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INFANTRY AND AIRCRAFT WEAPONS DIVISION

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REPORT ON

GRENADE, RIFLE, HEAT, M31E1 WITH T1022E2 FUZE (U)

C-20,310

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Second Report On Ordnance Project No. TA1-2708J

(D. A. Project No. 505-04-001)

(Picatinny Arsenal TPR D-49)

RUSSELL W. GROSS

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JUNE 1959

Aberdeen Proving Ground
Maryland

U5
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1959

UF 765 .G767 1959

Gross, Russell W.

Test of grenade, rifle,
HEAT, M31E1 with T1022E2
fuze (U) #29579624

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RWGross/ch
22 May 1959

TEST OF GRENADE, RIFLE, HEAT, M31E1 WITH T1022E2 FUZE (U)

Second Report on Ordnance Project No. TA1-2708J

Dates of Test: 14 April thru 16 April 1959

ABSTRACT

(U) The object of the test was to determine the effectiveness of the T1022E2 rifle grenade fuze with respect to graze and delay arming, and to demonstrate the plate penetration characteristics of the M31E1 grenade.

(C) The grenades were fired at ambient, -40°F, and +125°F temperature in the following five phases: non-arming, arming, graze sensitivity, penetration of 65° oblique-angled plate, and penetration of normal-angled plate. The results of each phase are: non-arming - no functions occurred; arming - one grenade failed after being conditioned at -40°F; graze sensitivity - three grenades failed at ambient temperature, four failed at +125°F and two failed at -40°F; penetration of 65° oblique-angled plate - all grenades functioned; penetration of normal-angled plate - one grenade failed at +125°F. This failure is attributed to the fin separating from the stabilizer tube allowing the grenade to impact the plate on its side, thus causing the fuze to break away from the grenade body and the stabilizer tube.

(C) Fifteen fins separated from the stabilizer tube on firing during the complete test. Possible causes of some of the failures are due to erratic flight of the grenades caused by separation or partial separation of the fin.

(U) It is recommended that during future production of this item a more positive method of securing the fin to the stabilizer tube be employed.

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1. INTRODUCTION

(U) The object of this development test is to provide an improved rifle grenade fuze for use with the M31E1 grenade.

(U) The new fuze, T1022E2, added a graze-functioning element, and arming delay, and drop safety features to this anti-tank weapon system. The drop safety device was evaluated for aerial delivery by Aberdeen Proving Ground, and results are contained in Aberdeen Proving Ground Firing Record B-14139.

(U) Industrial engineering study on the T1022E2 fuze was conducted under Ordnance Project Number TA1-2708J. A description of the fuze is presented in Picatinny Arsenal Notes on Development Type Material, Number 172. (Reference development tests in Test Program Requests 3837 and 3897.) This fuze has also undergone production engineering study and a more economical design has evolved that is more suitable for mass production.

(U) Picatinny Arsenal conducted evaluation tests on the T1022E2 fuzes assembled in M31E1 grenades. A total of 250 inert-loaded grenades and H.E. loaded fuzes were used. The test program included: drop test (40-foot); graze function; arming test; transportation vibration test; conditioning at +160°F; conditioning at -80°F; salt spray; static detonator safety; JAN cycle; oblique-plate functioning; and normal-plate functioning. Descriptions of tests and test results are contained in Report Number 61-1902, Proof Testing Unit, Picatinny Arsenal.

(U) A test was conducted at Aberdeen Proving Ground in March 1958, in accordance with Test Program Request Number D-49. The object of this test was to determine the effectiveness of the T1022E2 rifle grenade fuze with respect to graze and delay arming, and to demonstrate the plate penetration characteristics of the M31E1 grenade. Test procedures and results are contained in Report Number DPS/TA1-2708J/1. The quantity of failures warranted additional tests.

(U) Test Program Request Number D-68 was conducted in December 1958 using 100 inert rounds with shunted M48 electric detonators and T96 primers with dummy firing pins. After recovery the rounds were X-rayed and disassembled to determine the cause of malfunction. (Reference Aberdeen Proving Ground Firing Record Number B-14238.)

(C) Since the proving ground tests, Picatinny Arsenal has conducted an extensive investigation of the fuze to determine and eliminate the cause of decreased functioning reliability. Friction in the gear system was found to be the major cause for these failures. Deformed ground springs were another contributing cause. To correct these problems on existing fuzes, a quantity was degreased, visually inspected, and checked for delay-arming times. The fuzes were degreased with acetone which, in turn, reduced the friction which was apparent in the gear system. Only those samples which passed the inspection and armed with proper delay arming times were selected for testing. Local ballistic tests were conducted with rounds bearing these selected fuzes with satisfactory results. Proposed drawing changes should eliminate these problem areas on any future production of this fuze.

(U) The following program was reconducted in accordance with Test Program Request Number D-49.

2. (U) DESCRIPTION OF MATERIEL

60 Grenade, Rifle, HEAT, M31 with Modified Nose Cap, with Fuze, HE, M211 Lot LS-25-6B.

170 Grenade, Rifle, HEAT, M31E1, with Fuze, HE, T1022E2 with M48 Detonator and T96 primer with HE Booster Lot PA-E-28514.

50 Grenade, Rifle, Inert, M31E1, with Fuze, HE, T1022E2 with HE Booster Lot PA-E-28656.

78 Cartridge, Grenade, Rifle, Cal..30, M3 packed two to each grenade Lot LC-12167.

202 Cartridge, Grenade, Rifle, Cal..30, M3 Lot FA-2.

1 U. S. Rifle, Cal..30, M1, with M7A3 Grenade Launcher.

1 Special Rifle Mount.

1 piece Armor Plate, 3' x 3' x $\frac{1}{2}$".

1 piece Armor Plate, 6' x 6' x $\frac{1}{2}$".

1 piece Armor Plate, 10' x 12' x 3".

1 piece Armor Plate, 6' x 6' x 4".

1 piece Armor Plate, 6' x 6' x 5".

3. DETAILS OF TEST

3.1 Procedure and Results

(U) The testing program was divided into five phases: non-arming, arming, graze sensitivity, penetration of normal plate, and penetration of obliqued-angled plate.

(U) All grenades were fired from a Cal..30 M1 rifle equipped with an M7A3 grenade launcher which was held firmly by a special rifle mount.

3.1.1 (U) Procedure. In the non-arming phase, one piece of armor plate, 3' x 3' x $\frac{1}{2}$" was rigidly supported perpendicular to the line of fire nine feet from the M7A3 launcher. The M31E1 inert grenades with HE T1022E2 fuzes were

fired with cartridge lot number LC-12167 in this phase. Grenades and cartridges were temperature-conditioned for a minimum of 24 hours and were fired at the conditioned temperature.

DATA SHEET NUMBER 1 (C)

Round Number	Fuze Number	Temperature	Velocity, fps
1	511	Ambient	131
2	573	Ambient	137
3	475	Ambient	125
4	526	Ambient	134
5	525	Ambient	137
6	496	Ambient	141
7	457	Ambient	139
8	472	Ambient	124
9	503	Ambient	135
10	473	Ambient	139
11	507	+125°F	142
12	476	+125°F	143
13	594	+125°F	142
14	516	+125°F	141
15	480	+125°F	141
16	597	+125°F	141
17	512	+125°F	141
18	521	+125°F	138
19	481	+125°F	125
20	477	+125°F	140
21	615	+125°F	142
22	500	+125°F	106
23	623	+125°F	143
24	630	+125°F	139
25	466	+125°F	141
26	123 S	+125°F	136
27	543	+125°F	141
28	604	+125°F	102
29	528	+125°F	103
30	558	+125°F	141
31	7XS	-40°F	133
32	246 S	-40°F	140
33	204 S	-40°F	137
34	243 S	-40°F	122
35	318 S	-40°F	135
36	324 S	-40°F	138
37	6XS	-40°F	139
38	203 S	-40°F	129
39	213 S	-40°F	102
40	289 S	-40°F	134
41	151 S	-40°F	121
42	323	-40°F	135
43	3X	-40°F	133

Round Number	Fuze Number	Temperature	Velocity, fps
44	165S	-40°F	131
45	8XS	-40°F	132
46	5XS	-40°F	136
47	152S	-40°F	Lost
48	3XAS	-40°F	137
49	4X	-40°F	131
50	9XS	-40°F	141

3.1.2 (C) Results. There were no grenade functions or target damage in this phase.

Round Number 47 - The velocity was too low to record. The grenade dropped approximately eight inches in nine feet of travel, passed below the armor plate, and impacted on normal soil fourteen feet from the grenade launcher.

The distance between the grenade launcher and the first velocity screen was 2 feet. The distance between screens was 3.5 feet. The average velocity was 133.4 fps.

3.1.3 (U) Procedure. In the arming phase, one piece of armor plate, 6' x 6' x ½" was rigidly supported perpendicular to the line of fire 25 feet from the M7A3 launcher. The M31E1 HE T1022E2 fuzes were fired with cartridge lot, No. FA-2, in this phase. The grenades were temperature-conditioned for a minimum of 24 hours and fired at the conditioned temperature. The cartridges received no conditioning.

DATA SHEET NUMBER 2 (C)

Round Number	Grenade Number	Fuze Number	Temperature	Function on Impact	Velocity, fps
1	186	196	Ambient	High Order	150
2	254	374	Ambient	High Order	153
3	258	432	Ambient	High Order	154
4	269	387	Ambient	High Order	150
5	185	142	Ambient	High Order	149
6	245	429	Ambient	High Order	153
7	206	442	Ambient	High Order	150
8	60	114	Ambient	High Order	149
9	71	133	Ambient	High Order	153
10	273	360	Ambient	High Order	153
11	232	302	+125°F	High Order	151
12	95	117	+125°F	High Order	154
13	261	378	+125°F	High Order	154
14	243	406	+125°F	High Order	154
15	221	443	+125°F	High Order	151
16	220	386	+125°F	High Order	152
17	228	281	+125°F	High Order	152

Round Number	Grenade Number	Fuze Number	Temperature	Function on Impact	Velocity, fps
18	18	358	+125°F	High Order	154
19	101	153	+125°F	High Order	146
20	226	237	+125°F	High Order	151
21	235	267	+125°F	High Order	148
22	281	599	+125°F	High Order	152
23	279	600	+125°F	High Order	150
24	280	551	+125°F	High Order	150
25	82	118	+125°F	High Order	154
26	293	607	+125°F	High Order	153
27	294	617	+125°F	High Order	152
28	323	616	+125°F	High Order	149
29	308	520	+125°F	High Order	149
30	311	479	+125°F	High Order	149
31	145	152	-40°F	High Order	153
32	209	400	-40°F	High Order	155
33	205	410	-40°F	High Order	154
34	215	365	-40°F	High Order	154
35	135	146	-40°F	High Order	153
36	142	139	-40°F	High Order	154
37	214	417	-40°F	High Order	151
38	144	287	-40°F	High Order	151
39	230	249	-40°F	High Order	150
40	213	399	-40°F	High Order	154
41	325	539	-40°F	Failed	154
42	291	587	-40°F	High Order	152
43	343	542	-40°F	High Order	152
44	336	486	-40°F	High Order	152
45	303	460	-40°F	High Order	156
46	331	614	-40°F	High Order	154
47	324	461	-40°F	High Order	150
48	288	585	-40°F	High Order	154
49	313	530	-40°F	High Order	153
50	300	454	-40°F	High Order	Lost

3.1.4 (C) Results. Grenades that functioned made a hole in the target approximately 3/4 inch in diameter. The grenade that failed rendered no damage to the target.

Round Number 41 - Failed even though it had a good impact on the armor plate.

The distance between the grenade launcher and the first velocity screen was 2.5 feet. The distance between screens was 3 feet. The average velocity was 151.9 fps.

3.1.5 (U) Procedure. In the graze sensitivity phase, the impact area was firm, level soil, free from obstructions and with no severe inclinations or declinations. The M31E1 HE grenades with HE T1022E2 fuzes were used in this phase. The grenades were temperature-conditioned for a minimum of 24 hours and fired at the conditioned temperature. Round numbers 1 thru 28

were fired with cartridge lot No. LS-12167, and were conditioned with the grenades. Round numbers 29 thru 60 were fired with cartridge lot, No. FA-2, which received no conditioning.

DATA SHEET NUMBER 3 (C)

Round Number	Grenade Number	Fuze Number	Temperature	Function on Impact	Range, feet	Velocity, fps
1	222	218	Ambient	High Order	120	None
2	237	330	Ambient	Failed	110	None
3	198	370	Ambient	High Order	130	None
4	242	253	Ambient	Failed	100	None
5	196	379	Ambient	High Order	140	None
6	240	264	Ambient	High Order	130	None
7	187	282	Ambient	High Order	130	None
8	217	369	Ambient	High Order	120	None
9	193	404	Ambient	High Order	120	None
10	241	201	Ambient	High Order	130	None
11	342	581	Ambient	High Order	120	None
12	316	487	Ambient	High Order	120	None
13	327	455	Ambient	High Order	130	None
14	328	492	Ambient	Failed	130	None
15	339	540	Ambient	High Order	130	None
16	314	513	Ambient	High Order	130	None
17	315	575	Ambient	High Order	130	None
18	341	632	Ambient	High Order	130	None
19	330	588	Ambient	High Order	130	None
20	329	550	Ambient	High Order	140	None
21	225	102	+125°F	High Order	120	None
22	212	395	+125°F	Failed	120	None
23	244	375	+125°F	High Order	100	None
24	180	232	+125°F	High Order	100	None
25	234	313	+125°F	High Order	90	None
26	104	345	+125°F	Failed	100	None
27	197	411	+125°F	High Order	90	None
28	238	312	+125°F	Failed	100	None
29	282	470	+125°F	High Order	100	148
30	310	537	+125°F	High Order	110	150
31	305	502	+125°F	High Order	100	144
32	284	547	+125°F	High Order	110	148
33	296	549	+125°F	High Order	110	146
34	312	631	+125°F	High Order	110	149
35	278	524	+125°F	High Order	120	149
36	275	514	+125°F	High Order	120	150
37	276	468	+125°F	High Order	100	147
38	204	401	+125°F	High Order	100	152
39	287	470A	+125°F	High Order	100	149
40	157	268	+125°F	Failed	100	144
41	181	200	-40°F	High Order	100	148
42	163	238	-40°F	High Order	110	149

Round Number	Grenade Number	Fuze Number	Temperature	Function on Impact	Range, feet	Velocity, fps
43	184	348	-40°F	High Order	110	150
44	264	419	-40°F	High Order	100	147
45	165	228	-40°F	High Order	100	148
46	248	367	-40°F	High Order	100	147
47	262	354	-40°F	High Order	100	147
48	307	533	-40°F	High Order	100	148
49	322	504	-40°F	High Order	100	149
50	246	352	-40°F	High Order	100	148
51	298	545	-40°F	High Order	100	144
52	233	546	-40°F	High Order	100	146
53	260	364	-40°F	High Order	100	143
54	319	582	-40°F	High Order	100	145
55	270	396	-40°F	Failed	100	150
56	326	506	-40°F	High Order	90	147
57	335	606	-40°F	High Order	100	146
58	332	510	-40°F	Failed	100	148
59	292	544	-40°F	High Order	100	152
60	283	527	-40°F	High Order	100	146

3.1.6 (C) Results. The elevation for round numbers 1 thru 22 was 5° and 23 thru 60 was 3°.

The range is the distance from the launcher to initial impact.

Round Number 4 - poor flight, oscillated approximately 30°.

Round Numbers 8, 16, 25, and 39 - fin separated from the stabilizer tube on firing.

Angle of impact for round numbers 8, 16, 25, and 31 was 90°, 0°, 45°, and 0° respectively. Angle of impact for the other rounds was approximately equal to the elevation at which they were fired.

Function occurred on the fourth, third, sixth, and second impact for round numbers 21, 31, 39, and 44 respectively. All other rounds functioned on initial impact.

The distance between the grenade launcher and the first velocity screen was 5 feet. The distance between screens were 3.5 feet. The average velocity for round numbers 29 thru 60 was 147.6 fps.

3.1.7 (U) Procedure. In the penetration of oblique - angled plate phase, one piece of armor plate, 10' x 12' x 3", was positioned perpendicular to the terrain but forming an inclosed angle of 25° with the line of fire at a range of 75 feet from the launcher.

The M31E1 HE grenade with HE T1022E2 fuze and M31 HE grenade with HE M211 fuze (used as control rounds) was fired with cartridge lot number

FA-2 in this phase. The grenades were temperature-conditioned for a minimum of 24 hours and fired at the conditioned temperature. The cartridges received no conditioning.

DATA SHEET NUMBER 4 (C)

Round Number	Grenade Number	Fuze Number	Temperature	Grenade Model	Penetration Depth, inches	Velocity, fps
1	272	434	Ambient	M31E1	4-1/2	147
2	259	377	Ambient	M31E1	5-3/4	147
3	266	398	Ambient	M31E1	0	125
4	251	385	Ambient	M31E1	Perforated	149
5	252	425	Ambient	M31E1	5-1/4	149
6	263	427	Ambient	M31E1	Perforated	147
7	176	293	Ambient	M31E1	Perforated	148
8	247	355	Ambient	M31E1	Perforated	147
9	255	361	Ambient	M31E1	Perforated	146
10	179	288	Ambient	M31E1	Perforated	150
11	162	121	/125°F	M31E1	0	None
12	302	533	/125°F	M31E1	Perforated	None
13	304	458	/125°F	M31E1	Perforated	None
14	153	2X	/125°F	M31E1	0	None
15	140	170	/125°F	M31E1	Perforated	None
16	183	3	/125°F	M31E1	0	None
17	239	247	/125°F	M31E1	Perforated	None
18	236	45	/125°F	M31E1	Perforated	None
19	201	413	/125°F	M31E1	Perforated	None
20	199	402	/125°F	M31E1	Perforated	None
21	93	329	-40°F	M31E1	3-1/2	None
22	127	333	-40°F	M31E1	1-3/4	None
23	233	164	-40°F	M31E1	Perforated	None
24	107	351	-40°F	M31E1	4-1/4	None
25	91	9	-40°F	M31E1	5-3/4	None
26	125	322	-40°F	M31E1	Perforated	None
27	211	409	-40°F	M31E1	Perforated	None
28	203	439	-40°F	M31E1	Perforated	None
29	126	278	-40°F	M31E1	0	None
30	208	418	-40°F	M31E1	5	None
31	None	None	Ambient	M31	Perforated	None
32	None	None	Ambient	M31	Perforated	None
33	None	None	Ambient	M31	Perforated	None
34	None	None	Ambient	M31	Perforated	None
35	None	None	Ambient	M31	Perforated	None
36	None	None	Ambient	M31	Perforated	None
37	None	None	Ambient	M31	Perforated	None
38	None	None	Ambient	M31	Perforated	None
39	None	None	Ambient	M31	Perforated	None
40	None	None	Ambient	M31	Perforated	None
41	None	None	/125°F	M31	Perforated	None
42	None	None	/125°F	M31	Perforated	None
43	None	None	/125°F	M31	Perforated	None

Round Number	Grenade Number	Fuze Number	Temperature	Grenade Model	Penetration Depth, inches	Velocity, fps
44	None	None	+125°F	M31	Perforated	None
45	None	None	+125°F	M31	Perforated	None
46	None	None	+125°F	M31	Perforated	None
47	None	None	+125°F	M31	Perforated	None
48	None	None	+125°F	M31	Perforated	None
49	None	None	+125°F	M31	Perforated	None
50	None	None	+125°F	M31	Perforated	None
51	None	None	-40°F	M31	Perforated	None
52	None	None	-40°F	M31	Perforated	None
53	None	None	-40°F	M31	5-3/4	None
54	None	None	-40°F	M31	Perforated	None
55	None	None	-40°F	M31	Perforated	None
56	None	None	-40°F	M31	Perforated	None
57	None	None	-40°F	M31	Perforated	None
58	None	None	-40°F	M31	Perforated	None
59	None	None	-40°F	M31	Perforated	None
60	None	None	-40°F	M31	Perforated	None

3.1.8 (C) Results. The distance between the grenade launcher and the first velocity screen was 4.5 feet. The distance between screens was 3.5 feet. The average velocity for round numbers 1 thru 10 was 145.5 fps. No velocities requested on remainder of the program.

Round Numbers 3, 11, 14 - incident angle was 0°, which accounts for no penetration.

Round Numbers 6, 18 - incident angle was 90°.

Round Number 7 - incident angle was 135°.

Round Numbers 16, 29 - incident angle was approximately 180°, rounds failed to function on impact with the plate but functioned on ground impact.

Round Numbers 21, 25, 30 - impacted plate near previous impact points.

Round Numbers 6, 14, 29 - fin separated from stabilizer tube on firing.

The depth of penetration was measured to some obstruction in the hole in the armor plate.

3.1.9 (U) Procedure. In the penetration of normal-plate phase, two pieces of armor plate, 6' x 6' x 5" and 6' x 6' x 4", were positioned perpendicular to the line of fire at a range of 75 feet from the grenade launcher.

The M31E1 HE grenade with HE T1022E2 fuze and M31 HE grenade with HE M211 fuze (used as control rounds) was fired with cartridge lot number FA-2 in this phase. The grenades were temperature-conditioned for a minimum of 24 hours and fired at the conditioned temperature. The cartridges received no conditioning.

DATA SHEET NUMBER 5 (C)

Round Number	Grenade Number	Fuze Number	Temperature	Grenade Model	Penetration Depth, inches
1	148	342	Ambient	M31E1	Perforated
2	170	147	Ambient	M31E1	0
3	151	175	Ambient	M31E1	Perforated
4	171	338	Ambient	M31E1	6-1/2
5	155	320	Ambient	M31E1	Perforated
6	156	309	Ambient	M31E1	Perforated
7	164	297	Ambient	M31E1	Perforated
8	168	136	Ambient	M31E1	Perforated
9	161	239	Ambient	M31E1	0
10	169	210	Ambient	M31E1	Perforated
11	172	229	+125°F	M31E1	Failed
12	223	100	+125°F	M31E1	3-1/2
13	175	311	+125°F	M31E1	Perforated
14	253	415	+125°F	M31E1	Perforated
15	268	357	+125°F	M31E1	0
16	295	536	+125°F	M31E1	0
17	174	179	+125°F	M31E1	Perforated
18	250	382	+125°F	M31E1	8-3/4
19	178	307	+125°F	M31E1	Perforated
20	271	421	+125°F	M31E1	6
21	81	262	-40°F	M31E1	8-1/2
22	143	319	-40°F	M31E1	Perforated
23	97	None	-40°F	M31E1	2-1/2
24	141	233	-40°F	M31E1	7
25	112	273	-40°F	M31E1	5
26	224	223	-40°F	M31E1	6-1/2
27	202	363	-40°F	M31E1	4-3/4
28	100	X	-40°F	M31E1	7-1/2
29	219	437	-40°F	M31E1	4-1/2
30	207	42	-40°F	M31E1	Perforated
31	None	None	Ambient	M31	Perforated
32	None	None	Ambient	M31	Perforated
33	None	None	Ambient	M31	Perforated
34	None	None	Ambient	M31	Perforated
35	None	None	Ambient	M31	Perforated
36	None	None	Ambient	M31	Perforated
37	None	None	Ambient	M31	Perforated
38	None	None	Ambient	M31	Perforated
39	None	None	Ambient	M31	Perforated
40	None	None	Ambient	M31	Perforated
41	None	None	+125°F	M31	Perforated
42	None	None	+125°F	M31	Perforated
43	None	None	+125°F	M31	Perforated
44	None	None	+125°F	M31	Perforated
45	None	None	+125°F	M31	Perforated

Round Number	Grenade Number	Fuze Number	Temperature	Grenade Model	Penetration Depth, inches
46	None	None	+125°F	M31	Perforated
47	None	None	+125°F	M31	Perforated
48	None	None	+125°F	M31	Perforated
49	None	None	+125°F	M31	Perforated
50	None	None	+125°F	M31	Perforated
51	None	None	-40°F	M31	Perforated
52	None	None	-40°F	M31	3-1/2
53	None	None	-40°F	M31	Perforated
54	None	None	-40°F	M31	Perforated
55	None	None	-40°F	M31	Perforated
56	None	None	-40°F	M31	Perforated
57	None	None	-40°F	M31	Perforated
58	None	None	-40°F	M31	Perforated
59	None	None	-40°F	M31	Perforated
60	None	None	-40°F	M31	8

3.1.10 (C) Results. No velocities were requested in this phase.

Round Numbers 2, 11, 15, 16 - the fuze separated from the grenade on plate impact. The fuzes functioned on ground impact, except number 11 which failed. These malfunctions are attributed to the fin separating from the stabilizer tube on firing allowing the angle of impact to be 0°.

Round Numbers 9, 12, 20, 25, 28 - angle of impact was approximately 0°, 20°, 30°, 30°, 45° respectively. The fin separated from the stabilizer tube on firing.

The depth of penetration was measured to some obstruction in the hole in the plate.

3.2 (C) Observations

It was observed before firing that the rivets securing the fin to the stabilizer tube were loose on some of the M31E1 grenades. It is believed that the gases from the cartridge forced the rivets out as the fin left the muzzle of the grenade launcher. This was evidenced by a quantity of rivets being located on the ground beneath the launcher. All of the M31 grenades had very stable flights.

The grenade and fuze numbers correspond with X-rays taken at Picatinny Arsenal before testing.

4. (C) CONCLUSIONS

It is concluded that:

a. Fewer failures would have occurred if the grenades impacted at the proper angle.

b. Temperature has no functioning effect on either the T1022E2 or M211 fuze.

c. Penetration differences between the M31E1 grenade and the M31 grenade are negligible.

5. (C) RECOMMENDATIONS

It is recommended that in the future production of the M31E1 grenade, a more positive method of securing the fin to the stabilizer tube be employed.

SUBMITTED:

Russell W. Gross
RUSSELL W. GROSS
Test Director

REVIEWED:

Victor L. Grafton
VICTOR L. GRAFTON
Chief, Bomb and Fragmentation Branch

Claude E. Brown
CLAUDE E. BROWN
Chief, Infantry and Aircraft Weapons Division

APPROVED:

H. A. Noble
H. A. NOBLE
Assistant Deputy Director
for Engineering Testing
Development and Proof Services

APPENDICES

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Department of the Army
Ordnance Corps
Picatinny Arsenal
Dover, N. J.

APPENDIX A

Mr. KWong/mr/3136

Correspondence

DC2

SUBJECT: Test Program Request No. D-49 - Grenade, Rifle, HEAT, M31E1 (With T102E2 Fuze)

TO: Commanding General
Aberdeen Proving Ground
Aberdeen, Maryland

ATTN: ORDBG

REFERENCE: a. TT1038, Picatinny Arsenal to Aberdeen Prov Ground and Chief of Ordnance, 31 January 1958
b. TT1330, Picatinny Arsenal to Aberdeen Prov Ground and Chief of Ordnance, 10 February 1958

1. Reference a outlined the test program for the M31E1 Rifle Grenade as requested by Chief of Ordnance and Reference b revised the number of available M31E1 Grenades from 300 to 281 rounds. Inclosed is the detail Test Program Request No. D-49 for the subject grenade. The 281 M31E1 Grenades in the Test Program Request were shipped to your Proving Ground on 6 February 1958. Ordnance Ammunition Command informed this Arsenal that Letterkenny Ordnance Depot, Pennsylvania was to furnish the 60 standard M31 Grenades between 5 and 7 February 1958. Approval of this test program has been requested from Chief of Ordnance.

2. Funding Data - Funds in the amount of $5,000 are available on AIF Order 87110100-99-60198. Following your review of the subject test program request, advise this Arsenal immediately as to the adequacy of these funds.

3. Coordination

a. Office, Chief of Ordnance, ORDTW

b. Picatinny Arsenal - Project Engineers, Mr. J. Fagan and Mr. K. Wong, Picatinny Arsenal Extension 5270

c. Ordnance Ammunition Command, ORDIX-ARB

ORDBB-DC2
SUBJECT: Test Program Request No. D-49 - Grenade, Rifle, HEAT, M31E1 (With T1022E2 Fuze)

d. Headquarters U. S. Marine Corps, AOMF

4. Notification for Test Attendance

a. Office, Chief of Ordnance, ORDTW, Mr. Kowaleski

b. Picatinny Arsenal, Industrial Engineering Division, Mr. J. Fagan and Mr. K. Wong

c. Ordnance Ammunition Command, ORDLY-ARBM, Mr. C. Zeman

d. Marine Corps, AOMF, Lt. Col. Reynolds

Request notice of attendance 3 days prior to testing.

FOR THE COMMANDER:

H. D. RUTKOVSKY
Assistant

1 Incl
1. TTR D-49 (in dupe)

CC
OAC, ORDLY-ARB, Mr. Monahan w/incl
OCO, ORDTW, Mr. Kowaleski w/incl
OAC, ORDLY-ARBM, Mr. Zeman w/incl
Hdqtrs, US Marine Corps, AOMF, Lt Col Reynolds w/incl

Mr. K. Wong/mr/3136
Test Program Request No. D-49
Picatinny Arsenal, Dover, N. J.

1. Material for Test

a. 281 Grenade, Rifle, HEAT, M31E1 w/Fuze, Grenade, Rifle, T1022E2 (HE loaded), Lot PA-SR-13-57

b. 60 Grenade, Rifle, HEAT, M31 w/Fuze, Grenade, Rifle, M211 (HE loaded)

2. Project Authority

a. Project No. TA1-2708J (PA-3-6)

b. Authority: TT13213, Chief of Ordnance to Picatinny Arsenal, 29 January 1958

3. Arsenal Expenditure Order No.

AIF 87110100-99-60198

4. Object of Development

To develop an improved rifle grenade fuze for use with the M31E1 Grenade. This new Fuze, T1022E2, added a graze functioning element, an arming delay and drop safety features to this anti-tank weapon system.

5. History Sketch

Reference development tests in Test Program Request 3837 and 3897. The industrial engineering study on the T1022E2 Fuze was conducted under Ordnance Project No. AR-AF-17. A description of the fuze is presented in Picatinny Arsenal Notes on Development Type Material No. 172.

6. Description in Detail of Improvements Made Since Last Proving Ground Test

This T1022E2 Fuze has undergone production engineering study evolving a more economical design that is more suitable for mass production. In addition, a drop safety device has been added. This device was evaluated for Aerial Delivery by Aberdeen Proving Ground and results are contained in Aberdeen Proving Ground Firing Record B-14139.

7. Local Tests

Local evaluation tests were conducted on the T1022E2 Fuzes assembled in M31E1 Grenades. A total of 250 inert loaded grenades and HE loaded fuzes were used. The test program included: drop test (40 foot), Graze

Function, Arming Test, Transportation Vibration Test, Conditioning at +160°F, Conditioning at -80°F, Salt Spray, Static Detonator Safety, JAN Cycle, oblique plate functioning and normal plate functioning. Description of tests and test results are reported in Report No. 61-1902, Proof Testing Unit, Picatinny Arsenal.

8. Object of Test

To determine the effectiveness of the T1022E2 Rifle Grenade Fuze with respect to graze and delay arming, and to demonstrate the plate penetration characteristics of the M31E1 Grenade.

9. Precautions in Handling and Testing

The usual precautions in handling HE loaded grenades and fuzes should be observed.

10. Recommended Test Program

All grenades are to be fired from a .30 Caliber M1 Rifle assembled to a M7A3 Grenade Launcher.

a. Non-Arming Tests

a.1. Ten of the Grenades, M31E1, of paragraph 1a will be fired at ambient temperature against a rigidly supported $\frac{1}{2}$ inch thick steel plate positioned perpendicular to the line of fire at 9 feet from the M7A3 Launcher. None of these rounds should function on impact with the target; however, they may fire on impact after dropping to the ground. Record whether the grenade functions on impact with the target and description of target damage.

a.2. Repeat the non-arming test of a.1., except that 20 M31E1 Grenades should be used, and that these grenades should be conditioned at +125°F for a minimum of 24 hours and fired at the conditioning temperature.

a.3. Repeat the non-arming test of a.1., except that 20 M31E1 Grenades should be used and that these grenades should be conditioned at -40°F for a minimum of 24 hours and fired at the conditioning temperature.

b. Arming Tests

b.1. Ten Grenades M31E1 from paragraph 1a will be fired at ambient temperatures against a rigidly supported $\frac{1}{2}$ inch thick steel

plate positioned perpendicular to line of fire at 25 feet from the launcher. Each of these rounds should function on target impact. Record the functioning of the grenade and describe target damage.

b.2. Repeat the arming test of b.1., except that 20 M31E1 Grenades should be conditioned at +125°F for a minimum of 24 hours and fired at the conditioning temperature.

b.3. Repeat the arming test of b.1., except that 20 M31E1 Grenades should be used, and that these grenades should be conditioned at -40°F for a minimum of 24 hours and fired at the conditioning temperature.

c. Graze Sensitivity

c.1. Twenty M31E1 Grenades from paragraph 1a will be launched at ambient temperature. The launcher should be positioned at 5° elevation. Point of impact willoccur at approximately 100 feet from the launcher. The impact area should consist of normal, level, hard soil, free from obstructions and with no severe inclination or declination of the ground. Record the observed angle of impact, whether grenade functions on initial or subsequent impact, and distance from launcher to point of impact.

c.2. Repeat the graze sensitivity test of c.1., except that the 20 grenades should be conditioned at +125°F for a minimum of 24 hours and fired at the conditioning temperature.

c.3. Repeat the graze sensitivity test of c.1., except that the 20 grenades should be conditioned at -40°F for a minimum of 24 hours and fired at the conditioning temperature.

d. Penetration Tests at Normal Plate

d.1. Ten Grenades, M31E1, will be launched at ambient temperature against 9 inch armor plate positioned perpendicular to the line of firing at a distance of 75 feet from the launcher. Record grenade functioning, depth of penetration, and target damage.

d.2. Repeat test d.1., except that the 10 grenades, M31E1, should be conditioned at +125°F for a minimum of 24 hours and fired at the conditioning temperature.

d.3. Repeat test d.1., except that the 10 grenades (M31E1) should be conditioned at -40°F for a minimum of 24 hours and fired at the conditioning temperature.

d.4. Repeat tests d.1., d.2., and d.3, except for each phase of firing, 10 standard Grenades M31 (w/M211 Fuzes) from paragraph 1.b. should be used.

e. Penetration Tests at Obliqued Angle Plate

e.1. Ten Grenades, M31E1, will be launched at ambient temperature against 3 inch armor plate positioned perpendicular to the terrain but forming an inclosed angle of 25 degrees with the line of firing. The range should be 75 feet from the launcher. Record grenade functioning, depth of penetration, target damage and incident angle of grenade with the target plate.

e.2. Repeat test e.2., except that the 10 Grenades (M31E1) should be conditioned at +125°F for a minimum of 24 hours and fired at the conditioned temperature.

e.3. Repeat test e.1., except that the 10 Grenades (M31E1) should be conditioned at -40°F for a minimum of 24 hours and fired at the conditioning temperature.

e.4. Repeat tests e.1, e.2., and e.3., except for each phase of firing, 10 standard Grenades M31 (w/M211 Fuzes) from paragraph 1.b. should be used.

NOTE: Above procedure requires 220 M31E1 and 60 M31 Rounds. The additional 61 M31E1 Grenades to be furnished may be fired at the discretion of the Marine Corps observers.

11. Coordination

Office, Chief of Ordnance
Ordnance Ammunition Command
Aberdeen Proving Ground
Headquarters U. S. Marine Corps
Picatinny Arsenal

12. Report Distribution

Office, Chief of Ordnance, ORDTW and ORDTM
Picatinny Arsenal, 3 copies
Ordnance Ammunition Command, ORDLY-AR
Marine Corps, AO4F

H. D. RUTKOVSKY
Assistant

ORDTS 1st Ind Mr. Nowaleski/rn/77994
OA/801-5797
SUBJECT: Test Program Request No. D49 for Ballistic Tests of Grenade, Rifle, HEAT, M31M1

DA, OCO O, Washington 25, D.C., 21 Feb 53

TO: CO, Aberdeen Proving Ground, Md., ATTN: DRTS

1. The inclosed TPR No. D-49 is approved and forwarded for necessary action.

2. Picatinny Arsenal teletype 1530 dated 18 February 1953 (a copy of which was furnished to your station) requests that additional measurements be made during the conduct of this test program. It is desired that the measurements requested be incorporated in the inclosed TPR.

FOR THE CHIEF OF ORDNANCE:

1 Incl
n/c

G. P. GRANT
Lt Col, Ord Corps
Assistant

CC
Picatinny Arsenal, ATTN: ORDSB-DC2

ORDNANCE CORPS
PICATINNY ARSENAL
DOVER, NEW JERSEY

Mr. ALanior/ml/5111

MAR 25 '59 -1 PM

IN REPLY
REFER TO:
INDUSTRIAL ENGINEERING DIVISION
ORDBB-DC3

SUBJECT: TPR No. D-49, Grenade, Rifle, M31E1 with Fuze, T1022E2

TO: Commanding General
Aberdeon Proving Ground
Aberdeen, Maryland
ATTN: ORDBG

REFERENCE: a. TPR No. D-49, Picatinny Arsenal to Aberdeen Proving Ground, 17 Feb 58
b. Telephone conversation between A. Lanior of Picatinny Arsenal and R. Gross of Aberdeen Proving Ground, 18 Feb 59

1. This Arsenal is currently preparing 220 complete rounds of Grenade, Rifle, M31E1 with Fuze, T1022E2 for submission to your Proving Ground for engineering tests. These rounds will be shipped during the week of 16 March 1959. A quantity of 170 of these rounds will be fully HE loaded and 50 rounds will contain inert loaded grenade bodies with HE loaded fuzes. The rounds containing the inert filler are to be used during the non-arming phase of the test in order to expedite dud destruction. Ordnance Ammunition Command has been requested by this Arsenal to have 60 standard rounds (Grenade, Rifle, M31 with Fuze, M211) shipped to your Proving Ground for use in this program.

2. It is requested that the entire program be reconducted in accordance with Reference a as discussed in Reference b.

3. Since previous Proving Ground tests, this Arsenal has conducted an extensive investigation of the fuze in order to determine and eliminate the cause of decreased functioning reliability. Friction in the fuze's gear system was found to be the major cause for these failures. Deformed ground springs which interfered with the rotor's rotation and weak rotor springs were other contributing causes. In order to correct these problem areas on existing fuzes, a quantity was degreased, visually inspected and checked for delay arming times. The fuzes were degreased with acetone in order to insure the cleanliness of

the metal parts which were left contaminated by the metal parts producer. Degreasing also reduced the friction which was apparent in the gear system. Only those samples which passed the inspection and armed with proper delay arming times were selected for Proving Ground tests. Local ballistic tests were conducted with rounds bearing these selected fuzes with satisfactory results. Proposed drawing changes should eliminate these problem areas on any future production of this fuze.

4. Additional funds in the amount of $6,000 will be forwarded as an increase to Army Industrial Fund Order 97110100-99-60129 under separate cover. The applicable OO Form AOS-2 will also be forwarded under separate cover.

5. Notification for test attendance:

a. Office, Chief of Ordnance, ORDTW, Mr. Kowaleski

b. Ordnance Ammunition Command, ORDLY-AR, Mr. F. Motta

c. U. S. Marine Corps, AO4F, Lt Col Reynolds

d. Picatinny Arsenal, Industrial Engineering Division, Mr. W. Gray and Mr. A. Lanier

Request notice of attendance 3 days prior to testing.

FOR THE COMMANDER:

H. D. RUTKOVSKY
Assistant

1 Incl
1. OO Form AOS-2, s/c

CC
OAC, ORDLY-AI and
ORDLY-AR, Mr. Motta, w/o Incl
OCO, ORDTW, Mr. Kowaleski, w/o Incl
U.S. Marine Corps, AO4F,
Lt Col Reynolds, w/o Incl

APPENDIX B

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	Commanding Officer Picatinny Arsenal	
6, 7, 8	Dover, New Jersey	3
	Commanding General Ordnance Ammunition Command Joliet, Illinois	
9	ATTN: ORDLY-AR - Mr. F. Motta	1
10	ORDLY-AI	1
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