Establishment of a TATB Manufacturing Process for Triaminotrinitrobenzene (TATB) at Holston Army Ammunition Plant

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Briefing Outline

- Review of Benziger TATB Synthesis Process
- History on TATB Requirements & Manufacture
- TATB Program Overview
- Overview of TATB Facility at Holston AAP
- Qualification of TATB and PBX Formulations
- Conclusions
- Acknowledgements
Review Benziger Synthesis for TATB

First Step - Nitrate TCB to TCTNB

• 1,3,5-Trichlorobenzene (TCB) is used as the starting material for both Wet-aminated and Dry-aminated TATB

• TCB is nitrated in an Oleum / Nitric Acid solution to yield 1,3,5-Trichloro-2,4,6-trinitrobenzene (TCTNB)
Review Benziger Synthesis for TATB

**Second Step - Aminate TCTNB to TATB**

- TCTNB is aminated with ammonia gas to yield 1,3,5-triamino-2,4,6-trinitrobenzene (TATB)
- The Type of TATB Depends on Amination Conditions (i.e. whether water and/or an emulsifier is present in the reaction)
- TATB physical attributes influenced in amination step (i.e. particle size, crystalline surface characteristics, etc)
Why So Much Emphasis On TATB ?!

- TATB is one of the least sensitive explosive materials available
- Critical ingredient in numerous IM Fuze systems within DOD
- Ex. applications for TATB formulations (PBXN-7 & PBXW-14):

<table>
<thead>
<tr>
<th>Bomb Type</th>
<th>warhead Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Purpose Bombs</td>
<td>2.75 HE Warhead</td>
</tr>
<tr>
<td>Penetrator Bombs</td>
<td>Quickstrike Mine</td>
</tr>
<tr>
<td>Tactical Tomahawk</td>
<td>60mm Mortar</td>
</tr>
<tr>
<td>SLAM ER</td>
<td>81mm Mortar</td>
</tr>
<tr>
<td>JSOW FTB</td>
<td>120mm Mortar</td>
</tr>
</tbody>
</table>

- DOE applications are both tactical and strategic
Recent TATB History

• 1993 - CONUS production of TATB ceased
• 1999 - DOD began OCONUS TATB procurement from UK
• 2005 - Last qualified TATB source ceased production
• 2007 - DOD / DOE Joint Working Group established
• 2008 - NNSA / DOE TATB Study Group established
• 2010 - Lab and pilot demonstrations of Benziger TATB synthesis by BAE Systems & ATK
• 2011 - TATB facilitization contract awarded at Holston AAP
• 2013 (March) - TATB Facility fully commissioned
• 2013 (May) - Manufacture of qualification batches for TATB, PBXN-7, & PBXW-14 completed
Benziger TATB: Truly a “Joint” Program

- Program participation by all DOD Services, multiple DOE Agencies, and Industry
- TATB Working Group Participants:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUSD (AT&amp;L) / PSA / LW&amp;M</td>
<td>Rock Island Contracting Com.</td>
</tr>
<tr>
<td>NAWC China Lake</td>
<td>679th ARSS, Eglin AFB</td>
</tr>
<tr>
<td>NSWC Indian Head</td>
<td>DOE, HQ NNSA</td>
</tr>
<tr>
<td>NAWCAD Pax River</td>
<td>DOE, LANL</td>
</tr>
<tr>
<td>PD Joint Services</td>
<td>DOE, LLNL</td>
</tr>
<tr>
<td>PM CAS</td>
<td>DOE, Pantex</td>
</tr>
<tr>
<td>ARDEC</td>
<td>DLA, Strategic Materials</td>
</tr>
<tr>
<td>Joint Munitions Command</td>
<td>BAE Systems</td>
</tr>
</tbody>
</table>
Schematic of New TATB Facility

- TATB Facility designed to use much of the existing infrastructure in Agile Plant
- Provided a cost effective manufacturing capability for Benziger TATB
- Enhances the capabilities of the Agile Facility for other Energetic / Critical Materials

Building G-10 Agile Manufacturing Plant for Energetic Materials At Holston AAP

Key:
Red – Legacy equipment used for TATB processing
Green – New equipment being installed for TATB
TATB Manufacturing Infrastructure and Process

• **TATB Process Includes:**
  - Nitration
  - Amination
  - Purification (Reflux & Washing)
  - Recovery (Filter & Filter Press)
  - Acid Handling (Oleum & SNA)

• **Process Equipment:**
  - Glass Lined Reactors
  - Pressure Vessels
  - Wash Tank / Filter Press
  - Toluene Storage Tank
  - Ammonia Delivery System
  - TCB (Heaters and Feed System)
TATB Manufacturing Infrastructure and Process (Continued)

• Process Control
  - Highly Automated
  - > 330 I/O Points
  - Safety PLC

• Facility Operation & Capacity:
  - Fully integrated into HSAAP Agile Plant
  - Projected capacity >20,000 lbs / month if needed
# TATB Product Qualification Batches

## TATB Attributes

<table>
<thead>
<tr>
<th>TATB Attributes</th>
<th>HSAAP TATB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size (USSS Screen Nos. 15, 35, 60, 85, &amp; 105)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Crystal Morphology (SEM)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Total &amp; Inorganic Chlorine (%)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Purity (%)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Impurity Levels (%): T3, T4, &amp; TCTNB</td>
<td>PASSED</td>
</tr>
<tr>
<td>DSC (°C, Peak Onset &amp; Max)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Ash Content (%)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Vacuum Thermal Stability</td>
<td>PASSED</td>
</tr>
<tr>
<td>Impact, Friction, ESD</td>
<td>PASSED</td>
</tr>
<tr>
<td>Angle of Repose</td>
<td>PASSED</td>
</tr>
<tr>
<td>Infrared Spectroscopy</td>
<td>PASSED</td>
</tr>
</tbody>
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## Product Qualification Batches

- Qualification batches produced in HSAAP Agile Plant
- Minimum requirement for 5 consecutive batches meeting specification

## Applicable Specifications

- TATB Military Specification No. WS23158
- New Joint DOD / DOE Specification (MIL-DTL-32337)
# PBXN-7 and PBXW-14

## Product Qualification Batches

<table>
<thead>
<tr>
<th>PBX Attributes</th>
<th>PBXN-7 &amp; PBXW-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition</td>
<td>PASSED</td>
</tr>
<tr>
<td>Granulation (USSS Sieves): PBXN-7: Nos. 6, 14, 18, &amp; 100 PBXW-14: Nos. 6, 12, 40, &amp; 100</td>
<td>PASSED</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Purity (%)</td>
<td>PASSED</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>PASSED</td>
</tr>
<tr>
<td>Pressed Density</td>
<td>PASSED</td>
</tr>
<tr>
<td>Vacuum Thermal Stability</td>
<td>PASSED</td>
</tr>
<tr>
<td>Workmanship</td>
<td>PASSED</td>
</tr>
<tr>
<td>Impact, Friction, ESD</td>
<td>PASSED</td>
</tr>
<tr>
<td>Shock Sensitivity (LSGT)</td>
<td>PASSED</td>
</tr>
</tbody>
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### Product Qualification Batches

- Qualification batches produced in standard Holston AAP PBX Infrastructure (Building G-6)
- Min. requirement for 3 batches of both PBXN-7 and PBXW-14 fully meeting specification

### Applicable Specifications

- PBXN-7: MIL-DTL-82874D
- PBXW-14: MIL-DTL-32280
Testing & Qualification Summary for Benziger TATB and Formulations

• The Benziger TATB and the corresponding PBXN-7 & PBXW-14 formulations from Holston AAP are fully compliant with Mil-Specs.

• The Benziger TATB Produced at Holston AAP is chemically and physically indistinguishable from legacy TATB product.

• Government Laboratories participating in the qualification program:
  • DOD: NAWC China Lake, NSWC Indian Head, ARDEC
  • DOE: LLNL, LANL, PANTEX

• Full DOD qualification of the Holston Benziger TATB and PBXN-7 / PBXW-14 formulations is expected before the end of CY-2013.
Summary

• TATB Synthesis via Traditional Benziger Process has been Effectively Demonstrated on a Production Scale at Holston AAP

• The TATB Product is Fully Compliant with All Applicable DOD and DOE Specifications

• The TATB has been Formulated into PBXN-7 and PBXW-14 using Traditional PBX Coating Equipment at Holston AAP

• The PBXN-7 and the PBXW-14 is Fully Compliant with All Applicable DOD Specifications

• These Explosive Formulations are being Evaluated by Applicable DOD Labs & Full Qualification is Expected by the End of CY-2013

• The projected Capacity of the TATB Facility should be Capable of Meeting All Foreseeable Future Demand and the TATB Product Cost Should Be Lower than Historic Levels
Acknowledgements

- Office of the Under Secretary of Defense for Acquisition, Technology, & Logistics, Portfolio Systems, Land Warfare, and Munitions
- Program Executive Office Ammunition
- Project Director Joint Services
- US Department of Energy, National Nuclear Security Administration (NNSA), Non-Nuclear Materials Division
- US Army, ARDEC
- US Navy: NAVAIR Weapons Division, China Lake; NAVAIR Aircraft Division; Pax River; NSWC, Indian Head Division