

SA+AW

CORRECTED COPY  
ABERDEEN PROVING GROUND  
ABERDEEN PROVING GROUND, MARYLAND 21005  
FIRING RECORD

8 February 1967

USATECOM Project No. 8-7-0210-01,  
Engineer Design Test of Grenades,  
M19A1, M22, and M23 with XM16E1  
Rifle (Safety Evaluation Phase)

Firing Record No.: S-46549  
Dates of Test: 17 November through  
13 December 1966  
Authority: Letter AMSTE-BC, 10  
October 1966

W. O. No. 331-909-70 js

ITEMS UNDER TEST

Rifle, 5.56-mm, XM16E1.  
Three lots of rifle grenades, smoke, WP, M19A1, lot EA-2-28;  
smoke, yellow, M22A2, lot OAP-9-10; and smoke, violet streamer,  
M23, lot RD-13-4.  
One lot of cartridge, grenade launcher blank, 5.56-mm, lot RA-1-8.

SUPPORTING FACILITIES AND MATERIALS

Weapon:

Rifles, 5.56-mm, XM16E1, serial Nos. 161537 (No. 1), 162969 (No. 2),  
and 163305 (No. 3).

Facilities:

Test stand capable of supporting the XM16E1 rifle when fired at 0°  
through 45° elevation.  
Climatic temperature conditioning facilities, capable of maintain-  
ing temperatures from 0°F to 155°F and large enough to allow the  
test items to be stored and fired from within.

Instrumentation:

Two lumiline screens.  
One counter chronograph.

Firing Position:

Range, 300 meters, cleared, to allow observation of the grenades  
from moment of launch to impact, and to collect range data.

SMALL ARMS &  
AIRCRAFT WEAPONS  
BRANCH, B-350

Digitized by:

## DETAILS OF TEST

The test was conducted to determine the compatibility of the XM16E1 rifle with the various types of smoke grenades (originally designed for use with the M1 rifle), and cartridge, 5.56-mm, grenade launcher, blank.

The standard rifle grenade test fixture was modified for this test by substituting a wooden rifle rest in lieu of the standard rest and allowing the wooden rest and rifle to recoil 4 inches. The rearward movement of the rest and rifle was terminated by the placement of four sandbags to the rear of the rest. The rifle was supported in the wooden rest by nylon straps placed over the foregrip and the rear part of the stock. A piece of sponge rubber (1 inch thick) was placed between the butt of the rifle and the rear support of the rest. Firing was accomplished by carefully attaching a lanyard to the trigger of the weapon; the gunner then retired to a safe position before firing the grenade.

Ranges and velocities were recorded for the rounds fired at 70°F. Lumiline screens were located 5.70 and 18.85 feet from the muzzle of the weapon. Observers, in a shelter, were located 150 meters downrange and 50 meters to the right of the impact area to record range and impact data.

Firings at 0°F and 155°F were conducted at an elevation of 17°; only velocities were recorded for these firings. Lumiline screens were located at 2.83 and 13.00 feet from the muzzle. Test components for all temperature requirements were conditioned for a minimum of 12 hours prior to firing.

Rifles fired with the butt resting on concrete were fired at 45° elevation, from the horizontal with the gunner supporting the rifle, in the kneeling position. Velocities were not obtained for these rounds. Ability of the stock to withstand the shock of the grenades being fired was the primary concern of this phase of testing.

Cartridges, grenades, and rifles were inspected before and after firing (when possible).

## ROUND-BY-ROUND DATA

Round-by-round data are contained in Inclosure 2.

Results are summarized in Tables I through VI.

## SUMMARY OF RESULTS

Table I. Range and Velocity Data, Firings Conducted at 70°F

Rifle: XM16E1, 5.56-mm, serial No. 161537 (No. 1).

Cartridge: Grenade launcher, blank, 5.56-mm, lot RA-1-8.

	Elev, 45°		Elev, 30°		Elev, 20°	
	Vel, fps	Range, m	Vel, fps	Range, m	Vel, fps	Range, m
Grenade: Yellow smoke, M22A2.						
Avg	146	171.9	143	154.4	141	102.3
Max	156	177.0	147	168.9	147	114.5
Min	141	155.0	138	102.6	134	96.5
Var	15	22.0	9	66.3	13	18.0
Std Dev	5.2	8.5	2.6	17.8	4.8	7.1
Grenade: Violet streamer, M23.						
Avg	168	222.3	143	202.7	161	122.9
Max	174	234.2	148	214.5	169	138.9
Min	162	210.0	139	193.5	154	113.7
Var	12	24.2	9	21.0	15	25.2
Std Dev	4.3	9.4	3.3	7.3	5.5	8.5
Grenade: Smoke, WP, M19A1.						
Avg	122	139.3	127	122.5	122	76.3
Max	125	143.1	133	129.5	124	79.6
Min	119	131.9	117	113.8	120	74.9
Var	6	11.2	16	15.7	4	4.7
Std Dev	2.0	4.1	5.6	4.8	1.6	1.7

Notes: Velocities computed at 12.27 feet.

No weapon malfunctions or case casualties occurred during these firings.

Five of the M23 grenades failed to function when launched.

Considerable muzzle flash occurs with the M23 violet streamer grenades; they also deposited a large amount of carbon on the outer forward portion of the barrel and front sight.

Table II. Velocity Data, Firings Conducted at 0°F

Rifle: XM16E1, 5.56-mm, serial No. 161537 (No. 1).

Cartridge: Grenade launcher, blank, 5.56-mm, lot RA-1-8.

Elevation: 17°.

	Velocity, fps		
	Grenade		
	Yellow Smoke, M22A2	Violet Streamer, M23	Smoke, WP, M19A1
Avg	133	134	117
Max	138	161	119
Min	127	121	113
Var	11	40	6
Std Dev	2.4	11.0	1.6

Notes: Velocities computed at 7.91 feet.

No weapon malfunctions or case casualties were noted during these firings.

One M23 violet streamer and four M19A1, WP, smoke, grenades failed to function properly.

Again, the M23 violet streamer grenade produced considerable muzzle flash and carbon deposit. Keys to containers, containing the grenades, broke at this temperature (Figures 1 and 2, Inclosure 3).

Table III. Velocity Data, Firings Conducted at 155°F

Rifle: XM16E1, 5.56-mm, serial No. 161537 (No. 1) and 162969 (No. 2).  
 Cartridge: Grenade launcher, blank, 5.56-mm, lot RA-1-8.  
 Elevation: 17°.

	Velocity, fps		
	Grenade		
	Yellow Smoke, M22A2	Violet Streamer, M23	Smoke, WP, M19A1
Avg	150		129
Max	156	a -	133
Min	141		123
Var	15		10
Std Dev	4.8		2.7

<sup>a</sup>Accurate velocities could not be obtained for the violet streamer grenades because particles of the grenade filler blew out through the air hole in the ogive of the grenade. Only two velocities that could be considered valid were recorded (round 91, 193 fps and round 97, 189 fps).

Notes: Rifle No. 161537 became inoperative while firing the M22A2 grenades. Upon inspection, the carrier key and gas tube were found damaged. The total number of rifle grenades fired on this weapon was 134. Rifle No. 162969 was substituted for the damaged weapon.

Five of the 17 WP grenades fired failed to function upon impact. This includes one grenade which separated from the fin stabilizer, with the stabilizer remaining on the rifle, and the grenade impacting 15 meters downrange (Figure 3, Inclosure 3). One round failed to eject, cause unknown.

During these firings, the mouth of some cases failed to open fully, but did not appear to affect the performance of the rifle nor the functioning of the grenade (Figure 4, Inclosure 3).

As mentioned earlier, the M23 grenade produced considerable muzzle flash and carbon deposits.

At this temperature, as at 0°F, the keys to the grenade containers broke in use, making it necessary for the gunner to complete opening of each container with a pair of pliers.

Velocities computed at 7.91 feet.

Table IV. Results of Firing with Stock Resting on Concrete, Kneeling Position

Ambient Temperature: 40°F.

Rifle: XM16E1, 5.56-mm, serial Nos. 162969 and 163305.

Elevation: 45°.

No. Rds Fired	Function		Comments
	Rifle	Grenade	
Rifle: No. 162969 (previous rounds, 0). Date Fired: 21 November 1966. Grenade: Yellow smoke, M22A2.			
4	Satis	Satis	No apparent damage to rifle.
Rifle: No. 162969 (previous rounds, 48). Date Fired: 12 December 1966.			
10	Satis	Satis	Hairline cracks appeared in butt of rifle after firing first grenade. One failure to eject fired case occurred.
Rifle: No. 162969. Grenade: Violet streamer, M23.			
10	Satis	Satis	No change in condition of stock.
Rifle: No. 162969. Grenade: Smoke, WP, M19A1.			
5	Satis	Satis	Cracks, increasing in number and length on the second grenade firing. Toe of stock was broken off (1-1/2 by 3-3/4 inch piece, including sling swivel) on fifth round fired.
Rifle: No. 163305 (previous rounds, 0). Date Fired: 13 December 1966. Grenade: Smoke, WP, M19A1.			
5	Satis	Satis	No damage to rifle or stock, toe of stock slightly scuffed.

See Notes, page 7.

Table IV (Cont'd)

Notes: Before this phase of the test was fired, rifle No. 162969 had been fired four rounds, with the stock resting on concrete and 44 rounds at 155° from a rest. The hairline cracks in the rifle stock appeared after the first M22A2 grenade was fired (after the rifle had been subjected to the hot and cold tests). Cracking did not increase until firing of the second M19A1 WP grenade (after 19 more grenades). The fifth WP grenade fired caused a piece of the stock, 1-1/2 by 3-3/4 inches, including the sling swivel, to break off.

One failure to eject occurred, cause unknown.

Considerable muzzle flash and carbon deposit on the flash suppressor and forward part of the barrel occurred when firing the M23 violet streamer grenade.

No case casualties occurred during these firings.

Rifle No. 163305 was used to determine if the WP grenades were the direct cause of the stock breakages. Five rounds were fired from this new weapon; no damage to the weapon or stock occurred although minor scuffing of the toe was noted.

Photographs of the broken stock and scuffed toe are contained in Figures 5 and 6 (Inclosure 3).

Table V. Rifle Functioning Test Data

Ammunition: Cartridge, 5.56-mm, ball, M193, lot WCC-6089.

<u>No. Rds Fired</u>	<u>Rifle Serial No.</u>	<u>Type Fire</u>	<u>Malfunc</u>
10	162969	Semi	None
10	161537	Semi	None

Notes: Rifle No. 162969 was fired with the broken stock and without cleaning; no difficulties were encountered.

Rifle No. 161537 was fired after installation of new carrier key and straightening of the gas tube; this rifle was cleaned before firing. Functioning was satisfactory.

No case casualties occurred.

Table VI. Impulse and Recoil Energy Data

The following data were calculated by using the velocity and grenade weight information contained in the firings conducted on 18 and 21 November 1966, ammunition temperature 70°F.

No. Rds	Rd Nos.	Elev, deg	Avg Vel, fps	Weight			Free Recoil, fps	Recoil Force, lb	Grenade KE, ft-lb
				Chg, lb	Proj, lb	Rifle, lb			
Grenade: Smoke, WP, M19A1.									
5	12 to 16	45	122	0.00286	1.60	6.92	30.15	73.3	370
10	37 to 46	30	127	.00286	1.59	6.92	31.12	76.0	398
5	57 to 61	20	122	.00286	1.60	6.92	30.15	70.8	370
Grenade: Yellow smoke, M22A2.									
5	2 to 6	45	146	0.00286	1.24	6.92	28.10	51.0	410
10	17 to 26	30	143	.00286	1.24	6.92	27.57	47.9	394
4	47 to 51	20	141	.00286	1.24	6.92	27.21	45.6	383
Grenade: Violet streamer, M23.									
4	7 to 11	45	168	0.00286	1.00	6.92	26.22	37.2	438
5	27 to 36	30	143	.00286	1.01	6.92	22.81	28.2	321
5	52 to 56	20	161	.00286	1.03	6.92	25.91	34.9	415

KE = Kinetic energy.

Note: The forces calculated for the three types of grenades fired appear to be three to four times greater than those recorded for shotguns (ref D&PS Firing Record No. S-46430, "Feasibility Test of Seven Slide-Action Shotguns and Six Muzzle Devices for Shotguns").

## OBSERVATIONS AND REMARKS

The three types of M1 rifle grenades tested functioned properly when fired from the XM16E1 rifle. The violet streamer grenade causes considerable muzzle flash and produces deposits of large amounts of carbon on the exterior of the weapon but does not appear to affect the operation of the weapon. The flash and sparklers produced by this particular grenade, upon launching, was annoying to the gunner when the rifle was fired with the butt resting on concrete and supported by the gunner.

The capability of the XM16E1 rifle to launch the M1 rifle grenades with its integral grenade launcher appears satisfactory. The rifle stock will probably crack if placed against a solid object for repeated grenade launchings. Fouling from the grenade cartridge is minor; light carbon deposits form in the bolt, chamber, and bore; medium deposits form around the locking ring and inside the bolt carrier. The heaviest carbon deposits were formed around the flash suppressor and the outside of the barrel, this was caused mostly by the violet streamer M23 grenades.

The procedure for firing rifle grenades should be followed as outlined in TM9-1330-220, "Grenades, Hand and Rifles" and FM23-30, "Grenades and Pyrotechnics". Until a further study can be made it is not recommended that pyrotechnics or signal grenades be fired with the butt of the weapon held against the shoulder or any other part of the body (ref Inclosure 4).

This is the final report on this task.

SUBMITTED:

*F. G. Killeen*

F. G. KILLEEN  
Test Director

REVIEWED:

FOR THE COMMANDER:

*S. A. Doilney*  
S. A. DOILNEY

Chief, Small Arms and  
Aircraft Weapons Branch

*Claude E. Brown*  
CLAUDE E. BROWN

Chief, Infantry and Aircraft  
Weapons Division  
Development and Proof Services

5 Incls

1. Authority
2. Round-by-Round Data
3. Photographs
4. Safety Statement
5. Distribution



AUTHORITY

Firing Record No. S-46549

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

AMSTE-BC

10 OCT 1966

SUBJECT: Engineer Design Test (Safety Evaluation Phase) of Rifle Grenades  
Fired from XM16E1 Rifle

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

1. References:

- a. Msg, AMSMU-RE-M 9-2464 dated 301913Z Sep 66, inclosed.
- b. Mtg 3 Oct 64 at D&PS with representatives of TECOM and Frankford Arsenal to discuss subject test.

2. As cited in referenced details of message, USA Munitions Command requests an expeditious action to safety evaluate the XM16E1 Rifle when firing the listed rifle grenades. The primary objective is to conduct tests which will determine the structural integrity of rifle and grenade. Safety test of the grenade cartridge is not desired unless unsafe conditions are found during test of the system. As discussed at referenced meeting, Frankford Arsenal will provide cartridge test results.

3. It is requested that Commanding Officer, Aberdeen Proving Ground conduct tests to determine the following:

- a. Structural integrity of rifle and grenade.
- b. Recommended method of firing, i.e., butt of rifle on ground; from the hip; etc.
- c. Impulse.
- d. Record velocities and dispersions.

4. Frankford Arsenal will provide funds, ammunition and information concerning availability of weapons which represents latest production. USA Procurement and Supply Agency will provide grenades.

AMSTE-BC

17 OCT 1966

SUBJECT: Engineer Design Test (Safety Evaluation Phase) of Rifle Grenades

5. A brief outline of test plan is required in letter form (5 cys).
6. It is requested that recommendation be provided in letter form (5 cys) as to safety of item for field use.
7. USATECOM Project No. 8-7-0210-01 is assigned.

FOR THE COMMANDER:

1 Incl  
as

  
**AUSTIN TRIPLETT, Jr.**  
Colonel  
Dir. Inf Mat Test

COPY/js

Firing Record No. S-46549

NNNNCZCAFA965

RFTU JAW RUEOESI0082 2741004-UUUU--RUEOFAA.

10-55

3 OCT 66

DE RUEPPA0138 2732031

ACTION: BC

ZNR UUUUU

R 301913Z SEP 66

FM CGUSAMUCOM DOVER

TO RUEOFAA/CGUSATECOMAPG ABERDEEN

INFO RUEOHFA/CGUSAMC WASHDC

RUEOFAA/COUSADPSAPG ABERDEEN

RUEOPUA/COUSAFA PHILA

BT

UNCLAS AMSMU-RE-M 9-2464 FOR AMSTE-BC CRIDER INFO FOR AMCPM-RS-W MAJOR  
ANDOLINA FOR STEAP-DP DOILNY FOR SMUFA-U1000 DR MANNING AND SMUFA-H9000  
COL JOHNSON FROM USAMUCOM SGD READ

1. CONFIRMING TELECON 30 SEP 66 CRIDGER SPAULDING FOLLOWING HARDWARE  
ITEMS WILL BE DELIVERED TO USAD&PS BY DATES INDICATED:

A. 500 EA COMMERCIAL 5.56MM GRENADE CARTRIDGES MANUFACTURED BY REMINGTON  
ARMS - 5 OCT 66

B. 100 EA GRENADE RIFLE M19A1 WHITE PHOSPHORUS 4 OCT 66

C. 100 EA GRENADE RIFLE M22 SMOKE YELLOW 4 OCT 66

D. 100 EA GRENADE RIFLE M23 SMOKE VIOLET STREAMER 4 OCT 66

2. REF CONFIDENTIAL LETTER D/A TO USAMC DTD 10 JUN 66, SUBJ 5.56MM  
CRIMPED CARTRIDGE (U), UNCLASSIFIED 1ST IND USAMC TO USAMUCOM DTD 25  
JUL 66, AND UNCLASSIFIED 2ND IND

PAGE 2 RUEPPAØ138 UNCLAS

USAMUCOM TO FA DTD 12 AUG 66. COPIES OF 2ND IND WERE PROVIDED AMSTE-BC AND ANCPM-RD-W 12 AUG 66. BASIC LETTER ESTABLISHED PRIORITY AS Ø2 FOR SEA AND REQUESTED USAMC (QUOTE) "TAKE NECESSARY ACTION TO PROVIDE SAFETY CERTIFICATION OF THE 5.56MM CRIMPED CARTRIDGE AND THE XM16E1 RIFLE IN THE RIFLE GRENADE LAUNCHING ROLES" (END QUOTE). ACCORDING TO 1ST IND YOUR COMMAND ADVISED THAT (QUOTE) "SAFETY CERTIFICATION MUST BE OBTAINED FOR EACH TYPE OF GRENADE TO BE FIRED FROM THE XM16E1 RIFLE" (END QUOTE). IT WAS AGREED IN TELECON CRIDER KROSSER 1Ø AUG 66 THAT A SINGLE COLOR OF THE M22 SMOKE SERIES AND A SINGLE COLOR OF THE M23 SMOKE STREAMER SERIES WOULD SUFFICE TO ESTABLISH SAFETY OF THOSE TWO SERIES. EXCEPT FOR SUBSTITUTION OF VIOLET COLOR FOR GREEN COLOR IN M23 SMOKE STREAMER, GRENADES LISTED IN PAR 1 ABOVE ARE SAME AS LISTED IN PARA 2, CITED 2ND IND. COLOR SUBSTITUTION WAS CAUSED BY CURRENT LOCAL UNAVAILABILITY OF GREEN COLOR.

3. IT WAS AGREED IN TELECON CRIDER SPAULDING 3Ø SEP 66 THAT YOUR COMMAND WOULD TAKE IMMEDIATE ACTION AS FOLLOWS:

A. ADVICE FRANKFORD ARSENAL ESTIMATED COST OF TESTING.

B. DIRECT USAD&PS TO PERFORM WHATEVER TESTS YOU CONSIDER NECESSARY TO DETERMINE SAFETY OF THE THREE COMBINATIONS OF XM16E1 RIFLE, 5.56MM COMMERCIAL GRENADE CARTRIDGE AND RIFLE GRENADES LISTED ABOVE. IT IS IMPORTANT TO NOTE THAT IT IS SAFETY OF THE COMBINATIONS INCLUDING RIFLE GRENADE WHICH MUST BE DETERMINED AND NOT SAFETY OF THE COMMERCIAL 5.56MM GRENADE CARTRIDGE PER SE.

PAGE 3 RUEPPA0138 UNCLAS

C. ADVISE USAMC MAJOR ANDOLINA BY TELEPHONE ASAP EXPECTED DATE BY WHICH YOU EXPECT TO PROVIDE SAFETY EVALUATION OF THE THREE CITED COMBINATIONS.

D. PROVIDE WRITTEN SAFETY EVALUTION TO USAMC WITH COPIES TO FA AND HQ USAMUCOM.

4. REQUEST YOU CONTACT LT COL JOHNSON OR CAPT HILDEBRANDT AT FRANKFORD ARSENAL BY TELEPHONE EXTENSIONS 2-4240 OR 5207, AS SOON AS TEST COST ESTIMATE IS AVAILABLE SO THAT NECESSARY FUNDING ACTION CAN BE EXPEDITED.

BT

COPY/js

Firing Record No. S-46549

NNNNCZCAFA491

RTTU JAW RUEOPUA0026 2831915-UUUU--RUEOFAA.

DATE: 11 OCT 66  
ACTION: D&PS

ZNR UUUUU

INFO: COMPT

R 101812Z OCT 66

FM COFA PHILA

TO RUEOFAA/CTUSATECOM ABERDEEN PROVING GR, MD

INFO RUEOFAA/COUSADPS ABERDEEN PROVING GR, MD

BT

UNCLAS FOR AMSTE-BO MR CRIDER INFO STEAP-DS-T1 MR DOILNEY FROM

SMUFA-U4100 TT10280 FRY

SUBJ: FUNDING OF 5.56MM RIFLE GRENADE SAFETY EVALUATION TESTS CON-  
FIRMING DISCUSSION BETWEEN MR. CRIDER AND MR. DENESQUITA OF FA, FUNDS  
ALLOCATED UNDER WORK DIRECTIVE K2-09-0002, AMCMS CODE 4810.16.  
2323.1.01, PRON U1-6-U5129-01-F6-K2 W.O. 68449-02-003 APPLICABLE FOR  
IMMEDIATE REFERENCED TEST REQUIREMENTS. ADDITIONAL FUNDS (\$8000.00)  
WILL BE FORWARDED THIS WEEK UNDER XO 78426-02-001, OMS 4810.16.0217.1.01.

BT



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

AMSTE-BC  
8-7-0210-01

2 NOV 1966

SUBJECT: Engineer Design Test (Safety Evaluation Phase) of Rifle Grenades  
Fired from XM16E1 Rifle

TO: Commanding Officer  
Aberdeen Proving Ground  
ATTN: STEAP-DS  
Aberdeen Proving Ground, Md. 21005

1. Reference letter, AMSTE-BC, 10 Oct 65, subj as above.
2. Meeting, 3 Oct 66 at APG with representatives of USATECOM and Frankford Arsenal to discuss subject tests.
3. It is requested that subject test be confined to temperature extremes from 0 degrees F. to plus 155 degrees F. Also, firing at 70 degrees F. is desired. Temperature condition the complete system, i.e., grenade cartridge, weapon and grenades.

FOR THE COMMANDER:

*Thomas E. Dee Jr*  
THOMAS E. DEE, Jr.  
Actg Dir  
Inf Mat Test Dir

## ROUND-BY-ROUND DATA

## Velocity and Range Data

Rifle: 5.56-mm, XM16E1, No. 161537 (No. 1), previous pounds, 0.  
 Head Space: 1.4656 in.  
 Firing Pin Protrusion: 0.034 in.  
 Firing Pin Indent: 0.031 in.  
 Cartridge Type: GL5.56, lot RA-1-8.

Range: Trench Warfare, T-2 position; line of fire, 32° from south.  
 Distance between Screens: 13.15 feet.  
 Gun to 1st Screen: 5.70 feet.  
 Ammunition Temperature: 70°F.  
 Ambient Temperature: 56.4°F.

<u>Time Fired</u>	<u>Rd No.</u>	<u>Grenade Wt, lb</u>	<u>Vel, fps</u>	<u>Range, meters</u>	<u>Remarks</u>
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Date Fired: 17 November 1966.  
 Elevation: 45°.  
 Grenade: Smoke, yellow, M22A2, lot OAP-9-10.

1105	1	1.25	-	180	Good smoke.
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Date Fired: 18 November 1966.

1100	2	1.23	141	155.0	No function (safety on).
15	3	1.25	143	175.0	Good smoke.
26	4	1.25	145	177.0	
30	5	1.24	146	177.0	
35	6	1.25	156	175.5	

Grenade: Smoke, violet streamer, M23, lot RD-13-4.

1300	7	1.01	166	210.0	No function (safety on).
15	8	1.00	168	221.0	Good smoke <sup>a</sup> .
20	9	0.97	174	234.2	
25	10	1.01	162	214.7	
28	11	1.00	Lost	231.6	

Grenade: Smoke (WP), M19A1, lot EA-2-28.

1335	12	1.58	124	143.1	Good smoke and streamers.
50	13	1.56	125	143.0	
1400	14	1.63	119	131.9	
06	15	1.63	122	138.6	
11	16	1.60	122	139.8	

<sup>a</sup>Tumbled on impact.

Inclosure 2, page 1

## Firing Record No. S-46549

<u>Time Fired</u>	<u>Rd No.</u>	<u>Grenade Wt, lb</u>	<u>Vel, fps</u>	<u>Range, meters</u>	<u>Remarks</u>
Elevation: 30°.					
Grenade: Smoke, yellow, M22A2, lot OAP-9-10.					
1510	17	1.23	138	102.6	Good smoke <sup>b</sup> .
15	18	1.22	146	168.9	
17	19	1.24	141	152.4	
21	20	1.22	145	161.7	
1525	21	1.25	145	162.3	Good smoke.
35	22	1.25	141	157.8	
40	23	1.24	145	160.8	
Date Fired: 21 November 1966.					
0915	24	1.24	142	154.9	Good smoke.
18	25	1.24	145	164.5	
30	26	1.24	140	157.8	
Grenade: Smoke, violet streamer, M23, lot RD-13-4.					
0937	27	0.97	148	214.2	Good streamer <sup>a</sup> .
42	28	0.98	146	214.5	No function, no smoke.
48	29	1.03	139	195.4	
54	30	1.00	Lost	207.3	
57	31	1.03	Lost	193.5	
1003	32	1.02	142	199.0	No smoke.
07	33	1.01	Lost	199.0	No function, no smoke.
12	34	1.04	141	208.5	
16	35	1.00	Lost	198.9	No function, no smoke.
20	36	1.03	Lost	197.0	
Grenade: Smoke (WP), M19A1, lot EA-2-28.					
1027	37	1.58	118	115.3	Good smoke and streamer.
33	38	1.61	122	124.5	
36	39	1.58	131	124.5	
40	40	1.60	130	125.0	
45	41	1.58	133	124.4	
50	42	1.59	127	119.7	
56	43	1.58	132	127.4	

<sup>a</sup>Tumbled on impact.<sup>b</sup>Unstable flight, grazed second lumiline screen.

## Firing Record No. S-46549

<u>Time Fired</u>	<u>Rd No.</u>	<u>Grenade Wt, lb</u>	<u>Vel, fps</u>	<u>Range, meters</u>	<u>Remarks</u>
1101	44	1.60	128	121.3	
05	45	1.59	131	129.5	
10	46	1.61	117	113.8	

Elevation: 20°.

Grenade: Smoke, yellow, M22A2, lot OAP-9-10.

1320	47	1.22	143	101.8	Good smoke.
25	48	1.24	Lost	-	Hit 2nd velocity screen.
35	49	1.23	139	114.5	
40	50	1.25	134	96.5	
45	51	1.24	147	97.7	Flame and smoke.

Grenade: Smoke, violet streamer, M23, lot RD-13-4.

1350	52	1.04	154	113.7	Good streamer.
55	53	1.01	166	119.9	No function.
1405	54	1.03	157	119.2	Good streamer.
11	55	1.05	169	122.7	No function.
15	56	1.00	161	138.9	Good streamer.

Grenade: Smoke (WP), M19A1, lot EA-2-28.

1425	57	1.61	121	75.4	Good smoke and streamer.
30	58	1.59	124	79.6	
40	59	1.60	120	74.9	
50	60	1.61	122	75.1	
55	61	1.57	124	76.3	

Notes: No case casualties occurred during these firings.  
 Considerable muzzle flash occurs with the M23 grenade.  
 All grenades functioned as intended unless otherwise noted.

## Hot and Cold Room Test

Head Space: 1.4656 in. Distance between Screens: 10.17 feet.  
 Firing Pin Protrusion: 0.034 in. Gun to 1st Screen: 2.83 feet.  
 Firing Pin Indent: 0.029 in. Elevation: 17.5°.  
 Firing Pin Diameter: 0.059 in. Cartridge Type: GL5-56, lot RA-1-8.  
 Range: Main Front, Cold Room No. 1; line of fire, 36° from south.

<u>Time Fired</u>	<u>Rd No.</u>	<u>Vel, fps</u>	<u>Remarks</u>
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Date Fired: 1 December 1966.

Rifle: 5.56-mm, M16E1, No. 161537 (No. 1); previous rounds, 61 grenades.

Temperature of Components: 0°F.

Grenade: Smoke, yellow, M22A2, lot OAP-9-10.

1010	1	-	Good smoke.
15	2	127	
45	3	135	Smoke and flame.
55	4	133	Good smoke.
59	5	-	
1102	6	131	-a
20	7	129	-a
24	8	134	
25	9	135	
29	10	134	
32	11	134	
35	12	133	
37	13	133	
40	14	133	
42	15	134	
45	16	135	
1300	17	138	
04	18	135	Light smoke <sup>a</sup> .
06	19	136	
08	20	133	

Grenade: Smoke, violet streamer, M23, lot RD-13-4.

1310	21	128	Light streamer <sup>b</sup> .
14	22	128	Heavy streamer.
17	23	128	Good streamer.
19	24	136	
1322	25	129	Bright muzzle flash.

<sup>a</sup>Tumbled on impact.<sup>b</sup>Considerable muzzle flash, characteristic of the M23 grenade.

Firing Record No. S-46549

<u>Time Fired</u>	<u>Rd No.</u>	<u>Vel, fps</u>	<u>Remarks</u>
26	26	140	No function on impact.
28	27	138	
30	28	133	
32	29	128	
35	30	163	
37	31	130	
40	32	127	
43	33	126	
45	34	120	
47	35	144	
48	36	161	
50	37	132	
51	38	129	
54	39	121	
1400	40	132	

Date Fired: 2 December 1966.

Grenade: Smoke (WP), M19A1, lot EA-2-8.

0920	41	116	Good smoke and streamers.
25	42	115	
30	43	114	
33	44	113	
37	45	116	
39	46	118	
41	47	116	
43	48	119	
45	49	117	
47	50	118	
50	51	116	No function on impact.
53	52	118	
57	53	116	
59	54	119	
1000	55	116	No function on impact.
1002	56	117	Good smoke and streamers.
04	57	118	
06	58	118	No function on impact.
08	59	117	
10	60	115	

<u>Time Fired</u>	<u>Rd No.</u>	<u>Vel, fps</u>	<u>Remarks</u>
Date Fired: 6 December 1966.			
Temperature of Test Components: 155°F.			
Grenade: Smoke, yellow, M22A2, lot OAP-9-10.			
0935	61	c -	Good smoke.
42	62	c -	
47	63	c -	
52	64	c -	
1000	65	c -	
05	66	c -	
25	67	144	
30	68	154	
34	69	d152	
38	70	153	
42	71	152	
46	72	142	
50	73	e154	

Changed rifles; new rifle serial No. 162969 (No. 2); previous rounds, 4.

58	74	c -	
1103	75	150	
06	76	156	
10	77	153	
14	78	c -	
17	79	141	
20	80	150	

Grenade: Smoke, violet streamer, M23, lot RD-13-4.

1152	81	f -	Good thick streamer.
35	82	-	
1300	83	-	Good thick streamer, and bright muzzle flash.
08	84	-	
12	85	-	
15	86	-	
18	87	-	

<sup>c</sup>Velocities lost.

<sup>d</sup>Bolt started sticking.

<sup>e</sup>Unable to close bolt, gas tube and carrier key bent.

<sup>f</sup>Unable to obtain accurate velocities, due to parts of the grenade filler blowing out through the air hole in the ogive of the grenade.

## Firing Record No. S-46549

<u>Time Fired</u>	<u>Rd No.</u>	<u>Vel, fps</u>	<u>Remarks</u>
22	88	-	
25	89	-	
30	90	-	
34	91	193	Failure to eject.
37	92	-	
42	93	-	
45	94	-	
49	95	-	
53	96	-	
57	97	189	
1400	98	-	
03	99	-	
08	100	-	

Date Fired: 7 December 1966.

Grenade: Smoke (WP), M19A1, lot EA-2-28.

0937	101	130	Good smoke.
45	102	128	Functioned on screen.
1014	103	126	Good smoke.
27	104	130	
30	105	g 37	No function on impact (stabilizer separated).
40	106	123	Good smoke.
45	107	133	No function on impact.
57	108	126	Good smoke.
1101	109	131	
10	110	131	No function on impact.
15	111	132	No function on impact.
24	112	126	Good smoke.
27	113	129	
1035	114	127	Good smoke.
38	115	131	No function on impact.
45	116	130	
57	117	126	

<sup>g</sup>Grenade separated from stabilizer; stabilizer remained on rifle.  
Grenade impacted 15 meters from rifle, did not function.

Notes: No case casualties occurred during these firings. Cases do not open fully when fired at 155°F.

At 0°F and 155°F, the keys provided to open the grenade containers broke.

Except where noted, all grenades functioned on impact or functioned as intended (violet streamer).

## Stock Resting on Concrete

Firing Pin Indent: 0.027 in.                      Range: Trench Warfare, T-2  
 Cartridge: 5.56-mm, grenade                      Position; line of fire, 32° from  
                  launcher, blank, lot RA-1-8.                      south.  
 Fired with rifle butt resting on concrete, rifle held at approximately  
 45° elevation.

<u>Time Fired</u>	<u>Rd No.</u>	<u>Remarks</u>
Date Fired: 21 November 1966.		
Rifle: 5.56-mm, M16E1, No. 162969 (No. 2); previous rounds, 0.		
Head Space: 1.4646 in.		
Firing Pin Protrusion: 0.032 in.		
Firing Pin Diameter: 0.060 in.		
Ambient Temperature: 48°F.		
Grenade: Yellow smoke, M22A2, lot OAP-9-10.		
1500	1	No function on impact. Toe scuffed.
05	2	
10	3	
	4	

Date Fired: 12 December 1966.  
 Rifle: No. 162969 (No. 2); previous rounds, 48 (44 rounds fired during  
 the hot phase).  
 Ambient Temperature: 40°.

0945	49	Hairline cracks appeared at base of stock.
1000	50	No change in stock.
02	51	
05	52	
07	53	
11	54	Did not function on impact.
25	55	
28	56	One fired cartridge failed to eject.
31	57	Did not function on impact.
34	58	Did not function on impact.

Grenade: Violet streamer, M23, lot RD-13-4.

1036	59	No change in condition of stock <sup>a</sup> .
38	60	
40	61	
42	62	
44	63	

<sup>a</sup>Considerable muzzle flash and carbon deposit on the flash suppressor occur when firing the M23 grenades.

<u>Time Fired</u>	<u>Rd No.</u>	<u>Remarks</u>
46	64	
48	65	
50	66	
51	67	
55	68	

Grenade: Smoke (WP), M19, lot EA-2-28.

1330	69	No change in condition of stock.
40	70	Cracks lengthening and increasing in number.
45	71	No change in stock from previous round.
50	72	
55	73	Toe of stock broke off (1-1/2 by 3-3/4 inch piece, including sling swivel).

Date Fired: 13 December 1966.

Rifle: No. 163305 (No. 3), previous rounds, 0.

Firing Pin Protrusion: 0.032 in.

Firing Pin Diameter: 0.059 in.

Head Space: 1.4656 in.

Ambient Temperature: 34°F.

Grenade: Smoke (WP), M19A1, lot EA-2-28.

0925	1	
30	2	
35	3	
40	4	
45	5	Toe of stock scuffed, no other damage to stock was evident.

Notes: No case casualties occurred during these firings.  
 There were no rifle malfunctions.  
 All grenades functioned on impact.

## Rifle Functioning

Date Fired: 14 December 1966.

Ammunition: Cartridge, 5.56-mm, ball, M193, lot WCC-6089.

<u>Time Fired</u>	<u>Rd Nos.</u>	<u>Rifle No.</u>	<u>Type Fire</u>	<u>Malfunc</u>	<u>Remarks</u>
0930	1 to 10	162969	Semi	None	Rifle functioned satisfactorily, with stock broken.
0940	1 to 10	161537	Semi	None	Rifle functioned satisfactorily.

Note: No case casualties occurred during these firings.

PHOTOGRAPHS



Figure 1, 6476/66: Metal Grenade Container Opened with Pliers due to Broken Key.

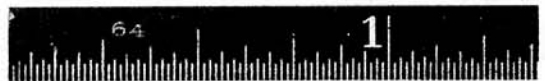


Figure 2, 6473/66: Keys Broke at 0° and 155°F Firings.

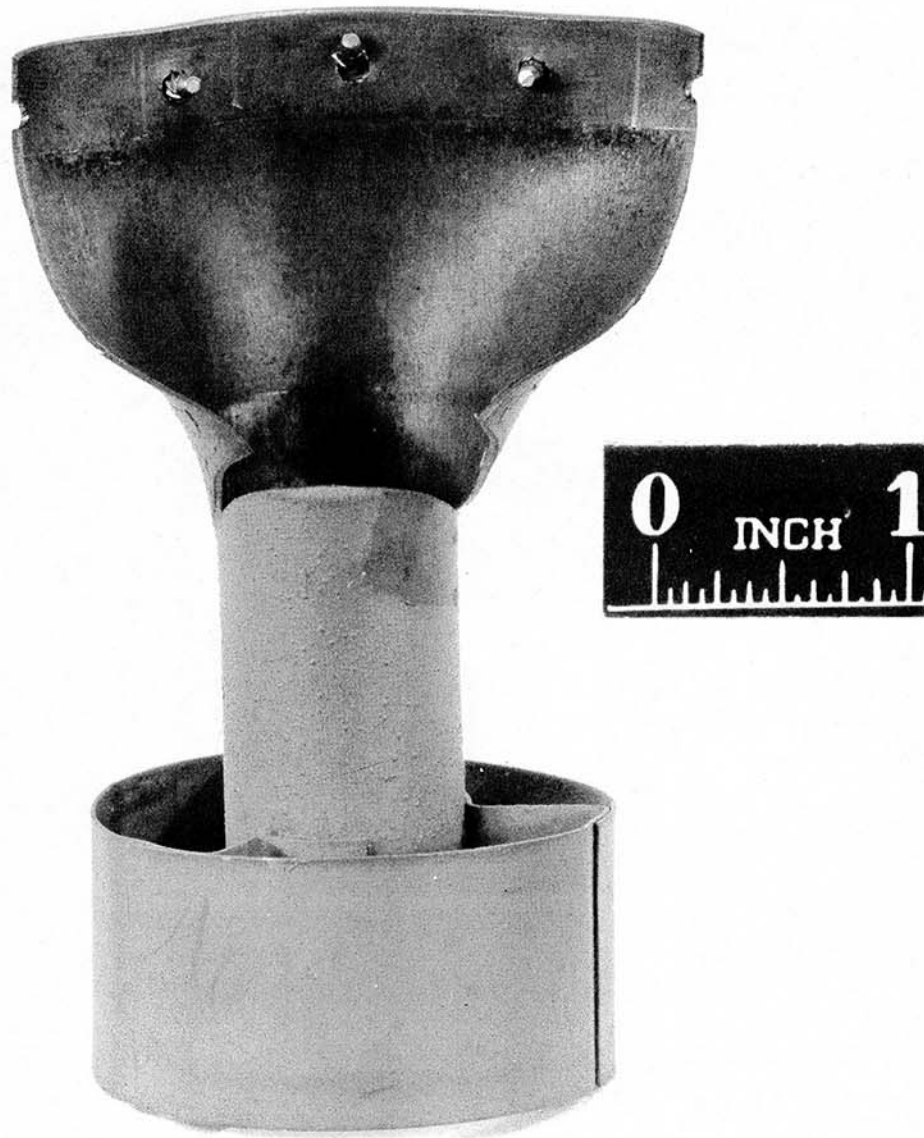


Figure 3, 6475/66: Stabilizer Remained on Flash Suppressor of Rifle during Firings at 155°F.

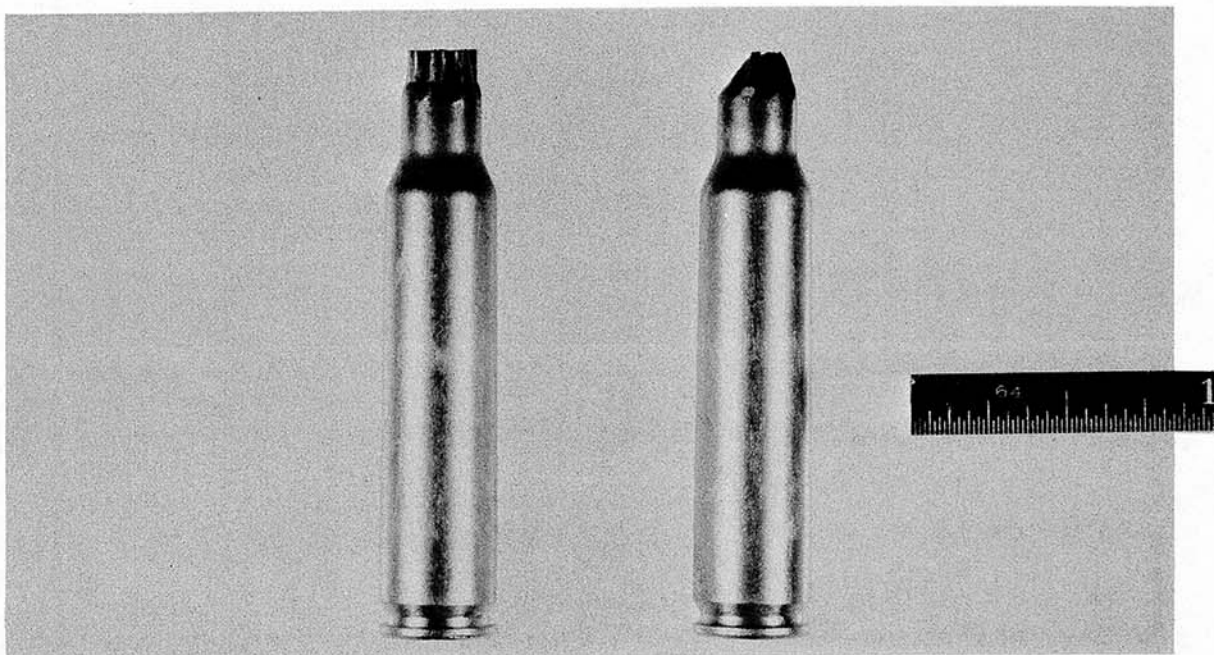
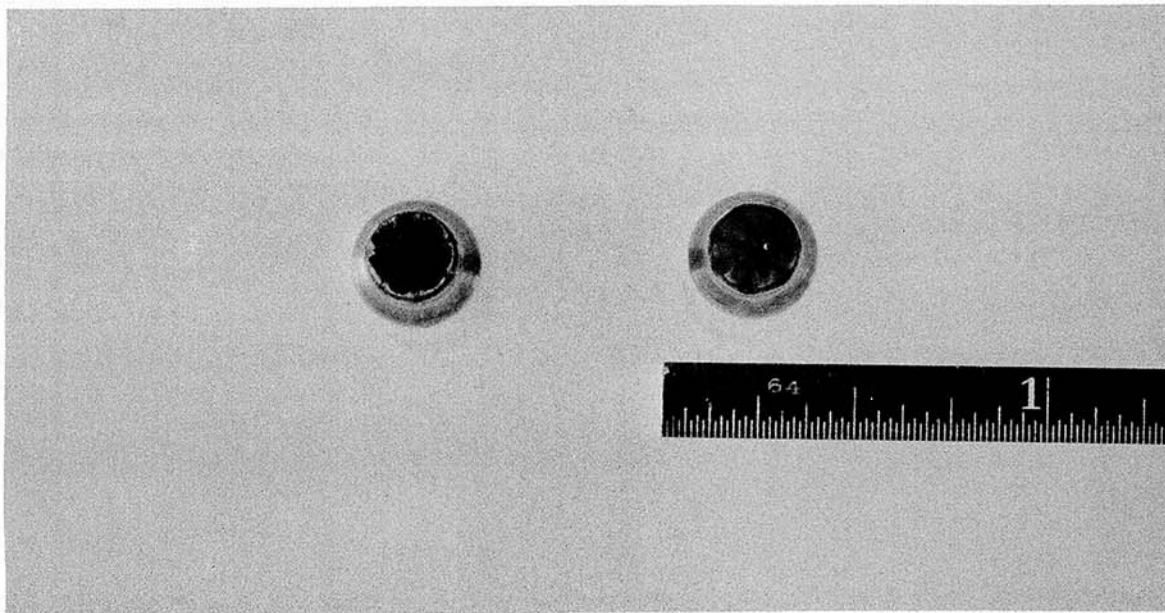


Figure 4, 6474/66: Cartridge Case. LEFT: Normal Opening. RIGHT: Result of Firings at 155°F (About One-Half the Cases Fired at 155°F Produced Similar Results).

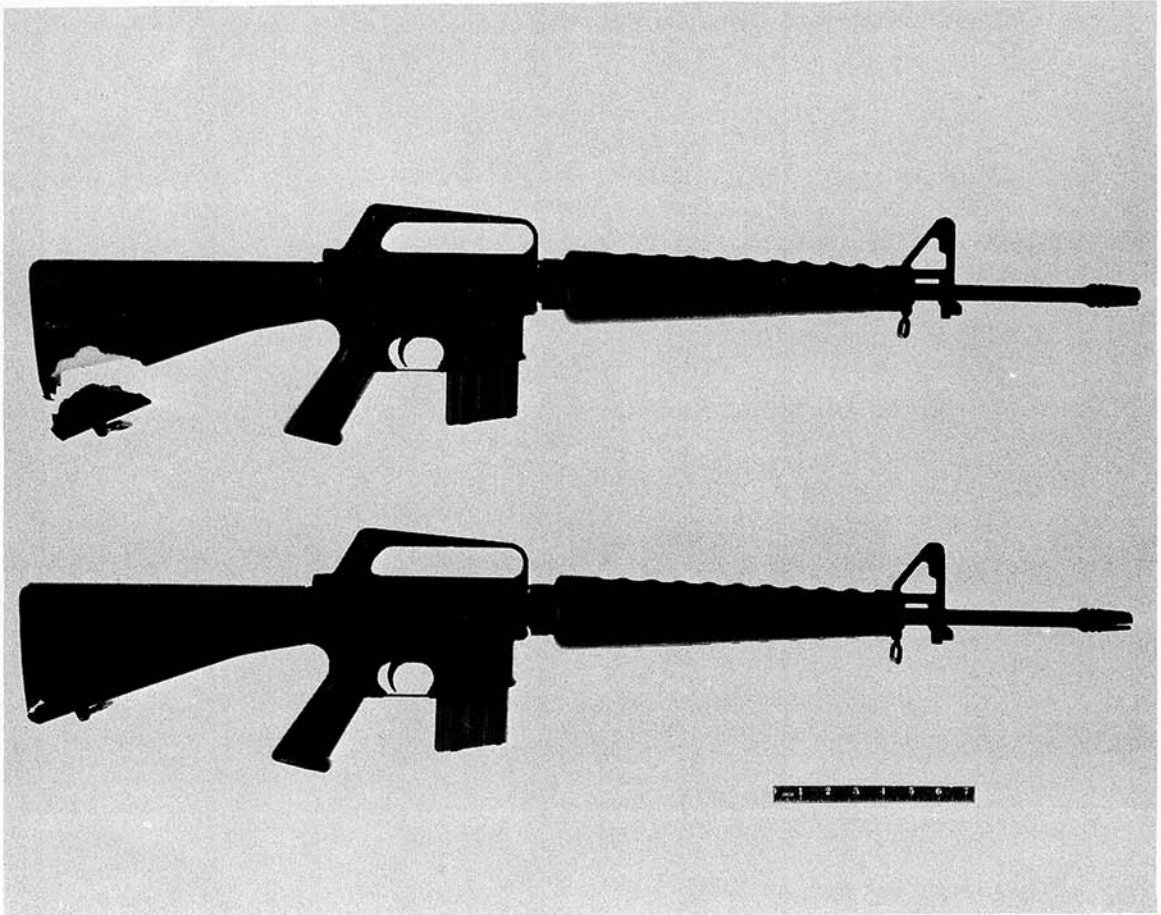


Figure 5, 6349/66: TOP: Rifle, No. 162969 (Launched 44 Rifle Grenades during Firings at 155°F, and 29 Grenades with Butt Resting on Concrete before Complete Break Occurred). BOTTOM: Rifle, No. 163305 (Launched Five Grenades with Butt Resting on Concrete, Minor Scuffing of Toe of Stock Occurred).

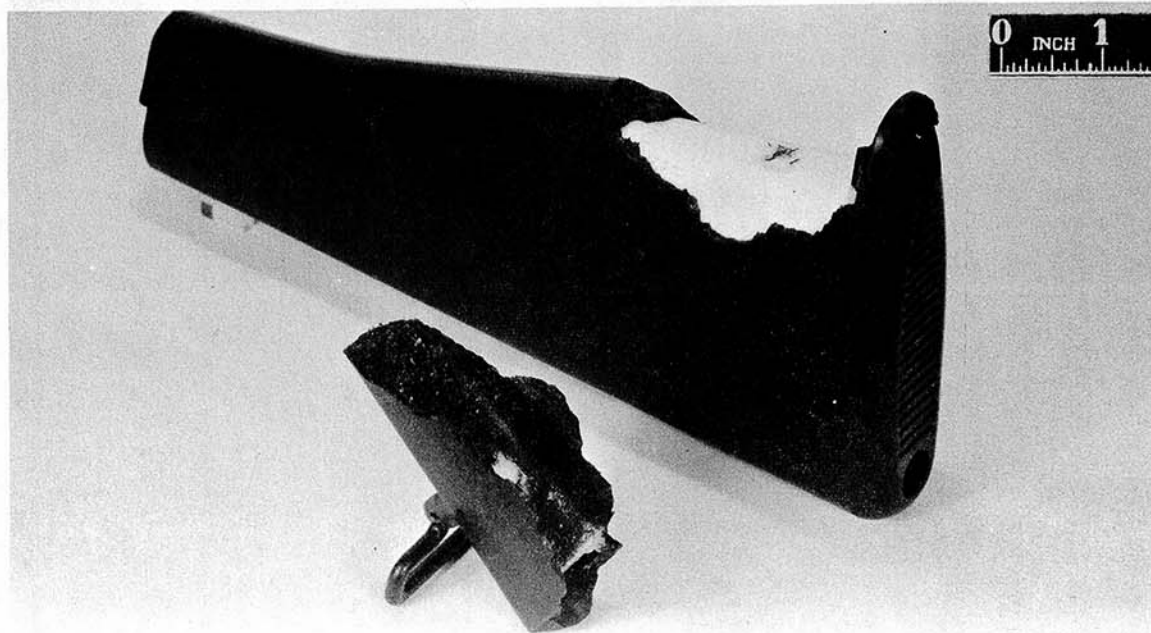


Figure 6, 6350/66: TOP: Stock from Rifle, No. 163305, Showing Scuffed Toe. BOTTOM: Stock from Rifle, No. 162969, Showing Breakage.

## SAFETY STATEMENT

STEAP-DS-TI

SUBJECT: Safety Statement on Engineer Design Test (Safety Evaluation Phase) of Rifle Grenades Fired From XM16E1 Rifle, USATECOM Proj No. 8-7-0210-01

TO: Commanding General  
U.S. Army Test and Evaluation Command  
ATTN: AMSTE-BG

## 1. References:

- a. AMSTE-BG letter, 10 Oct 1966, Subject: Engineer Design Test (Safety Evaluation Phase) of Rifle Grenades Fired From XM16E1 Rifle.
- b. AMSMU-RE-M Teletype No. 9-2464, dated 30 Sept 1966.

2. During the period of 17 November 1966 through 13 December 1966, a total of 212 rifle grenades were fired from the M16E1 rifle using 5.56-mm, grenade launcher, blank, cartridges, lot RA-1-8. The test items were subjected to temperature extremes from 0°F to +155°F. Firings at 70°F were also conducted and during this phase of the test velocity and range were recorded for 20°, 30°, and 45° firing elevations. Thirty-four of the test items were fired with the butt of the rifle resting on concrete and the rifle held at a 45 degree angle from the horizontal. Inclosure 1 is a summary of firing results.

3. The number of rifle grenades fired and the very small number of malfunctions which occurred during these firings indicate that the XM16E1 rifle is suitable for firing the various type of rifle grenades tested. The procedure for firing should comply with the instructions set forth in TM9-1330-220, Grenades, Hand and Rifle; and FM23-30, Grenades and Pyrotechnics. Until further study can be made it is not recommended that the firing of pyrotechnics or signal grenades be made with the butt of the weapon held against the shoulder or any other part of the body.

FOR THE COMMANDER:

1 Incl  
as

/t/ J. A. TOLEN  
Ass't Deputy Director for  
Engineering Testing  
Development and Proof Services

Inclosure 4, page 1

## Summary of Firing Results

<u>Rds Fired</u>	<u>Grenade Type</u>	<u>Elevation, deg</u>	<u>Avg Vel, fps</u>	<u>Avg Range, m</u>	<u>Malfunctions</u>
<u>Rifle No. 161537.</u>					
<u>Temperature: 70°F.</u>					
6	Yellow smoke, M22A2	45	146	171.9	0
10		30	143	154.4	0
5		20	141	102.3	0
5	Violet streamer, M23	45	168	222.3	0
10		30	143	202.7	0
5		20	161	122.9	0

Rifle No. 161537.  
Temperature: 70°F.

5	Smoke, WP, M19A1	45	122	139.3	0
10		30	127	122.5	0
5		20	122	76.3	0

Temperature: 0°F.

20	Yellow smoke, M22A2	17	133	-	0
20	Violet streamer, M23	17	134	-	0
20	Smoke, WP, M19A1	17	117	-	0

Temperature: 155°F.  
Rifle No. 162969.

20	Yellow smoke, M22A2	17	150	-	Bolt sticking <sup>a</sup> .
20	Violet streamer, M23	17	<sup>b</sup>	-	1FJ
17	Smoke, WP, M19A1	17	129	-	Fin separated from grenade <sup>c</sup> .

Rifle fired with butt resting on concrete.

14	Yellow smoke, M22A2	45	-	-	d
10	Violet streamer, M23	45	-	-	

Rifle No. 163305.

10	Smoke, WP, M19A1	45	-	-	e, f
----	------------------	----	---	---	------

<sup>a</sup>Bolt started sticking on round number 69. It was necessary to change the rifle after round 73, due to bent gas tube and damaged bolt carrier key. Total number of grenades fired was 134. Repaired gas tube installed new carrier key, and fired 10 rounds of M193 ball cartridges; the weapon functioned satisfactorily.

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