Insensitive Munition and Warheads
Performance Testing of PAX-3

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2004 Insensitive Munitions and Energetic Materials Technology Symposium
San Francisco, California 15-17 November 2004
Outline

• **Background**
• **Candidate Explosives**
• **Testing for Down-Selection**
• **Calculations**
• **IM Testing**
• **Conclusions**
Background

Objective: To Design a Warhead To Defeat both Armor and Structure Targets.

- **High Explosive**
  - Accelerate and move metal
  - High pressure applied quickly
  - Pressure pulse fades rapidly

- **High Blast Explosive**
  - Damage caused by overpressure
  - Less initial pressure pulse
  - Increased length of pressure pulse and pmpulse

CURRENT SOLUTION
1 ARMOR WEAPON
1 BUNKER WEAPON

ONGOING WORK
1 WEAPON FOR ARMOR, & BUNKER TARGETS
Candidate Explosives

• Hexal 70/30: RDX based, pressed
• HTA-3: HMX based, castable
• Aluminized Comp-A3: RDX based, pressed
• PAX-3: HMX based, pressed
• LX-14: Baseline
Warhead Testing for Explosive Downselect (146mm Warhead)

• Long Stand-Off Testing for Jet Characterization
  – PAX-3 produced straightest jets
  – PAX-3 had highest tip velocity

• Short Stand-Off for Penetration Performance
  – PAX-3 had excellent penetration results
    • Pax-3 demonstrated 78% of LX-14 performance
    • Twice that of other high blast explosives

• Blast Effect Against Concrete Walls
  – Larger through-hole than LX-14 baseline
  – PAX-3 created largest rear spall damage
PAX-3 146-mm Blast Effect
Bunker Defeat Test 81-mm

- 6” x 6” side timbers
- 4” x 4” top timbers
- 3’ thick sand wall with interlocking sand bags
- 81-mm Warhead
Bunker Defeat Test 81-mm

PAX-3 Successfully Defeats Bunker!
Modeling & Simulation

• PAX-3 was downselected for further evaluation after successful 146-mm and static 81-mm bunker testing

• CALE Modeling and Simulation
  – Performed on 81-mm and 72-mm warhead designs
  – Optimized jet performance and characterization

• 81-mm and 72-mm loaded with PAX-3
  – Analyze and compare actual data with models for penetration performance and jet characterization.
## CHEETAH Calculations of PAX-3

### COMPOSITION:
- **PAX-3 Variations**
- 6.5% CAB, 9.5% BDNPA/F
- 84% (HMX + Aluminum)

<table>
<thead>
<tr>
<th></th>
<th>Density 99%TMD (g/cc)</th>
<th>CJ Pressure (GPa)</th>
<th>Detonation Velocity (km/s)</th>
<th>Expansion Energy $E_{6.5}$ (kJ/cc)</th>
<th>Total Mechanical Energy $E_{\text{tot}}$ (kJ/cc)</th>
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<tbody>
<tr>
<td>0% Al</td>
<td>1.760</td>
<td>29.7</td>
<td>8.34</td>
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<td>10% Al</td>
<td>1.810</td>
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<td>15% Al</td>
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<td>18% Al</td>
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<td>19% Al</td>
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<tr>
<td>20% Al (PAX-3)</td>
<td>1.862</td>
<td>26.6</td>
<td>7.63</td>
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<td>25% Al</td>
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<td>23.5</td>
<td>7.51</td>
<td>8.47</td>
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<tr>
<td>30% Al</td>
<td>1.918</td>
<td>22.6</td>
<td>7.47</td>
<td>8.17</td>
<td>14.01</td>
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*20% Aluminum Gives Good Balance*
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<thead>
<tr>
<th>Test</th>
<th>PAX-2A</th>
<th>PAX-3</th>
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<tbody>
<tr>
<td>ABL Impact</td>
<td>6.9-11 cm</td>
<td>6.9-11 cm</td>
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<tr>
<td>ABL Friction</td>
<td>800 @ 8ft/sec</td>
<td>800 @ 8ft/sec</td>
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<tr>
<td>Unconfined ESD</td>
<td>&gt; 8 J</td>
<td>&gt; 8 J</td>
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<tr>
<td>SBAT</td>
<td>365°F</td>
<td>360°F</td>
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<tr>
<td>NOL card gap</td>
<td>137 - 123</td>
<td>124</td>
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Small Scale Sensitivity Data indicates NO Safe Handling Issues!
IM Testing

A series of IM tests were conducted on PAX-3 in a 81-mm Generic Shape Charge. IM tests chosen for evaluation were bullet impact (BI), fragment impact (FI), fast cook-off (FCO), and slow cook-off (SCO).
Bullet Impact Set-Up

- High Speed Cameras
- Blast Gauges
- Gun 50-Cal
- Velocity Screens
- Test Item
Bullet Impact
Bullet Impact

Un-reacted PAX-3

Virtually All PAX-3 Explosive Recovered
PASSED!
Fragment Impact Set-Up

- High Speed Cameras
- Blast Gauges
- Velocity Screens
- Gun 50-Cal
- Test Item
- TOA1
- TOA2
Fragment Impact Set-Up
Fragment Impact

Un-reacted PAX-3

Virtually all Unexploded Ordnance Recovered
PASSED!
Fast Cook-Off Set-Up
Fast Cook-Off

Type V Reaction – Burn
PASSED!
Slow Cook-Off Set-Up

Type III and Type IV Reaction – Explosion/Deflagration
Case Venting Can Fix This Reaction
Conclusions

• Successfully designed and demonstrated single high penetration/high blast warhead

• PAX-3 explosive was downselected from a group of high blast explosives through experimentation and testing

• Allows for a single multipurpose design to be fielded with armor defeat and enhanced blast capabilities

• PAX-3 was shown to be IM compliant