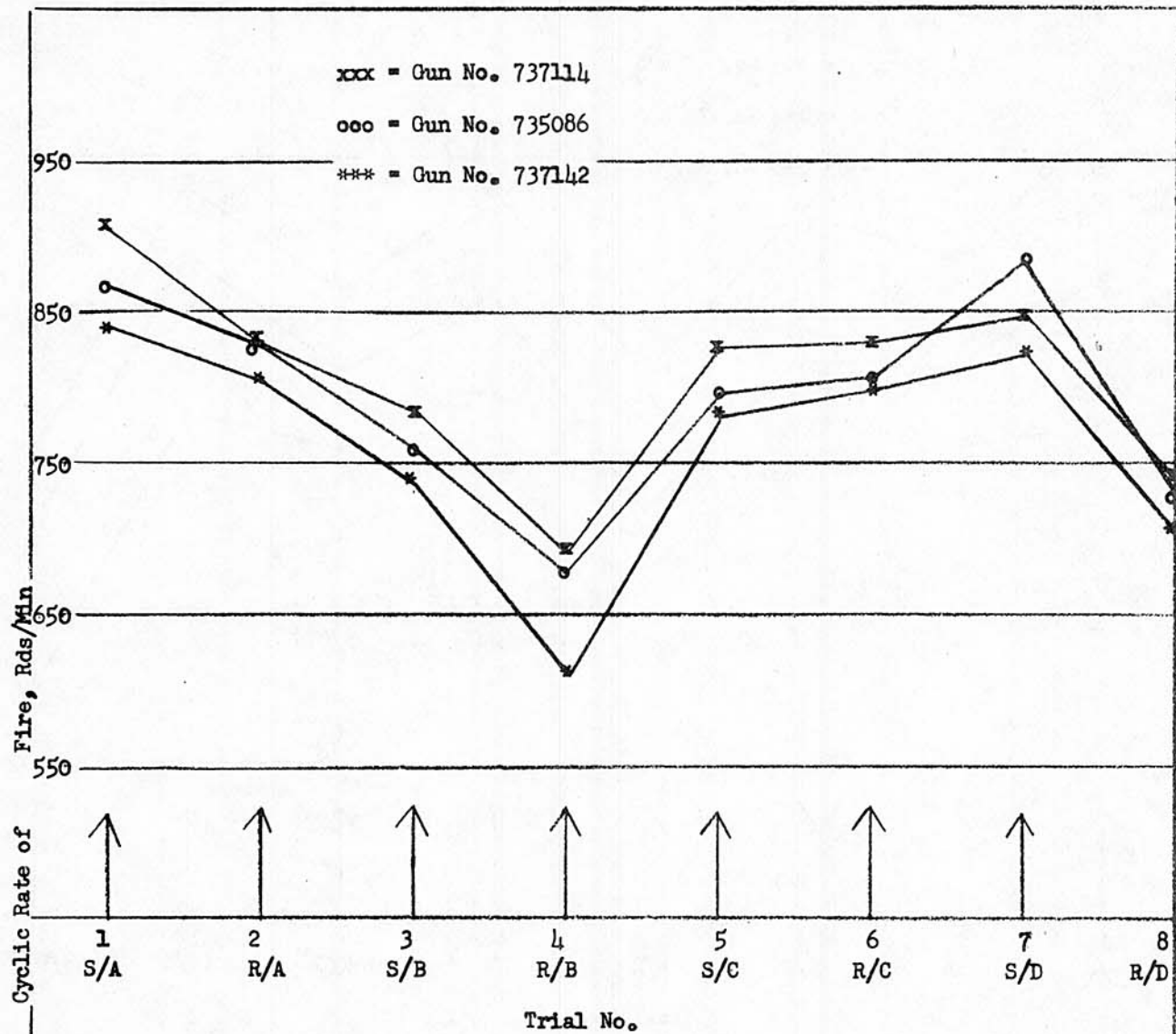
S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.6-3. Cyclic Rate of Fire Test During Initial Phase of High Temperature Test for Three ML6A1 Rifles.



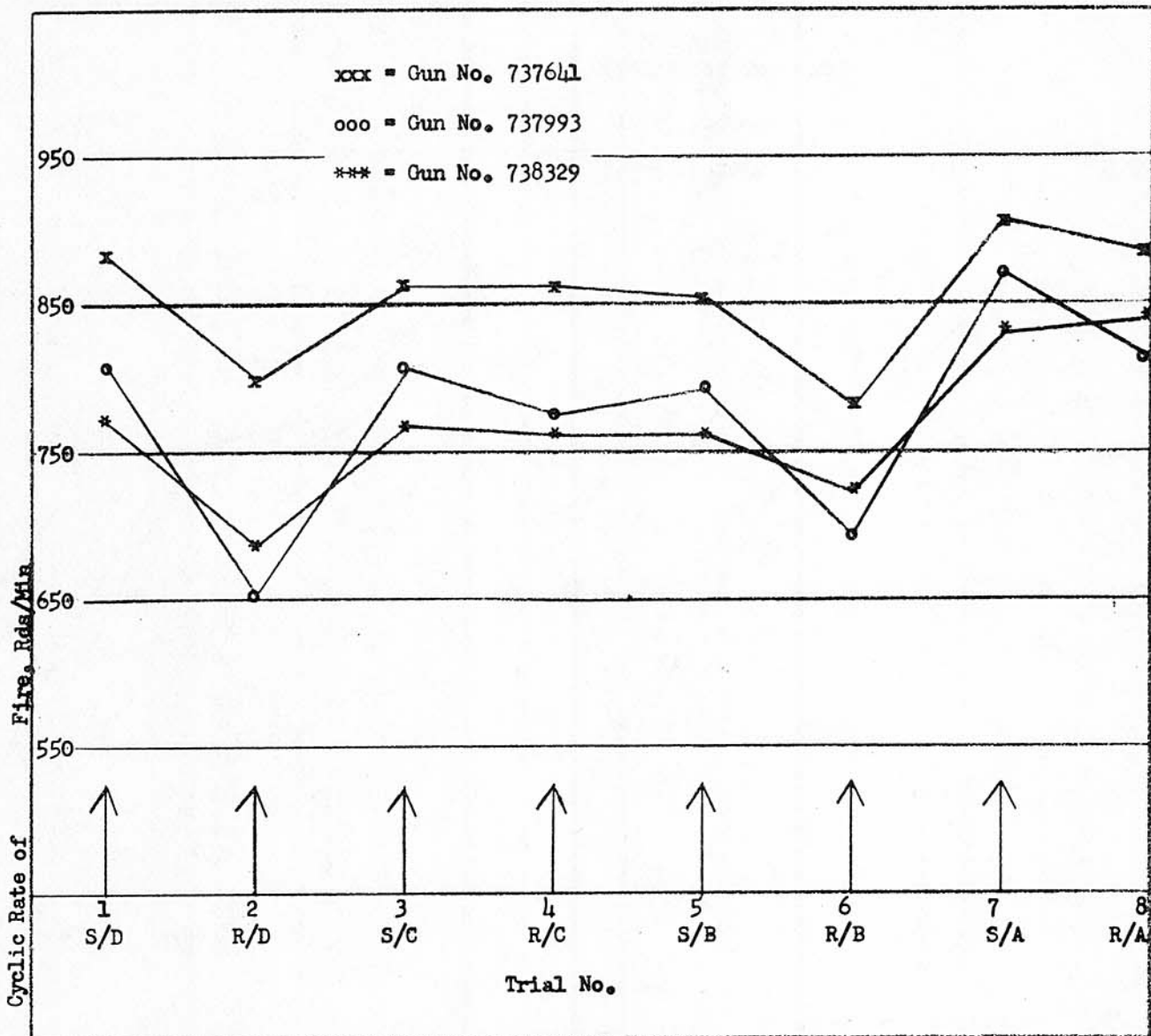
S/C = Standard buffer while firing M196, ball propellant ammunition.  
R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-4. Cyclic Rate of Fire Test During Initial Phase of High Temperature Test for Three M16A1 Rifles.



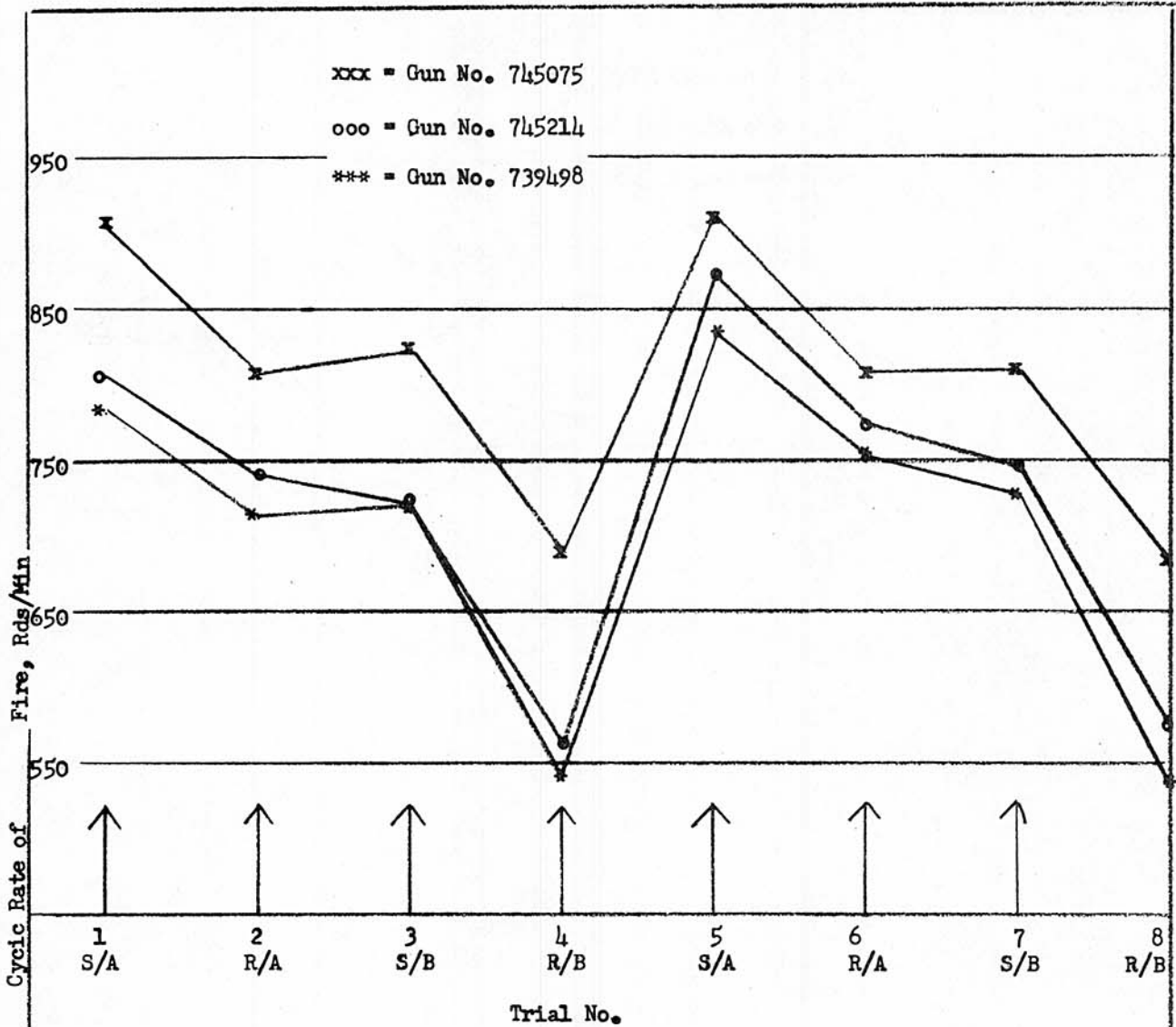
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-5. Cyclic Rate of Fire Test During Final Phase of High Temperature Test for Three M16A1 Rifles.



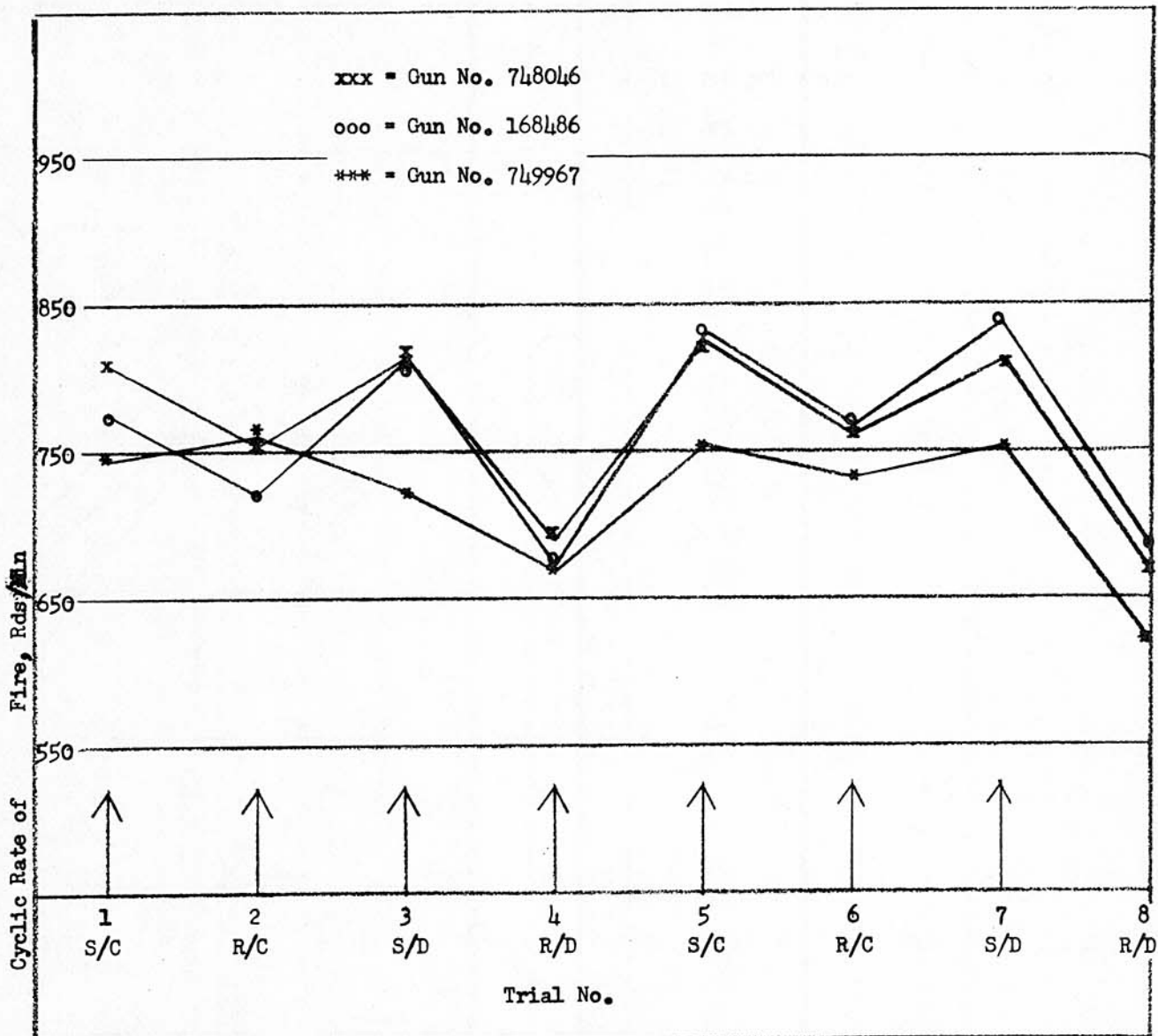
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesignated buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesignated buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesignated buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesignated buffer while firing M193, ball propellant ammunition.

Figure 2.6-6 Cyclic Rate of Fire Test During Final Phase of High Temperature Test for Three M16A1 Rifles.



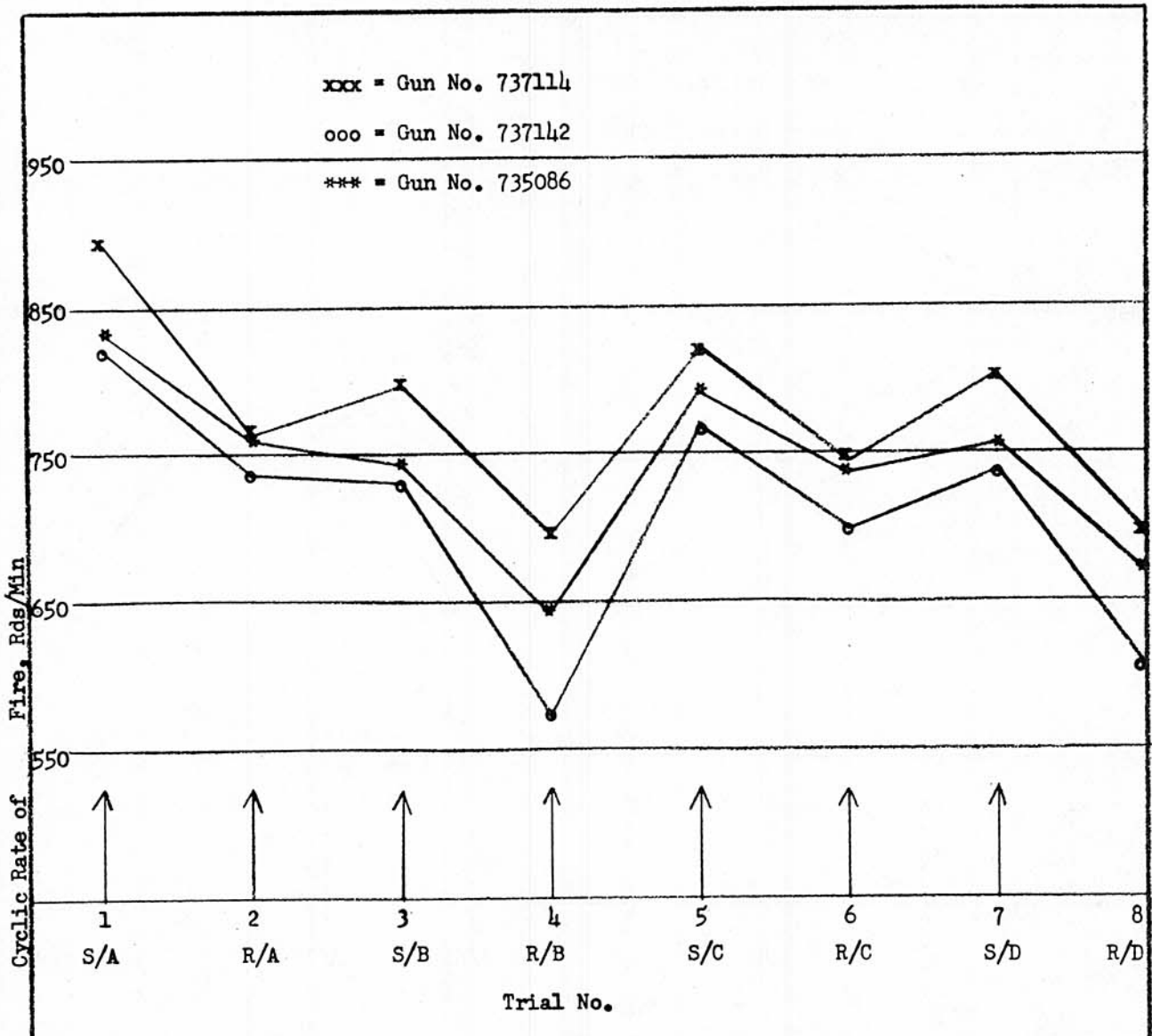
S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.6-7. Cyclic Rate of Fire Test During Final Phase of High Temperature Test for Three M16A1 Rifles.



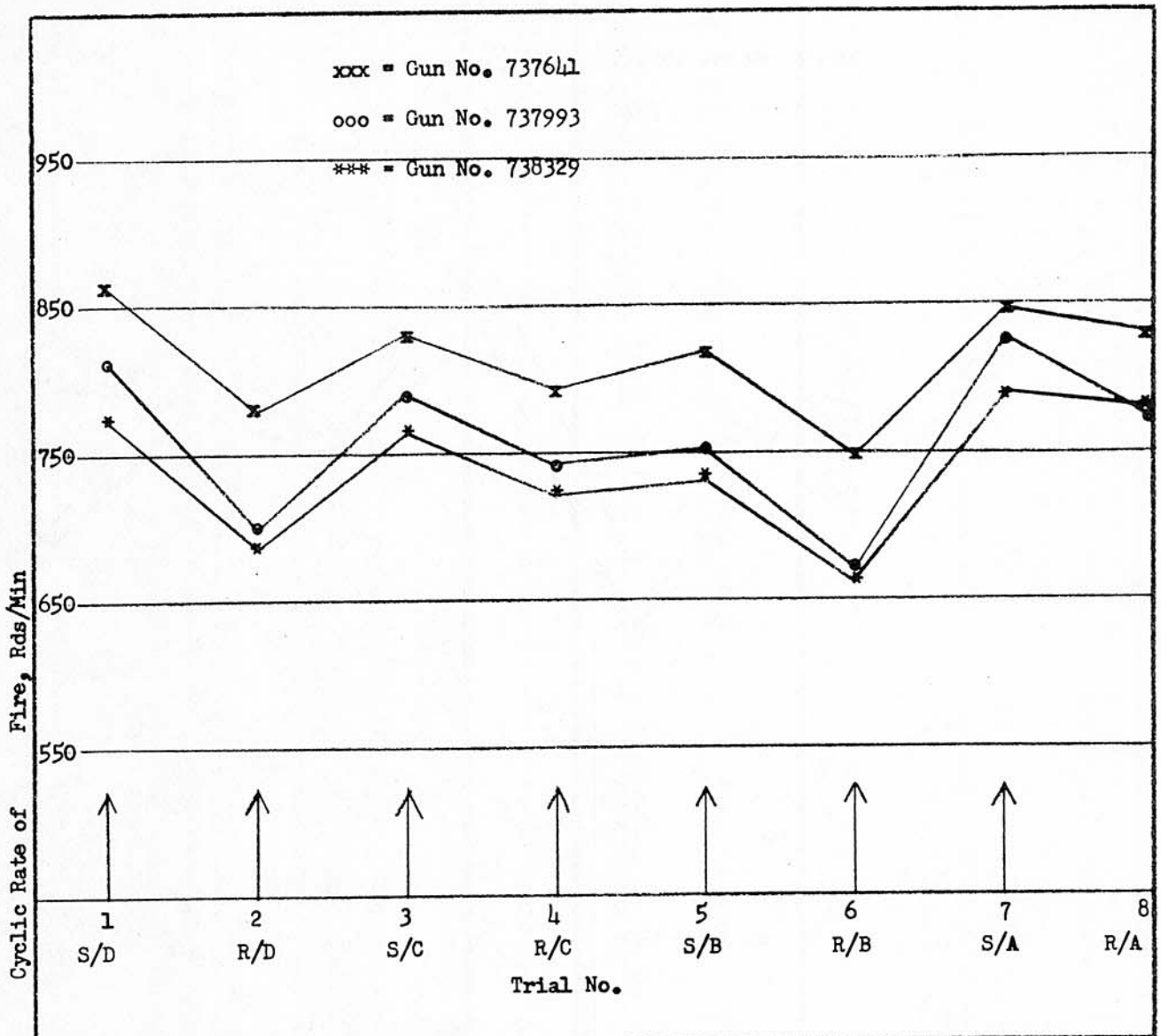
S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-8. Cyclic Rate of Fire Test During Final Phase of High Temperature Test for Three M16A1 Rifles.



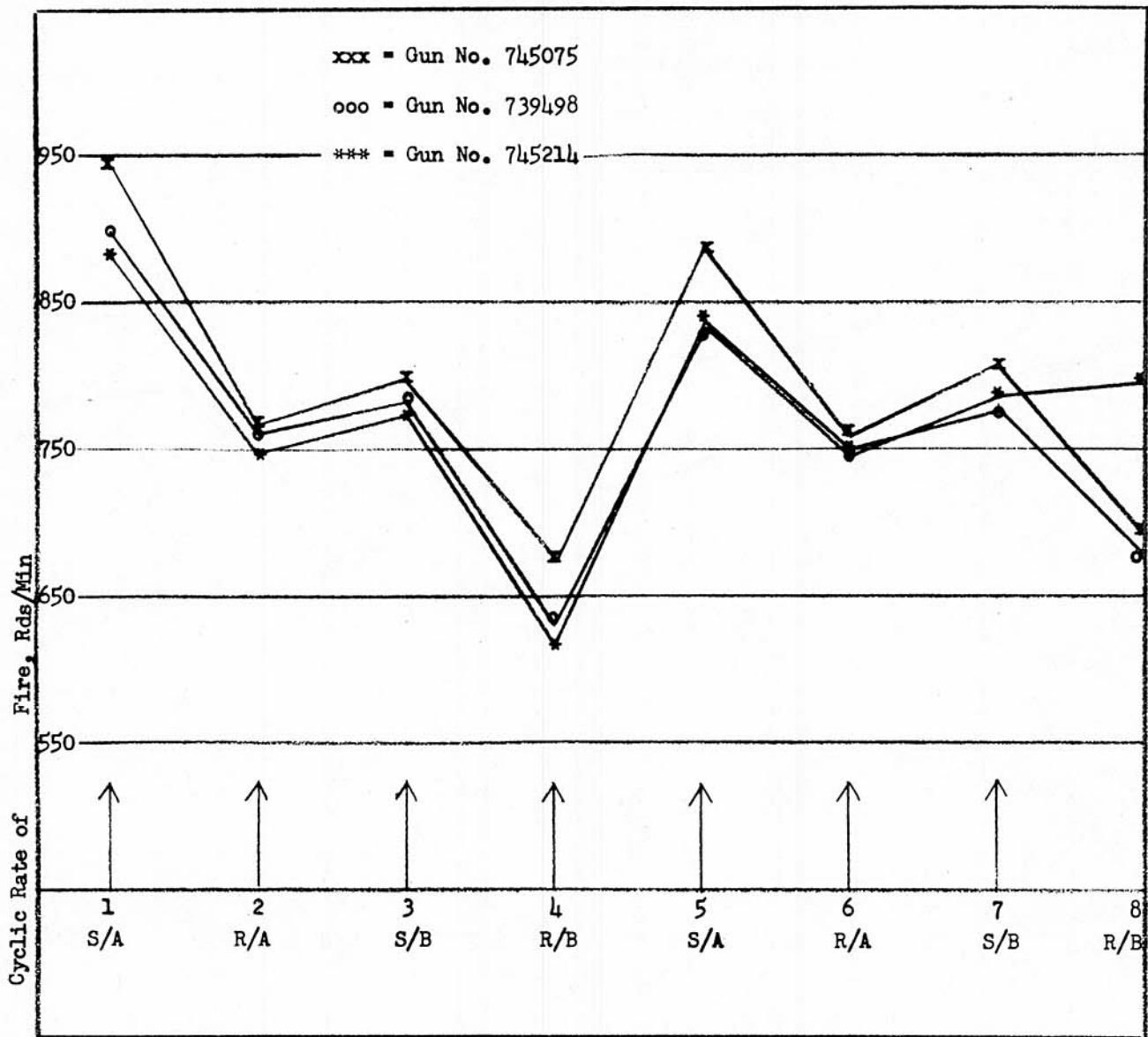
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-9. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Temperature Test for Three M16A1 Rifles.



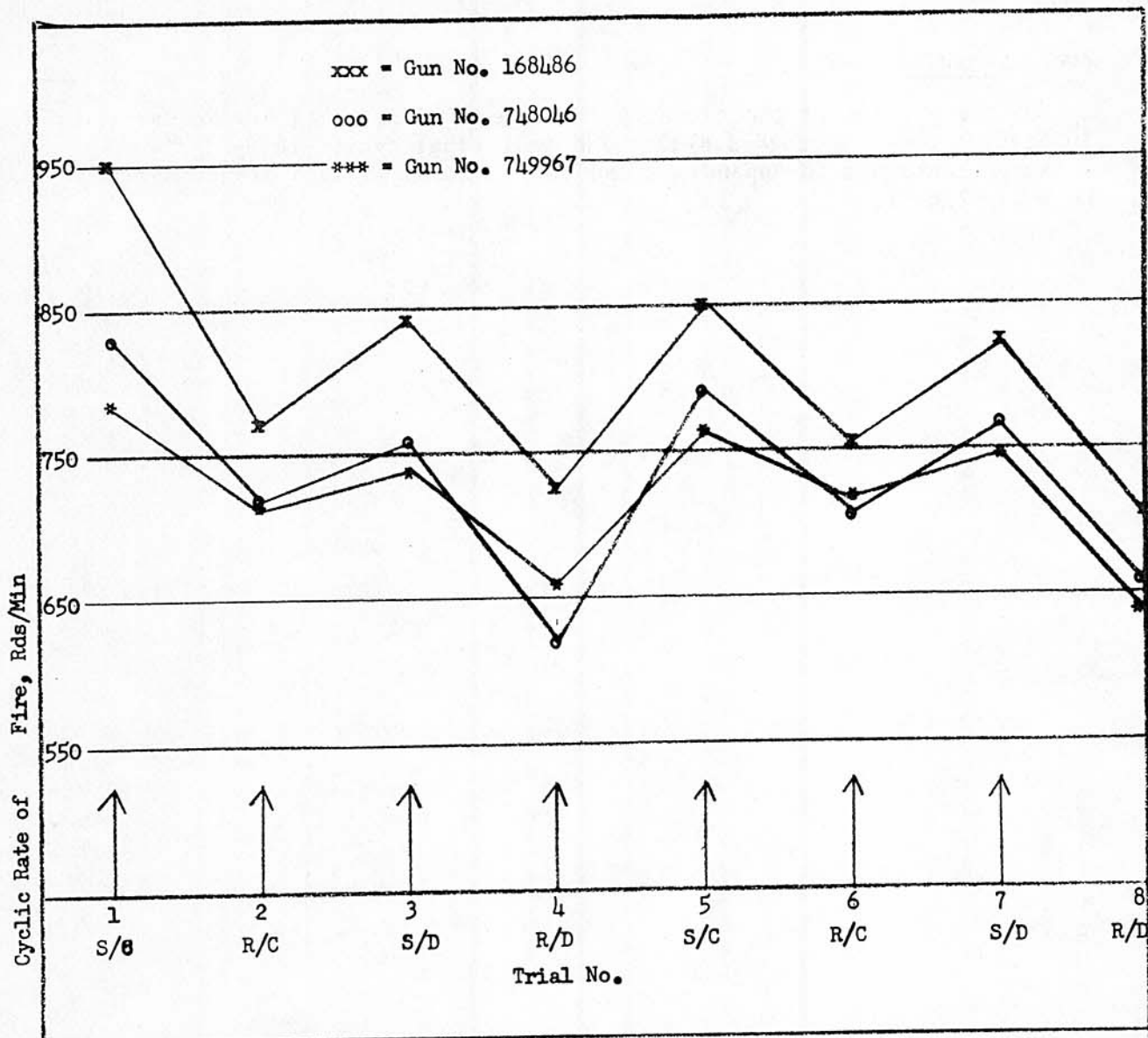
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.6-10. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Temperature Test for Three M16A1 Rifles.



- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.6-11. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Temperature Test for Three M16A1 Rifles.



- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.6-12. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following High Temperature Test for Three M16A1 Rifles.

#### 2.6.4 Results

The results of the three cyclic rate-of-fire tests are summarized in Figures 2.6-1 through 2.6-12. The individual cyclic rate-of-fire data are contained in Appendix I and the functioning data are summarized in Table 2.6-II.

Table 2.6-II. Summary of Malfunction Data for High-Temperature Test (+155°F)

Gun No.	Ammunition Lot No.	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic; A = Automatic)												Total Malfunctions	Remarks							
		FBR		BOB		COEC		FJ		PX		Total										
		Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.											
SA	A	SA	A	SA	A	SA	A	SA	A	SA	A											
735086	LC12177	280													0							
	TW18166	280													0							
	LC12081	280	1	1											2							
	TW18001	280													0							
737114	LC12177	280	1												1							
	TW18166	280													0							
	LC12081	280													0							
	TW18001	280													0							
737142	LC12177	280													0							
	TW18166	280													0							
	LC12081	280													0							
	TW18001	280													0							
737641	LC12177	280	1	2											4	The center ring spring from the standard buffer was bent and damaged. All of the ring springs were replaced.						
	TW18166	280													0							
	LC12081	360	1		2										3							
	TW18001	360													0							
737993	LC12177	280	1												1							
	TW18166	280													0							
	LC12081	280	1												1							
	TW18001	280													0							
738329	LC12177	280	1												1	The finish on the upper receiver was worn and bright in some areas (Figure 2.12-1).						
	TW18166	280													0							
	LC12081	280													0							
	TW18001	280													0							
739498	LC12177	560	1		1										2	One gas ring on the bolt was broken; the ring was replaced.						
	TW18166	560	3												7							
745075	LC12177	560													1							
	TW18166	560													0							
745214	LC12177	560	2												2							
	TW18166	560	1												1							
748046	LC12081	560													1							
	TW18001	560													1							
749967	LC12081	560	8												8							
	TW18001	560	8												8							
168486	LC12081	560	4	5	1	1									12	Same as gun No. 739498.						
	TW18001	560													0							
<b>Totals</b>		<b>13600</b>	<b>0</b>	<b>31</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>10</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>62</b>
	Semiautomatic <sup>a</sup>		0	(0,0)		5	(4,1)		0	(0,0)		0	(0,0)		0	(0,0)		0	(0,0)		5	(4,1)
	Automatic <sup>a</sup>		31	(31,0)		11	(10,1)		5	(1,4)		3	(0,3)		6	(1,5)		1	(0,1)		57	(43,14)
			31	(31,0)		16	(14,2)		5	(1,4)		3	(0,3)		6	(1,5)		1	(0,1)		62	(47,15)

<sup>a</sup> First number in parentheses indicates standard buffer malfunctions, second number indicates redesigned buffer malfunctions.  
 LC12177, standard buffer: 12  
 LC12177, redesigned buffer: 0 | 12  
 TW18166, standard buffer: 4 | 8  
 TW18166, redesigned buffer: 4 | 8  
 LC12081, standard buffer: 22 | 33  
 LC12081, redesigned buffer: 11 | 33  
 TW18001, standard buffer: 9 | 9  
 TW18001, redesigned buffer: 0 | 9

### 2.6.5 Analysis

The cyclic rate-of-fire data illustrated in Figures 2.6-1 through 2.6-12 show, as in the initial cyclic rate-of-fire test and in the high-humidity test, that the redesigned buffer, in comparison to the standard buffer, consistently provided reduced rates during the high temperature test regardless of the lot of ammunition or the characteristics of the individual weapon. However, of 96 cyclic rate trials with the redesigned buffer conducted at high temperature conditions, 9 trials were below the minimum permitted rate of 650 rds/min while 10 trials exceeded 850 rds/min. The record for the standard buffer was no trials below the minimum rate and 38 trials exceeding the upper rate.

In addition to the weapon performance data it was noted during some tracer firings that the failure-to-trace rate was much greater than the 20 per cent permitted by ammunition acceptance standards. As a result, observers were positioned outside the climatic chamber and a kraft paper witness target was erected at approximately 25 meters from the gun muzzle.

During the subsequent firing trials the tracer deficiency appeared to be associated principally with lot LC12081, and in addition to the high failure-to-trace rate (as high as 75 percent in some observed 20-round trials), extreme bullet yaw, stripped or ruptured jackets, and excessive dispersion were evident on the 25-meter target. A somewhat unique performance phenomena was also noted with several of the test rifles. While following the schedule in Table 2.6-I, and immediately after changing to lot LC12081, the target results of the first 20-rounds of lot LC12081 would appear quite normal but near the conclusion of the scheduled 80-round trial, gross dispersion, yaw, and stripped jackets would occur. The first 20 rounds of the next 80-round trial, with a lot other than LC12081 would be similarly unacceptable but would then rapidly improve until acceptable performance was regained by the last 20 rounds of the trial. The re-introduction of lot LC12081 would again reverse the performance record.

The apparent deficiency of lot LC12081 was cited in a teletype message to USAMUCOM (see Appendix II) and a separate study was undertaken to investigate the problem.

## 2.7 FOULING TEST (+20°F)

### 2.7.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a re-designed buffer when firing various types of ammunition under conditions presumed to result in increased propellant fouling.
- b. To compare the above performance with similar firings employing the standard buffer.

### 2.7.2 Criteria

Same as par. 2.5.2.

### 2.7.3 Method

The weapons and ammunition are subjected to +20°F for a minimum of 12 hours prior to firing and between firing cycles. Each of the weapons is fired approximately 300 rounds on each of five days. Firing is alternated between semiautomatic and automatic fire each 20 rounds. Automatic fire is accomplished in bursts of about three rounds. The weapons are disassembled, cleaned, and lubricated with the prescribed lubricant prior to storage at +20°F, but no cleaning or lubrication is accomplished during the test.

The firing schedule in Table 2.7-I was followed.

Table 2.7-I. Fouling Test Schedule

<u>Trial No.</u>	<u>Buffer</u>	<u>Rds Fired Per Gun</u>	<u>Ammunition Type<sup>a</sup></u>		
			<u>Guns</u>		
			<u>1 to 6</u>	<u>7 to 9</u>	<u>10 to 12</u>
b <sub>1</sub>	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
b <sub>2</sub>	Std	140	A	A	C
c <sub>3</sub>	Redesigned	140	B	A	C

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>After 12 hours of conditioning.

<sup>c</sup>After 36 hours of conditioning.

Table 2.7-I (Cont'd)

Trial No.	Buffer	Rds Fired Per Gun	Ammunition Type <sup>a</sup>		
			Guns		
			1 to 6	7 to 9	10 to 12
c 4	Std	140	C	B	D
d 5	Redesigned	140	D	B	D
d 6	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
e 7	Std	140	D	A	C
e 8	Redesigned	140	C	A	C
f 9	Std	140	B	B	D
f <sub>10</sub>	Redesigned	140	A	B	D
f <sub>11</sub>	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
g <sub>12</sub>	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		

<sup>a</sup>See explanation, Table 2.3-I.

<sup>c</sup>After 36 hours of conditioning.

<sup>d</sup>After 60 hours of conditioning.

<sup>e</sup>After 84 hours of conditioning.

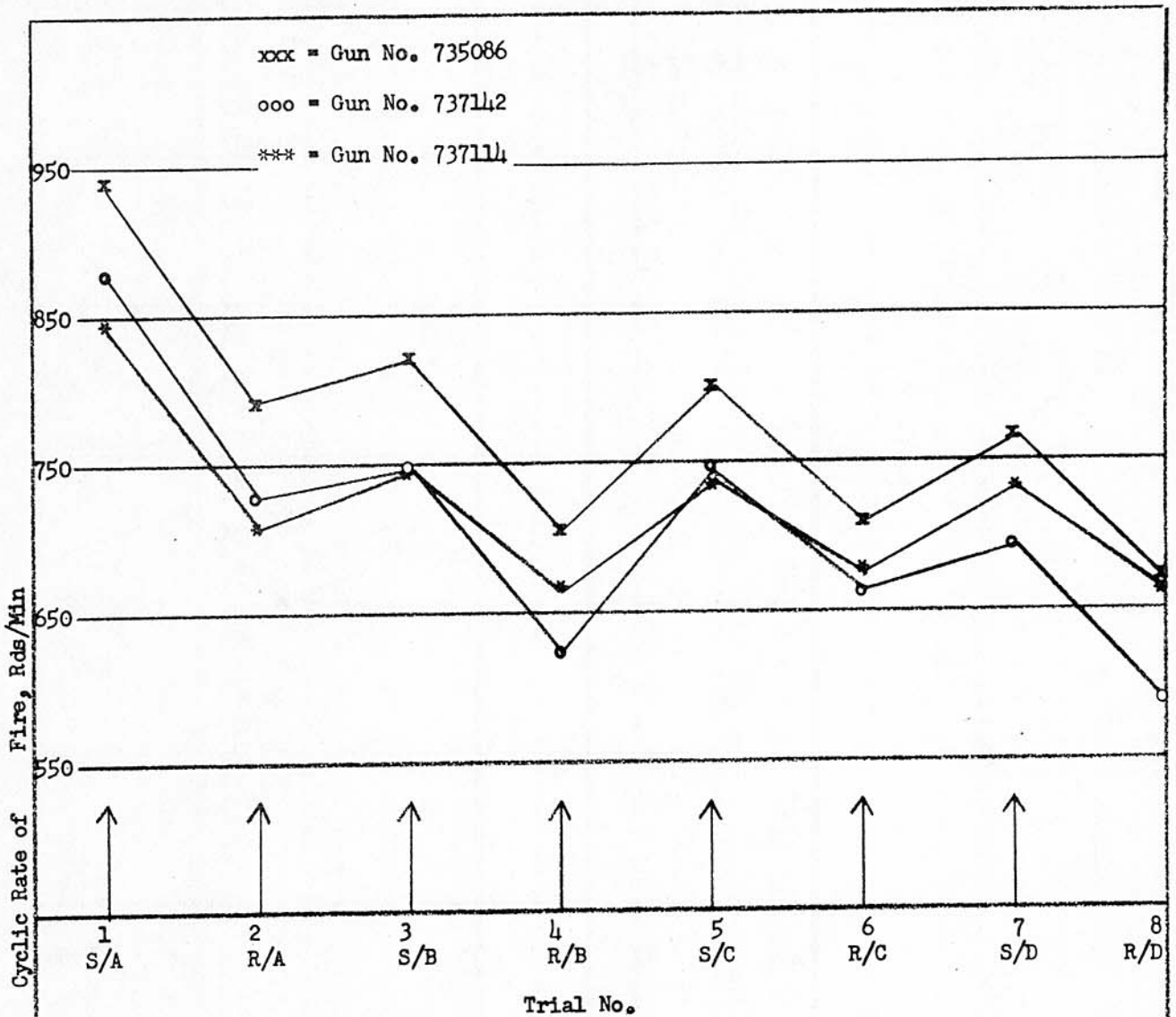
<sup>f</sup>After 108 hours of conditioning.

<sup>g</sup>Fired under normal ambient conditions following cleaning and lubrication.

#### 2.7.4 Results

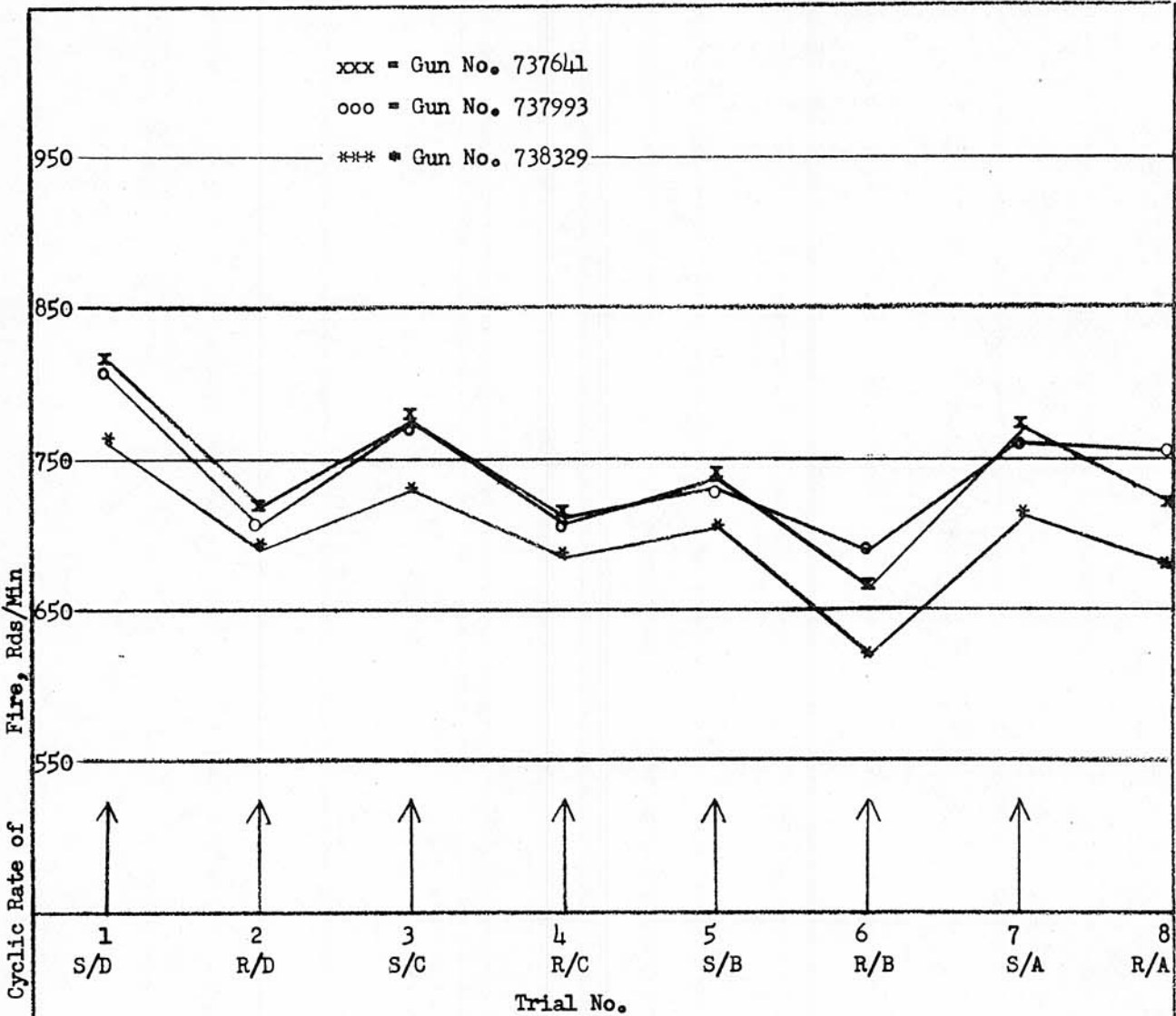
The results of the four cyclic rate-of-fire tests are summarized in Figures 2.7-1 through 2.7-16. The individual cyclic rate-of-fire data are contained in Appendix I.

The functioning data are summarized in Table 2.7-II, page 91.



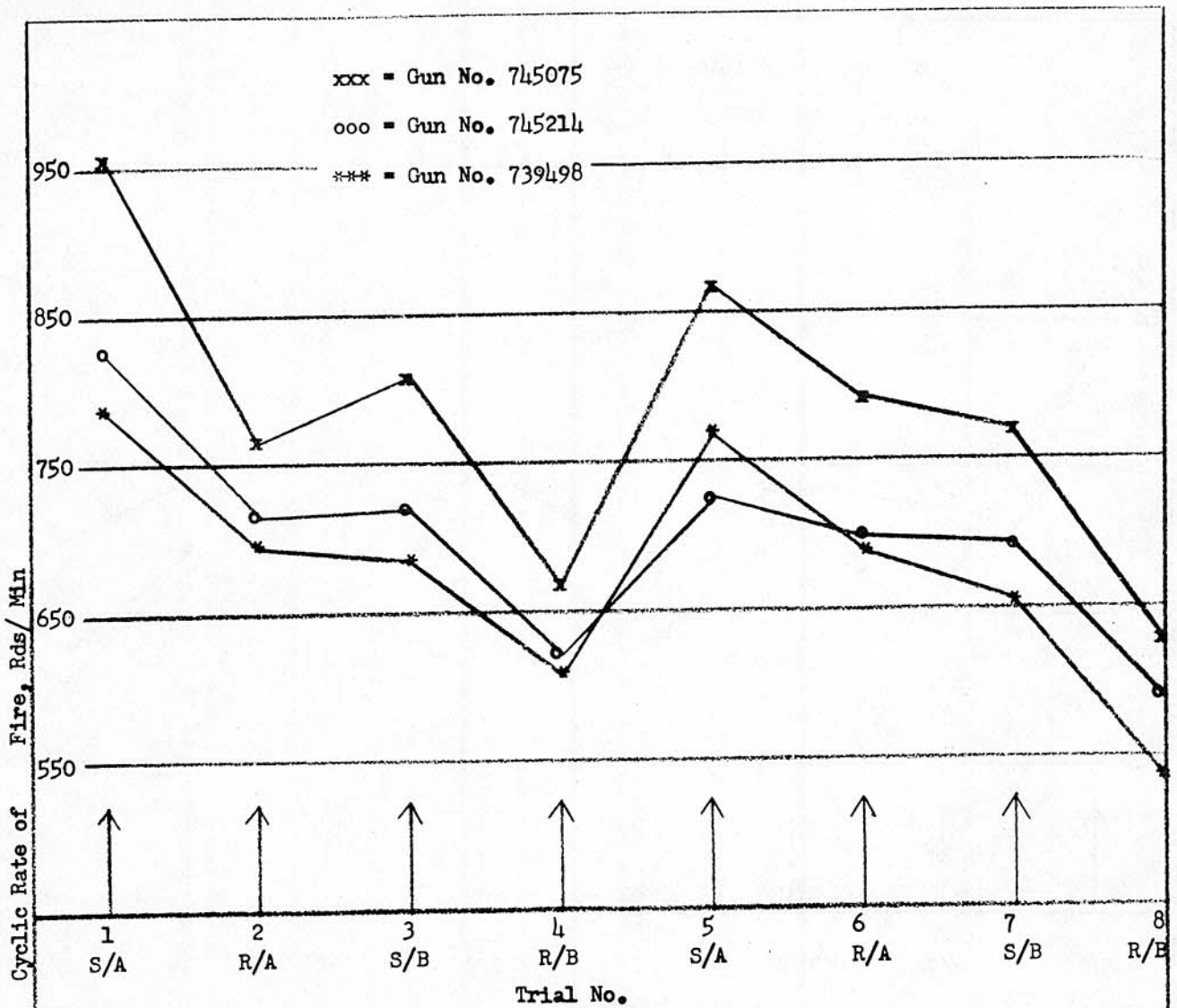
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, Ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-1. Cyclic Rate of Fire Test During Initial Phase of Fouling Test for Three M16A1 Rifles.



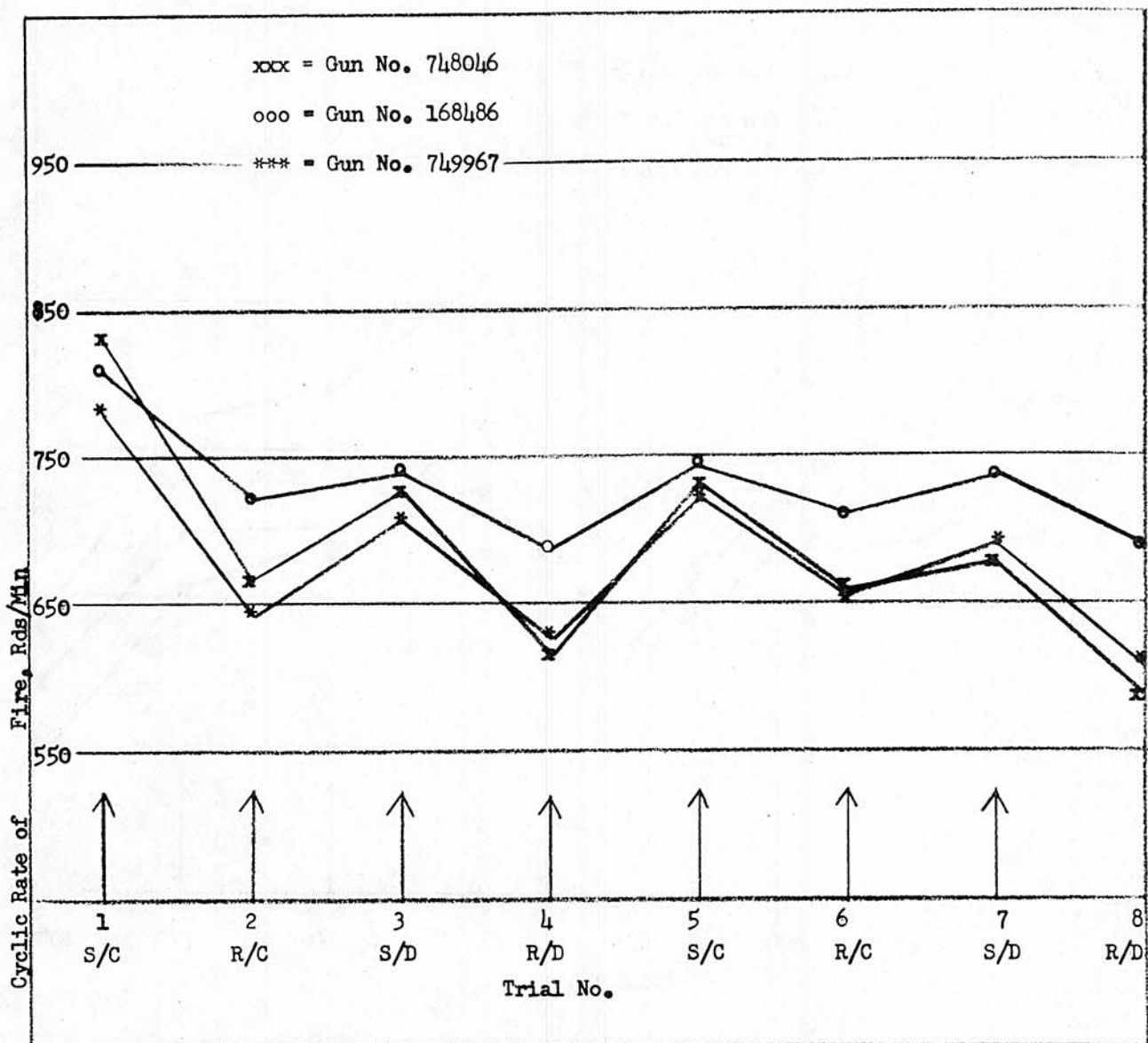
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.7-2. Cyclic Rate of Fire Test During Initial Phase of Fouling Test for Three ML6A1 Rifles.



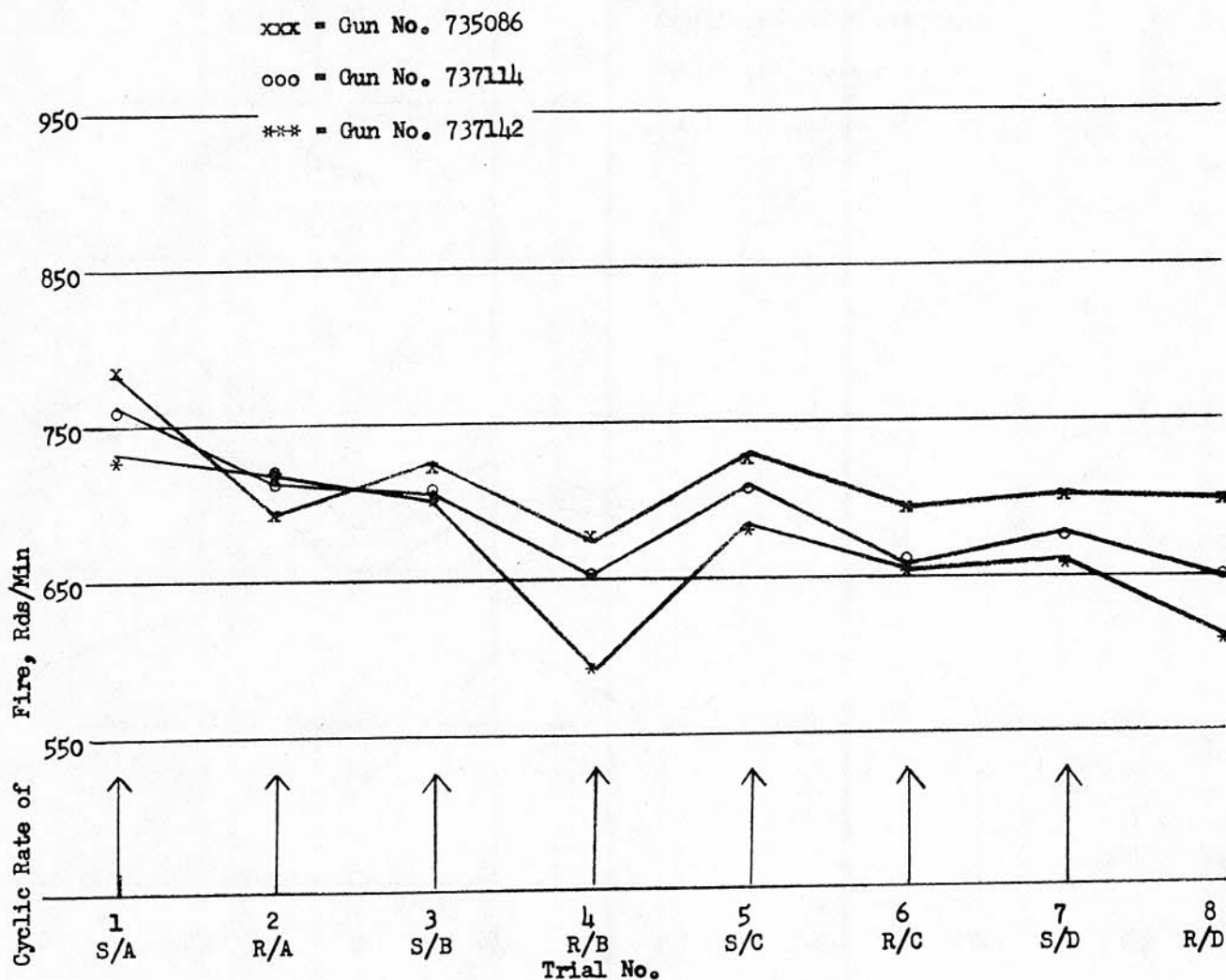
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.7-3. Cyclic Rate of Fire Test During Initial Phase of Fouling Test for Three M16A1 Rifles.



S/C = Standard buffer while firing M196, ball propellant ammunition.  
R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-4. Cyclic Rate of Fire Test During Initial Phase of Fouling Test for Three M16A1 Rifles.



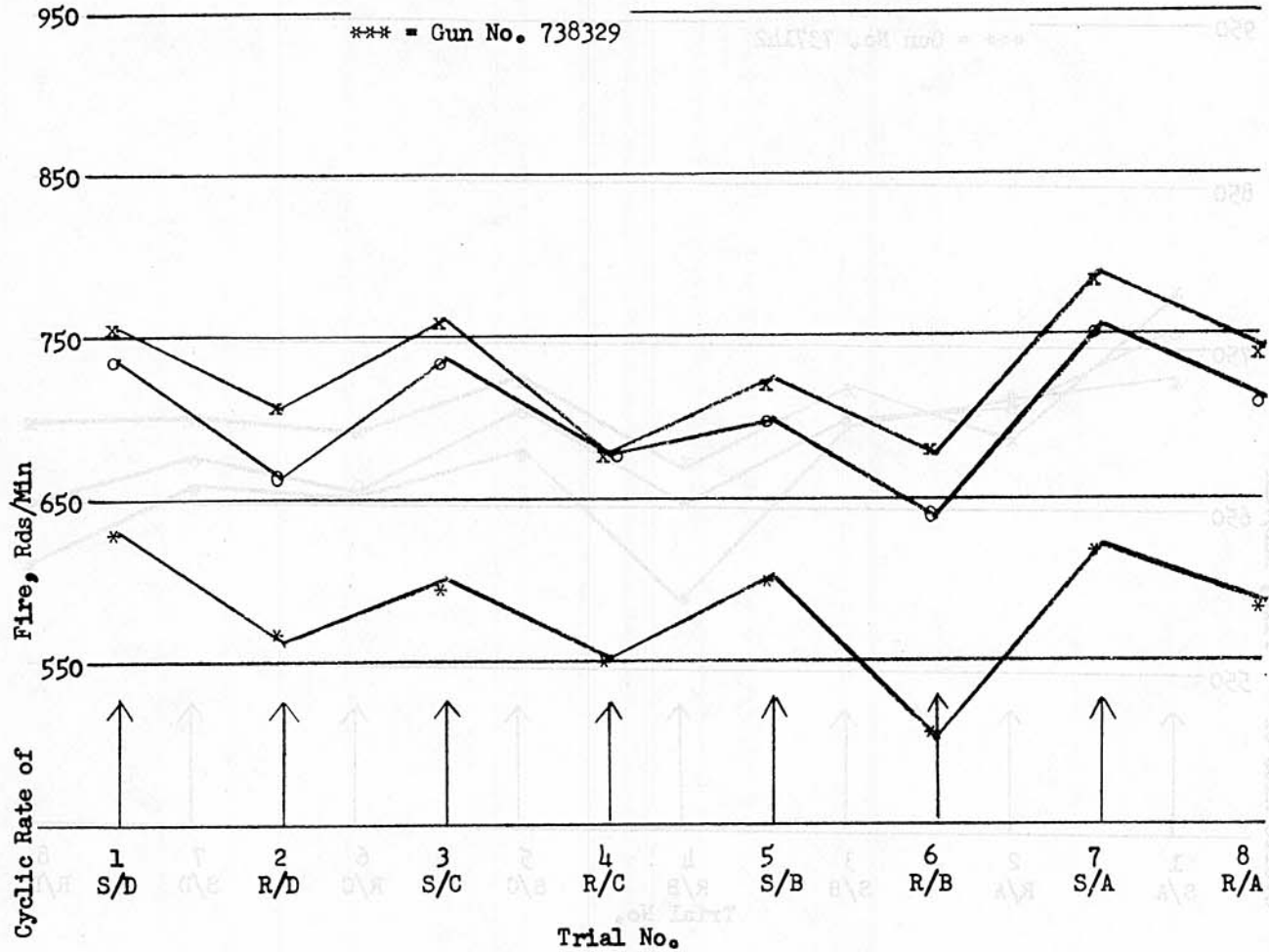
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-5. Cyclic Rate of Fire Test During Second Phase of Fouling Test for Three M16A1 Rifles.

xxx = Gun No. 737641

ooo = Gun No. 737993

\*\*\* = Gun No. 738329



S/D = Standard buffer while firing M196, 8208M propellant ammunition.

R/D = Redesign buffer while firing M196, 8208M propellant ammunition.

S/C = Standard buffer while firing M196, ball propellant ammunition.

R/C = Redesign buffer while firing M196, ball propellant ammunition.

S/B = Standard buffer while firing M193, 8208M propellant ammunition.

R/B = Redesign buffer while firing M193, 8208M propellant ammunition.

S/A = Standard buffer while firing M193, ball propellant ammunition.

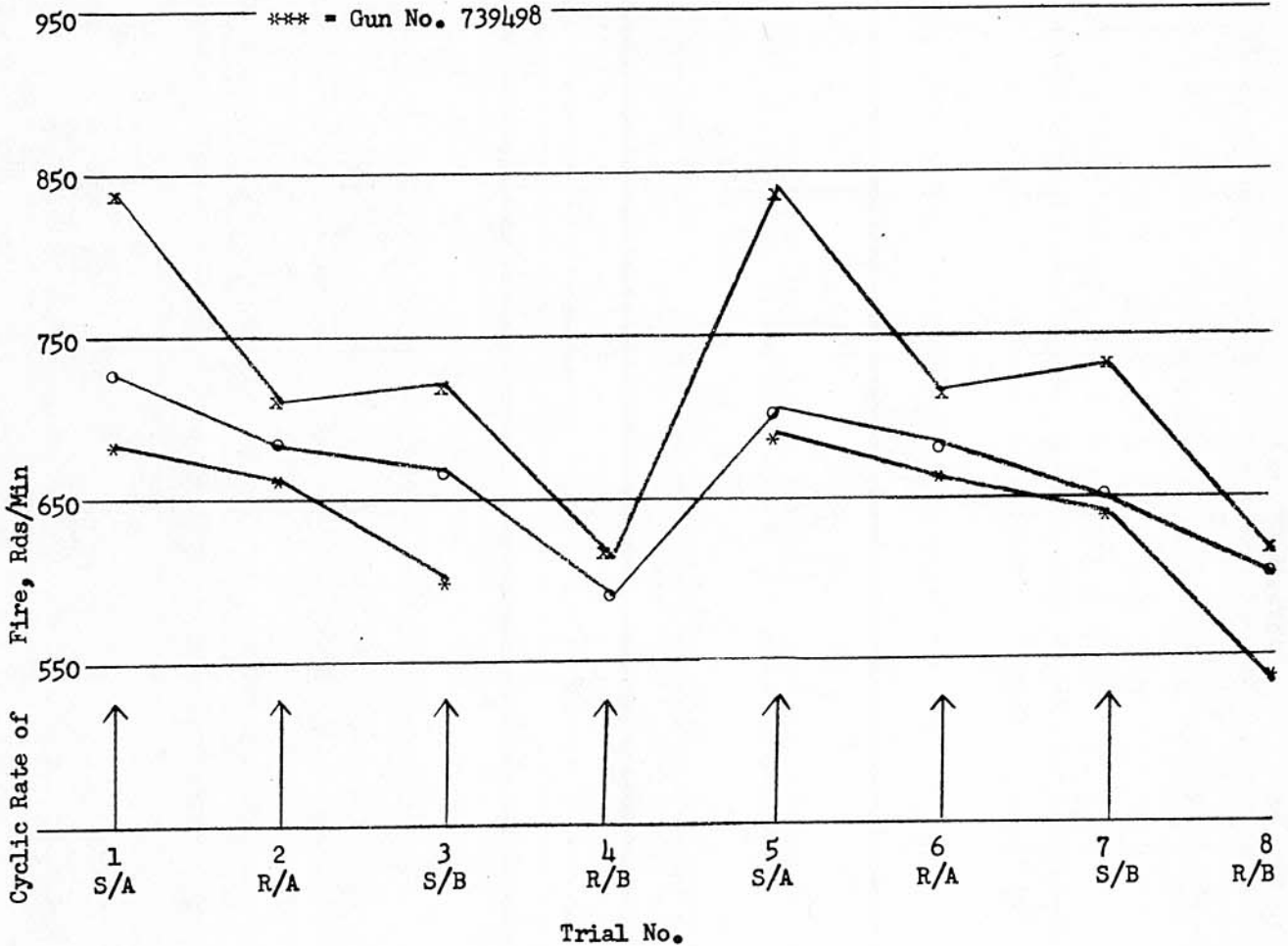
R/A = Redesign buffer while firing M193, ball propellant ammunition.

Figure 2.7- 6. Cyclic Rate of Fire Test During Second Phase of Fouling Test for Three M16A1 Rifles.

xxx = Gun No. 745075

ooo = Gun No. 745214

\*\*\* = Gun No. 739498



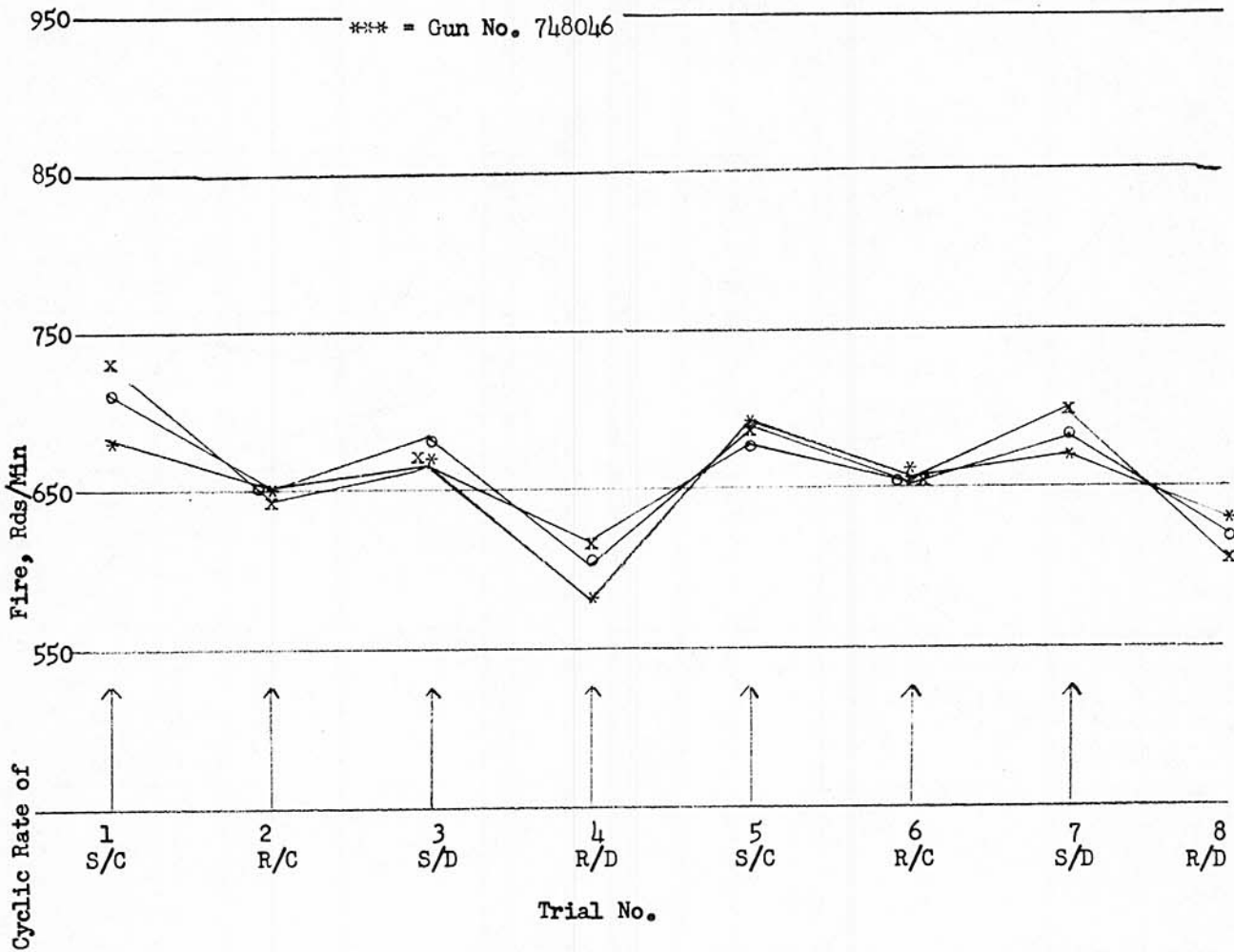
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.7-7. Cyclic Rate of Fire Test During Second Phase of Fouling Test for Three M16A1 Rifles.

xxx = Gun No. 749967

ooo = Gun No. 168486

\*\*\* = Gun No. 748046



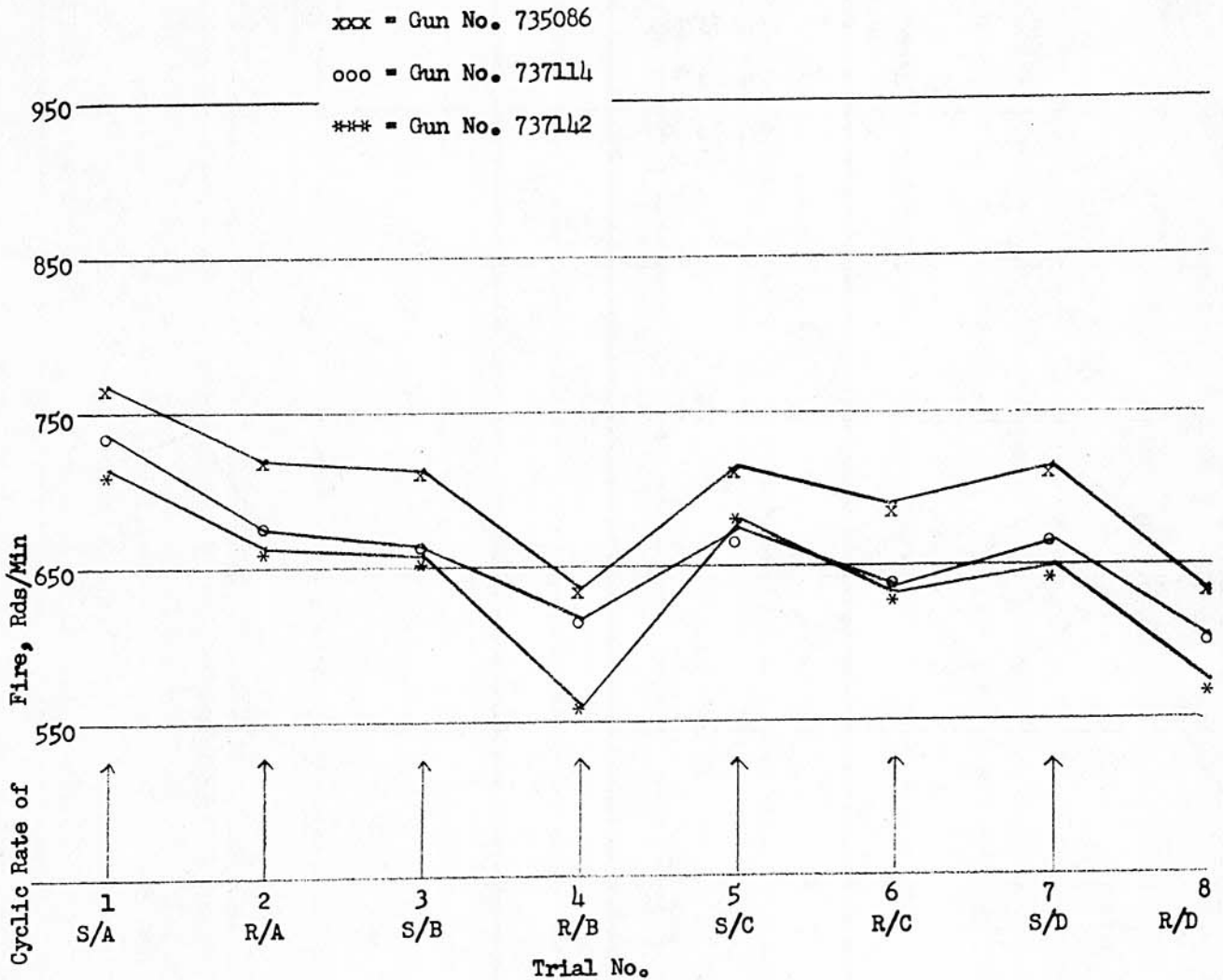
S/C = Standard buffer while firing M196, ball propellant ammunition.

R/C = Redesigned buffer while firing M196, ball propellant ammunition.

S/D = Standard buffer while firing M196, 8208M propellant ammunition.

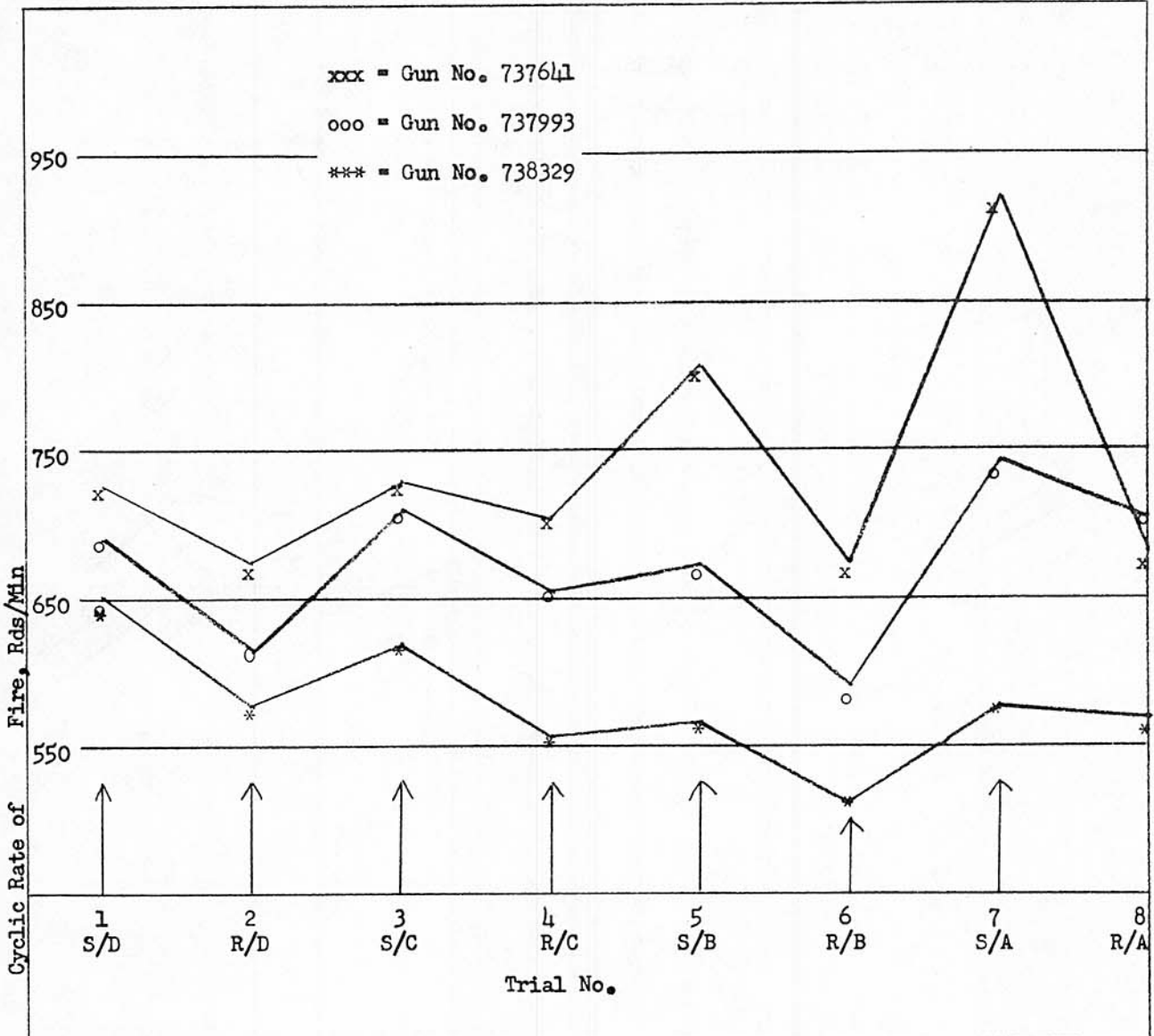
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-8. Cyclic Rate of Fire Test During Second Phase of Fouling Test for Three M16A1 Rifles.



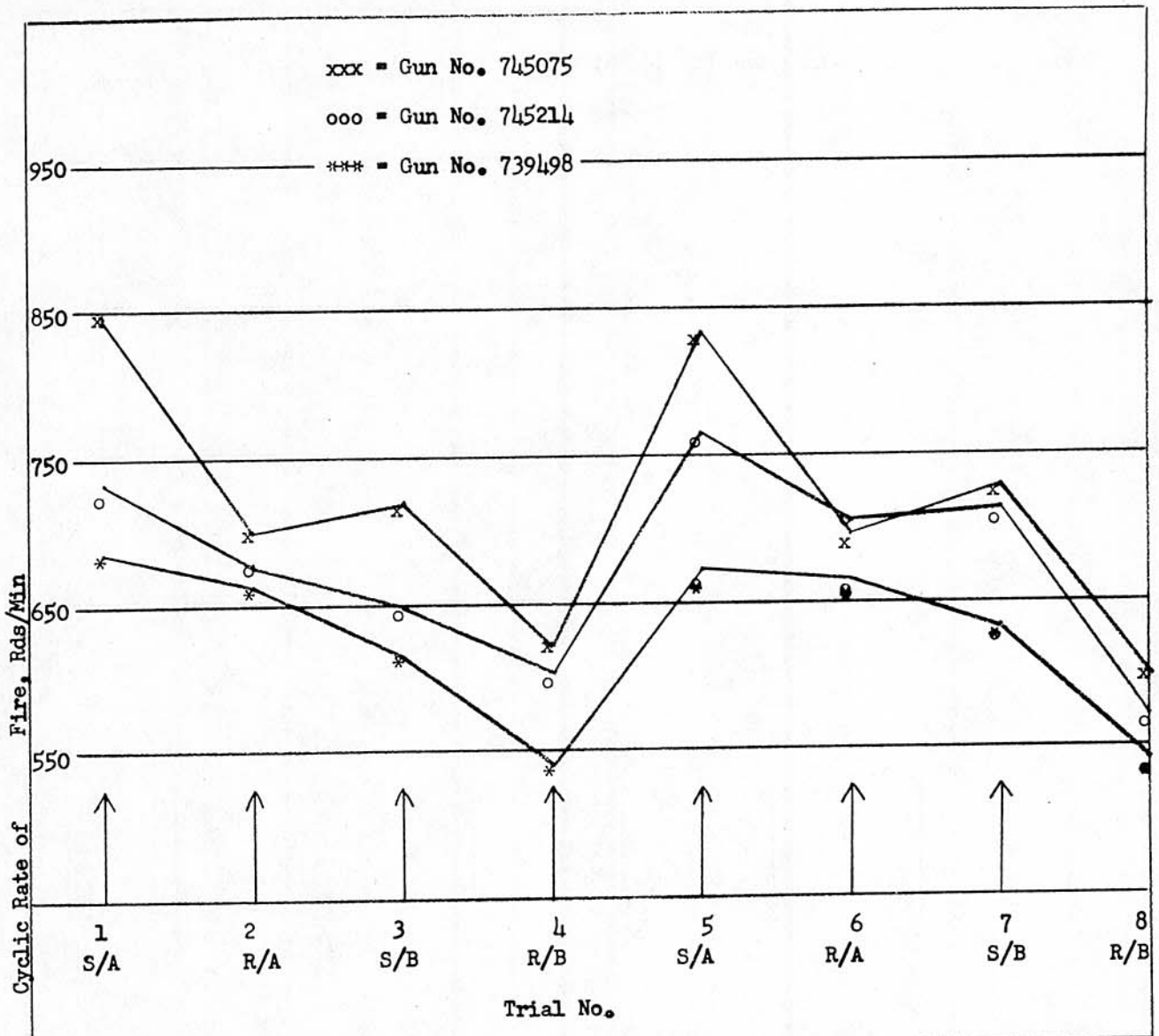
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesugned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesugned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesugned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesugned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-9. Cyclic Rate of Fire Test During Final Phase of Fouling Test for Three M16A1 Rifles.



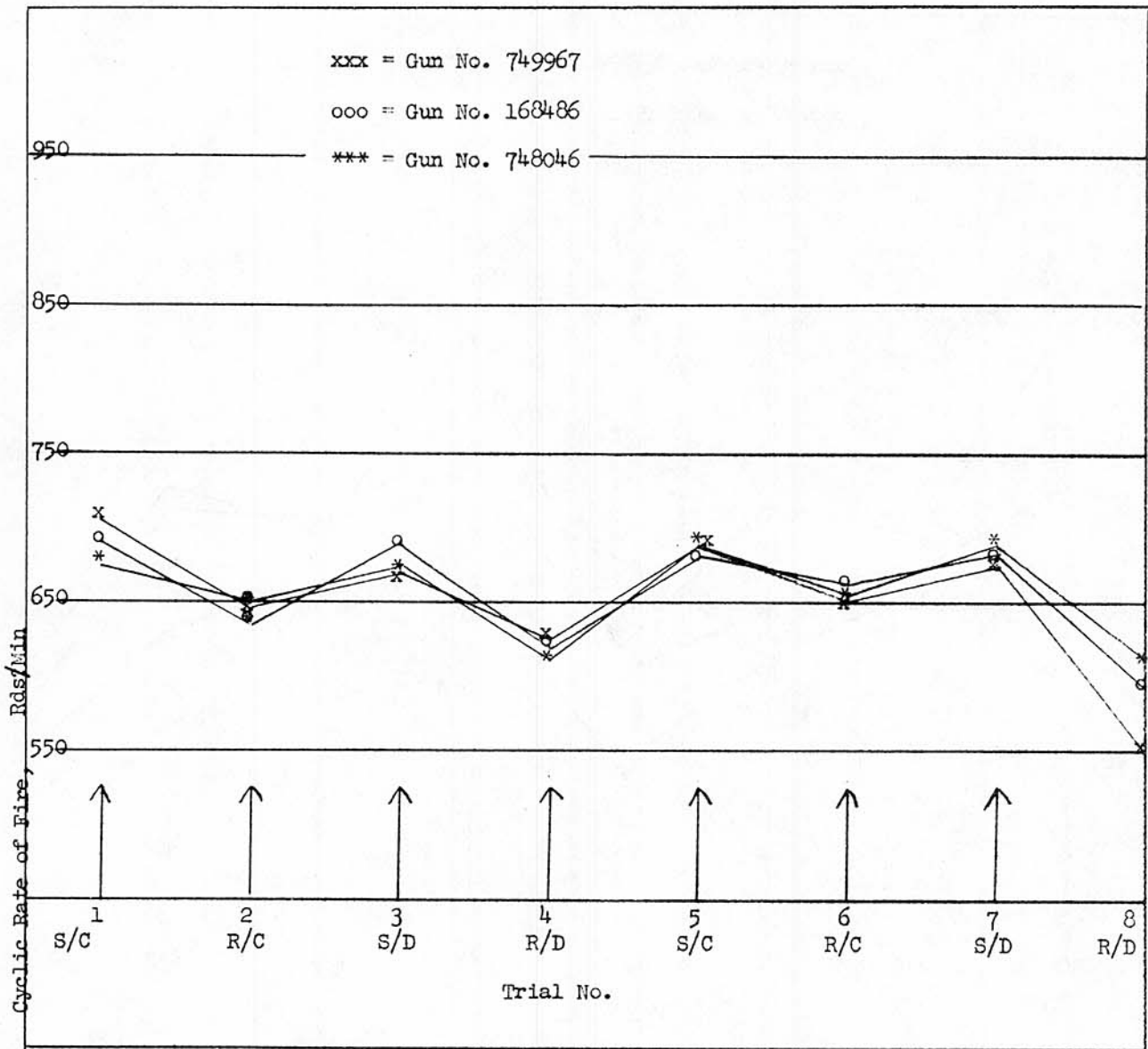
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.7-10. Cyclic Rate of Fire Test During Final Phase of Fouling Test for Three M16A1 Rifles.



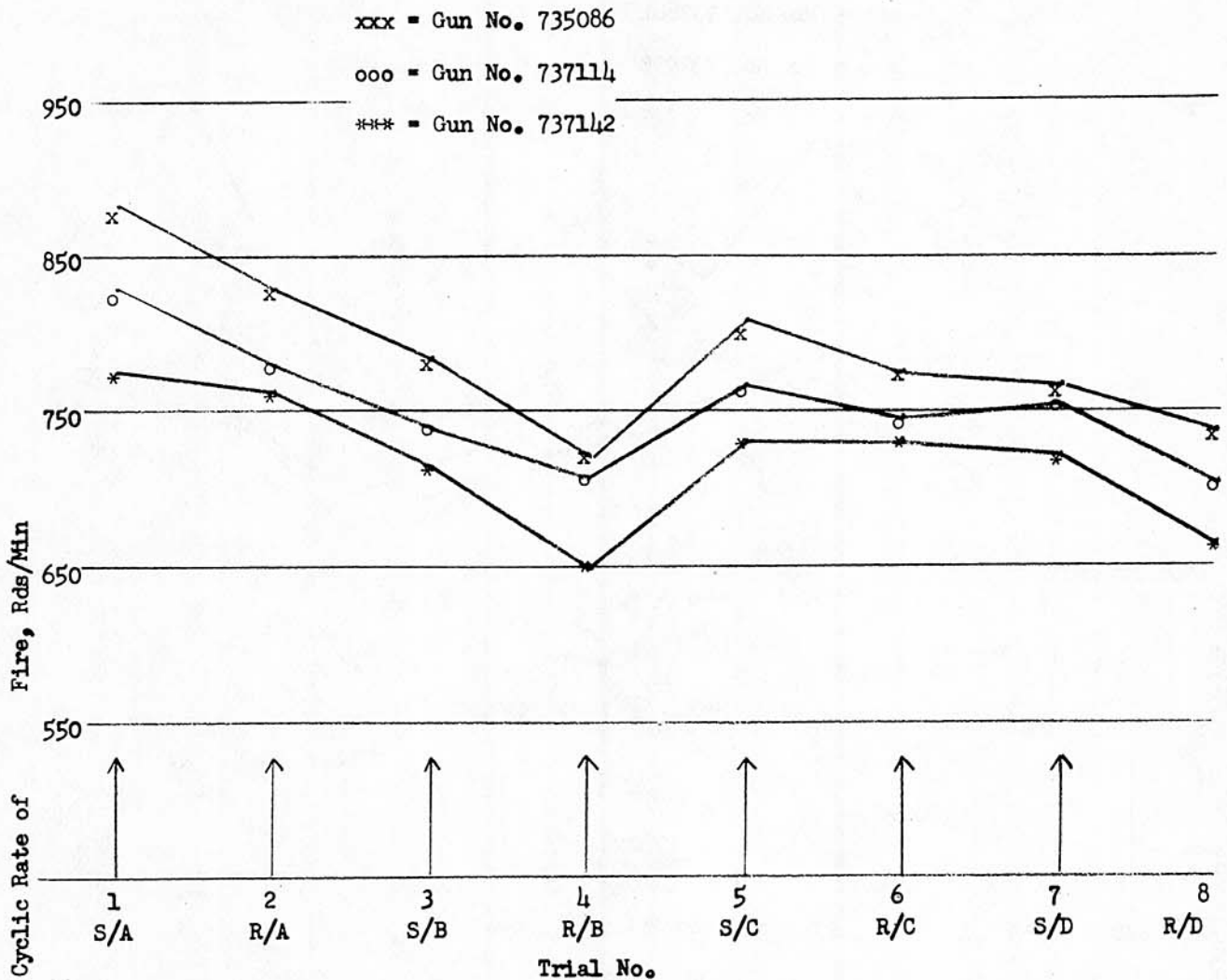
S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.7- 11. Cyclic Rate of Fire Test During Final Phase of Fouling Test for Three M16A1 Rifles.



S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7- 12. Cyclic Rate of Fire Test During Final Phase of Fouling Test for Three M16A1 Rifles.



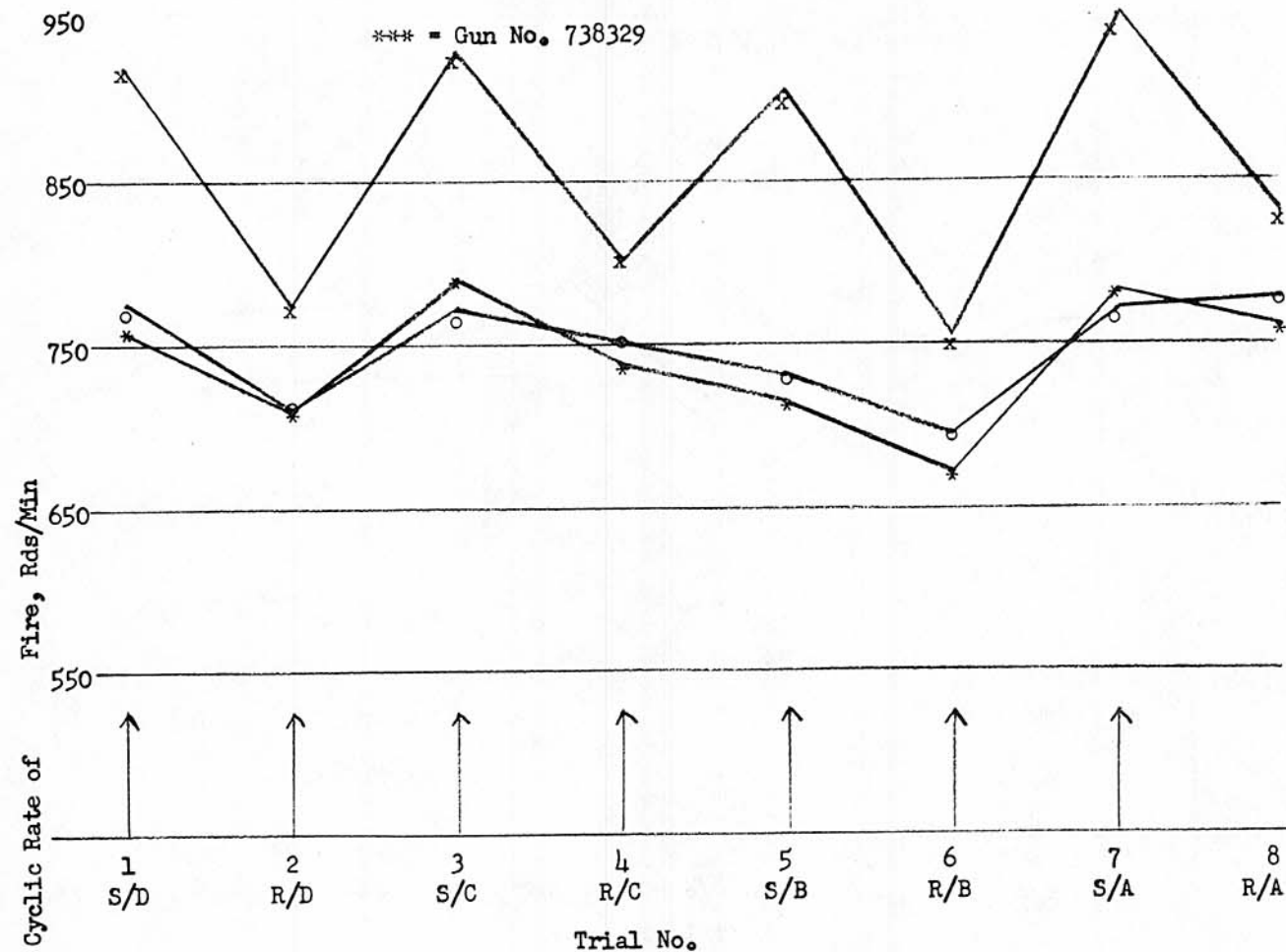
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-13. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following Fouling Test for Three M16A1 Rifles.

xxx = Gun No. 737641

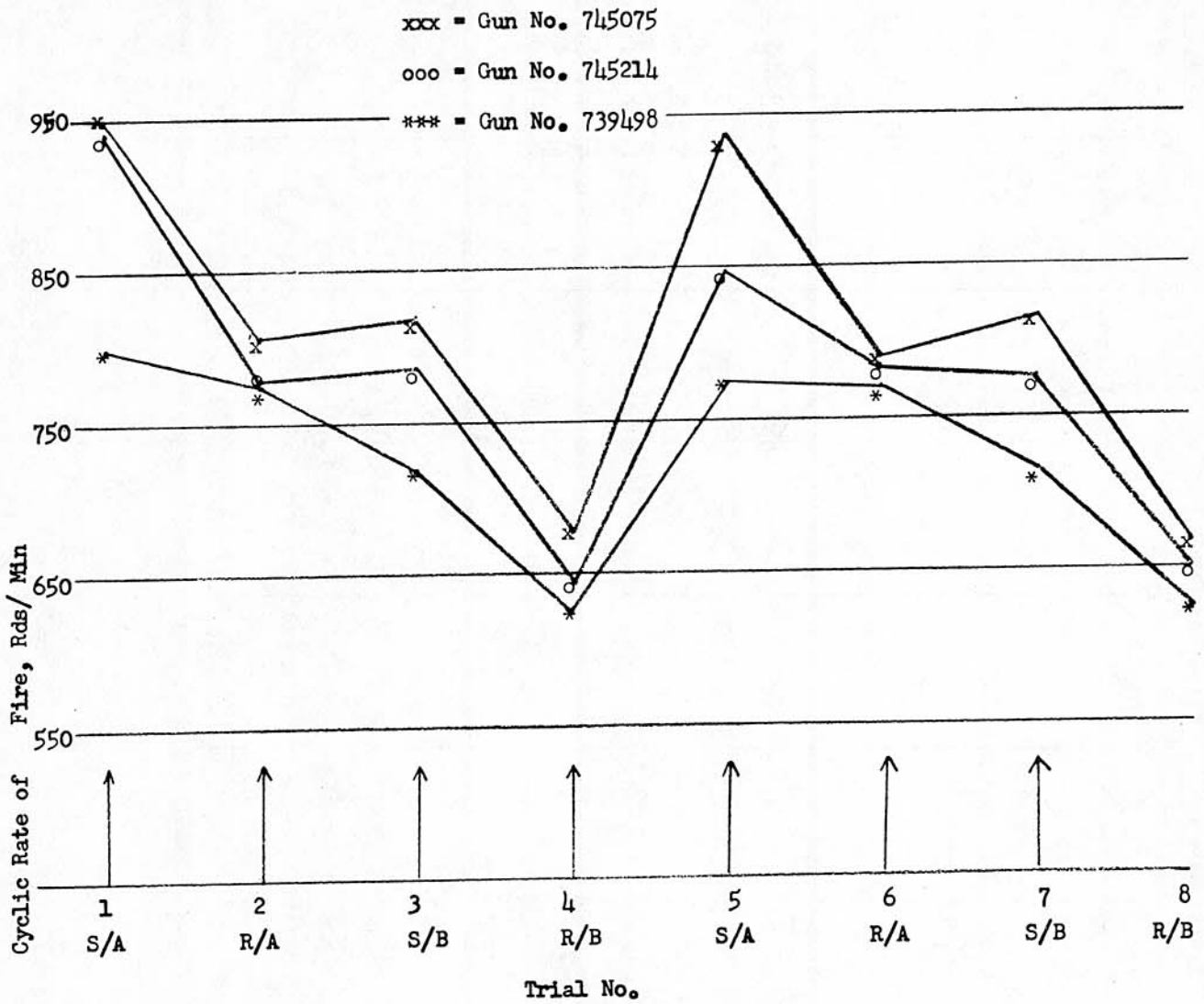
ooo = Gun No. 737993

\*\*\* = Gun No. 738329



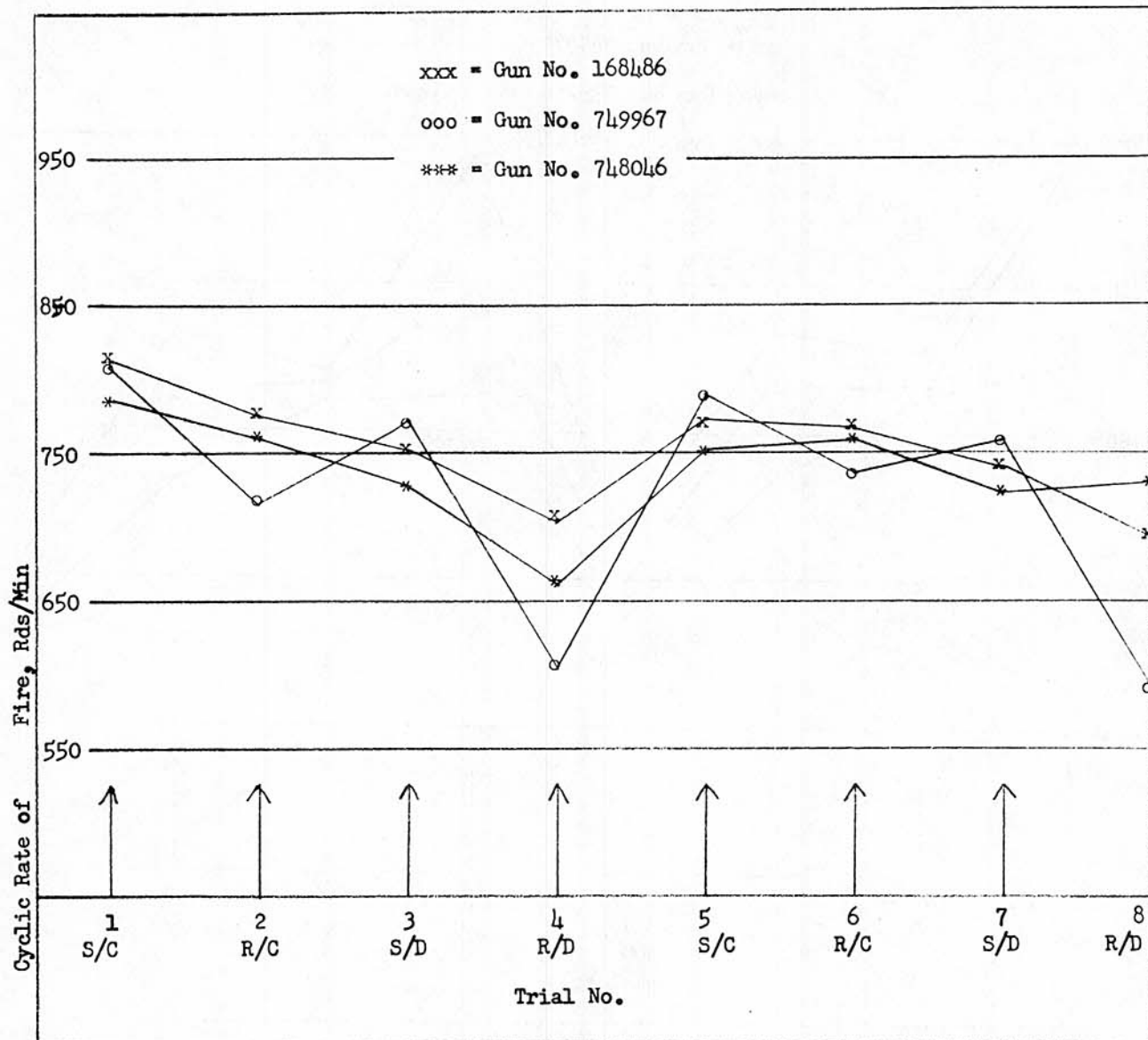
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.  
S/C = Standard buffer while firing M196, ball propellant ammunition.  
R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
S/A = Standard buffer while firing M193, ball propellant ammunition.  
R/A = Redesigned buffer while firing M193, ball propellant ammunition.

Figure 2.7-14. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following Fouling Test for Three M16A1 Rifles.



S/A = Standard buffer while firing M193, ball propellant ammunition.  
R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.7- 15. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following Fouling Test for Three M16A1 Rifles.



- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.7-16. Cyclic Rate of Fire Test after Cleaning and at Normal Ambient Following Fouling Test for Three M16A1 Rifles.

Table 2.7-11. Summary of Malfunction Data for Fouling Test (+20°F)

Gun No.	Ammunition Lot No.	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic, A = Automatic)												Total Malfunctions	Remarks																
		FPR		FBR		BOB		FF		COEC		FF-1				DF	FX														
		Std	Red	Std	Red	Std	Red	Std	Red	Std	Red	Std	Red					Std	Red												
735086	LC12177	440	1													0	During the latter phases of test it														
	TW18166	440														1	was observed that the standard buffer														
	LC12081	440														3	ring springs were often stuck or														
	TW18001	440														0	jammed together. The springs could														
737114	LC12177	440														3	be separated by tapping the buffer														
	TW18166	440														8	but a drop of lubricant was required														
	LC12081	440														5	to prevent immediate relocking of the														
	TW18001	440														0	ring springs. At the conclusion of test the														
737142	LC12177	440														1	ring springs in seven buffers were														
	TW18166	440														1	jammed.														
	LC12081	440														0															
	TW18001	440														3															
737641	LC12177	490														12															
	TW18166	490														6															
	LC12081	490														7															
	TW18001	534														0															
737993	LC12177	440														1															
	TW18166	440														1															
	LC12081	440														0															
	TW18001	440														1															
738329	LC12177	440														13	Broken extractor spring replaced.														
	TW18166	440														14															
	LC12081	500														18															
	TW18001	440														12															
739498	LC12177	901														3															
	TW18166	880														19															
	LC12177	880														1	Broken extractor spring replaced.														
	TW18166	880														0															
745214	LC12177	962														8															
	TW18166	880														8															
748046	LC12081	906														4															
	TW18001	880														2															
749967	LC12081	975														7															
	TW18001	972														23															
168486	LC12081	880														13															
	TW18001	979														15															
<b>Totals</b>		21839	1	75	1	1	0	2	1	0	0	0	2	6	0	3	19	0	1	6	32	26	23	16	0	1	0	0	0	217	

Semiautomatic<sup>b</sup> 2 (1,1) 1 (0,1) 0 (0,0) 9 (6,3) 1 (0,1) 55 (32,23) 0 (0,0) 0 (0,0) 0 (0,0) 68 (39,29)  
 Automatic<sup>b</sup> 76 (75,1) 2 (2,0) 2 (0,2) 19 (0,19) 6 (0,6) 42 (26,16) 1 (1,0) 1 (0,1) 0 (0,0) 149 (104,45)  
 78 (76,2) 3 (2,1) 2 (0,2) 28 (6,22) 7 (0,7) 97 (58,39) 1 (1,0) 1 (0,1) 0 (0,0) 217 (143,74)

<sup>a</sup>These malfunctions are not included in any totals; the malfunctions were attributed to a broken extractor spring.  
<sup>b</sup>First number in parentheses indicates standard buffer malfunctions, second number indicates redesigned buffer malfunctions.

LC12177, standard buffer: 19 31  
 LC12177, redesigned buffer: 12  
 TW18166, standard buffer: 35 64  
 TW18166, redesigned buffer: 29  
 LC12081, standard buffer: 37 57  
 LC12081, redesigned buffer: 20  
 TW18001, standard buffer: 52 65  
 TW18001, redesigned buffer: 13

### 2.7.5 Analysis

The redesigned buffer demonstrated again in this test a consistent reduction in rates of fire when compared to the standard buffer. This rate reduction brought many more trials below the minimum rate of 650 rounds per minute in this subtest than in previous subtests. During 143 trials conducted at +20°F, 62 trials with the redesigned buffer were below 650 rounds per minute while no trials exceeded 850 rounds per minute. The record for the standard buffer was 14 trials below the minimum rate and 5 trials exceeding the upper rate.

One of the objectives in this test was to determine if a difference in fouling of the weapon mechanism could be detected as a result of firing tracer versus ball ammunition. While there was some evidence to indicate that tracer-fired guns were fouled somewhat more severely than were the ball-projectile-fired guns, the evidence was often contradictory and a close surveillance during the test to further differentiate fouling by propellant type was unsuccessful.

## 2.8 LOW TEMPERATURE (-65°F)

### 2.8.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a redesigned buffer when firing various types of ammunition during low-temperature conditions.
- b. To compare the above performance with similar firings employing the standard buffer.

### 2.8.2 Criteria

Same as par. 2.5.2.

### 2.8.3 Method

The method of test is described in par. 3.3.1b, Interim Pamphlet 20-20, TECP 700-700, 11 April 1966.

The firing schedule is contained in Table 2.8-I.

Table 2.8-I. Low Temperature Schedule

Trial No. <sup>b</sup>	Buffer	Rds Fired Per Gun <sup>c</sup>	Ammunition Type <sup>a</sup>		
			Guns		
			1 to 6	7 to 9	10 to 12
1	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
2	Std	200	A	A	C
3	Redesigned	200	B	A	C
4	Std	200	C	B	D
5	Redesigned	200	D	B	D
6	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
7	Std	200	D	A	C
8	Redesigned	200	C	A	C
9	Std	200	B	B	D
10	Redesigned	200	A	B	D
11	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		
<sup>d</sup> 12	Std and Redesigned	160	Repeat cyclic rate-of-fire test.		

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>Except for trials No. 1, 6, 11, and 12, which are fired in an uninterrupted exercise, all other trials are divided into 100-round cycles, two hours apart. A 2-hour (minimum) conditioning period is also observed between each 200-round trial.

<sup>c</sup>Weapons are removed from the chamber for maintenance after trial No. 3, 6, 9, and 11; no other lubrication or maintenance is provided.

<sup>d</sup>Fired under normal ambient conditions following cleaning and lubrication.

#### 2.8.4 Results

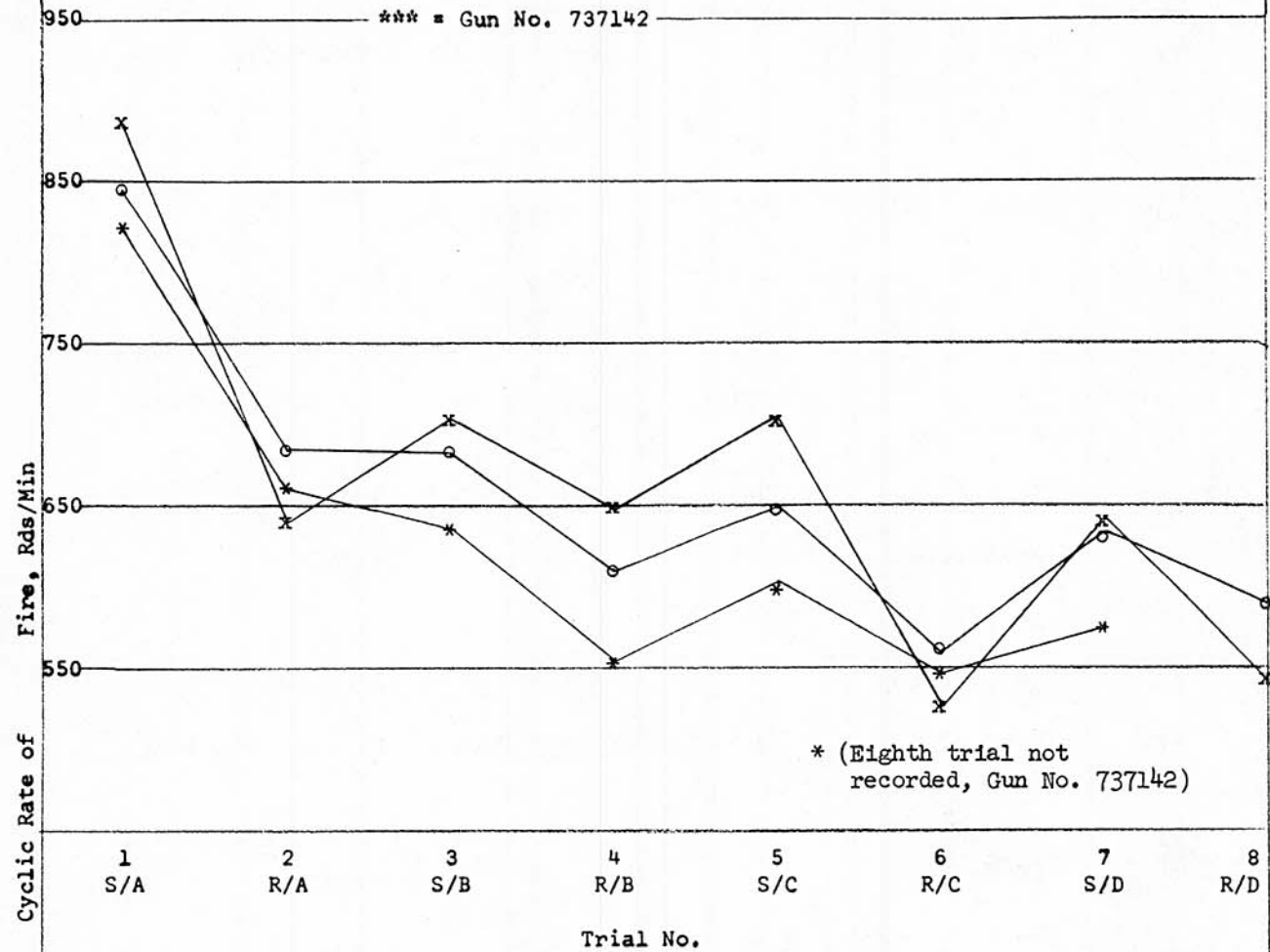
The results of the four cyclic rate-of-fire tests are summarized in Figures 2.8-1 through 2.8-16. The individual rate-of-fire data are contained in Appendix I.

The functioning data are summarized in Table 2.8-II, page 110.

xxx = Gun No. 737114

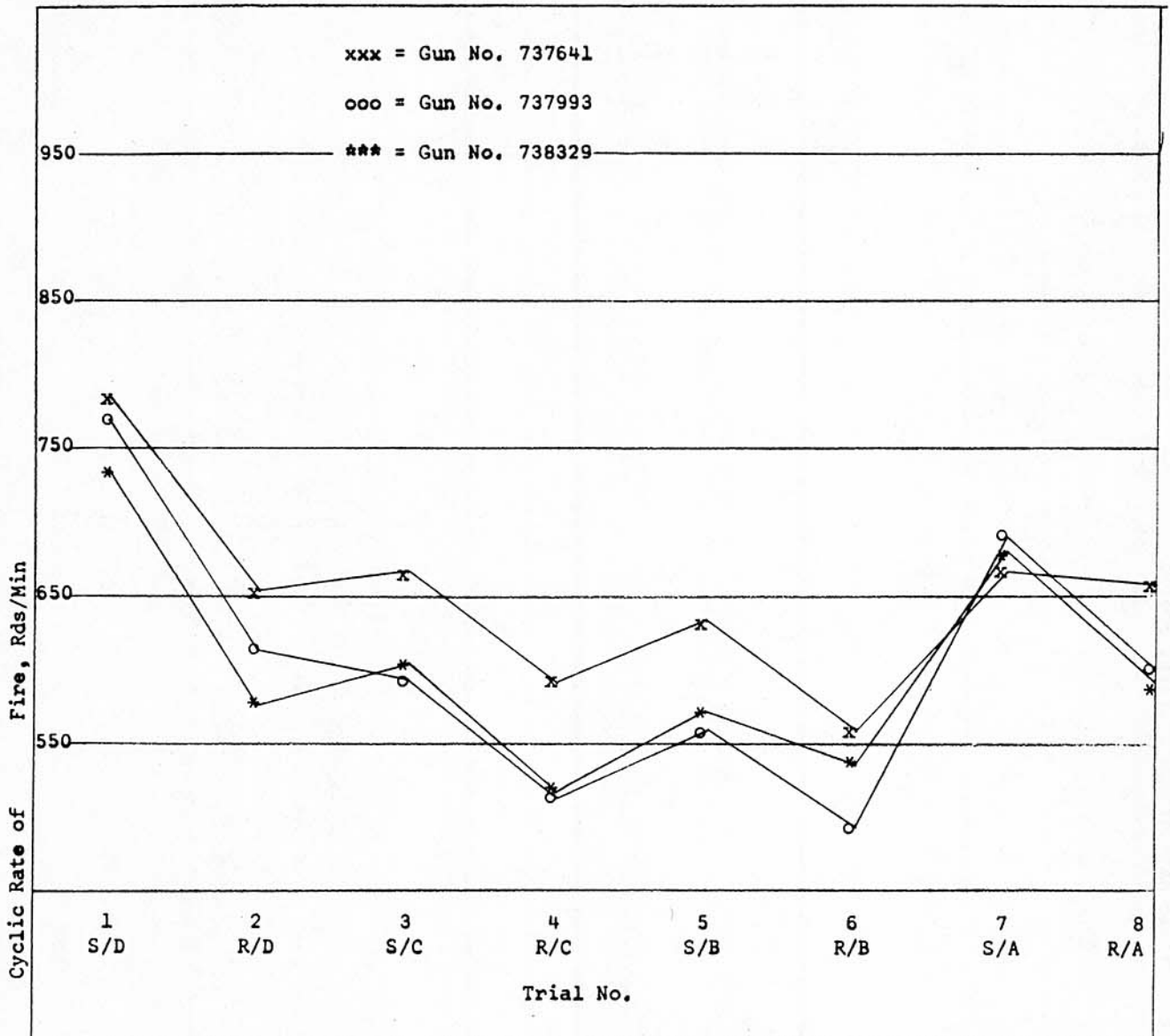
ooo = Gun No. 735086

\*\*\* = Gun No. 737142



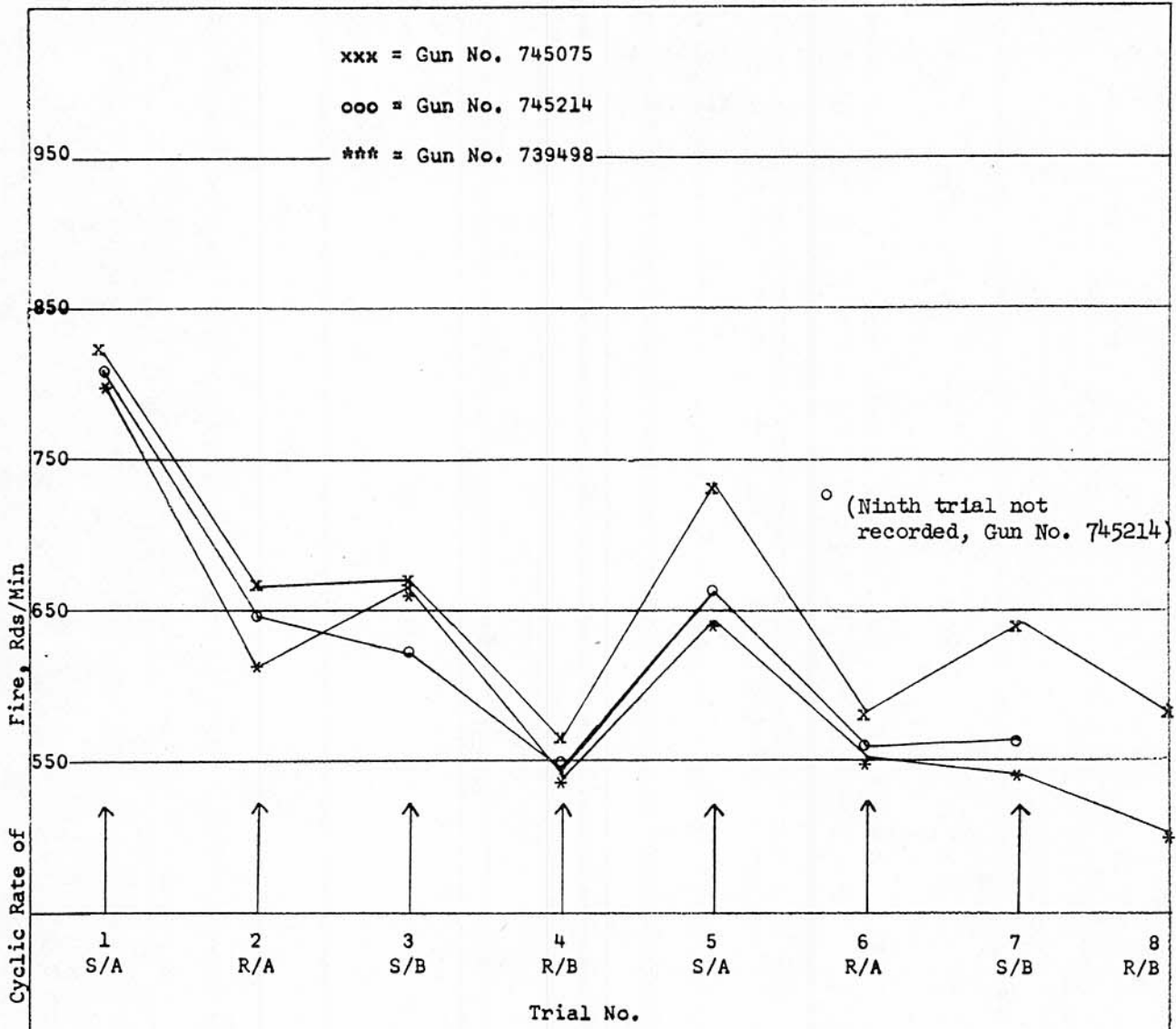
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-1. Cyclic Rate of Fire Test During Initial Phase of Low Temperature Test for Three M16A1 Rifles.



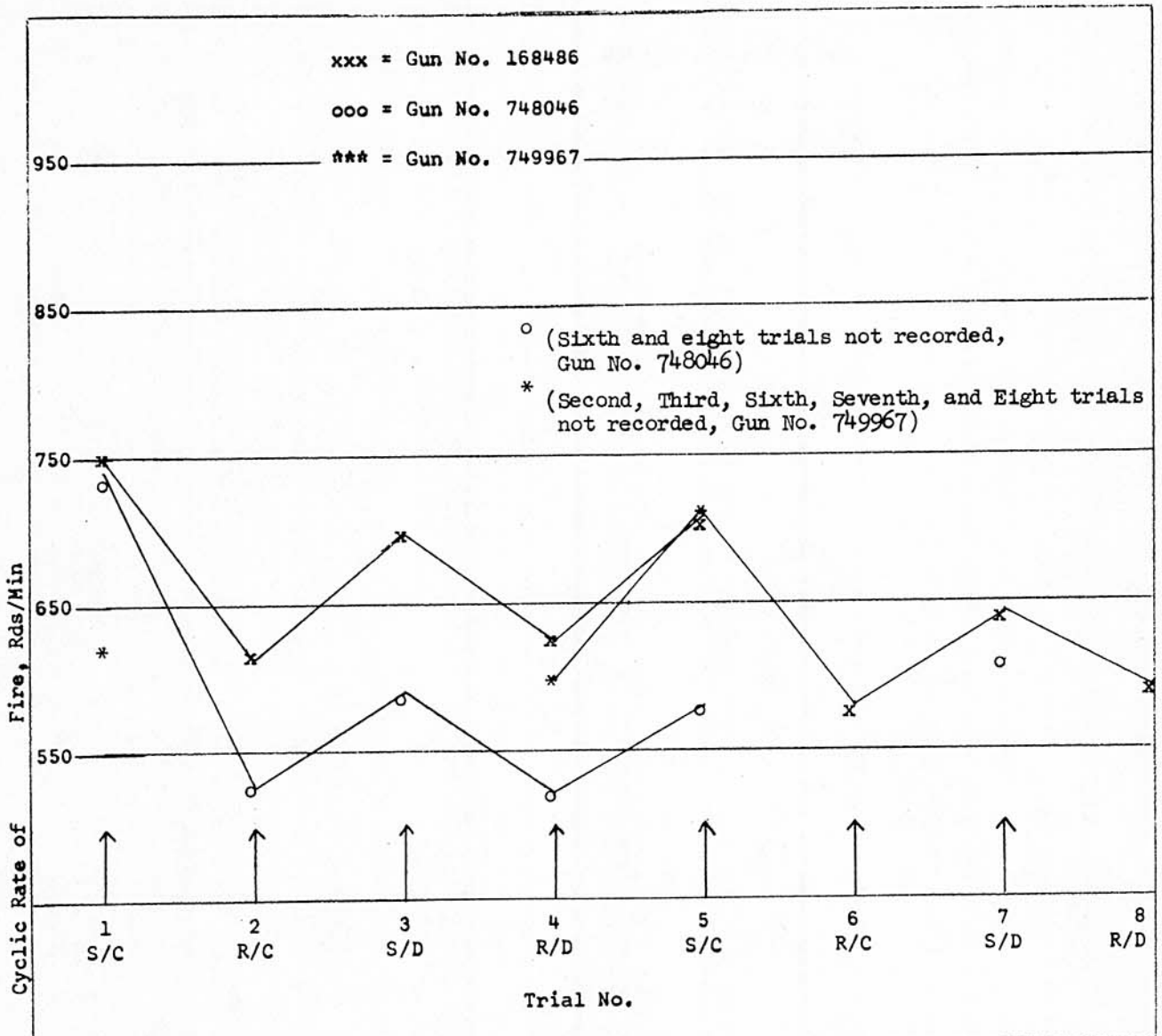
S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
 S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-2. Cyclic Rate of Fire Test During Initial Phase of Low Temperature Test for Three M16A1 Rifles.



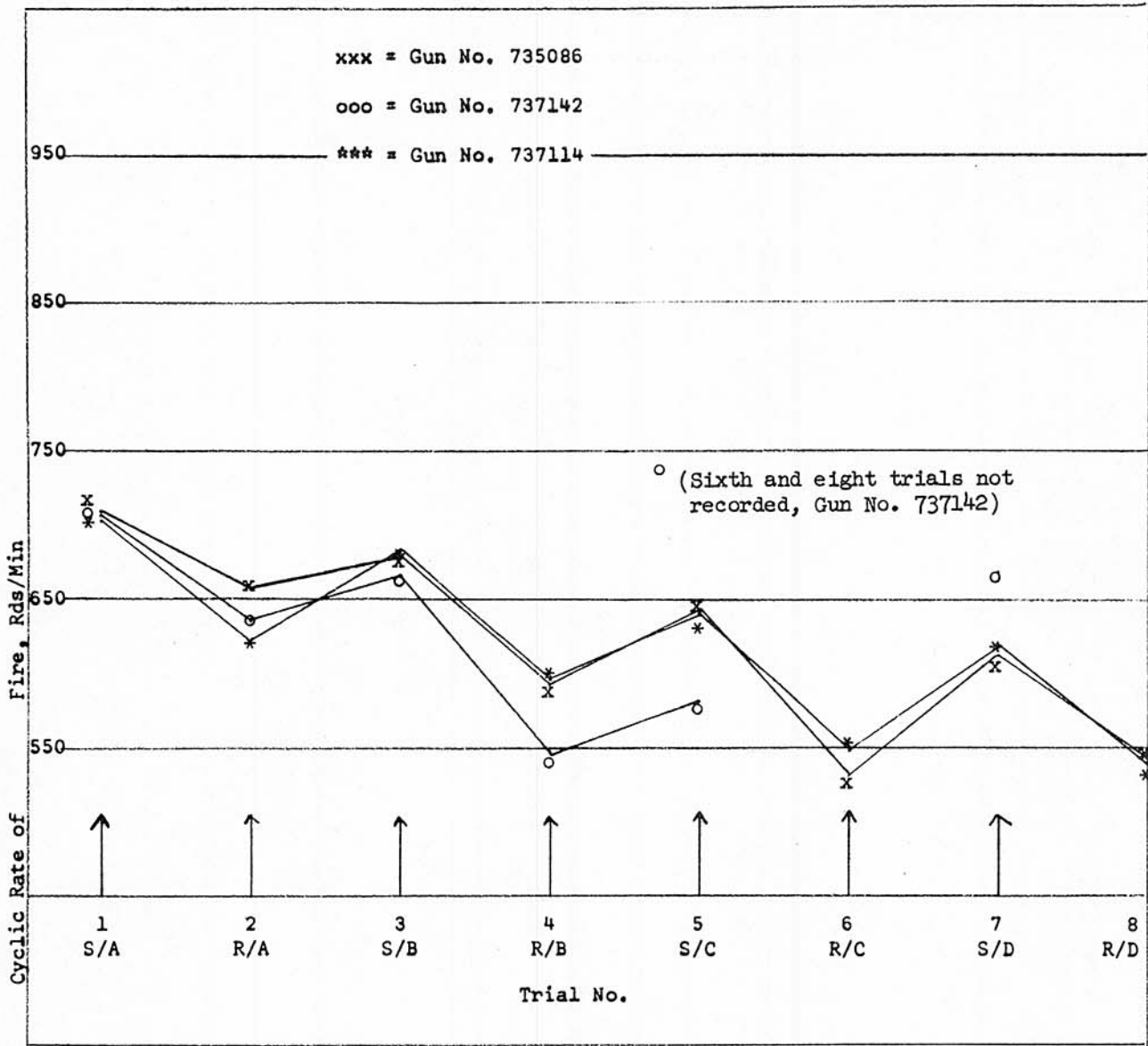
S/A = Standard buffer while during M193, ball propellant ammunition.  
 R/A = Redesignated buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesignated buffer while firing M193, 8208M propellant ammunition.

Figure 2.8-3. Cyclic Rate of Fire Test During Initial Phase of Low Temperature Test for Three M16A1 Rifles.



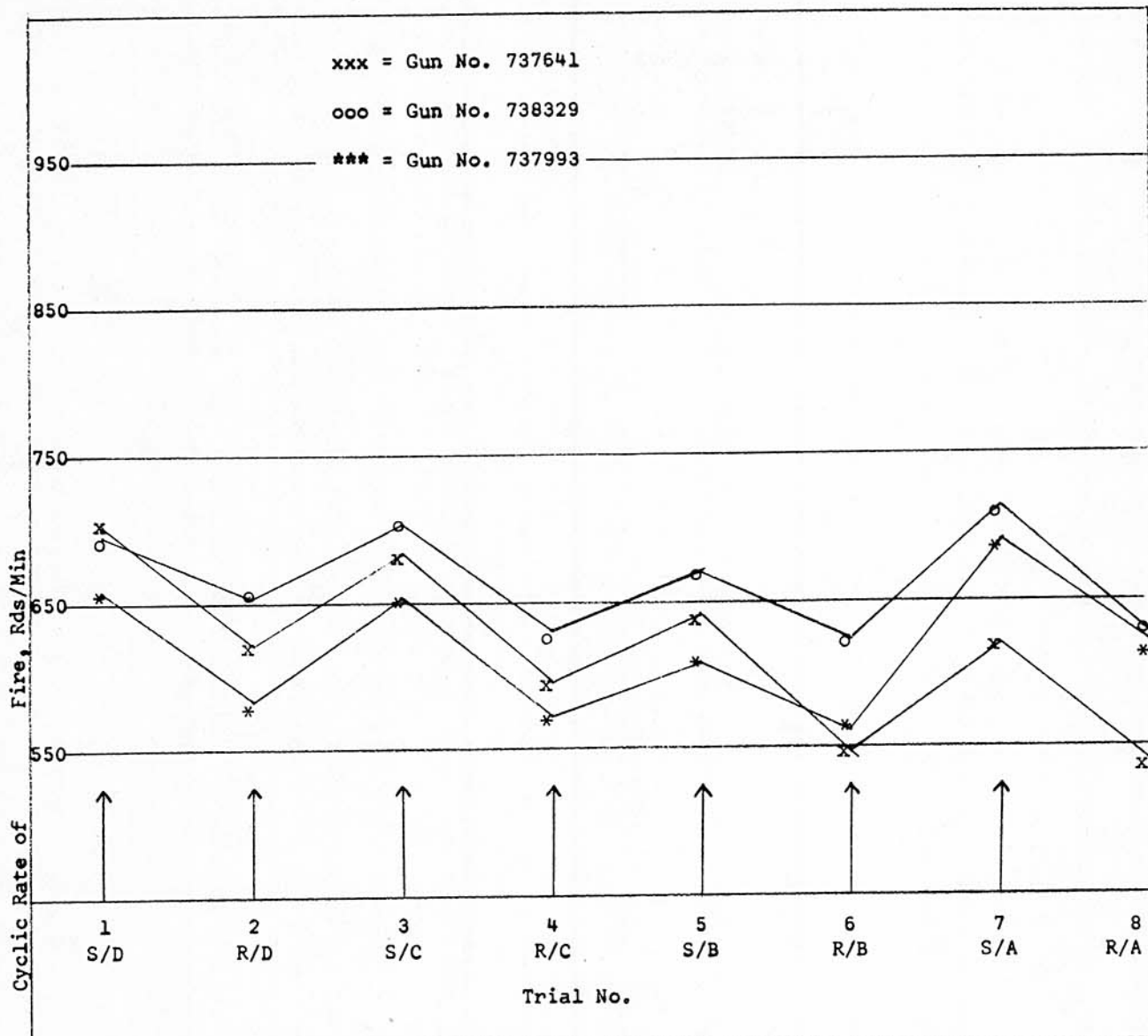
S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-4. Cyclic Rate of Fire Test During Initial Phase of Low Temperature Test for Three M16A1 Rifles.



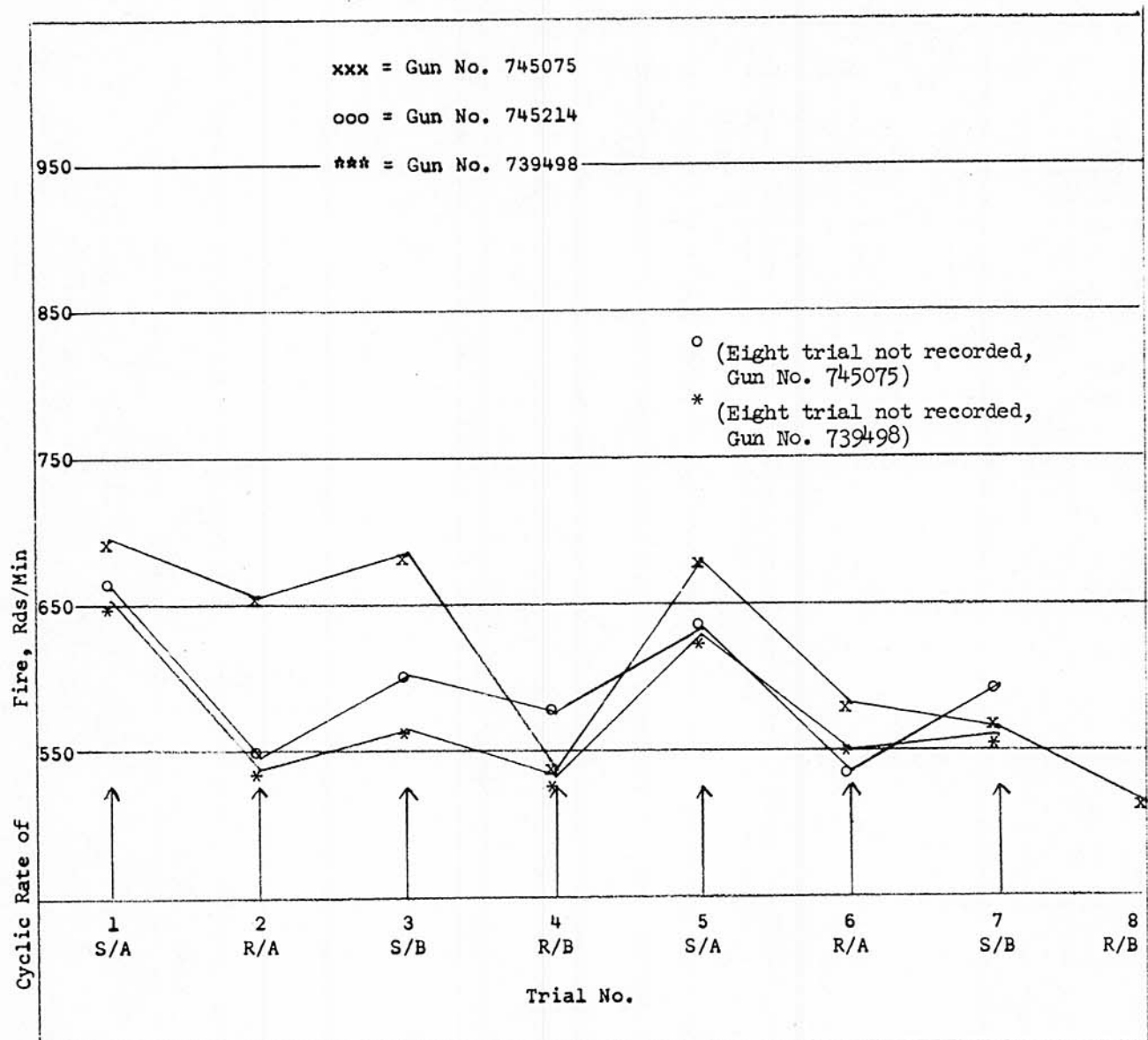
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-5. Cyclic Rate of Fire During Second Phase of Low Temperature Test for Three M16A1 Rifles.



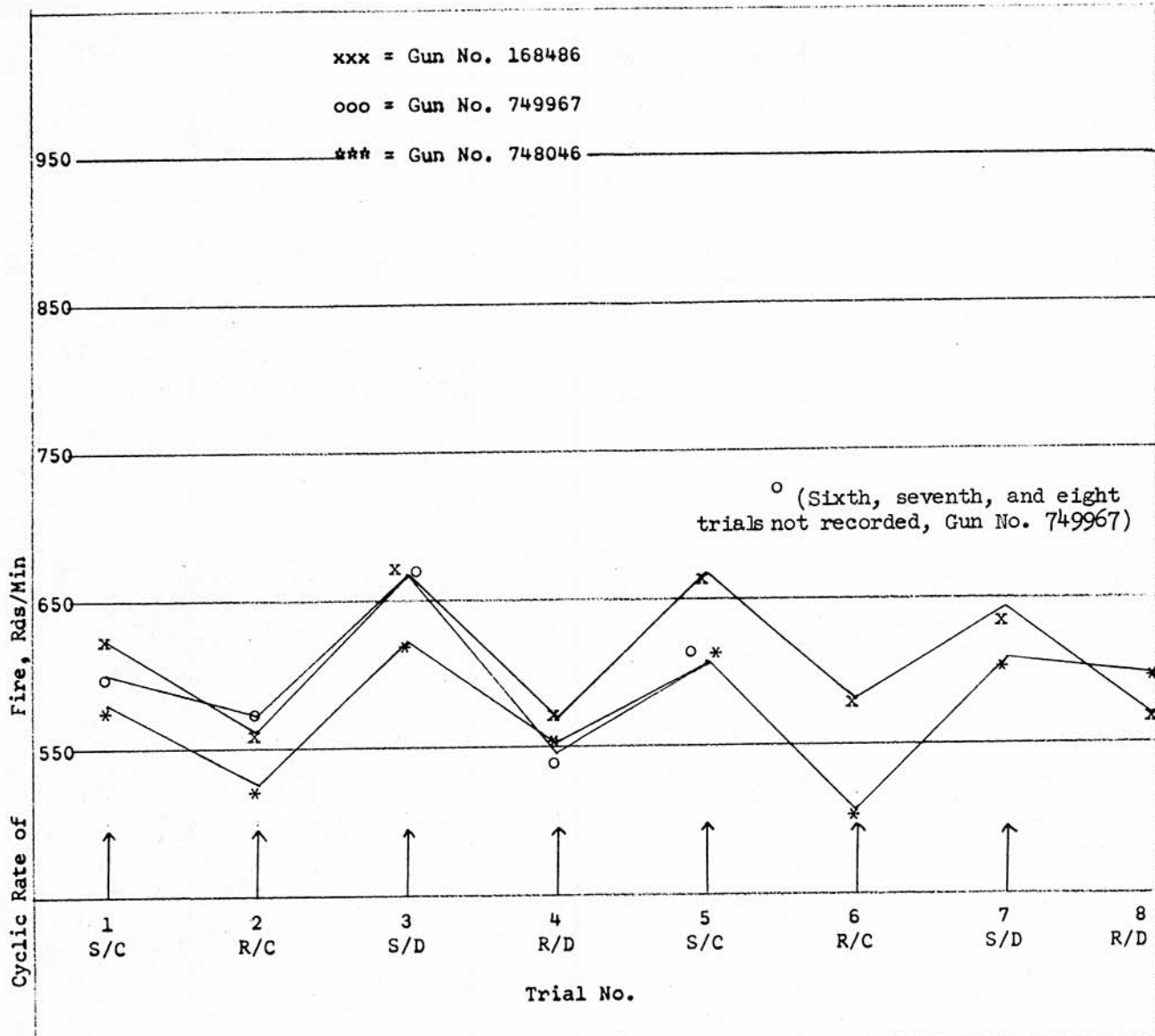
S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
 S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-6. Cyclic Rate of Fire During Second Phase of Low Temperature Test for Three M16A1 Rifles.



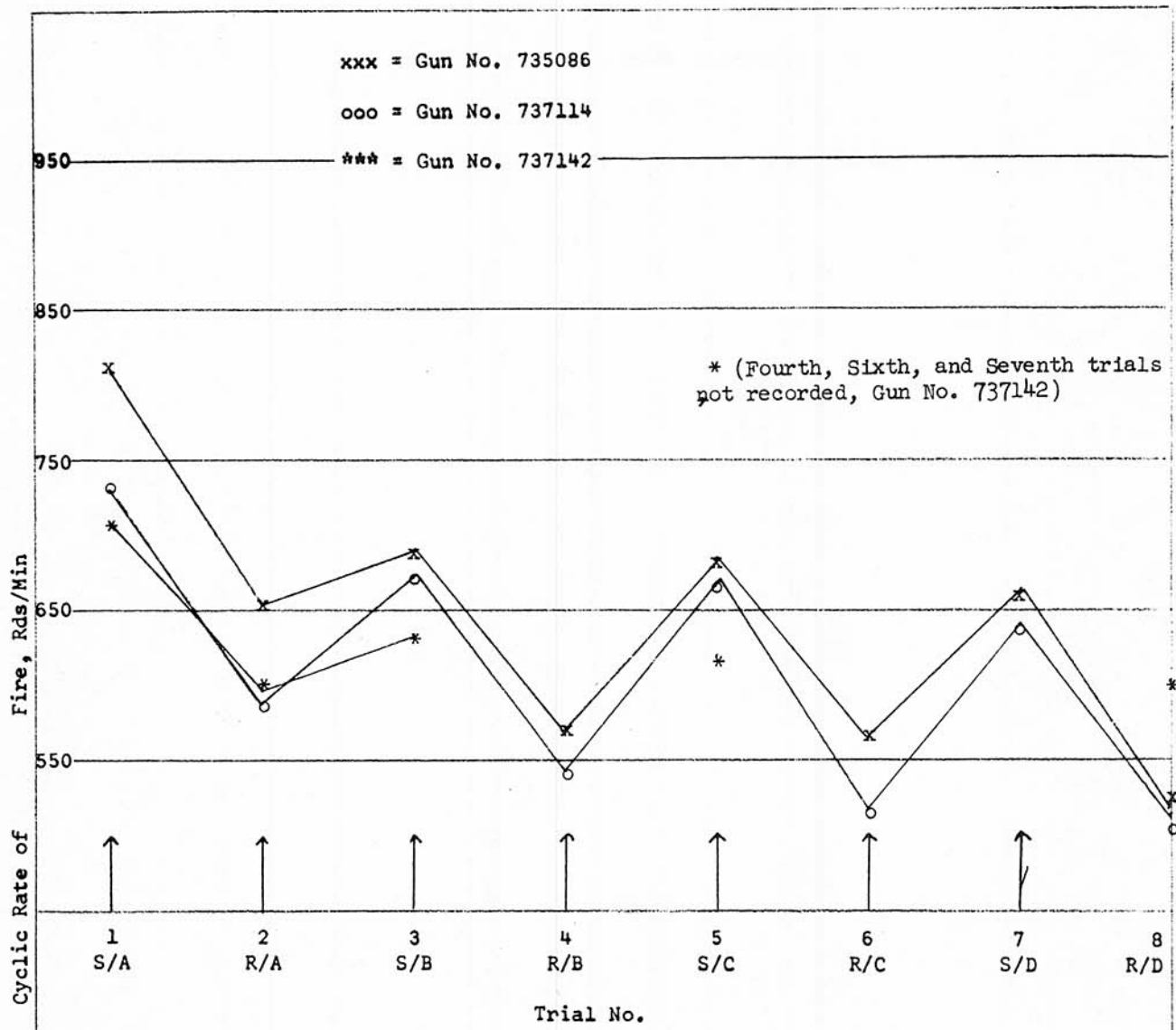
S/A = Standard buffer while firing M193, ball propellant ammunition.  
R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.8-7. Cyclic Rate of Fire During Second Phase of Low Temperature Test for Three M16A1 Rifles.



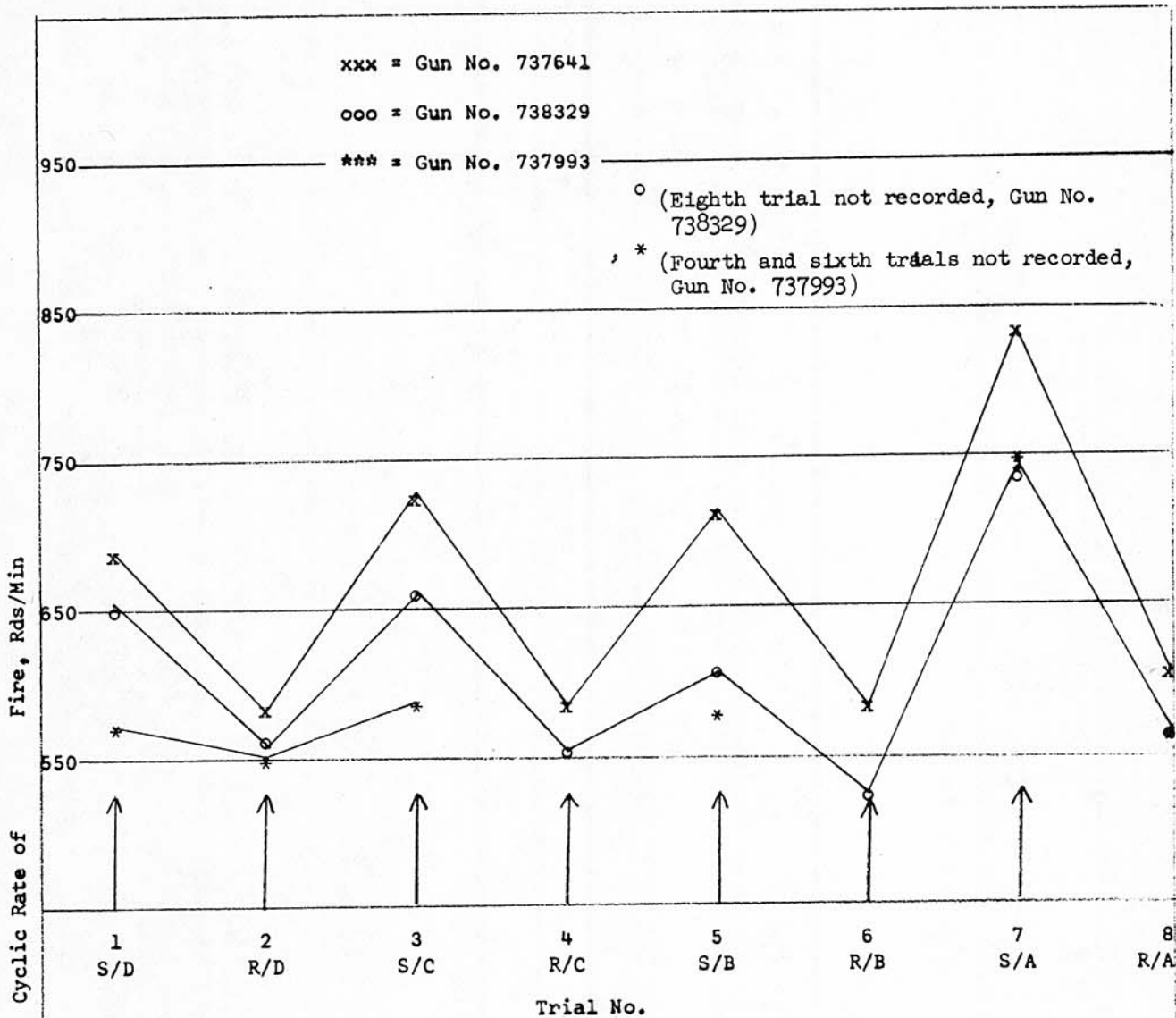
S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-8. Cyclic Rate of Fire During Second Phase of Low Temperature Test for Three M16A1 Rifles.



- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-9. Cyclic Rate of Fire During Final Phase of Low Temperature Test for Three M16A1 Rifles.



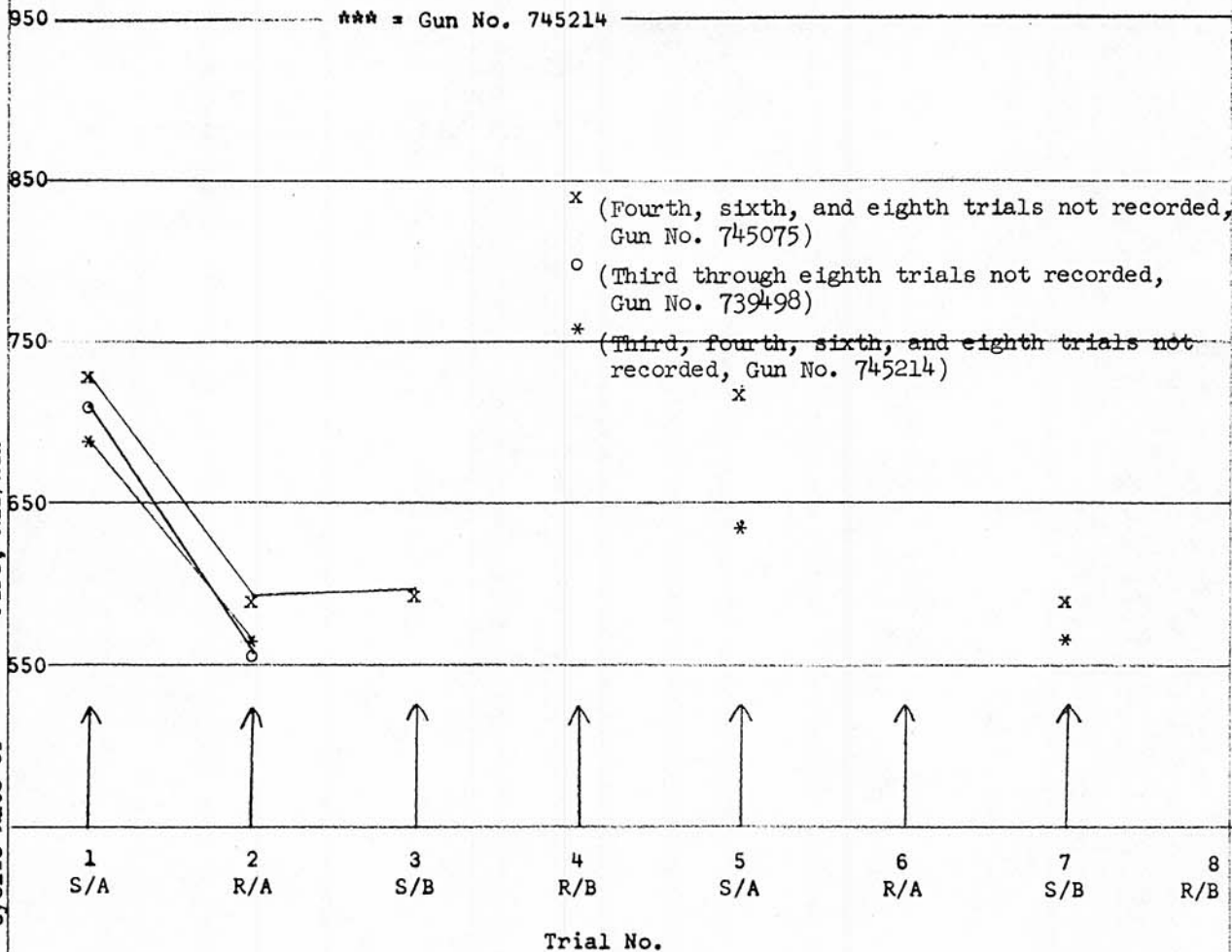
S/A = Standard buffer while firing M193, ball propellant ammunition.  
R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.  
S/C = Standard buffer while firing M196, ball propellant ammunition.  
R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-10. Cyclic Rate of Fire During Final Phase of Low Temperature Test for Three M16A1 Rifles.

xxx = Gun No. 745075

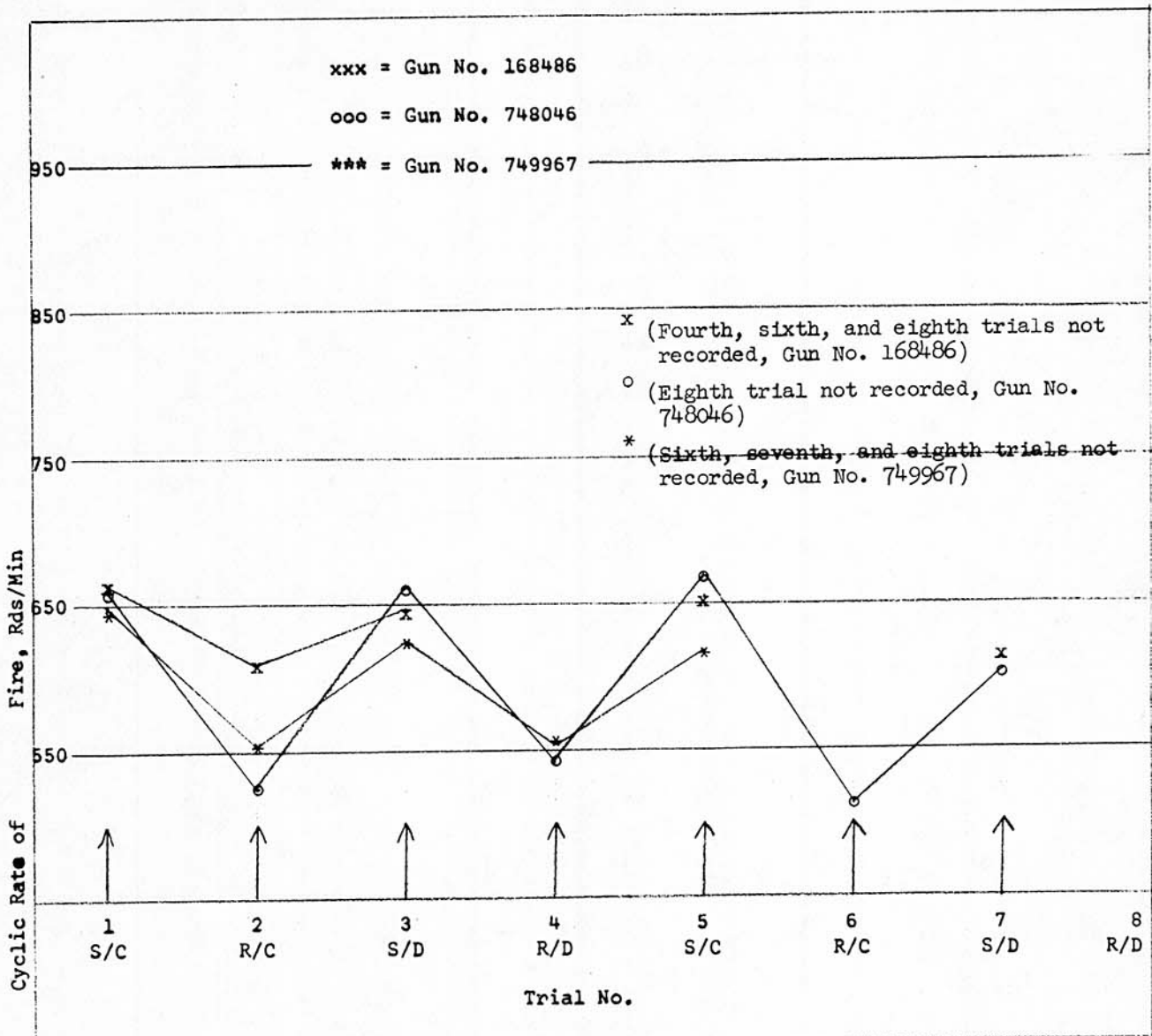
ooo = Gun No. 739498

\*\*\* = Gun No. 745214



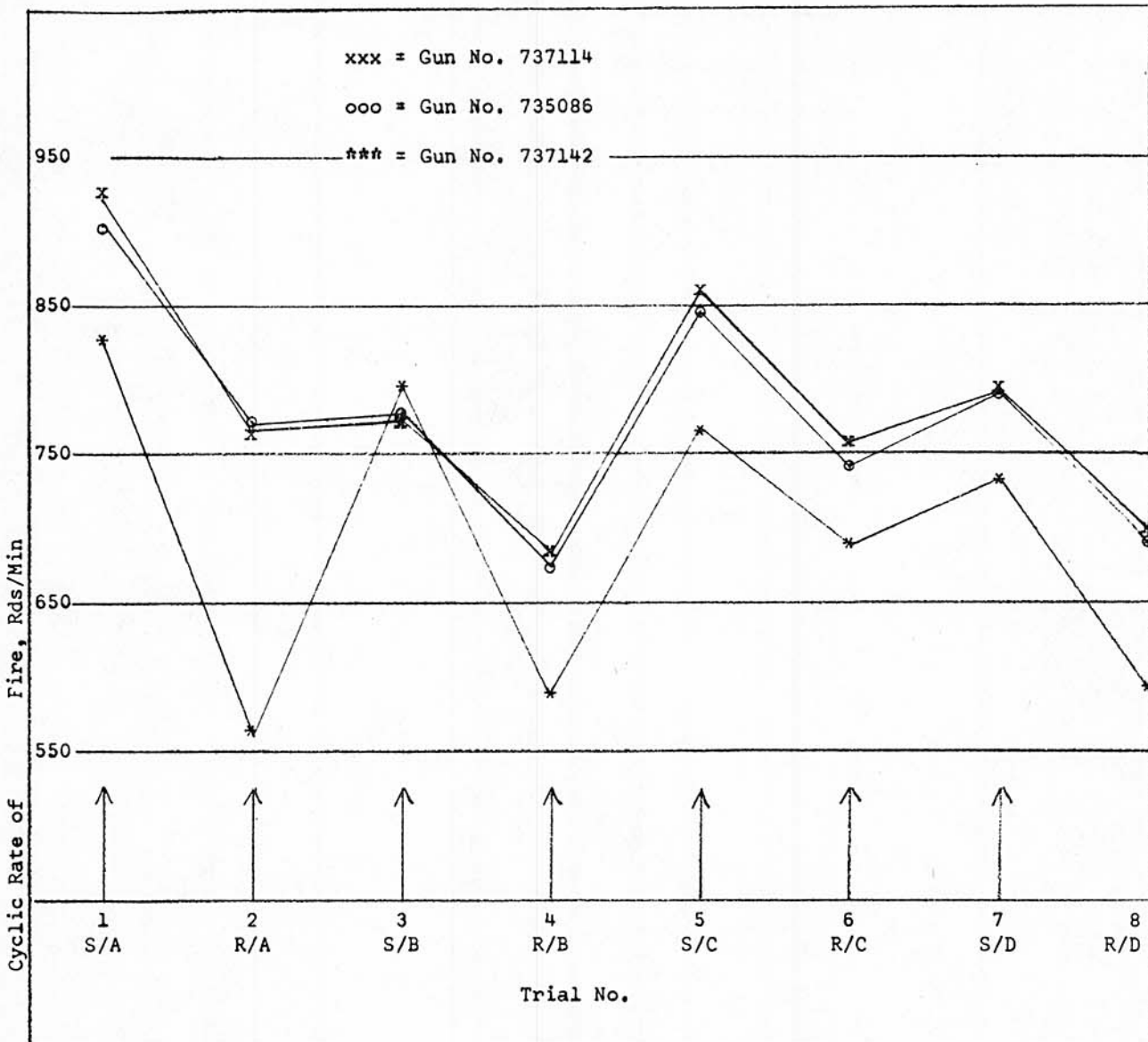
S/A = Standard buffer while firing M193, ball propellant ammunition.  
R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.8-11. Cyclic Rate of Fire During Final Phase of Low Temperature Test for Three M16A1 Rifles.



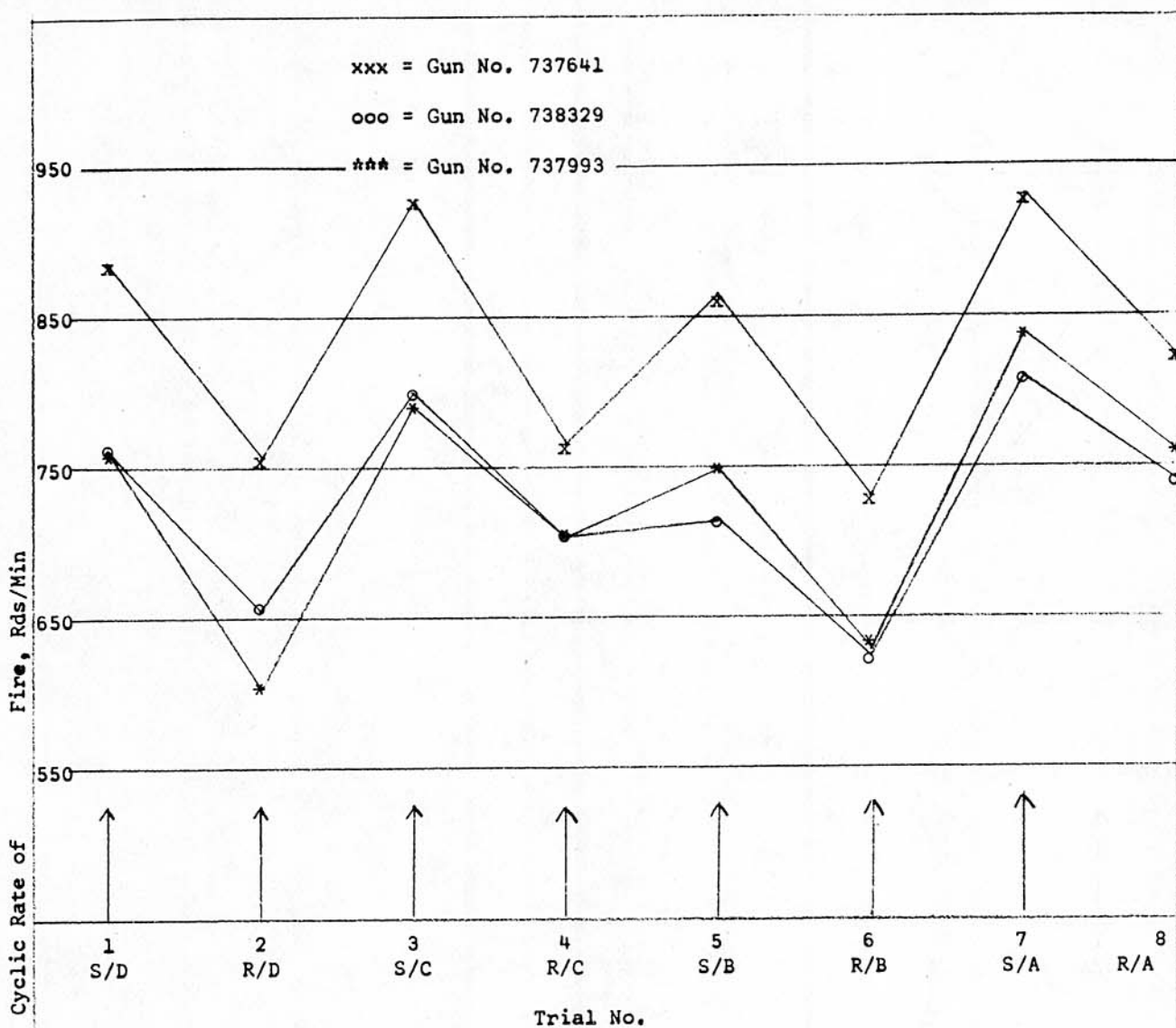
S/C = Standard buffer while firing M196, ball propellant ammunition.  
R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-12. Cyclic Rate of Fire During Final Phase of Low Temperature Test for Three M16A1 Rifles.



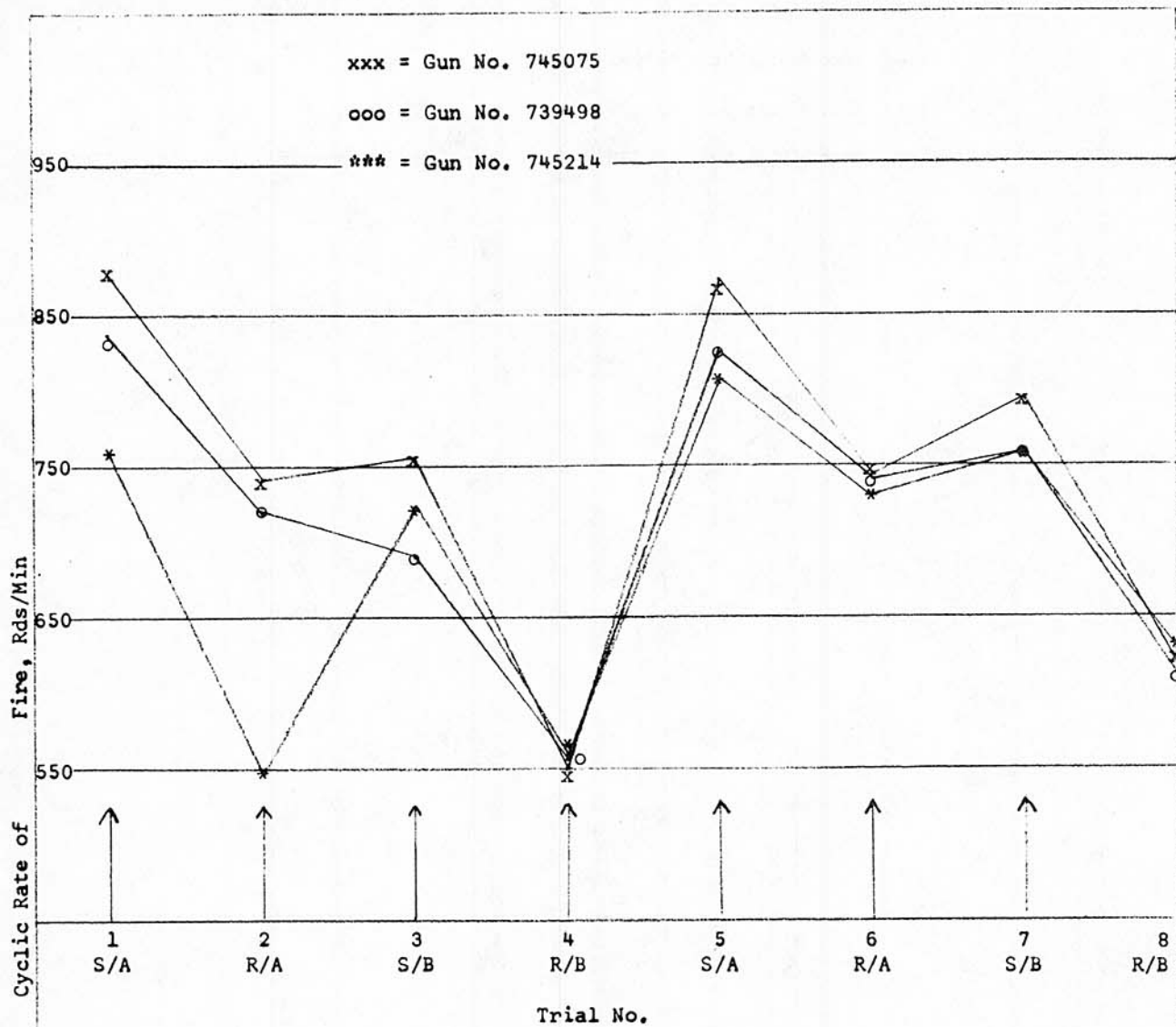
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-13. Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Low Temperature Test for Three M16A1 Rifles.



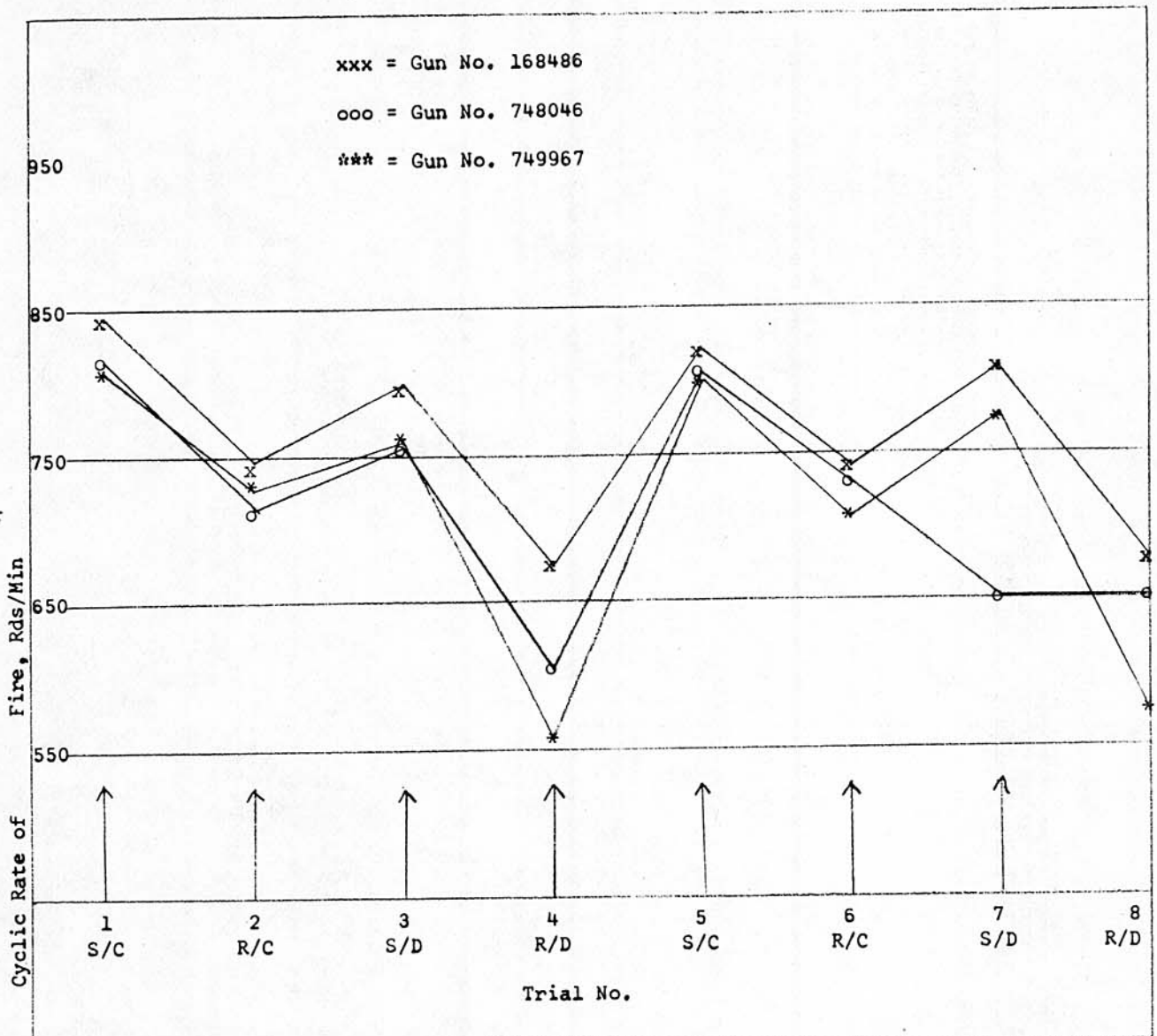
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-14. Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Low Temperature Test for Three M16A1 Rifles.



S/A = Standard buffer while firing M193, ball propellant ammunition.  
 R/A = Redesigned buffer while firing M193, ball propellant ammunition.  
 S/B = Standard buffer while firing M193, 8208M propellant ammunition.  
 R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.

Figure 2.8-15. Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Low Temperature Test for Three M16A1 Rifles.



S/C = Standard buffer while firing M196, ball propellant ammunition.  
 R/C = Redesigned buffer while firing M196, ball propellant ammunition.  
 S/D = Standard buffer while firing M196, 8208M propellant ammunition.  
 R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.8-16. Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Low Temperature Test for Three M16A1 Rifles.

Table 2.8-II. Summary of Malfunction Data for Low-Temperature Test (-65°F)

Gun No.	Ammunition Lot No.	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic; A = Automatic)												Total Malfunctions	Remarks																					
		FBR		F2R		BOB		PF		COEC		FF-1				FX																				
		Std	Red	Std	Red	Std	Red	Std	Red	Std	Red	Std	Red	Std	Red	Std	Red																			
735086	LC12177	1																3	With the majority of weapons, and within 300 rounds of firing following cleaning, the bolt of the rifle would become firmly frozen in the locked position at the end of the conditioning periods and the firing pin was often frozen in the bolt carrier. In many of the final firing phases, immediately before cleaning, it was necessary to repeatedly dry-fire and hand-cycle the guns before firing could be initiated.																	
	Tw18166	2	1															12																		
	LC12081	1																12																		
	Tw18001	1																6																		
737114	LC12177	3																15																		
	Tw18166	1																7																		
	LC12081	1																8																		
	Tw18001	1																9																		
737142	LC12177	4																2																		
	Tw18166	1																12																		
	LC12081	1																33																		
	Tw18001	1																33																		
737641	LC12177	5																8	The problem noted in Table 2.7-1 concerning stuck and jammed ring springs occurred repeatedly in this test and the standard buffer in gun No. 737641 was replaced.																	
	Tw18166	1																9																		
	LC12081	13																22																		
	Tw18001	8																22																		
737993	LC12177	7																6																		
	Tw18166	1																12																		
	LC12081	1																21																		
	Tw18001	1																35																		
738329	LC12177	2																5	A broken extractor spring was replaced.																	
	Tw18166	1																19																		
	LC12081	1																17																		
	Tw18001	1																15																		
739498	LC12177	4																19																		
	Tw18166	1																34																		
745075	LC12177	1																11																		
	Tw18166	1																25																		
745214	LC12177	2																18																		
	Tw18166	15																89																		
748046	LC12081	1																34																		
	Tw18001	1																14																		
749967	LC12081	30																106																		
	Tw18001	26																74																		
168486	LC12081	1																34																		
	Tw18001	1100																20																		
Totals		26820	2124	0	22	1	3	4	5	0	0	0	6	31	28	76	9	52	29	47	0	73	33	113	13	42	37	51	0	1	2	8	0	0	5	817

Semiautomatic<sup>b</sup> 2 (2,0) 5 (1,4) 34 (6,28) 38 (9,29) 33 (0,33) 50 (13,37) 2 (0,2) 0 (0,0) 164 (31,133)  
 Automatic<sup>b</sup> 146 (124,22) 8 (3,5) 107 (31,76) 99 (52,47) 186 (75,113) 93 (42,51) 9 (1,8) 5 (0,5) 653 (326,327)  
 148 (126,22) 13 (4,9) 0 (0,0) 141 (37,104) 137 (61,76) 219 (73,146) 143 (55,88) 11 (1,10) 5 (0,5) 817 (357,460)

<sup>a</sup>These malfunctions were caused by the trigger pin moving out of position; they do not appear in any of the malfunction totals.  
<sup>b</sup>First number in parentheses indicates standard buffer malfunctions, second number indicates redesigned buffer malfunctions.

- LC12177, standard buffer: 44
- LC12177, redesigned buffer: 35
- Tw18166, standard buffer: 81
- Tw18166, redesigned buffer: 220
- LC12081, standard buffer: 139
- LC12081, redesigned buffer: 281
- Tw18001, standard buffer: 171
- Tw18001, redesigned buffer: 237
- Tw18001, redesigned buffer: 115
- 817

### 2.8.5 Analysis

Under this extreme low-temperature environment, the redesigned buffer consistently provided rates of such a low level that functioning performance of the weapons was clearly inferior to the performance of the same weapons when fired with the standard buffer. This degradation in performance is noted, notwithstanding the fact that the redesigned buffer eliminated a large and significant number of failures to fire.

Due to the low level of reliability, only 112 successful rate trials were obtained at  $-65^{\circ}\text{F}$  with the redesigned buffer, 32 short of the attempted 144 trials. Of these trials, 103 were below 650 rounds per minute (the lowest rate for a continuous 20-round burst was 493 rounds per minute and none were above 850 rounds per minute. The record for the standard buffer in 136 trials was 62 trials below the minimum level and one above 850 rounds per minute.

## 2.9 EXTREME-ATTITUDE FUNCTIONING TEST

### 2.9.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a re-designed buffer when firing various types of ammunition in a number of hand-held positions.
- b. To compare the above performance with similar firings employing the standard buffer.

### 2.9.2 Criteria

Same as par. 2.5.2.

### 2.9.3 Method

The firing positions are identified in paragraph 3.3.10i, j, m, n; Interim Pamphlet 20-20, TECP 700-700, 11 April 66. Rifle Nos. 1 through 6 only are fired.

The firing schedule is contained in Table 2.9-I.

Table 2.9-I. Function Test Schedule

<u>Trial No.</u>	<u>Buffer</u>	<u>Firing Position</u>	<u>Rds Fired Per Gun</u>	<u>Ammunition Type<sup>a</sup> Guns 1 to 6</u>
1	Std	b -	40	A
2	Redesigned	b -	40	B
3	Std	b -	40	C
4	Redesigned	b -	40	D
5	Std	b -	40	D
6	Redesigned	b -	40	C
7	Std	b -	40	B
8	Redesigned	b -	40	A
9	Std and redesigned	Normal	160	Repeat cyclic rate-of-fire test.
10	Disassemble, clean, and lubricate.			
11 to 20	Repeat trials 1 to 10 <sup>c</sup> .			
21 to 30	Repeat trials 1 to 10 <sup>d</sup> .			
31 to 40	Repeat trials 1 to 10 <sup>e</sup> .			
41	Std and redesigned	Normal	160	Repeat cyclic rate-of-fire test.

<sup>a</sup>See explanation, Table 2.3-1.

<sup>b</sup>Hand held, +80° elevation, semiautomatically.

<sup>c</sup>Hand held, +80° elevation, automatically.

<sup>d</sup>Hand held, -80° depression, semiautomatically.

<sup>e</sup>Hand held, -80° depression, automatically.

#### 2.9.4 Results

The initial and final cyclic rate-of-fire data are shown in Figures 2.9-1 through 2.9-4. All of the individual cyclic rate-of-fire data are contained in Appendix I.

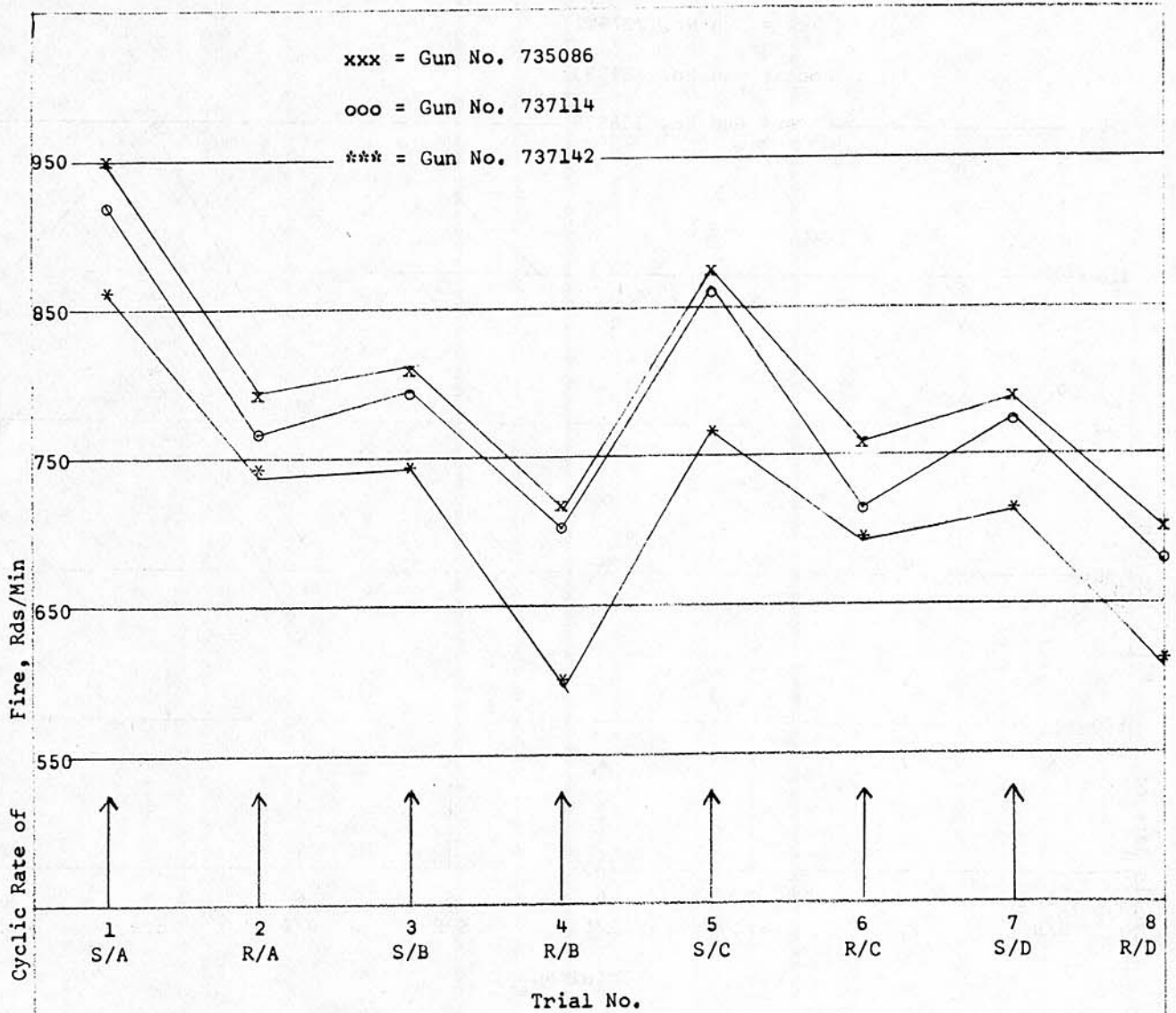
The functioning data are summarized in Table 2.9-II.

Table 2.9-II. Summary of Malfunction Data for Extreme-Attitude Functioning Test

Gun No.	Ammunition Lot No.	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic; A = Automatic)												Total	Remarks	
		FFR		FBR		ROB		FF		COEC		FF-I				Total Mal-funct
		Std SA	Red. SA	Std SA	Red. SA	Std SA	Red. SA	Std SA	Red. SA	Std SA	Red. SA	Std SA	Red. SA			
735086	LC12177	52	1											53		
	TW18166	520	1											1		
	LC12081	520	4							1	1			6		
	TW18001	520	1							1				2		
737114	LC12177	520	1											6	One magazine was re-moved from test.	
	TW18166	520				1	3	2						6		
	LC12081	556											1	1		
	TW18001	520												17		
737142	LC12177	520	1											20	A broken extractor spring was replaced.	
	TW18166	522				6		1	1					3		
	LC12081	520	3											11		
	TW18001	520	2											11		
737641	LC12177	520	1											56	A broken extractor spring and pin were replaced.	
	TW18166	534	8											9		
	LC12081	538	26	1		1	1	1	2					32		
	TW18001	527	14											14		
737993	LC12177	520	29							1				30		
	TW18166	520	28			4								36		
	LC12081	520	1											1		
	TW18001	520	8											10		
738329	LC12177	523	17											18	A broken extractor spring was replaced.	
	TW18166	544	1											10		
	LC12081	520												2		
	TW18001	520												9		
Totals		12584	2 273 0	1 2 1 2 1 1 0 12 2 2 6 33 4 0 0 2 1 1 0 4 3 0 0 0	0 353										353	
Semiautomatic <sup>b</sup>			2 (2,0)	4 (2,2)	13 (1,12)	35 (2,35)	2 (0,2)	5 (1,4)	0 (0,0)	0 (0,0)	0 (0,0)	61 (8,53)				
Automatic <sup>b</sup>			274 (273,1)	2 (1,1)	2 (0,2)	10 (6,4)	1 (0,1)	3 (0,3)	0 (0,0)	0 (0,0)	0 (0,0)	292 (280,12)				
			276 (275,1)	6 (3,3)	15 (1,14)	45 (8,37)	3 (0,3)	8 (1,7)	0 (0,0)	0 (0,0)	0 (0,0)	353 (288,65)				

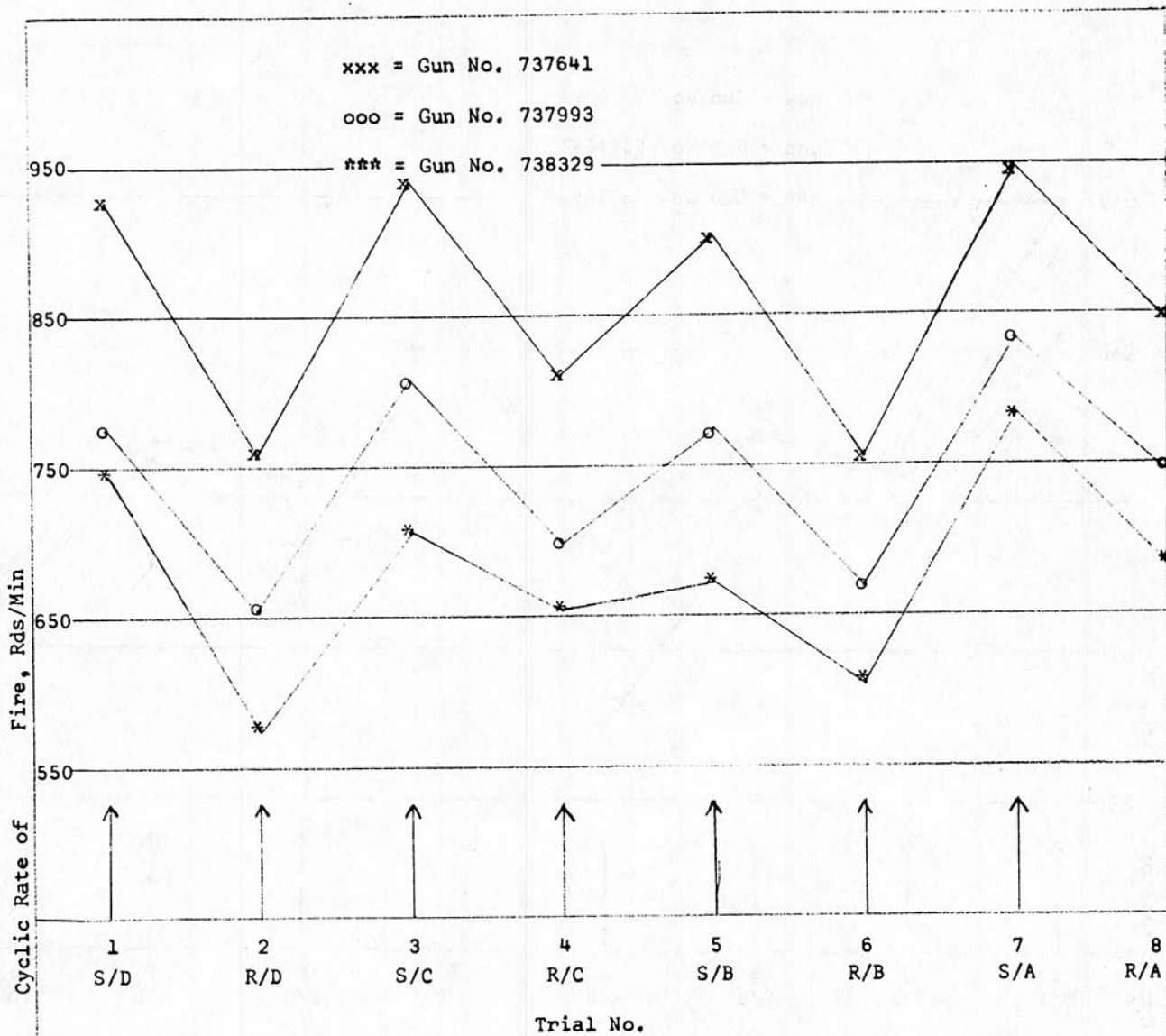
<sup>a</sup>Attributed to a broken extractor spring; malfunctions not counted in any of the totals.  
<sup>b</sup>First number in parentheses indicates standard buffer malfunctions; second number indicates redesigned buffer.

LC12177, std buffer:	179	}	180
LC12177, red. buffer:	1		
TW18166, std buffer:	43	}	76
TW18166, red. buffer:	33		
LC12081, std buffer:	41	}	50
LC12081, red. buffer:	9		
TW18001, std buffer:	25	}	47
TW18001, red. buffer:	22		
Total			353



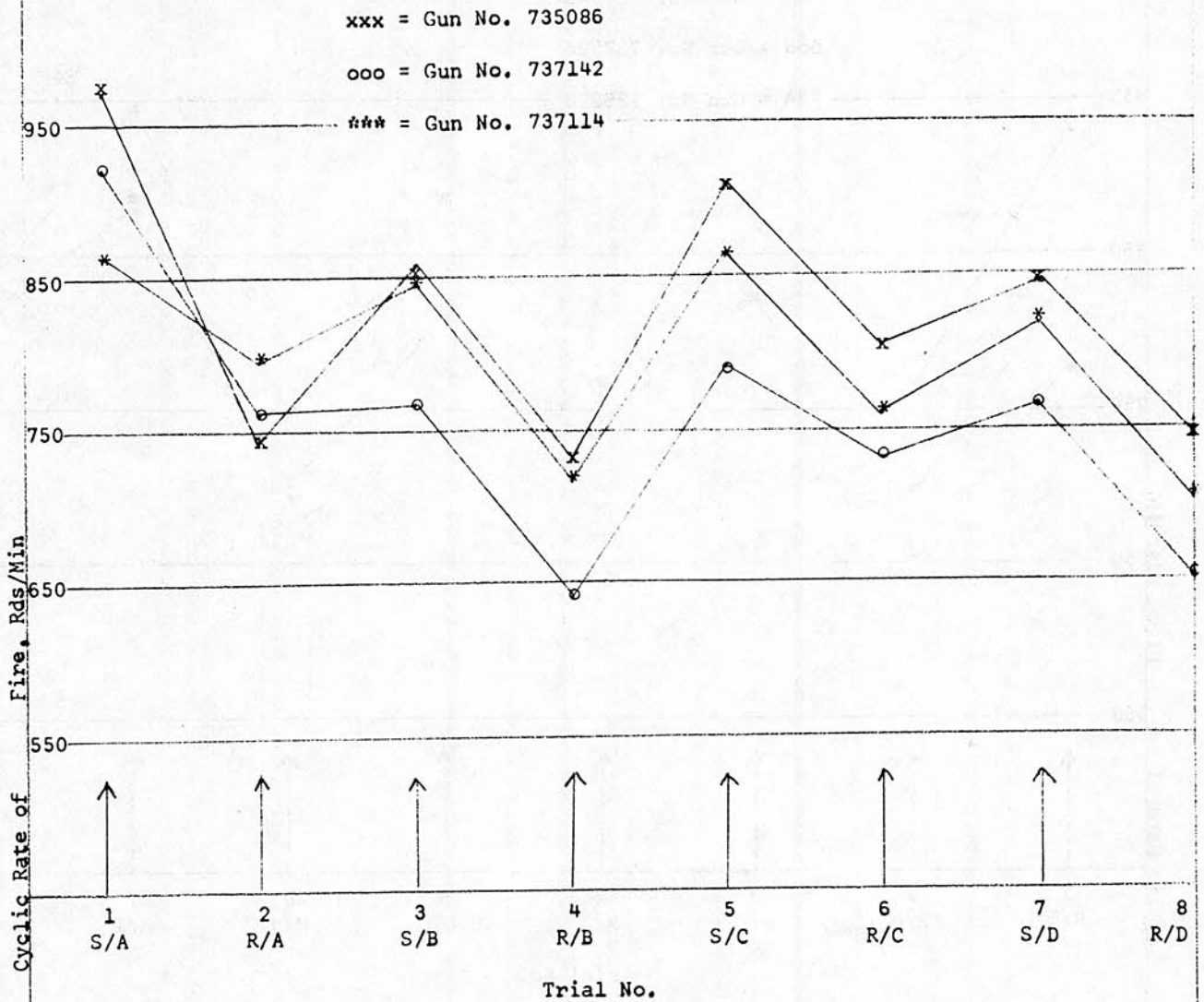
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.9-1. Initial Cyclic Rate of Fire Test at Normal Ambient During Extreme Attitude Functioning Test for Three M16A1 Rifles.



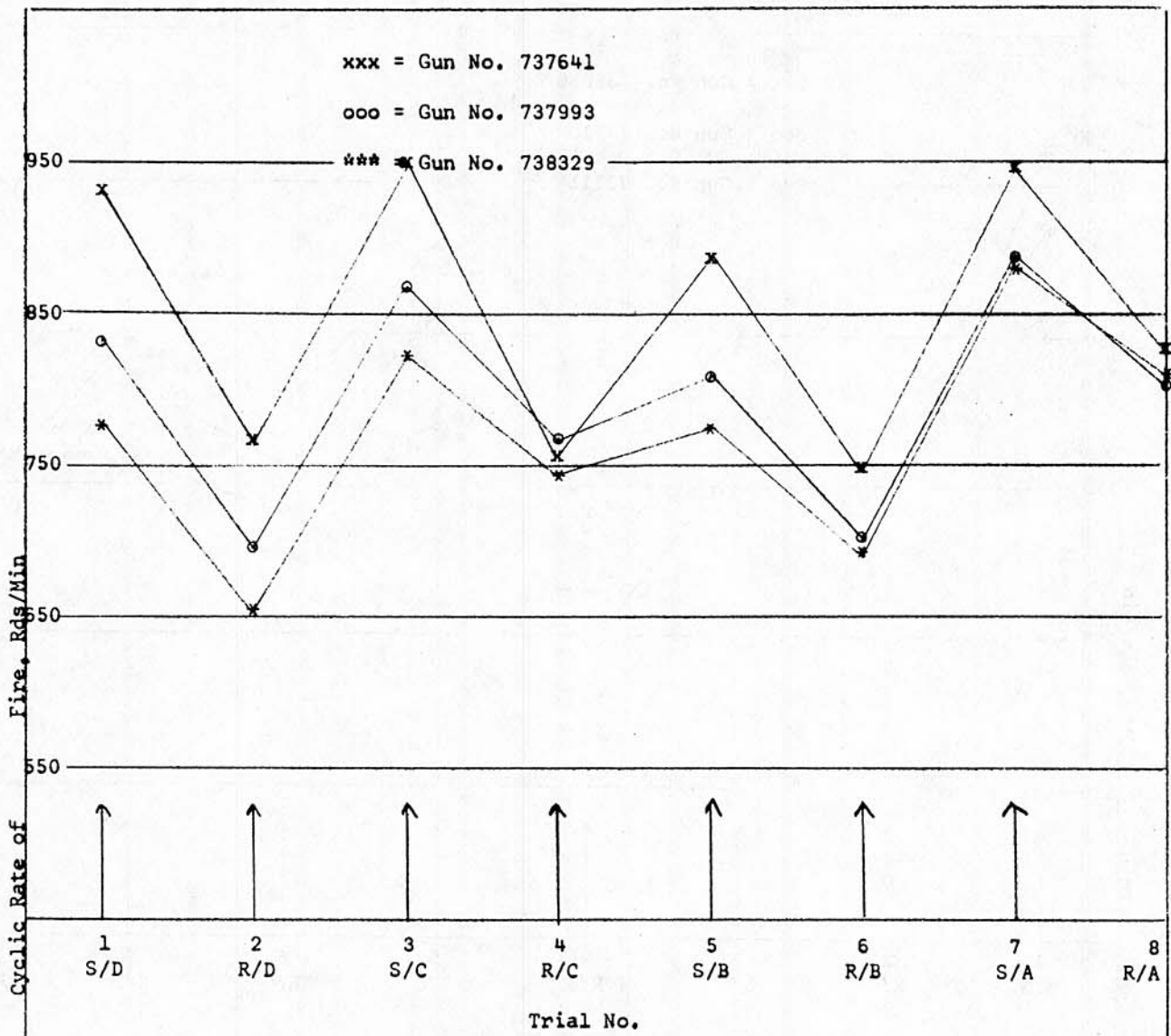
- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.9-2. Initial Cyclic Rate of Fire Test at Normal Ambient During Extreme Attitude Functioning Test for Three M16A1 Rifles.



- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.9-3. Final Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Extreme Attitude Functioning Test for Three M16A1 Rifles.



- S/A = Standard buffer while firing M193, ball propellant ammunition.
- R/A = Redesigned buffer while firing M193, ball propellant ammunition.
- S/B = Standard buffer while firing M193, 8208M propellant ammunition.
- R/B = Redesigned buffer while firing M193, 8208M propellant ammunition.
- S/C = Standard buffer while firing M196, ball propellant ammunition.
- R/C = Redesigned buffer while firing M196, ball propellant ammunition.
- S/D = Standard buffer while firing M196, 8208M propellant ammunition.
- R/D = Redesigned buffer while firing M196, 8208M propellant ammunition.

Figure 2.9-4. Final Cyclic Rate of Fire Test After Cleaning and at Normal Ambient Following Extreme Attitude Functioning Test for Three M16A1 Rifles.

### 2.9.5 Analysis

All of the cyclic rate-of-fire trials were conducted with the guns at a normal attitude and at normal ambient conditions. Among 120 trials with the redesigned buffer, 15 trials were below 650 rounds per minute and two trials above 850 rounds per minute. The record for the standard buffer was no trials below 650 rounds per minute and 50 trials above 850 rounds per minute.

The performance data in Table 2.9-II demonstrates to a remarkable degree a critical sensitivity of the M16A1 rifle when equipped with the standard buffer. During the conduct of this subtest, 276 failures to fire occurred and the following observations were noted:

- a. All but two of the failures to fire occurred during automatic (3-round burst) mode.
- b. All but one of the failures to fire occurred with the standard buffer installed.
- c. Approximately 63 per cent of the failures to fire occurred with lot LC12177, 16 per cent with lot TW18166, 12 per cent with lot LC12081 and 9 per cent with lot TW18001.
- d. Considering all failures to fire that occurred, 193 were at +80° elevation, 75 at -80° depression, and 8 at 0° elevation during cyclic rate-of-fire trails.
- e. A total of 168 of the failures to fire occurred during the first 40 rounds of firing and immediately after cleaning.
- f. Lot LC12177 was always fired first in each exercise immediately after cleaning and the standard buffer was employed first before being exchanged with the redesigned buffer.
- g. All rounds which failed to fire were later successfully fired under normal conditions in a gun not under test.

Additional firings were conducted with gun No. 737641 and ammunition lot LC12177 to confirm that failures to fire would not occur immediately after cleaning with the redesigned buffer installed at both extremes of elevation and depression. No failures to fire occurred during this exercise.

While the degree of sensitivity of the M16A1 rifle (standard buffer equipped) to extreme attitude firings was amply demonstrated, a precise explanation of the deficiency remained beyond the scope of this test. It should be pointed out however, that all six test guns at this point in their "life" were firing their highest average cyclic rate of fire and, in addition, the two extreme attitudes tested only permit

hand-held and not shoulder support of the rifle. It can be speculated that a more pronounced rearward motion of the gun in recoil results and this factor, combined with high rates of fire, may have increased the severity of "bolt bounce" which has been attributed as the major cause of failures to fire. In comparison, the redesigned buffer substantially reduced the firing rate and the internal inertia weights may have reacted exactly as intended by design; i.e., moving forward after initial carrier impact to provide a second impact to the carrier and completing carrier closure before the hammer contacts the firing pin.

## 2.10 ACCELERATED RATE TEST

### 2.10.1 Objective

To determine the effect on cyclic rate of fire of the M16A1 rifle as a result of firing 140 rounds as rapidly as possible (seven 20-round magazines are issued with each rifle).

### 2.10.2 Criteria

Same as par. 2.3.2.

### 2.10.3 Method

Cyclic rates of fire are recorded for each 20-round magazine. Rifles No. 7 through 12 only are fired. The firing schedule is contained in Table 2.10-I.

Table 2.10-I. Accelerated Rate Schedule

<u>Trial No.<sup>b</sup></u>	<u>Buffer</u>	<u>Rds Fired Per Gun<sup>c</sup></u>	<u>Ammunition Type<sup>a</sup></u>	
			<u>7 to 9</u>	<u>10 to 12</u>
1	Std	140	A	C
2	Red.	140	A	C
3	Std	140	B	D
4	Red.	140	B	D

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>A minimum cooling period of 15 minutes is observed between trials.

<sup>c</sup>All rounds are fired automatically in 20-round bursts, attempting to fire the 140 rounds as rapidly as possible.

## 2.10.4 Results

The cyclic rate of fire data are shown in Figures 2.10-1 through 2.10-8. The individual cyclic rate of fire data are contained in Appendix I.

The functioning data are summarized in Table 2.10-II.

Table 2.10-II. Summary of Malfunction Data for Accelerated Firing Test

Gun No.	Ammunition Lot No.	Total Rds Fired <sup>a</sup>	Malfunctions by Buffer Model <sup>b</sup>						Total Mal-funct
			FFR		BOB		FF-1		
			Std	Red.	Std	Red.	Std	Red.	
739498	LC12177	280							
	TW18166	280				2		1	3
745075	LC12177	280			1				1
	TW18166	280							
745214	LC12177	280	2						2
	TW18166	280							
748046	LC12081	280							
	TW18001	280							
749967	LC12081	280	1						1
	TW18001	280							
168486	LC12081	280							
	TW18001	280							
Totals		3360	3	0	1	2	1	0	0
			3		3		1		7

<sup>a</sup>Each gun was fired 140 rounds with each lot and buffer combination.

<sup>b</sup>All firing done in full automatic mode in 20-round bursts.

LC12177, standard buffer:	3	}	3
LC12177, redesigned buffer:	0		
TW18166, standard buffer:	1	}	3
TW18166, redesigned buffer:	2		
LC12081, standard buffer:	1	}	1
LC12081, redesigned buffer:	0		
TW18001, standard buffer:	0	}	0
TW18001, redesigned buffer:	0		
Total	7		

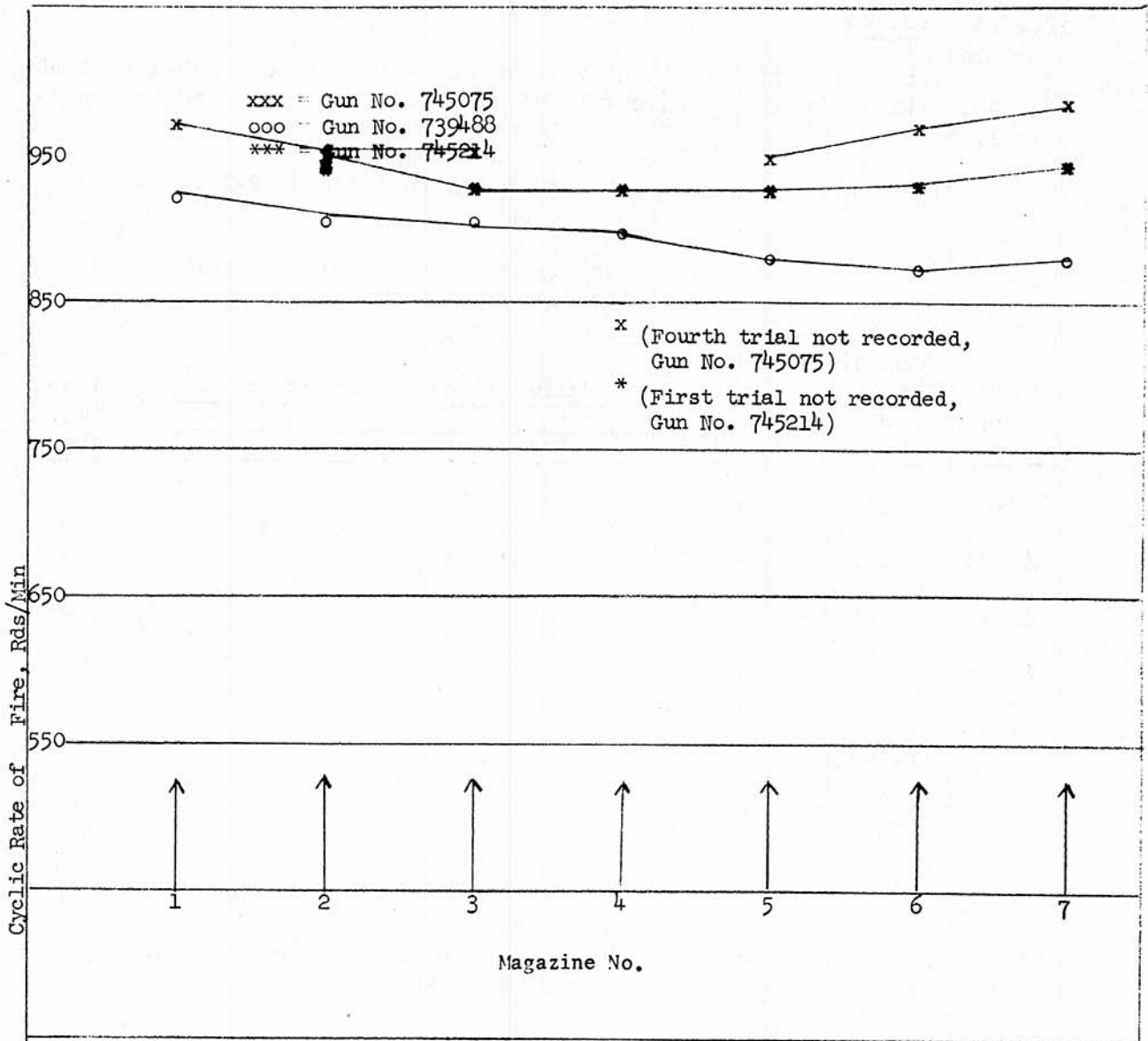


Figure 2.10 - 1. Cyclic Rate of Fire Test During Accelerated Firing for Three M16A1 Rifles with Standard Buffer and Ammunition Lot LC 12177.

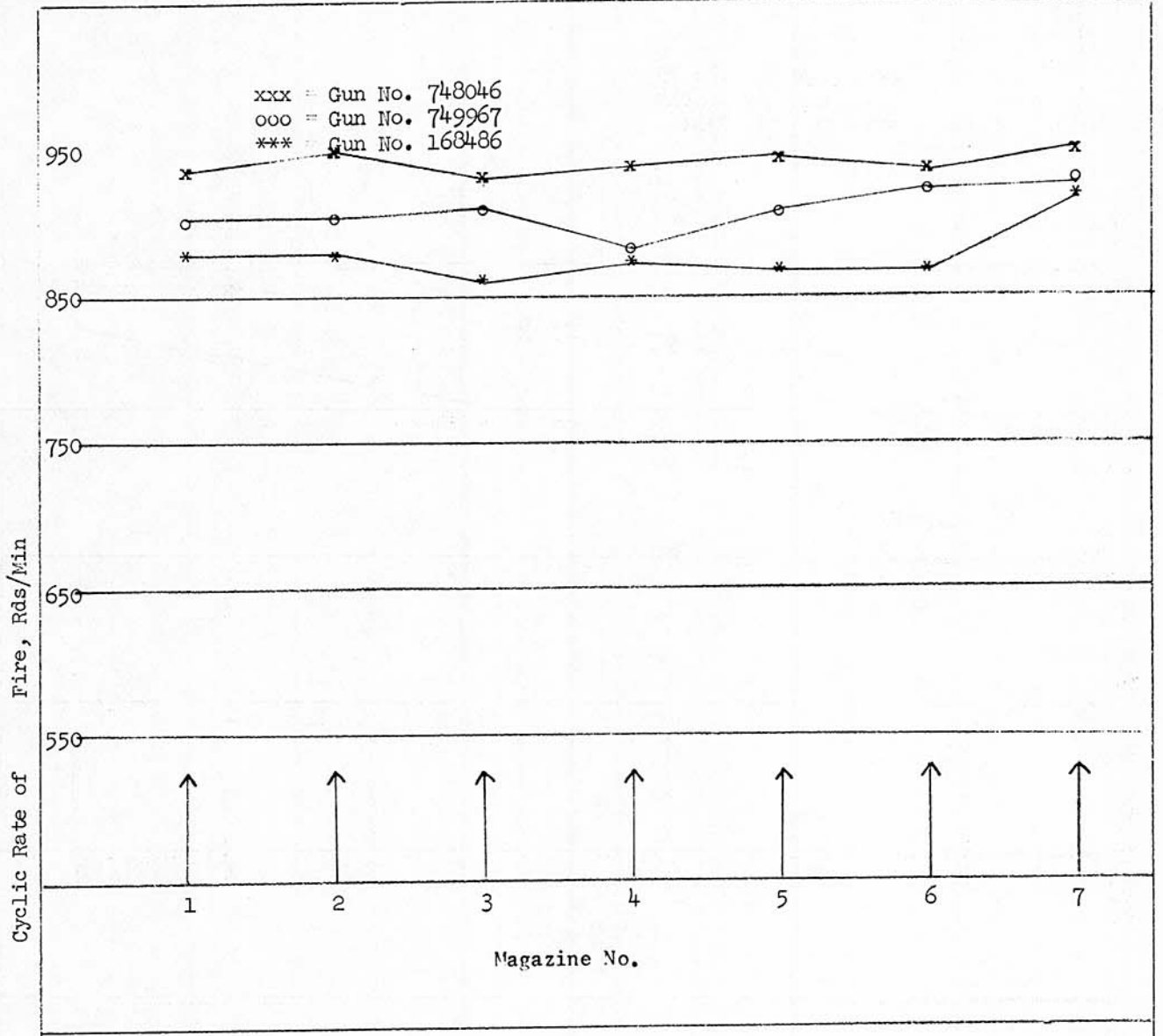


Figure 2.10 - 2. Cyclic Rate of Fire Test During Accelerated Firing for Three M16A1 Rifles with Standard Buffer and Ammunition Lot LC 12081.

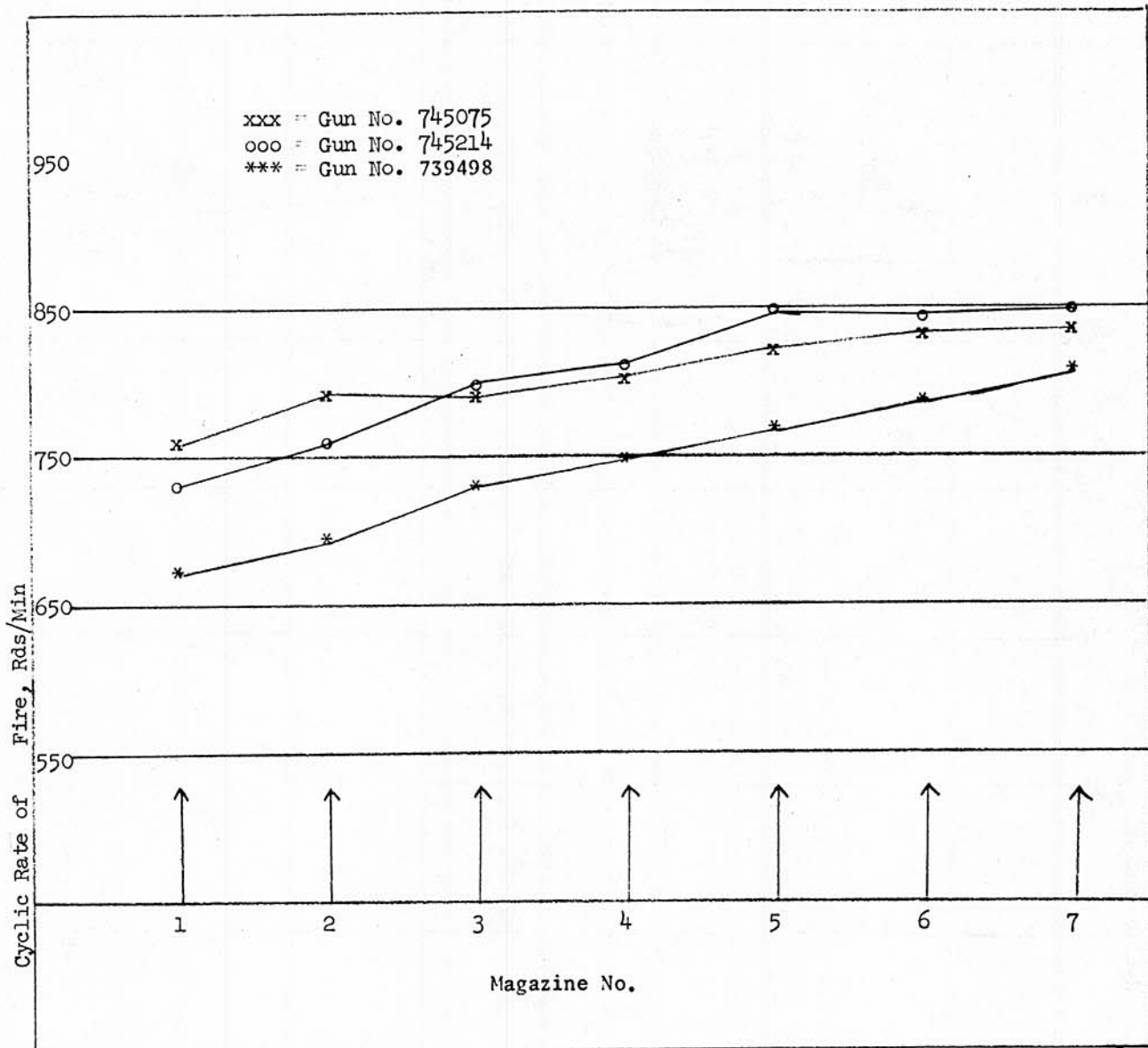


Figure 2.10 - 3. Cyclic Rate of Fire During Accelerated Firing for Three M16A1 Rifles with Redesigned Buffer and Ammunition Lot LC 12177.

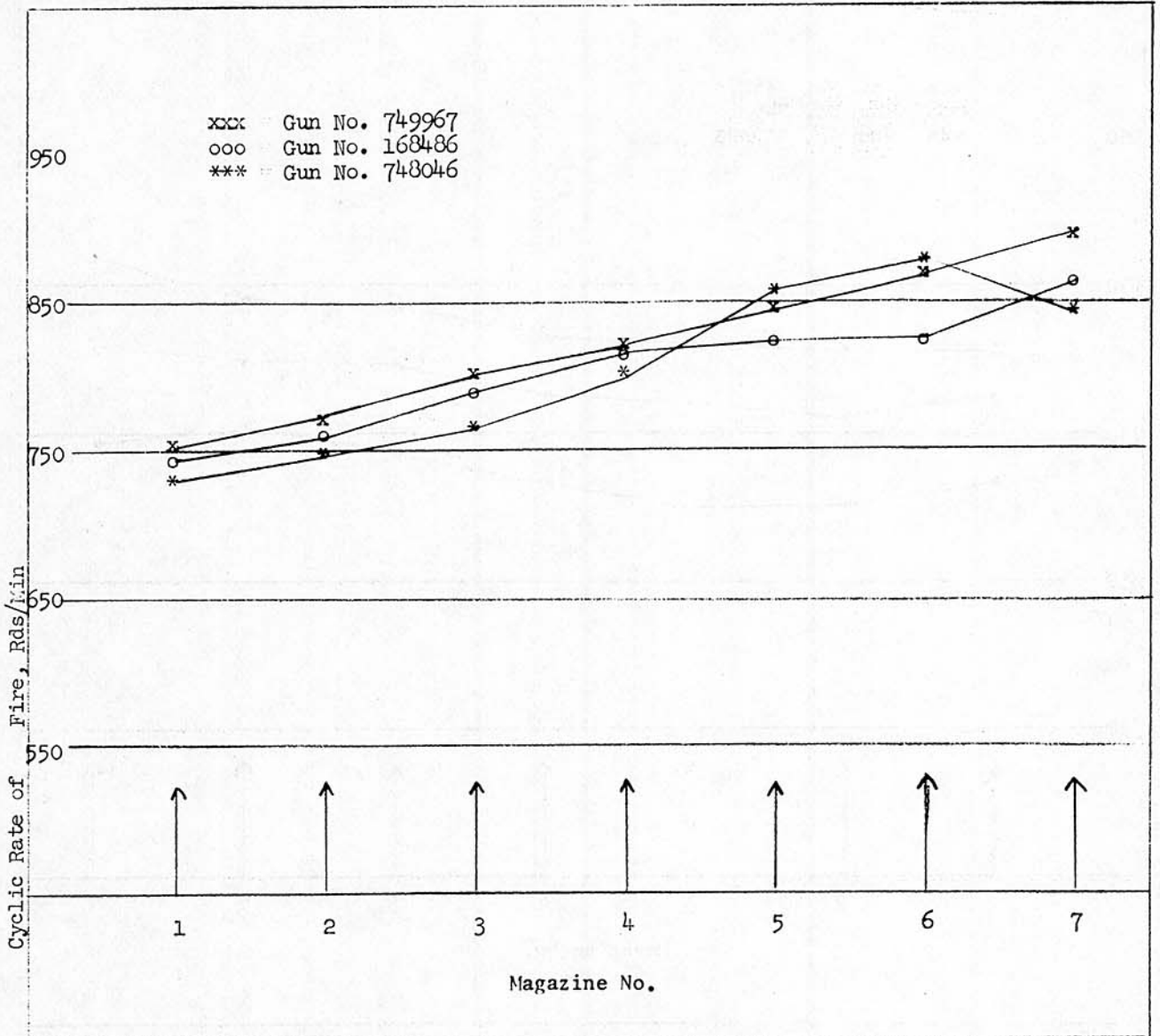


Figure 2.10 - 4. Cyclic Rate of Fire During Accelerated Firing for Three MG41 Rifles with Redesigned Buffer and Ammunition Lot LC 12081.

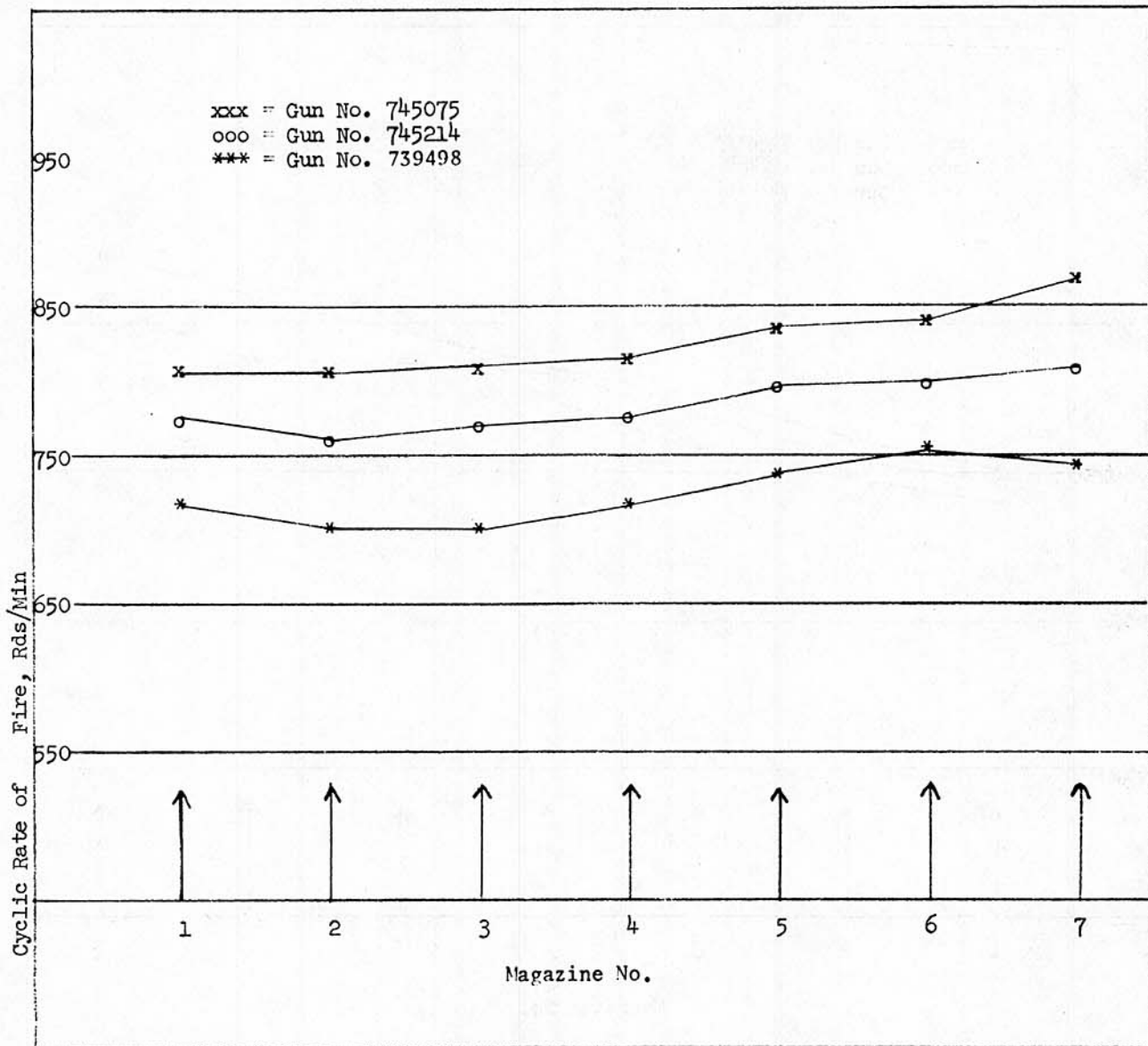


Figure 2.10 - 5. Cyclic Rate of Fire Test During Accelerated Firing for Three M16A1 Rifles with Standard Buffer and Ammunition Lot TW 18166.

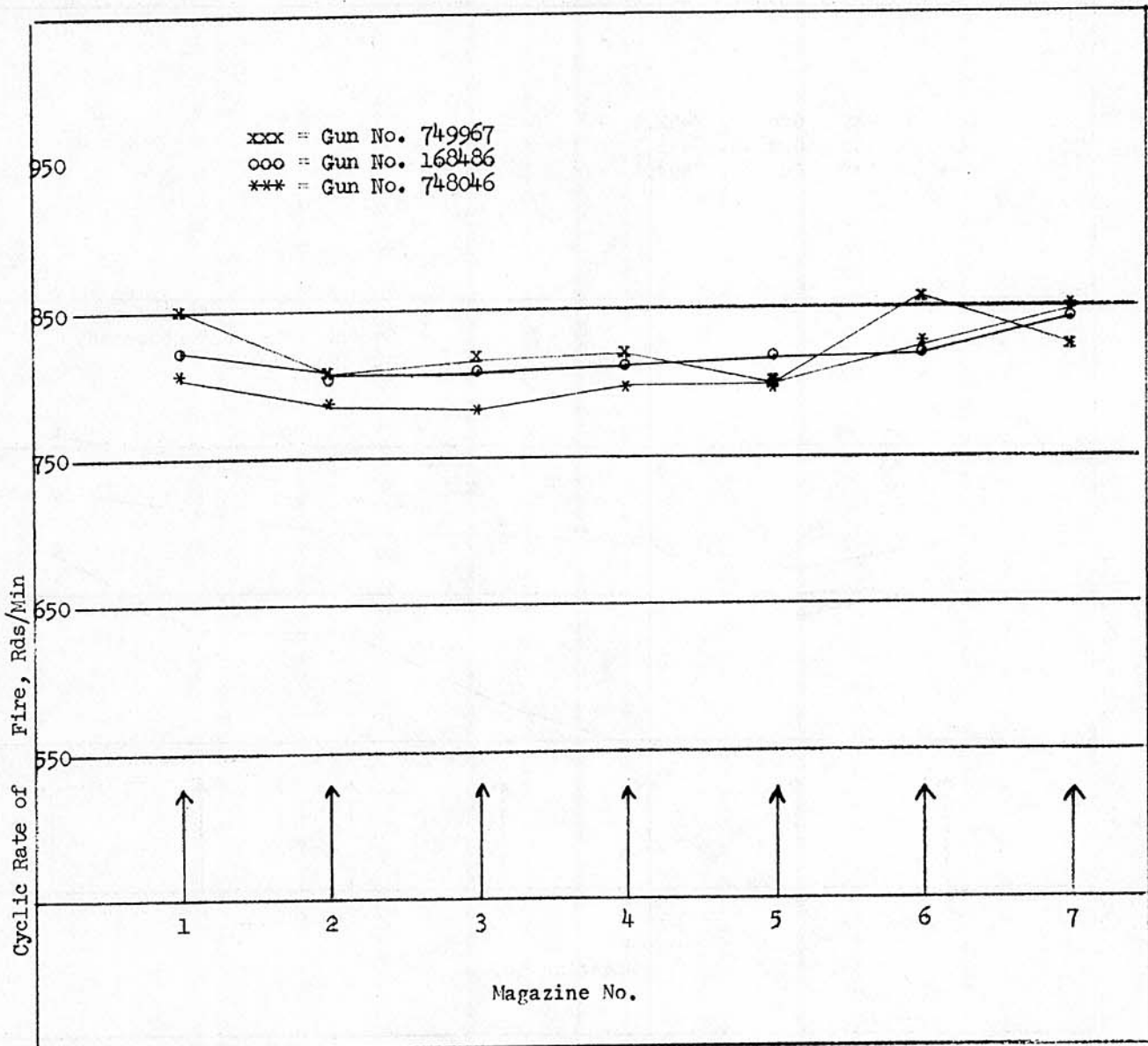


Figure 2.10 - 6. Cyclic Rate of Fire During Accelerated Firing for Three M16A1 Rifles with Standard Buffer and Ammunition Lot TW 1800L.

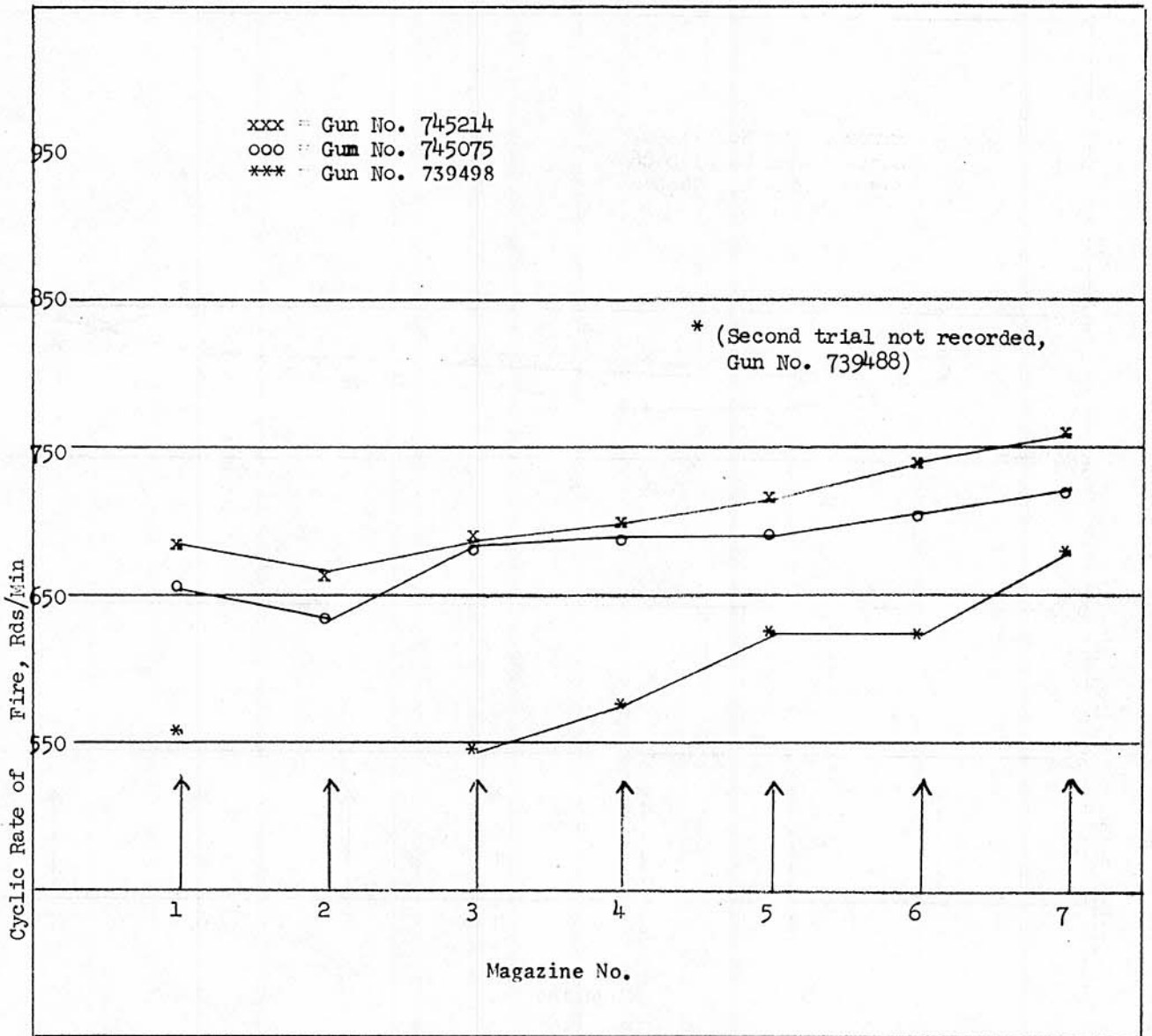


Figure 2.10 - 7. Cyclic Rate of Fire During Accelerated Firing for Three M16A1 Rifles with Redesigned Buffer And Ammunition Lot TW 18166.

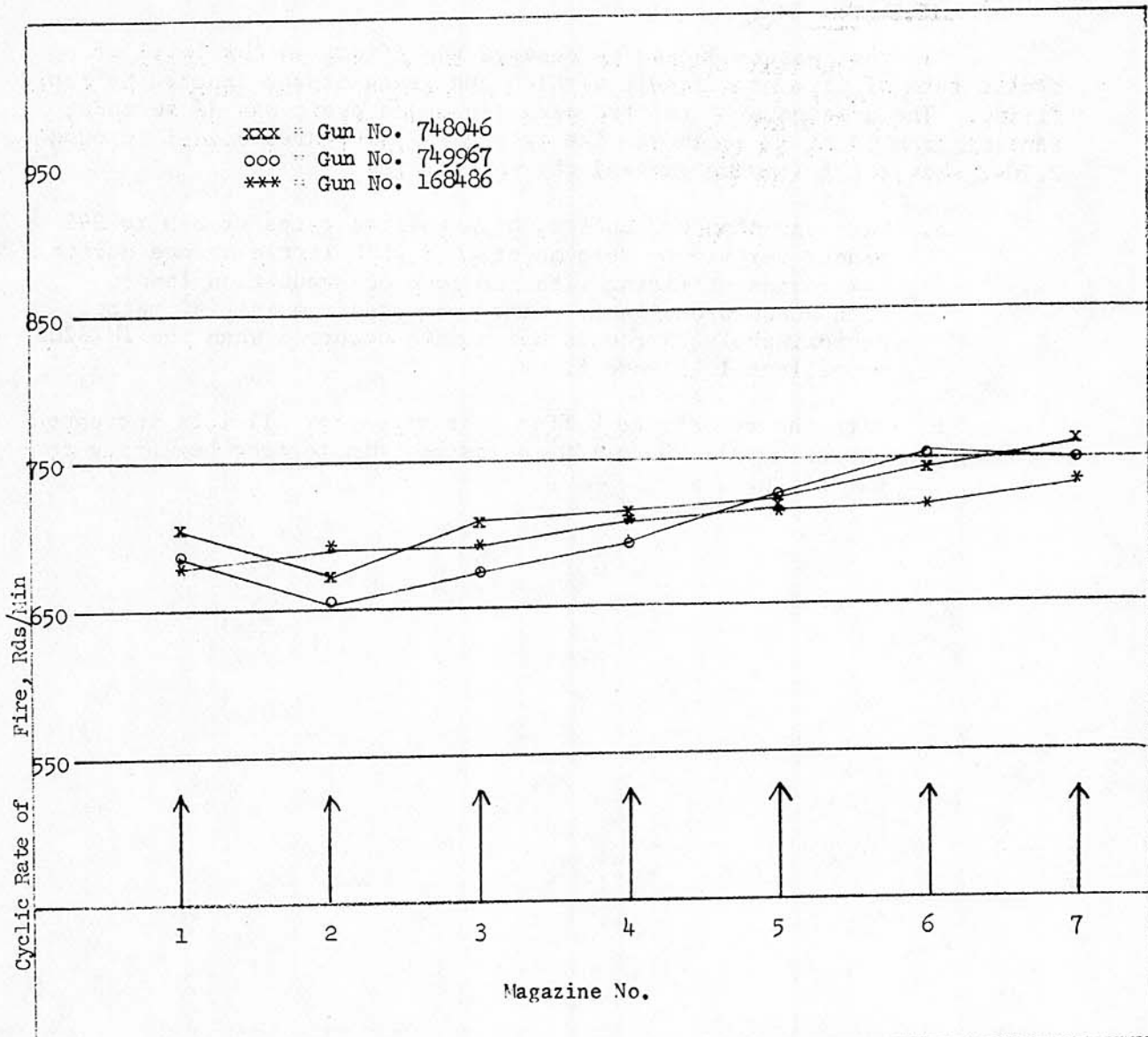


Figure 2.10 - 8. Cyclic Rate of Fire During Accelerated Firing for Three M16A1 Rifles with Redesigned Buffer and Ammunition Lot TW 18001.

### 2.10.5 Analysis

The test was conducted to observe the effect on the level of cyclic rate of fire as a result of high gun temperatures induced by rapid firing. The average time to fire each 140-round cycle was 44 seconds, ranging from 34 to 59 seconds. The rate data in Figures 2.10-1 through 2.10-8 show the following general characteristics:

- a. With the standard buffer, high initial rates of 879 to 972 rounds per minute were maintained with little change during 140 rounds of firing with the lots of ammunition loaded with WC846 propellant. Some increase from initial rates, approximately 25 rounds per minute occurred when the IMR8208 propellant lots were fired.
- b. With the redesigned buffer, the rates for all lots increased approximately 75 to 100 rounds per minute from beginning to end of test.

## 2.11 DYNAMIC DUST TEST

### 2.11.1 Objective

- a. To evaluate the performance of the M16A1 rifle with a redesigned buffer when firing various types of ammunition during a severe dust environment.
- b. To compare the above performance with similar firings employing the standard buffer.

### 2.11.2 Criteria

Weapon assembled with redesigned buffers shall perform equal to or better than weapons assembled with standard buffers.

### 2.11.3 Method

The method of test is described in paragraph 2.11.2a of Reference 2. Rifle Nos. 7 through 12 only are fired.

The firing schedule is contained in Table 2.11-I.

Table 2.11-I. Dynamic Dust Test Schedule

Trial No. <sup>b</sup>	Buffer	Rds Fired per Gun <sup>c</sup>	Ammunition Type <sup>a</sup>	
			Guns	
			7 to 9	10 to 12
1	Standard	140	A	C
2	Redesigned	140	A	C
3	Standard	140	B	D
4	Redesigned	140	B	D

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>The weapons are cleaned and lubricated at the beginning of test and after each trail.

<sup>c</sup>The cyclic rate of fire is measured during the firing of the first, third and final magazine in each trial; the second and fifth magazines are fired in 3-round bursts, and the fourth and sixth magazines semi-automatically.

2.11.4 Results

The results of the cyclic rate-of-fire tests are summarized in Table 2.11-II and the individual cyclic rate-of-fire data are contained in Appendix I.

The functioning data are summarized in Tables 2.11-III and 2.11-IV.

Table 2.11-II. Cyclic Rate-of-Fire Data During Dynamic Dust

Magazine No.	Buffer Model	Gun No.					
		739498	745075	745214	748046	749967	168486
		Lot LC12177			Lot LC12081		
1	Std	944	996	930	<sup>a</sup> 899	926	944
3	Std	825	838	799	863	-	844
7	Std	834	<sup>b</sup> 859	<sup>b</sup> 815	<sup>a</sup> 856	<sup>b</sup> 861	<sup>b</sup> 883
1	Red.	845	784	791	832	825	737
3	Red.	707	718	747	737	<sup>a</sup> 799	710
7	Red.	<sup>b</sup> 737	726	737	780	822	-
		Lot TW18166			Lot TW18001		
1	Std	879	871	791	900	859	921
3	Std	593	775	<sup>a</sup> 655	791	<sup>a</sup> 719	770
7	Std	654	643	678	825	-	816
1	Red.	723	657	690	764	750	<sup>a</sup> 671
3	Red.	664	633	690	690	693	-
7	Red.	<sup>b</sup> 629	<sup>a, b</sup> 580	696	678	758	<sup>a</sup> 740

<sup>a</sup>Due to a stoppage, the rate was measured for ten continuous rounds.

<sup>b</sup>The firing was conducted after the dust test was stopped as a result of a difficult-to-clear malfunction.

Table 2.11-III. Summary of Performance Characteristics  
During Dynamic Dust Conditions

Gun No.	Time to First Mal-function, min:sec <sup>a</sup>	Total Time to Final Stoppage or End of Test, min:sec <sup>b</sup>	Total "Open-Bolt" Time, min:sec <sup>c</sup>	Type of First Mal-function	Type of Final Stoppage	No. of Rds to First Mal-function	No. of Rds to Final Stoppage or End of Test
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Standard Buffer

Ammunition: Lot LC12177.

739498	0:80	2:04	1:39	FF1	-	80	140
745075	2:26	2:26	1:59	FX	FX	101	101
745214	1:06	2:21	2:09	FF1	FF	60	80

Ammunition: Lot TW18166.

739498	0:55	2:17	1:53	FF1	-	60	140
745075	0:55	2:22	2:02	FF1	-	60	140
745214	1:16	3:20	2:57	FF1	-	60	140

Ammunition: Lot LC12081.

748046	0:41	3:13	2:55	FF1	-	20	140
749967	0:16	2:51	2:47	BOB	FF1	33	40
168486	0:43	1:04	0:53	FF1	BOB	60	81

Ammunition: Lot TW18001.

748046	0:33	1:45	1:26	FF1	-	40	140
749967	0:29	1:31	1:21	FF1	BOB	40	61
168486	0:29	1:30	1:11	FF1	-	40	140

Redesigned Buffer

Ammunition: Lot LC12177.

<sup>d</sup> 739498	1:47	3:19	2:57	FF	BOB	62	107
<sup>d</sup> 739498	-	2:33	1:58	-	-	-	140
745075	2:06	2:56	2:22	BOB	-	101	140
745214	1:01	1:58	1:47	FF1	FX	60	80

*2.4 ang*

*467*

See footnotes on page 134.

Table 2.11-III (Cont'd)

<u>Gun No.</u>	<u>Time to First Mal-function, min:sec<sup>a</sup></u>	<u>Total Time to Final Stoppage or End of Test, min:sec<sup>b</sup></u>	<u>Total "Open, Bolt" Time, min:sec<sup>c</sup></u>	<u>Type of First Mal-function</u>	<u>Type of Final Stoppage</u>	<u>No. of Rds to First Mal-function</u>	<u>No. of Rds to Final Stoppage or End of Test</u>
Ammunition: Lot TW18166.							
739498	0:23	2:24	2:02	BOB	BOB	21	101
745075	0:58	2:56	2:32	FF1	FF	60	120
745214	0:18	2:38	2:11	FF1	-	20	140
Ammunition: Lot LC12081.							
748046	0:46	2:16	1:53	FF1	-	60	140
749967	0:35	2:33	2:13	FF1	-	40	140
168486	1:26	1:32	1:03	FF1	BOB	100	126
Ammunition: Lot TW18001.							
748046	0:56	1:58	1:39	FF1	-	60	140
749967	0:49	1:13	0:56	FF1	-	80	140
168486	0:02	1:03	0:59	FF	FF	15	58

<sup>a</sup>Time to first malfunction, as well as time to final stoppage or end of test, starts when first round is fired.

<sup>b</sup>The final stoppage was a malfunction which, because of the difficulty in clearing, made it necessary to stop the blowing dust; "end of test" signifies successful firing of 140 rounds during continuous (dynamic) dust application.

<sup>c</sup>"Open-bolt" time is the total time the bolt was rearward and the chamber exposed to blowing dust; open-bolt time occurred during magazine changes and during the clearing of malfunctions.

<sup>d</sup>An extra trial with this gun was inadvertently conducted.

Table 2.11-IV. Summary of Malfunction Data for Dynamic Dust Test

Gun No.	Ammunition Lot No.	Total Rds Fired <sup>a</sup>	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic; A = Automatic)												Total Malfunctions									
			FBR		BOB		FF		FF-1		FJ		FX											
			Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.	Std	Red.										
739498	LC12177	387			1		1	2							1	6								
	TW18166	241		2	2											11								
745075	LC12177	241		2										1		4								
	TW18166	260				1	1	3	1	2						8								
745214	LC12177	160													1	6								
	TW18166	280			4	1	1	2	2	4						16								
748046	LC12081	280	1					1	1	1	1	3				12								
	TW18001	280						1	2	2	2					7								
749967	LC12081	180		1				1	1	2	3					9								
	TW18001	201	1			4		1	1	1	1					8								
168486	LC12081	207		1				1	1	1	1					6								
	TW18001	198						6	6	2	3					18								
Totals		2915	0	1	0	1	4	5	3	4	5	10	9	13	16	1	3	0	1	1	0	1	1	111
Semiautomatic <sup>c</sup>			0	(0,0)		6	(1,5)	14	(4,10)		26	(13,13)		1	(1,0)		2	(1,1)		49	(20,29)			
Automatic <sup>c</sup>			1	(1,0)		7	(4,3)	14	(5,9)		35	(19,16)		4	(3,1)		1	(0,1)		62	(32,30)			
			1	(1,0)		13	(5,8)	28	(9,19)		61	(32,29)		5	(4,1)		5	(1,2)		111	(52,59)			

<sup>a</sup>Unless a stoppage terminated continuous testing, 140 rounds were fired with each buffer in each gun for each of the designated lots; 40 rounds semiautomatically and 100 rounds automatically (40 in 3-round bursts and 60 in 20-round bursts).

<sup>b</sup>One extra 140-round trial was inadvertently conducted.

<sup>c</sup>The first number in parentheses indicates standard buffer malfunctions; the second number indicates redesigned buffer malfunctions.

LC12177, standard buffer:	7	16
LC12177, redesigned buffer:	9	
TW18166, standard buffer:	16	35
TW18166, redesigned buffer:	19	
LC12081, standard buffer:	14	27
LC12081, redesigned buffer:	13	
TW18001, standard buffer:	15	33
TW18001, redesigned buffer:	18	
Total	111	

### 2.11.5 Analysis

The cyclic rate-of-fire data show that the dynamic dust environment does not significantly slow the M16A1 rifle in rate of fire, although a high number of stoppages and malfunctions are induced by the dust. It was judged that the vast majority of stoppages would not have been eliminated by greater energy in the forward moving bolt. The initial rates of fire also demonstrated a continued high-rate level which appeared typical with the guns in this test which had been fired more than 8500 rounds. The highest single rate of fire, 996 rounds per minute, was recorded in the dynamic dust test with gun No. 745075.

The data in Tables 2.11-III and 2.11-IV show that the guns equipped with the redesigned buffer met the test criteria standard of "equal" performance; in 25 attempted trials of 140 rounds, seven trials were successfully completed with each of the buffers.

Following the 11 trials which were not completed due to stoppages which were difficult to clear, an attempt was later made to finish the firing to a total of 140 rounds for each gun. Malfunctions occurring during these exercises were not counted in Table 2.11-IV. During these trials, which were conducted without further application of dust, 13 failures-to-extract occurred, all of which were cartridge-rim shears. Four occurred with the redesigned buffer, three with lot LC12177 and one with lot TW18166, and nine occurred with the standard buffer, three with lot LC12177 and six with lot LC12081. This was the first significant occasion of failures to extract occurring in any of the subtests. As was noted in the inspection test, none of the test weapons had chromeplated chambers, which might have alleviated this problem to some degree.

## 2.12 SALT-WATER IMMERSION

### 2.12.1 Objective

To evaluate the performance of M16A1 rifle with a redesigned buffer when firing various types of ammunition during high-temperature - high-humidity conditions following salt-water immersion.

### 2.12.2 Criteria

Same as par. 2.11.2.

### 2.12.3 Method

The method of test is described in par. 3.3.5, Interim Pamphlet 20-20, TECP 700-700, 11 April 1966.

The firing schedule is contained in Table 2.12-I.

Table 2.12-I. Salt-Water Immersion Test Schedule

Trial No.	Buffer	Rds. Fired Per Gun <sup>b</sup>	Ammunition Type <sup>a</sup>			
			Guns			
			1 to 3	4 to 6	7 to 9	10 to 12
1	Redesigned	300	A	C	B	D

<sup>a</sup>See explanation, Table 2.3-I.

<sup>b</sup>The cyclic rate of fire is measured for one 20-round burst each firing day.

### 2.12.4 Results

Test results are summarized in Tables 2.12-II and 2.12-III and in the following paragraphs.

Up to the fifth day of high-humidity and high-temperature storage following salt-water immersion, it was possible to complete most of the scheduled firings on the first, third, and fifth days without resorting to any restorative action, although the number of malfunctions was high. During and following the fifth day, a number of restorative or remedial actions were attempted to permit scheduled firings on the eighth and tenth (final) days to continue. Because the remedial action was experimental in nature and not always equally applied to each gun, the

malfunctions beyond the fifth day are recorded but not included in the final malfunction totals in Table 2.12-II. The following observations were made during the test:

- a. During the 10-day environmental exposure period, all guns were stored with a round in the rifle chamber, a 19-round magazine in place and the dust cover closed.
- b. During the firing on the fifth day, and for the remainder of the test, it became necessary to wipe the ammunition with a cloth and reload the ammunition in a magazine which had been disassembled and also wiped with a cloth. This was necessary as the action of the magazine followers had become extremely sluggish and in many cases the rounds were loose and not under spring tension in the magazines. Gun No. 738329 was removed from test on the fifth day when it became impossible to retract the bolt. Other problems experienced with this gun are discussed in par. 2.12.5.
- c. On the eighth day, water from a canteen was liberally used in an attempt to rinse away salt and the accumulation of corrosion and fouling on five of the guns. In addition, the chamber was wire-brushed on two guns using water as a cleaning agent. During the firing on the eighth day, a failure to extract was experienced on the first round fired (the round stored in the rifle chamber) with 9 of the 11 guns remaining in test. In four instances the failure to extract was cleared by manually cycling the bolt and in five instances the cartridge-case rim sheared and a cleaning rod was required to remove the fired case.
- d. As a result of the first-round failures to extract experienced on the eighth day, firing on the tenth day was not initiated until the chambered round (round stored in the rifle chamber) was first manually extracted and ejected without attempting to fire the round. In addition, all the ammunition was washed in water to remove salt deposits in the rim of the cartridge cases and at the neck joint of the cases. These deposits had not been removed during the wiping operation on the fifth day.
- e. Firing was then completed on the tenth day, but only after the majority of the guns had been liberally rinsed with water and in some instances water and a wire brush were used to clean the rifle chamber.

Table 2.12-II. Summary of Malfunction Data for Salt-Water Immersion Test

Ammunition Lot No.	Gun No.	Total Rounds Fired	Malfunctions by Buffer Model and Mode of Fire (SA = Semiautomatic, A = Automatic) <sup>a</sup>												Total Malfunctions									
			FFR		FBR		BOB		FF		COEC		FF-1			FJ		FX		FTR				
			Red.	SA	Red.	SA	Red.	SA	Red.	SA	Red.	SA	Red.	SA		Red.	SA	Red.	SA	Red.	SA			
b 735086	LC12177	180	1		1	3																	6	
		60		1		1																		5
		60		1		1																		12
c 737114	LC12177	180				9	8		1															26
		60		1		1																		11
		60																						1
d 737142	LC12177	180				4	14		3															25
		60		1		1																		11
		60				3	5		1															21
d 737641	TW18166	180				6	1																	11
		60				2																		4
		60				3																		4
d 737993	TW18166	180				10	2																	15
		60				11																		16
		60				7	4		2															19
d 738329	TW18166	121	1	1		5																		10
		-	Not fired																				-	
		-	Not fired																				-	
d 739498	LC12081	180				2	4		1															10
		60				19	3		1															25
		60				5	1																	6
d 745075	LC12081	180				5	3																	11
		60				17	3																	25
		60																						5
d 745214	LC12081	180				1																		2
		60																						2
		60				13																		19
d 748046	TW18001	180				5	17																	25
		60				1	1																	6
		60				2																		8
d 749967	TW18001	180				4	15																	21
		60				12	20																	34
		60				8	20		2															33
d 168486	TW18001	180				1	1																	10
		60				2	1																	5
		60				1	1																	9
		60				1																		3
Grand Total		3421	7	7	5	1	10	0	146	156	10	3	16	26	9	0	23	1	34	0				454
Total <sup>b</sup>			3	2	1	1	2	0	52	62	6	2	0	16	1	0	5	0	8	0				161

<sup>a</sup>Sixty rounds were fired on each of the five firing days; 20 rounds SA and 40 rounds A (20 in one burst, 20 in 3-round bursts).

<sup>b</sup>Total includes firing on first, third and fifth days only.

<sup>c</sup>Eight day.

<sup>d</sup>Tenth day.

Table 2.12-III. Cyclic Rate-of-Fire Data (Rounds per Minute) for Salt-Water Immersion Test

Firing Day	Buffer	Gun No.											
		735086	737114	737142	737641	737993	738329	739498	745075	745214	748046	749967	168486
		Lot LC12177	Lot LC12177	Lot TW18166	Lot TW18166	Lot TW18166	Lot TW18166	Lot LC12081	Lot LC12081	Lot LC12081	Lot TW18001	Lot TW18001	
1	Red.	808	783	767	776	703	666	791	770	792	730	712	716
3	Red.	767	708	660	729	601	609	712	690	759	565	a612	633
5	Red.	714	a631	-	710	678	-	a659	724	741	692	-	693
8	Red.	759	-	737	753	-	-	654	558	737	649	-	696
10	Red.	706	714	628	704	a486	-	703	643	a626	506	a555	674

<sup>a</sup>The rate was obtained for only ten rounds of a burst due to a stoppage in firing.

### 2.12.5 Analysis

The original test plan criteria stated definite levels of performance against which the M16A1 rifle equipped with a redesigned buffer was to be evaluated. The criteria was changed in the letter of approval for the test plan (Reference 4) to read as stated in par. 2.12.2. However, with only 12 test weapons and four lots of ammunition to be fired, it appeared essential to fire a minimum of three guns with each lot in the salt-water immersion test. As the salt-water immersion test is usually considered a destructive test, it was not feasible to attempt to rebuild the guns and refire with the standard buffers and the performance level of M16A1 rifles equipped with the standard buffer is not known.

Perhaps the most useful information in the test, particularly applicable to combat use, can be summarized as follows:

- a. Firing of the M16A1 rifle and its ammunition immediately after inadvertent immersion in salt water can be done without loss of effectiveness. No malfunctions occurred with any of the 12 test guns during the first day of firing. However, prior to firing, the bolt must be retracted and the barrel depressed to insure that no water remains in the rifle bore.
- b. While firing can still be accomplished without any prior maintenance on the third day following immersion, it can only be done with a significant degradation in effectiveness. Fifty malfunctions occurred during the firing on the third day in this test.
- c. If the weapons and ammunition are not cleaned by the fifth day, it is unlikely that attempted firing will be successful and first-round failures to extract will render most guns inoperative.
- d. The following corrective steps during combat use should be taken as soon as possible when the M16A1 rifle and ammunition have been immersed in or exposed to salt water, and when normally prescribed disassembly, cleaning, and lubrication of the weapon cannot be performed.
  - (1) Rinse the gun, magazines, and ammunition with clean, salt-free water, and dry with a cloth. If practicable, disassemble and clean the magazine and clean the chamber with a wire brush. If water is unavailable, wipe the items with a dry cloth.

- (2) Do not attempt to fire any chambered round after it has remained in the rifle chamber more than 12 hours; replace the chambered round with a clean round and destroy the chambered round.
- (3) Repeat the above procedures on each subsequent day until complete disassembly and cleaning and lubrication can be performed.

During the conduct of the high-temperature test, the exterior finish on the upper receiver of gun No. 738329 became noticeably worn and bright. This loss of protective finish gradually increased through the subsequent subtests and, during the salt-water immersion test, the receiver became so severely corroded that it was clearly unserviceable. Figure 2.12-1 shows the damaged receiver and Figure 2.12-2 shows a receiver from the same production lot, No. 737993, which was subjected to the same subtests as was the damaged gun. Note that although the upper receiver of gun No. 737993 shows relatively little wear, the protective finish on the charging handle has completely worn off. The finish on the charging handle of gun No. 737641 was also worn in a similar manner but the charging handles on the remaining guns showed only moderate and normal wear.

During the conduct of the low-temperature test, five new stainless-steel dust covers were installed on five of the rifles at the request of the project manager. These covers were then used in all subsequent tests. Figure 2.12-3 illustrates the condition of the standard-steel covers and the stainless-steel covers following all tests including salt-water immersion. The stainless-steel covers were judged to be an improvement over the standard covers as they were somewhat more impervious to rust and corrosion.



Figure 2.12-1: Gun No. 738329 Is Shown Following the Salt-Water Immersion Test.



Figure 2.12-2: Gun No. 737993 Is Shown Following the Salt-Water Immersion Test.

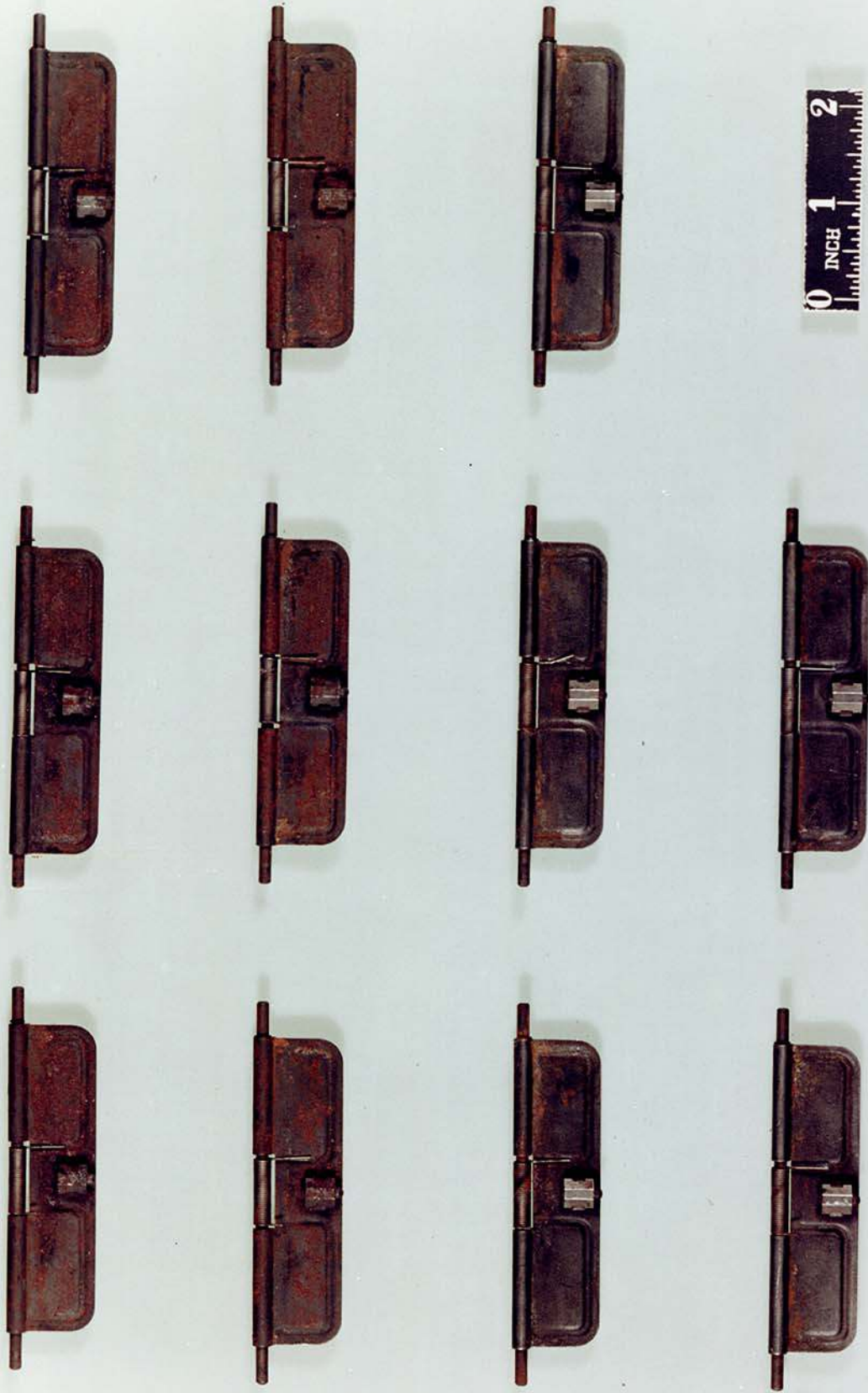


Figure 2.12-3: Six Standard Steel Dust Covers are Shown in the Top Two Rows and Five Stainless-Steel Covers Are Shown Below. Photograph Was Taken Following Salt-Water Immersion Test.

## 2.13 AMMUNITION CHARACTERISTICS

### 2.13.1 Objective

To determine the characteristics of the test lots of ammunition which pertain to buffer mechanism performance.

### 2.13.2 Criteria

- a. At +70°F, the average chamber pressure of M193 and M196 cartridges shall not exceed 52,000 psi and the average chamber pressure plus three standard deviations shall not exceed 58,000 psi (Reference 5, par. 3.10; Reference 6, par. 3.12).
- b. The average port pressure of M193 and M196 cartridges shall be 15,000  $\pm$  2000 psi (Reference 5, par. 3.11; Reference 6, par. 3.13).

### 2.13.3 Method

Port and chamber pressure measurements are obtained with 20 rounds of each test lot of ammunition with the ammunition temperature-conditioned at +70°F. The tests are repeated with the ammunition temperature-conditioned at -65°F and +155°F.

### 2.13.4 Results

The test results are summarized in Table 2.13-I and the individual data and the ammunition acceptance data sheets are contained in Appendix I.

Table 2.13-I. Summary of Port and Chamber Pressure Measurements for the Test Lots of Ammunition

Ammunition Temp, °F	Port Pressure, psi			Chamber Pressure, psi		
	Test Data			Test Data		
	Avg	Std Dev	Acc Avg <sup>a</sup>	Avg	Std Dev	Acc Avg <sup>a</sup>
Ammunition Lot: LC12177.						
+160	<sup>b</sup> 15345	250	14595	<sup>b</sup> 44445	919	47090
+ 70	<sup>c</sup> 11780	403	14400	<sup>d</sup> 43215	1304	48700
- 65	<sup>e</sup> 11520	340	14170	<sup>f</sup> 41400	2336	42765
Ammunition Lot: TW18166.						
+160	<sup>b</sup> 14055	389	14720	<sup>b</sup> 51225	1641	49000
+ 70	<sup>c</sup> 11650	447	14170	<sup>d</sup> 48580	1260	51300
- 65	<sup>e</sup> 12515	479	13420	<sup>f</sup> 45140	1778	47500
Ammunition Lot: LC12081 <sup>g</sup> .						
+160	<sup>b</sup> 13600	355	13485	48060	1476	45110
+ 70	<sup>c</sup> 12400	304	13700	<sup>d</sup> 43950	958	47000
- 65	13155	328	13520	42980	2599	43165
Ammunition Lot: TW18001.						
+160	<sup>b</sup> 14190	311	14160	<sup>b</sup> 49950	1490	47500
+ 70	<sup>c</sup> 11465	336	14140	<sup>d</sup> 47055	1750	47600
- 65	<sup>e</sup> 10880	414	13450	<sup>f</sup> 45040	2798	46200
Reference Ammunition Lot: LC-Y-5.56-501.						
+160	<sup>b</sup> 15055	402		47555	2705	
+ 70	<sup>c</sup> 13720	255	14700	<sup>d</sup> 42730	2887	46100
- 65	<sup>e</sup> 12775	275		<sup>f</sup> 44410	3800	

<sup>a</sup>Data from ammunition acceptance sheets.

<sup>b</sup>The data were obtained during a single day of firing for each designated letter.

<sup>c</sup>The data were obtained during a single day of firing for each designated letter.

<sup>d</sup>The data were obtained during a single day of firing for each designated letter.

<sup>e</sup>The data were obtained during a single day of firing for each designated letter.

<sup>f</sup>The data were obtained during a single day of firing for each designated letter.

<sup>g</sup>The following is quoted from the ammunition acceptance sheet for Lot LC12081: "Ammunition contained herein was originally withdrawn from Lot 12073 and 12074 for additional ballistic evaluation for trace performance."

### 2.13.5 Analysis

The data for the reference lot of ammunition in Table 2.13-I, at +70°F, show differences of +980 psi between test record values and assessed values for port pressure and +3370 psi for chamber pressure. If these "corrected" values are applied to the +70°F pressure results for the four test lots of ammunition, then all four lots meet chamber pressure criteria while only lot LC12081 meets the port pressure criteria.

The IMR 8208 propellant-loaded lots exhibited relatively high chamber-pressure characteristics at +70°F; approximately 10 per cent higher than the WC846 propellant-loaded lots. No similar significant difference was noted when comparing port pressures and there appears to be no correlation between port pressure variations and previously observed cyclic rate-of-fire characteristics for the lots of ammunition tested.

## SECTION 3. APPENDICES

## APPENDIX I - TEST DATA

Individual Cyclic Rate-of-Fire Data  
(Each rate is in rds/min for one 20-round magazine.)

D = Lot TW18001; M196, 8208 propellant.  
Std = Standard.  
Red. = Redesignated.

A = Lot LC12177; M193, ball propellant.  
B = Lot TW18166; M193, 8208 propellant.  
C = Lot LC12081; M196, ball propellant.

Trial No.	Buffer	735086	737114	737142	737641	737993	738329	739498	745075	745214	748046	749967	168486
		Gun No.											
Test Paragraph No.: 2.3. Condition: Ambient firing.													
1	Std	820-A	921-A	881-A	799-D	744-D	723-D	847-A	942-A	867-A	703-C	638-C	883-C
2	Red.	752-A	799-A	762-A	684-D	649-D	612-D	783-A	802-A	759-A	643-C	580-C	783-C
3	Std	727-B	799-B	727-B	879-C	847-C	825-C	759-B	809-B	770-B	672-D	637-D	863-D
4	Red.	612-B	675-B	629-B	792-C	786-C	758-C	649-B	714-B	657-B	588-D	564-D	691-D
5	Std	842-C	863-C	844-C	863-B	840-B	791-B	879-A	949-A	893-A	715-C	660-C	906-C
6	Red.	778-C	773-C	767-C	744-B	729-B	700-B	808-A	857-A	818-A	696-C	627-C	834-C
7	Std	804-D	834-D	783-D	972-A	947-A	889-A	802-B	863-B	808-B	699-D	715-D	847-D
8	Red.	696-D	710-D	690-D	869-A	873-A	838-A	693-B	737-B	696-B	643-D	614-D	744-D
Test Paragraph No.: 2.5. Condition: High humidity.													
1	Std	949-A	955-A	893-A	926-D	889-D	823-D	904-A	992-A	930-A	783-C	776-C	879-C
2	Red.	829-A	853-A	796-A	802-D	752-D	731-D	775-A	844-A	753-A	679-C	612-C	747-C
3	Std	851-B	877-B	794-B	949-C	897-C	851-C	744-B	881-B	767-B	722-D	643-D	813-D
4	Red.	723-B	749-B	668-B	825-C	781-C	759-C	657-B	737-B	620-B	620-D	566-D	723-D
5	Std	859-C	908-C	840-C	926-B	840-B	804-B	844-A	965-A	853-A	772-C	706-C	806-C
6	Red.	767-C	791-C	755-C	770-B	753-B	726-B	794-A	838-A	775-A	700-C	624-C	756-C
7	Std	844-D	867-D	808-D	965-A	937-A	933-A	808-B	897-B	801-B	758-D	703-D	847-D
8	Red.	727-D	747-D	722-D	893-A	879-A	845-A	698-B	750-B	666-B	689-D	574-D	756-D

Trial No. 735086 737114 737142 737641 737993 739498 745075 745214 748046 749967 168486  
 Buffer Gun No.

Test Paragraph No.: 2.5.  
 Condition: High humidity.

1	Std	823-A	879-A	806-A	808-D	770-D	726-D	863-A	937-A	893-A	829-C	668-C	873-C
2	Red.	816-A	816-A	776-A	764-D	714-D	679-D	775-A	829-A	788-A	747-C	600-C	755-C
3	Std	775-B	820-B	752-B	863-C	831-C	752-C	789-B	863-B	792-B	783-D	650-D	816-D
4	Red.	711-B	730-B	643-B	853-C	791-C	733-C	643-B	752-B	660-B	710-D	550-D	678-D
5	Std	813-C	859-C	791-C	853-B	813-B	716-B	847-A	930-A	879-A	825-C	719-C	844-C
6	Red.	784-C	786-C	744-C	789-B	762-B	648-B	794-A	820-A	791-A	750-C	641-C	816-C
7	Std	799-D	840-D	772-D	904-A	893-A	808-A	783-B	867-B	773-B	794-D	672-D	794-D
8	Red.	744-D	758-D	666-D	893-A	847-A	799-A	668-B	737-B	665-B	696-D	550-D	670-D

Test Paragraph No.: 2.5.  
 Condition: Ambient firing.

1	Std	869-A	926-A	875-A	844-D	816-D	791-D	904-A	972-A	926-A	879-C	729-C	981-C
2	Red.	794-A	808-A	775-A	753-D	706-D	730-D	767-A	808-A	762-A	723-C	619-C	818-C
3	Std	770-B	827-B	775-B	844-C	808-C	791-C	791-B	847-B	775-B	778-D	612-D	893-D
4	Red.	694-B	716-B	657-B	775-C	731-C	767-C	647-B	706-B	629-B	643-D	-	741-D
5	Std	781-C	863-C	764-C	806-B	767-B	744-B	838-A	915-A	816-A	808-C	-	961-C
6	Red.	734-C	753-C	719-C	738-B	699-B	690-B	749-A	781-A	741-A	710-C	-	778-C
7	Std	737-D	801-D	720-D	847-A	831-A	783-A	759-B	829-B	767-B	743-D	-	838-D
8	Red.	686-D	706-D	646-D	806-A	784-A	767-A	658-B	696-B	629-B	612-D	-	718-D

Test Paragraph No.: 2.6.  
 Condition: High temperature, +155°F.

1	Std	-	949-A	897-A	883-D	825-D	710-D	844-A	969-A	896-A	873-C	775-C	922-C
2	Red.	904-A	897-A	834-A	829-D	730-D	683-D	794-A	863-A	825-A	813-C	759-C	887-C
3	Std	816-B	863-B	767-B	910-C	863-C	744-C	765-B	853-B	777-B	818-D	-	915-D
4	Red.	759-B	788-B	703-B	893-C	842-C	759-C	602-B	738-B	670-B	716-D	666-D	808-D
5	Std	873-C	891-C	794-C	873-B	834-B	759-B	877-A	952-A	904-A	859-C	-	930-C
6	Red.	840-C	825-C	782-C	783-B	743-B	690-B	808-A	863-A	825-A	808-C	759-C	863-C
7	Std	863-D	893-D	808-D	880-A	915-A	844-A	792-B	871-B	825-B	883-D	778-D	930-D
8	Red.	716-D	773-D	657-D	893-A	840-A	809-A	633-B	703-B	657-B	708-D	600-D	759-D

Trial No. 735086 737114 737142 737641 737993 738329 739498 745075 745214 748046 749967 168486  
 Buffer Gun No.

Test Paragraph No.: 2.6  
 Condition: High temperature, +155°F.

1	Std	867-A	906-A	838-A	883-D	808-D	770-D	786-A	904-A	806-A	809-C	747-C	775-C
2	Red.	829-A	829-A	804-A	799-D	654-D	688-D	712-A	809-A	741-A	755-C	761-C	723-C
3	Std	761-B	786-B	736-B	863-C	806-C	767-C	723-B	822-B	723-B	816-D	772-D	816-D
4	Red.	678-B	691-B	611-B	863-C	776-C	761-C	542-B	691-B	564-B	690-D	672-D	674-D
5	Std	794-C	825-C	781-C	853-B	791-B	762-B	834-A	912-A	871-A	825-C	755-C	831-C
6	Red.	808-C	829-C	799-C	781-B	693-B	723-B	752-A	808-A	775-A	762-C	733-C	767-C
7	Std.	883-D	847-D	823-D	904-A	873-A	829-A	727-B	809-B	749-B	811-D	753-D	838-D
8	Red.	736-D	744-D	710-D	885-A	816-A	838-A	538-B	686-B	580-B	668-D	624-D	684-D

Test Paragraph No.: 2.6.  
 Condition: Ambient firing.

1	Std	831-A	893-A	820-A	863-D	811-D	773-D	897-A	942-A	883-A	829-C	783-C	949-C
2	Red.	759-A	762-A	737-A	778-D	698-D	688-D	762-A	765-A	747-A	719-C	712-C	770-C
3	Std.	744-B	794-B	730-B	832-C	791-C	764-C	781-B	799-B	773-B	755-D	740-D	840-D
4	Red.	642-B	694-B	571-B	794-C	744-C	722-C	629-B	675-B	617-B	621-D	660-D	726-D
5	Std	791-C	820-C	770-C	820-B	752-B	733-B	832-A	887-A	834-A	791-C	761-C	851-C
6	Red.	737-C	746-C	699-C	750-B	672-B	665-B	744-A	759-A	749-A	706-C	716-C	755-C
7	Std	756-D	802-D	737-D	847-A	825-A	788-A	786-B	808-B	775-B	765-D	747-D	822-D
8	Red.	672-D	699-D	606-D	834-A	775-A	778-A	796-B	693-B	629-B	660-D	640-D	704-D

Test Paragraph No.: 2.7.  
 Condition: Fouling test, +20°F.

1	Std	935-A	840-A	877-A	815-D	806-D	759-D	786-A	954-A	825-A	829-C	778-C	808-C
2	Red.	791-A	706-A	727-A	719-D	706-D	689-D	693-A	765-A	716-A	666-C	643-C	722-C
3	Std	820-B	747-B	747-B	775-C	775-C	729-C	686-B	808-B	719-B	726-D	706-D	740-D
4	Red.	706-B	666-B	623-B	712-C	708-C	684-C	607-B	668-B	622-B	614-D	627-D	686-D

Trial No.	Buffer	Gun No.											
		735086	737114	737142	737641	737993	738329	739498	745075	745214	748046	749967	168486
5	Std	799-C	741-C	744-C	730-B	737-B	703-B	767-A	867-A	726-A	730-C	719-C	743-C
6	Red.	710-C	674-C	666-C	690-B	664-B	620-B	689-A	792-A	699-A	659-C	657-C	712-C
7	Std	770-D	733-D	693-D	762-A	770-A	712-A	654-B	770-B	695-B	677-D	690-D	736-D
8	Red.	672-D	666-D	590-D	755-A	723-A	677-A	535-B	629-B	593-B	589-D	607-D	690-D

Test Paragraph No.: 2.7.  
Condition: Fouling test, +20°F.

1	Std	786-A	765-A	733-A	756-D	737-D	629-D	686-A	838-A	729-A	684-C	730-C	714-C
2	Red.	693-A	716-A	719-A	707-D	665-D	562-D	664-A	711-A	684-A	652-C	647-C	652-C
3	Std	726-B	708-B	703-B	763-C	733-C	602-C	602-B	723-B	670-B	666-D	666-D	686-D
4	Red.	674-B	653-B	593-B	678-C	678-C	554-C	-	614-B	593-B	581-D	617-D	604-D
5	Std	730-C	710-C	685-C	726-B	700-B	604-B	690-A	842-A	703-A	693-C	678-C	690-C
6	Red.	695-C	658-C	652-C	678-B	633-B	503-B	664-A	715-A	682-A	657-C	654-C	654-C
7	Std	703-D	678-D	660-D	791-A	758-A	622-A	642-B	733-B	649-B	672-D	700-D	684-D
8	Red.	700-D	649-D	611-D	746-A	712-A	588-A	538-B	617-B	602-B	632-D	606-D	623-D

Test Paragraph No.: 2.7.  
Condition: Fouling test, +20°F.

1	Std	770-A	737-A	716-A	726-D	690-D	651-D	686-A	847-A	733-A	672-C	706-C	690-C
2	Red.	723-A	674-A	666-A	674-D	614-D	577-D	662-A	699-A	678-A	649-C	644-C	633-C
3	Std	715-B	664-B	659-B	730-C	710-C	620-C	614-B	719-B	649-B	672-D	668-D	689-D
4	Red.	637-B	617-B	562-B	706-C	654-C	557-C	542-B	622-B	609-D	609-D	622-D	617-D
5	Std	715-C	674-C	680-C	808-B	672-B	566-B	672-A	834-A	765-A	688-C	688-C	680-C
6	Red.	689-C	633-C	632-C	674-B	590-B	513-B	665-A	696-A	706-A	654-C	651-C	662-C
7	Std	715-D	665-D	649-D	921-A	743-A	577-A	633-B	727-B	714-B	689-D	679-D	682-D
8	Red.	635-D	604-D	575-D	666-A	703-A	570-A	542-B	600-B	572-B	614-D	546-D	593-D

Trial No. 735086 737114 737142 737641 737993 738329 739498 745075 745214 748046 749967 168486  
 Buffer 735086 737114 737142 737641 737993 738329 739498 745075 745214 748046 749967 168486  
 Gun No. 735086 737114 737142 737641 737993 738329 739498 745075 745214 748046 749967 168486

Test Paragraph No.: 2.7.  
 Condition: Ambient firing.

1	Std	883-A	829-A	776-A	921-D	775-D	759-D	799-A	949-A	942-A	786-C	808-C	813-C
2	Red.	829-A	780-A	764-A	775-D	712-D	710-D	775-A	808-A	778-A	758-C	716-C	775-C
3	Std	786-B	740-B	716-B	930-C	773-C	791-C	720-B	820-B	786-B	726-D	773-D	752-D
4	Red.	723-B	708-B	649-B	802-C	752-C	733-C	627-B	678-B	648-B	660-D	604-D	703-D
5	Std	808-C	767-C	730-C	904-B	733-B	716-B	775-A	937-A	847-A	752-C	789-C	772-C
6	Red.	776-C	747-C	729-C	756-B	696-B	672-B	772-A	791-A	783-A	759-C	737-C	767-C
7	Std	767-D	753-D	723-D	949-A	770-A	781-A	716-B	816-B	776-B	723-D	759-D	740-D
8	Red.	737-D	704-D	665-D	829-A	778-A	759-A	624-B	668-B	651-B	730-D	593-D	693-D

Test Paragraph No.: 2.8.  
 Condition: Low temperature, -65°F.

1	Std	844-A	887-A	821-A	786-D	770-D	737-D	798-A	825-A	808-A	744-C	624-C	749-C
2	Red.	684-A	640-A	660-A	654-D	614-D	577-D	612-A	666-A	646-A	527-C	-	614-C
3	Std	682-B	702-B	635-B	666-C	593-C	604-C	665-B	668-B	620-B	590-D	-	696-D
4	Red.	610-B	597-B	554-B	591-C	514-C	516-C	540-B	564-B	542-B	521-D	598-D	627-D
5	Std	649-C	703-C	602-C	634-B	558-B	571-B	641-A	733-A	661-A	580-C	712-C	710-C
6	Red.	557-C	526-C	546-C	558-B	493-B	535-B	552-A	582-A	560-A	-	-	581-C
7	Std	633-D	646-D	575-D	666-A	690-A	678-A	540-B	640-B	563-B	609-D	-	643-D
8	Red.	588-D	542-D	-	657-A	601-A	592-A	506-B	582-B	-	-	-	593-D

Test Paragraph No.: 2.8.  
 Condition: Low temperature, -65°F.

1	Std	710-A	703-A	706-A	695-D	604-D	658-D	654-A	695-A	662-A	580-C	600-C	624-C
2	Red.	657-A	622-A	636-A	654-D	556-D	584-D	538-A	554-A	546-A	526-C	572-C	562-C
3	Std	678-B	683-B	666-B	703-C	654-C	653-C	564-B	586-B	576-B	620-D	666-D	666-D
4	Red.	593-B	595-B	548-B	630-C	600-C	572-C	532-B	536-B	525-B	552-D	546-D	569-D
5	Std	643-C	641-C	581-C	670-B	576-B	609-B	628-A	678-A	633-A	606-C	606-C	667-C
6	Red.	531-C	549-C	-	623-B	540-B	562-B	550-A	581-A	535-A	506-C	-	581-C
7	Std	612-D	619-D	668-D	712-A	678-A	690-A	559-B	564-B	592-B	607-D	-	642-D
8	Red.	544-D	540-D	-	627-A	602-A	622-A	-	513-B	-	597-D	-	569-D

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 Buffer Gun No.

Test Paragraph No.: 2.8.  
 Condition: Low temperature, -65°F.

1	Std	808-A	730-A	707-A	688-D	572-D	653-D	710-A	730-A	690-A	660-C	649-C	665-C
2	Red.	653-A	588-A	596-A	581-D	501-D	558-D	558-A	593-A	566-A	525-C	554-C	609-C
3	Std	690-B	672-B	633-B	727-C	586-C	660-C	-	598-B	-	662-D	624-D	646-D
4	Red.	568-B	542-B	-	584-C	-	554-C	-	-	-	542-D	554-D	-
5	Std	684-C	668-C	619-C	714-B	577-B	604-B	-	722-A	638-A	668-C	617-C	654-C
6	Red.	564-C	516-C	-	581-B	-	523-B	-	-	-	513-C	-	-
7	Std	662-D	640-D	-	834-A	744-A	741-A	-	588-B	566-B	602-D	-	612-D
8	Red.	519-D	513-D	602-D	629-A	566-A	-	-	-	-	-	-	-

Test Paragraph No.: 2.8.  
 Condition: Ambient firing.

1	Std	904-A	921-A	826-A	887-D	762-D	762-D	838-A	877-A	758-A	816-C	808-C	844-C
2	Red.	770-A	767-A	562-A	756-D	604-D	654-D	719-A	741-A	546-A	716-C	727-C	747-C
3	Std	778-B	773-B	794-B	926-C	791-C	799-C	690-B	755-B	723-B	756-D	759-D	798-D
4	Red.	674-B	683-B	588-B	764-C	703-C	703-C	556-B	550-B	558-B	604-D	558-D	674-D
5	Std	844-C	859-C	767-C	863-B	749-B	714-B	825-A	873-A	808-A	806-C	799-C	820-C
6	Red.	741-C	756-C	690-C	730-B	628-B	624-B	741-A	744-A	730-A	730-C	706-C	741-C
7	Std	791-D	791-D	733-D	930-A	838-A	808-A	759-B	794-B	759-B	651-D	775-D	808-D
8	Red.	690-D	696-D	593-D	823-A	759-A	741-A	612-B	620-B	628-B	652-D	572-D	678-D

Test Paragraph No.: 2.9.  
 Condition: Ambient firing.

1	Std	947-A	921-A	861-A	926-D	775-D	744-D	-	-	-	-	-	-
2	Red.	794-A	767-A	737-A	758-D	654-D	574-D	-	-	-	-	-	-
3	Std	811-B	794-B	743-B	937-C	808-C	706-C	-	-	-	-	-	-
4	Red.	716-B	702-B	596-B	809-C	723-C	653-C	-	-	-	-	-	-

Trial No.	Buffer	753086	737114	737142	737641	737993	738329	739498	745075	745214	748046	749967	168486
							Gun No.						
5	Std	873-C	863-C	767-C	902-B	773-B	672-B						
6	Red.	758-C	715-C	693-C	755-B	668-B	604-B						
7	Std	789-D	776-D	714-D	947-A	834-A	783-A						
8	Red.	702-D	678-D	609-D	847-A	747-A	683-A						
Test Paragraph No.: 2.9.													
Condition: Ambient Firing.													
1	Std	949-A	937-A	863-A	926-D	808-D	730-D						
2	Red.	796-A	770-A	759-A	775-D	693-D	633-D						
3	Std	816-B	825-B	762-B	949-C	842-C	786-C						
4	Red.	730-B	716-B	643-B	857-C	759-C	707-C						
5	Std	902-C	883-C	808-C	915-B	802-B	740-B						
6	Red.	775-C	744-C	719-C	775-B	707-B	643-B						
7	Std	813-D	820-D	767-D	921-A	883-A	815-A						
8	Red.	723-D	720-D	664-D	863-A	799-A	730-A						
Test Paragraph No.: 2.9.													
Condition: Ambient firing.													
1	Std	924-A	924-A	851-A	887-D	883-D	861-D						
2	Red.	775-A	759-A	756-A	744-D	660-D	638-D						
3	Std	791-B	794-B	747-B	949-C	825-C	775-C						
4	Red.	686-B	696-B	659-B	794-C	726-C	679-C						
5	Std	857-C	853-C	804-C	908-B	764-B	710-B						
6	Red.	755-C	716-C	733-C	727-B	658-B	604-B						
7	Std	794-D	806-D	775-D	956-A	857-A	775-A						
8	Red.	690-D	704-D	644-D	816-A	768-A	703-A						

Trial No. 735086 737114 737142 737641 737993 738329 739498 745075 745214 748046 749967 168486  
 Buffer

Test Paragraph No.: 2.9.  
 Condition: Ambient firing.

1	Std	926-A	904-A	844-A	829-D	775-D	752-D
2	Red.	775-A	752-A	741-A	690-D	633-D	576-D
3	Std	808-B	802-B	744-B	857-C	816-C	733-C
4	Red.	690-B	684-B	643-B	723-C	747-C	690-C
5	Std	865-C	802-C	808-C	853-B	794-B	733-B
6	Red.	770-C	730-C	741-C	716-B	696-B	647-B
7	Std	829-D	811-D	783-D	930-A	867-A	816-A
8	Red.	726-D	690-D	684-D	794-A	791-A	744-A

Test Paragraph No.: 2.9.  
 Condition: Ambient firing.

1	Std	970-A	863-A	921-A	930-D	832-D	775-D
2	Red.	744-A	794-A	762-A	767-D	695-D	654-D
3	Std	857-B	844-B	767-B	949-C	867-C	820-C
4	Red.	730-B	716-B	638-B	756-C	767-C	744-C
5	Std	908-C	863-C	789-C	887-B	808-B	776-B
6	Red.	804-C	759-C	730-C	744-B	702-B	689-B
7	Std	845-D	816-D	765-D	947-A	887-A	881-A
8	Red.	744-D	703-D	651-D	827-A	802-A	808-A

Test Paragraph No.: 2.10.  
 Condition: Accelerated firing.

1	Std	924-A	972-A	-	937-C	904-C	879-C
2	Std	910-A	954-A	949-A	949-C	904-C	879-C
3	Std	902-A	954-A	926-A	930-C	910-C	859-C
4	Std	897-A	-	926-A	937-C	883-C	873-C
5	Std	879-A	949-A	926-A	944-C	908-C	867-C
6	Std	873-A	968-A	930-A	935-C	921-C	867-C
7	Std	879-A	983-A	942-A	949-C	924-C	915-C

Trial No.	Buffer	Gun No.										
		735086	737114	737142	737461	737993	738329	739498	745075	745214	748046	749967
1	Red.						672-A	759-A	737-A	729-C	752-C	744-C
2	Red.						693-A	794-A	759-A	747-C	773-C	759-C
3	Red.						730-A	791-A	799-A	765-C	802-C	789-C
4	Red.						747-A	804-A	813-A	799-C	820-C	816-C
5	Red.						767-A	823-A	847-A	859-C	844-C	822-C
6	Red.						786-A	834-A	845-A	877-C	869-C	825-C
7	Red.						806-A	834-A	847-A	840-C	897-C	863-C
Test Paragraph No.: 2.10.												
Condition: Accelerated firing.												
1	Std						716-B	806-B	775-B	804-D	851-D	823-D
2	Std						700-B	806-B	759-B	786-D	808-D	808-D
3	Std						699-B	811-B	770-B	783-D	816-D	808-D
4	Std						716-B	815-B	775-B	798-D	820-D	811-D
5	Std						737-B	836-B	796-B	799-D	799-D	816-D
6	Std						752-B	840-B	798-B	823-D	857-D	820-D
7	Std						743-B	869-B	809-B	847-D	825-D	842-D
Test Paragraph No.: 2.10.												
Condition: Accelerated firing.												
1	Red.						557-B	654-B	684-B	704-D	686-D	677-D
2	Red.						-	633-B	666-B	672-D	654-D	690-D
3	Red.						543-B	684-B	686-B	708-D	675-D	693-D
4	Red.						575-B	688-B	699-B	714-D	693-D	706-D
5	Red.						623-B	690-B	715-B	722-D	723-D	715-D
6	Red.						623-B	706-B	741-B	741-D	752-D	716-D
7	Red.						677-B	722-B	759-B	759-D	749-D	730-D
Test Paragraph No.: 2.11.												
Condition: Dust.												
1	Std						944-A	996-A	930-A	899-C	926-C	944-C
3	Std						825-A	838-A	799-A	863-C	-	844-C
7	Std						834-A	859-A	815-A	856-C	861-C	883-C

Trial No. 735086 737114 737142 737461 737993 738329 739498 745075 745214 748046 749967 168486  
 Buffer Gun No.

Test Paragraph No.: 2.11.  
 Condition: Dust.

1	Red.	845-A	784-A	791-A	832-C	825-C	737-C
3	Red.	707-A	718-A	747-A	737-C	799-C	710-C
7	Red.	737-A	726-A	737-A	780-C	822-C	-

Test Paragraph No.: 2.11.  
 Condition: Dust.

1	Std	879-B	871-B	791-B	900-D	859-D	921-D
3	Std	593-B	775-B	655-B	791-D	-	778-D
7	Std	654-B	643-B	678-B	825-D	-	816-D

Test Paragraph No.: 2.11.  
 Condition: Dust.

1	Red.	723-B	657-B	690-B	764-D	750-D	671-D
3	Red.	664-B	633-B	690-B	690-D	693-D	-
7	Red.	629-B	580-B	696-B	678-D	758-D	740-D

FRANKFORD ARSENAL  
QUALITY ASSURANCE DIRECTORATE  
AMMUNITION ENGINEERING DIVISION

REFERENCE AMMUNITION ASSESSMENT REPORT

QAD NO: 11-66

23 November 1966

SUBJECT: Assessment of Cartridges 5.56MM Reference. Drawing No. D10524633,  
Reference Lot No. LC-Y-556-501.

REFERENCE:

1. The following is a summary of the data:

A. Component Data

(1) Propellant

- a. Type WC846 AL 44489
- b. Charge 27.5 Grains

(2) Pressure Cylinder Lot WC 252 (Chamber) and Lot FA 4C-64

(3) Velocity Test Fixture, Dwg. F10524145

(4) Chamber & Port Pressure Test Fixture Dwg. F10524136.

B. Ballistic Data

(1) Average Velocity Results

- a. Velocity at 15 feet 3248 ft/sec  
Extreme Variation 102 ft/sec  
Standard Deviation 28 ft/sec

(2) Average Chamber Pressure Results

- a. Short Piston Velocity 3226 ft/sec  
Extreme Variation 87 ft/sec  
Standard Deviation 23 ft/sec

- b. Chamber Pressure 46,100 psi  
Extreme Variation 6,800 psi  
Standard Deviation 1,800 psi

(3) Average Port Pressure Results

- a. Port Pressure 14,700 psi  
Extreme Variation 1,300 psi  
Standard Deviation 300 psi

**C. Assessment Values**

Velocity at 15 feet	3248 ft/sec
Short Piston Velocity	3226 ft/sec
Chamber Pressure	46,100 psi
Port Pressure	14,700 psi

2. The foregoing assessment is effective immediately for subject cartridge, 5.56mm Reference, Lot LC-Y-556-501.

*E. A. Mathias*

E. A. MATHIAS  
Ch, Quality Engineering Branch  
Quality Assurance Directorate

PRESENTED 13 June 67  
 CITY PACKED 500,200  
 1305-014-4719-(A068)  
 FUNCTIONAL LOT NOS.  
 ACHS CODE 4810.16.0217.2.A2.Fy66  
 SPEC. NO. MIL-C-6011 REV. A/6  
 LCO DATE 5/5/66  
 DWG. NO. C10534193  
 REV B DATE 8/27/65

LAKE CITY ARMY AMMUNITION PLANT  
 INSPECTION REPORT - 5.56MM  
 ITEM Ctg., Tracer, M196  
 LOT NO. LC 12081  
 ACCEPTED  1ST TEST   
 REJECTED  RETEST   
 WAIVER   
 ACCEPTANCE DATE 19 June 67

CONTRACTOR: REM ARMS CO. INC.  
 CONTRACT NO. DA-49-010-AMC-3(A)  
 PRIMER NO. 41 MIX FA 956  
 PRIMER LOT NOS. 10-136,137,139  
 TRACER MIX R 2R4  
 IGNITER MIX R 20C  
 PROPELLANT TYPE WC R46  
 A.L. NO. 44663  
 CHG (GRS) 26.6 26.7  
 CASE- STEEL  BRASS   
 HEADSTAMP (YR) LC 67  
 BULLET JACKET Gilding Metals

FIRING TESTS				
	AMB	125°	160°	-65°
CHAMBER PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	47000	+5000	-1890	-3835
LIMIT - MAX	52,000	+5,000	+5,000	+5,000
AVG - 3 SD	52000			
LIMIT - MAX	58,000			
PORT PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	13700	+5	-215	-180
LIMIT	15,000 22,000	±2,000	±2,000	±2,000
VELOCITY @ 15 FT (FS)				
RDS FIRED	20	10	10	20
RECORD	3175	+49	-15	-88
LIMIT	3260±40	-250	-250	-250
STD DEV	18.0			
LIMIT	40			
ACCURACY (INCHES)				
RDS FIRED	90			
RECORD	3.26			
LIMIT	5.0			
TIME (MS)	50			
RECORD	1.20			
LIMIT	4.0			
LOSS & CASUALTY				
RDS FIRED	720			
RECORD	OK			
LIMIT				
CASUALTIES				
NONE				

TRACE	NO. RDS.	RECORD	LIMIT		
NO. TRACING @ 500 YDS	100	81	79		
NO. BULLET BURSTS		0	0		
NO. ERRATIC FLIGHTS		0	0		
NO. MUZZLE FLASHES		0	0		
WATERPROOF TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
50	1	3			
DESCRIPTION OF DEFECTS					
1 Ctg., W/2 or more mouth Bubbles @ 7½ PSI 30 Sec					
BULLET EXTRACTION TEST (LBS)					
NO. TESTED	SPEC. MIN.	NO. FAILED	MAX.	MIN.	MEAN
25	35	0	114	65	64
MERCURIUS NITRATE TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
50	0	5			
BASE CLOSURE SEAL TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
25	0	3			
VISUAL, GAGE & WEIGH INSPECTION					
1ST SAMPLE	DATE				
2ND SAMPLE					
	Critical	Major	Minor		
AQL %	.04	.25	1.50		
% DEFECTIVE					
DEFECT NO. & DESCRIPTION					
TOTAL					
PACKING INSPECTION - CONTAINER CONTENT					
MAJOR		MINOR			
% DEFECTIVE	AQL %	% DEFECTIVE	AQL %		
	1.0		2.5		
TOTAL AUTHORIZED RDS EXPENDED IN TESTS: 1,205					

REMARKS:  
 Ammunition contained herein was originally withdrawn from Lot 12073 and Lot 12074 for additional ballistic evaluation. for trace performance.

*James H. White*  
 QUALITY ASSURANCE REPRESENTATIVE

# TRACER

Date Presented 11 May 1967  
 Quantity Packed 90,000 Rds.  
 FSN 159-911-117-000  
 Functional Lot Nos. R  
 MCMC Code 1810-26-0217-2-AL  
 Spec. No. 11-0-50111 (18) v. Amend. 6  
 ECO \_\_\_\_\_ Date \_\_\_\_\_  
 Dwg. No. 11053193  
 Rev. B Date 8-27-66

TWIN CITIES ARMY AMMUNITION PLANT  
 INSPECTION REPORT - 5.56MM  
 ITEM 5.56mm Tracer 1100  
 Lot No. TW- 25001  
 Accepted  1st Test   
 Rejected  Retest   
 Waiver   
 Acceptance Date 17 May 1967

Contractor: Federal Cartridge Corp.  
 Contract No. 11-0-000-00000000  
 Primer No. 100  
 Primer Lot Nos. 1000  
 Tracer Mix \_\_\_\_\_  
 Igniter Mix \_\_\_\_\_  
 Propellant Type 11-0000  
 A.L. No. 1000  
 Chg. (Grs) 25.4  
 Case - Steel  Brass   
 Headstamp (Yr) 1967  
 Bullet Jacket Galvanized Metal

FIRING TESTS				
	AMB	125°	160°	-65°
CHAMBER PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	<u>17,000</u>	<u>+500</u>	<u>-100</u>	<u>-1100</u>
LIMIT - MAX	52,000	+ 5,000	+ 5,000	+ 5,000
AVG + 3 SD	<u>52,000</u>			
LIMIT - MAX	58,000			
PORT PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	<u>14,100</u>	<u>+230</u>	<u>+20</u>	<u>-690</u>
LIMIT - MAX	15,000			
LIMIT - MIN	12,000	12,000	12,000	12,000
ACCURACY @ 15 FT. (FS)				
RDS FIRED	20	10	10	20
RECORD	<u>3100</u>	<u>+10</u>	<u>+10</u>	<u>-110</u>
LIMIT - MAX	3250 ± 40	-250	-250	-250
LIMIT - MIN	2250			
DEV	40			

TRACE	NO. RDS.	RECORD	LIMIT
<u>Xa</u> TRACING @ 500 YDS		<u>91%</u>	<u>80%</u>
<del>NO. TESTED</del>			
<del>NO. FAILED</del>			
<del>NO. DEFECTIVE</del>			
<del>NO. WITH DEFECTS</del>			

WATERPROOF TEST		
NO. TESTED	NO. FAILED	SPEC. LIMIT
		<u>9</u>

DESCRIPTION OF DEFECTS  
4 cases (neck)  
1 case (base)

BULLET EXTRACTION TEST (Lbs.)					
No. Tested	SPEC. MIN.	NO. FAILED	MAX.	MIN.	MEAN
<u>20</u>	<u>35</u>	<u>0</u>	<u>50</u>	<u>52</u>	<u>76</u>

MERCURIUS NITRATE TEST		
NO. TESTED	NO. FAILED	SPEC. LIMIT
<u>20</u>	<u>0</u>	<u>0</u>

BASE CLOSURE SEAL TEST		
NO. TESTED	NO. FAILED	SPEC. LIMIT
<u>20</u>	<u>0</u>	<u>3</u>

VISUAL GAGE & WEIGH INSPECTION	
1st SAMPLE	DATE
<u>315</u>	<u>5-22-67</u>
2nd SAMPLE	

	CRITICAL	MAJOR	MINOR
AQL %	.04	.25	1.50
% DEFECTIVE			
DEFECT NO. & DESCRIPTION			<u>1/19</u>
			<u>1/22</u>
TOTAL			<u>2</u>

PACKING INSPECTION - CONTAINER CONTENT			
MAJOR		MINOR	
% DEFECTIVE	AQL %	% DEFECTIVE	AQL %
<u>0</u>	<u>1.0</u>		<u>2.5</u>

TOTAL AUTHORIZED RDS EXPENDED IN TESTS: 1130  
100  
1230

REMARKS: Retest required on subsequent lot because 1st lot failed specifications. Second sample Acceptable.

\_\_\_\_\_  
 CHIEF BALLISTICIAN TCAAP  
 \_\_\_\_\_  
 CHIEF, GOVERNMENT QA DIVISION  
 27 May 67

Date Presented 3 May 1967  
 Quantity Packed 50  
 National Lot Nos.                       
 NS Code 4030, 20, 0, 27, 0, 20  
 Spec. No.                      Rev. Amend. 2  
 ECO                      Date                       
 Dwg. No. 070523632  
 Rev.                      Date 2-17-65

TWIN CITIES ARMY AMMUNITION PLANT  
 INSPECTION REPORT - 5.56MM  
 ITEM 5.56mm Ball M 193  
 Lot No. TW-18166  
 Accepted  1st Test   
 Rejected  Retest   
 Waiver   
 Acceptance Date 12 May 1967

Contractor: Federal Cartridge Corp.  
 Contract No.                       
 Primer No.                       
 Primer Lot Nos. 1000 1000 1000 1000  
1000 1000 1000  
 Tracer Mix                       
 Igniter Mix                       
 Propellant Type IMR 8208  
 A.L. No. 44936, 44937  
 Chg. (Grs) 25.5 25.7  
 Case - Steel  Brass   
 Headstamp (Yr) 1967  
 Bullet Jacket 3181mg Metal

FIRING TESTS				
	AMB	125°	160°	-65°
CHAMBER PRESSURE (PSI)				
RECORDED	20	10	10	20
MAX	51,300	+3300	+2100	+3000
SD	51,100			
MAX	58,000			
CHAMBER PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	11,170	+330	+550	-750
LIMIT	15,000			
LIMIT	+2,000	+2,000	+2,000	+2,000
VELOCITY @ 15 FT. (FS)				
RDS FIRED	20	10	10	20
RECORD	3222	+53	+2	-117
LIMIT	3250 ± 40	-250	-250	-250
STD DEV	36.7			
LIMIT	40			
ACCURACY (INCHES)		RDS FIRED	RECORD	LIMIT
MEAN RADII @ 200 YDS	90	90	1.09	2.0
ACTION TIME (MS)	50	50	1.05	1.0
FUNCTION & CASUALTY		RDS FIRED	RECORD	LIMIT
RIFLE, 5.56MM, XM16E1	720	720		
CASUALTIES			None	

TRACE			
NO. TRACING @ 500 YDS	NO. BULLET BURSTS	NO. ERRATIC FLIGHTS	NO. MUZZLE FLASHES
WATERPROOF TEST			
NO. TESTED	NO. FAILED	SPEC. LIMIT	
50	0	3	
DESCRIPTION OF DEFECTS			
BULLET EXTRACTION TEST (Lbs.)			
No. Tested	SPEC. MIN.	NO. FAILED	MAX. MIN. MEAN
25	35	0	92 56 69
MERCURIOS NITRATE TEST			
NO. TESTED	NO. FAILED	SPEC. LIMIT	
50	2	100	
BASE CLOSURE SEAL TEST			
NO. TESTED	NO. FAILED	SPEC. LIMIT	
		3	
VISUAL GAGE & WEIGH INSPECTION			
1st SAMPLE	2500	DATE 5-8-67	
2nd SAMPLE			
		CRITICAL	MAJOR MINOR
AQL %		.04	.25 1.50
% DEFECTIVE			.04 .20
DEFECT NO. & DESCRIPTION			
			1/1 2/2
			1/5
TOTAL			1 3
PACKING INSPECTION - CONTAINER CONTENT			
MAJOR		MINOR	
% DEFECTIVE	AQL %	% DEFECTIVE	AQL %
0	1.0	0	2.5
TOTAL AUTHORIZED RDS EXPENDED IN TESTS: 1030			

REMARKS:

OF \_\_\_\_\_  
 J. Anderson      J. W. Mohr  
 CHIEF BALLISTICIAN TCAAP      CHIEF, GOVERNMENT QA DIVISION  
 12 May 67

DATE PRESENTED	4/24/67
QUANTITY PACKED	2,014,320
FSN	1305-926-3930-(A071)
FUNCTIONAL LOT NOS.	
AMCMS CODE	4810.16.0217.2.B1.Fv66
SPEC. NO.	MIL-C-9963D REV. A/2
ICD	DATE 5/5/66
WG. NO.	D10523632
MLV	D DATE 2/17/65

LAKE CITY ARMY AMMUNITION PLANT  
INSPECTION REPORT - 5.56MM

ITEM Ctr., 5.56mm Ball, M193

LOT NO. LC 12177

ACCEPTED  1ST TEST

REJECTED  RETEST

WAIVER

ACCEPTANCE DATE 30 April 67

CONTRACTOR: REM ARMS CO. INC.

CONTRACT NO. DA-49-010-AMC-3(A)

PRIMER NO. 41 MIX FA 956

PRIMER LOT NOS. 10-116 10-117  
10-115 10-114 10-113

TRACER MIX

IGNITER MIX

PROPELLANT TYPE WC 846

A.L. NO. 44660

CHG (GRS) 27.6

CASE- STEEL  BRASS

HEADSTAMP (YR) IC 67

BULLET JACKET Gilding Metal

FIRING TESTS				
	AMB	125°	160°	-65°
CHAMBER PRESSURE (PSI)				
RECORDED	48700	10	10	20
- MAX	52,000	+5,000	+5,000	+5,000
3 SD	54100			
LIMIT - MAX	58,000			
PORT PRESSURE (PSI)				
RDS FIRED	20	10	10	20
RECORD	14400	+455	+195	-230
LIMIT	15,000 ±2,000	±2,000	±2,000	±2,000
VELOCITY @ 15 FT (FS)				
RDS FIRED	20	10	10	20
RECORD	3231	+42	-4	-116
LIMIT	3200±40	-250	-250	-250
STD DEV	33.0			
LIMIT	40			
ACCURACY (INCHES)	RDS FIRED	RECORD	LIMIT	
MEAN RADIUS @ 200 YDS	90	1.60	2.0	
ACTION TIME (MS)	50	1.25	4.0	
FUNCTION & CASUALTY	RDS FIRED	RECORD	LIMIT	
TYPE, 5.56MM, XM16E1	720	OK		
CASUALTIES				
NONE				

TRACE		NO. RDS.	RECORD	LIMIT	
NO. TRACING @ 500 YDS					
NO. BULLET BURSTS					
NO. ERRATIC FLIGHTS					
NO. MUZZLE FLASHES					
WATERPROOF TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
50	0	3			
DESCRIPTION OF DEFECTS					
BULLET EXTRACTION TEST (LBS)					
NO. TESTED	SPEC. MIN.	NO. FAILED	MAX.	MIN.	MEAN
25	35	0	97	50	75
MERCURIUS NITRATE TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
50	0	0			
BASE CLOSURE SEAL TEST					
NO. TESTED	NO. FAILED	SPEC. LIMIT			
		3			
VISUAL GAGE & WEIGH INSPECTION					
1ST SAMPLE	DATE				
2ND SAMPLE	CRITICAL	MAJOR	MINOR		
AQL %	.04	.25	1.50		
% DEFECTIVE					
DEFECT NO. & DESCRIPTION					
SYSTEM EVALUATION					
Contractor Sample	2500	0	0		
Government Sample	2500	3	6		
TOTAL					
PACKING INSPECTION - CONTAINER CONTENT					
MAJOR		MINOR			
% DEFECTIVE	AQL %	% DEFECTIVE	AQL %		
0	1.0	3.13	2.5		
TOTAL AUTHORIZED RDS EXPENDED IN TESTS: 1,105					

REMARKS:

PAGE 1 OF 1

*J. H. ...*  
QUALITY ASSURANCE REPRESENTATIVE





MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel		CASTING NUMBER		MANUFACTURER		MODEL		NUMBER OF ROUNDS		NUMBER		FIRING STATUS (Check One)		DATE OF GAUGING	
Dist. (inches) From		Face of		Meas. indicated in .0001 of an inch.				BORESCOPE REMARKS:		BEFORE		AFTER			
Rear Face of Barrel	Flash Suppressor	LANDS .2190"	Grooves .2235"	Vert.	Hor.	Vert.	Hor.								
20.	1.	+0.0008	+0.0006	+0.0008	+0.0006										
19.70	2.00	6	7	9	10										
18.70	3.00	8	8	12	10										
17.70	4.00	6	7	11	9										
16.70	5.00	7	6	9	11										
15.70	6.00	7	7	10	12										
14.70	7.00	5	6	10	10										
13.70	8.00	5	6	7	9										
12.70	9.00	6	5	6	7										
11.70	10.00	7	5	6	8										
10.70	11.00	4	4	6	7										
9.70	12.00	6	4	7	8										
8.70	13.00	5	6	7	7										
7.70	14.00	6	6	8	7										
6.70	15.00	6	7	7	7										
5.70	16.00	7	8	8	7										
4.70	17.00	8	7	8	7										
3.70	18.00	8	7	8	7										
3.35	18.35	6	8	8	7										
2.85	18.85	8	7	7	9										
2.60	19.10	+0.0009	+0.0008	+0.0005	+0.0005										
<p>BORESCOPE REMARKS:</p> <p>CHAMBER, NOT CHROME PLATED.</p> <p>LIGHT TO MODERATE TOOL MARKS, INCREASING TO HEAVY TOWARD REAR FACE. CIRCUMFERENTIAL TOOL MARKS ON CENTERING SLOPE. LIGHT EDSIN AT FORWARD EDGE OF GAS PORT.</p>															
5.56 MM Barrel		A.F.													
11 SEPT. 1967		BY: WILMOTH BROWN													
		FOR: MR. STALEY													
		PLACE: P.T. DIV.													
		DATE: 9-11-67													
		W.O. 324-455-81													

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel

5.56 MM Barrel	DATE OF GAUGING 8 SEPT. 1967	FIRING STATUS (Check One) BEFORE AFTER	NUMBER 737641	MODEL MIGAI	MANUFACTURER COLT	CASTING NUMBER	PROOF OFFICER 324-955-81 MR. STALEY	Dist. (inches) From		Meas. indicated in .0001 of an inch.			
								Rear Face of Barrel	Face of Flash Suppressor	LANDS .2190"		Grooves .2235"	
										Vert.	Hor.	Vert.	Hor.
								20.	1.	+0.0009	+0.0009	+0.0008	+0.0006
								19.70	2.00	8	9	8	7
								18.70	3.00	4	7	6	9
								17.70	4.00	4	4	7	8
								16.70	5.00	4	4	5	6
								15.70	6.00	4	4	5	4
								14.70	7.00	4	5	4	4
								13.70	8.00	3	5	5	3
								12.70	9.00	6	7	7	6
								11.70	10.00	5	6	7	6
								10.70	11.00	5	6	7	6
								9.70	12.00	5	5	5	5
								8.70	13.00	6	4	5	6
								7.70	14.00	6	6	5	6
								6.70	15.00	7	8	4	6
								5.70	16.00	6	7	4	5
								4.70	17.00	7	6	5	6
								3.70	18.00	7	7	4	6
								3.35	18.35	6	8	7	5
								2.85	18.85	6	7	6	5
								2.60	19.10	+0.0006	+0.0007	+0.0004	+0.0004
BORESCOPE REMARKS:								LIGHT CIRCUMFERENTIAL TOOL MARKS, FROM ORIGIN OF RIFLING THROUGH-OUT BORE. VERY LIGHT METALLIC DEPOSITS THROUGH-OUT BORE. LIGHT EROSION ON FORWARD EDGE OF GAS PORT. CHAMBER NOT CHROME PLATED.					
								B.F.					
								BY: WILMOTH-BROWN					
								FOR: MR. STALEY					
								PLACE: P.T. BV.					
								DATE 8 SEPT. 1967					
								N.O. 324-955-81					

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel		CASTING NUMBER		MANUFACTURER		MODEL		NUMBER OF ROUNDS		FIRING STATUS (Check One)		DATE OF GAUGING	
X		C0L7		PROOF OFFICER 324-955-81 MR. STALEY		B.F. AT A.P.F.				BEFORE		AFTER	
Dist. (inches) From		Meas. indicated in .0001 of an inch.											
Rear Face of Barrel		Face of Flash Suppressor		LANDS .2190"		Grooves .2235"							
				Vert.	Hor.	Vert.	Hor.						
20.	1.	+.0010	+.0010	+.0010	+.0025								
19.70	2.00	9	9	8	10								
18.70	3.00	9	8	9	11								
17.70	4.00	9	7	9	12								
16.70	5.00	7	7	9	10								
15.70	6.00	5	7	8	8								
14.70	7.00	3	6	7	9								
13.70	8.00	4	6	8	7								
12.70	9.00	6	6	6	8								
11.70	10.00	5	6	5	6								
10.70	11.00	6	7	6	5								
9.70	12.00	5	6	5	5								
8.70	13.00	6	7	6	5								
7.70	14.00	6	5	5	5								
6.70	15.00	6	6	5	5								
5.70	16.00	7	7	6	5								
4.70	17.00	8	8	6	5								
3.70	18.00	7	8	5	5								
3.35	18.35	7	8	6	5								
2.85	18.85	7	8	6	6								
2.60	19.10	+.0006	+.0008	+.0007	+.0007								
BORESCOPE REMARKS:										LIGHT CIRCUMFERENTIAL TOOL MARKS AT Muzzle AND HEAVIER, EXTENDING REARWARD. HEAVY SPIRAL TOOL MARKS IN CHAMBER. LIGHT EROSION ON FORWARD EDGE OF GAS PORT. CHAMBER NOT CHROME PLATED			
B.F.													
5.56 MM Barrel		BY: WILMOTH-BROWN		FOR: MR. STALEY		PLACE: P.T. BY.		DATE: 8 SEPT. 1967		N.O.: 324-955-81			
8 SEPT. 1967													

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel		5.56 MM Barrel												
CASTING NUMBER	MANUFACTURER	MODEL	NUMBER OF ROUNDS	FIRING STATUS (Check One)		Dist. (inches) From				Meas. indicated in .0001 of an inch.				
				BEFORE	AFTER	Rear Face of Barrel	Face of Flash Suppressor	LANDS .2190"		Grooves .2235"				
								Vert.	Hor.	Vert.	Hor.			
5.56 MM Barrel	738329	M16A1	B.F. AT A.P.G.				20.	1.	+.0008	+.0009	+.0007	+.0004		
							19.70	2.00	9	9	7	9		
							18.70	3.00	8	7	8	9		
							17.70	4.00	8	6	8	10		
							16.70	5.00	8	7	8	8		
							15.70	6.00	6	7	8	7		
							14.70	7.00	7	6	6	6		
							13.70	8.00	5	6	6	6		
							12.70	9.00	9	7	7	6		
							11.70	10.00	8	7	4	7		
							10.70	11.00	7	8	5	7		
							9.70	12.00	8	7	6	6		
							8.70	13.00	9	8	7	6		
							7.70	14.00	8	6	7	5		
							6.70	15.00	9	7	6	7		
							5.70	16.00	7	9	7	5		
							4.70	17.00	8	9	5	8		
							3.70	18.00	9	7	5	8		
							3.35	18.35	9	9	5	9		
							2.85	18.85	9	7	6	7		
2.60	19.10	+.0010	+.0009	+.0005	+.0004									
BORESCOPE REMARKS:														
LIGHT CIRCUMFERENTIAL TOOL MARKS FROM ORIGIN OF RIFLING THROUGH-OUT BORE, LIGHT EROSION ON FORWARD EDGE OF GAS PORT. CHAMFER NOT CHROME PLATED.														
B.F.														
BY: WILMOTH-BROWN														
FOR: MR. STALEY														
PLACE: P.T. BY.														
DATE: 8 SEPT. 1967														
N.O. 324-955-81														
DATE OF GAUGING		8 SEPT 1967												

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel		CASTING NUMBER		MANUFACTURER		MODEL		NUMBER OF ROUNDS		FIRING STATUS (Check One)		DATE OF GAUGING	
				COLT		M16/M		B.F. AT A.P.G.		BEFORE		AFTER	
				PROOF OFFICER 324-955-81				MR. STALEY				11 SEPT. 1967	
Dist. (inches) From		Face of Flash Suppressor		Meas. indicated in .0001 of an inch.		LANDS .2190"		Grooves .2235"					
Rear Face of Barrel				Vert.		Hor.		Vert.		Hor.			
20.	1.	7.0008	7.0007	7.0008	7.0008								
19.70	2.00	7	7	9	11								
18.70	3.00	8	7	8	9								
17.70	4.00	7	6	11	10								
16.70	5.00	6	4	11	11								
15.70	6.00	4	3	7	11								
14.70	7.00	5	6	6	8								
13.70	8.00	4	4	9	8								
12.70	9.00	5	4	8	9								
11.70	10.00	4	5	6	8								
10.70	11.00	3	4	5	7								
9.70	12.00	4	4	5	6								
8.70	13.00	3	4	4	7								
7.70	14.00	5	4	5	4								
6.70	15.00	4	3	5	6								
5.70	16.00	5	4	6	5								
4.70	17.00	5	5	5	6								
3.70	18.00	6	4	5	6								
3.35	18.35	5	6	5	6								
2.85	18.85	7	6	7	6								
2.60	19.10	7.0007	7.0007	7.0005	7.0005								
BORESCOPE REMARKS:													
CHAMBER NOT CHROME PLATED.													
LIGHT TO MODERATE TOOL MARKS, WITH LIGHT													
METALLIC DEPOSITS THROUGH-OUT BORE. MODERATE													
EROSION AT FORWARD EDGE OF GAS PART.													
BY: A.F. WILMOTH-BROWN													
FOR: MR. STALEY													
PLACE: P.T. BOX													
DATE: 9-11-67													
W.O.: 324-955-81													

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

CASTING NUMBER		MANUFACTURER		MODEL		NUMBER		FIRING STATUS (Check One)		DATE OF GAUGING	
		COLT		M16A1		745214		BEFORE	AFTER	8 SEPT. 1967	
		PROOF OFFICER 324-955-81 MR. STALEY		NUMBER OF ROUNDS B.F. AT A.B.G.							
5.56 MM Barrel											
Dist. (inches) From			Meas. indicated in .0001 of an inch.								
	Rear Face of Barrel	Face of Flash Suppressor	LANDS .2190"		Grooves .2235"						
			Vert.	Hor.	Vert.	Hor.					
	20.	1.	+0.0007	+0.0005	+0.0004	+0.0003					
	19.70	2.00	4	7	6	5					
	18.70	3.00	4	5	6	5					
	17.70	4.00	5	4	5	4					
	16.70	5.00	3	4	3	5					
	15.70	6.00	2	4	3	4					
	14.70	7.00	1	2	2	3					
	13.70	8.00	3	3	2	2					
	12.70	9.00	2	3	4	4					
	11.70	10.00	3	4	2	3					
	10.70	11.00	3	3	2	3					
	9.70	12.00	4	6	3	3					
	8.70	13.00	5	4	3	3					
	7.70	14.00	4	4	3	3					
	6.70	15.00	5	5	3	4					
	5.70	16.00	7	6	4	4					
	4.70	17.00	6	6	4	4					
	3.70	18.00	5	6	3	4					
	3.35	18.35	5	7	4	5					
	2.85	18.85	5	6	4	5					
	2.60	19.10	+0.0006	+0.0005	+0.0003	+0.0003					
BORESCOPE REMARKS:											
LIGHT TOOL MARKS AT MID-BORE BECOMING HEAVIER TOWARD MUZZLE AND CHAMBER. HEAVY TOOL MARKS ON CENTERING SLOPE. LIGHT EBOSIN ON FORWARD EDGE OF GAS PORT. CHAMBER NOT CHROME PLATED.											
B.F.											
BY: WILMOTH-BROWN											
FOR: MR. STALEY											
PLACE: P.T. Bn.											
DATE: 8 SEPT. 1967											
W.O.: 324-955-81											







MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

CASTING NUMBER		MANUFACTURER		MODEL		NUMBER		FIRING STATUS (Check One)		DATE OF GAUGING		5.56 MM Barrel									
												Dist. (inches) From						Meas. indicated in .0001 of an inch.			
PROOF OFFICER 324-955-81 MR. STALEY		COLT		M16A1		762573		B.F. AT A.F.G.		BEFORE		AFTER		Rear Face of Barrel		Face of Flash Suppressor		LANDS .2190"		Grooves .2235"	
														Vert.	Hor.	Vert.	Hor.	Vert.	Hor.		
														20.	1.	7.0010	7.0009	7.0009	7.0008		
														19.70	2.00	10	10	8	11		
														18.70	3.00	8	8	10	8		
														17.70	4.00	8	10	9	9		
														16.70	5.00	9	9	8	9		
														15.70	6.00	9	7	10	7		
														14.70	7.00	8	7	8	7		
														13.70	8.00	6	7	9	8		
														12.70	9.00	5	7	6	8		
														11.70	10.00	4	4	5	7		
														10.70	11.00	5	4	7	7		
														9.70	12.00	6	5	7	6		
														8.70	13.00	4	6	7	6		
														7.70	14.00	5	4	7	7		
														6.70	15.00	5	6	7	8		
														5.70	16.00	5	6	5	8		
														4.70	17.00	5	4	7	8		
														3.70	18.00	5	6	7	7		
														3.35	18.35	5	6	7	7		
														2.85	18.85	6	6	7	6		
														2.60	19.10	7.0005	7.0005	7.0005	7.0004		
														BORESCOPE REMARKS: CHAMBER NOT CHROME PLATED. MODERATE TO HEAVY TOOL MARKS THROUGH-OUT BORE AND CENTERLINE SLOPE. LIGHT COPPERING THROUGH-OUT BORE. MODERATE EROSION AT FORWARD EDGE OF GAS PORT.							
5.56 MM Barrel																					
DATE OF GAUGING 11 SEPT. 1967																					

MULTIPLE STARGAUGING MEASUREMENT & INSPECTION DATA FORM

5.56 MM Barrel		CASTING NUMBER		MANUFACTURER		MODEL		NUMBER OF ROUNDS		FIRING STATUS (Check One)		DATE OF GAUGING	
Dist. (inches) From		Face of Flash		LANDS .2190"		Grooves .2235"		Meas. indicated in .0001 of an inch.		BEFORE		AFTER	
Rear Face of Barrel	Suppressor	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
20.	1.65	+0006"	+0005"	+0006"	+0005"								
19.70	2.00	4	5	6	7								
18.70	3.00	4	4	5	6								
17.70	4.00	4	3	4	5								
16.70	5.00	4	4	4	5								
15.70	6.00	5	5	5	4								
14.70	7.00	3	2	4	5								
13.70	8.00	2	2	4	6								
12.70	9.00	2	3	4	4								
11.70	10.00	4	4	4	4								
10.70	11.00	2	2	4	4								
9.70	12.00	5	4	4	4								
8.70	13.00	2	3	5	4								
7.70	14.00	3	3	5	5								
6.70	15.00	1	2	3	5								
5.70	16.00	1	2	4	4								
4.70	17.00	3	3	4	4								
3.70	18.00	3	3	5	4								
3.35	18.35	3	3	4	4								
2.85	18.85	3	3	4	4								
2.60	19.10	+0003"	+0003"	+0004	+0004								
<p>BORESCOPE REMARKS: <i>Circumferential tool marks extending from straight chamber thru-out bore. This condition more pronounced in grooves.</i></p> <p><i>B.F.</i></p> <p><i>By: OSBORNE &amp; Wilmoth</i></p> <p><i>FOR: GALLEY</i></p> <p><i>AT: B-400</i></p> <p><i>DATE: 21 Sept. 67</i></p> <p><i>G.I.O.: 324-955-81</i></p>													

Individual Port and Chamber Pressure Data

DATE: 22 November

PREVIOUS ROUNDS: 357

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC 12177

Round No.	AMMUNITION TEMPERATURE: +160°F		UNIVERSAL RECEIVER NO: 1			
	Instrumental Velocity at 15 feet	Free Copper Length at 78 feet	Free Copper Length	Compressed Copper Length	Port Pressure	PST
1	3168	3076	4001	3598	403	15200
2	3220	3128	↓	3594	407	15300
3	3192	3105	↓	3582	419	15600
4	3246	3160		3582	419	15600
5	3209	3113		3615	386	14700
6	3207	3120		3583	418	15600
7	3195	3106		3585	416	15500
8	3186	3097		3582	419	15600
9	3161	3072		3583	418	15600
10	3210	3122		3579	422	15700
11	3202	3107		3594	407	15300
12	3226	3134		3593	408	15300
13	3240	3151		3604	397	15000
14	3188	3097		3592	409	15300
15	3168	3083		3589	412	15400
16	3203	3116		3593	408	15300
17	3188	3102		3605	396	15000
18	3224	3136		3596	405	15200
19	3240	3156		3595	406	15300
20	3214	3121		3590	411	15400
Average	3204	3115				15345
Std. Dev.	24	25				250

DATE: 4 December

AMMUNITION: Cartridge 5.56 mm Ball m193 Lot LC 12177

Round No.	AMMUNITION TEMPERATURE: 70°F				PREVIOUS ROUNDS: 1169	
	BARREL NO: 26		UNIVERSAL RECEIVER NO: 1			
	Instrumental Velocity at		Free	Compressed	Port	
	15 feet	78 feet	Copper Length	Copper Length	Pressure	P.S.I.
1	3191	3104	.4003	3706	297	12300
2	3175	3083	↓	3716	287	12000
3	3133	3030	↓	3731	272	11600
4	3193	3106		3751	252	11000
5	3161	3064		3712	291	12100
6	3176	3086		3732	271	11500
7	3195	3106		3710	293	12200
8	3191	3098		3718	285	11900
9	3155	3069		3705	298	12300
10	3148	3049		3741	262	11300
11	3257	3163		3733	270	11500
12	3214	3121		3728	275	11600
13	3190	3102		3742	261	11200
14	3149	3062		3734	269	11500
15	3173	3083		3718	285	11900
16	3165	3075		3731	272	11600
17	3185	3092		3702	301	12400
18	3164	3077		3710	293	12200
19	3212	3129		3716	287	12000
20	3210	3117		3733	270	11500
Average	3182	3091				11780
Std. Dev.	29	30				403

DATE: 1 December

AMMUNITION: Cartridge 556 mm Ball M193 Lot LC 12177

Round No.	Instrumental Velocity at		Free Copper Length	Compressed Copper Length	TEMPERATURE: -65°F	UNIVERSAL RECEIVER NO: 1	PREVIOUS ROUNDS: 798	Port Pressure P.S.I.
	15 feet	70 feet						
1	3132	3041	.4001	3746	255	11100		
2	3099	3008	↓	3733	268	11400		
3	3064	2951	↓	3750	251	10900		
4	3093	2943		3749	252	11000		
5	3122	3026		3727	274	11600		
6	3080	2990		3736	265	11400		
7	3000	2912		3724	277	11700		
8	3206	3111		3726	275	11600		
9	3065	2975		3719	282	11900		
10	3105	2997		3717	284	11900		
11	3106	3011		3728	273	11600		
12	3105	3010		3720	281	11800		
13	3100	3011		3745	256	11100		
14	2995	2929		3732	269	11500		
15	3095	3002		3710	291	12100		
16	3146	3056		3736	265	11400		
17	3061	2971		3737	264	11300		
18	3110	3021		3717	284	11900		
19	3064	2966		3738	263	11300		
20	3006	2913		3718	283	11900		
AVG.	3088	2994				11520		
Std. Dev.	50	50				340		

DATE: 22 November 1967

PREVIOUS ROUNDS: 417

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC 12177

Round No.	AMMUNITION TEMPERATURE: +160°F		UNIVERSAL RECEIVER NO: 1			
	Instrumental velocity at 15 ft	78 ft	Free Copper Length	Compressed Copper Length	Chamber Pressure P.S.I.	
1	3174	3088	4002	3498	509	43500
2	3169	3081		3496	506	43600
3	3182	3096		3480	522	44500
4	3184	3098		3470	532	45000
5	3180	3093		3476	526	44700
6	3220	3130		3471	531	45000
7	3162	3074		3485	517	44200
8	3168	3081		3463	539	45500
9	3195	3111		3463	539	45500
10	3200	3113		3454	548	46000
11	3151	3049		3486	516	44200
12	3191	3042		3518	484	42400
13	3201	3106		3488	514	44000
14	3153	3067		3488	514	44000
15	3144	3052		3500	502	43400
16	3157	3069		3489	513	44000
17	3197	3114		3462	540	45500
18	3169	3084		3481	521	44400
19	3216	3131		3460	542	45700
20	3188	3104		3493	509	43800
Avg.	3178	3089				44445
Std. Dev.	23	25				919

DATE: 2 December

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC12177

AMMUNITION TEMPERATURE: 70°F PREVIOUS ROUNDS: 1003

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free Copper Length	Compressed Copper Length		Chamber Pressure P.S.I.
	15 feet	78 feet				
1	3134	3036	4002	3524	478	42000
2	3191	3088	↓	3454	548	46000
3	3120	3034		3539	463	41200
4	3145	3060		3497	505	43600
5	3169	3078		3500	502	43400
6	3148	3058		3510	492	42800
7	3138	3049		3511	491	42800
8	3096	3003		3525	477	42000
9	3148	3043		3523	479	42100
10	3177	3085		3473	529	44900
11	3190	3098		3465	537	45400
12	3131	3042		3516	486	42500
13	3109	3017		3499	503	43500
14	3114	3026		3529	473	44900
15	3145	3056		3494	508	43700
16	3119	3025		3524	478	42000
17	3168	3078		3490	512	43900
18	3149	3058		3504	498	43200
19	3100	3003		3530	472	41700
20	3129	3030		3512	490	42700
Avg.	3141	3048				43215
Std. Dev.	28	28				1304

DATE: 29 November

AMMUNITION: Cartridge 5.56 MM Ball M193 Lot LC 12177

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 608

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round no	Instrumental Velocity at		Free Copper Length	Compressed Copper Length		Chamber Pressure P.S.I.
	15 feet	78 feet				
1	3111	3023	.4003	.3514	489	42600
2	3065	2978	↓	3550	453	40600
3	3072	2987		3546	457	40900
4	3020	2933		3581	422	38800
5	3010	2919		3577	426	39000
6	3196	3045		3422	581	47800
7	3084	2992		3509	499	43000
8	3093	3004		3505	498	43200
9	3052	2962		3529	474	41800
10	3028	2934		3570	433	39400
11	3082	2996		3528	475	41900
12	3082	2993		3533	470	41600
13	3075	2984		3535	468	41500
14	3039	2947		3559	444	40100
15	3076	2980		3521	482	42300
16	3090	2945		3568	435	39500
17	3080	2981		3518	485	42400
18	3119	3025		3477	526	44700
19	3034	2941		3569	434	39500
20	3008	2914		3603	400	37400

Avg.  
Std. Dev.

3066  
37

2974  
36

41400  
2336

DATE: 22 november

PREVIOUS ROUNDS: 337

AMMUNITION: Cartridge 556 MM Ball M193 LOT TW18166

Round no.	AMMUNITION TEMPERATURE: +160° F		UNIVERSAL RECEIVER NO: 1			
	Instrumental Velocity at 15 feet	Free copper 78 feet Length	Compass Copper Length	Port Pressure P.S.I.		
1	3183	3090	4002	3643	359	14000
2	3249	3160	↓	3644	358	14000
3	3289	3201	↓	3676	326	13100
4	3265	3179		3629	373	14400
5	3244	3148		3664	338	13400
6	3227	3137		3647	355	13900
7	3278	3193		3659	343	13600
8	3244	3154		3640	362	14100
9	3258	3170		3640	362	14100
10	3203	3115		3643	359	14000
11	3225	3141		3649	353	13800
12	3261	3173		3647	355	13900
13	3205	3110		3630	372	14400
14	3238	3139		3627	375	14400
15	3249	3159		3651	351	13800
16	3233	3142		3627	375	14400
17	3259	3161		3643	359	14400
18	3270	3183		3630	372	14400
19	3250	3165		3620	382	14600
20	3237	3153		3630	372	14400
Average	3243	3154				14055
Std. Dev.	26	28				389

DATE: 4 December

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot TW 18166

Round no	AMMUNITION TEMPERATURE: 70°F				PREVIOUS ROUNDS: 114.9	
	BARREL NO: 26		UNIVERSAL		RECEIVER NO: 1	
	Instrumental velocity at	Free copper length	Compressed copper length	Port Pressure P.S.I.		
	15 feet	70 feet				
1	3169	3081	.4003	3728	275	11600
2	3165	3071	↓	3718	285	11900
3	3149	3060	↓	3724	279	11800
4	3158	3064		3710	293	12200
5	3165	3075		3722	281	11800
6	3201	3111		3702	301	12400
7	3167	3073		3733	270	11500
8	3166	3075		3724	279	11800
9	3151	3058		3740	263	11300
10	3156	3064		3739	264	11300
11	3194	3086		3721	282	11900
12	3197	3104		3738	265	11400
13	3189	3094		3740	263	11300
14	3213	3115		3711	292	12100
15	3160	3058		3704	299	12300
16	3190	3092		3765	238	10500
17	3181	3088		3726	277	11700
18	3171	3075		3745	258	11100
19	3196	3108		3730	273	11600
20	3152	3054		3732	271	11500
Average	3175	3080				11650
Std. Dev.	19	19				447

DATE: 1 December

AMMUNITION: Cartridge 556 mm Ball M193 Lot TW 18166

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 778

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental Velocity at		Free Copper Length	Compressed Copper Length		Port Pressure P.S.I.
	15 feet	70 feet				
1	3041	2951	4001	3682	319	12900
2	---	3009	↓	3684	317	12900
3	3102	3003	↓	3672	329	13200
4	3088	2997		3680	321	13000
5	3080	2982		3680	321	13000
6	3069	2980		3664	337	13400
7	3024	2932		3680	321	13000
8	3100	3010		3703	298	12300
9	3081	2986		3681	310	12700
10	3026	2935		3693	308	12600
11	3085	3000		3697	304	12500
12	3066	2980		3695	306	12500
13	3023	2932		3706	295	12200
14	3013	2928		3710	291	12100
15	3056	2970		3707	294	12200
16	3107	3018		3712	289	12100
17	3085	2992		3709	292	12100
18	3041	2947		3718	283	11900
19	3108	3019		3713	288	12000
20	3036	2947		3723	278	11700

AVG. 3065 2976  
Std. Dev. 31 31

12575  
479

DATE: 22 November 1967

PREVIOUS ROUNDS: 397

AMMUNITION: Cartridge 556 mm Ball M193 Lot TW 18166

Round No.	AMMUNITION TEMPERATURE: $+160^{\circ}\text{F}$		UNIVERSAL		RECEIVER NO: 1	
	Instrumental Velocity at 15ft	at 78ft	Free Copper Length	Compressed Copper Length	Exhauster Pressure P.S.I.	
1	3198	3098	4003	3348	655	51700
2	3191	3097	↓	3329	674	52700
3	3224	3121		3328	675	52800
4	3197	3103		3364	639	50900
5	3236	3138		3345	658	51900
6	3216	3121		3344	659	51900
7	3236	3151		3340	663	52200
8	3236	3144		3379	624	50100
9	3238	3142		3337	666	52300
10	3215	3124		3412	591	48300
11	3249	3162		3346	657	51800
12	3231	3137		3346	657	51800
13	3205	3097		3377	626	50200
14	3225	3128		3367	636	50700
15	3208	3117		3437	566	47000
16	3220	3127		3394	609	49300
17	3239	3146		3320	683	53200
18	3224	3123		3316	687	53400
19	3236	3149		3373	630	50400
20	3246	3147		3344	659	51900
Ava.	3223	3129				51225
Std Dev.	17	19				1641

DATE: 2 December

AMMUNITION: Cartridge 5.56mm Ball M193 Lot TW 18166

Round No.	AMMUNITION TEMPERATURE: 70°		PREVIOUS ROUNDS: 983			
	BARREL NO: 26		UNIVERSAL RECEIVER NO: 1			
	Instrumental Velocity at 15 feet	Free Copper 78 feet length	Compressed Copper length	Universal Receiver chamber Pressure PSI		
1	3104	3002	4002	3457	545	45800
2	3142	3042	↓	3409	593	48400
3	3110	3015	↓	3433	569	47200
4	3124	3033		3391	611	49400
5	3137	3051		3352	650	51400
6	3106	3010		3427	575	47500
7	3098	2995		3423	579	47700
8	3129	3035		3403	599	48800
9	3115	3026		3414	588	48200
10	3116	3030		3420	582	47900
11	3112	3019		3396	606	49100
12	3111	3016		3414	588	48200
13	3116	3018		3403	599	48800
14	3114	3010		3425	577	47600
15	3139	3046		3364	638	50800
16	3131	3039		3380	622	50000
17	3113	3020		3412	590	48300
18	3114	3018		3399	603	49000
19	3118	3028		3413	589	48200
20	3131	3044		3393	609	49300
AVG.	3119	3025				48580
Std. Dev.	12	15				1260



DATE: 20 November PREVIOUS ROUNDS: 237  
 AMMUNITION: Cartridge 5.56 mm Tracer m196 Lot LC 12001  
 AMMUNITION TEMPERATURE: +160°F  
 BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free Copper Length	Compressed Copper Length	Port Pressure	
	15 ft	78 ft				P.S.I.
1	3209	3114	4002	3645	357	14000
2	3163	3065	↓	3648	354	13900
3	3155	3059		3633	369	14300
4	3139	3062		3636	366	14200
5	3155	3049		3667	335	13400
6	3104	3013		3650	352	13800
7	3190	3087		3668	334	13300
8	3147	3050		3660	342	13500
9	3124	3025		3650	352	14200
10	3146	3055		3660	342	13500
11	3095	2997		3681	321	13000
12	3126	3067		3666	336	13400
13	3123	3015		3657	345	13600
14	3066	3021		3673	329	13200
15	3166	3109		3664	338	13400
16	3158	3076		3660	342	13500
17	3120	3064		3667	335	13400
18	3174	3080		3659	343	13600
19	3157	3063		3662	340	13500
20	3157	3058		3668	334	13300

19. 3144 3056 13600  
 18. 33 31 355

DATE: 4 December  
 AMMUNITION: Cartridge 5.56mm Tracer M196 Lot LC 12081  
 AMMUNITION TEMPERATURE: 70°F PREVIOUS ROUNDS: 1048  
 BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free copper length	Compressed copper length	port pressure	P.S.I.
	15 ft	78 feet				
1	3201	3095	4003	3691	312	12700
2	3137	3031	↓	3691	312	12700
3	3172	3075	↓	3701	302	12400
4	3187	3085	↓	3714	289	12100
5	3185	3087		3697	306	12500
6	3172	3108		3703	300	12400
7	3157	3059		3705	298	12300
8	3120	3018		3695	308	12600
9	3165	3077		3692	311	12700
10	3142	3045		3695	308	12600
11	3125	3023		3686	317	12900
12	3121	3029		3690	313	12700
13	3151	3061		3718	285	11900
14	3166	3105		3716	287	12000
15	3201	3104		3716	287	12000
16	3202	3104		3718	285	11900
17	3193	3085		3707	296	12300
18	3131	3014		3702	301	12400
19	3140	3042		3708	295	12200
20	3130	3047		3690	313	12700

Avg. 3160 3065  
 Std. Dev. 28 32

12400  
 304

DATE: 30 November

AMMUNITION: Cartridge 5.56 mm Tracer M196 Lot LC 12081 (8)

AMMUNITION TEMPERATURE: -65°F

PREVIOUS ROUNDS: 653

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round	Instrumental Velocity at 15 feet	Free Copper 78 feet length	Compressed Copper length	Port Pressure P.S.I.
1	3187	3084	4002	359 14000
2	3032	2934	↓	316 12800
3	3088	2989	↓	334 13300
4	3078	2992		323 13000
5	3092	2995		334 13300
6	3092	2992		314 12800
7	3082	2998		334 13300
8	3064	2983		338 13400
9	3008	2914		336 13400
10	3072	2975		322 13300
11	3046	2951		318 12900
12	3093	2990		329 13200
13	3063	2968		335 13400
14	3020	2932		308 12600
15	3091	3003		334 13300
16	3023	2913		329 13200
17	3077	2991		322 13300
18	3022	2931		325 13100
19	3070	2979		318 12900
20	3040	2954		309 12600

AVG. 3067 2973  
Std. Dev 40 39

13155  
328

DATE: 21 November

PREVIOUS ROUNDS: 131

AMMUNITION; Cartridge, 5.56 mm. TRACER, M196 Lot ~~16-12194~~ LC 12081

AMMUNITION; TEMPERATURE: +160°F

BARREL NO; 26

UNIVERSAL RECEIVER NO; 1

und No	Instrumental Velocity at		Free Copper length	Compressed Copper length	Pressure	Chamber Pressure P.S.I.
	15 ft	78 ft				
1	3153	3060	4003 ↓	3418	585	48000
2	3108	3024		3444	559	46700
3	3160	3065		3393	610	49300
4	3160	3067		3395	608	49200
5	3171	3068		3372	631	50400
6	3137	3040		3416	587	48100
7	3118	3012		3445	558	46600
8	3108	3021		3420	583	47900
9	3111	3016		3400	603	49000
10	3094	3002		3420	583	47900
11	3136	3037		3418	585	48000
12	3092	2992		3456	547	45900
13	3161	3062		3380	623	50000
14	3039	2961		3441	562	46800
15	3102	3002		3439	564	46900
16	3104	3027		3429	574	47400
17	3142	3040		3409	594	48500
18	3096	3000		3454	549	46000
19	3116	3014		3433	570	47200
20	3156	3061		3354	649	51400
avg	3123	3029				18060 ✓
1. Dev	33	30				1476

DATE: 2 December

AMMUNITION; Cartridge 5.56 MM Tracer M196 Lot LC 12081

AMMUNITION TEMPERATURE: 70°F PREVIOUS ROUNDS: 803

BARREL NO; 26 UNIVERSAL RECEIVER NO; 1

wind no.	Velocity at		Copper		Chamber Pressure PSI	
	15 feet	70 feet	Free length	Compressed length		
1	3090	3029	4003	3503	500	43300
2	3133	3045	↓	3487	516	44200
3	3138	3033	↓	3467	536	45300
4	3120	3027		3492	511	43900
5	3119	3014		3489	514	44000
6	3111	3009		3500	503	43500
7	3088	2985		3502	501	43400
8	3112	3007		3464	539	45500
9	3135	3034		3471	532	45000
10	3073	2979		3510	493	42900
11	3125	3048		3480	523	44500
12	3091	2992		3489	514	44000
13	3076	2977		3520	483	42300
14	3074	3004		3504	499	43300
15	3124	3036		3464	539	45500
16	3059	2972		3521	482	42300
17	3085	2995		3503	500	43300
18	3120	3013		3473	530	44900
19	3114	3014		3495	508	43700
20	3092	2988		3486	517	44200

AVG. 3104 3010 43950  
1. Dev. 24 23 958

DATE: 28 November

AMMUNITION; Cartridge 5.56 mm Tracer m196 Lot LC 12081

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 462

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at 15 feet	Free copper 78 feet length	Compressed copper length	Chamber Pressure P.S.I.
1	3022	2925	.4003	3548 455 40800
2	2983	2888	↓	3554 449 40400
3	2981	2877		3544 459 41000
4	3037	2942		3453 550 46100
5	2992	2936		3488 515 44100
6	3013	2910		3501 502 43400
7	2954	2860		3567 436 39600
8	2957	2864		3568 435 39500
9	3018	2919		3480 523 44500
10	3009	2925		3430 573 47400
11	2999	2900		3557 446 40200
12	3023	2930		3523 480 42100
13	3074	2975		3402 601 48900
14	3031	2947		3474 529 44900
15	3051	2956		3537 466 41400
16	3065	2980		3480 523 44500
17	3030	2936		3529 474 41800
18	3015	2919		3523 480 42100
19	3044	2949		3483 520 44400
20	3032	2940		3516 487 42500

Avg. 3016 2924  
Std. Dev. 32 33

42920  
2599

DATE: 22 November

PREVIOUS ROUNDS: 317

AMMUNITION: Cartridge 556 mm Tracer M196 Lot TW 18001

AMMUNITION TEMPERATURE: +160°F

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round no.	Instrumental Velocity at 15 feet	Free copper Length at 78 feet	Free copper Length	Compressed Copper Length	Port Pressure P.S.I.
1	3220	3137	4002	3624	378 14500
2	3225	3140	↓	3629	373 14400
3	3199	3090	↓	3623	379 14500
4	3234	3135		3625	377 14500
5	3243	3146		3629	373 14400
6	3229	3138		3625	377 14500
7	3218	3120		3629	373 14400
8	3228	3138		3620	382 14600
9	3189	3097		3625	377 14500
10	3193	3115		3643	359 14000
11	3273	3180		3637	365 14200
12	3214	3108		3634	368 14300
13	3198	3120		3639	363 14100
14	3224	3130		3650	352 13800
15	3230	3145		3653	349 13700
16	3218	3113		3636	366 14200
17	3238	3149		3650	352 13800
18	3221	3141		3649	353 13800
19	3230	3132		3652	350 13800
20	3171	3081		3649	353 13800

Average  
Std. Dev.

3220 3128  
22 23

14190  
311

DATE: 4 December

AMMUNITION: Cartridge 5.56 mm Tracer M196 Lot TW 18001

Round no.	AMMUNITION TEMPERATURE: 70°F		PREVIOUS ROUNDS: 1129			
	Instrumental velocity at 15 feet	Free copper Length	Compressed copper Length	Part Pressure P.S.I.	UNIVERSAL RECEIVER NO: 1	
1	3130	3036	.4002	3726	276	11700
2	3177	3075	↓	3713	289	12100
3	3163	3001	↓	3720	282	11900
4	3135	3045		3729	273	11600
5	3175	3069		3733	269	11500
6	3147	3049		3736	266	11400
7	3190	3096		3727	275	11600
8	3156	3060		3743	259	11200
9	3136	3047		3745	257	11100
10	3120	3027		3719	283	11900
11	3175	3073		3726	276	11700
12	3176	3106		3737	265	11400
13	3190	3088		3722	280	11800
14	3129	3043		3742	260	11200
15	3156	3085		3729	273	11600
16	3181	3083		3751	251	10900
17	3164	3054		3737	265	11400
18	3163	3064		3757	245	11100
19	3153	3054		3739	263	11300
20	3108	3012		3737	265	10900
AVG.	3153	3058				11465
Std. Dev.	26	27				336

DATE: 1 December

AMMUNITION: Cartridge 556 mm Trauer m196 Lot TW18001

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 758

BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round NO	Instrumental Velocity at		Free Copper Length	Compressed Copper Length	Port Pressure P.S.I.	
	15 feet	70 feet				
1	3001	2940	.4002	.3735	267	11400
2	3047	2948	↓	3732	270	11500
3	3051	2963		3738	264	11300
4	3090	2996		3727	275	11600
5	3051	2951		3748	254	11000
6	3032	2928		3743	259	11200
7	2993	2896		3738	264	11300
8	3053	2949		3766	236	10500
9	3085	2978		3752	250	10900
10	3053	2957		3774	228	10200
11	3105	3002		3763	239	10600
12	3034	2941		3766	236	10500
13	3086	2995		3763	239	10600
14	3058	2956		3758	244	10700
15	3053	2952		3758	244	10700
16	3109	3018		3756	246	10800
17	3079	2977		3746	256	11100
18	3098	2998		3770	232	10400
19	3053	2948		3773	229	10300
20	3054	2943		3750	252	11000
AVG. 3059 2962						
Std. Dev 31 29						
10880						
419						

DATE: 22 November

PREVIOUS ROUNDS: 377

AMMUNITION: Cartridge 5.56 mm Tracer M196<sup>10T</sup> TW 18001

Round No.	AMMUNITION TEMPERATURE: +160°F		UNIVERSAL		RECEIVER NO: 1	Chamber Pressure P.S.I.
	Barrel No: 26	Instrumental Velocity at	Free Copper Length	Compressed Copper Length		
	15ft	78ft				
1	3232	3132	.4002	3352	650	51400
2	3216	3130	↓	3387	615	49600
3	3215	3114		3406	596	48600
4	3224	3120		3342	660	52000
5	3198	3109		3379	623	50000
6	3222	3124		3376	626	50200
7	3134	3022		3438	584	46900
8	3218	3128		3355	647	51300
9	3199	3101		3372	630	50400
10	3183	3080		3363	639	50900
11	3182	3097		3394	608	49200
12	3201	3094		3357	645	51200
13	3196	3094		3375	627	50200
14	3198	3104		3363	639	50900
15	3160	3081		3436	566	47000
16	3211	3113		3365	637	50800
17	3220	3116		3361	641	51000
18	3222	3119		3358	644	51100
19	3169	3071		3408	594	48500
20	3179	3086		3421	581	47800
Avg.	3199	3102				49950
Std. Dev	25	26				1490

DATE: 2 December

AMMUNITION: Cartridge 5.56 mm Tracer M196 Lot TW 18001

Round No.	AMMUNITION TEMPERATURE: 70°F		PREVIOUS ROUNDS: 963			
	BARREL NO: 26		UNIVERSAL RECEIVER NO: 1			
	Instrumental Velocity at 15 feet	Free Copper Length 78 feet	Compressed Copper Length	Chamber Pressure P.S.I.		
1	3098	2991	4004	3383	621	49900
2	3129	3030	↓	3420	584	48000
3	3089	2999		3473	531	45000
4	3099	3010		3462	542	45700
5	3139	3047		3398	606	49100
6	3144	3054		3395	609	49300
7	3095	3008		3452	552	46200
8	3119	3031		3470	534	45200
9	3087	2989		3434	570	47200
10	3095	2990		3463	541	45600
11	3132	3036		3397	607	49200
12	3072	2983		3468	536	45300
13	3132	3026		3381	623	50000
14	3076	3024		3437	567	47100
15	3092	3001		3466	538	45400
16	3100	2991		3434	570	47200
17	3101	3031		3427	577	47600
18	3112	3006		3487	517	44200
19	3119	3018		3439	565	47000
20	3105	3006		3440	564	46900
Avg.	3107	3014				47055
Std. Dev.	21	21				1750

DATE: 29 November

AMMUNITION: Cartridge 5.56 mm Tracer M196 Lot TW 18001

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 568  
 BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round no	Instrumental Velocity at		Free Copper Length	Compressed Copper Length		Chamber Pressure P.S.I.
	15 feet	78 feet				
1	2972	2863	4002	3537	465	41300
2	2996	2896	↓	3480	522	44500
3	2980	2876		3497	505	43600
4	3069	2975		3356	646	51200
5	2997	2901		3478	524	44600
6	2978	2883		3505	497	43200
7	2970	2870		3515	487	42500
8	3049	2963		3371	631	50400
9	2997	2928		3430	572	47300
10	2998	2911		3456	546	45900
11	2994	2909		3435	567	47100
12	2994	2906		3446	556	46500
13	3015	2906		3476	526	44700
14	2970	2885		3529	473	41800
15	2974	2868		3519	483	42300
16	3023	2920		3474	528	44800
17	2959	2844		3505	497	43200
18	3042	2934		3396	606	49100
19	2976	2876		3505	497	43200
20	2981	2882		3496	506	43600
	2997	2900				45040
Std. Dev	29	33				2798

DATE: 29 November

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC-Y-5.56-501

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 548

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round	Instrumental velocity at 15 feet	Free copper 28 feet length	Compressed copper length	Chamber Pressure PSI
1	3140	3050	.4005	3396 609 49300
2	3091	2999	↓	3456 549 46000
3	3019	2932	↓	3562 543 45700
4	3083	2992		3484 521 44400
5	2985	2899		3589 416 38500
6	3109	3018		3403 602 48900
7	3049	2950		3472 533 45100
8	3095	3000		3463 542 45700
9	2976	2885		3593 412 38200
10	3060	2968		3495 510 43800
11	3048	2969		3505 500 43300
12	3004	2910		3532 473 41800
13	3108	3021		3367 638 50800
14	3082	2993		3493 512 43900
15	3094	3005		3458 547 45900
16	3068	2966		3487 518 44300
17	3130	3032		3416 589 48200
18	3102	3007		3439 566 47000
19	3043	2953		3543 462 41200
20	2963	2882		3626 379 36200

ava. 3062 2972  
H. Dev. 51 49

44410  
3800

DATE: 21 NOVEMBER PREVIOUS ROUNDS: 111

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC-Y-5.56-501

AMMUNITION TEMPERATURE: +160°F

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Shot No.	Instrumental Velocity at		Free Copper Length	Compressed Copper Length	Pressure	Chamber Pressure P.S.I.
	15 ft	28 ft				
1	3191	3092	4004 ↓	3450	554	46300
2	3189	3095		3432	572	47300
3	3255	3148		3315	689	53500
4	3194	3086		3456	548	46000
5	3128	3030		3423	581	47800
6	3209	3116		3445	559	46700
7	3160	3068		3458	546	45900
8	3189	3097		3416	588	48200
9	3203	3112		3435	569	47200
10	3168	3069		3476	528	44800
11	3176	3085		3462	542	45700
12	3183	3086		3440	564	46900
13	3259	3163		3293	711	54600
14	3286	3107		3457	547	45900
15	3155	3071		3488	516	44200
16	3174	3077		3429	575	47500
17	3212	3113		3358	646	51200
18	3189	3101		3443	561	46800
19	3164	3070		3465	539	45500
20	3220	3123		3398	606	49100
avg	3191	3095				47555
s.d.	31	30				2705

DATE: 22 November

PREVIOUS ROUNDS: 217

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC-V-5.56-501

AMMUNITION TEMPERATURE: +160°F

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free Copper Length	Compressed Copper Length		Port Pressure P.S.I.
	15 ft	78 ft				
1	3202	3113	4002	3610	392	14900
2	3187	3099	↓	3596	406	15300
3	3184	3092		3592	410	15400
4	3180	3096		3589	413	15400
5	3251	3143		3594	408	15300
6	3209	3120		3599	403	15200
7	3121	2924		3550	452	16400
8	3165	3073		3606	396	15000
9	3208	3120		3609	398	15000
10	3199	3116		3613	389	14800
11	3179	3077		3606	396	15000
12	3137	3046		3622	380	14600
13	3188	3100		3605	397	15000
14	3215	3119		3614	388	14800
15	3181	3090		3618	384	14700
16	3184	3093		3613	389	14800
17	3198	3100		3605	397	15000
18	3163	3077		3625	377	14500
19	3213	3113		3604	398	15000
20	3210	3109		3607	395	15000

16. 3189 3091  
 18. Dev 29 45

15055  
 402

DATE: 28 November

AMMUNITION; Cartridge 5.56 mm Ball M193 Lot LC-Y-5.56-501

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 442

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free	compressed		Chamber Pressure P.S.I.
	15 feet	78 feet	copper Length	copper Length		
1	3103	3012	4003	3449	554	46300
2	3064	2975	↓	3524	479	42100
3	3077	2994	↓	3485	518	44300
4	3057	2972		3455	548	46000
5	3018	2932		3582	421	38800
6	3050	2965		3515	488	42600
7	3057	2967		3502	501	43400
8	3102	3016		3425	578	47700
9	3092	3004		3469	534	45200
10	2983	2889		3543	460	41000
11	3034	2952		3504	499	43300
12	3098	2960		3523	480	42100
13	3009	2926		3578	425	39000
14	3051	2947		3591	462	41200
15	3073	2979		3481	522	44500
16	3028	2937		3519	484	42400
17	3090	3000		3486	517	44200
18	3046	2963		3508	495	43000
19	3021	2927		3493	510	43800
20	3092	3007		3468	535	45200

Avg. 3055 2966  
H. Dev. 33 34

43305  
2284

DATE: 30 November

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot-LC-Y-5.56-501

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 633

BARREL NO. 26

UNIVERSAL RECEIVER NO. 1

Round No.	Instrumental Velocity at		Free	Compressed		Part Pressure P.S.F.
	15 feet	78 feet	Copper Length	Copper Length		
1	3116	3021	.4002	3610	392	14900
2	3057	2975	↓	3614	388	14800
3	3065	2964		3629	373	14400
4	3094	2999		3658	344	13600
5	3014	2929		3639	363	14100
6	3086	3004		3639	363	14100
7	3029	2941	3642	360	14000	
8	3031	2948	3630	372	14400	
9	3099	3009	3628	374	14400	
10	3052	2958	3626	376	14500	
11	3174	3081	3636	366	14200	
12	3097	3012	3628	374	14400	
13	3087	3002	3630	372	14400	
14	3082	2992	3618	384	14700	
15	3163	3075	3621	381	14600	
16	3047	2954	3617	385	14700	
17	3098	3009	3625	377	14500	
18	3111	3024	3617	385	14700	
19	3053	2969	3636	366	14200	
20	3130	3037	3618	384	14700	

average  
6.121 3084 2995  
42 42

14415  
315

DATE: 1 December

AMMUNITION: Cartridge 5.56mm Ball 11193 Lot-LC-Y-5.56-501

AMMUNITION TEMPERATURE: -65°F PREVIOUS ROUNDS: 738

BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round NO.	Instrumental Velocity at 15 feet	Free Copper 78 feet Length	Compressed Copper Length	port Pressure P.S.I.		
1	3061	2955	4003	332	13300	
2	3061	2986	↓	3674	329	13200
3	3115	3028	↓	3694	309	12600
4	3124	3035		3692	311	12700
5	3113	3023		3673	330	13200
6	3104	3005		3696	307	12600
7	3127	3023		3694	309	12600
8	3039	2947		3686	317	12900
9	3058	2974		3695	308	12600
10	3189	3097		3701	302	12400
11	3085	2998		3701	302	12400
12	3085	2998		3693	310	12700
13	3055	2962		3688	315	12800
14	3116	3026		3697	306	12500
15	3123	3026		3678	325	13100
16	3065	2967		3691	312	12700
17	3059	2971		3682	321	13000
18	3027	2936		3682	321	13000
19	3074	2986		3692	311	12700
20	3000	2934		3698	305	12500

Avg, 3084 2994  
s. Dev 43 40

12775  
275

DATE: 2 December

AMMUNITION: Cartridge 5.56 mm Ball M193 Lot LC-Y-5.56-501

AMMUNITION TEMPERATURE: 70°F PREVIOUS ROUNDS: 863

BARREL NO: 26

UNIVERSAL RECEIVER NO: 1

Wind No.	Instrumental velocity at 15 feet	Free Copper Length	Compressed Copper Length		Chamber Pressure P.S.I.	
1	3216	3125	4004	3469	535	45200
2	3157	3071	↓	3500	504	43500
3	3126	3038	↓	3510	494	43000
4	3110	3018		3543	461	41000
5	3213	3128		3403	601	48900
6	3153	3062		3519	485	42400
7	3109	3018		3563	441	39900
8	3108	3022		3543	461	41000
9	3077	2979		3567	437	39700
10	3126	3035		3514	490	42700
11	3131	3030		3515	489	42600
12	3097	3013		3583	421	38800
13	3192	3096		3441	563	46900
14	3090	2998		3562	492	40000
15	3093	3002		3562	442	40000
16	3189	3102		3457	547	45900
17	3089	3002		3568	436	39600
18	3156	3070		3498	506	43600
19	3193	3100		3431	573	47400
20	3164	3079		3518	486	42500

Avg. 3139      3049      42730  
 Std. Dev. 44      45      2887

DATE: 4 December

AMMUNITION: cartridge 5.56 MM Ball 11193 Lot LC-Y-5,56-501

AMMUNITION TEMPERATURE: 70°F PREVIOUS ROUNDS: 1028

BARREL NO: 26 UNIVERSAL RECEIVER NO: 1

Round No.	Instrumental velocity at		Free Copper Length	Compressed Copper Length		Port Pressure PSI
	15 feet	78 feet				
1	3215	3125	.4002	3654	348	13700
2	3208	3115	↓	3643	359	14000
3	3225	3136	↓	3654	348	13700
4	3176	3092		3653	349	13700
5	3165	3082		3661	341	13500
6	3154	3066		3647	355	13900
7	3169	3079		3664	338	13400
8	3178	3083		3655	347	13700
9	3201	3107		3660	342	13500
10	3208	3124		3657	345	13600
11	3219	3134		3651	351	13800
12	3195	3111		3665	337	13400
13	3212	3131		3650	352	13800
14	3151	3061		3660	342	13500
15	3208	3117		3663	339	13500
16	3227	3142		3663	339	13500
17	3175	3080		3643	359	14000
18	3189	3096		3636	366	14200
19	3194	3101		3634	368	14300
20	3220	3128		3653	349	13700

AVG. 3194 3165  
Std. Dev. 24 25

13720  
255

Table I. Malfunctions and unserviceable parts

Malfunctions <sup>1</sup>	Number permitted in the 6,000-round reliability test	
	First 3,000 rounds	Second 3,000 rounds
Failure of forward assist assembly to assist bolt closure (XM16E1 only)		0 (See note 2)
Failure of bolt to lock		3
Failure of bolt stop to hold bolt open (last round of each magazine)		3
Failure to eject cartridge case		4
Failure to feed (cartridge visible)		4
Failure to feed (cartridge not visible)		3
Failure to fire semiautomatic (single rounds)		3
Light blow		3
Other malfunctions		1
Total malfunctions - above malfunctions combined		11
Unserviceable parts <sup>1</sup>	Number permitted in the 6,000-round reliability test	
	First 3,000 rounds	Second 3,000 rounds
Magazine assembly	0	1
Ejector spring	0	1
Extractor	0	1
Extractor spring	0	2
Other parts <sup>2</sup>	0	1
Total unserviceable parts - above unserviceable parts combined	0	3

<sup>1</sup>When malfunctions are traceable to particular parts, it is permissible to replace such parts and record them as unserviceable, subject to limitations of table I. When it is definitely established by the Government representative that previously recorded malfunctions are attributable to an unserviceable part, such malfunctions shall not be counted against the rifle being tested, provided that they occurred not more than 200 rounds prior to replacement of the unserviceable part. These 200 rounds shall have been fired with the unserviceable part. However, such malfunctions shall remain recorded and properly identified. An unserviceable part is one that causes malfunctions or impairs the safety of the weapon. Malfunctions attributable to ammunition shall not be counted against the rifle however, such malfunctions shall be recorded.

<sup>2</sup>In the event of any failure of bolt to lock, the forward assist assembly shall be operated. Failure of the forward assist assembly to remain engaged with the bolt carrier assembly during manual attempt to lock the bolt shall be counted as a failure of forward assist assembly to assist bolt closure malfunction. All failures of bolt to lock shall be counted as malfunctions.

<sup>3</sup>One unserviceable part other than those specified shall be allowed if in the judgment of the Government representative the failure does not represent an unsafe or defective condition which is prevalent throughout the lot of items involved.

COPY/vu

APPENDIX II - CORRESPONDENCE

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

S - 24 Jul 1967

AMSTE-BC

26 JUN 1967

SUBJECT: Test Directive for Product Improvement of Redesigned Buffer  
for M16A1 Rifle, USATECOM Project No. 8-7-0230-04

TO: Commanding Officer  
Aberdeen Proving Ground  
ATTN: STEAP-CO-P  
Aberdeen Proving Ground, Maryland 21005

1. Reference letter, AMSTE-BC, dated 26 Apr 67, subject: Concurrent Tests of Quality Assurance (Inspection and Comparison) and Product Improvement Test of Redesigned Buffer for M16A1 Rifles, USATECOM Project No. 8-7-0230-03, with 1st Indorsement, AMSWE-QA, dated 17 May 67.

2. After review of the various M16A1 Rifle tests being conducted by this command, it is considered inadvisable to conduct concurrent tests of the buffer assembly with any of the present tests. Independent tests will permit a comprehensive evaluation of the buffer assembly without jeopardizing the objectives of other tests.

3. The objectives of this test are:

a. To compare cyclic rates of fire using the old and new buffers.

b. To compare the bolt rebound upon closing using the old and new buffers.

4. Commanding Officer, Aberdeen Proving Ground is directed to conduct an independent product improvement test of the redesigned buffer assembly for the M16A1 Rifle. Tests should include:

a. Ammunition characteristics.

b. Extreme high and low temperature.

COPY/vu

AMSTE-BC

26 JUN 1967

SUBJECT: Test Directive for Product Improvement of Redesigned Buffer  
for M16A1 Rifle, USATECOM Project No. 8-7-0230-04

- c. Endurance.
- d. Temperature and humidity.
- e. Other, as deemed necessary.

5. For the above tests, materiel requirements and funds will be provided direct to Project Manager, Rifles, with information copy to this headquarters. As previously discussed with Small Arms Branch, Development and Proof Services, test plans should be prepared to accommodate the following:

- a. Twelve weapons (6 w/new buffers, 6 w/old buffers - Parkerized finish).
- b. Extruded grain propellant for both tracer and ball ammunition.
- c. Ball propellant for both tracer and ball ammunition.

6. During any given subtest, interchange buffers between rifles and take cyclic rates at various intervals during firing. Cyclic rates should be measured more frequently during the early phases of the tests than the late phases.

7. This is a Category I activity. USATECOM Project No. 8-7-0230-04 and SEA priority 1 is assigned.

8. A formal test plan is required with submission to this headquarters for approval by 24 July 1967. A formal test report is also required within 30 days after completion of tests.

9. Test plans and reports will be unclassified.

FOR THE COMMANDER:

2 Incl w/d

- 1. STE Form 1027
- 2. Dist List

/s/ Jack W. Morris  
/t/ JACK W. MORRIS  
LTC GS  
Act Dir, Inf Mat Test

Copies furnished: (w/o incl)

CG USAMC ATTN: AMCPM-RS  
CO APG ATTN: STEAP-DS-TI  
Pres USAIB ATTN: STEBC-SA  
USACDC Ln O, USATECOM  
USMC Ln O, USATECOM



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

22 DEC 1967

AMSTE-BC

SUBJECT: Fouling Tests of M16 Rifles

TO: Commanding Officer  
Aberdeen Proving Ground  
ATTN: STEAP-DS

1. This letter confirms verbal instructions to the Technical Director of Development and Proof Services to conduct subject tests as requested by the Infantry Materiel Testing Directorate, HQ, USATECOM, on 20 August 1967.
2. The tests consisted of:
  - a. Determining cyclic rates for three new M16 rifles using both ball and extruded propellant loaded cartridges.
  - b. Cleaning the weapons thereafter and firing of 1000 rounds each, using all ball propellant in one rifle, all extruded propellant in the second rifle, and a mixture of ball and tracer cartridges loaded with both ball and extruded propellants in the third rifle.
  - c. Approximately 50% semiautomatic and 50% automatic firings were imposed and the rifles were not cleaned after the 1000 round schedule.
3. Personnel from the Infantry Directorate will handcarry the rifles to HQ, USAMC, together with suitable borescope equipment to permit a detailed examination of the nature and extent of fouling obtained with each of the rifles. The services of a technician from Development and Proof Services to accompany the rifles was requested.
4. For immediate funding purposes, currently approved work orders for "Military Potential Tests of M16 Rifles" may be utilized. The results, however, are to be reported in conjunction with forthcoming tests of buffers for M16 rifles.

FOR THE COMMANDER:

*Robert B. Tully*  
ROBERT B. TULLY  
LTC GS  
Dir, Inf Mat Test Dir

**JOINT MESSAGEFORM**

RESERVED FOR COMMUNICATION CENTER

SECURITY CLASSIFICATION

UNCLASSIFIED

TYPE MSG	BOOK	MULTI	SINGLE
		M	

COMMUNICATIONS  
CENTER

PRECEDENCE

ACTION ROUTINE

INFO ROUTINE

1967 OCT 17 13 46

DTG

FROM:

COAPG MD

GREEN PROVING GROUND  
MARYLAND

TO:

CGUSAWECOM ROCK ISLAND ILL

INFO:

CGUSATECOM APG MD  
CGUSAMUCOM DOVER NJ  
COUSABRL APG MD

SPECIAL INSTRUCTIONS

UNCLASSIFIED **12742** FOR AMCPM-RD, MR. W. DAVIS,

AMSTE-BC, MR. C. CRIDER; AMSMU-RE, MR. SPAULDING; AMXBR-EB,  
MR. PIDDINGTON, FROM STEAP-DS-TI SGD WILSON AND TOLEN

SUBJ: FIRING OF M196 TRACER CARTRIDGES IN M16A1 RIFLES,

USATECOM PROJ NO. 8-7-0230-04

REF: STEAP-DS-TI TT 12491, 10 OCT 67, SUBJ: FIRING OF M196  
TRACER CARTRIDGES IN XM177E2 SUBMACHINE GUNS.

1. REF TT DISCUSSES INCOMPATIBILITY OF BALL PROPELLANT LOADED  
M196 CARTRIDGES WHEN FIRED IN XM177E2 SUBMACHINE GUN. EXCESSIVE  
DISPERSION, YAW AND FAILURE TO TRACE WERE OBSERVED. EXCESSIVE  
DISPERSION AND YAW DID NOT OCCUR WHEN FIRING A RELATIVELY NEW XM16E1  
RIFLE AND APPARENTLY WAS NOT OCCURRING DURING TEST OF M16A1 RIFLES  
IN REDESIGNED BUFFER EVALUATION.

2. HOWEVER, DURING CURRENT HIGH TEMPERATURE TESTS AT +155°F  
OF 12 M16A1 BUFFER TEST RIFLES, FIRING RESULTS OF BALL PROPELLANT

DATE	TIME
17	1400Z
MONTH	YEAR
OCT	67
PAGE NO.	NO. OF PAGES
1	3

D R A F T E R	TYPED NAME AND TITLE	PHONE
	S. A. DOILNEY, Chief, Small Arms and Aircraft Weapons Branch	4489

R E L E A S E R	SIGNATURE
	TYPED (or stamped) NAME AND TITLE J. A. TOLEN, Deputy Director for Engineering Testing

SECURITY CLASSIFICATION  
UNCL

REGRAIDING INSTRUCTIONS  
NA

PRECEDENCE	RELEASED BY	DRAFTED BY	PHONE
ACTION <b>ROUTINE</b>	J. A. TOLEN	A. WILSON	4489
INFO <b>ROUTINE</b>			

M196 TRACERS, LOT LC 12081, WERE TOTALLY UNACCEPTABLE. GROSS DISPERSION, EXCESSIVE YAW, JACKET RUPTURES AND FAILURE TO TRACE OCCURRED.

3. THE PROBLEM APPEARS TO BE A FUNCTION OF A NUMBER OF VARIABLES WHICH MAY INCLUDE GUN TEMPERATURE, PROPELLANT TYPE, BARREL FOULING, AMMUNITION TEMPERATURE, AND PREVIOUS FIRING HISTORY ON AN INDIVIDUAL WEAPON. FIRING SCHEDULE OF 80 ROUNDS IN APPROXIMATELY 8 MINUTES WITH MINIMUM OF 2 HOURS BETWEEN SCHEDULES IS NOT CONSIDERED SEVERE.

4. TO DATE ALL DISASTROUS TYPE RESULTS HAVE OCCURRED DURING AND IMMEDIATELY FOLLOWING THE FIRING OF LOT LC 12081. ACCEPTABLE RESULTS IN TEST WEAPONS CAN BE REGAINED SOON AFTER INTRODUCTION OF BALL PROJECTILE OR 8208M PROPELLANT LOADED TRACER FIRINGS.

5. DPS CANNOT PROCEED WITH FURTHER INVESTIGATION OF TRACER PROBLEM WITHIN THE CONFINES OF THE PRODUCT IMPROVEMENT TESTS OF XM177E2 SUBMACHINE GUNS AND M16A1 BUFFERS WITHOUT ADDITIONAL MATERIEL, FUNDS AND WRITTEN AUTHORITY.

6. DPS URGENTLY RECOMMENDS THAT AMCPM-RS SHIP 12 NEW M16A1 BARREL ASSEMBLIES AT ONCE TO APG FOR USE IN BUFFER TEST. POSSIBILITY EXISTS THAT METAL FOULED BARRELS MAY SOON INDUCE HIGH MALFUNCTION RATES WHICH COULD RESULT IN NON-DISCRIMINATORY

CONTROL NO.	TOR/TOD	PAGE NO.	NO. OF PAGES	MESSAGE IDENTIFICATION	INITIALS
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INFO <b>ROUTINE</b>			

TESTS BETWEEN STANDARD AND REDESIGNED BUFFERS. BARREL  
 REPLACEMENT WOULD THEN BE DONE AT D&PS OPTION, WITH OBJECTIVE OF  
 MAINTAINING INTEGRITY OF BUFFER EVALUATION. REPLACED BARRELS  
 WILL BE SECTIONED FOR FURTHER STUDY.

CONTROL NO.	TOR/TOD	PAGE NO. <b>3</b>	NO. OF PAGES <b>3</b>	MESSAGE IDENTIFICATION	INITIALS <b>Ps</b>
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**DD FORM 173-1**  
1 NOV 65

REPLACES EDITION OF 1 MAY 55 WHICH WILL BE USED.

### APPENDIX III - REFERENCES

1. Technical Manual, TM 9-1005-249-14, Rifle 5.56-MM, M16; August 1966.
2. Keele, E., Hendricks, G., and Staley, L., Final Report on Military Potential Test of Weapon Lubricants Employing 5.56-MM, M16A1 (XM16E1) Rifle. USATECOM Project No. 8-5-0060-02, Report No. DPS-2417, Aberdeen Proving Ground, May 1967. (Distribution Controlled by US Army Weapons Command.)
3. Specification SAPD-253B, Acceptance Testing for Rifle M16 and M16E1.
4. Letter, AMSTE-BC, Approval of Test Plan for Product Improvement Test of Redesigned Buffer for M16A1 Rifle, 29 August 1967.
5. Specification MIL-C-99630, Military Specification for Cartridge, 5.56-MM, M193.
6. Specification MIL-C-60111, Military Specification for Cartridge, 5.56-MM, M196.
7. Letter, AMSWE-SMM-SA, Lubrications and Preservatives for M16A1 Rifle, 2 June 1967.
8. Field Manual FM 23-9, Rifle 5.56-MM, XM16E1, July 1966.

APPENDIX IV - DISTRIBUTION LIST

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