TECHNICAL NOTE NO. LWL-CR-02F71

40mm FLOATING FLARE FEASIBILITY

Final Report
Contract No. DAAD05-71-C-0191

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ABSTRACT

A program was conducted to develop a floating flare for nighttime target or position marking in inundated areas. Red, green, and yellow flare rounds were developed to be compatible with the M79 and M203 40mm Grenade Launchers and with an external configuration similar to the 40mm Floating Target (Smoke) Marker.

A total of 144 static development tests, 75 ballute development tests, 15 feasibility demonstration tests, 66 environmental tests, and 9 delivery acceptance tests was conducted. Seventy-five rounds were delivered to the Land Warfare Laboratory.

The major program objectives and development goals were achieved. A target marker was developed which 1) is capable of launch from either the M70 or M203 40mm Grenade Launcher, 2) is capable of floatation in swamp or water-covered areas, 3) has an external configuration similar to the 40mm Floating Smoke Marker, and 4) contains a flare-emitting pyrotechnic element, a delay element that ignites the flare before impact, and a floatation device. Three exceptions were 1) the burn time of the red signal is 80 seconds rather than the goal of 90 seconds, 2) the green signal is not color identifiable beyond a range of 2200 meters compared to the goal of 3000 meters, and 3) overall reliability of the feasibility hardware was less than the 95 percent desired reliability.

FOREWORD

This program was conducted for U.S. Army Land Warfare Laboratory, Aberdeen Proving Ground, Maryland under Contract No. DAAD05-71-C-0191 from December, 1970 to September, 1971. The L.W.L. Contract Technical Supervisor was Mr. Neal Wogsland. Project Managers for the program were L. A. Wieder and P. D. Evanoff. The principal technical effort was performed by R. L. Borcherding and D. Campbell.

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INTRODUCTION

The objective of this program was the development of a floating flare for nighttime target or position marking in inundated areas.

The following design characteristics were included in the development goals:

a. The 40mm Floating Flare shall be developed as a 40mm cartridge with all components assembled as a single unit.

b. The flare shall be designed for delivery from both the M79 and the M203 Grenade Launchers.

c. The design shall incorporate the 40mm Cartridge Case XM195 for the launch system.

d. Flare colors required are red, green, and yellow.

e. The design shall incorporate a floatation device of the ballute type, which shall be fabricated from a material capable of withstanding the high temperatures of the gases produced by the burning flare.

f. The cubic measurements of the unit shall be the same as those of the 40mm Floating Smoke Marker and the final assembly length shall not exceed 5-1/4 inches.

g. The projectile and total cartridge weights shall be determined during development and, once determined, these weights shall be consistent.

h. The cartridge shall be man-air transportable and be safe for paradrop delivery.

i. The cartridge shall be expendable.

The following performance characteristics were included in the development goals:

a. The recoil momentum produced by the flare cartridge shall not exceed 4.0 lb-sec when fired from the M79 Grenade Launcher.

b. The flare cartridge shall be capable of operating and functioning under environmental condition "wet-hot," Category 2 of AR 70-38; operation under all environmental categories is desired but not essential.

c. The flare delay element (fuze) shall initiate the signal-emitting pyrotechnic before impact.

d. Ballute inflation shall be complete between the time of separation of the payload from the projectile body and impact onto the surface of the water.

e. The flare shall be capable of floating and functioning on mud or water of any depth and under all weather conditions.

f. The flare shall have a range capability of not less than 250 meters; a range of 300 meters is desirable.

g. The pyrotechnic mix shall produce a visible signal for a minimum of 1-1/2 minutes as measured from the time of payload ignition (at separation from the projectile body) to burnout after impact; the signal intensity and color shall be relatively uniform during the burn interval.

h. The flare signal shall be visible and the color identifiable from an observation distance of at least 3000 meters and from a minimum altitude of 1000 feet on a clear night.

i. The flare shall operate with 95 percent reliability in inundated areas.

j. The flare cartridge should be impact insensitive to small arms fire.

k. The flare cartridge shall have a storage shelf life of a minimum of five years.

The development goals also included the following:

a. Human Engineering Characteristics: require no special training and complete safety in operation.

b. Maintenance Concept: require no maintenance other than visual inspection prior to use.

c. Priority of Characteristics: reliability performance.

The program plan outline is presented in Appendix A.

CONCLUSIONS

The major program objectives were achieved. A target marker was developed which 1) is capable of launch from either the M79 or M203 40mm Grenade Launcher, 2) is capable of floatation in swamp or water-covered areas, 3) has an external configuration similar to the 40mm Floating Smoke Marker, and 4) contains a flare-emitting pyrotechnic element, a delay element that ignites the flare before impact, and a floatation device.

The specific development goals were met with the following three exceptions:

1. The burn time of the red signal is 80 seconds rather than 90 seconds.

2. The green signal is not color identifiable at a range greater than 2200 meters compared to the goal of 3000 meters.

3. Overall reliability was less than 95 percent.

It is believed that the first two shortcomings noted above can be improved by composition and/or internal mechanical component modifications. A significant improvement in the visibility of the green signal was made at the conclusion of the program by modifying the composition. The problems with the green flare were the principal causes of the reliability shortcoming. The reliability can be improved by improving ignition transfer from the first-fire to the composition mix.

DEVELOPMENT

1. GENERAL

Red, yellow, and green flare mix compositions compatible with the 40mm Target Marker (TMF-1) were developed in the initial phase of the program. This phase established basic formulations and those characteristics which would require modification of the TMF-1 design. A program test plan (Appendix A) also was prepared at that time.

A binder selection was made for the three colors following an evaluation of two binder systems. Pressing conditions were standardized to simplify formulation evaluation. Candles were pressed to length at 16,000-pound force and the weight was allowed to vary. Following formulation evaluation, the pressing conditions were optimized and candle weights established during flight tests for ballute development.

2. BINDER INVESTIGATION

An investigation was conducted to develop a pressable low-temperature-cure polyvinylchloride binder. A polyvinylchloride (PVC) dispersion resin plasticized with diethylphthalate (DEP) in a ratio of 7 parts PVC to 3 parts DEP was found to produce a damp, pressable composition when loaded with 70 to 75 percent strontium nitrate, magnesium powder and ammonium perchlorate. The compositions cured at temperatures less than 150°F.

However, large batches, i.e. 500 grams, processed with this binder produced wet putty-like material which was not suitable for pressing and cured to solid masses in 24 hours on standing at room temperature.

Reduction of the DEP concentrations to 23 percent of the binder gave dry pressable compositions. However, this modified binder was not suitable for red flame compositions because of poor flame color quality and high burning rates.

An alternate binder consisting of cellulose acetate (CA) plasticized with triacetin (TA) in the ratio of one to one was then investigated. This binder produced dry-to-damp compositions which were readily pressable and with flames of equal or superior color quality to those of the polyvinylchloride binder.

3. RED FLARE COMPOSITIONS

Thirty-one flare compositions were evaluated in the TMF-1 unit to develop a suitable flame color and burning rate. Twenty-four of these compositions contained the polyvinylchloride binder (PVC-DEP) and seven contained the cellulose acetate binder (CA/TA). A summary of the compositions investigated is given in Appendix B (test results).

a. Polyvinylchloride Binder

Burn time, color, and processability were evaluated for the PVC/DEP compositions as functions of binder, magnesium, ammonium perchlorate, strontium nitrate, and potassium nitrate content; and magnesium particle size. The following effects were observed in the evaluation tests.

Burn time was found to be most sensitive to binder and magnesium content. Increasing magnesium content from five to ten percent at the expense of binder reduced burn time to one-half its original value.

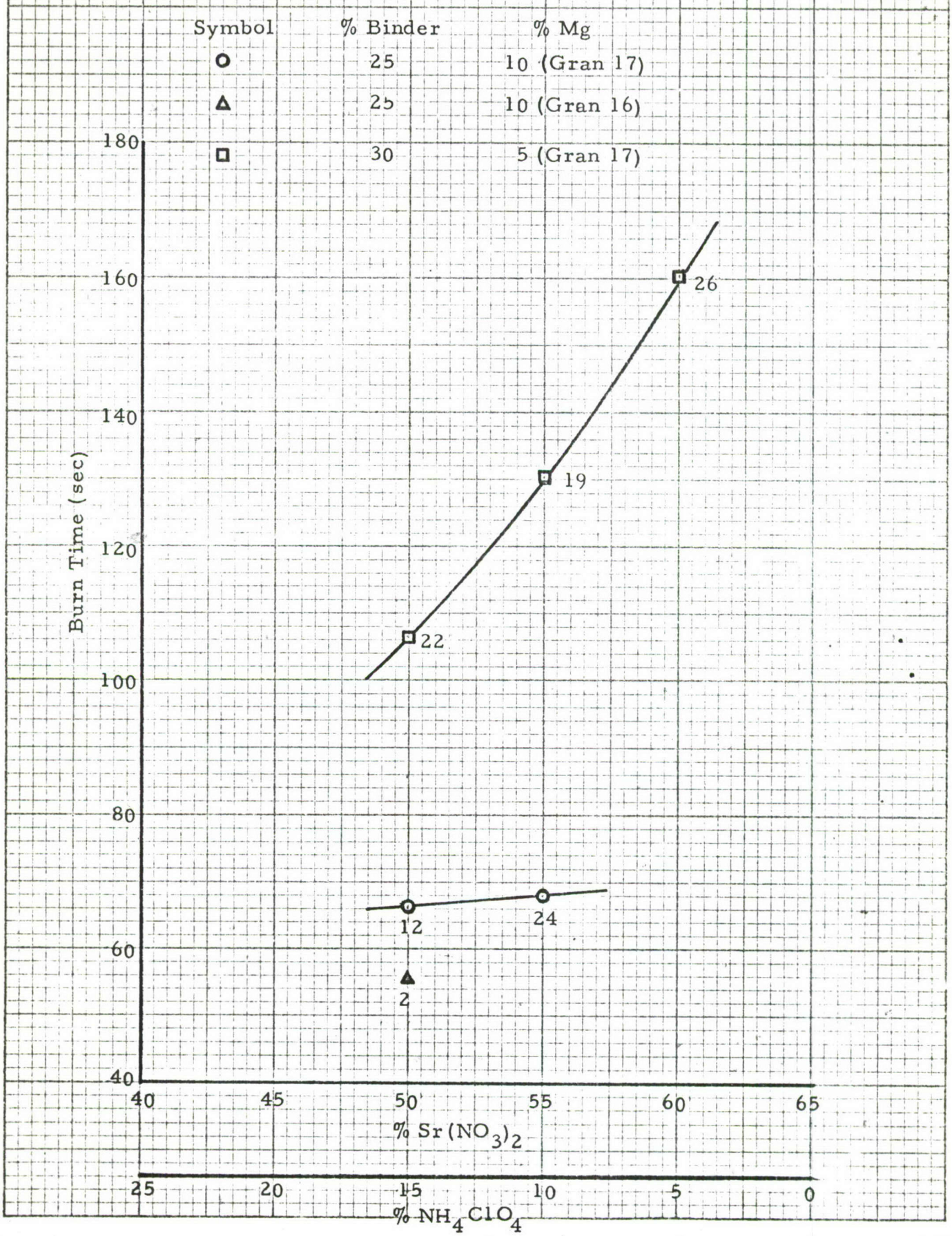
Burn time was also found to be a function of magnesium particle size. Burn time was increased over 20 percent by increasing the average particle size of the magnesium from 22 microns (Granulation 16) to 200 microns (Granulation 17).

Increasing strontium nitrate content at the expense of ammonium perchlorate was observed to increase burn time particularly with 30 percent binder content composition. Less or no effect was observed with compositions containing 25 percent binder.

Each of the above effects are shown graphically in Figure 1.

The substitution of potassium nitrate for strontium nitrate was found to significantly reduce the quality of the red flame. The strontium nitrate compositions containing at least ten percent ammonium perchlorate produced a red flame of good quality.

FIGURE 1 - Burning Time of Red Flare Compositions with Polyvinylchloride Binder as a Function of Strontium Nitrate and Ammonium Perchlorate Content



Compositions containing 10 to 15 percent ammonium perchlorate, 5 percent magnesium and 25 percent or more binder with a 7-to-3 ratio of polyvinylchloride to diethylphthalate approached castability.

Composition R-19 was found to best satisfy the burn time, color quality, processability, and ballute inflation requirements for the polyvinylchloride red flame compositions.

b. Cellulose Acetate Binder

Burn time, color, and ballute inflation characteristics were evaluated for pressed CA/TA compositions as functions of binder, magnesium, strontium nitrate, and ammonium perchlorate content and magnesium and ammonium perchlorate particle size.

Burn time as a function of strontium nitrate and ammonium perchlorate content is shown in Figure 2. Unlike the polyvinylchloride compositions, burn time was found to decrease with increasing strontium nitrate with the cellulose acetate binder.

The cellulose acetate composition which best achieved the program goals was R-29 which consists of:

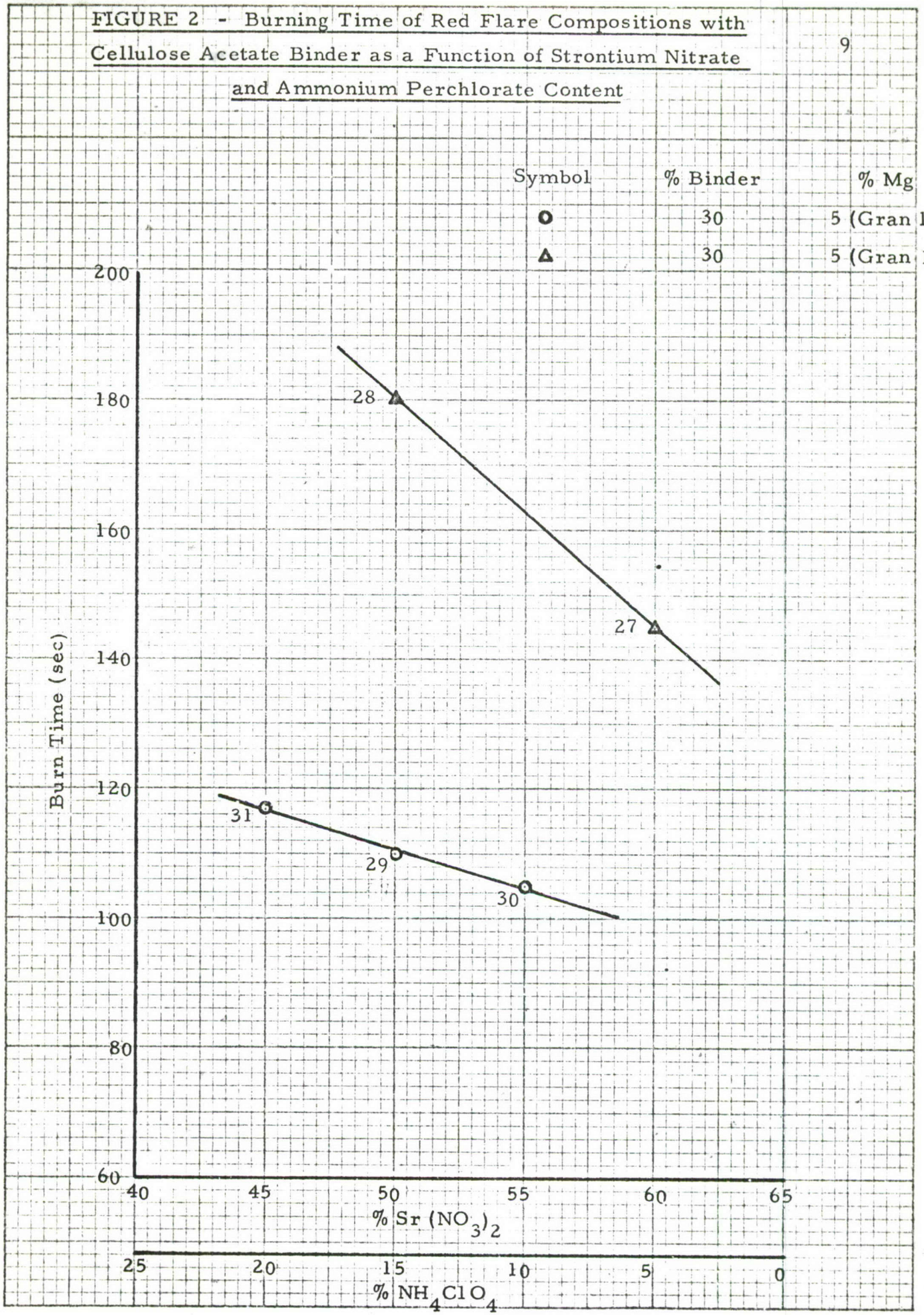
Ingredient	Weight %
Strontium nitrate (Grade 3)	50.0
Ammonium perchlorate (50μ)	15.0
Magnesium (Granulation 16)	5.0
Cellulose acetate	15.0
Triacetin	15.0

This composition was tested in twelve TMF-1 units in water to confirm a static burn time of 110 seconds. The flame from night tests was recognizable as a red light from a distance of 600 meters. This composition was suitable for flight, visibility, and temperature sensitivity testing.

4. YELLOW FLARE COMPOSITIONS

Twenty-two yellow flare compositions with the cellulose acetate binder were tested. The compositions and test results

FIGURE 2 - Burning Time of Red Flare Compositions with Cellulose Acetate Binder as a Function of Strontium Nitrate and Ammonium Perchlorate Content



are summarized in Appendix C. The effects of binder content at three levels, i.e. 25, 30 and 35 percent, magnesium particle size, i.e. Granulations 16 and 17, and total oxidizer content were investigated.

The effects of composition on burn time in the TMF-1 unit are shown graphically in Figures 3 and 4. Burn time was found to be a sensitive function of sodium nitrate/ammonium perchlorate ratio, binder content, and magnesium particle size.

Compositions containing Granulation 17 magnesium or less than 45 percent sodium nitrate gave unstable flames which were easily extinguished.

Burning times in excess of 110 seconds and stable combustion were achieved with compositions containing Granulation 16 magnesium, 30 percent binder and at least 45 percent sodium nitrate.

A yellow flame composition, Y-13, which was readily recognizable at 600 meters as a bright yellow light and burned stably for 140 seconds in the TMF-1 unit is given below.

Ingredient	Weight %
Sodium nitrate (30 μ)	50.0
Ammonium perchlorate (50 μ)	10.0
Magnesium (Granulation 16)	10.0
Cellulose acetate	15.0
Triacetin	15.0

This composition was suitable for flight, visibility, and temperature sensitivity testing.

5. GREEN FLARE COMPOSITIONS

Seventy-four green flare compositions were tested. Twenty-eight of these compositions contained the polyvinylchloride binder and the remainder the cellulose acetate binder. The compositions and test results are summarized in Appendix D.

The large number of tests resulted from the difficulty in achieving good color quality, stable combustion, and burn times greater than 90 seconds with the same composition. This

FIGURE 3 - Burning Time of Yellow Flare Compositions with Cellulose Acetate Binder

Symbol	% Binder	% Mg
○	25	20
□	30	15
△	35	10
———	Granulation 16 Mg	
- - -	Granulation 17 Mg	

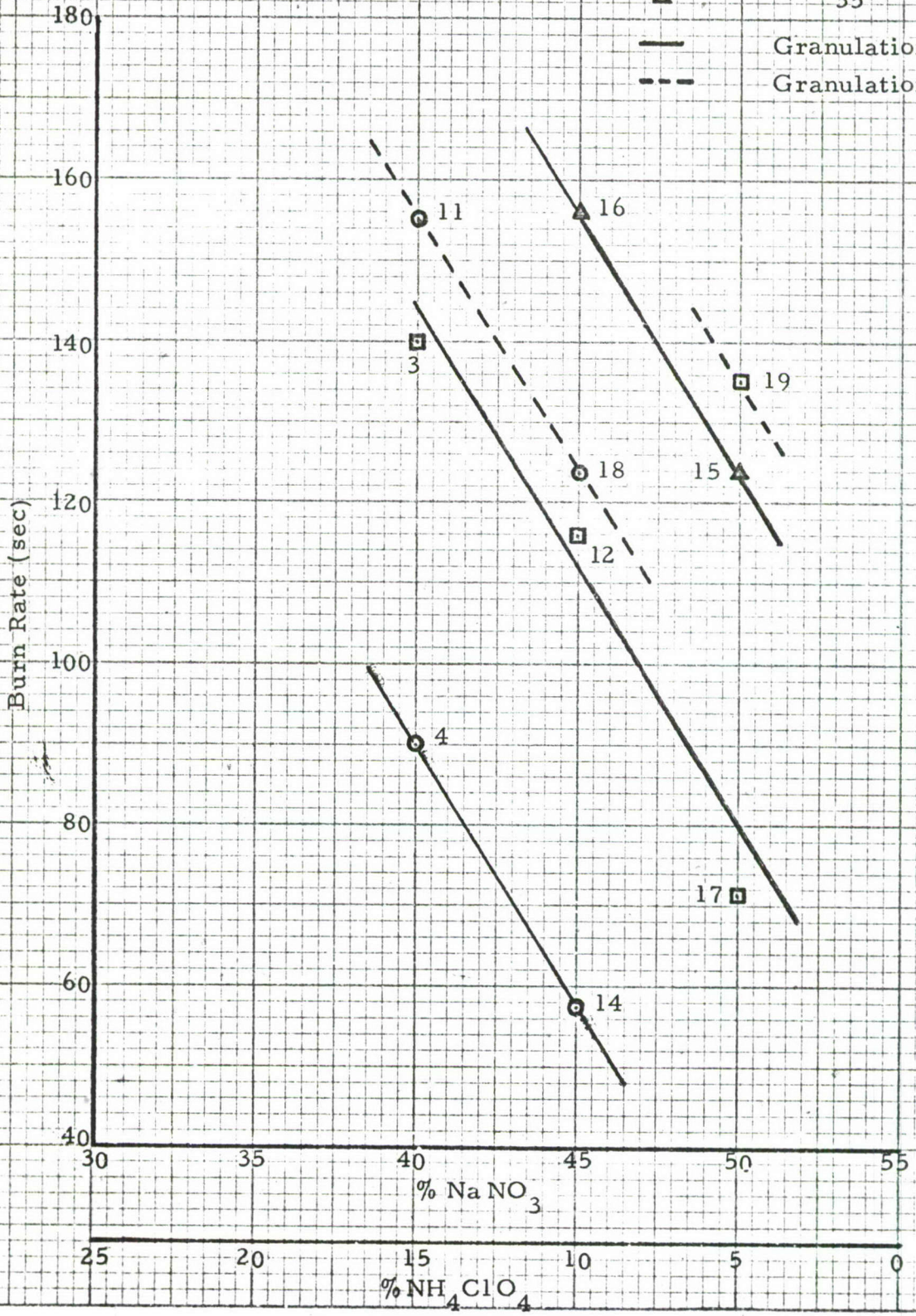
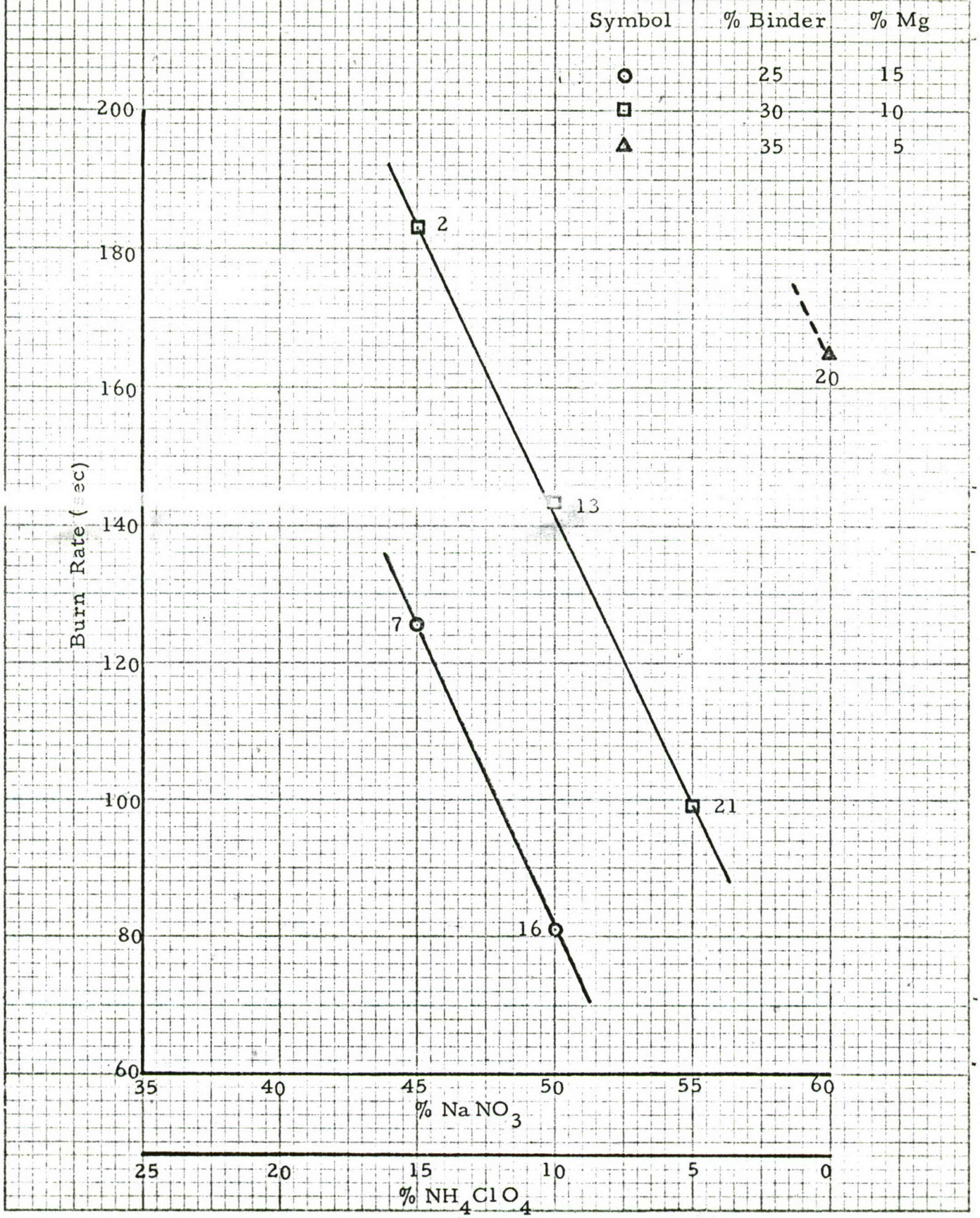


FIGURE 4 - Burning Time of Yellow Flare Compositions with Cellulose Acetate Binder

(Granulation 16 Magnesium)



problem stems from the difficulty in forming barium monochloride which produces the green flame in the combustion zone. The use of ammonium perchlorate and barium chloride in the compositions aid in formation of barium monochloride in the flame but barium chloride is difficult to vaporize and large amounts of barium chloride led to combustion instability and heavy slag. Boron and potassium perchlorate were also investigated in the compositions with limited success.

A solution to the problem was found with the use of ammonium chloride in combination with ammonium perchlorate. Ammonium chloride decomposes at a relatively low temperature and provides a source of chlorine for the barium. Ammonium chloride also increased burn time to an acceptable value as shown in Figure 5. Burn time of compositions containing a ammonium chloride was found to be relatively insensitive to barium nitrate content as shown in Figure 6. This permits low quantities of barium nitrate to be used in the composition and results in low slag formation.

The composition given below burns 120 to 125 seconds in the TMF-1 unit and produces the best quality green flame of the compositions investigated.

Ingredient	Weight %
Barium nitrate (JAN-B-162)	35.0
Ammonium chloride	5.0
Ammonium perchlorate (50 μ)	30.0
Magnesium (Granulation 17)	5.0
Cellulose acetate	12.5
Triacetin	12.5

Laboratory tests showed some yellow in the flame which may have been due to emission from the steel chimney used. While this composition was suitable for flight testing, further composition investigation was conducted to improve color intensity.

6. FLAME TEMPERATURE

The flame temperature for each color composition was measured by embedding thermocouples in the mix and observing the temperature profile as the surface burned past the thermocouple location. Maximum temperatures observed were:

FIGURE 5 - Burning Time of Green Flare Compositions as a Function of Ammonium Chloride and Ammonium Perchlorate Content

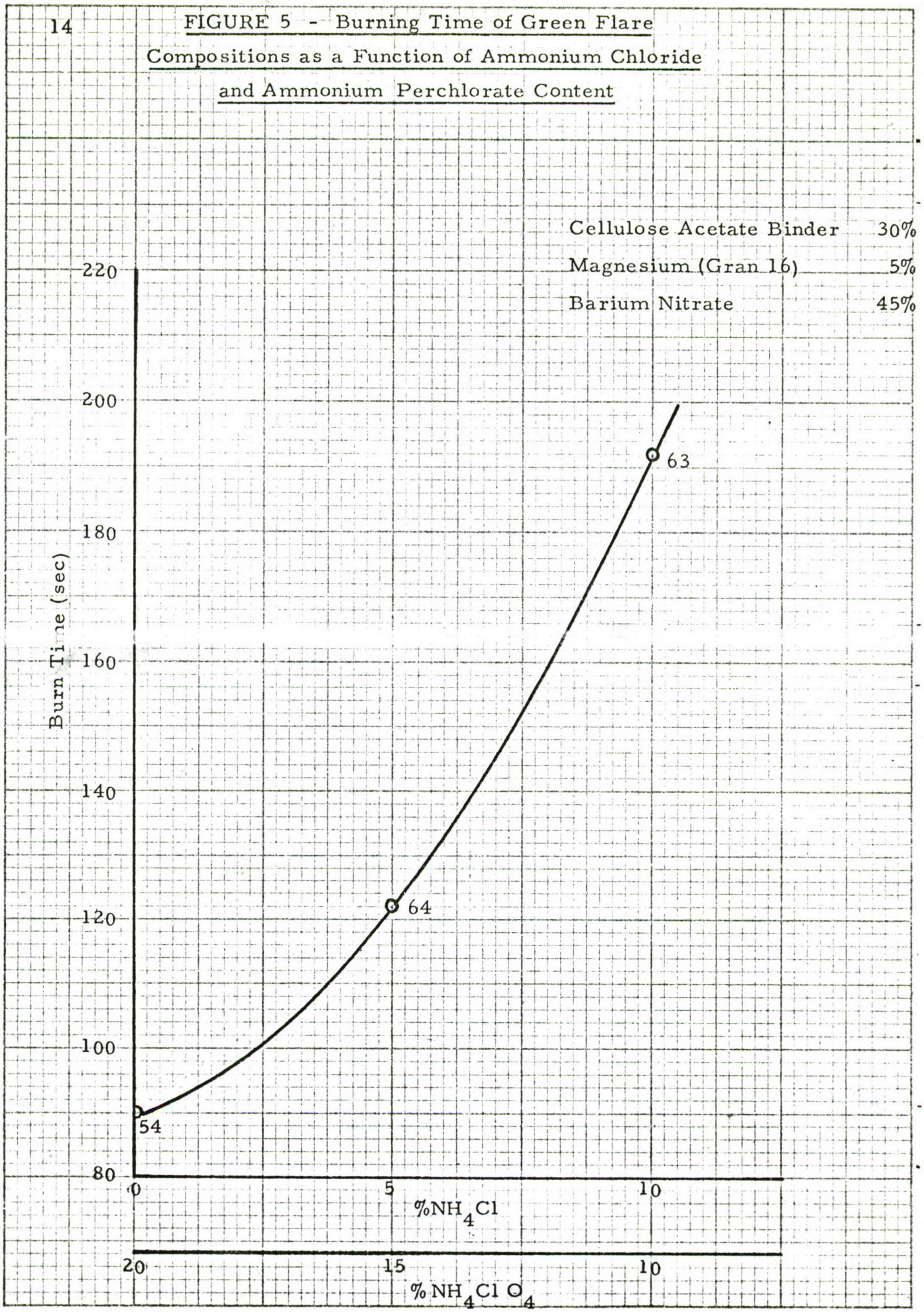
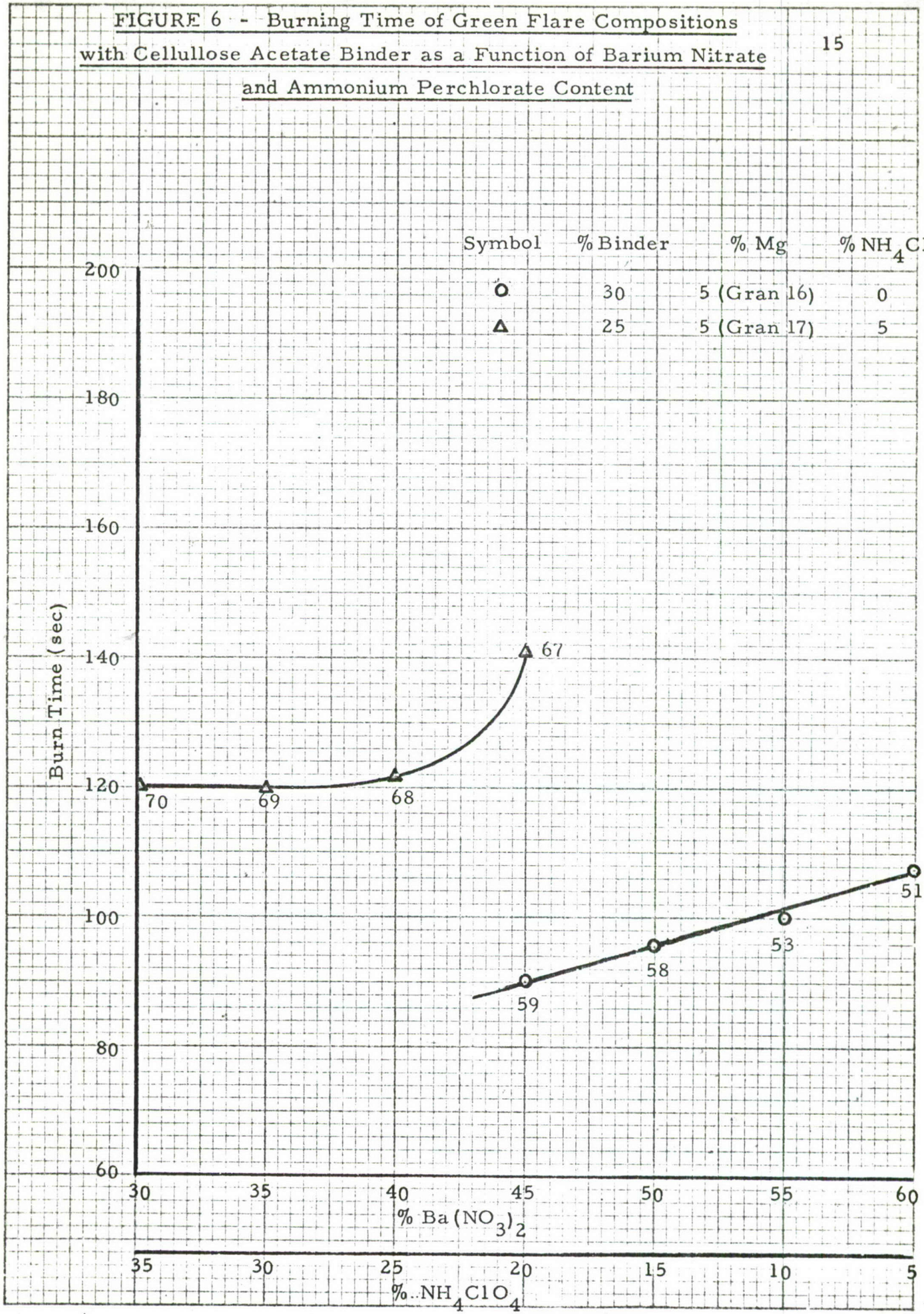


FIGURE 6 - Burning Time of Green Flare Compositions with Cellullose Acetate Binder as a Function of Barium Nitrate and Ammonium Perchlorate Content



Red (Test R-29)	2288°F
Yellow (Test Y-13)	2247°F
Green (Test G-69)	2343°F

These temperature measurements were used to aid in the selection of chimney and ballute materials. The values indicated that a steel chimney would be more adequate than the aluminum chimney of the TMF-1 design.

7. TEMPERATURE SENSITIVITY

Candles of each color, i.e., R-39 to R-42, Y-33 to Y-36, G-80 to G-83, were tested in water after four hours conditioning at the temperature extremes, -65°F and +165°F.

Burning time was not measurably affected by condition temperature. Ignition, however, was found to be less reliable at -65°F. Two candles, a yellow and a green, did not ignite after conditioning at the lower temperature.

8. BALLUTE DEVELOPMENT

Glass fabric was chosen as the basic material for the ballute on the basis of the flame temperatures of the flare compositions. Neoprene and silicone rubbers were evaluated as sealant coatings for the glass fabric.

Neoprene-coated glass was found inadequate. This material was easily ripped and was combustible in the exhaust gas environment of the flares.

Silicone-coated glass, however, was found to be a suitable ballute material. Both 5- and 7-mil fabric thicknesses were evaluated. The 7-mil fabric, RM-7 made by 3M, was the tougher of the two and was chosen for flight tests.

Holes were burned or ripped in the underside of RM-7 ballutes of the TMF-1 design during ignition in the initial flight tests. This problem was eliminated by doubling the ballute thickness on the bottom side. A modified packing technique was necessary to incorporate the additional ballute material into the unit. The technique which proved successful consisted of using vacuum for packing the ballute and rolling the edges of the material inward. With this technique, the ballute and flare canister were inserted into the body more readily than the TMF-1 design packed by the original procedure.

Two design modifications were required to insure firm ballute inflation during ignition. These were 1) a plastic insert in the chimney and 2) a reduced press pressure for the flare composition. The plastic orifice in the chimney results in a larger quantity of gas flow into the ballute during ignition. The orifice subsequently is melted, thus exposing the full chimney area following floatation of the unit. The reduced press pressures increased the gas flow rate. Burn times were also reduced but maintained a time of 110 seconds.

9. FEASIBILITY DEMONSTRATION

Eighteen rounds were tested in the feasibility demonstration phase in the presence of the Contract Technical Supervisor. Two rounds of each color were tested at night and six of each color during daylight hours. The test results are given in Appendix E.

The tests demonstrated the ability of the rounds to:

1. Sustain a flame and/or reignite after submergence in water.

2. Achieve a minimum range of 250 meters when launched at an angle of 35 degrees.

3. Burn a minimum of 90 seconds with green and yellow. The red flare burned 79 to 85 seconds.

Some effort was expended following these tests to eliminate flame pulsation with the yellow flare and increase the burning time of the red unit. The limited development effort produced no suitable improvement in the burning time of the red flare but a modification of the yellow composition resulted in smoother combustion.

The flare compositions and pressing conditions shown in Table I were frozen for the environmental tests.

TABLE I - FLOATING FLARE COMPOSITIONS

Color	Red	Yellow	Green
Composition (Wt. %)			
$Sr(NO_3)_2$	40.0	---	---
$NaNO_3$	---	45.0	---
$Ba(NO_3)_2$	---	---	30.0
NH_4ClO_4 (50 microns)	30.0	15.0	35.0
Magnesium (Gran 16)	5.0	15.0	5.0
NH_4Cl	---	---	5.0
Cellulose Acetate	12.5	12.5	12.5
Triacetin	12.5	12.5	12.5
Composition Weight (grams)	70	60	60
Pressing Force (lbs)	10,000	5,000	5,000

ENVIRONMENTAL TESTS

Sixty-six rounds were built and tested according to the plan outlined in Table I of Appendix A.

The groups I and II environmental conditioning was performed by General Testing Laboratories, Inc. The environmental test report is given in Appendix F. The flight tests of these rounds and the control units of Group VI were performed at Chemtronics and witnessed by the Contract Technical Supervisor. The results of these tests are given in Appendix G. The environmental conditioning had no adverse effects on the functional characteristics of the units.

Six units were subjected to bullet impact tests. The flare compositions were found to be insensitive to bullet impact. However, impact in the first-fire or delay resulted in ignition of these components and subsequently the flare mix. The flare composition extinguished following ejection after first-fire ignition from bullet impact. Following bullet impact of the delay, the canister ejected and the composition burned normally.

Night and day observation tests were performed with five units of each color. Observation was made from an aircraft flying at 1000 feet above ground level. The flames could be seen at ranges less than 2000 meters in daylight. At night, the red and yellow flares were visible and the color identifiable from a range greater than 3000 meters. The green flare was not color distinguishable from a range greater than 1000 meters, however.

DELIVERY ROUNDS

Eighty-four delivery rounds were manufactured with the flare compositions shown in Table I. Nine of these rounds were tested for acceptance. The acceptance test results are given in Appendix H.

Two of the three green rounds tested did not ignite due to lack of transfer energy from the first-fire to the flare composition. The green rounds were rebuilt with a layer between the first-fire and the flare composition that consisted of a mixture of the two. Three of the new green rounds were tested and successful ignition transfer was achieved. Burn times were short for these three rounds when the units sank because reused ballutes did not give proper floatation.

Twenty-five rounds of each color were delivered to the Land Warfare Laboratory for testing. The red and yellow units gave acceptable performance. The red and yellow signals were visible and color identifiable at a range exceeding 3000 meters and an altitude of 1000 feet. However, the color of the green units could not be recognized beyond a range of 1000 meters.

The green flare composition was then modified to the formulation given below and six rounds demonstrated at LWL. The modified formulation resulted in a significant improvement in the visible range, i.e., greater than 3000 meters, but was not color identifiable beyond 2200 meters. The green signal modification test results are given in Appendix I.

	Weight %
$Ba(NO_3)_2$	35.0
NH_4ClO_4 (400 μ)	20.0
NH_4Cl	10.0
Magnesium (Gran 16)	10.0
Cellulose Acetate	12.5
Triacetin	12.5

A cross section of the 40mm Floating Flare round is shown in Figure 7. The operational sequence is shown in Figure 8.

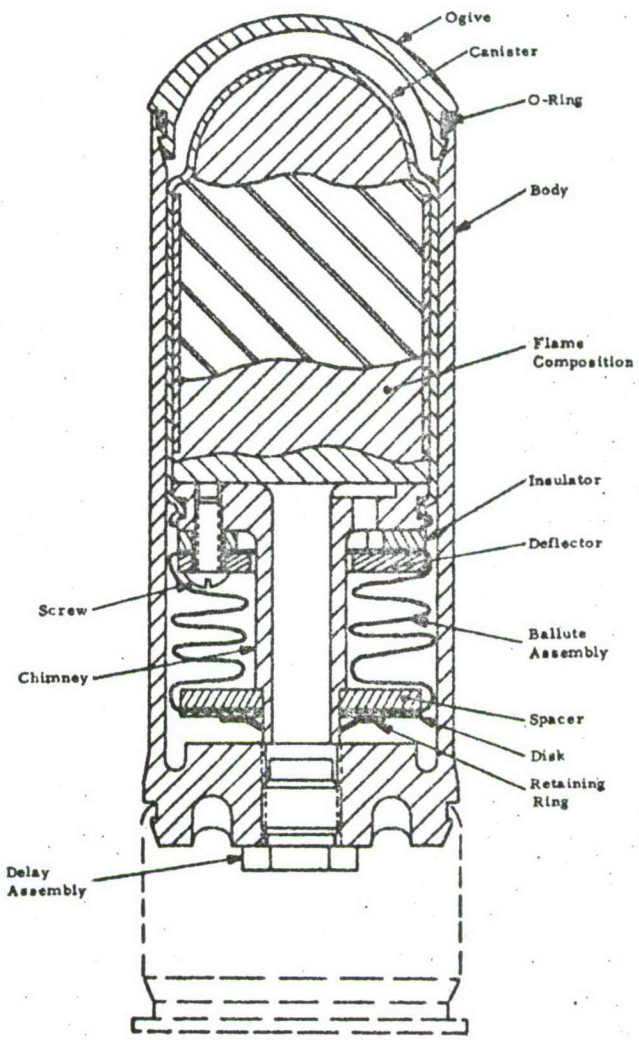


Figure 7 - Cross Section Drawing 40-mm Flare

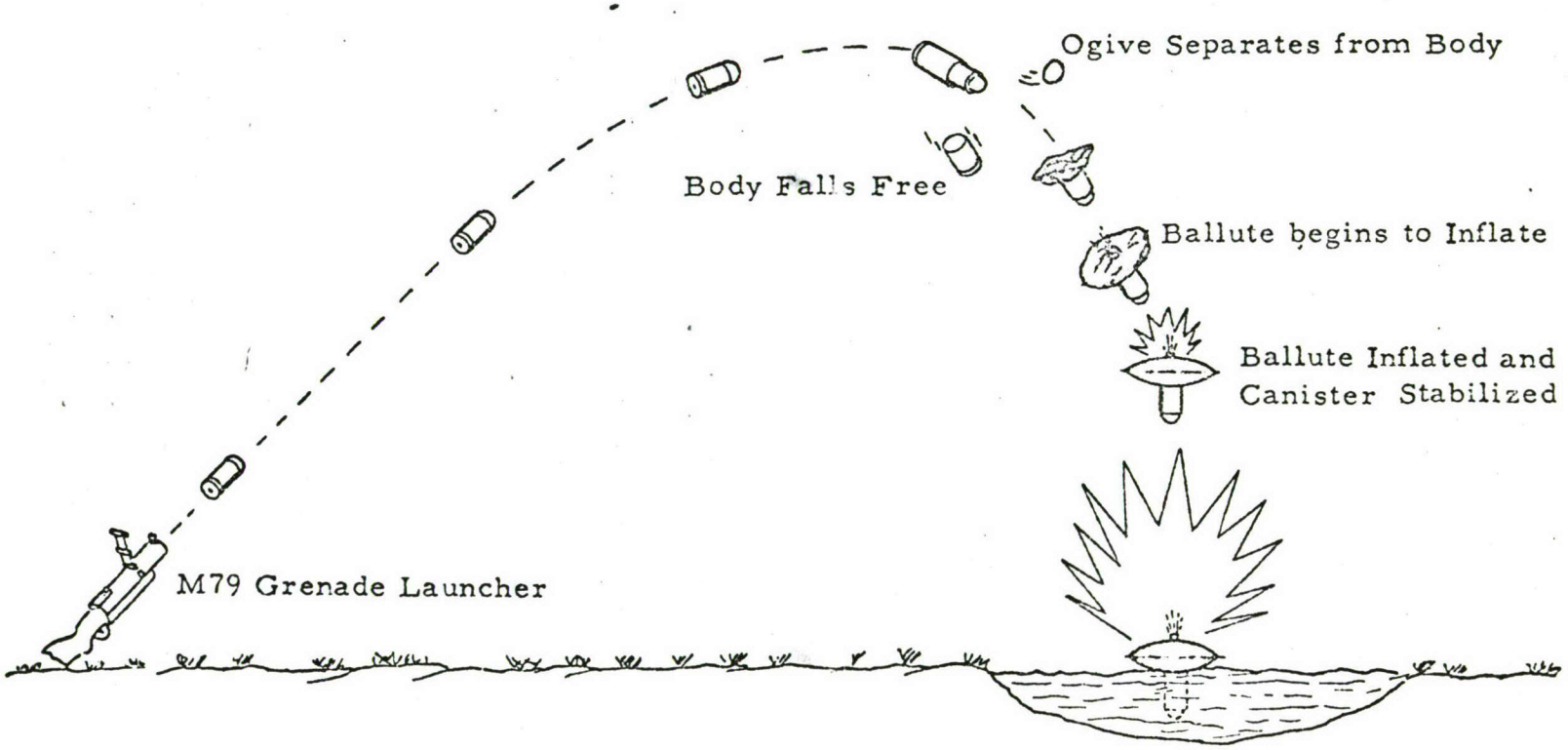


Figure 8. 40mm Floating Flare Sequence of Operation

APPENDIX A

PROGRAM PLAN

APPENDIX A - PROGRAM PLAN

(Test Plan for 40mm Floating Flare as prepared during initial planning of feasibility program.)

1. DEVELOPMENT TESTS

One hundred forty-four static tests of the flare formulation (forty-eight for each color) and seventy-five ballute tests are planned during the development phase of the program which ends in Week 17. Approximately fifteen flight tests (included in the seventy-five ballute tests) will be conducted at four strategic points throughout this phase to ascertain system compatability with M79 launching to increase confidence in the ability of the floating flare to pass the feasibility demonstration tests. The remaining ballute tests will be conducted statically in conjunction with flare formulation tests.

In evaluating the flame composition performance, the important characteristics will be ignition at temperature extremes, flare color, plume size, burn rate, and ability to sustain and reignite after splashing or submergence in water.

Initially, flame compositions in all three colors (red, yellow, and green) will be evaluated in the TMF-1 hardware using a chimney and canister but without the ballute. The grains will be ignited with a boron-potassium nitrate-teflon-laminac first fire pressed onto the grains which in turn will be ignited with a quick-match fuse cord. The flame composition tests for each color will evaluate binder content (nine tests), magnesium content (nine tests), magnesium particle size (nine tests), and nitrate content (nine tests). The two binder candidates are polyvinyl chloride and cellulose acetate plasticized with triacetin. Both are known to give pressable compositions with adequate mechanical properties and flame characteristics. As each flare formulation is finalized, tests at -65° and +165°F will be performed to determine burn rate and flare sustainment characteristics (twelve tests).

The results of each test conducted throughout the development, feasibility, and environmental and delivery acceptance will be recorded on a data sheet. Serialization of all units will begin with the initial flare formulation tests and continue through the delivery acceptance tests. The serial number will consist of the first letter of the color tested and sequential test numbers.

Thermocouple measurements at the chimney exit and burning surface will be made to obtain the flame temperatures of the red,

yellow, and green flare formulations. This information will be used in selecting ballute materials with adequate mechanical properties to withstand the high temperatures of the flare combustion products. A total of five static ballute tests is planned for each color during the finalization of the flare formulation. Ballutes will also be tested in the sixty flight tests throughout the finalization of the flare formulation development.

2. FEASIBILITY DEMONSTRATION TESTS

Fifteen 40mm Floating Flare rounds (five of each color -- red, yellow, green) will be fabricated for the feasibility demonstration phase of the program. These tests will be witnessed by the Contract Technical Supervisor at NCI. The units will be fired from the M79 grenade launcher at ambient temperatures into a lake. Color films made during development will be available for review at this time. The objective of these tests is to determine the ability of the round to 1) sustain a flame, and/or reignite after submergence in water, 2) achieve a minimum range of 250 meters when launched at an angle of approximately 35 degrees, and 3) burn a minimum of 90 seconds for each of the three required colors (red, yellow, and green). Fired hardware will be recovered for subsequent inspection to determine the ability of the ballute material to survive throughout the entire burn time.

Upon completion of these tests, a design review will be conducted at NCI by LWL and NCI representatives. Approval of the feasibility demonstration test results will constitute a design freeze and will allow fabrication of the sixty-six environmental units to be started. Deficiencies encountered during these tests will be thoroughly reviewed by both LWL and NCI, and all necessary modification and retesting will be mutually agreed upon at that time.

3. ENVIRONMENTAL TESTS

A total of sixty-six units (twenty-two of each color) will be tested according to the proposed test matrix outlined in Table I.

TABLE I

	Group I	II	III	IV	V	VI
Storage and transit conditions diurnal cycle (per Table 2-3, AR-70-38)	21					
Operational conditions diurnal cycle (per Table 2-3, AR-70-38)		15				
Rain fall (Per 2-8 Category 2, Wet-Hot AR-70-38)		15				
Sea salt fallout (per MIL-STD-810B, Method 509)		15				
Sand and dust (per MIL-E-5272C ASG, 4.11.3, Procedure III)		15				
Transportation and aircraft vibration (MTP 4-2-804)	21					
Bullet impact			6			
Day observation				6		
Night observation					9	
Control units (no environments)						9
Functional testing (total of 66 units)	21	15	6	6	6	9

The twenty-one Group I units and one inert unit will be packaged in an M2A1 Ammunition Box. This is the configuration in which the 40mm units would be subjected to the vibration and diurnal cycling of storage and transit conditions. The fifteen unpackaged units in Group II will be subjected to a diurnal cycle of operational conditions, rainfall, sea salt fallout, and blowing sand and dust conditions.

Six units (two of each color) have been designated for bullet impact tests. These units will be suspended vertically from a wire in front of a dirt embankment and then impacted with a 30-06 rifle slug fired at a distance of approximately 50 feet. Photography equipment will be available to record results of any units that ignite. Still photographs will be taken of units that successfully withstand this test.

Both day and night observation tests will be performed on a total of fifteen units (five of each color). These fifteen units will not be fired from the grenade launcher but will be ignited statically with a quickmatch fuze and placed in a water-filled container for the burning duration at the NCI test site.

The aircraft will fly at a minimum altitude of 1000 feet above ground level in a circular flight pattern range of 3000 meters. Photographs will be taken from the aircraft during the observation tests to document acquisition distances. Six units are planned for day observation tests and nine for night observation.

The remaining nine units are control units and therefore will not be subjected to any environments other than ambient storage.

The storage and transit conditions diurnal cycle, operational conditions diurnal cycle, and rainfall requirements will be per Category 2, Wet-Hot of AR-70-38. For sea salt fallout, it is proposed to use MIL-STD-810B, method 509 which subjects the unpackaged units to a salt concentration of approximately 1740 $gm/m^2/yr$ for 48 hours. It is also proposed to use MIL-E-5272C (ASG) 4.11.3, Procedure III sand and dust tests, to meet the blowing sand and blowing dust requirements in Category 4, Hot-Dry, plus the wind requirements in Category 2, Wet-Hot of AR-70-38. This test will subject unpackaged units to a dust concentration of 0.1 to 0.25 grams per cubic foot, at a temperature of 77°F and an air velocity of 2500 ± 500 feet per minute for a duration of three hours. The transportation and aircraft vibration tests will be conducted on packaged units per MTP 4-2-804, Curve A of Figure A-5.

At the conclusion of these tests, a joint LWL and NCI conference will be held to analyze all test results, data and photo coverage. Approval of this phase will permit the delivery unit fabrication to start.

4. DELIVERY ACCEPTANCE TESTS

With the approval of the environmental tests, a total of eighty-four units (twenty-eight of each color) will be fabricated for delivery. Nine of these rounds (three of each color) will be randomly selected for NCI acceptance testing. It is planned to function these nine rounds the same as the feasibility rounds in Week 25. Operational data will be recorded for each round and will be submitted with the load sheets on the seventy-five delivery rounds. NCI quality assurance personnel will witness these tests. LWL personnel may witness these tests, if they desire to do so.

APPENDIX B

DATA SHEETS FOR RED FLARE COMPOSITION TESTS

40-MM FLOATING FLARE - RED

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Sr Nitrate $(NO_3)_2$	Magnesium	Binder PVC/DEP	Secondary Oxidizer AP (50 μ)	Other Additives										
R-1	1-71	45	15	25	15		16		2.2	73	16	good	W	hot	S	Sparks
R-2	1-71	50	10	25	15		16		2.2	56	16	good	W	very hot	S	
R-3	1-71	45	10	25	20		16		2.2	64	16	good	W	very hot	S	
R-4	1-71	40	15	30	15		16		2.2	42	16	good	W	---	S	
R-5	1-71	40	15	30	15		17		2.2	85	16	good	W	---	S	
R-6	1-71	47.5	7.5	30	15		17		2.2	129	16	fair	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-7	1-71	43.75	11.25	30	15		16		2.2	114	16	white	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-8	1-71	43.75	11.25	30	15		17		2.2	61	16	white	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-9	1-71	40	11.25	30	18.75		17		2.2	120	16	white	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-10	1-71	45	11.25	25	18.75		17		2.2	92	16	poor	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-11	1-71	50	10	25	15		17		2.2	100	16	poor	W	cool	S	KNO_3 used for $Sr(NO_3)_2$
R-12	1-71	50	10	25	15		17		2.2	67	--	good	W	hot	S	Mix wet cast
R-13	1-71	50	10	25	15		17		2.2	60	--	good	W	hot	S	Course $Sr(NO_3)_2$; wet castable mix
R-14	1-71	50	10	25	15		17		2.2	45	16	good	W	hot	S	20 PVC/5 DEP; dry pressed
R-15	1-71	45	10	30	15		17		2.2	66	--	good	W	hot	S	Wet castable mix
R-16	1-71	45	15	25	15		17		2.2	58	16	red	W	hot	S	12.5 CA/12.5 TA; mix dry pressed.
R-17	1-71	45	15	25	15		17		2.2	42	16	red	W	hot	S	400 AP; CA/TA pressed.

40-MM FLOATING FLARE - RED

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Sr(NO_3)_2$	Magnesium	Binder PVC/DEP	Secondary Oxidizer AP (50μ)	Other Additives										
R-18	1-71	45	10	30	15		17		2.2	117	16	yellow	W	cool	S	KNO_3 rather than $Sr(NO_3)_2$
R-19	1-71	55	5	30	10		17	78	2.2	131 123	--	red	W	cool slag	S	Wet castable mix
R-20	1-71	55	5	30	10		17		2.2	110	16	yellow	W	cool slag	S	23/7 PVC/DEP; dry pressed.
R-21	1-71	50	5	30	15		17		2.2	85	16	orange	W	cool slag	S	23/7 PVC/DEP; dry pressed.
R-22	1-71	50	5	30	15		17	78	2.2	107	--	red	W	cool slag	S	Wet castable mix
R-23	1-71	30	10	30	15	15	17		2.2	88	16	orange	W	cool	S	Dry pressed; other additive KNO_3
R-24	1-71	55	10	25	10		17		2.2	68	16	red	W	hot	S	Pressed
R-25	1-71	55	10	28	10		17	79	2.2	91	--	red	W	hot	S	Castable
R-26	1-71	60	5	30	5		17		2.2	161	--	red	W	cool slag	S	Castable

40-MM FLOATING FLARE - RED

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Sr Nitrate $(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50 μ)	Other Additives										
R-27	1-71	60	5	30	5		17	76	2	146	16	flame out;red	W	hot	S	
R-28	1-71	50	5	30	15		17	76	2	180	16	red	W	cool slag	S	
R-29	1-71	50	5	30	15		16	76	2	110	16	red	W	cool	S	
R-29-1	1-71	50	5	30	15		16	76	2	111	16	red	W	cool	S	
R-29-2	1-71	50	5	30	15		16	76	2	117	16	red	W	cool	S	
R-29-3	1-71	50	5	30	15		16	76	2	111	16	red	W	cool	S	
R-29-4	1-71	50	5	30	15		16	76	2	112	16	red	W	cool	S	
R-29-5	1-71	50	5	30	15		16	76	2	109	16	red	W	cool	S	
R-29-6	1-71	50	5	30	15		16	76	2	109	16	red	W	cool	S	
R-29-7	1-71	50	5	30	15		16	76	2	110	16	red	W	cool	S	
R-29-8	1-71	50	5	30	15		16	76	2	113	16	red	W	cool	S	
R-29-9	1-71	50	5	30	15		16	76	2	110	16	red	W	cool	S	
R-29-10	1-71	50	5	30	15		16	76	2	111	16	red	L*	cool	S	Land test; top ejected in 50 sec.
R-29-11	1-71	50	5	30	15		16	76	2	109	16	red	W	cool	S	
R-30	1-71	55	5	30	10		16	76	2	105	16	red	W	red hot	S	
R-31	1-71	45	5	30	20		16	76	2	117	16	soft red	W	hot	S	
R-32	3-9	30	5	30	15		16	75	2.2	111	16		W	--	S	Flame temperature: 2288°F
R-33	3-9	30	5	30	15		16	75	2.2	109	16		W	--	S	Flame temperature: 2219°F

40-MM FLOATING FLARE - RED

Serial Number	Test Date (1971)	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Sr Nitrate $(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50 μ)	Other Additives										
R-34	3-15	30	5	30	15		16	75	2.2	--	16		W	good	S	Aluminum chimney melted.
R-35	3-15	30	5	30	15		16	75	2.2	--	16		L	good	F	7-mil glass silicone ballute, good inflation.
R-36	3-24	30	5	30	15		16	75	2.2	105	16	good	L	fair	F	Fair inflation; 270 meters @ 38°
R-37	3-24	30	5	30	15		16	75	2.2	104	16	good	L	good	F	Good inflation; 265 meters @ 38°
R-38	3-24	30	5	30	15		16	75	2.2	115	16	good	L	poor	F	Black Neoprene ballute ripped at bottom.
R-39	3-24	30	5	30	15		16	75	2.2	109	16	good	W	---	S	+165°F
R-40	3-25	30	5	30	15		16	75	2.2	107	16	good	W	---	S	+165°F
R-41	3-25	30	5	30	15		16	75	2.2	123	16	good	W	---	S	-65°F
R-42	3-25	30	5	30	15		16	75	2.2	116	16	good	W	---	S	-65°F
R-43	3-26	30	5	30	15		16	72	2.2	---	16	good	W	?	F	Light in flight, sank, surfaced later

40-MM FLOATING FLARE - RED

Serial Number	Test Date (1971)	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Sr(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives										
R-44	4-20	50	5	36	15		16	74	2.2	112	16		W	--	S	New mull
R-45	4-23	50	5	36	15		16	74	2.2	---	16	ood	L	good	F	Good inflation
R-46	4-23	50	5	36	15		16	74	2.2	---	16	--	W	no	F	Sank
R-47	4-24	50	5	30	15		16	60	2.2	90	2	ood	W	--	S	
R-48	4-24	50	5	30	15		16	60	2.2	97	2	ood	W	good	S	
R-49	4-24	50	5	30	15		16	60	2.2	91	2	ood	W	good	S	
R-50	4-24	50	5	30	15		16	60	2.2	91	2	ood	W	good	S	
R-51	4-27	50	5	30	15		16	60	2.2	---	2	--	W	--	F	Blew apart; granular first fire
R-52	4-27	50	5	30	15		16	60	2.2	---	2	--	W	--	F	Blew apart; granular first fire
R-53	4-27	50	5	30	15		16	60	2.2	80	2	ood	W	good	S	Plastic orifice
R-54	4-28	50	5	30	15		16	60	2.2	86	2		W	---	S	Plastic orifice; granular first fire
R-55	4-28	50	5	30	15		16	60	2.2	---	2		--	---	F	Plastic orifice; granular first fire
R-56	4-29	50	5	30	15		16	60	2.2	83	2		W	fair	F	Plastic orifice; aluminum chimney
R-57	4-29	50	5	30	15		16	60	2.2	82	2		W	fair	F	Plastic orifice; flame out in 30 seconds; steel chimney
R-58	4-29	50	5	30	15		16	60	2.2	85	2		L	no	F	Plastic orifice; ballute seam split; steel chimney
R-59	4-29	50	5	30	15		16	60	2.2	---	2		W	--	F	No ejection
R-60	4-30	50	5	30	15		16	60	2.2	90	5		W	good	F	Aluminum chimney erratic; flame out
R-61	4-31	50	5	30	15		16	60	2.2	102	5		L	no	F	

40-MM FLOATING FLARE - RED

Serial Number	Test Date (1971)	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Sr(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50 μ)	Other Additives										
R-62	5-3	50	5	30	15		16	60	2.2	83	5		W	OK	F	No orifice, alum. chimney sank on impact, surfaced; erratic combustion.
R-63	5-4	50	5	30	15		16	62	2.2	93	5		W	--	S	
R-64	5-4	50	5	30	15		16	60	2.2	84	5		W	OK	F	Flame out in 60 seconds; aluminum chimney
R-65	5-4	50	5	30	15		16	60	2.2	--	5		W	OK	F	Steel chimney, plastic orifice, extinguished.
R-66	5-5	50	5	30	15		16	60	2.2	--	5		W	OK	F	Loud report, floated.
R-67	5-5	50	5	30	15		16	60	2.2	83	5		W	OK	F	Plastic orifice
R-68	5-5	50	5	30	15		16	60	2.2	82	5		W	No	F	Ballute burned on bottom; plastic orifice
R-69	5-6	50	5	30	15		16	60	2.2	--	5		W	OK	F	Extinguished
R-70	5-6	50	5	30	15		16	60	2.2	83	5		W	OK	F	Underwater ejection
R-71	5-7	50	5	30	15		16	60	2.2	97	2		W	--	S	Plastic orifice
R-72	5-7	50	5	30	15		16	60	2.2	97	2		W	OK	S	Plastic orifice; flame out in 40 seconds; plugged
R-73	5-7	50	5	30	15		16	60	2.2	91	2		W	OK	S	No orifice; flame out in 40 seconds
R-74	5-7	50	5	30	15		16	65	2.2	98	3		W	OK	S	Orifice; flame out in 40 seconds
R-75	5-7	45	5	30	20		16	65	2.2	99	2		W	OK	S	Flame out
R-76	5-7	40	5	30	25		16	65	2.2	95	5		W	OK	S	Flame out in 60 seconds
R-77	5-7	40	5	30	25		16	65	2.2	96	5		W	OK	S	Flame out in 60 seconds
R-78	5-7	35	5	30	30		16	60	2.2	90	5		W	OK	S	Flame out in 85 seconds
R-79	5-7	35	5	30	30		16	65	2.2	90	5		W	OK	S	Flame out in 85 seconds

40-MM FLOATING FLARE - RED

Serial Number	Test Date (1971)	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press-sure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Sr(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives										
R-80	5-7	35	5	30	30		16	70	2.2	105	10		W	OK	S	
R-81	5-10	35	5	30	30		16	70	2.2	108	10		W	OK	S	
R-82	5-10	35	5	30	30		16	70	2.2	101	10		W	OK	F	
R-83	5-10	35	5	30	30		16	60	2.2	93	5		W	OK	F	
R-84	5-10	35	5	30	30		16	70	2.2	110	5		W	OK	F	
R-85	5-10	35	5	30	30		16	70	2.2	98	5		W	OK	F	Ejected under water.
R-86	5-10	35	5	30	30		16	70	2.2	--	5		W	--	F	No ejection
R-87	5-10	35	5	30	30		16	70	2.2	102	5		W	OK	F	Ejected under water
R-88	5-12	35	5	30	30		16	70	2.2	--	5		W	OK	F	Extinguished after 30 seconds
R-89	5-12	35	5	30	30		16	68	2.2	--	5		W	OK	F	Extinguished
R-90	5-12	35	5	30	30		16	68	2.2	--	5		W	OK	F	Erratic
R-91	5-13	40	5	30	25		16	60	2.2	80	5		W	OK	S	
R-92	5-13	40	5	30	25		16	70	2.2	93	10		W	OK	S	
R-93	5-13	40	5	30	25		16	70	2.2	96	10		W	OK	S	
R-94	5-13	40	5	30	25		16	70	2.2	--	5		W	OK	F	Extinguished after 30 seconds
R-95	5-13	40	5	30	25		16	70	2.2	129	5		W	OK	F	Erratic combustion
R-96	5-13	40	5	30	25		16	70	2.2	--	5		W	No	F	Sank
R-97	5-14	45	5	30	20		16	60	2.2	108	5		W	OK	S	

40-MM FLOATING FLARE - RED

Serial Number	Test Date (1971)	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Sr(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives										
R-98	5-14	45	5	30	20		16	70	2.2	103	10		W	OK	S	
R-99	5-14	45	5	30	20		16	70	2.2	99	10		W	OK	S	
R-100	5-14	50 40	5 5	30 30	15 25		16	10 60	2.2	110	10		W	OK	S	Smooth combustion
R-101	5-14	40	5	25	30		16	70	2.2	108	10		W	OK	S	Smooth combustion
R-102	5-14	40	5	25	30		16	60	2.2	74	5		W	OK	S	Smooth combustion
R-103	5-14	40	5	25	30		16	70	2.2	111	10		W	OK	S	
R-104	5-17	40	5	25	30		16	70	2.2	85	10		W	OK	S	
R-105	5-17	40	5	25	30		16	70	2.2	83	10		W	OK	S	
R-106	5-17	40	5	25	30		16	70	2.2	83	10		W	OK	S	
R-113	5-19	42	3	25	30		16	70	2.2	--	10		W	--	F	No ignition
R-114	5-19	42	3	25	30		16	70	2.2	--	10		W	--	F	No ignition
R-115	5-19	42	3	25	30		16	70	2.2	--	10		W	--	F	Ejection sank, extinguished
R-116	5-19	42	3	25	30		16	70	2.2	--	10		W	No	F	Ejection sank, extinguished

APPENDIX C

DATA SHEETS FOR YELLOW FLARE COMPOSITION TESTS

40-MM FLOATING FLARE - YELLOW

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$NaNO_3$		CA/TA	AP (50μ)											
Y-1	1-71	50	5	30	15		16	72	2.2	206	16	yellow	W	slag	S	
Y-2	1-71	45	10	30	15		16	72	2.2	183	16		W	hot	S	
Y-3	1-71	40	15	30	15		16		2.2	140*	16		W	hot	S	*Extinguished at 60 seconds
Y-4	1-71	40	20	25	15		16	71	2.2	90	16	yellow smooth	W	hot	S	
Y-5	1-71	50	10	30	5	$BaCl_2$	17		2.2	110*	16	yellow	W	hot	S	*Flame out
Y-6	1-71	40	15	25	20		16	71	2.2	*	16	yellow	W	hot	S	*Extinguished; very erratic combustion
Y-7	1-71	45	15	25	15		16	71	2.2	126	16	yellow	W	red hot	S	
Y-8	1-71	45	25	30	--		16	70	2.2	42	16	yellow	W	red hot	S	
Y-9	1-71	65	15	30	--		16	71	2.2	55	16	yellow	W	red hot	S	
Y-10	1-71	50	15	25	10		16	71	2.2	81	16	yellow	W	red hot	S	
Y-11	1-71	40	20	25	15		17	71	2.2	155*	16	yellow	W	hot	S	*Extinguished
Y-12	1-71	45	15	30	10		16	71	2.2	116	16	yellow	W	hot	S	Erratic combustion
Y-13	1-71	50	10	30	10		16	71	2.2	140	16	yellow	W	red hot	S	
Y-14	1-71	45	20	25	10		16	71	2.2	58	16	yellow	W	hot	S	
Y-15	1-71	50	10	35	5		16	71	2.2	123	16	yellow	W	hot	S	
Y-16	1-71	45	10	35	10		16	71	2.2	156	16	yellow	W	hot	S	
Y-17	1-71	50	15	30	5		16	71	2.2	72	16	yellow	W	hot	S	
Y-18	1-71	45	20	25	10		17	71	2.2	126	16	yellow	W	*	S	*No ballute

40mm Floating Flare -- Yellow

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate ($NaNO_3$)	Magnesium	Binder (CA/TA)	Secondary Oxidizer (AP (50μ))	Other Additives										
Y-19	1-71	50	15	30	5		17	71	2.2	135	16	yellow	W	hot	S	
Y-20	1-71	60	5	35	--		16	71	2.2	165	16	yellow	W	wet slag	S	
Y-21	1-71	55	10	30	5		16	71	2.2	99	16	yellow	W	wet slag	S	
Y-22	1-71	55	10	35	--		16	71	2.2	72	16	yellow	W	wet slag	S	
Y-23	3-9	50	10	30	10		16	70	2.2	125	16		W	--	S	Flame temperature: 2196°F
Y-24	3-9	50	10	30	10		16	70	2.2	125	16		W	--	S	Flame temperature: 2247°F
Y-25	3-15	50	10	30	10		16	70	2.2	--	16		L	fair	F	Burned on edge; ripped at bottom
Y-26	3-15	50	10	30	10		16	70	2.2	--	16		L	fair	F	7-mil retainer ring gone
Y-27	3-15	40 50	20 10	25 30	15 10		16	10 58	2.2	105	16		W	good	S	Ballute from throughout test
Y-28	3-15	50	10	30	10		16	69	2.2	135	16		W	good	S	Ballute soft for short time after ignition
Y-29	3-24	50	10	30	10		16	69	2.2	105	16		L	5-mil OK	F	260 meters @ 35°; ballute burned
Y-30	3-24	50	10	30	10		16	69	2.2	--	16		L	--	F	285 meters @ 35°; no ejection
Y-31	3-24	40 50	20 10	25 30	15 10		16	7 60	2.2	110	16		W	good	S	Black 7-mil Neoprene
Y-32	3-24	40 50	20 10	25 30	15 10		16	7 60	2.2	135	16		L	poor	F	Ballute ripped off; 7-mil Neoprene
Y-33	3-25	50	10	30	10		16	69	2.2	137	16		W	--	S	+165°
Y-34	3-25	50	10	30	10		16	69	2.2	148	16		W	--	S	+165°
Y-35	3-25	50	10	30	10		16	69	2.2	--	16		W	--	S	-65°
Y-36	3-25	50	10	30	10		16	69	2.2	140	16		W	--	S	-65°

40-MM FLOATING FLARE - YELLOW

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$NaNO_3$		CA/TA	AP (50μ)											
Y-37	3-26	50	10	30	10		16	68	2.2	--	16		W	?	F	Light in air; sank on impact
Y-38	4-20	50	10	30	10		16	67	2.2	143	16	good	W	--	S	New mull
Y-39	4-23	50	10	30	10		16	67	2.2	--	16	good	L	good	F	
Y-40	4-23	50	10	30	10		16	67	2.2	--	16	---	W	no	F	Sand after ignition in flight
Y-41	4-24	50	10	30	10		16	60	2.2	105	5	good	W		S	
Y-42	4-24	40 50	20 10	25 30	15 10		16	10 57.5	2.2	120	5	good	W	good	S	Two increments
Y-43	4-24	50	10	30	10		16	60	2.2	104	4	good	W	good	S	
Y-44	4-24	50	10	30	10		16	60	2.2	120	4	good	W	good	S	Rapid inflation of ballute
Y-45	4-25	50	10	30	10		16	60	2.2	126	3	good	W	good	S	Rapid inflation of ballute
Y-46	4-27	50	10	30	10		16	60	2.2	125	3	good	L		F	
Y-47	4-27	50	10	30	10		16	60	2.2	--	3	good	W	no	F	Inflated, but sank
Y-48	4-27	50	10	30	10		16	60	2.2	123	3		L	--	F	No ejection
Y-49	4-27	50	10	30	10		16	60	2.2	103	3		W	good	F	Plastic 1/4-inch orifice
Y-50	4-28	50	10	30	10		16	60	2.2	--	3		W	no	F	Plastic orifice, sank
Y-51	4-28	50	10	30	10		16	60	2.2	--	3		W	no	F	Plastic orifice, sank
Y-52	4-28	50	10	30	10		16	60	2.2	94	3		W	good	F	Plastic orifice, good floatation
Y-53	4-28	50	10	30	10		16	60	2.2	--	3		--	--	--	
Y-54	4-29	50	10	30	10		16	60	2.2	103	3		W	good	F	Aluminum chimney; plastic orifice

40-MM FLOATING FLARE - YELLOW

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$NaNO_3$		CA/TA	AP (50μ)											
Y-55	4-29	50	10	30	10		16	60	2.2	126	3		L	no	F	Holes in ballute, plastic orifice, steel chimney
Y-56	4-29	50	10	30	10		16	60	2.2	120	3		L	good	F	Plastic orifice, steel chimney
Y-57	4-30	50	10	30	10		16	60	2.2	--	5		W	poor		Plastic orifice, chimney came off
Y-58	4-30	50	10	30	10		16	60	2.2	129	5		L	poor	F	Plastic orifice, ripped ballute, steel chimney
Y-59	4-30	50	10	30	10		16	60	2.2	--	5		W	poor	F	Sank, no plastic orifices
Y-60	5-3	50	10	30	10		16	60	2.2	111	5		W	OK	F	Good inflation; no orifice
Y-61	5-4	50	10	30	10		16	60	2.2	--	5		W	OK	F	Extinguished
Y-62	5-4	50	10	30	10		16	60	2.2	--	5		W		F	Extinguished; sank
Y-63	5-5	50	10	30	10		16	60	2.2	111	5		W	OK	F	Good inflation; plastic orifice
Y-64	5-5	50	10	30	10		16	60	2.2	110	5		W	OK	F	Good inflation; plastic orifice
Y-65	5-6	50	10	30	10		16	60	2.2	--	5		W	OK	F	Extinguished
Y-66	5-6	50	10	30	10		16	60	2.2	112	5		W	OK	F	Good inflation
Y-67	5-6	50	10	30	10		16	60	2.2	103	5		W	OK	F	Good inflation
Y-68	5-10	50	10	30	10		16	60	2.2	106	5		W	OK	F	Good inflation
Y-69	5-10	50	10	30	10		16	60	2.2	105	5		W	OK	F	Ejected 10 feet
Y-70	5-10	50	10	30	10		16	60	2.2	109	5		W	OK	F	Ejected 10 feet
Y-71	5-10	50	10	30	10		16	60	2.2	99	5		W	OK	F	Loud report
Y-72	5-10	50	10	30	10		16	60	2.2	104	5		W	OK	F	Underwater ejection

40-MM FLOATING FLARE - YELLOW

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $NaNO_3$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives										
Y-73	5-10	50	10	30	10		16	60	2.2	--	5		W	OK	F	5-mil ballute
Y-74	5-10	50	10	30	10		16	60	2.2	--	5		W	OK	F	High sank; 5-mil ballute
Y-81	5-19	45	15	25	15		16	60	2.2	--	5		W	OK	F	No ignition
Y-82	5-19	45	15	25	15		16	60	2.2	100	5		W	OK	F	
Y-83	5-19	45	15	25	15		16	60	2.2	93	5		W	OK	F	
Y-84	5-19	45	15	25	15		16	60	2.2	96	5		W	OK	F	

APPENDIX D

DATA SHEETS FOR GREEN FLARE COMPOSITION TESTS

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$Ba(NO_3)_2$		PVC/DEP	AP (50 μ)											
G-1		40	10	30	10	10*	17		2.2	63	16	green yellow	W	hot	S	*Additive: $BaCl_2$
G-2		45	5	30	10	10*	17		2.2	102	16	poor	W	cool	S	
G-3		45	5	30	15	5*	17		2.2	95	16	poor	W	cool	S	
G-4		60	5	30	0	5*	17		2.2	210	16	poor	W	cool	S	Very little flame
G-5		45	5	30	20	--	17		2.2	64	16	poor	W		S	
G-6		50	5	25	10	10*	17		2.2	90	16	yellow/green	W		S	
G-7		50	5	30	10	5*	17		2.2	98	16	poor	W		S	
G-8		50	5	25	5	15	17		2.2	23	16	good	W		S	Additives: 10% $BaCl_2$, 5% boron
G-9		60	5	30		5*	17		2.2	105	16	fair	W	hot	S	Green with yellow pulses; +Additive: boron
G-10		60	2.5	30		7.5+	17		2.2	86	16	fair	W	hot	S	
G-11		50	2.5	35		7.5+	17		2.2	65	16	poor	W	hot	S	
G-12		55	2.5	25	5	12.5	17		2.2	66	16	fair	W	hot	S	Additives: 5% $BaCl_2$, 7.5% boron
G-13		55		25	7.5	12.5	--		2.2	54	16	fair	W	hot	S	Additives: 5% $BaCl_2$, 7.5% boron
G-14		58.5		24.4	4.86	12.17	--		2.2	65	16	fair	W	hot	S	Additives: 4.86% $BaCl_2$, 7.31% boron
G-15		60		25	5	10	--		2.2	122	16	white	W	hot	S	Additives: 5% $BaCl_2$, 5% boron
G-16		60		25	5	10+	--		2.2	60	16	fair/poor	W	hot	S	
G-17		60	5	25	5	5	17		2.2	no burn	16		W		S	Additive: H_3BO_3

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate Ba $(NO_3)_2$	Magnesium	Binder PVC/DEP	Secondary Oxidizer AP (50 μ)	Other Additives Boron										
G-18		65	5	25	5		17		2.2	114	16	good	W	hot	S	Heavy slag
G-19		60	5	25	5		17		2.2	118	16	fair	W	hot	S	
G-20		65	5	30			17		2.2	180	16	poor	W		S	
G-21		67.5	5	25	2.5		17		2.2	125	16	good/fair	W	hot	S	Heavy slag
G-22		65	5	25	2.5	2.5	17		2.2	85	16	fair	W		S	
G-23		70	5	25			17		2.2	150	16	fair	W	hot	S	Heavy slag
G-24		67.5	5	25		2.5	17		2.2	105	16	good	W	hot	S	

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$Ba(NO_3)_2$		CA/TA	AP (50 μ)											
G-25		60	5	30	5		17		2.2	160	16	green yellow	W	hot	S	Intermittent flame
G-26		50	15	30	5		17		2.2	69	16	green	W	hot	S	
G-27		50	5	30	15		17		2.2	*60	16	fair	W	--	S	*Extinguished
G-28		50	5	30	15		16		2.2	124	16	fair/good	W	hot	S	
G-29		50	5	30	15		16		2.2	124	16	fair/good	W	hot	S	
G-30		50	5	30	15	2+	16		2.2	73	16	green	W	hot	S	+Additive: boron
G-31		50	3	30	15	2+	16		2.2	90	16	green	W	hot	S	
G-32		50	5	28	15	2+	17		2.2	97	16	fair	W	hot	S	
G-33		55	10	30	5		17		2.2	93	16	good	W	hot	S	
G-34		55	10	25	5	5#	17		2.2	85	16	good	W	hot	S	#Additive: $BaCl_2$
G-35		50	10	30	5	5#	17		2.2	98	16	green yellow	W	hot	S	
G-36		45	10	30	5	10#	17		2.2	103	16	green	W	hot	S	
G-37		45	10	20	5	20#	17		2.2	80	16	green	W	hot	S	
G-38		45	10	10	5	30#	17		2.2	64	16	green	W	hot	S	Better green than G-35 through G-37
G-39		50	5	10	5	30#	17		2.2	120	16	poor	W	--	S	Erratic; extinguished
G-40		45	5	10	10	30#	17		2.2	150	16	fair	W	hot	S	Very small flame
G-41		45	5	10	10	30#	17		2.2	100	16	poor	W	hot	S	Very small flame
G-42		45	7.5	10	7.5	30#	17		2.2	80	16	poor	W	hot	S	

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		$Ba(NO_3)_2$		CA/TA	AP (50μ)											
G-43		50	3	30	15	2+	17		2.2	120	16	good/fair	W	hot	S	+Additive: Boron
G-44		50	5	28	15	2+	17		2.2	86	16	good/fair	W	hot	S	
G-45		50	6	28	15	1+	17		2.2	105	16	green	W	hot	S	Observed in night test at 600 meters as white-green
G-46		22.5	34	21	22.5*		17		2.2	56	16	green/white	W	hot	S	*Secondary oxidizer: $KClO_4$; binder: PVC/DEP
G-47		22.5	25	30	22.5*		17		2.2	95	16	good	W	hot	S	Erratic combustion; binder: PVC/DEP
G-48		22.5	15	40	22.5*		17		2.2	130	16	good	W	hot	S	Erratic combustion; binder: PVC/DEP
G-49		22.5	25	30	22.5*		16		2.2	46	16	green/white	W	hot	S	Binder: PVC/DEP
G-50		22.5	25	30	22.5*		17		2.2	109	16	fair	W	hot	S	Erratic combustion; binder: PVC/DEP
G-51		22.5	25	30	22.5*	5#	17		2.2	124	16	fair	W	hot	S	#Additive: $BaCl_2$. Erratic combustion; binder: PVC/DEP
G-52		22.5	34	21	22.5		17		2.2	45	16	green/white	W	hot	S	
G-53		55	5	30	10		16		2.2	100	16	poor	W	hot	S	
G-54		60	5	30	5		17		2.2	105	16	poor	W	hot	S	
G-55		22.5	25	30	22.5*		17		2.2	66	16	fair	W	hot	S	
G-56		45	34	21	--		17		2.2	30	16	green/fair	W	hot	S	Binder: PVC/DEP

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Ba(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives										
G-57	1-71	60	5	30	5		16	80	2.2	108	84	yellow	W	hot	S	Slag plugged ballute orifices
G-58	1-71	50	5	30	15		16	80	2.2	96	80	green yellow	W	hot	S	
G-59	1-71	45	5	30	20		16	80	2.2	90	78	green yellow	W	hot	S	Green spike in flame
G-60	1-71	25	5	30	20	20	16	80	2.2	109	83.5	yellow	W	hot	S	Additive: $BaCl_2$
G-61	1-71	25	5	30	20	20	16	80	2.2	109	87	yellow	W	hot	S	Additive: $BaCO_3$
G-62	1-71	40	5	35	20		16	80	2.2	112	74	green yellow	W	hot	S	
G-63	1-71	45	5	30	10	10*	16	80	2.2	192	86	green orange	W smooth	cool	S	*Additive: NH_4Cl
G-64	1-71	45	5	30	15	5*	16	80	2.2	122	80	yellow green	W	--	S	
G-65	1-71	35	5	30	20	10*	16	80	2.2	116	78	blue green	W		S	Copper chimney; erratic combustion
G-66	1-71	45	5	25	20	5*	16	80	2.2	89	78	green	W	red hot	S	Spit slag
G-67	1-71	45	5	25	20	5*	16	80	2.2	141	78	yellow green	W	red hot	S	Green spike
G-68	1-71	40	5	25	25	5*	16	80	2.2	122	74	green	W	hot	S	Green spike
G-69	1-71	35	5	25	30	5*	16	80	2.2	120	74	green	W	hot	S	
G-70	1-71	30	5	25	35	5*	16	80	2.2	125	67	green	W	hot	S	
G-70-1	1-71	30	5	25	35	5*	16	80	2.2	116	64	green	W	hot	S	
G-70-2	1-71	30	5	25	35	5*	16	80	2.2	120		green	W	hot	S	
G-70-3	1-71	30	5	25	35	5*	16	80	2.2	120		green	W	hot	S	
G-71	1-71	30	5	25	35	5*	15	80	2.2	109	61	green	W	hot	S	

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Other Additives										
		Ba $(NO_3)_2$		CA/TA	AP (50μ)											
G-72	1-71	30	5	25	35	5*	17	80	2.2	111	--	green	W	hot	S	*Additive: NH_4Cl; 400μ AP
G-73	1-71	30	5	25	30	10*	17	80	2.2	152	65	light green	W	hot	S	
G-74	1-71	30	5	25	30	10*	16	80	2.2	131	64	green yellow	W	hot	S	
G-75	3-9	30	5	25	35		17	75	2.2	125	16		W	--	S	Flame temperature: 2343°F
G-76	3-9	30	5	25	35		17	75	2.2	111	16		W	--	S	Flame temperature: 1933°F
G-77	3-15	30	5	25	35		17	75	2.2	--	16		L	--	F	No ignition
G-78	3-15	30	5	25	35		17	75	2.2	131	16		W	good	S	Ballute test; firm on ignition
G-79	3-15	30	5	25	35		17	75	2.2	--	16		L	--	F	265 meters; no ejection
G-80	3-25	30	5	25	35		17	75	2.2	129	16	good	W	--	S	+165°F
G-81	3-25	30	5	25	35		17	75	2.2	121	16	good	W	--	S	+165°F
G-82	3-25	30	5	25	35		17	75	2.2	--	16	--	W	--	S	-65°F
G-83	3-25	30	5	25	35		17	75	2.2	148	16	good	W	--	S	-65°F
G-84	3-25	30	5	25	35		17	75	2.2	106	16	good	L	rip	F	
G-85	3-25	30	5	25	35		17	75	2.2	--	16	--	L	--	F	No ejection
G-86	3-26	30	5	25	35		17	75	2.2	--	16	--	W	no	F	Light, sank; nut came off
G-87	3-26	30	5	25	35		17	75	2.2	--	16	--	W	no	F	Light, sank; nut came off; ripped ballute

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Ba(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50 μ)	Other Additives NH_4Cl										
G-88	4-23	30	5	25	35	5	17	72	2.2	--	16	good	L	OK	F	
G-89	4-23	30	5	25	35	--	16	72	2.2	--	16	good	W	no	F	Sank
G-90	4-24	30 30	5	25	35	5	17	10 62	2.2	123	16	good	W	no	S	
G-91	4-24	30	5	25	35	5	17	60	2.2	105	2		W		S	
G-92	4-24	30	5	25	35	5	16	60	2.2	82	2		W	good	S	Delayed inflation
G-93	4-24	30	5	25	35	5	16	60	2.2	105	2		W	good	S	
G-94	4-27	30	5	25	35	5	16	60	2.2	--	2		W	--	F	Blew apart; granulated first fire
G-95	4-27	30	5	25	35	5	16	60	2.2	--	2		L	--	F	Granulated first fire
G-96	4-28	30	5 3	25	35	5	16	60	2.2	95	2		W	--	S	Rapid ignition
G-97	4-28	30	5	25	35	5	16	60	2.2	--	2		W	--	F	
G-98	4-29	30	5	25	35	5	16	60	2.2	104	2		W	good	F	Aluminum chimney; plastic orifice
G-99	4-29	30	5	25	35	5	16	60	2.2	--	2		W	no	F	Steel chimney, sank; plastic orifice
G-100	4-29	30	5	25	35	5	16	60	2.2	85	2		L	no	F	No inflation; burned ballute
G-101	4-30	30	5	25	35	5	16	60	2.2	--	2		L	no	F	Steel chimney, ripped ballute; no ignition
G-102	4-30	30	5	25	35	5	16	60	2.2	--	2		W	no	F	Sank
G-105	5-3	30	5	25	35	5	16	60	2.2	85	2		W	OK	F	Aluminum chimney; no orifice
G-106	5-3	30	5	25	35	5	16	60	2.2	111	2		L	OK	F	Double bottom; aluminum chimney; no orifice
G-107	5-3	30	5	25	35	5	16	60	2.2	113	5		W	OK	F	Aluminum chimney; low ejection; no orifice

40-MM FLOATING FLARE - GREEN

Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pres-sure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate $Ba(NO_3)_2$	Magnesium	Binder CA/TA	Secondary Oxidizer AP (50μ)	Other Additives NH_4Cl										
G-108	5-4	30	5	25	35	5	16	60	2.2	--	5		L	OK	F	Inflated; extinguished in water
G-109	5-4	30	5	25	35	5	16	60	2.2	--	5		W	--	F	Sank--ejected; o-ring around ballute
G-110	5-6	30	5	25	35	5	16	60	2.2	100	5		W	OK	F	Good
G-111	5-6	30	5	25	35	5	16	60	2.2	97	5		W	OK	F	
G-112	5-10	30	5	25	35	5	16	60	2.2	105	5		W	OK	F	Good inflation
G-113	5-10	30	5	25	35	5	16	60	2.2	92	5		W	OK	F	Extinguished, surfaced
G-114	5-10	30	5	25	35	5	16	60	2.2	--	5		W	OK	F	Low ejection, extinguished, surfaced, sank
G-115	5-10	30	5	25	35	5	16	60	2.2	94	5		W	OK	F	Floated OK
G-116	5-10	30	5	25	35	5	16	60	2.2	108	5		W	OK	F	Ejected on water
G-117	5-10	30	5	25	35	5	16	60	2.2	100	5		W	OK	S	Night; good color
G-118	5-10	30	5	25	35	5	16	60	2.2	--	5		W	OK	S	Sank
G-119	5-10	30	5	25	35	5	16	60	2.2	--	5		L	OK	F	

APPENDIX E

FEASIBILITY DEMONSTRATION

TEST RESULTS

40-MM FLOATING FLARE FEASIBILITY DEMONSTRATION TESTS

	Serial Number	Test Date	Percent Composition					Magnesium Granulation	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Press Pressure (1000 lbs)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
			Nitrate	Magnesium	Binder (CA/TA)	Secondary Oxidizer (AP)	Other Additives NH_4Cl										
*	R-107	5-17	40	5	25	30	--	16	70	2.2	83	10	G	W	G	F	Night
*	Y-75	5-17	50	10	30	10	--	16	60	2.2	99	5	G	W	G	F	Night
*	G-120	5-17	30	5	25	35	5	16	60	2.2	101	5	G	W	G	F	Night
	R-108	5-17	40	5	25	30	--	16	70	2.2	79	10	G	W	G	F	Night, underwater ejection
	Y-76	5-17	50	10	30	10	--	16	60	2.2	100	5	G	W	G	F	Night, underwater ejection
	G-121	5-17	30	5	25	35	5	16	60	2.2	100	5	G	W	G	F	Night, underwater ejection
	R-109	5-18	40	5	25	30	--	16	70	2.2	85	10	G	W	G	F	Day
	Y-77	5-18	50	10	30	10	--	16	60	2.2	103	5	G	W	G	F	Day
	G-122	5-18	30	5	25	35	5	16	60	2.2	103	5	G	W	G	F	Day
	R-110	5-18	40	5	25	30	--	16	70	2.2	---	10	--	W	--	F	Day; sank, delay failure
	Y-78	5-18	50	10	30	10	--	16	60	2.2	---	5	--	W	--	F	Day; sank, delay failure
	G-123	5-18	30	5	25	35	5	16	60	2.2	97	5	G	W	G	F	Day
	R-111	5-18	40	5	25	30	--	16	70	2.2	83	10	G	W	G	F	Day
	Y-79	5-18	50	10	30	10	--	16	60	2.2	99	5	G	W	G	F	Day
	G-124	5-18	30	5	25	35	5	16	60	2.2	---	5	--	W	G	F	Day; no ignition, deployed
	R-112	5-18	40	5	25	30	--	16	70	2.2	84	10	G	W	G	F	Day
	Y-80	5-18	50	10	30	10	--	16	60	2.2	101	5	G	W	G	F	Day
	G-125	5-18	30	5	25	35	5	16	60	2.2	---	5	--	W	--	F	Day; sank, delay failure

* Letter denotes color, i.e., R is red, Y is yellow, and G is green.

APPENDIX F

ENVIRONMENTAL TESTING OF 40MM FLOATING FLARE CARTRIDGE

TEST REPORT NO. A-3827

DATE 12 July 1971

REPORT OF TEST ON

ENVIRONMENTAL TESTING
OF
CARTRIDGE 40MM, FLOATING FLARE

FOR

CHEMTRONICS, INC.
DIVISION OF AIRTRONICS, INC.
ASHEVILLE, NORTH CAROLINA 28802

GENERAL TESTING LABORATORIES, INC.
6840 Industrial Road
Springfield, Virginia 22151

	PREPARED	CHECKED	APPROVED
BY	A. A. Ellis	A. A. Ellis	C. M. Hening
SIGNED	A. A. Ellis	A. A. Ellis	C. M. Hening
DATE	12 July 1971	12 July 1971	12 July 1971

TABLE OF CONTENTS

TESTING

DATE 12 July 1971

REVISION PAGE

Revision Letter	Date	Page Number	Description
Original	12 July 1971		

TESTING

DATE 12 July 1971

ADMINISTRATIVE DATA

PURPOSE OF TEST

The purpose of the test program was to assure that the Chemtronics, Inc. Floating Smoke Flare can comply with environmental treatment as described herein and as required by Chemtronics, Inc. purchase order number 121347.

TEST PERFORMED FOR

Chemtronics, Inc.
Division of Airtronics, Inc.
Asheville, North Carolina 28802

TEST ARTICLE DESCRIPTION

The Chemtronic, Inc. Floating Smoke Flare is a cylindrical shaped object approximately 40 MM in diameter and approximately 5.0 inches in length.

MANUFACTURER

Chemtronics, Inc.
Division of Airtronics, Inc.
Asheville, North Carolina 28802

APPLICABLE DOCUMENTS

1. Army Regulation AR70-38
2. MIL-STD-810B
3. MIL-E-5272C
4. MTP 4-2-804

QUANTITY OF TEST ARTICLES

Thirty-six (36) Cartridge 40 MM, Floating Smoke Flares, one (1) group of fifteen (15) and one (1) group of twenty-one (21).

SECURITY CLASSIFICATION OF TEST ARTICLES

Unclassified

DATE TEST COMPLETED

21 June 1971

TEST CONDUCTED BY

General Testing Laboratories, Inc.
Pyrotechnic Laboratory
Hartwood Division
Hartwood, Virginia 22471

DISPOSITION OF TEST ARTICLES

Upon completion of the test program, the test articles were returned to Chemtronics, Inc., Asheville, North Carolina for further evaluation.

TABULAR SUMMARY SHEET

1. Component/Part Name per Generic Code: Floating Smoke Flares	2. Program or Weapon System: Not Applicable			
4. Originator's Report Title: Environmental Testing of Cartridge 40 MM, Floating Smoke Flares	5. Originator's Report No.: A-3829	3. Test Complete	Day 21	Month June 197
	6. Test Type, Etc.: Environmental	Report Complete	12	July 197

7. This test (supersedes) (supplements) report No.:

8. Item	8A. Part Type, Size, Rating, Lot, Etc.	9. Vendor	10. Vendor Part No.:	11. Ind/Gov Std No.:	12. Total Tested:
		Chemtronics, Inc.			Thirty-six (36)

13. Internal Specs., Etc Required to Utilize Rept.		Enc.	Sent with Report No.	14. MIL Specs./Std referenced ISC	
A	Army Regulation AR70-38			C	MIL-STD-810B
B	MTP 4-2-804			D	MIL-E-5272C

15A. Item	TEST OR ENVIRONMENT	C. Per Spec	D. Spec. Paragraph/ Method/ Condition	E. Test Levels, Duratition and other details	F. Number Tested	G. Number Failed
	Storage & Transit	A	Table 2-3	21 Hrs. duration 90-160°F/10-85% RH	15	0
	Operational Conditions	A	Table 2-3	21 Hrs. duration 74-100°F/78-85% RH	21	0
	Rain Fall	-	NCI Requirements	12 Hrs. duration, Total 9.5"	21	0
	Sea Salt Fallout	C	Method 509	48 Hrs. duration, 5% solution	21	0
	Sand and Dust	D	ASG 4.11.3 Proc. III	3 Hrs. duration	21	0
	Trans. & Aircraft Vib.	B	Appendix A	3 Hrs. 45 min. +145°F/3 Hrs. 45 min.-65°F	15	0

16. Summary of Report, Nature of Failures and Corrective Actions Taken:

17. Tested Beyond Vendor Catalog Specifications	18. Vendor Informed of Test Result By:	19. Signer	20. Contractor	Subcontrac
Yes ☐ No ☒	☐ Letter ☒ Copy of Report ☐ Oral	Aubrey A. Ellis	Chemtronics, Inc.	GTL

ABSTRACT

This report delineates dynamic and environmental testing of thirty-six (36) Floating Smoke Flares for Chemtronics, Inc., Asheville, North Carolina.

Storage and Transit Conditions Diurnal Cycle, Operational Conditions Diurnal Cycle, Rain Fall, Sea Salt Fallout, Sand and Dust and Transportation and Aircraft Vibration tests were conducted during the test program.

Upon completion of the test program, all test articles were returned to Chemtronics, Inc., Asheville, North Carolina for further evaluation.

TESTING

DATE 12 July 1971

FACTUAL DATA

1.0 TEST APPARATUS AND EQUIPMENT

1.1 Storage and Transit Conditions Diurnal Cycle

1.1.1 Temperature - Humidity Chamber
Standard Cabinet Company
Model: LHHCA/27FS

1.1.2 Recorder/Controller
Honeywell
Model: Y602C43-(AA)-24-111-893
Calibration Due: 18 August 1971

1.1.3 Hygrometer
Hygrodynamics
Model: 15-3000
Calibration Due: 8 October 1971

1.2 Operationa Conditions Diurnal Cycle

1.2.1 Temperature-Humidity-Solar Radiation Chamber
Tenney
Model A-141D
Thermal Recorder
Calibration Due: 22 November 1971
Humidity Recorder
Calibration Due: 24 November 1971

1.3 Rain Fall

1.3.1 Rain Fall Chamber
Industrial Filter and Pump Mfg. Co.
Model: CAR-1

1.4 Sea Salt Fallout

1.4.1 Marine Atmosphere Chamber
Industrial Filter and Pump Mfg. Co.
Model: CAR-1

1.5 Sand and Dust

1.5.1 Sand and Dust Chamber
General Testing Laboratories
Model: 64FS

DATE 12 July 1971

1.5.2 Temperature Recorder
Honeywell Brown
Model: 153X64P12-X-42
Range: -150° to 200°F
Calibration Due: 12 August 1971

1.6 Transportation and Aircraft Vibration

1.6.1 Vibration Exciter
M. B. Electronics
Model: C-150

1.6.2 Power Amplifier
M-B Electronics
Model: 4450

1.6.3 Accelerometer (Control)
Endevco Corporation
Model: 2271A
Calibration Due: 28 October 1971

1.6.4 Accelerometer (Monitor)
Endevco Corporation
Model: 2213
Calibration Due: 28 October 1971

1.6.5 Accelerometer Amplifier
Endevco Corporation
Model: 2713A/RA38
Calibration Due: 25 November 1971

1.6.6 Accelerometer Amplifier
Endevco Corporation
Model: 2713A/RA54
Calibration Due: 25 November 1971

1.6.7 Thermal Conditioning Shroud
Wyle Manufacturing Corporation
Model: TE-100-64

1.6.8 Temperature Recorder
Honeywell Brown
Model: 153X64P12-X-42
Range: -150° to 200°F
Calibration Due: 12 August 1971

TESTING

1.6.9 Control Oscillator
Bruel and Kjaer
Model: N575/N576-1029

1.6.10 Electronic Counter
M-B Electronics
Model: N212
Calibration Due: 12 September 1971

TESTING

DATE 12 July 1971

2.0 TEST PROCEDURE

2.1 General

The thirty-six (36) Floating Smoke Flares were sequentially subjected to the environmental test as presented in Table I.

TABLE I

REQUIREMENT	Group I	Group II
Storage and Transit Conditions Diurnal Cycle (per Table 2-3 AR 70-38)	15	
Operational Conditions Diurnal Cycle (per Table 2-3 AR 70-38		21
Rain Fall		21
Sea Salt Fallout (per MIL-STD-810B, Method 509		21
Sand and Dust (per MIL-E-5272 C ASG, 4.11.3, Proc. III		21
Transportation and Aircraft Vibration (MTP 4-2-804)	15	
Functional Testing (Total of 36 units)	15	21

In Group I, the 15 test Flares will be packaged in the shipping box. This is the configuration in which the Flares would be subjected to vibration.

2.2 Storage and Transit Conditions Diurnal Cycle

The test articles designated in Table I were subjected to twenty-one (21) hours of Temperature-Humidity exposure as presented in Table II.

TESTING

TABLE II

STORAGE AND TRANSIT CONDITIONS		
LOCAL TIME	INDUCED AIR TEMPERATURE °F	INDUCED RELATIVE HUMIDITY %
0300	94	80
0600	91	84
0900	117	74
1200	150	30
1500	160	10
1800	142	35
2100	105	59
2400	98	75
Max.	160	75
Min.	90	10

2.3 Operational Conditions Diurnal Cycle

The test articles designated in Table I were subjected to twenty-one (21) hours of Temperature - Humidity - Solar Radiation exposure as presented in Table III.

TESTING

DATE 12 July 1971

TABLE III

OPERATIONAL CONDITIONS				
LOCAL TIME	AMBIENT AIR TEMPERATURE °F	SOLAR RADIATION BTU/ft^2/hr	AMBIENT HUMIDITY Rel %	AMBIENT HUMIDITY Dew Pt. °F
0300	79	0	100	79
0600	78	70	100	78
0900	87	290	82	81
1200	94	360	75	84
1500	95	290	74	85
1800	90	70	82	84
2100	83	0	95	82
2400	80	0	100	80
Max.	95	360	100	85
Min.	78	0	74	78

2.4 Rain Fall

The test articles designated in Table I were subjected to twelve (12) hours exposure to simulated rain fall as presented in Table IV.

TABLE IV

TIME PERIOD	RATE (in./hr.)	TOTAL (in.)
1 Minute	27	0.45
5 Minutes	12	1.0
10 Minutes	9	1.5
1 Hour	5.5	5.5
10.73 Hours	0.098	1.5

TESTING

2.5 Sea Salt Fallout

The test articles designated in Table I were subjected to forty-eight (48) hours of salt fog exposure.

A sodium chloride solution was prepared by desolving five (5) parts by weight of sodium chloride in ninety-five (95) parts by weight of distilled water.

The salt spray chamber reservoir was filled with the sodium chloride solution and the test articles placed on the support racks within the chamber and the chamber temperature adjusted to 95°F.

2.6 Sand and Dust

The test articles designated in Table I were subjected to three (3) hours of Sand and Dust exposure.

The test articles were placed within the sand and dust chamber, the dust density determined, with light source and photo cell smoke meter, to be within the specified limits of 0.1 to 0.25 grams per cubic foot and the air velocity determined, with Alnor velometer, to be within the specified limits of 2500 (±500) feet per minute. The chamber temperature was adjusted to 77°F and stabilized for the duration of the test.

2.7 Transportation and Aircraft Vibration

The test articles designated in Table I were subjected to the vibration schedule of Table V for three (3) hours, forty-five (45) minutes at -65°F and three (3) hours, forty-five (45) minutes at 145°F in one (1) major axis only. Prior to the initiation of vibration testing, the test articles were conditioned for a period of four (4) hours at the required temperature.

DATE 12 July 1971

TABLE V

RESONANCE SURVEY		
FREQUENCY (Hz)	AMPLITUDE	DURATION
5 - 15 15 - 500	0.5 g 1.0 g	30 Minute dwell per resonance
	GROUND VEHICLE	
5.5 - 7 7 - 37	1.0" d.a. 2.5 g's	45 Minutes cycling less dwell
	AIRCRAFT	
37 - 52 52 - 500	0.036" d.a. 5.0 g's	3 Hrs. Cycling less dwelling

TESTING

2.8 Calibration of Instrumentation

All test equipment and/or instrumentation requiring calibration that was utilized in conducting the test program compiled with the accuracies and calibration techniques of MIL-C-45662A and was traceable to the National Bureau of Standards. Each instrument displayed a label as to the date of last calibration and the due date of next calibration.

3.0 TEST RESULTS

3.1 Storage and Transit Conditions Diurnal Cycle

The fifteen (15) Floating Smoke Flares designated for Storage and Transit Conditions Diurnal Cycle withstood the temperature/humidity exposure detailed in Table II of paragraph 2.2 without apparent indication of damage and/or deterioration as a result of the test.

3.2 Operational Conditions Diurnal Cycle

The twenty-one (21) Floating Smoke Flares designated for Operational Conditions Diurnal Cycle withstood the temperature/humidity/solar radiation exposure detailed in Table III of paragraph 2.3 without apparent indication of damage and/or deterioration as a result of the test.

3.3 Rain Fall

The twenty-one (21) Floating Smoke Flares designated for Rain Fall withstood the exposure detailed in Table IV of paragraph 2.4 without apparent indication of damage and/or deterioration as a result of the test.

3.4 Sea Salt Fallout

The twenty-one (21) Floating Smoke Flares designated for Sea Salt Fallout withstood the test exposure without apparent indication of damage and/or deterioration as a result of the test.

3.5 Sand and Dust

The twenty-one (21) Floating Smoke Flares designated for Sand and Dust withstood the test exposure without apparent indication of damage and/or deterioration as a result of the test.

TESTING

DATE 12 July 1971

3.6 Transportation and Aircraft Vibration

The fifteen (15) Floating Smoke Flares designated for Transportation and Aircraft Vibration withstood the vibration exposure detailed in Table V of paragraph 2.7 without apparent indication of damage and/or deterioration as a result of the test at either -65°F or 145°F.

Resonant frequencies determined during the resonance survey is presented in Table VI.

TABLE VI

RESONANCE SCHEDULE		
FREQUENCY (Hz)	TEMPERATURE (°F)	DURATION
111	145°	30 Minutes
187	145°	30 Minutes
308	145°	30 Minutes
425	145°	30 Minutes
114	-65°	30 Minutes
196	-65°	30 Minutes
379	-65°	30 Minutes
490	-65°	30 Minutes

TESTING

APPENDIX G

ENVIRONMENTAL FLIGHT TEST RESULTS

ENVIRONMENTAL FLIGHT TESTS - RED

Serial No.	Test Group (per Test Plan)	Range (meters)	Ejection Height from Water	Burn Time (sec)	Day/ Night	Comments
R-117	I	270	under	80	day	Burned 23 seconds underwater
R-118	I	285	under	79	day	
R-119	I	295	none	--	day	Delay failure
R-120	I	310	under	79	day	Burned 19 seconds underwater
R-121	I	300	above	81	day	
R-122	I	285	under	82	night	
R-123	I	300	on	83	night	
R-124	II	300	under	83	night	
R-125	II	305	under	81	night	
R-126	II	280	on	80	day	
R-127	II	300	under	80	day	
R-128	II	290	under	79	day	
R-129	VI	316	none	--	day	Delay failure
R-130	VI	285	under	--	day	Went out
R-131	VI	290	none	--	night	Delay failure

ENVIRONMENTAL FLIGHT TESTS - YELLOW

Serial No.	Test Group (per Test Plan)	Range (meters)	Ejection Height from Water	Burn Time (sec)	Day/ Night	Comments
Y-85	I	285	none	---	night	Delay failure
Y-86	I	300	none	---	night	Delay failure
Y-87	I	325	on	106	day	
Y-88	I	315	under	98	day	
Y-89	I	295	above	88	day	Flame out 75 seconds (hole in ballute ?)
Y-90	I	285	under	97	day	
Y-91	I	296	under	96	day	
Y-92	VI	283	high	86	night	Did not submerge
Y-93	II	295	above 20 ft.	98	day	
Y-94	II	310	above 10 ft.	96	day	
Y-95	II	305	none	---	day	Delay failure
Y-96	VI	285	high	93	night	Did not submerge
Y-97	VI	305	under	95	night	
Y-98	VI	310	on	98	day	
Y-99	VI	320	under	95	day	

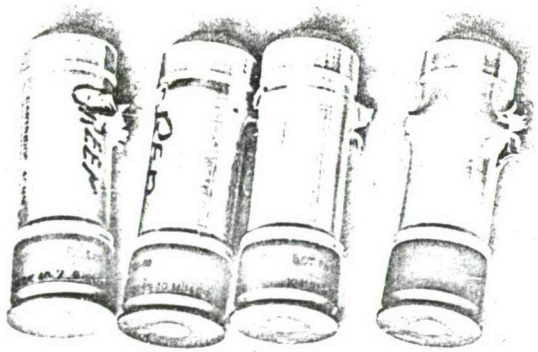
ENVIRONMENTAL FLIGHT TESTS - GREEN

Serial No.	Test Group (per Test Plan)	Range (meters)	Ejection Height from Water	Burn Time (sec)	Day/ Night	Comments
G-126	I	300	under	93	night	Erratic flame
G-127	I	325	on	117	night	
G-128	I	295	on	116	day	
G-129	I	290	none	---	day	Delay failure
G-130	I	305	under	122	day	Erratic flame
G-131	I	305	under	118	day	
G-132	I	280	under	116	day	
G-133	II	315	under	119	day	(hole in ballute ?)
G-134	II	300	above	---	day	Went out
G-135	II	305	none	---	night	Delay went out in flight
G-136	II	275	none	---	day	Delay failure
G-137	II	305	none	---	night	Delay went out in flight
G-138	VI	320	under	121	night	
G-139	VI	285	under	115	day	
G-140	VI	275	under	120	day	

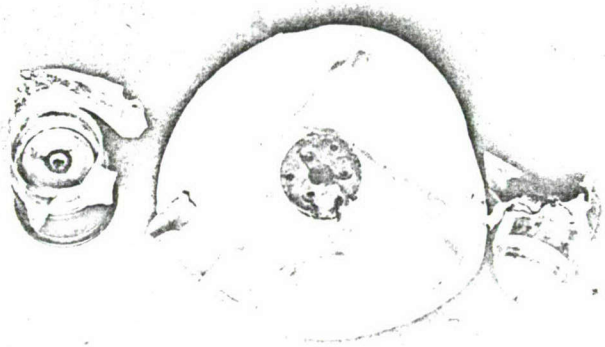
ENVIRONMENTAL TESTS

BULLET IMPACT

Serial No.	Impact Area	Result
R-133		No ignition
R-134		No ignition
G-146		No ignition
G-147		No ignition
Y-105	First fire	Ignited on impact and extinguished
Y-106	Delay	Ignited, ejected canister, and consumed flare mix



IMPACT IN FLARE MIX



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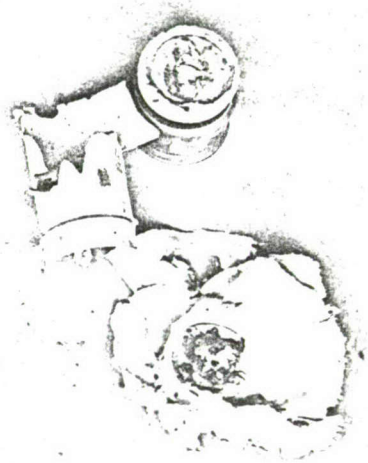

IMPACT IN DELAY

BULLET IMPACT TEST RESULTS

ENVIRONMENTAL TESTS

DAY AND NIGHT OBSERVATION

Serial No.	Time of Test	Burn Time (sec)	Observation Distance (miles)	Comments
R-135	day	92	1.0	Smoke but no flame visible
Y-100	day	92	1.5	--
G-141	day	98	1.0	Blue
R-136	day	82	--	Smoke but no flame visible
Y-101	day	94	.75	Flame visible
G-142	day	119	1.0	Smoke but no flame visible
Y-102	night	96	3.0	Very visible
R-137	night	74	3.5	Good red
G-143	night	123	--	Aircraft disoriented
R-138	night	--	2.5	Good red
Y-103	night	--	5.0	Good yellow
G-144	night	--	--	Very hard to see
R-139	night	82	4.5	Good red
G-145	night	115	1.5	Small light; white at 2 to 3 miles
Y-104	night	--	--	Aircraft disoriented

APPENDIX H

DELIVERY ROUNDS DATA

DELIVERY ACCEPTANCE TESTS

Serial No.	Range (meters)	Ejection Height from Water (ft)	Burn Time (sec)	Comments
R-166	295	60	85.0	---
R-167	295	100	---	Extinguished after ejection
R-168	295	125	87.5	---
Y-126	295	125	101.0	---
Y-127	295	125	90.0	---
Y-128	310	100	90.0	---
G-158	285	100	---	Extinguished after ejection
G-159	325	100	102.0	---
G-160	290	100	---	Extinguished on impact
G-158*	290	0	20.0	Burned under water, extinguished
G-159*	290	100	23.0	Floatation, then sank without extinguishment
G-160*	290	100	7.0	Floatation, then sank without extinguishment

*Rebuilt all green delivery units; test rounds used fired hardware which caused submergence.

APPENDIX I

IMPROVED GREEN FLARE

GREEN FLAME IMPROVEMENT FORMULATIONS

	ETV*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Ba(NO_3)_2$	30	35	40	45	35	40	45	35	35	35	35
NH_4ClO_4 (50μ)	35	30	25	20	25	20	15	20	20	20	--
NH_4ClO_4 (400μ)	--	--	--	--	--	--	--	--	--	--	20
NH_4Cl	5	5	5	5	10	10	10	10	10	10	10
Mg (Gran. 16)	5	5	5	5	5	5	5	10	--	5	10
Mg (Gran. 17)	--	--	--	--	--	--	--	--	10	5	--
Binder	25	25	25	25	25	25	25	25	25	25	25
Burn Time (sec)	100	73	73	69	96	96	99	80	103	73	90
Color	Y	G-Y	Y-G	Y	G-Y	Y	Y	G	G	G	G
Flame Size	small	medium	large	large	flame-out 60 sec.	flame-out 60 sec.	flame-out 60 sec.	large	pulse	small	large

*Environmental Test Formulation