High Speed Digital Infrared Imaging of the M201A1 Grenade Fuze Initiation Train
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Presentation Outline

• Background
  – M201A1 Pyrotechnic Delay Hand Grenade Fuze Description

• Approach
  – Digital IR Camera Description
  – Test Setup

• Test Results
  – Data Reduction Methodology

• Summary and Conclusions
**M201A1 Fuze Description**

- The M201A1 Fuze is used on a number of hand grenades including:
  - M18 Colored Smoke
  - AN-M14 Incendiary Thermite (TH-3)
  - AN-M8 HC (Hexachloroethane) Smoke
  - M73A CS Riot Control
  - M83 TA Practice (Teraphthalic Acid) Smoke
- Failures of these grenades to function are often attributed to M201A1 Fuze misfire
M201A1 Fuze Description

- Contains three stage initiation train:
  - Primer
  - Delay Column
  - Ignition Charge

- Functional Sequence
  - Remove of Safety Pin
  - Release of Safety Lever
  - Spring loaded striker impacts Percussion Primer
  - Delay Column initiated (2 sec delay)
  - Ignition Charge fires
Approach

• Typical thermal output assessment tools
  – Disassembly and dissection of energetics
  – Bomb Calorimetry
  – DSC (Differential Scanning Calorimetry)
  – TGA (Thermal Gravimetric Analysis)

• Approach
  – Measure thermal output of fuze initiation train without disassembly
  – Perform high speed IR imaging of surface of fuze body
  – Quantify surface temperature profile during function
Digital IR Camera Description

- FLIR Systems Thermovision SC4000 InSb Camera System
  - Wavelength: 3.0-5.0 µm
  - Resolution: 320 x 256 Pixels
  - Full Frame Rate: 420 Hz
  - Sensor Cooling: Stirling Closed Cycle
  - Lens: 100 mm InSb lens, f/2.3
  - Sensitivity: 0.018 ºC
  - Thermovision ExaminIR MAX Software

- Sub-Windowing allowed higher effective frame rate
  - Max frame rate used in test: 160 x 128 pixel frame @ 1324 fps
**Test Setup**

- Test Fixture Design
  - Rigid mount allowed viewing of the fuze body during function
  - Pneumatic actuator to remove safety pin
Test Setup

• Test Layout
  – High speed digital IR Camera System Positioned to allow fuze body to fill the field of view
Test Results

• Pyrotechnic Reaction Sequence – “Good Fuze”
Test Results

• Pyrotechnic Reaction Sequence – Misfire
Comparative High Speed Video Images

QE 365, Manufactured in 2000

QE 429, Manufactured in 1968
Data Reduction Methodology

Fuze Lot MEI85E001-005, QE #396
(approximately 24 years old at time of test)

Fuze Lot NYI-1633-12, QE #3
(approximately 47 years old at time of test)
Example Temperature Profiles
Summary and Conclusions

• High Speed Digital IR Camera Systems are effective in quantifying thermal output of pyrotechnic initiation trains

• Technique may be utilized on other pyrotechnic type items