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AUTHORITY

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TECHNICAL MEMORANDUM NO. 71-03

AMBUSH LIGHT (PYROTECHNIC)

By

Joseph N. Ruff
Munitions Branch

August 1971

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U.S. ARMY LAND WARFARE LABORATORY
Aberdeen Proving Ground, Maryland 21005
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U. S. ARMY LAND WARFARE LABORATORY

Aberdeen Proving Ground, Maryland  21005
ABSTRACT

This memorandum summarizes the development of a pyrotechnic ambush light by the U. S. Army Land Warfare Laboratory. The light was developed to provide ambush teams with the capability for on-command, instant lighting of kill zones.
FOREWORD

The need for a small, lightweight, portable light source for illumination of ambush kill zones has been recognized by combat units engaged in night ambush operations.

Under LWL Task 02-F-70, a pyrotechnic ambush light was developed and tested, and two hundred units were shipped to Vietnam for evaluation.

Development work and fabrication of the RVN evaluation quantity was accomplished by MRC Corporation under Work Assignments 16 and 19 of Support of Research and Development of Munitions Contract DAAD05-68-C-0253.
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<tr>
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<td>5</td>
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</table>
INTRODUCTION

Combat troops engaged in night ambush operations have a requirement for a small, lightweight, portable, easily deployed, disposable light source capable of providing instant light in conjunction with the initiation of the ambush.

One of the essential requirements for a successful ambush is the element of complete surprise. During night ambushes, success is enhanced if the surprise element is combined with simultaneous illumination of the kill zone to permit the troops initiating the ambush to effectively use individual point fire weapons in conjunction with preplaced, fixed-area-of-coverage mines generally used.

The inherent characteristics of the pyrotechnic type light indicate that it will satisfy ambush team requirements.

CONCLUSIONS

The Ambush Light (Pyrotechnic) is a safe, reliable item having successfully passed the Design Engineering (Safety Evaluation) Tests conducted by the Materiel Test Directorate of the U. S. Army Test and Evaluation Command.

The suitability and acceptability of the ambush light for combat operations will be determined after completion of the scheduled RVN evaluation.

GENERAL DESCRIPTION

The Ambush Light, Figure 1, is an electrically initiated pyrotechnic device intended for the illumination of ambush kill zones. The light source is a high-intensity pyrotechnic illumination candle contained in a collapsible, disposable, conical-shaped shield. A means of mounting the device on trees or bushes is incorporated in the design. The device is initiated by the M57 Electrical Firing Device (M18A1 APERS Mine Firing Device) through 100 feet of firing lead wire; full illumination is attained in approximately one-half second after actuation of the firing device. One minute of illumination at 125,000 candlepower is provided. When set up for use, the device is 14 inches long and 12 inches in diameter. Each Ambush Light is packed in a carrying case which may be carried by hand or slung over the shoulder. Total weight of the device, including firing device, lead wire, and carrying case, is 4-1/2 pounds. The device consists of three main components, a light shield assembly, illumination assembly, and the firing device with lead wire.
DESCRIPTION OF COMPONENTS

1. **Light Shield Assembly**

The Light Shield, Figure 2, is made of 40 mil aluminum-foil-faced asbestos cloth supported by five 1/8-inch diameter ribs which are hinged to a shield tube. The shield ribs are formed in a manner that provides a camming action which drives the ribs into the erect position when the illumination assembly is inserted into the shield tube.

2. **Illumination Assembly**

The Illumination Assembly, Figure 2, consists of two M127AI Signal, Ground, White Star Candles, which are arranged to burn sequentially, and an Atlas M100 Electric Match. The candle is spring-loaded in a tube to provide a constant flame front in relation to the light shield as the candle length decreases during the burn. A firing lead connector with shunting cover attached is located at the rear of the assembly. An integral mounting screw is provided to expedite mounting of the light on trees, bushes, etc.

3. **Firing Device and Lead Wire**

The M57 Electrical Firing Device (M18Al APERS Mine Firing Device), Figure 2, is used to initiate the Ambush Light. One hundred feet of firing lead wire, equipped with a shunted plug at each end, Figure 2, is provided.

SEQUENCE OF DEVELOPMENT

When LWL Task 02-F-70, Ambush Light (Pyrotechnic) was established, the intent was to use a candle being developed for Task 10-F-69, Bright Light Mob Dispersal (RC). However, after the Bright Light Candle was developed, comparison tests using this candle and other less expensive off-the-shelf candles were conducted. These comparison tests resulted in the decision to use the Signal, Ground, White Star, M127AI Candle. Two of these candles would be arranged to burn sequentially to provide a burn time of one minute.

Work Assignment 16 of Support of Research and Development of Munitions Contract DAAD05-68-C-0253 with MRC Corporation, Baltimore, Maryland, was initiated to develop the Ambush Light and produce 100 units for Engineering Testing (Safety Evaluation). Work Assignment 19, for fabrication of 200 units for RVN evaluation, was initiated prior to completion of the 100 units for Safety Evaluation so that manufacture of certain basic components could be expedited. When these basic components were fabricated, work was halted pending completion of Safety Evaluation Testing.

Upon completion of the 100 test units, an Engineering Design (Safety Evaluation) Test was conducted by USATECOM. The report of this test is contained in Appendix A. The testing proved the Ambush Light to be safe to handle,
transport and use, but a high malfunction rate was noted. Consequently, design modifications addressing the malfunction problem were made. These modifications consisted of changing the ignition mix formulation and providing for more rapid venting of the candle on ignition.

Sixty-six single candle units incorporating the corrective design modifications were fabricated and tested by MRC Corporation. All the units functioned properly during these tests. See Appendix B.

The USATECOM tests and the Instruction Manual were reviewed by the USALWL Safety Statement Committee and the USALWL Safety Statement was issued. See Appendix C.

Fabrication of the 200 RVN evaluation units, incorporating the corrective design changes, was continued to completion. These 200 units, along with the Instruction Manual, Appendix D, were shipped to RVN in June 1971.
Figure 2. AMBUSH LIGHT (PYROTECHNIC) COMPONENTS
SUBJECT: Final Letter Report of Engineer Design Test of Ambush Light (Pyrotechnic), USATECOM Project No. 8-MU-009-PAL-001
SUBJECT: Final Letter Report of Engineer Design Test of Ambush Light (Pyrotechnic), USACRiCOM Project No. 8-MU-306-PAL-001

to be mounted on trees or brush. The initiation system consists of an M57 electrical firing device and 100 feet of firing lead wire (Claymore mine type). The illumination assembly is stowed inside the collapsed light shield during shipment and storage prior to use. The ambush lights, in individual waterproof packages, are packaged two per standard M2A1 ammunition can. The ambush light is assembled by removing the illumination assembly from the collapsed light shield and inserting the front of the illumination assembly into the rear of the light shield. The assembled light can then be mounted on a tree or bush by the integral mounting screw. The lead wire plugs into the candle assembly which is functioned by the M57 firing device.

c. The purpose of this test was primarily to evaluate the safety aspects of the Ambush Light. Testing consisted of a rough handling test, 40-foot drop, bullet impact test, and a control firing. The test was conducted during the period 30 November 1970 through 29 January 1971.

3. OBJECTIVE;

The test objective was to provide the USALWL with a safety evaluation and limited operational data for the test item.

4. SUMMARY OF RESULTS:

a. Rough Handling Test - Thirty-two ambush lights were subjected to a rough handling test as illustrated in the flow chart, Figure 2, Inclosure 2. The test was conducted in accordance with MTP 4-2-602. No obvious damage occurred that could affect the functional performance of the ambush light.

b. Forty-Foot Drop Test - Four boxes, each containing four ambush lights, were subjected to a 40-foot drop test in accordance with MTP 4-2-601. The post-drop inspection revealed no indication of functioning. The lights were destroyed after test.

c. Bullet Impact Test - Five M2A1 cans, each containing two ambush lights, were impacted by 7.62mm projectiles from a distance of 100 feet. Three cans were impacted by M62 tracer projectiles and two cans by M60 ball projectiles. Two lights in individual waterproof carrying cases were impacted by M62 tracers. The eight ambush lights impacted by M62 tracer rounds ignited (Figures 3 and 4, Inclosure 2). The lid of one
M2A1 can was expelled 20 feet (Figure 5, Inclosure 2). The M80 ball projectiles did not ignite the ambush lights (Figure 6, Inclosure 2).

d. Functional Performance Test - Sixty-four ambush lights were assembled and functioned according to the instruction manual provided by the USAWL. Time from actuation of the M57 firing device to candle ignition, total burn time, general condition of the light after burnout, and other data that were pertinent to the handling and use of the light were recorded.

For test purposes the ambush lights were mounted on a wooden sawhorse by the integral mounting screw; several lights were also mounted on trees and telephone poles to check the effectiveness of the screw.

Eighteen of the lights were duds; 11 of 32 from the rough handling test and 7 of 32 untested. One dud was caused by an electric initiator failure; on all the others, the initiator functioned, but the candle failed to ignite.

The average burning time for the 46 lights which functioned was 56.5 seconds; the range of times was from 50.05 seconds to 65.80 seconds. For practical purposes, the candles ignited instantaneously; the average measured delay time was 0.35 second.

The ambush lights were easily mounted on the trees and telephone poles by the integral mounting screw.

The round-by-round results are listed in tables 1 and 2 of Inclosure 1.

5. CONCLUSIONS:

It is concluded that:

a. The ambush light can safely withstand the shocks and vibrations of rough handling.

b. The sensitivity of the ambush light to bullet impact is a fire hazard.

6. RECOMMENDATION:

It is recommended that the ambush light be considered safe to handle, transport, and fire with the following limitations:
STEAP-MT-TI

SUBJECT: Final Letter Report of Engineer Design Test of Ambush Light (Pyrotechnic), USATCOM Project No. 8-MU-009-PAL-001

a. The user be informed of the potential hazards resulting from bullet impact of the ambush light.

b. The instruction manual for the ambush light be available for the user.

FOR THE COMMANDER:

L. R. P. WITT

2 Incl

1. Round-by-Round Data Tables
   Associate Director
2. Photographs and Figures
   Materiel Testing Directorate

CF:
CG, USATCOM, ATTN: AMSTE-BC (2 cys)
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<th>General Condition at Burnout</th>
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<td>Light shield split at seam</td>
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</tr>
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<td>57.75</td>
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</tr>
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<td>First fire ignited, but candles did not burn; also, light shield split at seam</td>
<td>7 and 10</td>
</tr>
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<td>57.65</td>
<td>Normal</td>
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<td>Dud</td>
<td>58.15</td>
<td>First fire ignited, but candles did not burn; also, light shield split at seam</td>
<td>7 and 10</td>
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<tr>
<td>32</td>
<td>DEF</td>
<td>Dud</td>
<td>58.15</td>
<td>Normal</td>
<td>11</td>
</tr>
</tbody>
</table>
Footnotes:

Phases of the rough handling test to which the lights had been subjected before the functioning.

A - 7-foot packaged drop test at -50°F
B - Bounce test at -50°F
C - 5-foot unpackaged drop test at -50°F
D - 7-foot packaged drop test at +145°F
E - Bounce test at +145°F
F - 5-foot unpackaged drop test at +145°F.

NOTE: Date of test, 12 Jan 1971
Average temperature, 45°F
Average wind velocity, 12 mph with gusts to 25 mph.
<table>
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<th>No</th>
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<th>General Condition after Burnout and/or Remarks</th>
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<td>57.25</td>
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<tr>
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<td>Dud</td>
<td>57.25</td>
<td>First fire ignited, but candles did not burn; also, light shield folded back.</td>
</tr>
<tr>
<td>3</td>
<td>Dud</td>
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<tr>
<td>7</td>
<td>Dud</td>
<td>58.40</td>
<td>First fire ignited and a small flame was noticeable for 96 seconds, but the candle did not ignite.</td>
</tr>
<tr>
<td>8</td>
<td>.28</td>
<td>61.50</td>
<td>Normal</td>
</tr>
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<td>62.60</td>
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<td>10</td>
<td>.29</td>
<td>65.80</td>
<td>Normal</td>
</tr>
<tr>
<td>11</td>
<td>.26</td>
<td>58.40</td>
<td>Light shield split at seam and part of a candle fell on the ground while burning.</td>
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<td>Dud</td>
<td>61.50</td>
<td>First fire ignited, but candles did not burn.</td>
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<td>61.40</td>
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<tr>
<td>18</td>
<td>.27</td>
<td>56.85</td>
<td>Light shield split at seam.</td>
</tr>
<tr>
<td>19</td>
<td>.27</td>
<td>63.40</td>
<td>First fire ignited, but candles did not burn; also, light shield folded back.</td>
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<td>50.05</td>
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<td>First fire ignited, but candles did not burn; also, light shield folded back.</td>
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<td>63.40</td>
<td>Normal</td>
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<tr>
<td>24</td>
<td>Dud</td>
<td>54.00</td>
<td>Normal</td>
</tr>
<tr>
<td>25</td>
<td>The first candle lit, but was expelled 87 feet from the setup; the second candle did not ignite and remained in the item.</td>
<td></td>
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TABLE II - ROUND-BY-ROUND FUNCTIONING DATA FOR PREVIOUSLY-REVIEWED ITEM

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<th>Rd. No.</th>
<th>Ignition Delay Time, second</th>
<th>Total Burn Time, seconds</th>
<th>General Condition after Burnout and/or Remarks</th>
<th>Photo Figure Number, Inc.</th>
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<td>64.80</td>
<td>Normal</td>
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**NOTE:** Date of test, 13 Jan 1971
Average temperature, 22°F
Average wind velocity, 5 mph with gusts to 10 mph.
Figure 2: Rough Handling Outline
Figure 1: The ambulance light.
Figure 4: Result of 7.62mm Bullet Impact by MG2 Tracer.
Figure 6: Result of 7.62mm Bullet Impact by M80 Ball.
Figure 7: Typical round in which fire charge ignited, but candles did not burn.
Figure 8: First fire charge ignited, but candles did not burn.
### APPENDIX B

**TABLE 1**

**AMBUSH LIGHT - RELIABILITY TEST RESULTS**

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<th>UNIT NO.</th>
<th>DATE TESTED</th>
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* Failed to ignite on first try due to a faulty connector - Successful ignition obtained after connector pin was replaced.

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* Failed to ignite on first try due to faulty connector. By checking line resistance while "giggling" the connector, it was possible to obtain a satisfactory circuit - both units functioned properly once the open circuit was alleviated.

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CRDLWL - 8

SUBJECT: Safety Statement

The United States Army Land Warfare Laboratory, Aberdeen Proving Ground, Maryland, hereby certifies that the item described below meets the Safety Statement requirements in consonance with the Laboratory's mission and is hereby released for test purposes to other than LWL personnel. The issuance of this Statement does not preclude the use of good judgment and judicious use of all standard safety procedures outlined in the Instruction Manual for Ambush Light (Pyrotechnic) and other appropriate safety regulations.

(Item) Ambush Light (Pyrotechnic)

Description

The Ambush Light (Pyrotechnic) is an electrically initiated pyrotechnic device. The light is contained in a collapsible and disposable conical shaped light shield and incorporates a means for mounting on trees or bushes. The light is initiated by the M57 firing device (M18A1 APERS Mine Firing Device) through 100 feet of firing lead wire; full illumination is attained approximately one-half second after actuation of the firing device. When set up for use, the light is approximately 14 inches long and 12 inches in diameter. The light consists of three main components, a light shield assembly, illumination assembly, and an initiation system.

RICHARD L. CLARKSON
Colonel, GS
Commanding
APPENDIX D

INSTRUCTION MANUAL
FOR
AMBUSH LIGHT (PYROTECHNIC)

November 1970

U.S. ARMY LAND WARFARE LABORATORY
Aberdeen Proving Ground, Maryland 21005
EVALUATION QUESTIONNAIRE
(Ambush Light (Pyrotechnic))

U. S. Army Land Warfare Laboratory
Aberdeen Proving Ground, Maryland 21005

1. Was the unit damaged in shipment?
   Yes  No
   Remarks:

2. Is Instruction Manual complete and easy to understand?
   Yes  No
   Remarks:

3. Was the light easy to carry?
   Yes  No
   Remarks:

4. Was the light carried to the site in the carrying case?
   Yes  No
   If no, why not:

5. Was any difficulty encountered during assembly and mounting of the light?
   Yes  No
   Remarks:

6. Did any precipitation occur during the time light was set up for use?
   Yes  No
   If yes, number of hours of precipitation:
   Precipitation intensity: Light  Moderate  Heavy

7. Did light function properly?
   Yes  No
   Remarks:

8. Was light output adequate for mission accomplishment?
   Yes  No
   Remarks:

9. Did the smoke from the burning light create a problem?
   Yes  No
   Remarks:

10. For what period of time was illumination required?

11. If illumination was required for more than one minute, was any difficulty experienced in maintaining continuous light?
    Yes  No
    Remarks:

12. If light malfunctioned, explain:

13. Your comments or suggestions regarding the light's usefulness and desirability:
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<td>Installing Illumination Assembly in Shield Tube</td>
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CHAPTER 1
PURPOSE AND SCOPE

1. PURPOSE

This manual contains the operating instructions for the Ambush Light (Pyrotechnic). It is to be used by all personnel using the Ambush Light.

2. SCOPE

a. Chapter 2, Description, supplies a description of the Ambush Light, its packaging, and general data.

b. Chapter 3, Assembly, Installation and Operation, contains assembly procedures and installation and operation instructions.

c. Chapter 4, Safety Precautions, contains the safety precautions to be observed when using the Ambush Light.

3. REPORTS

Suggestions for improvement of the design of the Ambush Light should be transmitted through proper channels to the Commanding Officer, U. S. Army Land Warfare Laboratory, Aberdeen Proving Ground, Maryland 21005.

CHAPTER 2
DESCRIPTION

4. GENERAL DESCRIPTION

The Ambush Light, Figure 1, is an electrically initiated pyrotechnic device designed for the illumination of ambush kill zones. The light is contained in a collapsible and disposable conical-shaped light shield and incorporates a means for mounting on trees or bushes. The light is initiated by the M57 firing device (M18A1 APECS Mine Firing Device) through 100 feet of firing lead wire; full illumination is attained approximately one-half second after actuation of the firing device. When set up for use, the light is approximately 14 inches long and 12 inches in diameter. The light consists of three main components, a light shield assembly, illumination assembly, and an initiation system.

5. DETAILED DESCRIPTION

a. Light Shield Assembly

The Light Shield, Figure 2, is made of heat-resistant cloth supported by five ribs which are hinged to a shield tube. The shield ribs are formed in a manner
Figure 1. Ambush Light (Pyrotechnic)

Figure 2. Ambush Light Components
that provides a camming action which
drives the ribs into the erect position
when the illumination assembly is inserted
into the shield tube.

b. Illumination Assembly

The Illumination Assembly, Figure 2,
consists of a pyrotechnic candle and an
electrical initiator. The candle is spring-
loaded in a tube to provide a constant flame
front in relation to the light shield as
the candle length decreases during the burn.
A firing lead connector with shunting cover
attached is located at the rear of the
assembly. An integral mounting screw is
provided to expedite mounting of the light
on trees, bushes, etc.

c. Initiation System

The Initiation System, Figure 2, consists
of an M57 electrical firing device and 100
feet of firing lead wire.

6. PACKAGING

Each light, complete with firing lead wire
and M57 firing device, is individually
packaged in a water-resistant carrying case,
Figure 3, which is equipped with an adjust-
able strap that permits the light to be
carried in the hand or slung over the
shoulder. Before insertion in the carrying
case, the illumination assembly, surrounded by the folded light shield assembly, is sealed in a vapor barrier bag and the initiation system is placed in a polystyrene half nest container. Two complete lights are packed per M2A1 Metal Ammunition Can, and two ammunition cans are overpacked with a wire-bound wooden box.

NOTE: The lights are to remain in the metal ammunition cans during storage prior to deployment.

7. GENERAL DATA

   a. Weight (including carrying case): 4-1/2 pounds.

   b. Size (carrying case): 2-3/4" X 6-3/4" X 11".

   c. Size (set up for use): 14" long X 12" diameter.

   d. Light Output: 125,000 candlepower.

   e. Burn Time: 1 minute.

   f. Initiation Time (to full illumination): approximately .5 seconds.

CHAPTER 3

ASSEMBLY, INSTALLATION AND OPERATION

8. ASSEMBLY

   a. Remove the Carrying Case from the metal ammunition can (this would normally be performed prior to the start of a tactical operation, but if the units are to be cached, they should not be removed from the metal cans until just prior to use).

   b. Remove the light components from the carrying case.

   c. Remove the vapor barrier bag from the light shield/illumination assembly.

   d. Remove the firing device and lead wire from the polystyrene half nest container.

   e. Grasp unit in one hand near base of the shield tube, Figure 4.

   f. Hold unit in vertical position with forward end of shield up and with the other hand grasp the ends of the shield ribs and in succession pivot open the ribs fully, Figure 5.

   g. While holding the unit in the vertical position, grasp the illumination assembly near the base and remove it from the shield tube, Figure 6.
h. Inspect components for damage.
If the illumination assembly tube is
damaged (dented) or the end seal is not
intact, discard the unit. If the mount-
ing screw or the light shield ribs are
bent or become bent during assembly or
installation, simply grasp in the hands
and reshape.

i. Rotate the shield assembly to the
horizontal position and insert the front
of the illumination assembly into the rear
of the shield tube, being careful to align
the key on the illumination assembly with
the key slot in the shield tube, Figure 7.
Insert illumination assembly into the
shield tube until the illumination assembly
key contacts the end of the shield assembly
key slot. When the illumination assembly
is fully seated, its front face will extend
approximately 3/4 inch past the front face
of the shield tube.

NOTE: If the light shield assembly ribs
are not fully extended, it will be difficult
to insert the illumination assembly into
the shield tube without the use of undue
additional force.

9. INSTALLATION

Although conditions at the employment site
will dictate the installation method, it
is recommended that the integral mounting
screw provided be used whenever possible to attach the light to an opportune tree or bush. If the tree or bush selected is not large enough to accommodate the mounting screw, the strap from the carrying case may be used to lash the light to the smaller branches. If it is desired or necessary to mount the light on the ground, several small stakes or rocks may be used to hold the light in the desired position.

When an illumination period of more than one minute is required or a backup system is desired, place additional lights as required. To insure adequate lighting of the zone of action, the lights should be placed within a radius of 50 meters of the center of the zone.

a. Point the assembled light toward the center of the zone of action, grasp the base of the shield tube and rotate clockwise to engage the screw in the tree or bush selected.

b. Remove the shunting/dust cover from the illumination assembly firing lead connector.

c. Remove the dust cover from one end of the firing lead wire and plug wire into the illumination assembly connector.

d. Unspool the firing lead wire while proceeding to the command position.
e. Place M57 firing device safety bail in safe position, Figure 8, and remove connector dust cover.

f. Remove firing lead wire dust cover and plug wire into firing device.

10. **OPERATION**

   a. Place the firing device safety bail in the armed position.

   b. Squeeze firing device actuating handle sharply to initiate light.

   c. When an illumination period of more than one minute is desired, initiate additional lights in sequence as required.
CHAPTER 4

SAFETY PRECAUTIONS

Although the Ambush Light is relatively safe during handling and operation, it must be remembered that pyrotechnic material is hazardous. Because pyrotechnics are easily initiated, they are more dangerous than many types of ammunition.

da. A small arms bullet impact will normally ignite this device.

b. Ensure that friendly personnel are a minimum of 15 meters from the front of the light during initiation (burning ignition mix particles and a plastic ignition mix container are projected 2 to 4 meters forward).

c. If a light fails to initiate, wait three (3) minutes; then dispose of the light in accordance with existing procedures for disposal of pyrotechnics.

d. Unit should not be hand-held during burning.

e. Dispose of damaged components in accordance with EOD procedure (reference paragraph 8.h).

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**Ambush Light (Pyrotechnic)**

This report summarizes the development of a pyrotechnic ambush light by the U. S. Army Land Warfare Laboratory. The light was developed to provide ambush teams with the capability for on-command instant lighting of kill zones.