Development of the NLOS-LS PAM Warhead

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NLOS-PAM Team

- Prime Contractor: NetFires LLC
  - Raytheon Missile Systems
  - Lockheed Martin Missiles & Fire Control
NLOS-PAM Overview

- Low cost, direct attack missile
- Provides precision fire support for the Brigade Combat Team and for USN Littoral Combat Ship
PAM System Description

- Large multi-mode warhead
- 7-inch diameter 120 lb class
- Range 0-40 kilometers
- Effective against moving and stationary targets
- In-flight updates, retargeting and image capabilities
- Target sets
  - Light armor
  - Heavy armor
  - Bunkers
  - Fortifications

PAM Warhead Effectiveness

PAM Seeker Image of Land and Sea Targets
Multimode Warhead Challenges

- Short Stand-Off
- High Penetration Performance
- Strict IM requirements
- Cost as a Key Performance Characteristic
- Small Envelope
- Evolving Requirements
Warhead Overview

Explosive Billet
PIC
Liner
Retaining Ring
Fragment Barrier
Clamp Ring
Warhead Development

- Competitive Risk Reduction Effort
  - Trade Studies
    - Explosive Material (Penetration Performance vs. IM Performance)
    - Casing Design (Materials to reduce sensitivity to Fragment Impact)
    - Liner Material Study (Penetration Performance vs. Cost)
  - Analysis
    - Penetration Performance (Hydrocode)
    - Seeker Keep Out Zone
  - Testing
    - Jet Characterization
    - RHA and Armor Targets (Penetration Performance)
    - Soft Targets (Arena and Bunker Testing)
    -Insensitive Munitions Testing (Slow Cook-Off and Fragment Impact)
- Followed by the Detail Design Phase
Modeling & Simulation

- Fragment Barrier Analysis
  - Understanding the Physics
  - Study the effects of different Materials
  - Study the effects of different configurations

- Slow Cook-Off Performance Analysis
  - Design Features to Allow Venting
  - Thermal Analysis

- Penetration Performance
  - 2D Hydrocode
  - Optimize Design

- Jet Characteristics
  - 3D Hydrocode
  - Ensure Straightness of Jet
PAM Warhead Performance

<table>
<thead>
<tr>
<th>Key Characteristic</th>
<th>Performance</th>
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<tbody>
<tr>
<td>Range target penetration depth</td>
<td></td>
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<tr>
<td>Range target penetration diameter</td>
<td></td>
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<tr>
<td>RHA penetration</td>
<td></td>
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<tr>
<td>Mass</td>
<td></td>
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<tr>
<td>Design to cost</td>
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Performance Testing

- Tested 5 Different Design Variations
- Conducted over 100 Explosive Tests
  - Arena Testing
  - Jet Characterization
  - RHA Penetration
  - ERA Target Penetration
  - Environmental Testing
  - Behind Armor Debris Testing
  - Reliability (Vari-Comp)
# IM Testing

<table>
<thead>
<tr>
<th>Threat</th>
<th>Test Results</th>
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<tbody>
<tr>
<td>Fast Cook-off</td>
<td>Type V</td>
</tr>
<tr>
<td>Slow Cook-off</td>
<td>Type V</td>
</tr>
<tr>
<td>Bullet Impact</td>
<td>Type V</td>
</tr>
<tr>
<td>Fragment Impact</td>
<td>Type V</td>
</tr>
<tr>
<td>Sympathetic Detonation</td>
<td>Type V*</td>
</tr>
<tr>
<td>Shaped Charge Jet</td>
<td>Type I*</td>
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*Expected
Production Readiness

- Lean Design Effort
  - Use Low Cost Materials
  - Reduction of the number of Parts
  - Incorporation of Molded Components
  - Detail tolerance stack up analysis to optimize tolerances
  - Work with each component Vendors on reducing Cost Drivers
  - Streamline Assembly Process

- Early Development of Acceptance Testing
  - Perform Lot Acceptance Tests (LAT) to Characterize Variation

- Control of Critical Characteristics
  - Characteristics that mostly control performance variation

- Pilot Production Line incorporated on Qualification Build
Design Challenges

- Striking a Balance between Low Cost and High Performance
- Integrating Production Processes early on
- Mitigating Fragment Impact and Slow Cook-Off Hazards
- Maintain Performance with Environmental Factors
- Incorporating Environmentally Compliant Processes and Products
Acknowledgements

● Raytheon Missile Systems
  – Bill Zarr