Integration of a 40x46mm Grenade Proximity Fuze into a 30x113mm M789 (HEDP)
Outline

• Applications & Requirements
• Design Challenges
• Initial Design
• Design Analysis
• Final Prototype Design
• Testing & Results
• Summary and Future Plans
Application & Requirements

Application:

- M230 Gun on the Apache Helicopter
  - Increased Lethality Against Targets on Sand/Soft Earth

Requirements:

- Utilize a Current Low Velocity 40mm Grenade Circuit
- Flight Characteristics
  - Ballistic Match to M789 HEDP
- Fuze Requirements
  - Height of Burst (HOB)
  - Retain M759 Mechanical Safe & Arm
  - Maintain M759 All/No-Arm Distances

Direct Drop-in Addition to the LW30 Ammunition Family with HOB Capabilities
Design Challenges

More Strenuous Firing Environment:

• Higher Muzzle Velocity
• Higher Spin Rate
• Higher Setback Forces

<table>
<thead>
<tr>
<th></th>
<th>40x46mm Grenade</th>
<th>30x113mm Proximity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muzzle Velocity</td>
<td>76 mps</td>
<td>805 mps</td>
</tr>
<tr>
<td>Spin Rate</td>
<td>60 rps</td>
<td>975 rps</td>
</tr>
<tr>
<td>Setback Forces</td>
<td>14,000 G</td>
<td>100,000 G</td>
</tr>
</tbody>
</table>

Smaller Packaging Volume:

• Proximity Fuze Components Located Above the Line

Explosive Train Initiation Method:

• Electronic Initiation of a Mechanical Explosive Train

More Strenuous Operating Environment.

http://www.inetres.com/gp/military/infantry/grenade/40mm_ammo.html
http://www.inetres.com/gp/military/infantry/grenade/M203.html
Initial Design

Original Integration of a LW30 Proximity Fuze.
ANSYS Finite Element Analysis at Setback.

Inputs:

- **Material**: Minimum High Strength Aluminum Properties
- **Detonator Mass**: Twice the Expected Mass
- **Acceleration**: 100,000 G

Results:

- Fracture not Anticipated
- Safety Factor of Greater Than 2

Analysis Indicated Initial Design Would Survive LW30 Setback Force.
Design Analysis - Spin

ABAQUS Finite Element Analysis of Spin

Inputs:

- **Fuze Component Mass**: Worst Case Mass From Drawing Requirements
- **Spin**: M230 Spin vs. Time Profile
- **Loading**: Frictionless, so the Pins Take the Entire Spin Load
- **Initial Pin Diameter**: 0.050 inches

Results:

- **Aluminum Pins Would Fail**
- **Steel Pins Borderline Survive**
  - Safety Factor of About 1.5

Analysis Indicated Ø0.050 in Steel Pins were Marginal for Surviving Spin.
Final Prototype Design

Improved Producibility and Survivability.

- 2 Piece Assembly Frame
- No Radome
- Aluminum Cap
- 4 Thicker Support Pins
Electric Detonator Test 1:

- Tested Four Different Detonator Configurations.
  - 3 Manufacturers
  - 3 Different Output Strengths
- All Configurations Passed In-Line Function and Out-of-Line Safe Testing.

Electric Detonator Test 2:

- Tested a Single Optimized Detonator Configuration.
  - Smallest Size
  - Middle Output Strength
    - Provides Margin
      - Safety
      - Function
- Passed In-Line Function and Out-of-Line Safe Testing.
Soft Catch Testing:

- Inert Test Fuzes
- 500m Test from a MANN Barrel
- All Fuzes Survived Ballistic Environment
- Most were Powered up by 500m Target

Verified Fuze Survivability.
Summary:

• Successfully Packaged a 40mm Prox Fuze Circuit into a LW30 Fuze

• Improved the Design to Survive Ballistic Environment
  – Successfully Shown the Electronics Survive the Ballistic Environment and the Circuits Function in Flight

• Identified an Electric Initiation Method for the Explosive Train

Proof Of Concept Demonstrated with Room for Improvement.

Future Plans:

• Decreasing Battery Ramp Up Time

• Improving the Antenna Pattern

• Modifying the Design for Producibility

• Continuing in the Next Series of Testing
  – Live Fire HOB Testing
  – Environment and Drop Testing
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