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EDGEWOOD ARSENAL CONTRACTOR REPORT

EM-CR-76104

EXPLOSIVE CLASSIFICATION TESTING

OF

EXPERIMENTAL COLORED SMOKE COMPOSITIONS AND END ITEMS

By

F. L. McIntyre
G. L. McKown

October 1976

NASA NATIONAL SPACE TECHNOLOGY LABORATORIES
GENERAL ELECTRIC COMPANY
Engineering and Science Services Laboratory
Bay Saint Louis, Mississippi 39520

Contract NAS8-27750

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

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M18 granades	External heat test	Ignition and unconfirmed burning
TB 700-2 testing	Thermal stability	Impact sensitivity

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

Bulk material and end item hazard classification tests have been performed on four experimental M18 colored smoke formulations made from coarse ingredients. Compared to standard mixes, the new red, yellow, green and violet smoke compositions yielded essentially identical test results for thermal stability, card gap and burning tests but indicated greatly enhanced sensitivity toward impact. Detonation and external heat tests on packaged grenade end items made from the experimental materials gave no evidence of interround propagation, explosion or fragment dispersal.

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PREFACE

The work described in this report was authorized under US Army PEMA 4932, Project 5761313 and Technical Work Request EA-2400. 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 NAS8-27750. This work was initiated in April 1976 and completed May 1976.

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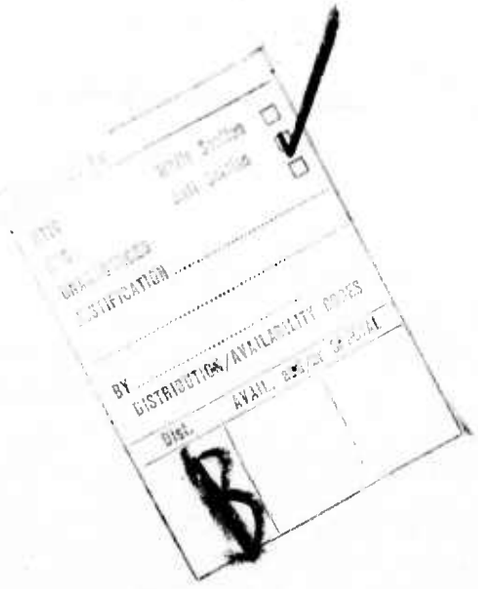

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EXPLOSIVE CLASSIFICATION TESTING OF EXPERIMENTAL COLORED SMOKE COMPOSITIONS AND END ITEMS

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 Project 5751249 experimental bulk materials and end-item munitions:

- Violet smoke mix
- Yellow smoke mix
- Red smoke mix
- Green smoke mix
- AN-M18 violet smoke grenade
- AN-M18 red smoke grenade
- AN-M18 yellow smoke grenade
- AN-M18 green smoke grenade

1.2 Authority. The work described in this report was authorized by MIPR 8166104601 F4W5 and by Technical Work Request EA-2400.

1.3 Background. The Manufacturing Technology Directorate of Edgewood Arsenal is currently involved via MMT Project 5751249 in increasing the producibility and lowering the cost of standard M18 colored smoke grenades. To aid in processing of materials through automated blending and filling equipment, experimental colored smoke formulations that use coarse ingredients and are regranulated after compaction have been devised. These formulations also differ from the composition of standard M18 mixes in that the oxidizer/fuel ratios have been increased as shown in table 1 in order to obtain the required burn characteristics.

Extensive hazard classification testing has been performed for standard colored smoke bulk formulations (1, 2) and end item munitions (3) under former Project 57x4099. However, the variations noted above in composition and material characteristics of the experimental mixtures require a reassessment of sensitivity and output energy parameters. Based on these test results, assignment of hazard classification and compatibility indices for manufacturing, transportation and storage of the bulk materials and end item munitions may then be accomplished.

Table 1. Ingredient Ratios for Standard and Experimental Grenade Formulations

Smoke color	Weight ratio, $KClO_3$/Sulfur		Weight ratio, $KClO_3$/$NaHCO_3$	
	Standard	Experimental	Standard	Experimental
Red	2.98	3.33	1.04	1.30
Yellow	2.35	2.82	0.61	0.80
Green	2.60	3.33	1.19	1.50
Violet	2.78	3.00	1.04	1.17

2.0 EXPERIMENTAL PROCEDURES

2.1 Bulk Compositions. Classification of a bulk pyrotechnic composition is currently accomplished by evaluation of test data obtained in accordance with Chapter 3, US Army TB 700-2. These tests are designed to determine the ease of initiation and the stability of a bulk pyrotechnic composition prior to shipping and handling. The following specific tests were accomplished:

(a) 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 5-cm (2-inch) cube sample was placed on top of a perpendicular 3.8 cm (1.5-inch) diameter by 10.2-cm (4-inch) long lead cylinder. The Number 8 blasting cap was placed perpendicular to and in contact with the top surface of the sample. A 5 cm (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.

(b) Ignition and Unconfined-Burning Test. These tests were conducted on single and multiple (four) 5-cm (2-inch) cube samples. The samples were 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.

(c) Thermal Stability Test. 5.0-cm (2-inch) cube 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.

(d) 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 to strike the sample. The results of the 20 tests per sample, 10 at 9.5-cm (3.75-inch) drop height and 10 at 25.4-cm (10-inch) drop height, were reported as the number of trials exhibiting (1) Explosion, (2) Decomposition, and (3) No Reaction.

(e) Card Gap Test. The sample materials were placed in a 14-cm (5.5-inch) long cold-drawn seamless steel tube, composition 1015, having an OD of 4.76-cm (1.875-inches) and a wall thickness of 0.56-cm (0.219-inch). The assembly was placed on a 15-cm x 15-cm x 1-cm steel witness plate in such a manner as to have a 1.6-mm air gap between the tube and the witness plate. Two pentolite pellets (5-cm diameter x 2.5-cm 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 J-2 Engineer's special blasting cap was positioned on top of the pentolite and the complete Card Gap test assembly was supported approximately 15-cm above the ground surface. The J-2 Engineer's special 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).

2.2 End Item Munitions. Evaluation of pyrotechnic end item munitions is currently accomplished by the test data obtained in accordance with Chapter 4 of US Army TB 700-2. The end item munitions are tested to determine their tendency to propagate from one shipping or packing case to another, and to evaluate the reaction resulting from burning the munitions in an intense fire. The following specific tests were conducted:

(a) Detonation Test A. This test is conducted on items which are packaged with more than one item in the standard storage and shipping container to determine if functioning of one item will cause other items in the container to function. The most centrally positioned item within the package was primed by its own fuse. The results of the test determine occurrence of propagation within a single container, fragmentation, blast, and fire hazards. The test was conducted a minimum of five times or until communication to adjacent items occurred. Evidence of propagation between donor and acceptor rounds, blast overpressure, and fragmentation dispersal from container rupture were recorded.

(b) Detonation Test B. This test is conducted, in the event of positive indications from the A test series, to determine if functioning of items in one container will cause functioning of items in adjacent containers. Since the A tests resulted in no communication within the container and the container was not ruptured, these tests were omitted.

(c) External Heat Test C (Open Flame). This test is designed to simulate a condition wherein the containers of the explosive or pyrotechnic items are completely enveloped in a hot fire. Four containers of the end items were arranged in a compact stack, approximating a cube. The containers were then secured with steel bands in two directions to maintain stacking until initiation of one or more items occurred without significantly affecting dispersal of fragments. The stack of containers was placed on a wooden crib, the interior of which was filled with scrap lumber. The crib and stack of items to be tested were covered with additional combustible material sufficient to sustain a hot fire. The entire mass was then saturated with approximately 50 gallons of 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 was recorded.

3.0 RESULTS

3.1 Bulk Compositions (See Data Sheets in Appendix A)

(a) Detonation Tests. None of the pyrotechnic compositions exhibited characteristics of an explosion or produced fragmentation. Test results are summarized in table 2.

Table 2. Detonation Test Summary

Sample designation	Test number	Material weight in grams	Test results		
			Exploded	Burned	Fragmented
Violet Smoke Mix Project 5751249	1	134.7	No	No	No
	2	134.7	No	No	No
	3	134.7	No	No	No
	4	134.7	No	No	No
	5	134.7	No	No	No
Red Smoke Mix Project 5751249	1	129.5	No	No	No
	2	129.5	No	No	No
	3	129.5	No	No	No
	4	129.5	No	No	No
	5	129.5	No	No	No
Yellow Smoke Mix Project 5751249	1	140.5	No	No	No
	2	140.5	No	No	No
	3	140.5	No	No	No
	4	140.5	No	No	No
	5	140.5	No	No	No
Green Smoke Mix Project 5751249	1	141.8	No	No	No
	2	141.8	No	No	No
	3	141.8	No	No	No
	4	141.8	No	No	No
	5	141.8	No	No	No

(b) Ignition and Unconfined Burning Tests. None of the pyrotechnic compositions tested exhibited characteristics of an explosion. Test results are summarized in table 3.

Table 3. Ignition and Unconfined Burning Test Summary

Sample designation	Material weight in grams	Test configuration	Test Results	
			Exploded	Avg. burn time in seconds
Violet Smoke Mix Project 5751249	134.7	Single cube	No	48
	134.7	Single cube	No	40
	538.6	Multiple cube	No	67
Red Smoke Mix Project 5751249	129.5	Single cube	No	64
	129.5	Single cube	No	65
	518	Multiple cube	No	82
Yellow Smoke Mix Project 5751249	140.5	Single cube	No	38
	140.5	Single cube	No	37
	562	Multiple cube	No	56
Green Smoke Mix Project 5751249	141.8	Single cube	No	73
	141.8	Single cube	No	81
	567.2	Multiple cube	No	89

(c) Thermal Stability Tests. None of the pyrotechnic compositions exhibited characteristics of an explosion, ignited, or any significant change in configuration in any observable fashion. Test results are shown in table 4.

Table 4. Thermal Stability Test Summary

Sample designation	Sample weight in grams	Explosion	Test results	
			Ignition	Change in configuration
Violet Smoke Mix Project 5751249	134.7	No	No	None
Red Smoke Mix Project 5751249	129.5	No	No	None
Yellow Smoke Mix Project 5751249	140.5	No	No	None
Green Smoke Mix Project 5751249	141.8	No	No	None

(d) Impact Sensitivity Tests. All four pyrotechnic mixes exhibited characteristics of an explosion and/or decomposition in a significant number of trials at both specified drop heights. The test results are given in table 5.

Table 5. Impact Sensitivity Test Summary

Sample designation	Weight in milligrams	Test results *					
		9.5 cm (3.75")			25.4 cm (10")		
		E	D	N	E	D	N
Violet Smoke Mix Project 5751249	10	3	3	4	4	6	0
Red Smoke Mix Project 5751249	10	3	3	4	6	3	1
Yellow Smoke Mix Project 5751249	10	3	5	2	9	1	0
Green Smoke Mix Project 5751249	10	5	2	3	10	0	0

*E = Explosion
D = Decomposition
N = No Apparent Reaction

(e) Card Gap Tests. None of the pyrotechnic compositions exhibited characteristics of mass detonation and zero card values were obtained. Test results are shown in table 6.

Table 6. Card Gap Test Summary

Sample designation	Test number	Sample weight in grams	Test results	
			Detonation	50% Card value
Violet Smoke Mix Project 5751249	1	143	No	0
	2	137	No	0
	3	138	No	0
Red Smoke Mix Project 5751249	1	140	No	0
	2	137	No	0
	3	141	No	0
Yellow Smoke Mix Project 5751249	1	137	No	0
	2	136	No	0
	3	132	No	0
Green Smoke Mix Project 5751249	1	150	No	0
	2	149	No	0
	3	149	No	0

3.2 End Item Munitions (See Data Sheets and Photographs in Appendixes B and C)

(a) Detonation Test A. The AN-M18 smoke grenades filled with the experimental coarse pyrotechnic mixtures did not exhibit characteristics of detonation or fragment dispersal. In none of the tests on the four colors (red, yellow, green or violet) was propagation observed from the donor round to adjacent acceptor rounds within the packing container, and no damage occurred to the exterior of the original shipping container. Results are summarized in table 7.

Table 7. Detonation Test A Summary

Sample designation	Test results	
	Propagation	Blast overpressure psig
M-18 Green Test Grenade Project 5751249	None	0
M-18 Violet Test Grenade Project 5751249	None	0
M-18 Yellow Test Grenade Project 5751249	None	0
M-18 Red Test Grenade Project 5751249	None	0

(b) External Heat Test C. None of the four experimental colored smoke grenades exhibited characteristics of a mass detonation. There was no measurable blast overpressure nor fragments, and dispersal of the functioned grenades was limited to the immediate test area. The resultant reactions were not significantly different from those reported previously for standard M18 colored smoke grenades (3). Results are summarized in table 8.

Table 8. External Heat Test C Summary

Sample designation	Test results			
	Test duration minutes	Detonation	Blast overpressure psig	Remarks
M18 Green Test Grenade Project 5751249	89	None	0	All consumed No fragments
M18 Violet Test Grenade Project 5751249	58	None	0	All consumed No fragments
M18 Yellow Test Grenade Project 5751249	50	None	0	All consumed No fragments
M18 Red Test Grenade Project 5751249	74	None	0	All consumed No fragments

4.0 DISCUSSION

Except for increased sensitivity of the bulk materials toward impact, the four experimental compositions generally behaved similarly to standard M18 grenade smoke formulations during all TB 200-2 testing. However, two examples of unusual behavior were observed and are reported here for the information of the developing agency.

(1) Visual observations of smoke production during tests on bulk mix and end items of the green formulation indicated poor performance in that grey to black smoke was produced during a significant fraction of the total burn time. The red, violet and yellow mixes did not exhibit this anomaly and appeared to produce acceptable smoke clouds.

(2) Following completion of all tests, five cases of excess grenades of each color were disposed by normal functioning. During this disposal, two yellow and two red grenades exploded with perceptible audible reports following initiation of the fuse trains. One of these yellow grenades was ejected with high velocity from the disposal pit into which it had been thrown. The cause of this abnormal behavior is unknown, but it is possibly due to higher than normal quantities of first fire mix, introduced during pilot scale production of these experimental munitions, rather than to characteristics of the smoke compositions.

5.0 REFERENCES

1. Schmidt, R. E., Dabul, A., and McIntyre, F. L. Edgewood Arsenal Contractor Report EM-CR-75017, General Electric Co., Miss. Compilation and Preliminary Analysis of Sensitivity Data for Pyrotechnics. May 1975.

2. McIntyre, F. L. Edgewood Arsenal Contractor Report EM-CR-75001, General Electric Co., Miss. Identification and Evaluation of Hazards Associated with Blending of Violet Smoke Mix by the Jet Airmix Process. March 1975.

3. Koger, D. M. and King, P. V. General Electric (Miss.) Contractor Report GE-MTSD-R-035. Pyrotechnic Hazards Classification and Evaluation Program, Phase I, Final Report. May 1970.

APPENDIX A

DATA SHEETS - BULK COMPOSITIONS

Date 5/24/76

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Project 5751249 M18 Colored Smoke Bulk Mix (Violet)

Propellant Spec. _____ Batch EA 3-76

Mfg Date 3-76

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 5 cm (2-inch) cubes Test: One blasting cap per sample.

Ignition & Unconfined Burning Test	Exploded		Average Burning Time
	Yes	No	Seconds
One 5 cm (2-inch) cubes	___	X	48
One 5 cm (2-inch) cubes	___	X	40
Four 5 cm (2-inch) cubes	___	X	67

Samples: Six 5 cm (2-inch) cubes Test: Ignite & burn unconfined.

Thermal Stability Test	Explosion		Ignition		Change in Configuration	
Test: 48 hrs at 75°C in vented oven.	Yes	No	Yes	No	Yes	No
One 5 cm (2") cube	___	X	___	X	___	X

Samples: One 5 cm (2") cube Weight Change: None

Card Gap Test 3 trials, No detonation 50% Value (No. of Cards) NA

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

9.5 cm (3.75") Drop Test 10 Trials			25.4 cm (10.0") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise 3	Decomposition Smoke No Noise 3	No Reaction No Smoke No Noise 4	Explosion Flame and Noise 4	Decomposition Smoke No Noise 6	No Reaction No Smoke No Noise 0

Approved:

Test Director F. M. Intzilo Test Department Head _____

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ICC Class B	

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Title _____

Organization _____

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Date 5/24/76

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Project 5751249 M18 Colored Smoke Bulk Mix (Yellow)

Propellant Spec. _____ Batch EA 3-76

Mfg Date 3-76

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	38
One 2-inch cube	—	x	37
Four 2-inch cubes	—	x	56

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

Thermal Stability Test

Test: 48 hrs at 75°C in vented oven.

	Explosion Yes	Explosion No	Ignition Yes	Ignition No	Change in Configuration Yes	Change in Configuration No
One 2-inch cube						
Samples: One 2-inch cube	—	x	—	x	—	x

Weight Change: None

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

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

9.5 cm (3.75") Drop Test 10 Trials			25.4 cm (10.0") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise 3	Decomposition Smoke No Noise 5	No Reaction No Smoke No Noise 2	Explosion Flame and Noise 9	Decomposition Smoke No Noise 1	No Reaction No Smoke No Noise 0

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Date 5/24/76

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Project 5751249 M18 Colored Smoke Bulk Mix (Red)

Propellant Spec. _____ Batch EA 376

Mfg Date 3-76

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	64
One 2-inch cube	___	x	65
Four 2-inch cubes	___	x	82

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

Thermal Stability Test	Explosion		Ignition		Change in Configuration	
Test: 48 hrs at 75°C in vented oven.	Yes	No	Yes	No	Yes	No
One 2-inch cube	___	x	___	x	___	x

Samples: One 2-inch cube Weight Change: None

Card Gap Test 3 trials, No detonation 50% Value (No. of Cards) NA

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

9.5 cm (3.75") Drop Test 10 Trials			25.4 cm (10.0") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise 3	Decomposition Smoke No Noise 3	No Reaction No Smoke No Noise 4	Explosion Flame and Noise 6	Decomposition Smoke No Noise 3	No Reaction No Smoke No Noise 1

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Date 5/24/76

Sponsoring Agency Edgewood Arsenal, Edgewood, Maryland

Contract No. NAS8-27750

Propellant Identity (Type No.) Project 5751249 M18 Colored Smoke Bulk (Green)

Propellant Spec. _____ Batch EA 3-76

Mfg Date 3-76

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	___	___	_____
One 2-inch cube	___	___	_____
Four 2-inch cubes	___	___	_____

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

Thermal Stability Test	Explosion		Ignition		Change in Configuration	
Test: 48 hrs at 75°C in vented oven.	Yes	No	Yes	No	Yes	No
One 2-inch cube	___	x	___	x	___	x

Samples: One 2-inch cube Weight Change: None

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

Impact Sensitivity Test

Bureau of Explosives Impact Apparatus

9.5 cm (3.75") Drop Test 10 Trials			25.4 cm (10.0") Drop Test 10 Trials		
No. of Trails Exhibiting			No. of Trials Exhibiting		
Explosion Flame and Noise 5	Decomposition Smoke No Noise 2	No Reaction No Smoke No Noise 3	Explosion Flame and Noise 10	Decomposition Smoke No Noise 0	No Reaction No Smoke No Noise 0

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APPENDIX B
END ITEM MUNITIONS

Test Type: TB 700-2 Standard End Item Detonation Test A	Date: 4/26/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 18-6-01A$_1$-A5 (5 each)
Contract Number: NAS8-27750	Designation: Project 5751249 AN-M18 Test Grenade (Green)
Specification:	Drawing Number:
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature: 17.2°C	Humidity: 61% RH	Barometric Pressure: 101.3 kPa
Wind Direction: (CW from north) 30°	Wind Velocity: 4.12 m/sec	

TEST SET UP

Priming: Atlas Matchhead Igniter	Location of Acceptor: Center most grenade
Booster: 1 gm UTC 3001 Propellant	Confinement: None

TEST RESULTS

Detonation Test A (5 total)		Detonation Test B		External Heat Test "C"	
Propagation		Propagation		Explosion	
Yes ___ No X		Yes ___ No ___		Yes ___ No ___	
Attachments	Photo Yes Map No Blast Press. No	Attachments	Photo ___ Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___
Test Conductor		Project Engineer		Test Dept. Head	

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: TB 700-2 Standard End Item Detonation Test A		Date: 4/26/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland		Test Number: 18-6-02A$_1$-A5
Contract Number: NAS8-27750	Designation: Project 5751249 AN-M18 Test Grenades (Yellow)	
Specification:	Drawing Number:	
Lot Number: EA 3/76	Manufacture Date: 3-76	

METEOROLOGICAL DATA

Temperature: 21.7°C	Humidity: 44% RH	Barometric Pressure: 101.2 kPa
Wind Direction (CW from north): 32°	Wind Velocity: 4.1 m/sec	

TEST SET UP

Priming: Atlas Matchhead Igniter	Location of Acceptor: Center most grenade
Booster: 1 gm UTC 3001 Propellant	Confinement: None

TEST RESULTS

Detonation Test A (5 total)		Detonation Test B		External Heat Test "C"	
Propagation		Propagation		Explosion	
Yes ___ No X		Yes ___ No ___		Yes ___ No ___	
Attachments	Photo Yes Map No Blast Press. No	Attachments	Photo ___ Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___
Test Conductor		Project Engineer		Test Dept. Head	

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
TB 700-2 Standard End Item Detonation Test A	4/28/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 18-6-04A$_1$-A5 (5 each)
Contract Number: NAS8-27750	Designation: Project 5751849 AN-M18 Test Grenade (Violet)
Specification	Drawing Number
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature	Humidity	Barometric Pressure
27.2°C	54% RH	101.6 kPa
Wind Direction (CW from north): 150°	Wind Velocity: 5.14 m/sec	

TEST SET UP

Priming	Location of Acceptor
Atlas Matchhead Igniter	Center most grenade
Booster: 1 gm UTC 3001 Propellant	Confinement: None

TEST RESULTS

Detonation Test A (5 total)		Detonation Test B		External Heat Test "C"	
Propagation		Propagation		Explosion	
Yes ___ No X		Yes ___ No ___		Yes ___ No ___	
Attachments	Photo Yes Map No Blast Press. No	Attachments	Photo ___ Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___
Test Conductor		Project Engineer		Test Dept. Head	

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: TB 700-2 Standard End Item Detonation Test A	Date: 4/28/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 18-6-05A_1-A5 (5 ea)
Contract Number: NAS8-27750	Designation: Project 5751249 AN-M18 Test Grenades (Red)
Specification:	Drawing Number:
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature: 25.6°C	Humidity: 58% RH	Barometric Pressure: 101.6 kPa
Wind Direction (CW from north): 50°	Wind Velocity: 3.60 m/sec	

TEST SET UP

Priming: Atlas Matchhead Igniter	Location of Acceptor: Center most grenade
Booster: 1 gm UTC 3001 Propellant	Confinement: None

TEST RESULTS

Detonation Test A (5 total)		Detonation Test B		External Heat Test "C"	
Propagation		Propagation		Explosion	
Yes ___ No X		Yes ___ No ___		Yes ___ No ___	
Attachments	Photo Yes Map No Blast Press. No	Attachments	Photo ___ Map ___ Blast Press. ___	Attachments	Photo ___ Map ___ Blast Press. ___
Test Conductor		Project Engineer [signature]		Test Dept. Head	

Assigned Classification

ICC Forbidden	
ICC Restricted *	
ICC Class A	
ICC Class B	

Signature

Title

Organization

*Shipping instructions are to be obtained from ICC Para. 1-13A(2)

Test Type: Standard TB 700-2 External Heat Test C	Date: 5/19/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 21-6-03
Contract Number: NAS-27750	Designation: AN-M18 Green Smoke Grenade Project 5751249
Specification:	Drawing Number:
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature: 25.6°C	Humidity: 36% RH	Barometric Pressure: 101.3 kPa
Wind Direction (CW from north): 150°	Wind Velocity: 3.60 m/sec	

TEST SET UP

Priming: 208 liters (55 gal) diesel fuel w/2 Electric Match Igniters	Location of Acceptor: 4 boxes of colored smoke banded inside pyre
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 ___	Yes ___ No ___	Yes ___ No X
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo X Map No Blast Press. None
Test Conductor	Project Engineer	Test Dept. Head

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 TB 700-2 External Heat Test C	Date: 5/19/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 21-6-04
Contract Number: NAS8-27750	Designation: AN-M18 Yellow Smoke Grenades Project 5751249
Specification: N/A	Drawing Number: N/A
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature: 23.9°C	Humidity: 33% RH	Barometric Pressure: 101.3 kPa
Wind Direction: (CW from north) 90°	Wind Velocity: 3.60 m/sec	

TEST SET UP

Priming: 208 liters (55 gal) diesel fuel w/2 Electric Match Igniters	Location of Acceptor: 4 boxes of colored smoke grenades banded inside pyre
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 ___	Yes ___ No ___	Yes ___ No X
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo Yes Map No Blast Press. None
Test Conductor	Project Engineer	Test Dept. Head

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
Standard TB 700-2 External Heat Test C	4/30/76
Sponsoring Agent: Edgewood Arsenal, Edgewood, Maryland	Test Number: 18-6-07

Contract Number: NAS8-27750	Designation: AN-M18 Violet Smoke Grenade Project 5751249
Specification: N/A	Drawing Number: N/A
Lot Number: EA 3-76	Manufacture Date: 3-76

METEOROLOGICAL DATA

Temperature: 23.3°C	Humidity: 90% RH	Barometric Pressure: 101.0 kPa
Wind Direction (CW from north): 150°	Wind Velocity: 6.2 m/sec	

TEST SET UP

Priming: 208 liters (55 gal) Diesel Fuel w/2 each Electric Match Igniters	Location of Acceptor: 4 boxes of Grenades Banded Inside Pyre
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 ___	Yes ___ No ___	Yes ___ No X
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo Yes Map No Blast Press. None
Test Conductor	Project Engineer [signature]	Test Dept. Head

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 TB 700-2 External Heat Test C			Date: 4/30/76
Sponsoring Agent			Test Number 18-6-06
Contract Number NAS8-27750		Designation: AN-M18 Red Smoke Grenades Project 5751249	
Specification: N/A		Drawing Number: N/A	
Lot Number: EA 3-76		Manufacture Date: 3-76	

METEOROLOGICAL DATA

Temperature: 26.1°C	Humidity: 64% RH	Barometric Pressure: 100.9 kPa
Wind Direction: (CW from north) 170°	Wind Velocity: 6.17 m/sec	

TEST SET UP

Priming: 208 liters (55 gal) Diesel Fuel w/2 each Electric Match Igniters	Location of Acceptor: 4 boxes of Grenades Banded Inside Pyre
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 ___	Yes ___ No ___	Yes ___ No X
Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo ___ Map ___ Blast Press. ___	Attachments: Photo Yes Map No Blast Press. None
Test Conductor	Project Engineer [signature]	Test Dept. Head

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

SELECTED PHOTOGRAPHS

Figure 1. Typical Pretest Configuration, Detonation Test A.

Figure 2. Typical Posttest Configuration, Detonation Test A.

Figure 3. Typical Test Results, Green Smoke Grenades.

Figure 4. Typical Test Result, Violet Smoke Grenades.

Figure 5. Typical Test Result, Yellow Smoke Grenades.

Figure 6. Typical Test Result, Red Smoke Grenades.

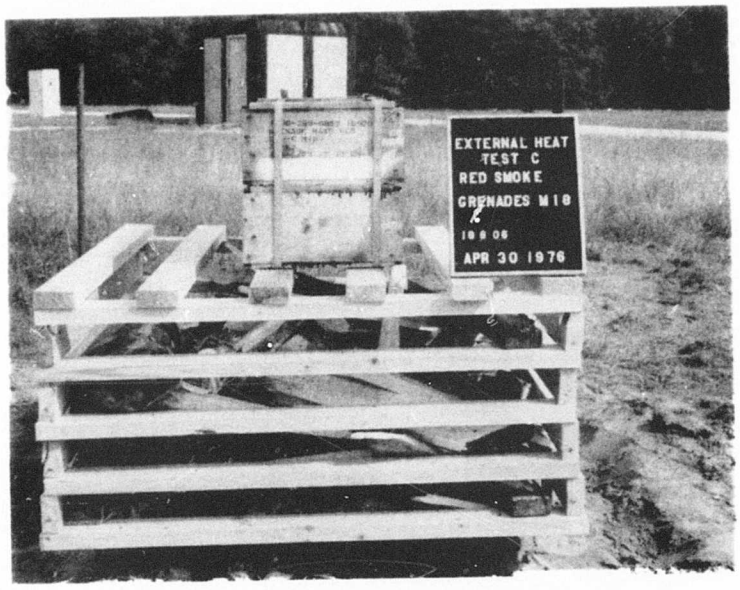

Figure 7. Crib for External Heat Test C.

Figure 8. Typical Funeral Pyre for C Tests.

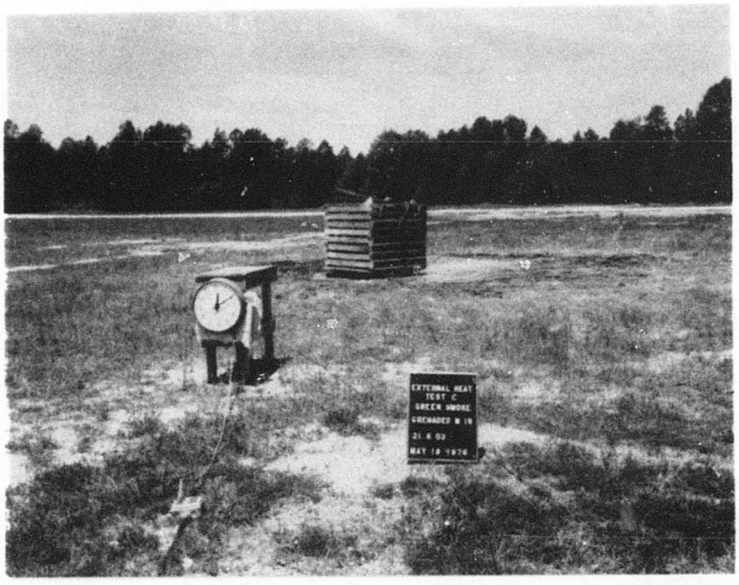

Figure 9. Typical Test Setup for C Tests.

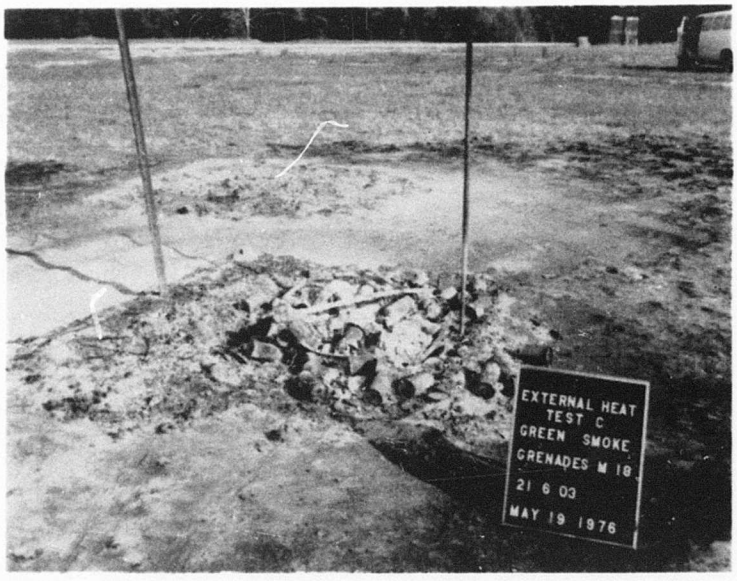

Figure 10. Test Result for Green Smoke Grenades.

Figure 11. Test Result for Red Smoke Grenades.

Figure 12. Test Result for Yellow Smoke Grenades.

Figure 13. Test Result for Violet Smoke Grenades.

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