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M759 RECONFIGURED FUZE BASE
FINAL REPORT

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The M759 fuze spitback was prevented from dislodging during setback by a spitter crimp. Should the spitter crimp fail, the spitback could release during setback and strike the liner, resulting in a premature or inbore function. The base of the M759 fuze was redesigned to be loaded from the top end to eliminate the spitter crimp. In this manner the spitback charge is kept from dislodging during setback by a machined spitback charge holder piece.

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INTRODUCTION

The M759 point initiating - base detonating (PIBD) fuze (fig. 1) is used on the 30-mm M789 HEDP cartridge.

The operation of the M759 fuze (fig. 2) is described as follows: during setback the M759 fuze piston and body assembly move rearward. Under the action of a spring force, pressure on both sides of the restrictor is equalized and the firing pin moves forward, disengaging from its safe position. Subsequent spin imparted to the projectile then locks the body assembly in the rear position and causes the rotor assembly to move to the in-line position. Arming occurs within 150 meters from the muzzle. Upon impact the nose piece is driven into the firing pin assembly. The firing pin stabs the detonator, initiating the spitback explosive. The main charge is then ignited by the spitback charge.

The spitback is kept from dislodging during setback, thus initiating the main explosive by a spitter crimp. Each spitter crimp has five 100% inspections associated with it to insure the crimp is proper. Should the spitter crimp fail, the spitback could release during setback and strike the liner, creating the potential for an inbore.

As the result of an inbore incident in October 1984, the Army Materiel Command (AMC) Fuze Review Board directed the implementation of a redesigned base into the M759 fuze. The board insists that safety be designed into the fuze rather than a consequence of inspection.

The proposed solution to this problem was the elimination of the spitter crimp. The M759 fuze was redesigned to be loaded from the top end and the spitback charge kept from dislodging during setback by a machined spitback charge holder piece.

TEST OBJECTIVES

The objectives of this test were to collect data to support the qualification of the M759 reconfigured fuze base (fig. 3) by:

1. Determining if the reconfigured base can meet established criteria for durability, storage, and transit.

2. Verifying that the interface between the projectile and the fuze, and the terminal effects of the reconfigured base, are not degraded from the current production configuration by rough handling or other physical or environmental effects.

3. Collecting sufficient data to determine the interior ballistic characteristics of the reconfigured fuze base cartridge.

4. Determining terminal effects associated with armor penetration of the reconfigured fuze base cartridge.

5. Verifying metal parts security of the reconfigured fuze base cartridge.

TEST PROCEDURES

Testing was conducted in two phases, environmental and firing tests. The environmental tests were conducted on 300 test rounds and 150 control rounds. One thousand four-hundred and eighty test rounds and 410 control rounds were then temperature conditioned and subjected to the firing tests (table 1).

Moments of inertia (MI) of the modified projectile were measured for comparison with current production projectiles.

A visual inspection of all high explosive rounds was accomplished prior to and following environmental simulation.

Radiographic inspection was accomplished prior to and following each environmental simulation subtest so that post-test comparisons could be made.

Five environmental simulation tests, as outlined below, were conducted to insure that the projectile to reconfigured fuze base interface was adequate, and to insure that the reconfigured fuze base performs properly when subjected to environmental extremes.

1. Transportation-vibration-temperature

2. Waterproofness

3. Thermal shock

4. Extreme temperature storage

5. Temperature-humidity-altitude

The following firing tests were performed at Yuma Proving Ground, North Pad, and West Gun firing ranges:

1. Charge establishment

2. Fuze arming

3. Muzzle impact

4. Armor penetration

5. Weapon compatibility

6. Graze sensitivity

Targets were located at ranges of 500, 1000, and 1500 meters depending ont he purpose of the test. The principal target used was 40- by 60-feet in size and was adjustable for various angles of obliquity. Armor penetration tests were fired against targets of 1-inch homogenous armor. The graze range was also used with sod and macadam at ranges of 1000 and 2000 meters.

The ammunition was conditioned to three temperatures of -54°, 21°, and 71° C to detect any performance degradation or safety hazard condition that might result from use at temperature extremes. Armor penetration measurements and arming-distance verification tests (all-arm, nonarm) were included in all of the firings of rounds previously subjected to environmental simulation testing. Arming distance tests were conducted by firing at targets of 2024-T3 aluminum, 0.063-inch thickness, placed at 15 meters in front of the gun (for nonarm) and 150 meters (for all-arm)

The following data were recorded for each round fired:

1. Fuze functioning

2. Complete perforations

3. Metal parts security

4. Wind velocity and direction

5. Gun elevation

6. Ammunition temperature

7. Range to target

8. Cartridge case abnormalities subsequent to firing

TEST RESULTS

No anomalies were noted during the inspections and radiographic examinations of 10 rounds used to determine the center of gravity (CG) and MI.

Each of the five environmental subtests previously identified was accomplished by environmental simulation personnel. Review of the environmental simulation report indicated all rounds tested were found free from any irregularities after the simulations. These rounds were subsequently fired and no degradation in performance was observed.

Metal parts security information was obtained on all rounds fired by using witness screens which were checked after firing for any metal fragments which may have been ejected from the weapon during the firing sequence. Witness screens showed no indication of metal parts security problems. No projectile parts or evidence of rotating band was found.

Transportation-Vibration-Temperature

This test was fired using 60 test and 30 control rounds. All rounds were temperature conditioned at three different temperatures. No irregularities were noted and no failures occurred during firings.

Waterproofness

This test was conducted using 60 test and 30 control rounds. Rounds were placed in a tank of water under a 3 psi vacuum and all rounds (both test and control) showed evidence of leakage (bubbles) in the area of the fuze wind screen. The probable reason for leakage is that there is no waterproof seal at the windscreen-ogive interface. In the current design of both the fielded and the reconfigured fuze base, the wind screen is crimped to the nose of the fuze, easily allowing trapped air to escape when placed under vacuum. During subsequent firing, no failures occurred and no other anomalies were noted.

Thermal Shock

This test was fired using 60 test and 30 control rounds. All rounds were fired at their respective targets within 3 minutes of being removed from the conditioning chambers. One failure occurred during the firings at the all-arm target at 150 meters. No failures were observed during the firing of the 30 control rounds.

Extreme Temperature Storage

This subtest was the first subtest fired. The M230 automatic gun was initially used for this test but the first two firing attempts resulted in weapon damaging failures. These failures were considered a propellant related problem and had no adverse affect on the decision concerning the adoption of the M759 reconfigured fuze base. No fuze failures occurred during this test and the high pressures observed during the extreme temperature storage test have no bearing on the adoption of this design.

The initial incident occurred after firing only three rounds. After the gun was repaired, a second incident was experienced, again after firing only three rounds. This time the incident resulted in catastrophic damage to the gun. Following the second gun incident, use of the M230 automatic gun for firing of ammunition which had been conditioned at higher temperatures was discontinued. Firing of the remainder of the 60 test and 30 control rounds subjected to the extreme temperature environments was completed using a Mann barrel. Additional rounds were fired to measure peak velocity and case mouth pressure. As a result of the overpressure experienced with this test log, all 30-mm ammunition lots have been restricted from firing at elevated temperatures (in excess of 63° C.

One feature of the M230 gun, which contributes significantly to the damage often sustained when overpressure rounds are fired, is the open, unsupported area on the bolt face. With the combination of high case mouth pressure and the unsupported area on the bolt face, the high pressure causes the aluminum case to deform into the unsupported area. If the case deforms sufficiently into the unsupported area (coining) it may be severe enough to slow the firing rate of the weapon due to the drag experienced each time the bolt is unlocked. When the deformation is more severe, the case may rupture. If rupture occurs, it normally results in damage to the gun. As a result of this experience, future testing should stipulate high temperature conditioning at 63° C rather than the 71° C required by the MIL-STD tests.

NOTE: When ball-type propellant is exposed to high temperatures for a long period of time (for example as in the 28-day extreme temperature storage test), the deterrent coating begins to migrate and the propellant exhibits abnormal burn characteristics and high case mouth pressures.

Temperature-Humidity-Altitude

A total of 60 test and 30 control rounds were fired. No anomalies or metal parts security problems were noted.

Results obtained from the firing tests are described below for each specific test.

Charge Establishment

No irregularities were noted during the firing of this subtest. All rounds were fired at 21° C.

Fuze Arming

One round functioned at the nonarm target. No other irregularities were noted except for the high pressures found in the hot rounds. A large percentage of the rounds fired at the nonarm target functioned later upon impact against the more distant destruct plate.

Muzzle Impact

A total of 45 test and 15 control rounds were fired from the M230 Mann barrel at a 0.063-inch thick, 2024 T-3 aluminum plate which was located a distance of 1 meter in front of the muzzle. No rounds were observed to function on the plate and no other irregularities were noted.

Armor Penetration

A total of 250 test and 45 control rounds were fired. Conditioned rounds were fired at a zero-degree obliquity armor target at ranges of 500 and 1500 meters. Ambient rounds were fired at an armor target at 50-degrees obliquity, also at ranges of 500 and 1500 meters. All rounds fired penetrated the armor target. Impact locations were measured and recorded after every shot.

Weapon Compatibility

This test was not fired because the case failures observed in the extreme temperature firings were expected to incur a high risk of further damage to the M230 gun. The reconfigured fuze base rounds were cycled, without firing, through the automatic gun. No ammunition handling problems were observed. Rounds fired from the Mann barrel showed no weapon compatibility problems associated with this design.

Graze Sensitivity

A total of 300 test and 150 control rounds were fired from the M230 Mann barrel at two different target media (sod and macadam) from two ranges (1000 and 2000 meters). Test rounds were compared to control rounds. The design of the M759 fuze is for function upon impact. Test rounds appeared to function more frequently on impact rather than functioning on ricochet after impacting on the macadam. A total of three duds were noted at both ranges firing into both the sod and macadam.

CONCLUSIONS

Interior and exterior ballistics do not differ from the standard round. Terminal effects of the projectile/fuze are not degraded. No metal parts problems were observed. The modified projectile can be safely handled and transported. The projectile/fuze interface was not degraded by the simulated environmental conditioning to which it was subjected.

The M759 reconfigured fuze base passed all testing planned with no discrepancies and is an acceptable replacement for the current production M759 fuze.

RECOMMENDATIONS

The round was tested for critical issues in the categories of safety, terminal effects, functioning reliability, weapon interface, and MIL-STD tests. Based on Army Materiel Systems Analysis Activity's (AMSAA's) analysis of the results, AMSAA recommends that the M759 reconfigured fuze base be adopted as the fuze for all subsequent buys of the 30-mm family of rounds.

Table. Test matrix for 30-mm M789 HEDP cartridge assembled with PIP configuration M759 fuze.

		Number of rounds at each temperature (°C)					
		Test rounds			Control rounds		
Subtest	Test Code	-54	21	71	-54	21	71
Pretest inspection and physical characteristics							
Physical characteristics	TD-48						
Environmental tests							
Trans-vib-temperature	TD-12	20	20	20	10	10	10
Waterproofness	TD-18						
Thermal shock	TD-23						
Extreme temp storage	TD-24						
Temp-humid-alt	TD-29	20	20	20	10	10	10
Firing tests							
Charge establishment	TD-01		10			10	
Fuze Arming	TD-02	100	100	100	20	20	20
Muzzle impact	TD-06	15	15	15	5	5	5
Graze sensitivity	TD-09	100	100	100	5	5	5
Armor penetration	TD-36	75	75	75	25	25	25
Weapon compatibility (not fired)	TD-38	100	100	100	25	25	25
Subtotals		490	510	490	130	150	130
Totals			1480			410	

LEGEND: Temp-humid-alt - temperature-humidity-altitude
trans-vib-temp - transportation-vibration-temperature

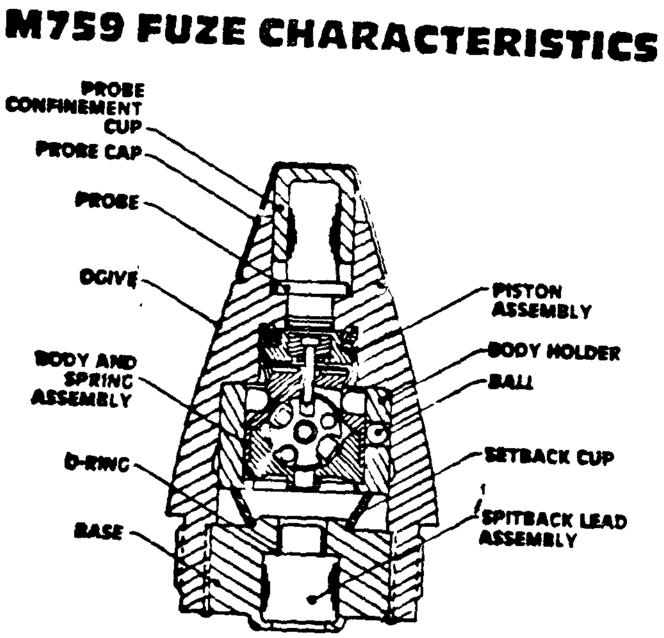

Figure 1. M759 point-initiating/base-detonating fuze

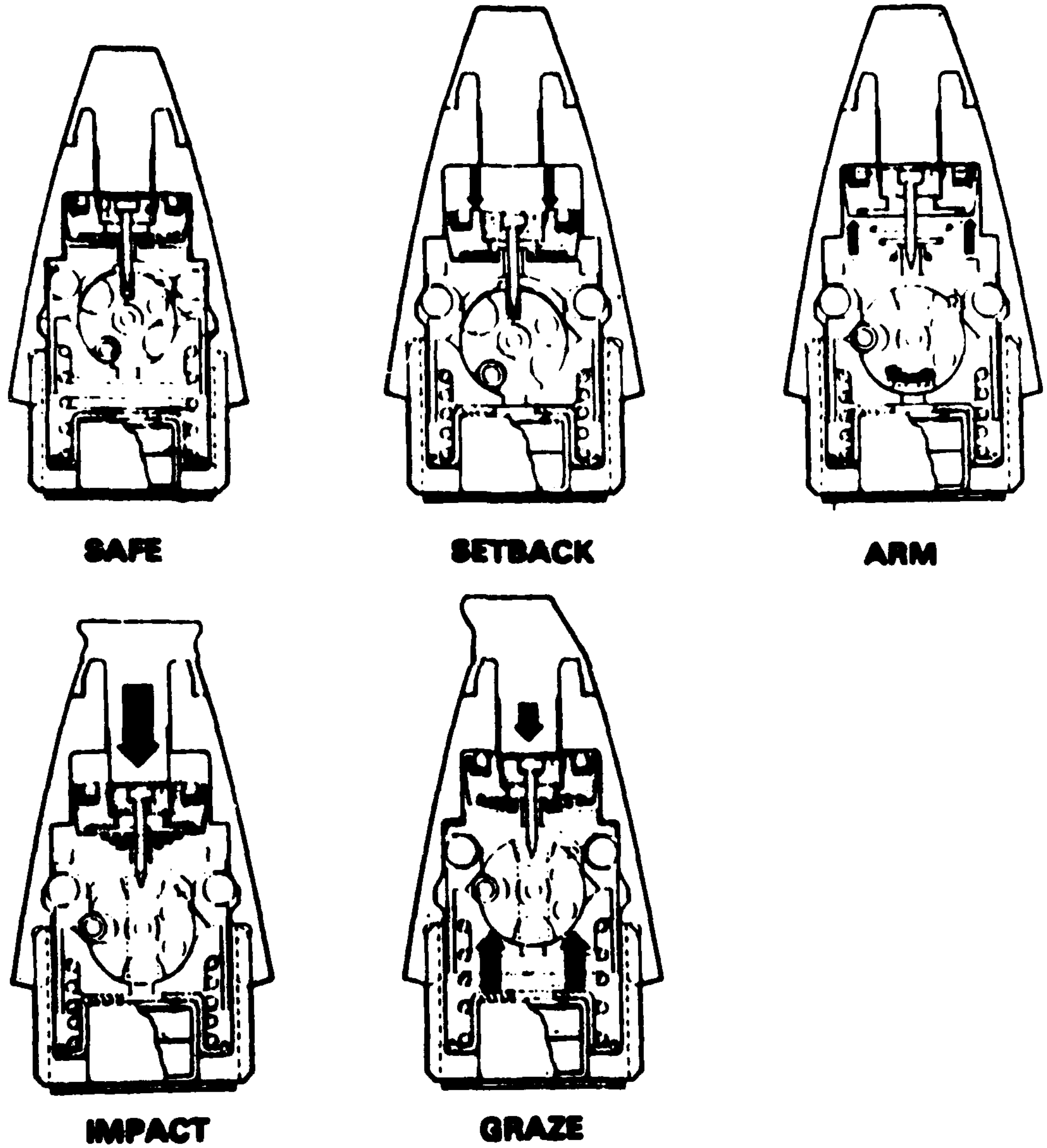

Figure 2. Operation of the M759 fuze

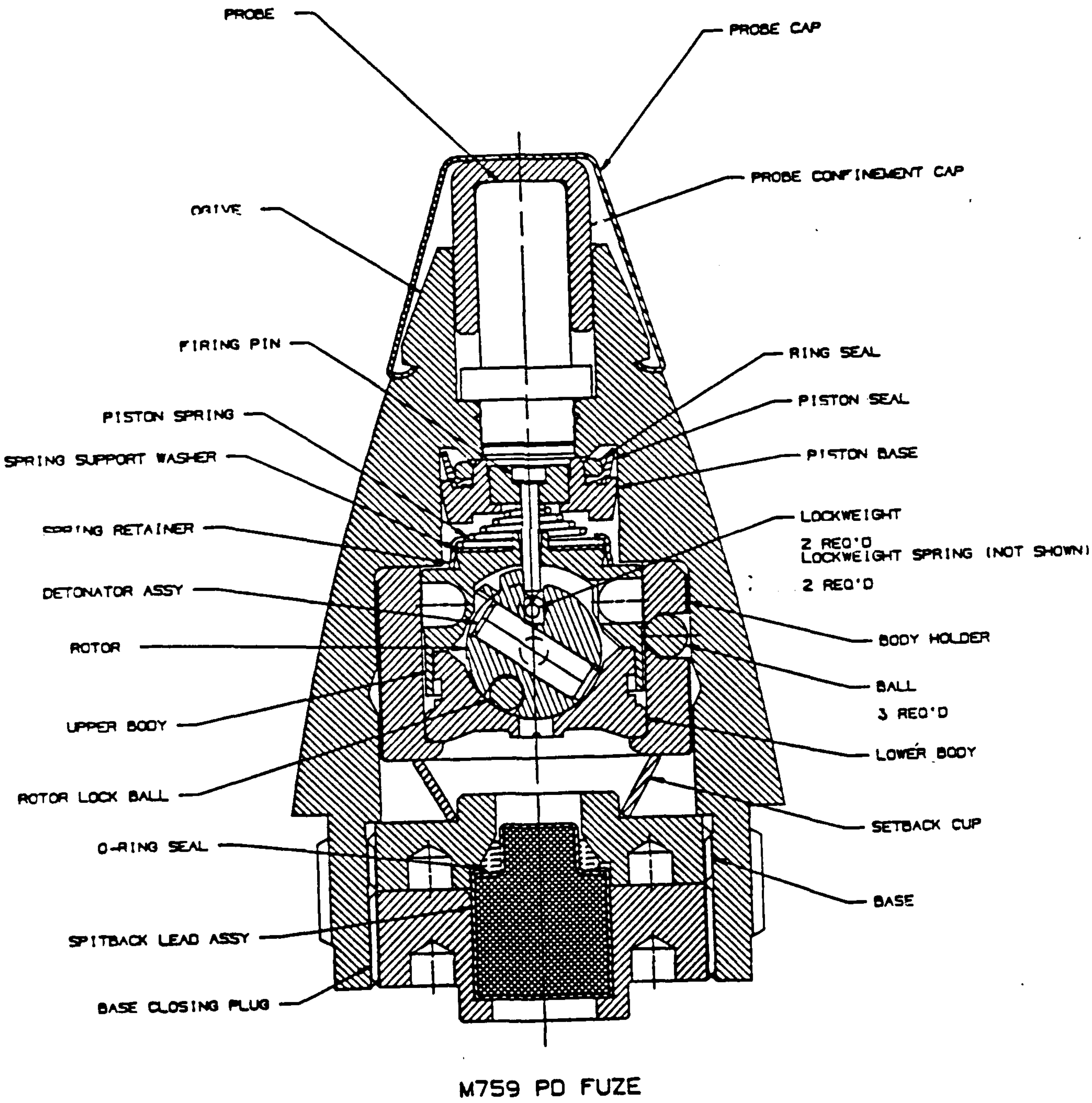

Figure 3. M759 reconfigured fuze base

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