U.S. Army Research, Development and Engineering Command

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

U.S. Forces Light and Medium Mortar Ammunition Insensitive Munitions Path

Nickolas Baldwin
• United States Code, Title 10, Chapter 141, Section 2389. Ensuring safety regarding insensitive munitions:
  – The Secretary of Defense shall ensure, to the extent practicable, that insensitive munitions under development or procurement are safe throughout development and fielding when subject to unplanned stimuli.

• Department of Defense Directive 5000.01, Enclosure 1 (Additional Policy)
  – E1.1.23. Safety. Safety shall be addressed throughout the acquisition process. Safety considerations include human (includes human/system interfaces), toxic/hazardous materials and substances, production/manufacturing, testing, facilities, logistical support, weapons, and munitions/explosives. All systems containing energetics shall comply with insensitive munitions criteria.
60mm Baseline Configurations

Item Nomenclature
Cartridge, 60mm: HE, M720A1/M768

- M734A1 Multi-option Fuze (M720A1)
- M783 PD/DLY Fuze (M768)
- PAX-21 Explosive
- HF-1 Steel Body
- M27 Fin Assembly
- Plastic Ring Support
- Obturator
- M235 Propelling Charge

TC: OCT 01  MR: APR 06

Item Nomenclature
Cartridge, 60mm: HE, M888

- M935 PD Fuze
- M204 Propelling Charge
- M7 Fin Assembly
- Projectile Body
- Oburator
- M702 Ignition Cartridge

M720A1/M768 Baseline IM Performance

<table>
<thead>
<tr>
<th>Configuration Item</th>
<th>M720</th>
<th>M720A1/M768</th>
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<tbody>
<tr>
<td>Fuze booster material</td>
<td>Comp A-5</td>
<td>PBXN-5</td>
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<tr>
<td>Plastic fuze adapter</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Explosive fill</td>
<td>Comp-B</td>
<td>PAX-21</td>
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<tr>
<td>Projectile body</td>
<td>1340 Steel</td>
<td>HF-1</td>
</tr>
<tr>
<td>Propellant Charge</td>
<td>M204 (flake)</td>
<td>M235 (ball)</td>
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<tr>
<td>Fiber Tube</td>
<td>Short</td>
<td>Long</td>
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<tr>
<td>Orientation</td>
<td>Fuze down</td>
<td>Fuze up</td>
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<table>
<thead>
<tr>
<th>IM Test</th>
<th>FCO</th>
<th>SCO</th>
<th>BI</th>
<th>FI</th>
<th>SD</th>
<th>SCJI</th>
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<tbody>
<tr>
<td>Passing Criteria</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>III</td>
<td>III</td>
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<td>M720 (Baseline)</td>
<td>II</td>
<td>III</td>
<td>V</td>
<td>III</td>
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<td>M720A1/M768</td>
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<td>II</td>
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<td>III</td>
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</table>

Reactions:
- VI: No Sustained Reaction
- V: Burn
- IV: Deflagration
- III: Explosion
- II: Partial Detonation
- I: Detonation
60mm IM Enhanced Design Strategy

60mm IM Path Forward

- **M734A1/M783 Fuze (M720A1 & M768):**
  - Maintain current PBXN-5 lead and booster
- **M935 Fuze (M888):**
  - Replace RDX lead with PBXN-5
  - Replace Comp A-5 booster with PBXW-14
  - Implement scored booster cup
- **Maintain current plastic fuze thread insert**
- **Implement PBXW-14 supplemental charge**
- **Adopt IMX-104 main charge.**
- **Packaging:**
  - Maintain current longer fiber tube (PA189)
  - New metal can over pack (PA191).
  - Package all rounds nose up
60mm Fuze Reliability Testing

M720A1/M768 (M783/M734A1 Fuze):
• Instrumented Detonation Testing
  – 2 rounds @ Ambient
    • IMX-104 main fill
    • PBXN-5 fuze booster
    • Plastic fuze adapter
    • HF-1 shell body

<table>
<thead>
<tr>
<th>Shot # 1</th>
<th>Shot # 2</th>
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<tbody>
<tr>
<td>1</td>
<td>$t_0$</td>
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<tr>
<td>2</td>
<td>3.9222</td>
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<td>3</td>
<td>7.687</td>
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<td>4</td>
<td>11.1248</td>
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<td>5</td>
<td>14.6342</td>
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</table>
60mm Initiation Reliability

Likelihood Ratio Analysis Using Linear Normal Response

Confidence
1.4 1.6 1.8 2.0 2.2
Stimulus (g/cc)
0.001
0.01
0.1
0.5
0.9
0.99
0.999
0.9999

Probability
Ideal
0.500
0.800
0.900
0.950
0.980
0.990

Predicted reliability @ current booster density requirement

Reliability Requirement
• Assessed HF-1 and 1340 Steel with IMX-104 in 60mm.
• Results are promising with cheaper 1340 Steel → cost savings.

<table>
<thead>
<tr>
<th>Range [m]</th>
<th>60mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel - AB</td>
<td>Pit Test Data (1340 / CompB)</td>
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<td>1.00</td>
</tr>
<tr>
<td>1000</td>
<td>1.00</td>
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<tr>
<td>1500</td>
<td>1.00</td>
</tr>
<tr>
<td>2000</td>
<td>1.00</td>
</tr>
<tr>
<td>2500</td>
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<td>1.00</td>
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</table>
**Item Nomenclature**

**Cartridge, 81mm: HE, M889A2/M821A2**

- M220 Propelling Charge
- M299 Ignition Ctg.
- M24 Fin Assembly
- HF-1 Steel Body
- Obturator
- Comp-B Explosive
- M734A1 MOFM (M821A2)
- M783 PD/DLY Fuze (M889A2) - PBXN-5 Booster

**Item Nomenclature**

**Cartridge, 81mm: HE, M889A1 (C869)**

- M935 PD Fuze - Comp A-5 Booster
- M220 Propelling Charge
- M299 Ignition Cartridge
- M24 Fin Assembly
- COMP B Explosive Fill
- HF-1 Steel Projectile Body
- Obturating Ring
- M935 PD Fuze

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**Baseline IM Testing on M821A2 mortars:**

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</tr>
<tr>
<td>81mm Baseline (Comp-B)</td>
<td>III</td>
<td>I</td>
<td>IV</td>
<td>I</td>
<td>I</td>
<td>Fail</td>
</tr>
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</table>

**Reactions:**

- VI: No Sustained Reaction
- V: Burn
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81mm IM Path Forward

- M734A1/M783 Fuze (M821A2 & M889A2):
  - Maintain current PBXN-5 lead and booster
- M935 Fuze (M889A1):
  - Replace RDX lead with PBXN-5
  - Replace Comp A-5 booster with PBXW-14
  - Implement scored booster cup
- Implement PBXW-14 supplemental charge
- Implement plastic fuze thread insert
- Adopt IMX-104 main charge.
- Packaging:
  - Replace current fiber tube conical support with more robust ring design
  - Maintain current metal can (PA 156)
  - Package all rounds

**81mm IM Design**
IM Testing on M821A2 cartridges utilizing IM fill performed in FY09:

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<td>IV</td>
<td>I</td>
<td>Fail</td>
<td>Fail</td>
</tr>
<tr>
<td>81mm IM Enhanced (M821A2/M889A2)</td>
<td>V*</td>
<td>V*</td>
<td>IV*</td>
<td>I*</td>
<td>IV*</td>
<td>Fail</td>
</tr>
<tr>
<td>81mm IM Enhanced (M889A1)</td>
<td>V*</td>
<td>V*</td>
<td>IV*</td>
<td>IV*</td>
<td>IV*</td>
<td>Fail</td>
</tr>
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Reactions:
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* - Unofficial scores. Pending IM Board review
81mm Formal SCO Test

- Full-up M821A2/M889A2 configuration
- Type V reaction
- Highly effective fuze venting
Type V reaction
Highly effective fuze venting
• IM Strategy
  – Current IM Technology:
    • Fuze Venting
    • Packaging Improvements
  – CLIMEx downselect
    • IMX-104
    – PBXW-14
• Significant IM performance improvement demonstrated
• Initiation Reliability vs. IM
  – Supplemental Charges
• Incremental IM Approach
  – Further development required for full IM compliance
  • SCJI

No “new” rounds. Minimal unit cost impact
Questions?

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