Processing and Sensitivity Testing of the Insensitive TNT Based Explosive – PAX-44

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Overview

• ATK Strategy for IM Replacement Energetics
• M795 Energetic Replacement Project
• PAX-44 – Basic Information
• Processing Experiments and Demonstrations
  • LAP Study
  • Finishing Study
• IM Experiments and Demonstrations
  • BI Test series
  • Cook Off Testing
  • Sympathetic Detonation Testing
• Conclusions
**Overarching Goal:**

- Provide MIL-STD 2105C Compliant Energetic Solutions based on Low-Cost Proven Technologies to drive Low Life-Cycle Cost Growth and meet Warfighter Demands

- Comply with system specific Threat Hazard Assessments with the target goals of full 2105C compliance

- Utilize proven basic technologies to minimize implementation upsets with a focused Design For Six Sigma driven approach

- Plan for Low Life-Cycle Cost Growth
  - Break the standard cycle of high cost IM energetics
  - Provide cost effective solutions without passing the costs up the supply chain
  - Maximize fielding amounts of needed munitions on a fixed POM budget
M795 Energetic Replacement Project

- IM Improvement for Legacy GP Artillery Rounds
- 155mm M795 HE used as test bed
- Culmination of a multi-year multi source competition
- ATK was a primary stakeholder as the provider of legacy energetics
- Competitive test covered all aspects of supply chain and munitions life-cycle
- Testing was conducted as head-to-head sensitivity and performance testing with consideration for life-cycle cost impact
• TNT Based IM energetic

• 80/20 TNT / Performance Desensitizing Additive (PDA)

• PDA was an engineered, oxygen carrying, density matched, organic fuel that serves as an inert additive to dilute threat stimuli but contributes near-equivalent energy in the detonation regime

• Formulation allows all the benefits of TNT
  • Easy melt casting
  • Flaking
  • Low-toxicity
  • Excellent storage characteristics

• PDA is designed to provides advantages to shock mitigation (BI, FI, SD, SCJ) and benefits to Cook-off thermal stability
• Iowa Army Ammunition Plant – Indirect Fire Business Unit
  • Full Scale Pour of 45 Projectiles using production equipment
  • Screening experiment to determine if x-ray acceptable rounds could be cast with PAX-44 using the current range of process controls (TNT -> Comp-B)
  • Follow on testing to determine effect of feather and process additives

• Army ARDEC Bldg. 810 Process Optimization Experiments
  • Belt Flaking PAX-44 for feather material
  • Optimized Model Based Controller cooling profiles
  • On-site test articles for ARDEC IM testing
Pour Quality Progression

An advanced weapon and space systems company
**Finishing Study**

- **ATK – Energetic Systems Division**
  - NTIB TNT Facility

- Supplier of TNT for M795 LAP operations

- Only domestic manufacturer of TNT

- **GOAL**
  - Use standard finishing process and production equipment to make PAX-44 flakes conforming to the same military quality standard as Type I Flake TNT
  - Demonstrate path for low impact facilitization of PAX-44 if needed to support major testing or classification operations
• **IM Experimentation and Demonstrations**
  
  • Bullet Impact Testing
    – 9 PAX-44 tests (NTS-Camden, ATK-LS, ARDEC)
  
  • Cook-off Testing
    – Fast Cook-off (NTS-Camden)
  
  • Sympathetic Detonation Testing
    – Duplicate testing (NTS-Camden)
PAX- 44 BI Testing – Phase 1

• Initial Testing Conducted with Projectiles from first casting at IAAAP
• (2) Tests – STANAG 4241
• Repeated Type III Reaction
• Sensitivity linked to cast quality
• Efforts to improve casting quality (Feathering, Process Additives, MBC Cooling)

• Consistent Improvement of Bullet Impact Response over range of cast-qualities
PAX- 44 BI Testing – “No Reactions”

- Rounds with excellent cast quality repeatedly demonstrated “No Reaction” aka Type VI reaction to Bullet Impact Testing
• **Unfortunately, Cast quality is not the only driver of Bullet Impact Response**
  
  • 3 Tests (above) all conducted using X-Ray Approved munitions
    – Passed MIL-P 63252 rev A and MIL-STD 453 Criteria for TNT loaded projectiles
  
  • Reactions ranged from Type III Explosion to “No Reaction”
  
  • As yet an unresolved issue
Cook Off Testing

• Energetic and System level Improvements to M795 Cook Off response showed incremental improvement, but did not meet program goals

• Why is cook off so tough?
  • Logistical Configuration
    – Large Explosive/Case mass ratio
    – Vertical Orientation
  • Energetic Issues
    – Foaming TNT provides infinite path flame front
    – Work underway to provide additional Cook-off Response mitigation
• Initial indications showed that shock propagation was likely at expected separation distances

• Testing conducted for information purposes and to provide baseline data for improvement projects
Conclusions

• **PAX-44 has demonstrated capabilities**

  • **Processing**
    – High TNT percentage allows it to be processed in a manner consistent with TNT and Comp-B
    – Relative low additive percentage allows it to be drum-flaked and meet TNT spec for flake character
    – Builds on TNT strengths of long-term stability and low chemical reactivity

  • **Sensitivity**
    – IM testing of PAX-44 loaded munitions show improved response to impact based testing
    – PAX-44 shows incremental improvement with respect to SD testing and Cook Off

  • **Cost**
    – Using proven low-cost materials the cost impact to making an energetic fill less sensitive can be minimized