IM Explosive for SMAW
HEAA Warhead


Indian Head Division, Naval Surface Warfare Center
Indian Head, MD

April 8, 2009
NDIA Gun and Missile Systems Conference

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Presentation Outline

• Objectives
• Approach
• System Description
• Explosive Selection
• Qualification and Performance Tests
• Summary
• Acknowledgements
Objectives

• Replace SMAW HEAA warhead fill (Octol) with explosive of comparable performance and improved IM characteristics
  – Sponsor directive: only system change will be explosive fill

• Meet current HEAA penetration requirements

• Qualify SMAW HEAA with IM warhead fill (SMAW HEAA-IM Warhead)
Approach

- **Phase I: Explosive Selection**
  - Explosive Selection Committee
  - IM and Performance Testing in SMAW HEAA Warhead
  - Downselection to Final Explosive Fill

- **Phase II: Qualification and Performance Testing SMAW HEAA-IM Warhead**
SMAW HEAA System Description

- Shoulder-launched Multi-purpose Assault Weapon High Explosive Anti-Armor
- DODIC HX06
- Effective against medium armor
- SMAW HEAA consists of:
  - MK 153 MOD 0 Launcher
  - SMAW HEAA Encased Assault Rocket (EAR)
- SMAW HEAA Rocket consists of:
  - Rocket motor
  - Impact fuze
  - Shaped charge, high explosive warhead
Selection of IM Explosive Candidates
Explosives Assessment

- Explosive Output
- IM Survivability
- Safety & Reliability
- Producibility / Life Cycle Costs
Explosive Candidates

- PBXN-9
  - Used in Navy & Army shaped charge ordnance
  - Good IM in FCO/SCO/BI
  - Bad IM in FI

- PBXN-11
  - Better performance than PBXN-9
  - Good IM in FCO/SCO
  - Bad IM in BI/FI

- PBXW-114
  - Equivalent performance to PBXN-110
  - Good IM in FCO/SCO/BI
  - Potential for significant improvement in FI
# Explosive Properties

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Composition</th>
<th>Manufacture Method</th>
<th>Density, g/cc</th>
<th>FCO/SCO/BI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBXN-9</td>
<td>HMX/binder</td>
<td>pressed</td>
<td>1.73</td>
<td>V/V/V</td>
</tr>
<tr>
<td>PBXN-11</td>
<td>HMX/binder</td>
<td>pressed</td>
<td>1.80</td>
<td>V/V/IV</td>
</tr>
<tr>
<td>PBXW-114</td>
<td>HMX/Al/binder</td>
<td>cast</td>
<td>1.71</td>
<td>V/V/V</td>
</tr>
<tr>
<td>Octol</td>
<td>HMX/TNT</td>
<td>melt (sedimentation) cast</td>
<td>1.82</td>
<td>I/I/V</td>
</tr>
</tbody>
</table>
Phase I. IM and Performance Tests
Phase I Testing

• Slow Cook-Off
  – 2 warheads of each explosive fill plus Octol baseline
  – Tests performed at Dahlgren Division, NSWC

• Fragmentation Impact
  – 2 warheads of each explosive fill plus Octol baseline
  – Tests performed at Dahlgren Division, NSWC

• Penetration
  – 3 warheads of each explosive fill (2 for PBXN-11) plus Octol baseline
  – Tests performed at Dahlgren Division, NSWC

• Flash X-ray
  – 2 warheads of PBXN-9 and PBXW-114 fills plus Octol baseline
  – No PBXN-11 loaded warheads available
  – Tests performed at ARL, Aberdeen, MD
Slow Cook-Off Test

- MIL-STD-2105C (STANAG 4382)
- 2 tests per explosive candidate and Octol baseline
- Live warhead, other components were inert mass simulates
- Six thermocouples recorded temperatures
- Tests were continuously monitored by two video cameras
- Photographs of test set-up and post test results taken
Slow Cook–Off Results

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBXN-9</td>
<td>Type IV (Deflagration)</td>
</tr>
<tr>
<td>PBXN-11</td>
<td>Type V (Burn)</td>
</tr>
<tr>
<td>PBXW-114</td>
<td>Type IV (Deflagration)</td>
</tr>
<tr>
<td>Octol</td>
<td>Type I (Detonation)</td>
</tr>
</tbody>
</table>

PBXN-11 post test
Octol post test
Liner Ejected from Warhead in all SCO tests of Explosive Candidates
Fragment Impact Test

- MIL-STD-2105C (STANAG 4496)
- 2 tests per explosive candidate and Octol baseline
  - Fragment velocity ~8000 ft/sec first test; ~6000 ft/sec second test
- Live warhead, other components were inert mass simulates
- Pressure gauges @ 15’, 22’ and 34’
- 3 Foil velocity screens measured fragment velocity
- Test recorded using digital Phantom cameras
### Fragment Impact Results

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBXN-9</td>
<td>Type I (Detonation)</td>
</tr>
<tr>
<td>PBXN-11</td>
<td>Type I (Detonation)</td>
</tr>
<tr>
<td>PBXW-114</td>
<td>Type I (Detonation) &amp; Type IV (Deflagration)</td>
</tr>
<tr>
<td>Octol</td>
<td>Type I (Detonation)</td>
</tr>
</tbody>
</table>
Warhead Penetration Tests

- 3 Tests per explosive candidate and Octol baseline
  - Except only 2 PBXN-11 warheads available
- Test continuously monitored by a video cameras
- Photographs of test set-up and post test results taken

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Average Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBXN-9</td>
<td>passed</td>
</tr>
<tr>
<td>PBXN-11</td>
<td>passed</td>
</tr>
<tr>
<td>PBXW-114</td>
<td>failed</td>
</tr>
<tr>
<td>Octol</td>
<td>baseline</td>
</tr>
</tbody>
</table>
PBXN-11 Loading

• Problems encountered loading PBXN-11 charges

• PBXN-11 tended to adhere to case wall when pressed under conditions used for PBXN-9 charges and caused case deformation

• PBXN-11 charges for tests were pressed as free-standing billets, slipped into warhead case, and then pressed lightly

• Loading process improvement required if PBXN-11 selected
## Summary of Phase I Results

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Density</th>
<th>Current Processibility</th>
<th>Penetration</th>
<th>SCO</th>
<th>IM Reactions</th>
<th>Frag Impact (T1 8000 ft/sec, T2 6000 ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBXN-9</td>
<td>1.744</td>
<td>Yes</td>
<td>passed</td>
<td>IV (2) Deflagration</td>
<td>I (2) Detonation</td>
<td></td>
</tr>
<tr>
<td>PBXN-11</td>
<td>1.769 *</td>
<td>No</td>
<td>passed</td>
<td>V (2) Burn</td>
<td>I (2) Detonation</td>
<td></td>
</tr>
<tr>
<td>PBXW-114</td>
<td>~1.71</td>
<td>Yes</td>
<td>failed</td>
<td>IV (2) Deflagration</td>
<td>I (1) Detonation</td>
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<tr>
<td>Octol</td>
<td>1.80-1.85</td>
<td>N/A</td>
<td>baseline</td>
<td>I (2) Detonation</td>
<td>I (2) Detonation</td>
<td></td>
</tr>
</tbody>
</table>

* 98% TMD is 1.793 gm/cc. 1.769 is 96.7% TMD
IM Explosive Selection

• PBXN-9 Selected
• Based on
  – Performed well in penetration tests
  – IM characteristics
  – Fielded as main charge in other shaped charge warheads
  – Drop in solution
• Place barrier tape between PBXN-5 booster and PBXN-9 explosive
• Informally refer to SMAW HEAA system with PBXN-9 warhead fill as “SMAW HEAA-IM Warhead”
Phase II. Qualification and Performance Tests for SMAW HEAA-IM Warhead
Qualification and Performance Tests

• Objectives

  – Ensure that SMAW HEAA-IM Warhead meets IM and Hazard Classification (HC) requirements

  – Obtain Final (Type) Qualification of the SMAW HEAA-IM Warhead

  – Verify that replacement of warhead fill has not caused degradation of system performance
Phase II Tests

• Test Items
  - Built by Nammo Talley, Inc.
  - Warheads loaded by IHDIV, NSWC
  - Liners are Government Furnished Material (GFM)
  - Mk 259 Fuzes are GFM

• Testing will be conducted by National Technical Systems (NTS), Camden, Arkansas during March – June 2009
Qualification Tests

Tests harmonized for IM and HC Purposes, but include only a limited subset of HC and FTQ tests, since this effort is only changing the warhead explosive fill and not safety features of the system.

- Basic Safety Tests w/ Thermal Stability
- Sympathetic Detonation (Stack Test)
- Fast Cook-Off
- Slow Cook-Off
- Bullet Impact
- Fragment Impact
## Phase II Test Matrix

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Live WH w/ Booster</th>
<th>Rocket Motor Live</th>
<th>Rocket Motor Inert</th>
<th>Fuze Live</th>
<th>Fuze Inert</th>
<th>Spotting Round Live</th>
<th>Spotting Round None</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-day T&amp;H, Thermal Stability, Vibration, 4-day T&amp;H, 40 ft. drop</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>28-day T&amp;H, Thermal Stability, Vibration, 4-day T&amp;H, Flight Performance Testing</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Flight Performance Testing (Baseline)</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Sympathetic Detonation - Confined Stack Test</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Sympathetic Detonation - Unconfined Stack Test</td>
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<tr>
<td>Fast Cook Off</td>
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<td>Slow Cook-Off</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Bullet Impact</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Fragment Impact</td>
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<td>1</td>
<td>1</td>
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</tbody>
</table>
## Phase II Test Matrix (continued)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Live WH w/ Booster</th>
<th>Rocket Motor</th>
<th>Fuze</th>
<th>Spotting Round</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Live</td>
<td>Inert</td>
<td>Live</td>
</tr>
<tr>
<td>3 Month Aging, Penetration Testing</td>
<td>WH only</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WH only</td>
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<td></td>
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<tr>
<td></td>
<td>WH only</td>
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</tr>
<tr>
<td>6 Month Aging, Penetration Testing</td>
<td>WH only</td>
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<td>WH only</td>
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<tr>
<td></td>
<td>WH only</td>
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<td></td>
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</tr>
<tr>
<td>Vibration, Penetration Testing</td>
<td>WH only</td>
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<tr>
<td></td>
<td>WH only</td>
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<td>Baseline Penetration Testing</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>WH only</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

- PBXN-9 selected as IM explosive for SMAW HEAA warhead
- Qualification test plan received concurrence from WSESRB, NOSSA, DDESB, and Navy, Army & Air Force Hazard Classification Offices
- Warheads have been loaded
- Test items have been built
- Qualification and performance testing is underway
Acknowledgments

• Sponsor: Marine Corps Systems Command Program Manager for Ammunition (PM Ammo)
  – Program Manager: Richard Dooley
  – Engineer: Richard Hardy
  – Technical Advisor: Tim Portner, Dahlgren Division, NSWC

• Test item build: Nammo Talley, Inc.
  – Project Manager: Will Betush
  – Project Engineer: Glade Hansen
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  – Phone: 301-744-2575
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