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LIMITED RANGE TEST OF THE M16 RIFLE WITH EIGHT TYPES OF RIFLE AND HAND GRENADES

by
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Directorate of Armament Development
Det 4, Research and Technology Division
Air Force Systems Command
Eglin Air Force Base, Florida

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FOREWORD

Detachment 4, Research and Technology Division, directed and monitored this test of the M16 rifle using standard Army-type rifle and hand grenades during October 1964. Manuscript was released December 1964.

While the test was arranged and monitored by Det 4, RTD personnel, the actual firings were accomplished and range test equipment was installed by personnel of the Small Arms Marksmanship Training Unit, 4420th Combat Support Group, Special Air Warfare Center (TAC), Eglin AFB, Florida.

Engineering Services Project No. 912A-0000-97205 applies to this report.

This technical report has been reviewed and is approved.

CHARLES E. WOOD
Major, USAF
Chief, Ballistics Division

ABSTRACT

Range tables have been constructed for eight Army-type rifle and hand grenades fired from the M16 rifle. The range and time of flight were measured for launch elevation angles of 5° to 45°. Final range data are the result of averaging the individual data points and compensating for wind effects. Tables are presented for the following grenades: M21 Hand Grenade with M1A2 Adapter, M30 Hand Grenade with M1A2 Adapter, M31 Rifle Grenade, M34 Hand Grenade with M1A2 Adapter, M22A2 Rifle Grenade, M23 Rifle Grenade, M27 Rifle Grenade, and the M7A1 CN Hand Grenade with M2A1 Adapter. No breakage of component parts of the guns or gun stocks occurred during the tests.

CONTENTS

TABLES

SECTION I

INTRODUCTION

The ultimate purpose of the test discussed in this report was to establish range tables for the M16 rifle using standard Army-type hand and rifle grenades. The following discussion describes the manner in which test data were obtained, analyzed, and correlated to construct a table of range and time-of-flight at different launch elevation angles for several types of grenades.

The compatibility of the M16 rifle with various Army-type grenades presently used with the M14 and M1 rifle was established during the tests conducted by OOAMA (OOYEC) at Hill AFB, Utah. During the Hill AFB tests, range data were obtained for elevation angles of 30° and 45°. The test at Eglin AFB provided range data at lower elevation angles.

SECTION II

TEST SET-UP

Firings were conducted at the Eglin AFB Auxiliary Field No. 9 ammunition disposal area. Using a transit, a straight line of fire was established along which markers were placed at intervals of 50 ft. The rifle was firmly implaced with two stacks of sand bags; the hand guard rested on the front stack of bags and the butt plate was placed tightly against the rear stack. The bags were situated so as to obtain the desired rifle elevation angle. The elevation angle was measured by means of an inclinometer placed inside the rifle muzzle. The rifle azimuth was checked by means of a plumb which was extended from the rifle to the line of fire marked on the ground. The rifle was held firmly in place and the elevation angle double-checked for each firing. The range to impact was measured with a steel tape. Measurements were made both in the direction of fire and laterally to each side of the line of fire. The time of flight for each grenade was measured with stop watches. Wind direction and magnitude were determined with a portable anemometer.

SECTION III

TEST PROCEDURES AND RESULTS

For all except the M34 WP hand grenade, the ground range to impact was measured directly with the steel tape. For the M21 and M30 practice hand grenades launched at high elevation angles, the flight time exceeded the fuze time, causing air bursts. For these grenades the impact angle was assumed equal to the launch angle. From an estimate of the height of the grenades at airburst and with the assumed impact angle, the increment in range from airburst to impact was computed. This distance was subtracted from the measured impact distance to obtain the range to airburst without wind direction. For the M34 WP grenade, the range beneath the airbursts was clearly indicated by an area of burned phosphorous. The M21 practice grenades air-burst zero to 20 ft high at 35° elevation and approximately 45 ft high at 45° elevation. The M30 practice grenade air-burst zero to 50 ft high at 35° elevation and approximately 75 ft high at 45° elevation. The M34 WP hand grenade air-burst zero to approximately 15 ft high at 35° and 45° elevation.

A minimum of five rounds of each type of grenade was fired at elevation angle of 5°, 15°, 25°, 35°, and 45°, with the exception of the M22 rifle grenade which was not fired at 15° and the M34 WP hand grenade which was not fired at elevation angles below 25°. An average was made of the range and the time of flight at each elevation angle. For most of the grenades fired, the deviation in range did not exceed 10% of the average range. The increment in range due to wind drift was determined by multiplying the approximate wind velocity by the average time of flight. This increment was then added or subtracted from the average measured range to obtain the range shown in Table III.

The M34 WP grenade was not fired at angles below 25° due to the potential hazard to the firing personnel without protective cover. The ranges shown in the enclosed range table were computed theoretically for angles up to 25°, and then correlated with the measured data.

Table I shows the raw data as measured at the Eglin AFB test site. Table II presents a similar set of data obtained during the Hill AFB tests. No wind data are available for the Hill AFB test. Table III presents the final correlated range data.

It is noted that detonation did not occur for any of the M31 HEAT grenades. At an elevation angle of 45° the grenades impacted at approximately 45° and buried approximately half the grenade length into damp,

firm sand. At the very low angles the grenades slid along the ground, coming to rest at a range much larger than the impact ranges shown in Tables I and III.

Examination of the data obtained by Hill AFB personnel indicated that no consistent variation in range was obtained when five different rifles were used during the test. Therefore, at the Eglin AFB tests, no attempt was made to identify a particular rifle with a series of firings. A total of 191 grenades were fired during the tests at Eglin AFB. No breakage of component parts of the guns or gun stocks occurred.

Although no consideration was given to the effect of rifle and cartridge temperature on grenade range, these effects might be of sufficient importance to warrant investigation.

TABLE IA. M23 RIFLE GRENADE (SMOKE STREAMER)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	159	394	474	585	632
	Time	1.8	3.0	4.5	5.9	6.9
	Deflection	1R	25R	20R	12L	6L
2	Range	174	389	500	611	638
	Time	1.4	2.9	4.5	6.0	6.9
	Deflection	1R	25R	0	18L	24L
3	Range	203	367	527	640	621
	Time	1.5	2.4	4.1	6.1	7.2
	Deflection	4R	6L	40R	24L	12L
4	Range	249	379	517	645	627
	Time	1.3	2.8	4.1	5.6	7.3
	Deflection	1L	—	4L	9L	2L
5	Range	198	350	575	630	565
	Time	1.2	2.5	4.1	5.8	7.2
	Deflection	4R	8R	5L	23R	24L
6	Range	—	365	—	—	—
	Time	—	2.5	—	—	—
	Deflection	—	—	—	—	—
7	Range	—	420	—	—	—
	Time	—	3.2	—	—	—
	Deflection	—	18L	—	—	—

*Negligible Wind

Legend for Tables IA-IH: AB denotes approximately air burst height.
GB denotes ground burst.
L denotes deflection left of firing line.
R denotes deflection right of firing line.
All ranges and deflections measured in feet.
Time is measured in seconds.

TABLE IB. M21 HAND GRENADE WITH M1A2 ADAPTER (PRACTICE FRAGMENTATION)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	144	210	347	412	360
	Time	1.2	2.7	3.6	4.7	6.4
	Deflection	0	0	0	0(AB20)	0(AB45)
2	Range	142	213	298	352	440
	Time	1.2	2.5	3.6	4.5	6.3
	Deflection	0	6R	5L	2L(GB)	0(AB45)
3	Range	142	233	311	350	421
	Time	1.3	2.8	3.6	4.7	6.2
	Deflection	0	0	3L	0(AB20)	0(AB45)
4	Range	138	236	309	346	404
	Time	1.1	2.7	3.6	4.7	5.4
	Deflection	0	0	5L	0(GB)	0(AB40)
5	Range	145	213	315	379	394
	Time	1.2	2.5	3.8	4.7	5.8
	Deflection	0	6R	10R	0(AB5)	0(AB50)

*8-knot average headwind

TABLE IC. M30 HAND GRENADE WITH M1A2 ADAPTER (PRACTICE FRAGMENTATION)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	140	259	371	456	459
	Time	1.3	2.8	4.5	—	5.8
	Deflection	0	6R	6L	15R(AB20)	9R
2	Range	136	245	383	427	492
	Time	1.3	2.8	4.0	—	5.6
	Deflection	0	3R	0	20R(AB50)	20L
3	Range	140	274	365	412	465
	Time	1.2	2.7	4.0	—	5.2
	Deflection	0	4R	5R	0(GB)	15R
4	Range	159	271	365	419	489
	Time	1.4	2.8	3.8	—	5.5
	Deflection	0	8R	16R	13L(AB20)	24R
5	Range	128	285	386	432	520
	Time	1.2	2.8	4.0	—	5.1
	Deflection	0	0	0	14R(AB20)	9R

*8-knot average headwind

TABLE ID. M22A2 RIFLE GRENADE (SMOKE IMPACT)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	152	—	409	497	537
	Time	1.1	—	4.0	5.2	6.8
	Deflection	2R	—	9R	4R	6R
2	Range	156	—	415	521	546
	Time	1.3	—	4.0	5.0	6.8
	Deflection	2R	—	10R	6L	24R
3	Range	161	—	438	546	546
	Time	1.3	—	4.2	5.3	6.9
	Deflection	0	—	7R	10R	32R
4	Range	172	—	447	533	565
	Time	1.2	—	4.2	5.4	6.5
	Deflection	2R	—	9R	2L	20R
5	Range	—	—	447	550	574
	Time	—	—	4.2	—	6.5
	Deflection	—	—	1R	1R	0
6	Range	—	—	462	—	—
	Time	—	—	4.2	—	—
	Deflection	—	—	15R	—	—

*Negligible Wind

TABLE IE. M31 RIFLE GRENADE (HEAT)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	148	288	465	605	615
	Time	1.4	2.7	4.2	—	6.7
	Deflection	0	0	7L	0	5R
2	Range	147	308	467	613	625
	Time	1.4	2.5	—	5.5	6.9
	Deflection	2R	5L	6R	10L	10L
3	Range	147	312	467	607	675
	Time	1.4	2.6	4.4	5.8	7.1
	Deflection	3R	3R	15L	8R	20L
4	Range	146	312	467	638	648
	Time	1.2	2.9	4.2	5.9	6.9
	Deflection	0	0	5R	17L	17L
5	Range	138	316	475	639	651
	Time	1.4	2.8	4.3	5.8	7.0
	Deflection	2L	4R	7L	13L	10L

*5-knot average tailwind

TABLE IF. M27 RIFLE GRENADE (ILLUMINATING)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	124	188	335	383	361
	Time	1.1	1.9	3.8	4.9	6.6
	Deflection	1R	3R	7R	7R	0
2	Range	127	221	334	394	362
	Time	1.2	2.7	3.8	4.8	5.8
	Deflection	1R	1R	7R	6R	7R
3	Range	128	227	345	409	418
	Time	1.1	2.7	3.9	5.0	5.9
	Deflection	2R	0	5R	5L	4R
4	Range	131	230	345	400	420
	Time	1.1	2.7	3.6	5.0	5.3
	Deflection	2R	3L	9R	12R	3R
5	Range	129	256	348	418	426
	Time	1.1	2.5	3.8	4.8	5.3
	Deflection	2R	2R	6R	2L	5R

*Negligible Wind

TABLE IG. M34 HAND GRENADE WITH M1A2 ADAPTER (WHITE PHOSPHOROUS)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	—	—	252	318	330
	Time	—	—	3.5	—	4.2
	Deflection	—	—	0	3R	0
2	Range	—	—	232	298	285
	Time	—	—	3.5	—	4.6
	Deflection	—	—	8L	11L	—
3	Range	—	—	245	301	285
	Time	—	—	2.5	—	4.9
	Deflection	—	—	8L	5R	—
4	Range	—	—	236	310	295
	Time	—	—	3.0	—	4.9
	Deflection	—	—	0	3R	—
5	Range	—	—	250	308	285
	Time	—	—	3.2	5.4	4.9
	Deflection	—	—	0	10R	—

*Negligible Wind

TABLE IH. M7A1 CN HAND GRENADE WITH M2A1 ADAPTER (TEAR GAS)*

Grenade No.		Elevation Angle (deg)				
		5	15	25	35	45
1	Range	100	225	280	305	318
	Time	1.2	2.2	3.2	4.2	—
	Deflection	0	0	3R	—	—
2	Range	100	225	274	325	320
	Time	1.0	2.1	3.3	4.1	5
	Deflection	0	0	2L	8R	0
3	Range	120	225	283	300	324
	Time	1.6	—	3.3	4.2	5.1
	Deflection	0	0	6L	8R	12R
4	Range	70	220	255	300	316
	Time	—	2.1	3.1	4.4	5.2
	Deflection	0	0	0	13R	0
5	Range	98	230	302	282	315
	Time	1.1	2.2	3.2	4.0	5.3
	Deflection	0	0	2L	14R	0
6	Range	—	—	295	345	—
	Time	—	—	3.1	4.1	—
	Deflection	—	—	0	—	—
7	Range	—	—	240	270	—
	Time	—	—	3.5	3.9	—
	Deflection	—	—	6R	8R	—

*6-knot average headwind

TABLE IIA. M34 HAND GRENADE WITH M1A2 ADAPTER (WHITE PHOSPHOROUS).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°	305*	300	295	Air Burst	348
	307	325	310	347	348
	310	310	320	340	335
	325	340	325	345	338
	330	355	315	360	335
30°	—	300	325	330	340
	—	325	320	315	335
	—	320	320	320	315
	—	335	315	320	320
	—	320	310	310	305

*All entries in Tables IIA-G are ranges in feet unless otherwise indicated.

TABLE IIB. M7A1 CN HAND GRENADE WITH M2A1 ADAPTER (TEAR GAS).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°	340	350	347	388	375
	338	357	400	385	365
	365	360	353	390	360
	340	375	350	400	340
	380	375	340	350	348
30°	345	310	310	375	390
	365	325	345	380	350
	350	340	340	340	360
	390	355	340	350	370
	310	360	350	370	340

TABLE IIC. M27 RIFLE GRENADE (ILLUMINATING).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°	400	405	390	435	430
	400	410	407	425	425
	408	415	415	420	423
	410	443	415	412	423
	395	447	440	408	415
30°	365	365	390	390	405
	385	365	395	395	375
	390	370	370	397	400
	410	380	400	407	360
	415	380	400	410	390

TABLE IID. M22A2 RIFLE GRENADE (SMOKE, IMPACT).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°	606	620	612	610	560
	613	615	612	620	615
	616	630	590	620	610
	612	618	625	625	600
	618	660	625	630	595
30°	560	550	550	550	530
	545	540	530	525	525
	545	535	535	520	530
	540	525	520	535	535
	530	515	515	540	510

TABLE IIE. M31 RIFLE GRENADE (HEAT).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°	641	618	585	600	621
	643	623	610	630	635
	645	624	615	640	630
	650	626	618	645	625
	653	630	630	625	620
30°	455	450	460	483	462
	465	465	475	493	485
	465	468	480	495	485
	473	475	483	500	508
	475	475	485	508	515

TABLE IIF. M26 HAND GRENADE WITH M1A2 ADAPTER (FRAGMENTATION).

Elevation Angle	Rifle Number				
	1	2	3	4	5
45°					
Approximate Distance Out	450	450	450	450	400
Approximate Airburst Height	150	150	150	150	150
These ranges were approximately the same for 5 rounds fired from each rifle. Exact data not available.					
30°	425	400	410	415	470
	440	435	420	420	460
	440	440	425	420	445
	440	445	435	435	445
	445	445	450	460	455

TABLE IIC. M19A1 RIFLE GRENADE (WHITE PHOSPHOROUS) AT 45° ELEVATION*

Rifle Number				
1	2	3	4	5
425	445	450	450	495
440	450	445	445	490
448	450	455	455	470
450	455	455	455	475
458	465	445	445	475

*No data for 30° elevation

TABLE III. RANGE TABLES FOR EIGHT GRENADES USING THE M16 RIFLE.

M21 Hand Grenade with M1A2 Adapter (Practice Fragmentation)		
Elevation (deg)	Range (ft)	Time (sec)
5	156	1.2
10	213	1.8
15	265	2.5
20	315	3.1
25	360	3.7
30	392	4.2
35	413*	4.8
40	430*	5.3
45	438*	5.8

M50 Hand Grenade with M1A2 Adapter (Practice Fragmentation)		
Elevation (deg)	Range (ft)	Time (sec)
5	162	1.3
10	235	2.0
15	302	2.8
20	367	3.5
25	425	4.2
30	465	4.8
35	492*	5.4
40	507*	5.9
45	512*	6.5

M31 Rifle Grenade (HEAT)		
Elevation (deg)	Range (ft)	Time (sec)
5	138	1.2
10	217	2.0
15	295	2.8
20	373	3.5
25	448	4.3
30	521	5.0
35	586	5.8
40	612	6.4
45	617	6.9

M34 Hand Grenade with M1A2 Adapter (White Phosphorous)		
Elevation (deg)	Range (ft)	Time (sec)
5	68	0.6
10	125	1.2
15	180	1.8
20	227	2.2
25	267	2.9
30	291	3.4
35	305*	3.8
40	315*	4.3
45	320*	4.7

M22A2 Rifle Grenade (Smoke, Impact)		
Elevation (deg)	Range (ft)	Time (sec)
5	160	1.2
10	240	1.9
15	310	2.6
20	380	3.3
25	440	4.1
30	490	4.7
35	530	5.4
40	550	6.1
45	560	6.8

M23 Rifle Grenade (Smoke Streamer)		
Elevation (deg)	Range (ft)	Time (sec)
5	200	1.4
10	295	2.2
15	380	2.9
20	460	3.7
25	525	4.4
30	580	5.1
35	620	5.8
40	630	6.5
45	635	7.2

M27 Rifle Grenade (Illuminating)		
Elevation (deg)	Range (ft)	Time (sec)
5	130	1.1
10	185	1.9
15	240	2.6
20	295	3.2
25	345	3.8
30	380	4.5
35	405	4.9
40	415	5.4
45	420	5.7

M7A1 CN Hand Grenade with M2A1 Adapter (Tear Gas)		
Elevation (deg)	Range (ft)	Time (sec)
5	115	1.2
10	190	1.7
15	246	2.2
20	285	2.7
25	312	3.2
30	334	3.7
35	349	4.2
40	360	4.6
45	369	5.1

*Air Burst

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13. ABSTRACT

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