DEMNB-based IM Formulations for the 120mm Mortar

2012 IMEMTS 14-18 May 2012

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Technical Objective

Objective – IM Compliance

- Develop melt cast insensitive explosives to replace TNT-based fills which currently fail most (or all) IM tests
- IM demonstration for Army artillery and mortars
- Maintain (or improve) performance requirements of TNT-based fills

Co-solidified nitrate salt eutectic system (DEMN)

- Nitrate salts
  - Easily manufactured in high yield
  - Nitrate salts available at low cost
- Added particulate energetic materials
  - Tailor sensitivity
  - Increase Performance
- Low melt for steam processing
  - Compatible with existing LAP facilities
  - Reduced loading and processing cost

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Background – DEMN-based Replacements for TNT

**DEMN-III J (IMX-103)**

- Characterized for performance ($D_V$, Gurney energy, initiability, fragmentation) & sensitivity
- PM-CAS downselected DEMN-III J as backup candidate for M795 transition
- Significant IM gains demonstrated in M795 155 mm projectile successful
  - Passes 4 of 6 Tests
  - First formulation to pass sympathetic detonation in 155 mm M795 artillery projectile **WITHOUT** a barrier!
- Pilot Plant Loading at ARDEC (4/4 acceptable projectiles with minimal engineering controls)

**IM Scorecard for the M795 artillery projectile**

<table>
<thead>
<tr>
<th>Explosive Fill</th>
<th>BI</th>
<th>FI</th>
<th>SCO</th>
<th>FCO</th>
<th>SD</th>
<th>SCJI</th>
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<tbody>
<tr>
<td>TNT</td>
<td>IV</td>
<td>IV</td>
<td>III</td>
<td>III</td>
<td>I</td>
<td>(I)</td>
</tr>
<tr>
<td>IMX-103</td>
<td>IV</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>III</td>
<td>I</td>
</tr>
</tbody>
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Build on Success of DEMN-III J

- Add sensitizing agent
- Achieve Comp B performance
- Demonstrate initiation and IM Response

M934A1 120mm Mortar (Comp B explosive fill)

- Melt cast design
- Embedded PBXW-14 supplemental charge
- Replace CH-6 with less sensitive
- 1090 mild steel body
- M734A1 Modified Multi-option Fuze (PBXW-14 fuze booster)

Comp B fails ALL IM tests in 120 mm mortar
- 0.50-cal AP round into mortar warhead center of mass
- Flash on impact and exit (also seen in 0.50-cal BI test on M795 projectile)
- Mortar body breakup
- Ejection of reducing adapter/fuze
- Scattering of numerous pieces of unreacted material and 3 mortar pieces

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Improved BI Response

- **Mild response** (mortar body in 3 pieces)
  - High Recovery
    - 99.8% of mortar body
    - 92.5% of unreacted explosive
  - PBXW-14 Supplemental charge recovered
  - Fuze/adapter recovered 52’ from test stand

- **Type IV response**
  - Deflagration
  - Type I – Detonation for Comp B

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Fragment Impact Test

- Flash on impact
- Mortar body translation
- Ejection of fuze/adapter

STANAG fragment at 6000 ft/s into mortar warhead center of mass
Ignition of DEMN fill in mortar body

- Ejection and burning of W-14 supplemental charge
Mild response
- Mortar lands 16’ from table in 1 piece
- Contents burn to completion
- Remnants of PBXW-14 supplemental charge can
- Fuze/adapter recovered 32’ from test stand

Type V Burn response
(Type I – Detonation for Comp B)

Ignition of DEMN fill in mortar body
Slow Cookoff Test

- Disposable sheet metal oven
  - Heater cartridges
  - Blower/circulator fan
  - Heated at 50°F/hour

- Type III Explosion response
  - Minimal pressure
  - 41.5% of mortar body recovered
  - Minimal witness plate scarring

- Better venting mechanism needed
Two shipping containers
  - Each holds 2 mortars in fiber tube
    - 1 up, 1 down
Donor (yellow, nose up) - functional initiation
Adjacent Acceptor (pink, nose down)
Diagonal Acceptor (green, nose up)
Inert (unpainted, sand-filled)

Initiation train
  - RP-87 detonator
  - M734A1 Fuze modified W-14 booster in reducing adapter
  - W-14 supplemental charge in crimped aluminum can

Witness plate
  - Scarring demonstrates detonation in donor round
  - Obturator groove markings (lack of)
Non-Detonative Response of Acceptors

- **Adjacent mortar body**
  - Several pieces recovered (40-120’)
  - Tail fin, supplemental charge, fuze/adapter
  - Scarring on half of witness plate

- **Diagonal Mortar body**
  - Split at thin-walled obturator groove
  - Each half filled with unreacted explosive
  - Minimal scarring on side witness plate

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Shaped Charge Jet Impact Test

- Standard SCJI Test
  - RPG surrogate
  - Impact along centerline at center of mass
  - Witness plates below and adjacent to projectile
Technical Results – Mortar SCJI Results

- **Witness plates**
  - Mild scarring on side witness
  - Vastly different from that of SD donor
  - No markings on bottom witness

- **Recovery**
  - Only recovered fragment was threaded for attaching tail
  - Only damage tail recovered from SD donor

- **Pressure**
  - Minimal pressure above baseline from shaped charge
  - Not indicative of detonation

- **Passing** non-detonative response

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Summary of DEMN-IX Mortar IM Tests

Passing responses
- Fragment impact – Type V burn
- Sympathetic detonation – non-detonative passing response
- Shaped charge jet impact – non-detonative passing response

Bullet Impact
- Type IV w/ 0.50-cal bullet (fuze >50 feet)
- Still significant improvement over Comp B

Slow Cookoff
- Type III Response
- Need to address currently insufficient venting design
- Fast cookoff – TBD; Likely to fail without venting

First Comp B type fill to pass SCJI

IM Results for M934A1 120mm Mortars

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<tr>
<td>DEMN-IX H</td>
<td>(IV)</td>
<td>(V)</td>
<td>(III)*</td>
<td>TBD</td>
<td>(P)</td>
<td>(P)</td>
</tr>
<tr>
<td>Comp B</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>II</td>
<td>I</td>
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- Rachel Ehlers

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