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EDGEWOOD ARSENAL CONTRACTOR REPORT

EM-CR-74054

(EA - 4D51)

EXPLOSIVE CLASSIFICATION TESTING FOR PYROTECHNIC BULK COMPOSITION AND END ITEMS

by

Fred L. McIntyre

March 1975

NASA NATIONAL SPACE TECHNOLOGY LABORATORIES
General Electric Company
Engineering and Science Services Laboratory
Bay Saint Louis, Mississippi 39520

Contract No. NAS8-27750

DEPARTMENT OF THE ARMY
Headquarters, Edgewood Arsenal
Aberdeen Proving Ground, Maryland 21010

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DTA and Parr bomb tests
Sensitivity of heat producing compounds

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

Results of classification testing in accordance with US Army Technical Bulletin 700-2 Change, Chapters 3 and 4. Three bulk compositions and two end item munitions were tested. Additional results of all bulk pyrotechnic composition tested to date are included in appendix C of this report.

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PREFACE

The work described in this report was authorized under US Army MIPR B4030 and TWR EA 4D51. It was performed at the NASA National Space Technology Laboratories (NSTL) for the Edgewood Arsenal Resident Laboratory (EARL) and NASA-NSTL by the General Electric Company under Contract No. NAS8-27750. The work was initiated on 24 September 1973 and completed in June 1974.

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SUMMARY

This document contains reports of the following:

- Results of classification testing performed on the following three bulk pyrotechnic compositions in accordance with US Army Technical Bulletin 700-2 Change 1, Chapter 3:
  - Starter mix I
  - Igniter Charge
  - Match Head mix V
- Results of testing performed on the following two end item munitions containing pyrotechnic compositions in accordance with US Army Technical Bulletin 700-2 Change 1, Chapter 4:
  - XM227E1 Fuse, Hand Grenade
  - M-2 105mm Yellow Smoke Canister

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EXPLOSIVE CLASSIFICATION TESTING FOR PYROTECHNIC BULK COMPOSITION AND END ITEMS

1.0 INTRODUCTION

1.1 Objective. The objective of this study was to provide results of classification testing, in accordance with US Army TB 700-2, Change 1, on the following end items and bulk pyrotechnic compositions:

- Starter Mix I Dwg. #B143-7-2
- Igniter Charge Dwg. #B143-8-1
- Match Head Mix V Dwg. #B143-11-1
- XM227E1
- M2-105mm Yellow Smoke Canister

In addition, a series of tests were performed to determine the caloric output and thermal decomposition of the subject pyrotechnic compositions by Differential Thermal Analysis and Parr bomb calorimetry.

The results of tests on these items may be utilized by the cognizant DOD/DOT agencies to assign hazards classification and compatibility for transportation and storage of bulk pyrotechnic compositions and end-item munitions.

1.2 Authority. The work described in this report was authorized by TWR EA-4D51.

1.3 Background. Classification of a bulk pyrotechnic composition is currently accomplished by evaluation of test data obtained in accordance with Chapter 3, TB 700-2. Chapter 3 of TB 700-2 provides test requirements to assign hazards classification for transportation of bulk pyrotechnic compositions. These tests are designed to determine the ease of initiation and the stability of a bulk pyrotechnic composition prior to shipping and handling. Specific tests determined in TB 700-2, Change 1, Chapter 3 were:

- Detonation Test
- Ignition and Unconfined Burning
- Thermal Stability
- Impact Sensitivity
- Card Gap Test

Evaluation of pyrotechnic end item munitions is currently accomplished by the test data obtained from specific tests in accordance with Chapter 4, TB 700-2. Chapter 4 of TB 700-2 provides test requirements for pyrotechnic end item munitions manufactured packaged, and ready for field use. The end item munitions are tested to determine their tendency to propagate from one shipping or packing case to another, and the reaction resulting from burning the munitions in an intense fire. The specific tests delineated in TB 700-2, Change 1, Chapter 4, were:

- Detonation Test "A"
- Detonation Test "B"
- External Heat Test "C"

2.0 EXPERIMENTAL PROCEDURES

2.1 Bulk Compositions

2.1.1 Detonation Test. A series of tests were performed to measure the sensitivity of the compositions to the reaction of a Number 8 blasting cap. A 2-inch cube sample was placed on top of a perpendicular 1-1/2-inch (diameter) by 4-inch lead cylinder. The Number 8 blasting cap was placed perpendicular to and in contact with the top surface of the sample. A 2-inch wood cylinder with a hole drilled through its center was utilized to position and support the blasting cap. The cap was initiated by a suitable electrical current. Detonation of the sample was evidenced by the deformation (mushrooming) of the lead cylinder. This test was conducted a minimum of five times, or until detonation was evidenced, whichever was less. Observations were made to determine whether the sample exploded, burned, and/or fragmented.

2.1.2 Ignition and Unconfined Burning Test. These tests were conducted on single and multiple (four) 2-inch cube samples. For Test No. 1 (single sample test) a 2-inch cube sample was placed on a bed of kerosene soaked sawdust which was ignited with an electrically-initiated match head igniter. This test was conducted a minimum of two times. The Ignition and Unconfined Burning Test data includes a report of occurrence of detonation or burning times of samples.

2.1.3 Thermal Stability Test. The samples were subjected to elevated temperatures to permit the observance of characteristic tendencies to detonate, ignite, decompose or change in configuration under adverse storage conditions. The samples were placed in an explosion-proof oven in which the temperature was 75°C (167°F) and maintained at this temperature for a period of 48 hours. Oven temperature was continuously recorded throughout the test period. Observations recorded were whether the test specimen exploded, ignited, and/or underwent a change in configuration such as weight loss or color change.

2.1.4 Impact Sensitivity Test. A series of twenty tests were performed to determine the sensitivity of the pyrotechnic compositions to mechanical shock (impact). These tests utilized the Bureau of Explosives impact test apparatus. A 10-mg sample was placed in the test cup, the test weight was dropped from a predetermined height, striking the sample.

The results of the 20 tests per sample (10 at 3-3/4-inch drop height and 10 at 10-inch drop height) were reported as the number of trials exhibiting (1) Explosion, (2) Decomposition, and (3) No Reaction.

2.1.5 Card Gap Test. The sample materials were placed in a 5.5-inch (long) cold-drawn, seamless steel tube, composition 1015, having an OD of 1.875 inches and a wall thickness of 0.219 inch. The assembly was placed on a 6 x 6 x 3/8-inch steel witness plate in such a manner as to have a 1/16-inch air gap between the tube and the witness plate. Two pentolite pellets (2-inch diameter x 1-inch high) were placed directly on top of the assembly and in contact with the sample material; i.e., without the intervention of any acetate cards between the sample and pellets. (Acetate cards are used only when evidence of a detonation occurs on the first test trial.) A Engineers Special J-2 blasting cap was positioned on top of the pentolite and the complete Card Gap test assembly was supported approximately six inches above the ground surface. The Engineers Special J-2 blasting cap was then initiated causing detonation of the two pentolite pellets. This test was conducted three times per sample. Observations were recorded regarding whether detonation occurred and the required number of cards for 50 percent detonability (50 percent value).

2.1.6 Additional Test Methods. Additional tests to aid in delineation of performance of an explosive characteristics were conducted on the bulk sample materials. These tests outlined herein were:

- Differential Thermal Analysis (DTA)
- Parr Bomb

The data obtained from these tests can be utilized to determine performance and explosive properties to aid in classification for transportation and storage by the cognizant DOD/DOT agencies.

Differential Thermal Analysis is used to determine whether physical and chemical reactions occur when compositions are subjected to an increase in temperature by detection of exothermic or endothermic changes in a sample. The temperature difference between a sample and a thermally-inert reference material is measured as both are heated at a constant rate. The selected reference material does not undergo any thermal reaction over the temperature range under investigation, so that any exothermic or endothermic change occurring within the sample material causes the temperature to either exceed (exothermic) or lag (endothermic) that of the reference material. The physical or chemical reactions that occur during a differential thermal analysis are related to the mass, size, heating rate, and particle size of the sample. These chemical or physical reactions represent changes in the material relative to decomposition, dehydration, crystalline transition, melting, boiling, evaporation, polymerization, oxidation, and reduction. Observations were recorded to determine (1) exothermic or endothermic changes and (2) decomposition.

Test samples of the selected materials were burned in a standard oxygen-filled metal Parr bomb submerged in a measured quantity of water. By observing the rise in water temperature resulting from combustion of the sample, it is possible to calculate the caloric output of the sample during complete combustion. The standard test method utilized is ASTM Procedure D240-64 "Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calometer."

2.2 End-Item Munitions

2.2.1 Detonation "Test A". This test was conducted on items which were packaged with more than one item in the standard storage and shipping container to determine if functioning of one item would cause other items in the container to function. The most centrally positioned item within the package was primed by its own fuse or an Engineers Special J-2 blasting cap. The results of the test determine occurrence of propagation within a single container, fragmentation hazards, blast hazards, and fire dispersement hazards. The test was to be conducted a minimum of five times or until communication to adjacent items occurred, whichever was less. Evidence of (1) propagation between donor and acceptor rounds, (2) blast overpressure, and (3) fragmentation dispersal from container rupture were recorded.

2.2.2 Detonation "Test B". This test was conducted to determine if the functioning of items in one container would cause functioning of items in adjacent containers. If the detonation "Test A" resulted in no communication within the container or the outside container was not ruptured, these tests were omitted. The item in the donor container was primed and initiated by its own fuse or by an Engineers Special J-2 blasting cap. The item primed in the donor container was the closest item to the explosive item in the acceptor container. This assured subjection of the acceptor explosives to maximum blast effects from donor material. The acceptor container was positioned in a manner which provided the minimum separation between the explosive components in the two containers. The test results were documented to determine propagation from one container to another, fragmentation hazards, blast hazards, and fire dispersal hazards. This test was performed a minimum of five times.

2.2.3 External Heat "Test C" (Open Flame). This test was designed to simulate a condition where the containers of the explosive or pyrotechnic items are completely enveloped in a hot fire. One to six containers were required to perform this test. These containers were arranged in a compact stack, approximating a cube. The containers were then secured with steel bands in two directions. These steel bands were intended to maintain stacking unitl initiation of one or more items occurred. (The steel bands must be incapable of significantly affecting dispersal of fragments.) The stack of containers was placed on a crib of sufficient dimension to hold and stack the containers approximately 30 inches high. The interior of the crib was filled with combustible material; i.e., scrap lumber, etc. The crib and stack of items to be tested were then covered with additional combustible material sufficient to sustain a hot fire. The entire mass was then saturated with approximately 50 gallons of JP-4 or diesel fuel and ignited in two locations by electric squibs and two ounces of smokeless powder. Still photographs were taken before and after the test. Resulting fragments and missiles were identified and their location with respect to the test position recorded.

3.0 RESULTS

3.1 Bulk Compositions

3.1.1 Detonation Tests. None of the pyrotechnic compositions exhibited characteristics of an explosion or fragmentation. Test data is given in appendix A and results summarized in table 1.

Table 1. Detonation Test Summary

Sample Designation	Test No.	Material Weight In Grams	Test Results Exploded	Burned	Fragmented
Starter Mix 1 Dwg. #B143-7-2	1	305.3	No	Yes	No
	2	305.0	No	Yes	No
	3	304.7	No	Yes	No
	4	305.3	No	Yes	No
	5	305.0	No	Yes	No
Igniter Charge Dwg. #B143-8-1	1	105.0	No	No	No
	2	105.5	No	No	No
	3	105.9	No	No	No
	4	105.9	No	No	No
	5	106.0	No	No	No
Match Head Mix V Dwg. #B143-11-1	1	196.0	No	Yes	No
	2	196.8	No	Yes	No
	3	197.2	No	Yes	No
	4	196.8	No	Yes	No
	5	197.4	No	Yes	No

See appendix A for data sheets.

3.1.2 Ignition and Unconfined Burning Tests. None of the pyrotechnic compositions tested exhibited characteristics of an explosion. Test results are summarized in table 2.

3.1.3 Thermal Stability Tests. None of the pyrotechnic compositions exhibited characteristics of an explosion, ignited, or changed configuration in any observable fashion. Test results are shown in table 3.

3.1.4 Impact Sensitivity Tests. Starter Mix I and Igniter Charge did not exhibit characteristics of an explosion, or decompose perceptively at either specified drop height. Match Head Mix V exhibited characteristics of an explosion and decomposition at both specified drop heights. See test results in table 4.

3.1.5 Card Gap Tests. None of the pyrotechnic compositions exhibited characteristics of mass detonation and zero card values were obtained. Tests results are shown in table 5.

3.1.6 DTA and Parr Bomb Calorimetry. Test results are shown in table 6.

Table 2. Ignition and Unconfined Burning Test Summary

Sample Designation	Material Weight In Grams	Test Configuration	Exploded	Avg. Burn Time in Seconds
Starter Mix Dwg. #B143-7-2	305	Single Cube	No	27
	305	Single Cube	No	26
	1220	Multiple Cube	No	28
Igniter Charge Dwg. #B143-8-1	105	Single Cube	No	95
	105	Single Cube	No	110
	420	Multiple Cube	No	75
Match Head Mix V Dwg. #143-11-1	196	Single Cube	No	13
	196	Single Cube	No	16
	784	Multiple Cube	No	22

See appendix A for data sheets.

Table 3. Thermal Stability Test Summary

Sample Designation	Sample Weight In Grams	Explosion	Test Results	
			Ignition	Change in Configuration
Starter Mix I Dwg. #B143-7-2	305	No	No	No
Igniter Charge Dwg. #B143-8-1	105.9	No	No	Wt. Loss 1.1 Grams
Match Head Mix V Dwg. #B143-11-1	196.8	No	No	No

See appendix A for detailed data sheets.

Table 4. Impact Sensitivity Test Summary

Sample Designation	Sample Weight In Mg.	Test Results (1)					
		3-3/4 Inch			10 Inch		
		E	D	N	E	D	N
Starter Mix I Dwg. #B143-7-2	10	0	0	10	0	0	10
Igniter Charge Dwg. #B143-8-1	10	0	0	10	0	0	10
Match Head Mix V Dwg. #B143-11-1	10	2	1	7	9	1	0

See appendix A for data sheets.

(1) Test Results E = Explodes; D = Decomposes; N = No Reaction

Table 5. Card Gap Test Summary

Sample Designation	Test No.	Sample Weight In Grams	Test Results	
			Detonation	50% Card Value
Starter Mix I Dwg. #B143-7-2	1	340	No	0
	2	340	No	0
	3	340	No	0
Igniter Charge Dwg. #B143-8-1	1	111	No	0
	2	111	No	0
	3	111	No	0
Match Head Mix V Dwg. #B143-11-1	1	201	No	0
	2	201	No	0
	3	201	No	0

See appendix A for data sheets.

Table 6. Performance Test Findings

Sample Designation	Test No.	Diff. Therm. Analysis		Parr Bomb	
		Sample Weight	Decomp. Temp. °C	Sample Weight	Heat of Comb. Kcal/gm
Starter Mix 1 Dwg. #B143-7-2	1	50 mg	—	1 gm	No Ignition
	2	50 mg	858.5	1 gm	No Ignition
	3	50 mg	509.0	1 gm	No Ignition
	Avg.	50 mg	683.75	1 gm	N/A
Igniter Charge Dwg. #B143-8-1	1	50 mg	316.2	1 gm	1.740
	2	75 mg	323.75	1 gm	2.082
	3	50 mg	323.75	1 gm	2.220
	Avg.	58.3 mg	321.2	1 gm	2.014
Match Head Mix V Dwg. #B143-11-1	1	50 mg	296.7	1 gm	1.176
	2	50 mg	297.2	1 gm	1.249
	3	50 mg	299.4	1 gm	1.137
	Avg.	50 mg	297.8	1 gm	1.187

3.2 End-Item Munitions

3.2.1 Detonation Tests "A". The XM227E1 fuse failed to propagate in five trials and this item did not exhibit characteristics of detonation or fragment dispersal. The M-2 105mm yellow smoke canister propagated and all items were initiated and consumed in place. No blast overpressure was recorded now was there any fragment dispersal. No tests were performed on the XM227E1 in the standard end item test, Detonation Test "B" because data interpretation negates such test requirements (see paragraph 4-5b2 of TB 700-2). There were insufficient materials available to perform these tests on the M2-105mm Yellow Smoke Canisters. Results are given in appendix B and summarized in table 7.

3.2.2 External Heat Test "C". The XM227E1 fuse failed to exhibit characteristics of mass detonation, blast overpressure and the fragment dispersal was minimal. The resultant reactions were not significantly different from those obtained previously using similar pyrotechnic end items; e.g., M201A1 fuse. Test results are shown in table 8.

4.0 DISCUSSION

The values obtained from the DTA and Parr Bomb test series indicate that the decomposition temperatures are well within the expected range of similar pyrotechnic compositions (see EA-FR-1G0X, Table 4-6 "Standard Parr Bomb Test Results" and table 4-7

"Differential Thermal Analysis Test Results"). The caloric output is well within the groupings of similar pyrotechnic composition. Results for Starter Mix I indicated lack of a total ignition and values obtained were quite erratic.

Appendix C contains a summary of all TB 700-2 test data accumulated since the inception of the Pyrotechnic Bulk Composition and End Items explosive classification testing program.

Table 7. Detonation Test "A" Summary

Sample Designation	Propagation	Blast Overpressure ($\bar{X}$ psig)	Mean Frag. No.	Max. Dist. in Feet
XM227E1	None	None	0	0
M2 - 105mm Yellow Smoke Canister	Yes	None	0	0

See appendix B for data sheets.

Table 8. External Heat Test "C" Summary

Sample Designation	Test Duration In Minutes	Detonation	Blast Overpressure	No Frag.	Max. Dist. in/ft
XM227E1	28	No	None	10	25 25

See appendix B for data sheets.

APPENDIX A - BULK CLASSIFICATION DATA SHEETS

Date 6/30/74

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Starter Mix 1
Propell

Propellant Spec. Dwg. #B143-7-2 Batch 4-1

Mfg Date _____

Detonation Test	Exploded		Burned		Fragmented	
	Yes	No	Yes	No	Yes	No
No. 8 Blasting Cap Test I	___	x	x	___	___	x
Test II	___	x	x	___	___	x
Test III	___	x	x	___	___	x
Test IV	___	x	x	___	___	x
Test V	___	x	x	___	___	x

Samples: Five 2-inch cubes. Test: One blasting cap per sample.

Ignition & Unconfined Burning Test	Exploded		Average Burning Time
	Yes	No	Seconds
One 2-inch cube	___	x	27
One 2-inch cube	___	x	26
Four 2-inch cubes	___	x	28

Samples: Six 2-inch cubes Test: Ignite & burn unconfined.

Thermal Stability Test	Explosion		Ignition		Change in Configuration	
	Yes	No	Yes	No	Yes	No
One 2-inch cube	___	x	___	x	___	x

Samples: One 2-inch cube Test: 48 hours at 75% C. in vented oven.

Card Gap Test No detonation-3 trials 50% Value 0 (No. of Cards) 0

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

Ten 3-3/4" (± 1/16") Drop Test
10 Trials

Ten 10" (± 1/16") Drop Test
10 Trials

No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise	Decomposition Smoke No Noise	No Reaction No Smoke No Noise 10	Explosion Flame and Noise	Decomposition Smoke No Noise	No Reaction No Smoke No Noise 10

Approved:
Test Director Steve Fuentes Test Department Head Wayne H. Tilson

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Assigned Classification

ICC Forbidden	
ICC Restricted*	
ICC Class A	
ICC Class B	

DOD Approval

Signature _____

Title _____

Organization _____

*Shipping instructions are to be requested from ICC (para 3-13A (2).

Date 6/30/74

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Igniter Charge
Propell
Propellant Spec. Dwg. #B143-8-1 Batch 5-1

Mfg Date 6/24/74

Detonation Test	Exploded Yes	Exploded No	Burned Yes	Burned No	Fragmented Yes	Fragmented No
No. 8 Blasting Cap Test I	___	x	___	x	___	x
Test II	___	x	___	x	___	x
Test III	___	x	___	x	___	x
Test IV	___	x	___	x	___	x
Test V	___	x	___	x	___	x

Samples: Five 2-inch cubes. Test: One blasting cap per sample.

Ignition & Unconfined Burning Test	Exploded Yes	Exploded No	Average Burning Time Seconds
One 2-inch cube	___	x	95
One 2-inch cube	___	x	110
Four 2-inch cubes	___	x	75

Samples: Six 2-inch cubes Test: Ignite & burn unconfined.

Thermal Stability Test	Explosion Yes	Explosion No	Ignition Yes	Ignition No	Change in Configuration Yes	Change in Configuration No
One 2-inch cube	___	x	___	x	___	x

Samples: One 2-inch cube Test: 48 hours at 75% C. in vented oven.

Card Gap Test No detonation-3 trials 50% Value 0 (No. of Cards) 0

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

Ten 3-3/4" (± 1/16") Drop Test 10 Trials			Ten 10" (± 1/16") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise	Decomposition Smoke No Noise	No Reaction No Smoke No Noise 10	Explosion Flame and Noise	Decomposition Smoke No Noise	No Reaction No Smoke No Noise 10

Approved:
Test Director Steve Fuerst Test Department Head Payne R. Kilgore

---

Assigned Classification

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ICC Restricted*	
ICC Class A	
ICC Class B	

DOD Approval

Signature _____

Title _____

Organization _____

*Shipping instructions are to be requested from ICC (para 3-13A (2).

Date 6/30/74

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Match Head Mix V
Propell
Propellant Spec. Dwg. #B143-11-1 Batch 4-1

Mfg Date 6/15/74

Detonation Test	Exploded		Burned		Fragmented	
	Yes	No	Yes	No	Yes	No
No. 8 Blasting Cap Test I	___	x	x	___	___	x
Test II	___	x	x	___	___	x
Test III	___	x	x	___	___	x
Test IV	___	x	x	___	___	x
Test V	___	x	x	___	___	x

Samples: Five 2-inch cubes. Test: One blasting cap per sample.

Ignition & Unconfined Burning Test	Exploded		Average Burning Time
	Yes	No	Seconds
One 2-inch cube	___	x	13
One 2-inch cube	___	x	16
Four 2-inch cubes	___	x	22

Samples: Six 2-inch cubes Test: Ignite & burn unconfined.

Thermal Stability Test	Explosion		Ignition		Change in Configuration	
	Yes	No	Yes	No	Yes	No
One 2-inch cube	___	x	___	x	___	x

Samples: One 2-inch cube Test: 48 hours at 75% C. in vented oven.

Card Gap Test No detonation - 3 trials 50% Value 0 (No. of Cards) 0

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

Ten 3-3/4" (± 1/16") Drop Test 10 Trials			Ten 10" (± 1/16") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise 2	Decomposition Smoke No Noise 1	No Reaction No Smoke No Noise 7	Explosion Flame and Noise 9	Decomposition Smoke No Noise 1	No Reaction No Smoke No Noise 0

Approved:
Test Director Steve Fuentes Test Department Head Wayne R. Tilson

---

Assigned Classification

ICC Forbidden	
ICC Restricted*	
ICC Class A	
ICC Class B	

DOD Approval

Signature ___

Title ___

Organization ___

*Shipping instructions are to be requested from ICC (para 3-13A (2).

APPENDIX B - END ITEM MUNITIONS DATA SHEETS

Test Type: Detonation Test "A"	Date: 2 Jan 1974
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 1A
Contract Number: NAS8-27750	Designation: Fuze Hand Grenade XM227E1
Specification: DAAA15-72-C-0317	Drawing Number: N/A
Lot Number: Col-1-3	Manufacture Date: Unknown

METEOROLOGICAL DATA

Temperature: 55°F	Humidity: 98%	Barometric Pressure: 30.17
Wind Direction: 60°	Wind Velocity: 4 mph	

TEST SET UP

Priming: Match Head Igniter	Location of Acceptor: Center most fuse (second layer)
Booster: None	Confinement: None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Fragmentation
Yes ___ No X	Yes ___ No ___	Yes ___ No ___
Attachments: Photo X, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___
Test Conductor: S. Fuentes	Project Engineer: F. L. McIntyre	Test Dept. Head: C. H. Lasseigne

Assigned Classification

ICC Forbidden	
ICC Restricted*	
ICC Class A	
ICC Class B	

DOD Approval

Signature _____

Title _____

Organization _____

*Shipping instructions are to be requested from ICC (para 3-13A (2).

Test Type	Date
Detonation Test "A"	2 Jan 1974
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 2A
Contract Number: NAS8-27750	Designation: Fuse Hand Grenade XM227E1
Specification: DAAA15-72-C-0317	Drawing Number: N/A
Lot Number: Col-1-3	Manufacture Date: Unknown

METEOROLOGICAL DATA

Temperature	Humidity	Barometric Pressure
55°F	98%	30.17
Wind Direction	**Wind Velocity**	
60°	4 mph	

TEST SET UP

Priming	Location of Acceptor
Match Head Igniter	Center most fuse Third layer
Booster	**Confinement**
None	None

TEST RESULTS

Detonation Test A		Detonation Test B		External Heat Test "C"	
Propagation		Propagation		Fragmentation	
Yes ___ No X		Yes ___ No ___		Yes ___ No ___	
Attachments	Photo x Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___
Test Conductor: S. Fuentes		Project Engineer: F. L. McIntyre		Test Dept. Head: C. H. Lasseigne	

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping Instructions are to be obtained from ICC Para. 3-13A(2)

Test Type	Date
Detonation Test "A"	2 Jan. 1974
Sponsoring Agent Edgewood Arsenal, Edgewood, Maryland	**Test Number** 3A

Contract Number NAS8-27750	**Designation** Fuse, Hand Grenade XM227E1
Specification DAAA15-72-C-0317	**Drawing Number** N/A
Lot Number Col-1-3	**Manufacture Date** Unknown

METEOROLOGICAL DATA

Temperature 56°F	**Humidity** 97%	**Barometric Pressure** 30.16
Wind Direction 38°	**Wind Velocity** 3 mph	

TEST SET UP

Priming Match Head Igniter	**Location of Acceptor** Center most fuse Second layer
Booster None	**Confinement** None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Fragmentation
Yes ___ No x	Yes ___ No ___	Yes ___ No ___
Attachments: Photo x; Map ___; Blast Press. ___	Attachments: Photo ___; Map ___; Blast Press. ___	Attachments: Photo ___; Map ___; Blast Press. ___
Test Conductor S. Fuentes	Project Engineer F. L. McIntyre	Test Dept. Head A. H. Lanuzzi

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping Instructions are to be obtained from ICC Para. 3-13A(2)

Test Type	Date
Detonation Test "A"	2 Jan. 1974
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 4A

Contract Number: NAS8-27750	Designation: Fuse, Hand Grenade XM227E1
Specification: DAAA15-72-C-0317	Drawing Number: N/A
Lot Number: Col-1-3	Manufacture Date: Unknown

METEOROLOGICAL DATA

Temperature: 57°F	Humidity: 96%	Barometric Pressure: 30.16
Wind Direction: 35°	Wind Velocity: 2 mph	

TEST SET UP

Priming: Match Head Igniter	Location of Acceptor: Center most fuse, Third layer
Booster: None	Confinement: None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Fragmentation
Yes ___ No X	Yes ___ No ___	Yes ___ No ___
Attachments: Photo X, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___
Test Conductor: S. Fuentes	Project Engineer: F. L. McIntyre	Test Dept. Head: A. H. Lasagni

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping Instructions are to be obtained from ICC Para. 3-13A(2)

Test Type	Date
Detonation Test "A"	2 Jan. 1974
Sponsoring Agent Edgewood Arsenal, Edgewood, Maryland	**Test Number** 5A
Contract Number NAS8-27750	**Designation** Fuse, Hand Grenade XM227E1
Specification DAAA15-72-C-0317	**Drawing Number** N/A
Lot Number Col-1-3	**Manufacture Date** Unknown

METEOROLOGICAL DATA

Temperature	Humidity	Barometric Pressure
57°F	96%	30.16
Wind Direction 35°	**Wind Velocity** 3 mph	

TEST SET UP

Priming	Location of Acceptor
Match Head Igniter	Center most round Second layer
Booster None	**Confinement** None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Fragmentation
Yes ___ No x	Yes ___ No ___	Yes ___ No ___
Attachments: Photo x, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___	Attachments: Photo ___, Map ___, Blast Press. ___
Test Conductor S. Fuentes	Project Engineer F. L. McIntyre	Test Dept. Head G. H. Lasseigne

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping Instructions are to be obtained from ICC Para. 3-13A(2)

Test Type	Date
External Heat Test "C"	4 Jan. 1974
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 1C

Contract Number: NAS8-27750	Designation: Fuse, Hand Grenade XM227E1
Specification: DAAA15-72-C-0317	Drawing Number: N/A
Lot Number: Col-1-3	Manufacture Date: Unknown

METEOROLOGICAL DATA

Temperature: 40°F	Humidity: 100%	Barometric Pressure: 30.16
Wind Direction: 330°	Wind Velocity: 8 mph	

TEST SET UP

Priming: Match Head Igniter Opposite Sides of Pyre	Location of Acceptor: Two boxes interior of funeral pyre w/20 gallons diesel
Booster: UTC 3001 Propellant 10 grams	Confinement: Sand 2 boxes each side acceptor

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Fragmentation
Yes ___ No ___	Yes ___ No ___	Yes ___ No x
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo x Map x Blast Press. ___
Test Conductor: S. Fuentes	Project Engineer: F. L. McIntyre	Test Dept. Head: A. H. Lasseigne

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping Instructions are to be obtained from ICC ~~Para.~~ 3-13A(2)

Test Type: Standard End Item Test, Detonation Test "A"	Date: 2-13-74
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: A3
Contract Number: NAS8-27750	Designation: M2, 105mm Yellow Smoke Canister
Specification: DAAA-15-69-C-0358	Drawing Number: C15-11-60
Lot Number: B/B 8-69	Manufacture Date: 7/69

METEOROLOGICAL DATA

Temperature: 75°F	Humidity: 47%	Barometric Pressure: 29.98
Wind Direction: 170°	Wind Velocity: 9 mph	

TEST SET UP

Priming:	Location of Acceptor: Centermost round top layer
Booster:	Confinement: None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Explosion
Yes X No	Yes ___ No ___	Yes ___ No ___
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___
Test Conductor: [signature]	Project Engineer: [signature]	Test Dept. Head: [signature]

Assigned Classification

ICC Forbidden	
ICC Restricted*	
ICC Class A	
ICC Class B	

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Organization _____

*Shipping instructions are to be requested from ICC (para 3-13A (2).

Test Type	Date
Standard End Item Test, Detonation Test "A"	2-13-74
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: A2

Contract Number: NAS8-27750	Designation: M2, 105mm Yellow Smoke Canister
Specification: DAAA-15-69-C-0358	Drawing Number: C15-11-60
Lot Number: B/B 8-69	Manufacture Date: 7/69

METEOROLOGICAL DATA

Temperature	Humidity	Barometric Pressure
74°F	48%	29.99

Wind Direction: 180°	Wind Velocity: 9 mph

TEST SET UP

Priming: Match Head Igniter	Location of Acceptor: Centermost round top layer
Booster: 2 gm 3001 UTC Propellant	Confinement: None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Explosion
Yes ___ No x	Yes ___ No ___	Yes ___ No ___
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___
Test Conductor: S Fuentes	Project Engineer: F H McIntyre	Test Dept. Head: Wayne A. Stiles

---

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping instructions are to be obtained from ICC Para. 3-13A(2)

Test Type: Standard End Item Test, Detonation Test "A"	Date: 2-13-74
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: A1
Contract Number: NAS8-27750	Designation: M2, 105mm Yellow Smoke Canister
Specification: DAAA-15-69-C-0358	Drawing Number: C15-11-60
Lot Number: B/B 8-69	Manufacture Date: 7/69

METEOROLOGICAL DATA

Temperature: 71°F	Humidity: 50%	Barometric Pressure: 30.00
Wind Direction: 175°	Wind Velocity: 10 mph	

TEST SET UP

Priming: Match Head Igniter	Location of Acceptor: Centermost round top layer
Booster: 2 gm UTC 3001 Propellant	Confinement: None

TEST RESULTS

Detonation Test A	Detonation Test B	External Heat Test "C"
Propagation	Propagation	Explosion
Yes ___ No X	Yes ___ No ___	Yes ___ No ___
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___
Test Conductor: [signature]	Project Engineer: [signature]	Test Dept. Head: [signature]

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping instructions are to be obtained from ICC Para. 3-13A(2)

APPENDIX C - BULK CLASSIFICATION DATA SUMMARY

C-1. Detonation Test Results Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS
Sulfur Green	B143-2-1	No Reaction
Sulfur Red	B143-3-1	No Reaction
Sulfur Yellow	B143-4-1	No Reaction
Sulfur Violet	B143-5-1	No Reaction
Lactose Green	B143-2-6	No Reaction
Lactose Red	B143-3-7	No Reaction
Lactose Yellow	B143-4-7	No Reaction
Lactose Violet	B143-5-2	No Reaction
Fuel Mix	B143-10-1	No Reaction
HC White Smoke	B143-1-1	No Reaction
CS Riot Gas T-752	-	Burned
Starter Mix II	B143-7-5	Burned
Starter Mix III	B143-7-6	Burned
Starter Mix VI	B143-7-3	Burned
Starter Mix XII	B143-7-1	Burned
Starter Mix V	B143-7-9	Burned
Starter Mix XXV	B143-7-4	Burned
First Fire VII	B143-9-1	Burned
First Fire X	B143-9-3	Burned
First Fire 31	B143-9-5	Burned
Plastic Bonded Starter Mix	-	Burned
Thermate	B143-13-1	No Reaction
Delay Mix V	B143-12-1	Burned
Impregnator Mix	B143-15-1	No Reaction
Igniter Mix R20C	-	No Reaction
Igniter Mix III	B143-8-2	Burned
Tracer Composition R284	-	No Reaction
Yellow Star Mix	-	No Reaction
Match Head Mix VI	B143-12-1	Burned
Scratcher Mix 1	B143-15-2	Burned
CS Pyro Mix	B143-14-10	No Reaction
Starter Mix 1	B143-7-2	Burned
Igniter Charge	B143-8-1	No Reaction
Match Head Mix V	B143-11-1	Burned

C-2. Ignition and Unconfined Burn Test Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS
Sulfur Green	B143-2-1	No Explosion
Sulfur Red	B143-3-1	No Explosion
Sulfur Yellow	B143-4-1	No Explosion
Sulfur Violet	B143-5-1	No Explosion
Lactose Green	B143-2-6	No Explosion
Lactose Red	B143-3-7	No Explosion
Lactose Yellow	B143-4-7	No Explosion
Lactose Violet	B143-5-2	No Explosion
Fuel Mix	B143-10-1	No Explosion
HC White Smoke	B143-1-1	No Ignition
CS Riot Gas T-752	-	No Explosion
Starter Mix II	B143-7-5	No Explosion
Starter Mix III	B143-7-6	No Explosion
Starter Mix VI	B143-7-3	No Explosion
Starter Mix XII	B143-7-1	No Explosion
Starter Mix V	B143-7-9	No Explosion
Starter Mix XXV	B143-7-4	No Explosion
First Fire VII	B143-9-1	No Explosion
First Fire X	B143-9-3	No Explosion
First Fire 31	B143-9-5	No Explosion
Plastic Bonded Starter Mix	-	No Explosion
Thermate	B143-13-1	No Ignition
Delay Mix V	B143-12-1	No Explosion
Impregnator Mix	B143-15-1	No Explosion
Igniter Mix R20C	-	No Explosion
Igniter Mix III	B143-8-2	No Explosion
Tracer Composition R284	-	No Explosion
Yellow Star Mix	-	No Explosion
Match Head Mix VI	B143-12-1	No Explosion
Scratcher Mix 1	B143-15-2	No Explosion
CS Pyro Mix	B143-14-10	No Explosion
Starter Mix 1	B143-7-2	No Explosion
Igniter Charge	B143-8-1	No Explosion
Match Head Mix V	B143-11-1	No Explosion

C-3. Thermal Stability Test Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS
Sulfur Green	B143-2-1	No Explosion
Sulfur Red	B143-3-1	No Explosion
Sulfur Yellow	B143-4-1	No Explosion
Sulfur Violet	B143-5-1	No Explosion
Lactose Green	B143-2-6	No Explosion
Lactose Red	B143-3-7	No Explosion
Lactose Yellow	B143-4-7	No Explosion
Lactose Violet	B143-5-2	No Explosion
Fuel Mix	B143-10-1	No Explosion
HC White Smoke	B143-1-1	Weight Loss (99.9 g)
CS Riot Gas T-752	-	No Explosion
Starter Mix II	B143-7-5	No Explosion
Starter Mix III	B143-7-6	No Explosion
Starter Mix VI	B143-7-3	No Explosion
Starter Mix XII	B143-7-1	No Explosion
Starter Mix V	B143-7-9	Weight Loss (19.5 g)
Starter Mix XXV	B143-7-4	No Explosion
First Fire VII	B143-9-1	No Explosion
First Fire X	B143-9-3	No Explosion
First Fire 31	B143-9-5	No Explosion
Plastic Bonded Starter Mix	-	No Explosion
Thermate	B143-13-1	No Explosion
Delay Mix V	B143-12-1	No Explosion
Impregnator Mix	B143-15-1	Weight Loss (31.4 g)
Igniter Mix R20C	-	No Explosion
Igniter Mix III	B143-8-2	No Explosion
Tracer Composition R284	-	No Explosion
Yellow Star Mix	-	No Explosion
Match Head Mix VI	B143-12-1	No Explosion
Scratcher Mix 1	B143-15-2	No Explosion
CS Pyro Mix	B143-14-10	No Explosion
Starter Mix 1	B143-7-2	No Explosion
Igniter Charge	B143-8-1	Weight Loss (1.1 g)
Match Head Mix V	B143-11-1	No Explosion

C-4. Impact Sensitivity Test Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS	
		3-3/4"	10"
Sulfur Green	B143-2-1	0	0
Sulfur Red	B143-3-1	0	0
Sulfur Yellow	B143-4-1	0	0
Sulfur Violet	B143-5-1	0	2
Lactose Green	B143-2-6	0	0
Lactose Red	B143-3-7	0	0
Lactose Yellow	B143-4-7	0	1
Lactose Violet	B143-5-2	0	0
Fuel Mix	B143-10-1	0	1
HC White Smoke	B143-1-1	0	0
CS Riot Gas T-752	-	0	0
Starter Mix II	B143-7-5	0	0
Starter Mix III	B143-7-6	0	0
Starter Mix VI	B143-7-3	0	9
Starter Mix XII	B143-7-1	0	2
Starter Mix V	B143-7-9	0	0
Starter Mix XXV	B143-7-4	0	0
First Fire VII	B143-9-1	0	0
First Fire X	B143-9-3	0	0
First Fire 31	B143-9-5	0	0
Plastic Bonded Starter Mix	-	0	0
Thermate	B143-13-1	0	4
Delay Mix V	B143-12-1	0	0
Impregnator Mix	B143-15-1	0	0
Igniter Mix R20C	-	0	1
Igniter Mix III	B143-8-2	0	0
Tracer Composition R284	-	1	9
Yellow Star Mix	-	3	10
Match Head Mix VI	B143-12-1	0	10
Scratcher Mix 1	B143-15-2	N/A	N/A
CS Pyro Mix	B143-14-10	0	0
Starter Mix 1	B143-7-2	0	0
Igniter Charge	B143-8-1	0	0
Match Head Mix V	B143-11-1	2	9

NOTE: Test results indicate explosions only. A zero value indicated that neither reaction nor decomposition occurred.

C-5. Card Gap Test Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS
Sulfur Green	B143-2-1	No Detonation
Sulfur Red	B143-3-1	No Detonation
Sulfur Yellow	B143-4-1	No Detonation
Sulfur Violet	B143-5-1	No Detonation
Lactose Green	B143-2-6	No Detonation
Lactose Red	B143-3-7	No Detonation
Lactose Yellow	B143-4-7	No Detonation
Lactose Violet	B143-5-2	No Detonation
Fuel Mix	B143-10-1	No Detonation
HC White Smoke	B143-1-1	No Detonation
CS Riot Gas T-752	-	No Detonation
Starter Mix II	B143-7-5	No Detonation
Starter Mix III	B143-7-6	No Detonation
Starter Mix VI	B143-7-3	No Detonation
Starter Mix XII	B143-7-1	No Detonation
Starter Mix V	B143-7-9	No Detonation
Starter Mix XXV	B143-7-4	No Detonation
First Fire VII	B143-9-1	No Detonation
First Fire X	B143-9-3	No Detonation
First Fire 31	B143-9-5	No Detonation
Plastic Bonded Starter Mix	-	No Detonation
Thermate	B143-13-1	No Detonation
Delay Mix V	B143-12-1	No Detonation
Impregnator Mix	B143-15-1	No Detonation
Igniter Mix R20C	-	No Detonation
Igniter Mix III	B143-8-2	No Detonation
Tracer Composition R284	-	No Detonation
Yellow Star Mix	-	No Detonation
Match Head Mix VI	B143-12-1	No Detonation
Scratcher Mix 1	B143-15-2	No Detonation
CS Pyro Mix	B143-14-10	No Detonation
Starter Mix 1	B143-7-2	No Detonation
Igniter Charge	B143-8-1	No Detonation
Match Head Mix V	B143-11-1	No Detonation

C-6. Parr Bomb Test Summary

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS K CAL/GRAM
Sulfur Green	B143-2-1	2.487
Sulfur Red	B143-3-1	2.282
Sulfur Yellow	B143-4-1	2.275
Sulfur Violet	B153-5-1	2.294
Lactose Green	B143-2-6	2.960
Lactose Red	B143-3-7	2.988
Lactose Yellow	B143-4-7	2.763
Lactose Violet	B143-5-2	2.345
Fuel Mix	B143-10-1	1.000
CS Pyro	B143-14-10	3.248
HC White Smoke	B143-1-1	939
Yellow Star Mix	-	1.680
First Fire X	B143-9-3	882
First Fire 31	B143-9-5	1.017
Plastic Bonded Starter Mix	-	5.545
Tracer Mix R284	-	7.369
Igniter Mix R20C	-	8.163
Delay V	B143-12-1	658
Igniter Charge	B143-8-1	2.014
Match Head Mix V	B143-11-1	1.187

C-7. Differential Thermal Analysis Test Results

SAMPLE MATERIAL	DRAWING NUMBER	TEST RESULTS IGNITION TEMP. °C
Sulfur Green	B143-2-1	196
Sulfur Red	B143-3-1	201
Sulfur Yellow	B143-4-1	196
Sulfur Violet	B143-5-1	221
Lactose Green	B143-2-6	332
Lactose Red	B143-3-7	197
Lactose Yellow	B143-4-7	227
Lactose Violet	B143-5-2	210
Fuel Mix	B143-10-1	193
CS Pyro	B143-14-10	203
HC White Smoke	B143-1-1	193
First Fire X	B143-9-3	896
First Fire 31	B143-9-5	997
Impregnator Mix	B143-15-1	441
Plastic Bonded Starter Mix	-	172
Igniter Mix R20C	-	477
Delay V	B143-12-1	764
Tracer Composition R284	-	629
Yellow Star Mix	-	577
Starter Mix I	B143-7-2	684
Igniter Charge	B143-8-2	321
Match Head Mix V	B143-11-1	298

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