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CONSUMABLE MIDI SMOKE GRENADE

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AAI Corporation

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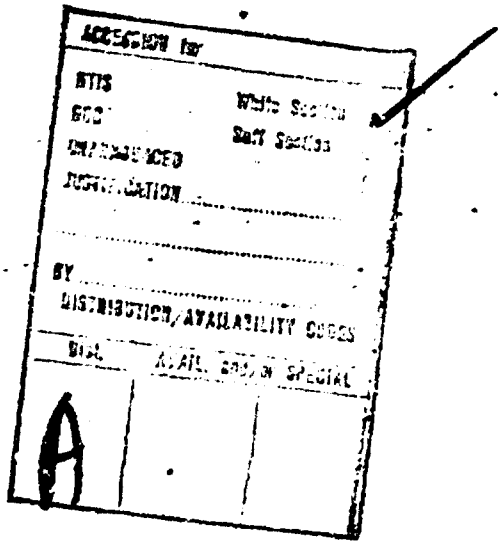

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This report describes the design and preliminary development of a self-consuming, colored smoke grenade. This consumable grenade effort was a continuation of the LWL Midi Smoke Grenade program as reported in Technical Report No. LWL-CR-09F70. The consumable grenade retains the basic size and output of the Midi Grenade, and provides the additional feature of self-destruction so that the grenade components become unusable by an enemy as booby trap hardware. A quantity of one hundred consumable grenades of smoke colors red, green, and violet, were

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fabricated and delivered under this effort. These units were evaluated by USAMEL and were found satisfactory for smoke quality, output and consumability.

INTRODUCTION

The development of a Consumable Midi Smoke Grenade was the final phase of development by USALWL of the basic Midi Smoke Grenade. The consumable midi, Figure 1, is basically a one-piece plastic container and fuze, having the same overall dimensions and smoke producing characteristics as the midi. When the smoke producing function is complete, an ignition charge in the base of the consumable grenade ignites the plastic housing, thereby rendering all components unusable as potential booby trap hardware.

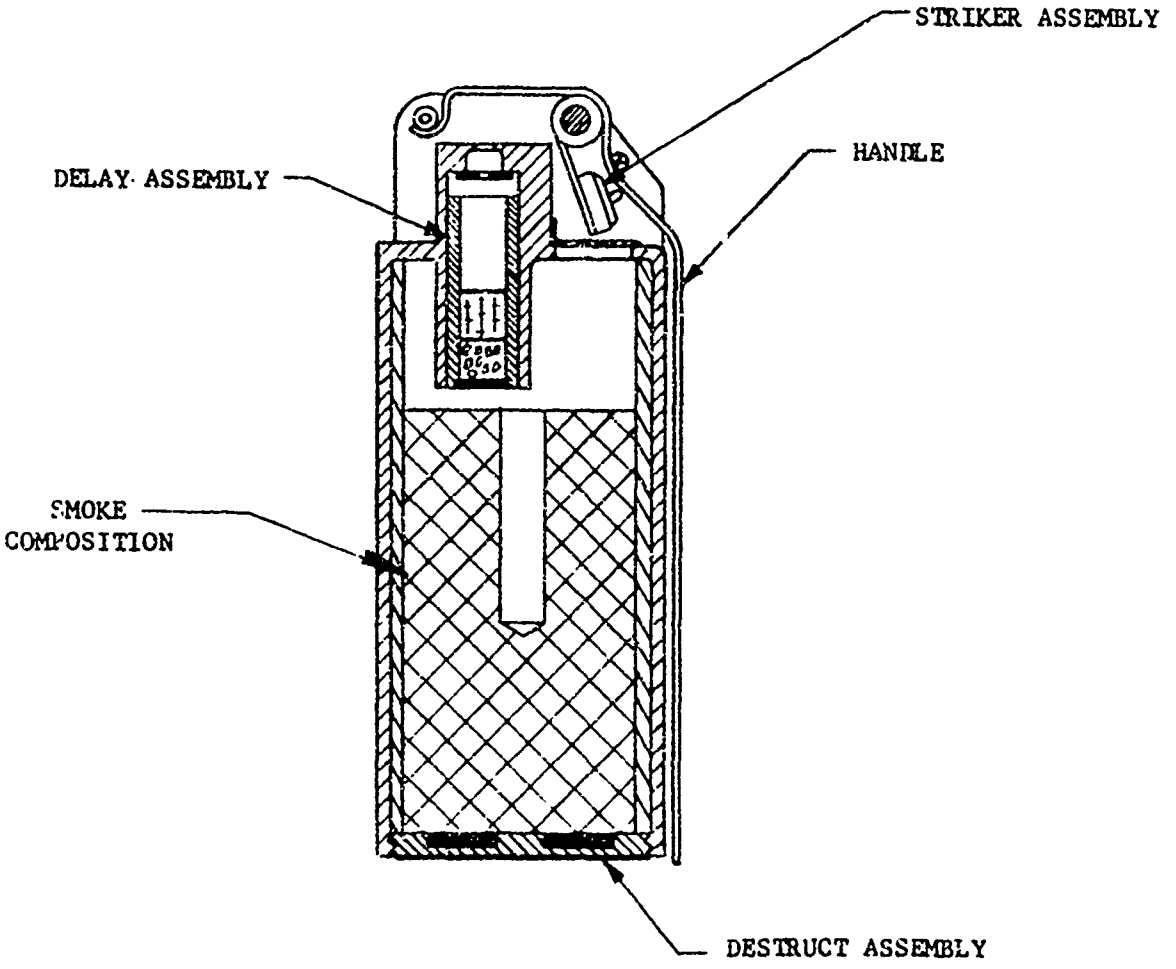


Figure 1. Consumable "Midi" Smoke Grenade.

DEVELOPMENT

The smoke grenade developed under this contract consisted of a molded plastic container into which the fuze elements and a smoke cartridge were assembled. Two types of plastic material were used initially to determine if either was suitable for the grenade container. Low density polyethylene was eliminated

because the production process resulted in containers with varying thicknesses. This resulted in distortion of portions of the container and rapid melting at the thin cross-section areas of the container body which caused the smoke cartridge to separate prematurely from the head and fuze section of the grenade. Delrin (acetal homopolymer resin) proved to be a better material both for its molding qualities and its functional capability. Some minor difficulty was experienced with melting and flaming of the material but this problem was resolved by extending the liner of the smoke cartridge to insulate the container wall.

The basic size and function of the consumable midi smoke grenade was modeled after the midi smoke grenade. The grenade size was designed to fit standard 40mm packaging, including bandoleers for convenient carrying by personnel. This size and similarity of function to the midi smoke grenade was maintained during development of the consumable midi smoke grenade. The smoke mix composition was the same as in the midi grenade.

The initial consumable design consisted of a molded Delrin container into which the fuze elements and a smoke cartridge were assembled. Upon ignition the smoke erupted through two cored holes in the grenade head. Resulting heat during smoke emission caused extensive damage to the grenade body but only moderate damage to the head and fuze area. This was not satisfactory because it was desirable for the major destruction to occur in the head or fuze area to prevent possible reuse of these components by the enemy as a "booby trap". Total destruction of the grenade container was achieved occasionally when sufficient heat was generated during smoke emission to cause combustion of the plastic; however, this presented another problem. Flame is undesirable during smoke emission as this can result in production of only black smoke and fire. To prevent combustion of the plastic during smoke emission, an insulating ring was assembled in the head of the grenade. This was subsequently added as an extension of the smoke cartridge liner. This solution to the problem made it necessary to design a destruct sequence which would ignite after smoke emission and cause combustion of the container.

To obtain combusion of the container at the proper time, a flame-producing pyrotechnic composition was added to the base plug, Figure 2.

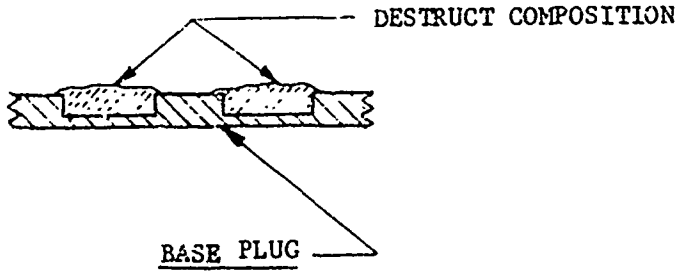


Figure 2.

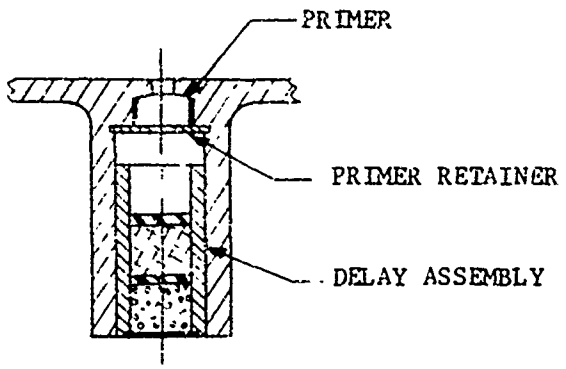
The location of this pyrotechnic destruct mechanism permitted complete consumption of the smoke composition before the destruct material could ignite.

The destruct composition was added to the base plug in paste form and dried prior to assembly in the grenade body. The pyrotechnic paste composition was blended using the following materials and quantities:

	Material	% By Weight
Dry Mix	Magnesium	80
	Class 7 black powder	20
Binder	Butyl acetate	90
	Nitrocellulose	10

Dry mix and binder are then mixed to a thick paste of approximately 85% dry mix to 15% binder. Numerous tests were conducted to ascertain reliability of the destruct concept and there were no failures which could be attributed to malfunction of the destruct system.

The delay and ignition components of the grenade were designed for assembly into a molded cavity in the grenade body. Initially, the delay tube containing the delay element, the smoke ignition composition, and the primer holder were assembled through the top of the grenade. This design functioned satisfactorily, but ignition problems were encountered periodically when back pressure in the delay tube caused the primer to be ejected from the holder. Consequent loss of pressure caused ignition failure at the smoke composition/ignition mix interface. Modification of the molded delay cavity and elimination of the primer holder resolved the primer ejection problem and increased the reliability of the ignition system. This design, Figure 3, was incorporated into the consumable midi grenades which were delivered for evaluation.



FINAL DELAY AND IGNITION DESIGN

Figure 3.

One-hundred "Consumable" Midi Smoke Grenades consisting of twenty-five each of green, red, yellow and violet smoke were to be manufactured and, during the test and acceptance phase, no problems were encountered with the ignition and destruct mechanism of the grenades. Unforeseen difficulty did arise as a number of grenades flamed during the tests. Various changes were made in the compacting procedure of the smoke composition and ignition mix which resulted in decreasing the percentage of flaming in all colors except yellow. Since the most important aspect of this program was the manufacture and delivery of a "consumable" grenade, and time did not permit a full investigation of the problem, it was decided to stop work on the yellow smoke grenade and deliver one-hundred grenades made up of the other three colors. Satisfactory results obtained during the acceptance tests of the red, violet and green smoke grenades permitted the completion of assembly and subsequent delivery of the one-hundred "Consumable" Midi Smoke Grenades as required.

SUMMARY OF TEST RESULTS

A total of seventy Consumable Midi Smoke Grenades were tested during the course of development. Since many tests were conducted in the development of a mechanical design or some function other than destruct capability, a tabulation of burn times, smoke quality, and percent destruct on each test is not available.

It is important, however, to note that of the last forty-five tests conducted, not one failure of the destruct sequence was recorded and total destruct was achieved in every test. With adjustments to core depth in the smoke cartridge, smoke quality and volume were satisfactory and consistent in all colors except yellow.

In the LWL evaluation of the delivered items, every grenade which was tested consumed satisfactorily.

RECOMMENDATIONS

To reduce the cost of grenade manufacture, it is suggested that further development be directed toward an epoxy-based delay housed in a consumable plastic sleeve to replace the current delay pressed into a steel tube.

The cause of the flaming problem with the yellow smoke grenade should be investigated and corrected.