EVALUATION OF 7.62 MM CARTRIDGES ASSEMBLED WITH CALIBER .30 API AND INCENDIARY BULLETS

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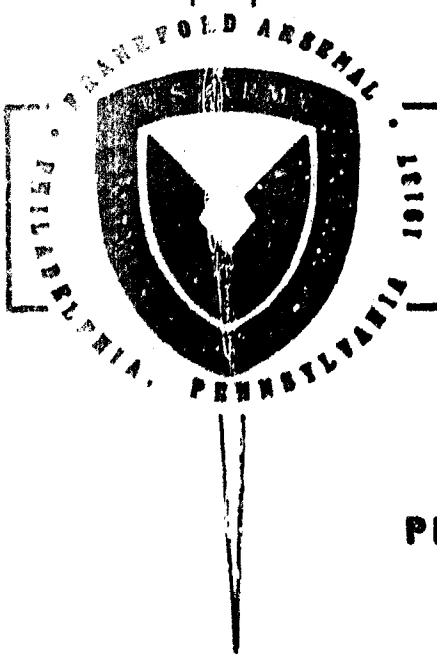

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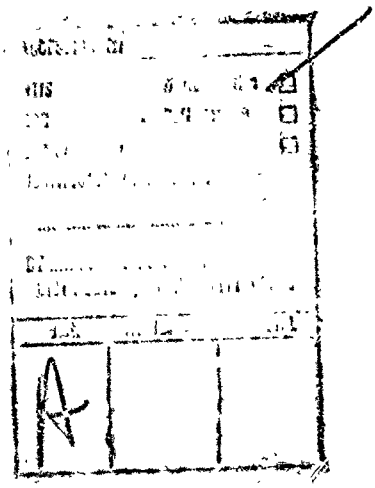

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18. SUPPLEMENTARY NOTES

The object of these tests was primarily to evaluate a sample of 7.62 mm cartridges assembled with Caliber .30 bullets for their functional performance and safety, with secondary emphasis on terminal performance.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Cartridge 7.62 mm API; Incendiary; Small Arms Ammunition;
Cartridge Caliber .30 API; Incendiary

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes an evaluation of a sample of 7.62 mm cartridges that were assembled with Caliber .30 armor piercing incendiaty (API) and incendiary bullets for the U.S. Air Force (USAF).

The terminal performance as well as the overall cartridge performance was evaluated. The results are presented in this report. In general, the 7.62 mm cartridges, assembled with Caliber .30 API and incendiary bullets,

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20. ABSTRACT (Continued)

performed satisfactorily in the 7.62 mm minigun. However, the rifling twist of other 7.62 mm weapons is slower than that in the minigun and did not provide adequate spin to stabilize the bullets. The terminal performance of these cartridges is similar to that of their Caliber .30 equivalents.

It was concluded that the 7.62 mm API and incendiary cartridges described in this report are suitable for minigun use.

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INTRODUCTION

In 1969 the U.S. Air Force (USAF) had an immediate requirement to field test 7.62 mm ammunition with armor piercing incendiary (API) and incendiary capability. Since these cartridge types did not exist in the 7.62 mm family of cartridges, but did exist as Caliber .30 cartridges, it was decided to use the Caliber .30 bullets assembled into 7.62 mm cases. Consequently, in June of 1969, Frankford Arsenal received a Military Interdepartmental Purchase Request (MIPR) from the USAF Aeronautical Systems Division (ASD) situated at Wright-Patterson Air Force Base. That document provided for the fabrication of 200,000 7.62 mm cartridges assembled with Caliber .30 API bullets, and 20,000 7.62 mm cartridges assembled with Caliber .30 incendiary bullets. These cartridges were to be loaded to a velocity that was as close as possible to the Caliber .30 cartridge velocities but still within the 7.62 mm pressure limits. The 220,000 cartridges were to be linked and packed for minigun consumption.

Approximately four months after receipt of the Air Force MIPR, assembly of the 7.62 mm API and incendiary cartridges was completed. Several thousand rounds of each cartridge type were expended in ballistic evaluation tests in the minigun and in other 7.62 mm weapons. Air Force representation from the Tactical Air Command (TAC) and the ASD were present for a portion of the testing.

DISCUSSION

The types of tests performed in-house at Frankford Arsenal, and the results obtained are summarized in Table 1. While these tests indicated a satisfactory level of cartridge performance, certain deficiencies were encountered that warrant comment.

During accuracy testing in the 7.62 mm test barrel having 1 turn in 12 inch twist rate, it was observed that the Caliber .30 API bullet was not stable; while the Caliber .30 incendiary bullet apparently was. The instability observed in the Caliber .30 API bullet resulted in excessive bullet yawing, erratic flight (with extreme spreads in the order of 89 inches at the 300-yard accuracy target), and a subsequent decrease in down-range effectiveness. When both the API and incendiary were fired in a special 7.62 mm test barrel having a 1 turn in 10 inch twist rate, the extreme spreads were satisfactory as noted in Table 1. It is further noted that when fired in the 7.62 mm minigun barrel, which has a 1 turn in 10 inch twist rate, both the incendiary and API bullets exhibited satisfactory stability.

During the testing of the incendiary cartridge, two bullet bursts were encountered in the velocity testing. These bursts resulted in a bright flash at the muzzle of the weapon, and a subsequent loss of the velocity measurement since the bullet did not pass the screens. To more

Table 1. Summary of Ballistic Evaluation, Cartridge 7.62 mm Assembled with Caliber .30 API and Incendiary Bullets

	API	Incendiary
Accuracy (in) at 300 Yards		
Extreme Vertical	6.8	9.6
Extreme Horizontal	5.8	11.1
Extreme Spread	7.9	13.1
Velocity (ft/sec) at 78 ft		
+70°F	2725	2692
+125°F	2750	2738
-65°F	2642	2626
Chamber Pressure (PSI)		
+70°F	46000	41900
+125°F	47400	44700
-65°F	43700	41000
Port Pressure (PSI)	12000	11200
Waterproof (Case Mouth) 50 rd sample		
fast leaks	7	13
slow leaks	26	27
Action Time (milli sec)		
Test 1	1.251	1.300
Test 2	1.246	1.280
Bullet Extraction (pounds)	131	133
Function and Casualty		
+70°F	OK	OK
+125°F	OK	OK
-65°F	OK	OK
Minigun Velocity (ft/sec) at 78 ft		
Burst 1	2737	2728
Burst 2	2796	2734
Burst 3	2747	

accurately determine the rate of occurrence of these malfunctions, a function test was conducted with an M60 machine gun, firing 280 rounds at a rolling paper target. In this test, no bullet burst or any other abnormalities occurred.

A number of cartridge waterproofing failures were encountered during the testing. These "leakers" were expected to cause no difficulties in the end use of these cartridges by the Air Force, providing the ammunition was not stored under humid conditions for long periods of time. The ammunition was, furthermore, packed in the M548 shipping and storage container which is itself waterproof and airtight.

A limited investigation of the terminal performance of these cartridges was conducted. The test procedures and criteria for the Caliber .30 API and incendiary cartridges was used to evaluate the 7.62 mm equivalents. It was determined that the 7.62 mm equivalent cartridges performed "as good as" the Caliber .30 cartridges. Other comments on the terminal performance and some representative photographs are included in Appendix A.

As stated before, the API bullet was not stable in the 1 turn in 12 inch twist barrels, but was stable in the 1 in 10 inch barrel. In order to predict under what conditions the bullet would and would not be stable, an attempt was made to determine the stability factor of the API bullet.

The stability factor was computed by two independent methods. The first, a yaw-card method, entailed firing through 20 cards placed at 1 foot intervals, in the bullet's path. The resultant analysis, by the methods of Hitchcock[1] and of Myers[2], yielded an estimate of 1.26 for the stability factor.

In the second method, moments of inertia were measured by means of a torsion pendulum and used as inputs into a previously verified computer program to calculate the center of pressure and normal force coefficient by the Van Dyke, hybrid, second-order, supersonic-flow theory. The stability factor could then be computed by standard methods and was found to be 1.27.

Both measures applied to stationary gun, and atmospheric conditions of 59°F, 78 percent RH and 750 mm Hg atmospheric pressure, and twist rate of 1 turn in 10 inches. Under these same conditions with a 1 turn in 12 inch barrel the stability factor is 0.88. The theoretical lower limit of the stability factor for stable flight is 1.0. When the value of stability factor is less than 1.0, the yawing motion (imparted by launch effects) of the projectile will no longer damp out. The yaw will tend to increase, and

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[1] Aerodynamics of Small Arms Bullets, H.P. Hitchcock, BRL Report No. 276, 8 May 1942.

[2] Stability of Experimental Caliber .60 Bullets, Second Report on Project 3/137, Frank E. Myers, Frankford Arsenal Report R-714, March 1946.

cause the projectile eventually to tumble. In practical applications 1.1 is commonly used as the lower limit of stability factor under all operating conditions; i.e. low temperature. This provides a modest margin, to allow for bullet variations due to manufacturing, and also for twist variations in gun barrels.

The stability factor is partially a function of air density. Temperature is one of the variables that affects air density, and also affects Mach number, which in turn affects the overturning moment of the bullet. The stability factor is also a function of both the bullet velocity with respect to the gun and with respect to the air. Therefore, stability will be affected by firing from a moving aircraft. A curve can be generated showing the relation between bullet stability and aircraft velocity for firing in a given direction under a fixed set of atmospheric conditions. A family of such curves can be generated for different temperatures, holding the other atmospheric condition constant. This was accomplished by first generating a curve of the overturning moment derivitive as a function of Mach number using the Van Dyke hybrid flow theory.

Two families of curves were generated. The first set of curves, labeled Figure 1 is for forward horizontal firing from a moving aircraft and represents the most severe condition. The second set of curves, labeled Figure 2 is for firing horizontally sidewise from a moving aircraft. For firing at a position between forward (0^{o}) and sidewise ($\pm 90^{o}$), and at an elevation other than horizontal, the stability value will lie between those given by the two curves. These curves do not apply to any firing directed toward the rear of the aircraft.

It can be seen from the curves that, by the criterion of 1.1 as the minimum practical stability factor, the acceptable range of firing conditions is quite limited for this bullet.

Upon completion of these evaluations, a safety statement for each cartridge was transmitted to AMSMU-Q for appropriate action in accordance with procedures prescribed in USAMUCOMR 700-56. These statements, attached as Appendix B, summarize the information obtained and list cartridge performance deficiencies experienced during the testing.

CONCLUSIONS

The Caliber .30 API and incendiary bullets, reloaded into 7.62 mm cases perform satisfactorily when fired in the minigun under specific conditions. However, the basic problem of instability in the 7.62 mm weapons other than the minigun makes the API an unsuitable design for 7.62 mm cartridge.

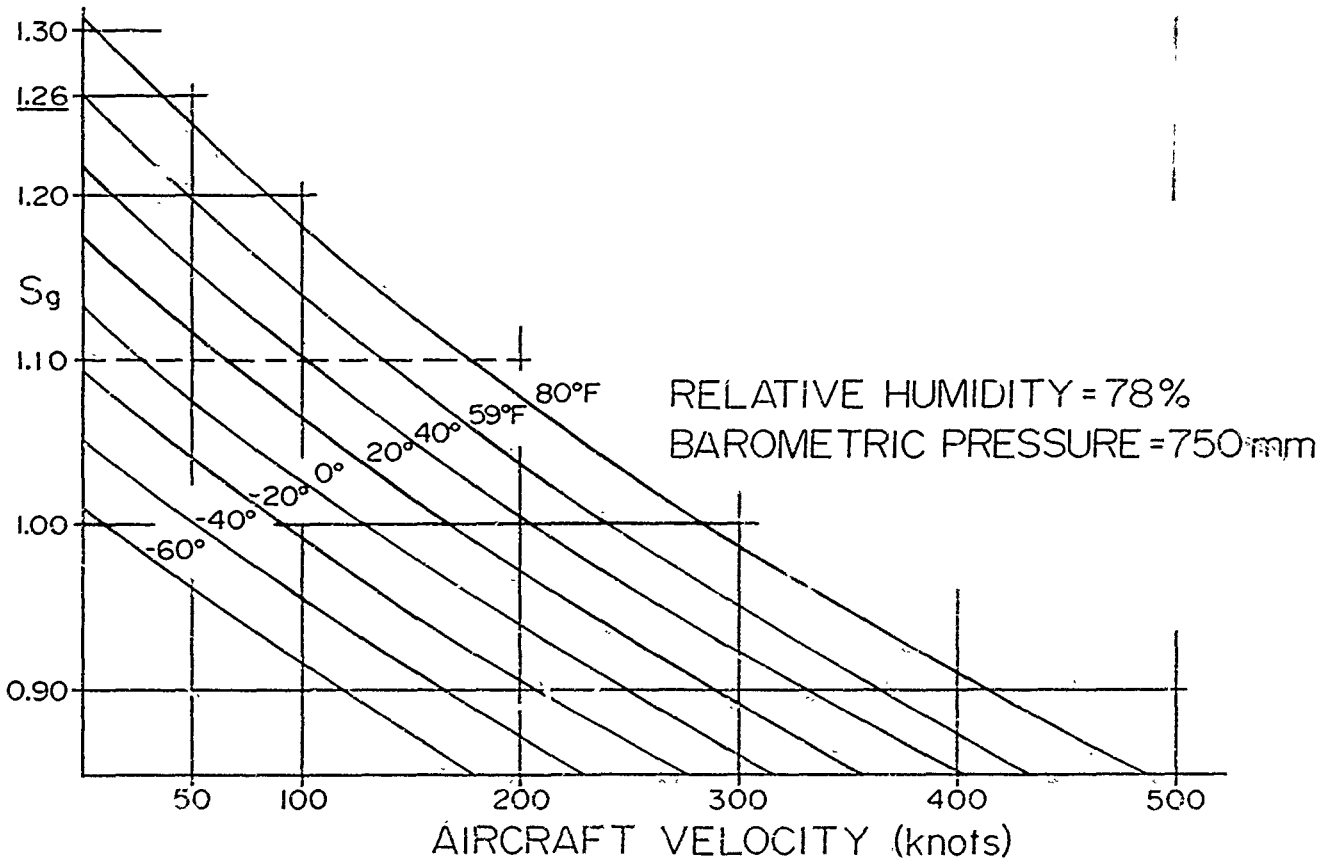

Figure 1. Gyroscopic Stability Factor vs Aircraft Velocity for Forward Fire Cal..30 APT.

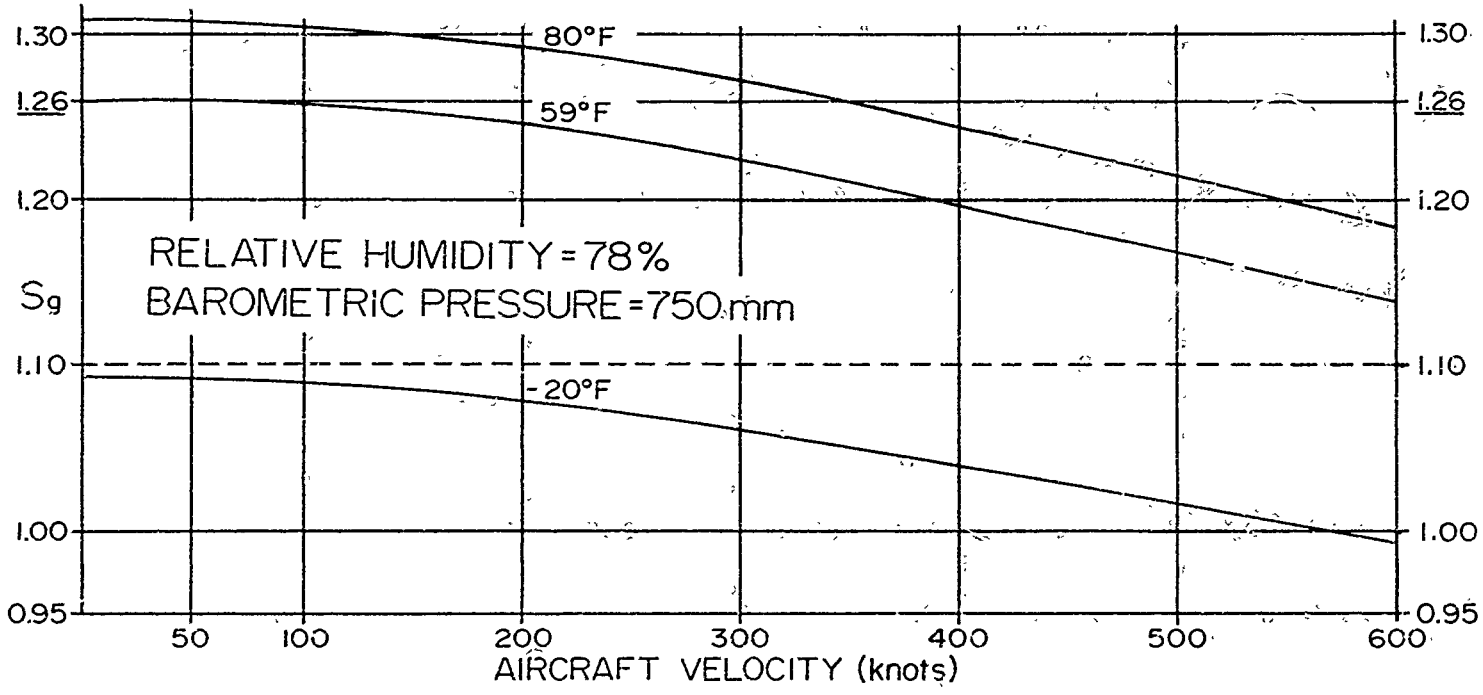

Figure 2. Gyroscopic Stability Factor vs Aircraft Velocity for Sidewise Horizontal Fire Cal..30 API.

RECOMMENDATIONS

It is recommended that the Caliber .30 API bullet be redesigned, if possible, so that it is adequately stable in all 7.62 mm weapon systems, should a requirement for such a cartridge exist. It is further recommended that should a need exist for a 7.62 mm incendiary cartridge, additional testing be performed on the Caliber 30 bullet to determine its suitability in all 7.62 mm weapons.

APPENDIX A

Terminal Performance

1. Armor Piercing Incendiary Cartridge

Penetration was measured at 100 yards by firing into a 7/8 inch thick steel armor plate. The average penetration of 20 rounds was .509 inch.

Flash was observed on a 10-gage mild steel plate at 175 yards. Of 20 rounds fired, all flashed and completely penetrated the 10-gage mild steel plate. Typical flash photographs are shown in the following:

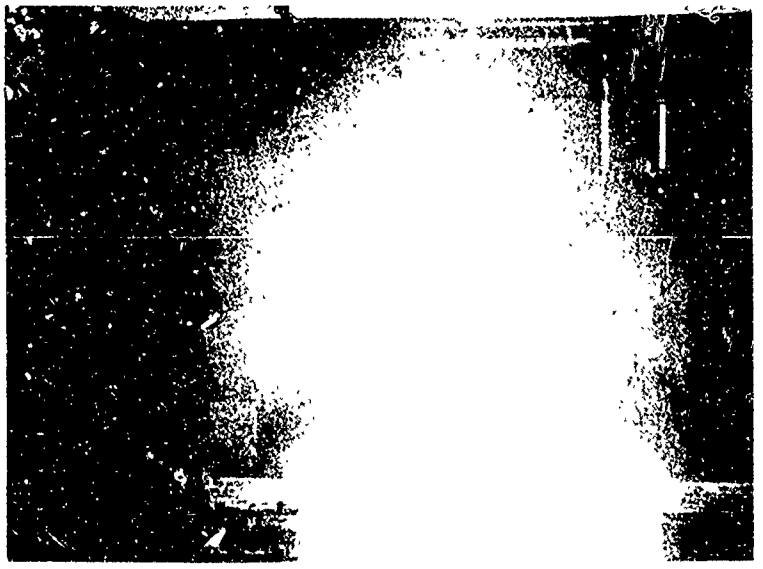

Figure A-1, Typical API Flash at 175 yards

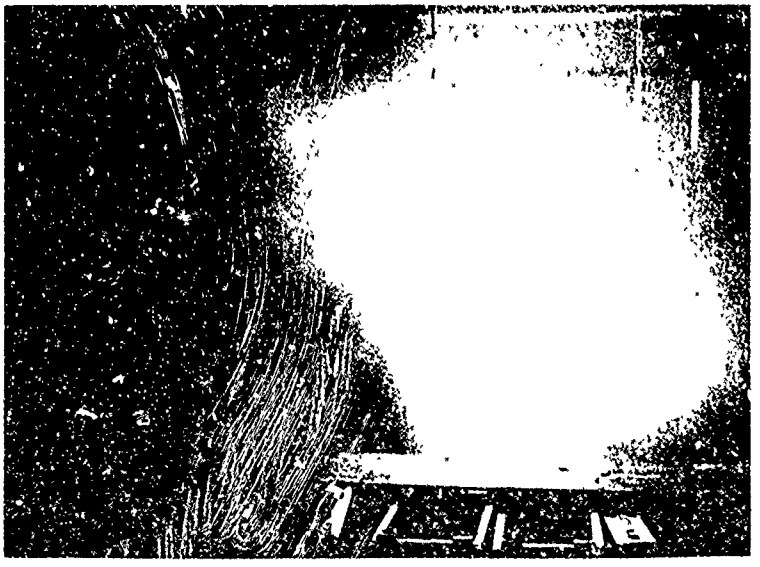

Figure A 2. Typical API Flash at 175 yards

2. Incendiary Cartridge

Flash of the incendiary bullet was observed at 175 yards with a series of aluminum plates. The first plate, placed at an angle of 45°, was .020 inches thick. The second, third and fourth plates were .025 inches, .050 inches and .051 inches thick, respectively. Of 20 rounds, 19 flashed satisfactorily. Photographs of the target and a typical flash are shown in the following:

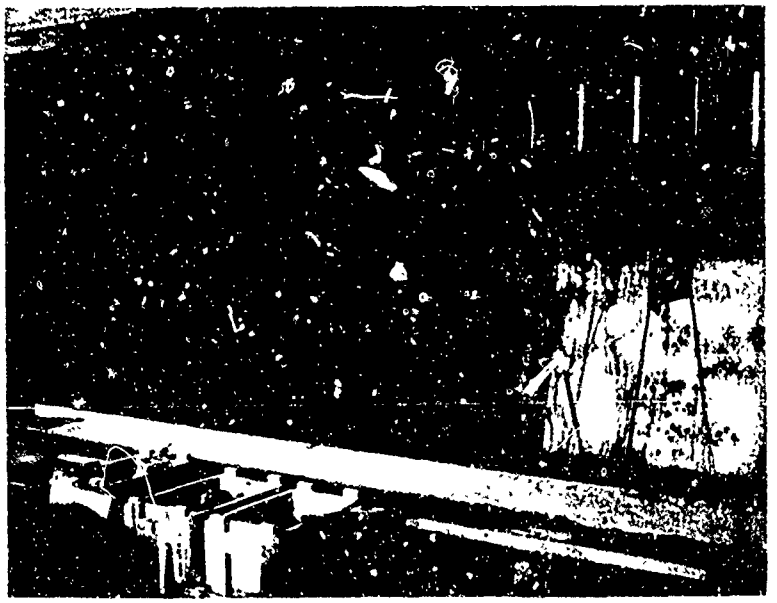

Figure A-3. Incendiary Flash Target at 175 Yards

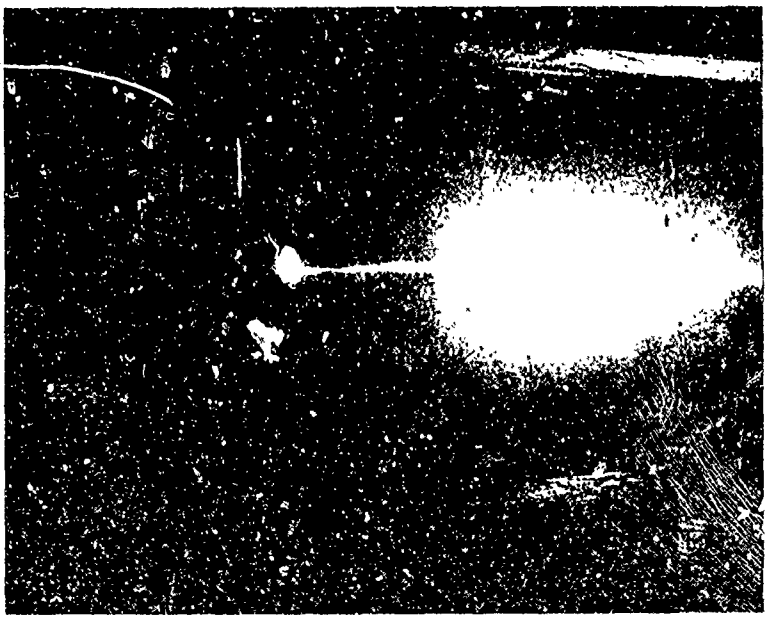

Figure A-4. Incendiary Flash at 175 Yards

3. Minigun Firing

A 100-round belt each of API, incendiary and Ball M80 was fired at a target at 100 yards. The dispersion patterns of the API and incendiary were as good as that of the Ball M80.

In a second firing, all rounds penetrated 3/8 inch plywood at 100 yards without bursting, but flashed on the dirt hill at 600 yards. In a third firing, both API and incendiary flashed and penetrated a 10-gage mild steel plate at 600 yards. Neither round would penetrate two 10-gage mild steel plates spaced 6 inches apart at 600 yards. (Firing from a test barrel at 1500 yards both API and incendiary flashed on a 10-gage mild steel plate, but neither would penetrate.

4. Flammable Liquids

Firing into gasoline cans at 600 yards both the API and incendiary rounds flashed, penetrated and ignited gasoline (see Figures A-5 and A-6).

Figure A-5. Flammable Liquids Target at 600 Yards

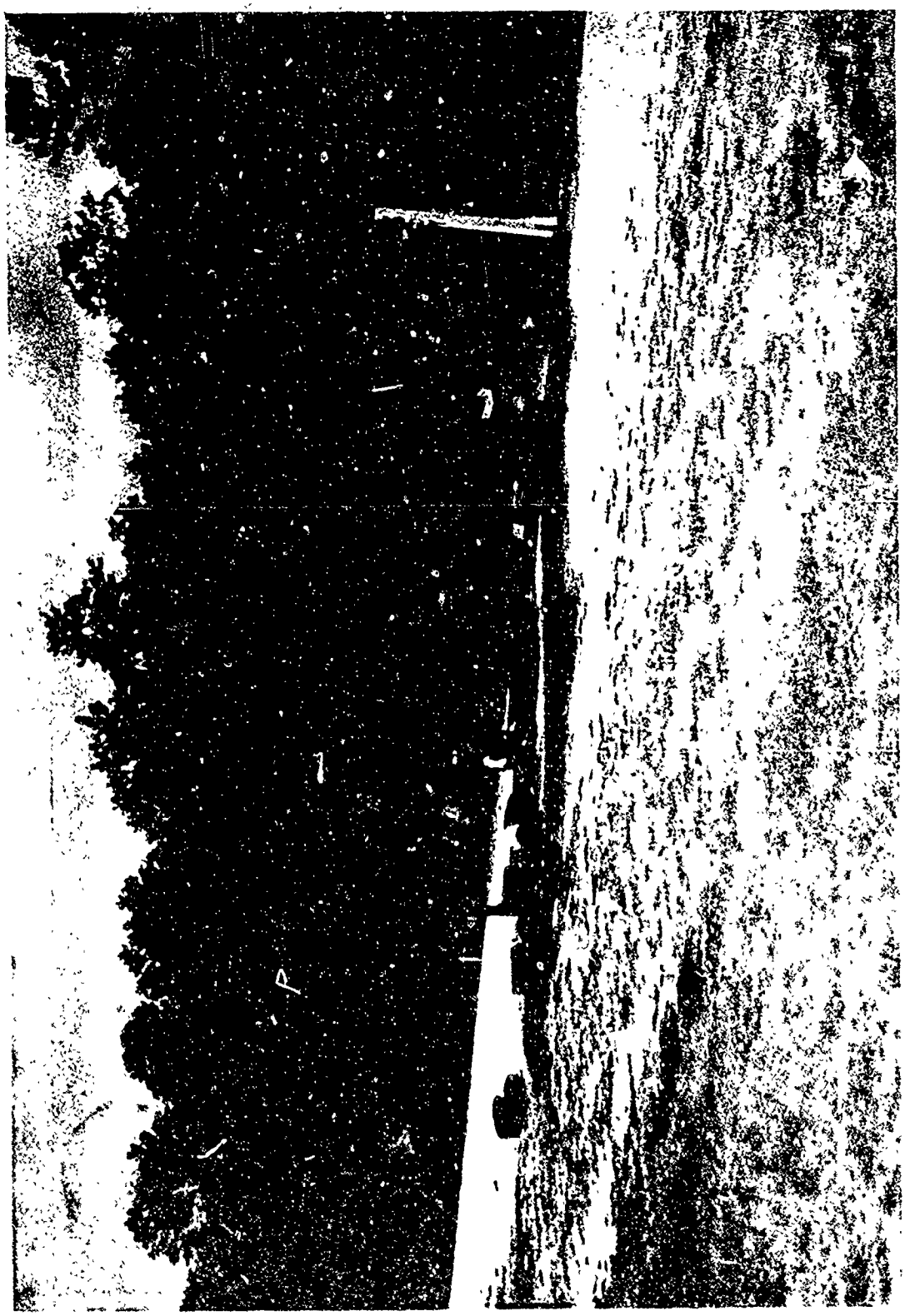

Figure A-6. Results of Flammable Liquids Test at 600 Yards

APPENDIX B

Safety Statements for Cartridge, 7.62MM Incendiary and Cartridge, 7.62MM Armor Piercing Incendiary

1. This safety statement is issued for 7.62MM Incendiary and 7.62MM Armor Piercing Incendiary Ammunition. The 7.62MM Incendiary round consists of a recannelured Cal..30 INC bullet inserted in a 7.62MM case, and the 7.62MM Armor Piercing Incendiary round consists of a recannelured Caliber 30 Armor Piercing Incendiary bullet inserted in a 7.62MM case.

2. Armor Piercing Incendiary Cartridge

a. Testing consisted of firing for velocity, chamber pressure, and function and casualty across the temperature range of -65° F to +125° F and for port pressure, accuracy, penetration, and action time at +70° F temperature.

b. All tests were conducted using Mann barrels except function and casualty which was conducted using the M60 Machine Gun and Minigun.

c. Accuracy tests over a 300 yard range in a Mann barrel having a one in ten inch twist indicated an extreme spread of 7.9 inches. These results denote a satisfactory level of accuracy when fired in the Minigun which also has one in ten inch twist barrels. Accuracy tests were also conducted using a one in twelve inch twist barrel with a resultant 89.0 inch extreme spread. Excessive dispersion patterns will be experienced when firing in other U. S. 7.62MM weapons, all of which have one in twelve inch twist barrels.

d. During the function and casualty firings at the -65° F temperature, six incidents of breech flash were reported. The occurrence of breech flashes in machine gun fire is not considered hazardous.

e. Approximately 1900 rounds of armor piercing incendiary ammunition were fired in all of the tests and the only significant occurrence was six breech flashes at -65° F during the function and casualty firings.

3. Incendiary Cartridge

a. Testing consisted of firing for velocity, chamber pressure, and function and casualty across the temperature range of -65° F to +125° F and for port pressure, accuracy, incendiary flash and action time at +70° F temperature.

b. During the velocity firings, two muzzle bursts occurred, one at +70° F and one at +125° F. Muzzle flashes were reported during velocity and chamber pressure tests and questionable muzzle bursts were reported during the function and casualty test. A subsequent function and casualty retest exhibited no muzzle bursts. A muzzle burst identifies an unsatisfactory performance involving the disintegration of a bullet as it emerges from the gun barrel and the occurrence of an excessively loud report. A muzzle burst may be hazardous to personnel or material adjacent to and

forward of the gun muzzle due to shrapnel effect of the bullet fragments. The occurrence of muzzle flashes are not unusual and are not considered hazardous.

c. Approximately 1250 rounds of incendiary ammunition were fired in all of the tests. Significant occurrences were five muzzle flashes, four questionable muzzle bursts and two positive muzzle bursts. There were no instability problems encountered in firing this ammunition.

4. As a result of and within the scope of all of the tests performed, the only hazards presented when firing 7.62MM Armor Piercing Incendiary and 7.62MM Incendiary ammunition are those due to muzzle bursts when firing incendiary ammunition.

5. In addition to precautions to be observed due to muzzle bursts when firing the Incendiary ammunition, all safety procedures and standard operating procedures exercised in preparation and execution of firing, care and handling of any small caliber development ammunition shall be observed for both ammunition types.

CONCURRENCE:

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