

Reclamation and Reformulation of TATB from PBX-9502 and LX-17

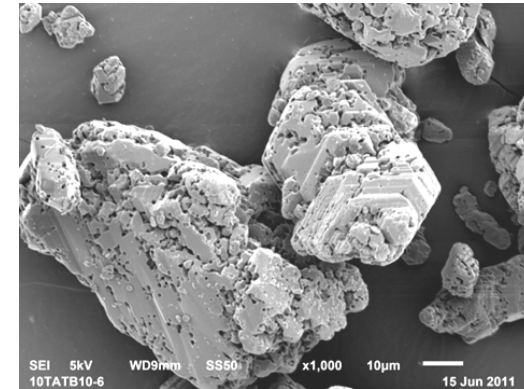
Dr. Jacob Morris BAE Systems, Kingsport, TN
Mr. Crane Robinson US Army, Picatinny, NJ
Mr. Tim Mahoney US Navy, China Lake, CA



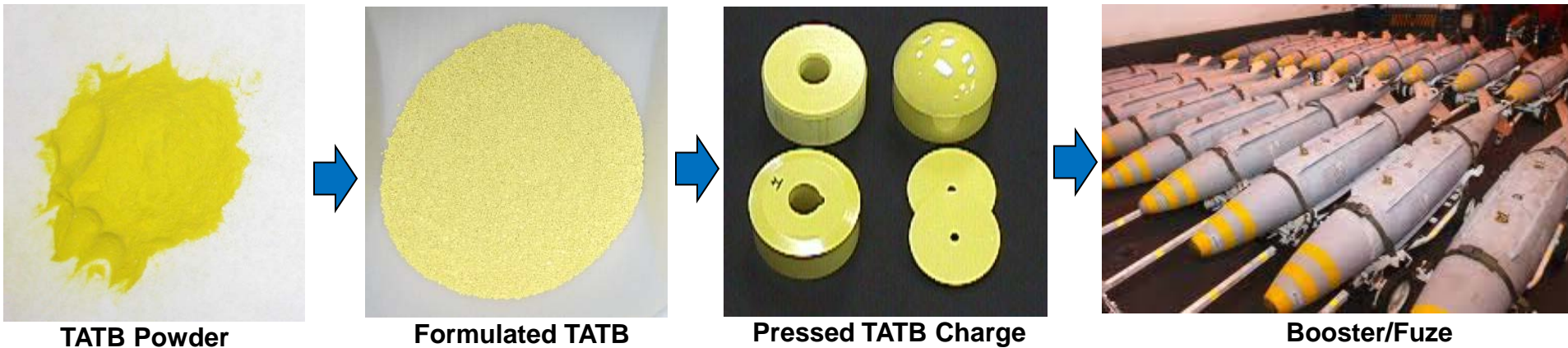


TATB Overview

- TATB (Triaminotrinitrobenzene) is a critical insensitive explosive
- Main component in a number of DoD/DoE booster and fuze weapon assemblies
- Production-scale manufacturing source no longer existed in Western-world countries
- Joint DoD/DoE initiative created to restore U.S. TATB manufacturing capabilities
- BAE Systems at HSAAP downselected as contractor to manufacture TATB



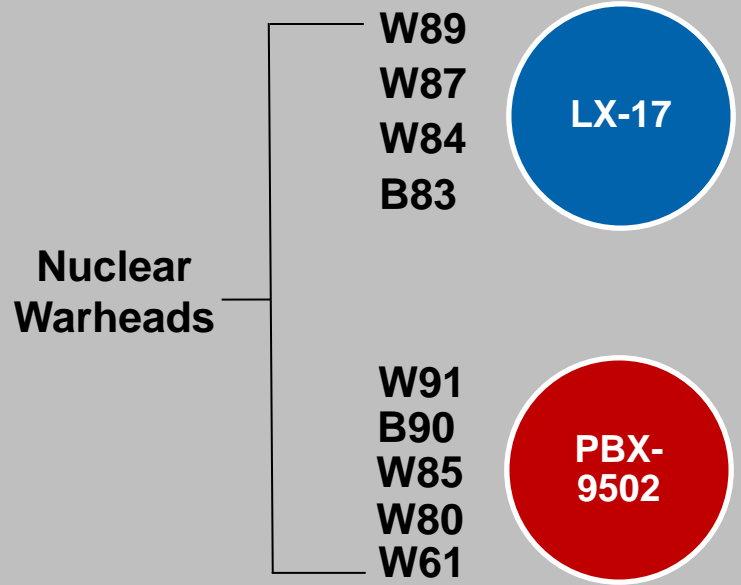
TATB Crystals





TATB Applications

Department of Energy



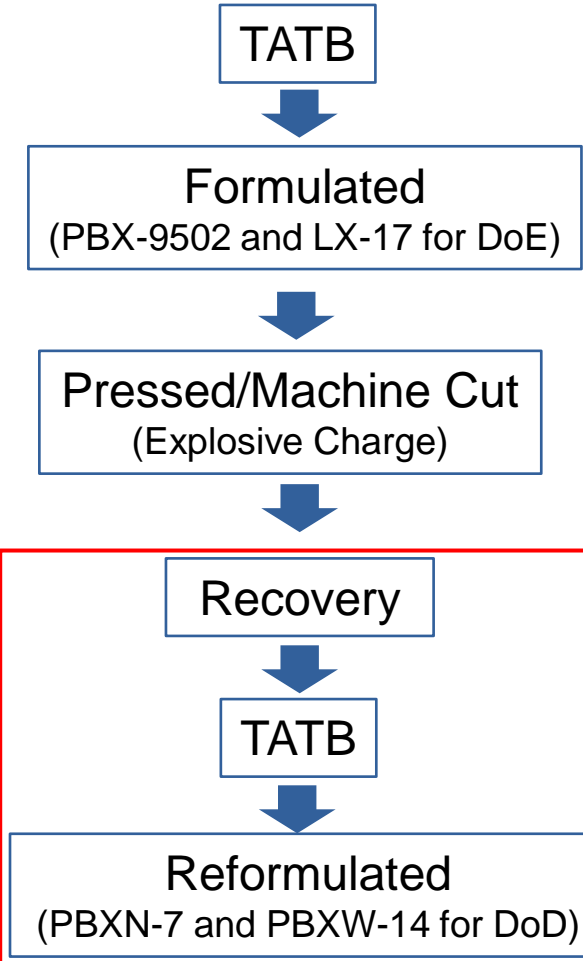
Department of Defense





TATB Recovery and Reuse

- TATB Manufacturing Facility recently built at HSAAP (TATB Qualification in 2013)
- As a overall risk mitigation effort to the Facilitization Program, DoD desired alternate source of TATB be pursued
- The US DoE has a surplus of PBX-9502 and LX-17 machine cutting available
- BAE Systems initiated a program with DoD/DoE to **recover** TATB from surplus DoE machine cuttings for potential **reuse** in DoD weapons applications



LX-17 Machine Cuttings



PBX-9502 Machine Cuttings

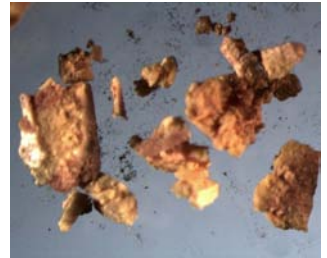
Focus of program at HSAAP



Machine Cuttings

PBX-9502
95% TATB
5% Kel-F 800 binder

LX-17
92.5% TATB
7.5% Kel-F 800 binder
Red Dye





Program Overview

Phase 1: Lab-Scale Reclamation Development

- TATB recovery parameters developed and optimized on the lab-scale
- Novel test methods developed for recovered TATB
- Data assessed by Joint TATB team



Phase 2: Reclamation and Reformulation Prove-Out

- Optimized recovery parameters demonstrated on the multi-pound scale
- Recovered TATB formulated into PBXN-7 and PBXW-14 for DOD evaluation



Phase 3: Production-Scale Reclamation and Reformulation

- Reclamation and reformulation scaled to production at HSAAP
- Over 12,000 lbs of TATB reclaimed from machine cuttings
- Formulation of PBXN-7 and PBXW-14 with reclaimed TATB
- PBXN-7 and PBXW-14 currently in qualification





Phase 1: Lab-Scale Reclamation

Reclamation Development

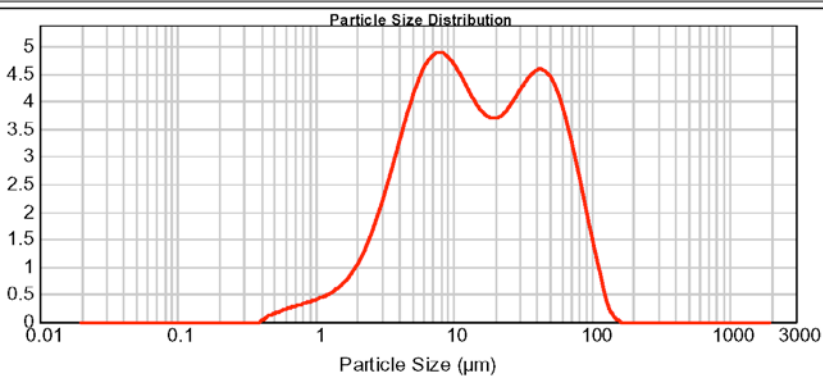
- TATB recovery parameters developed and optimized on the lab-scale using 3-L still
- Process parameters for reclamation: solvent type, temperature, solvent:PBX ratio, and extraction time
- Key Measurements of reclaimed TATB: Particle Size and Residual Kel-F 800 Binder
- Process found to be solvent dependant for amount of residual binder
- Particle size of reclaimed TATB very similar for all reclamation conditions



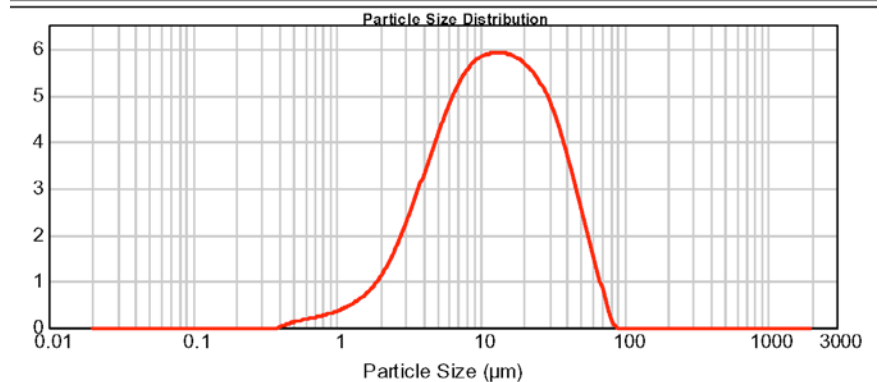


Size Distribution of TATB from PBX-9502 and LX-17

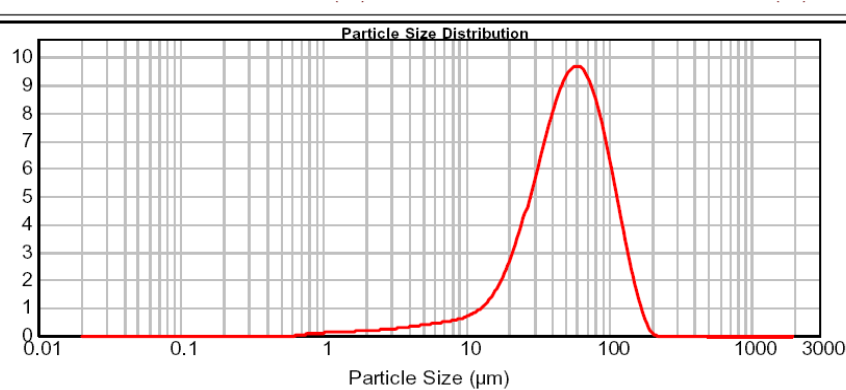
Reclaimed TATB from PBX-9502



Reclaimed TATB from LX-17



Benziger TATB

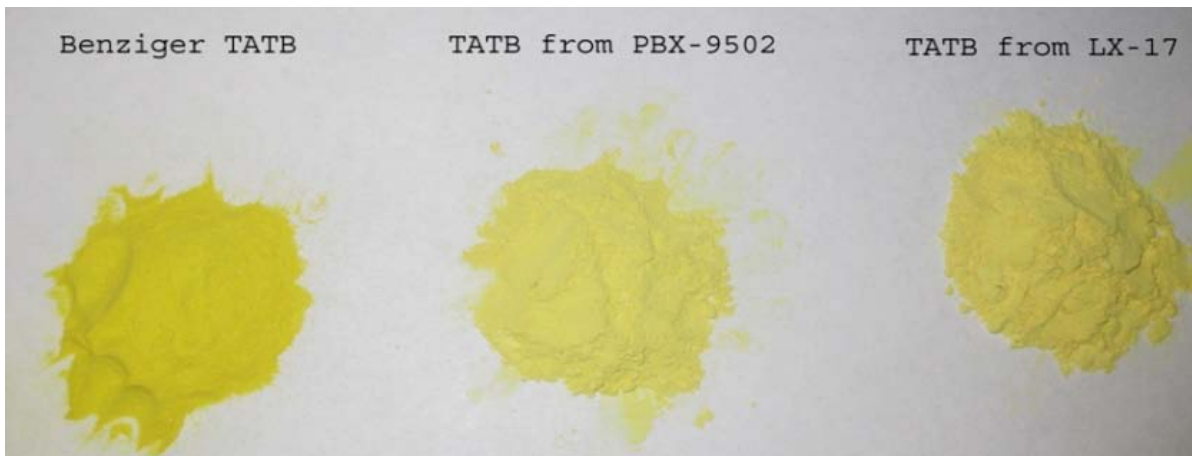


- Reclaimed TATB has smaller particle size than virgin Benziger TATB
- Attrition of crystals is indicative of the TATB crystals being fractured during the PBX processing and pressing.
- TATB from LX-17 smaller than from PBX-9502 (WA-TATB)



Phase 2: TATB Reclamation Scale-Up

- The optimized reclamation parameters were scaled-up in the laboratory to the kilogram scale.
- Two 1-kg samples of TATB were reclaimed at this scale from both PBX-9502 and LX-17 using an 18-liter still
- Reclaimed TATB particle size similar to Phase I effort. Residual binder on the TATB <0.2%





Phase 2: PBXN-7 / PBXW-14 Formulation

- The reclaimed TATB was formulated into PBXN-7 and PBXW-14 using the standard Holston laboratory procedure and equipment

- A total of four samples were produced:
 - 1 kg PBXN-7 from PBX-9502 TATB
 - 1 kg PBXN-7 from LX-17 TATB
 - 1 kg PBXW-14 from PBX-9502 TATB
 - 1 kg PBXW-14 from LX-17 TATB

- The formulations processed the same as virgin Benziger TATB

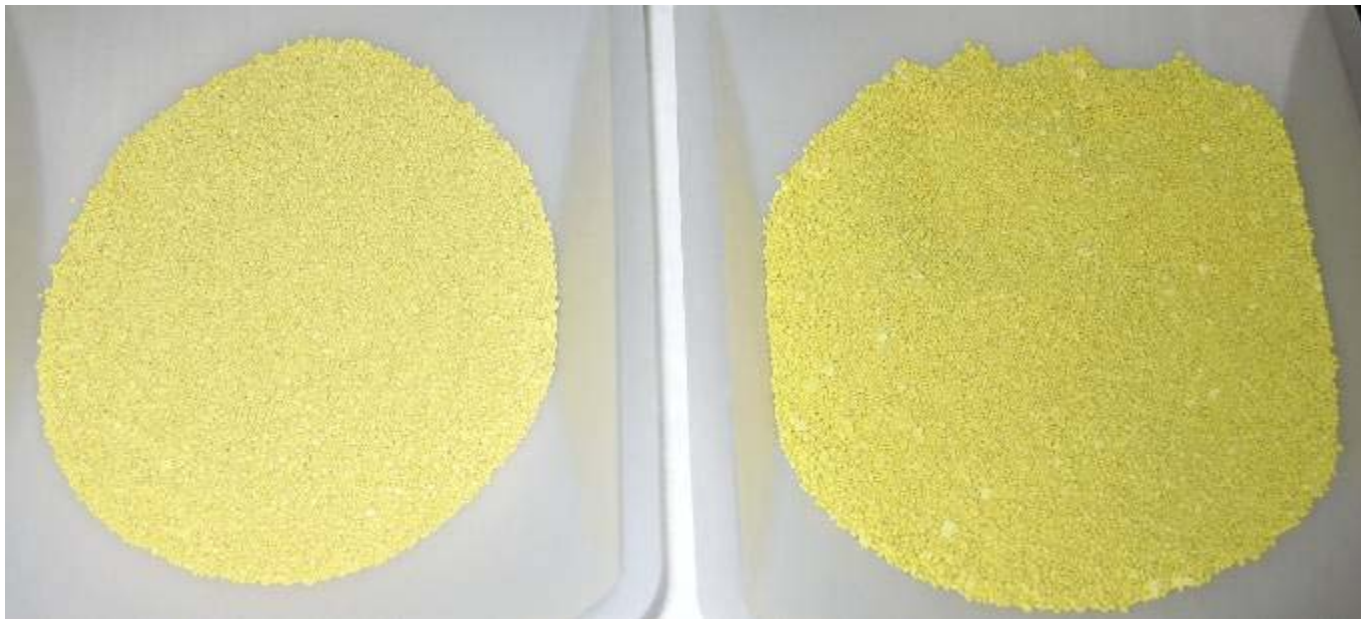
- All 4 batches passed the standard Mil-Spec testing, including:
 - Composition, granulation, bulk density, pressed density, impact, VTS



Phase 2: PBXN-7 Formulation

N-7 From Benziger TATB

N-7 From Reclaimed TATB





Phase 2: SSGT Results

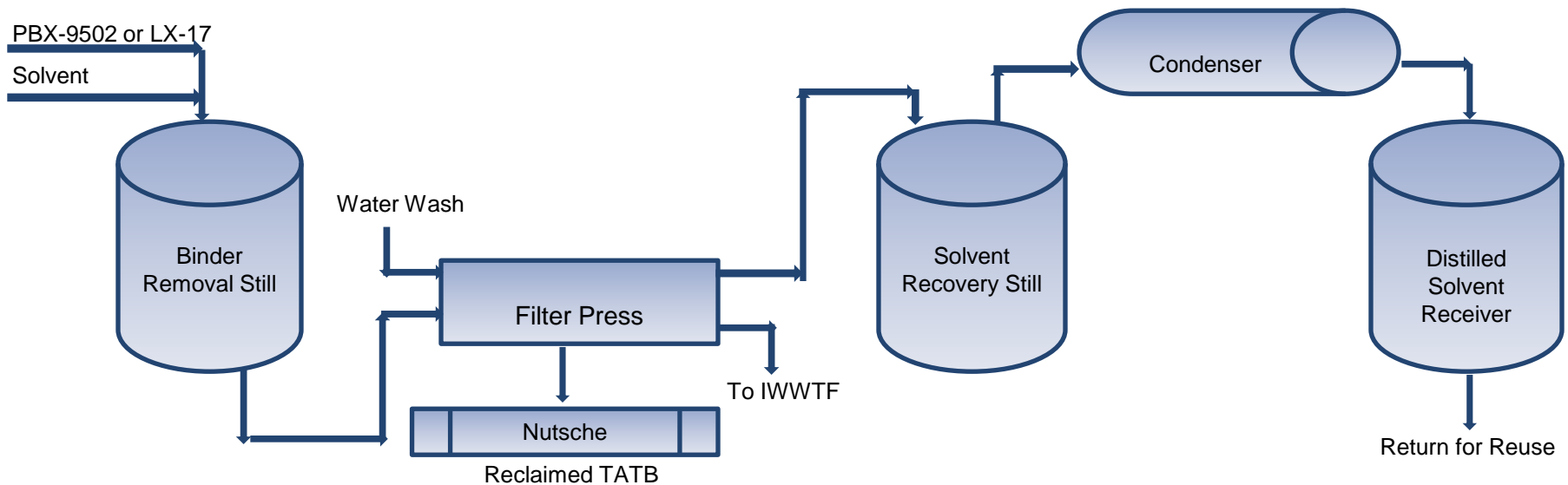
- Small scale gap testing (SSGT) was performed on PBXN-7 using reclaimed TATB to compare relative performance with PBXN-7 made with Benziger TATB
- Testing was performed at Reynolds System Inc (RSI)
- Testing was performed at -60 °C to provide worst case shock initiation data
- Difference in shock sensitivity is less than 1%, which is well within lot-to-lot variation

Shock initiation characteristics of both PBXN-7 samples are the same and would perform in initiation systems with the same degree of reliability



Phase 3: TATB Reclamation in Production

- The reclamation process scaled to the Agile Manufacturing Facility at HSAAP (G-10)
- Reclamation performed in 6,000 gallon still
- Extracted TATB from both PBX-9502 (8,000 lbs) and LX-17 (6,500 lbs)
- Extraction solvent distilled and reused





Phase 3: TATB Reclamation in Production

- TATB reclamation effort in production complete:
 - PBX-9502: 7,000 lbs of TATB recovered (3 Batches)
 - LX-17: 5,200 lbs of TATB recovered (3 Batches)

- All batches met the residual binder specification

- Reclamation solvent distilled after each batch and reused, with no loss or effect on binder removal

- TATB tested by the new military specification, including:
 - Purity Analysis by HPLC, GC
 - Chlorine Content
 - Particle Size/ Shape Analysis
 - Safety Data (Impact, Friction, ESD)
 - Thermal Analysis by DSC, VTS
 - **BAE Holston Residual Binder Test**



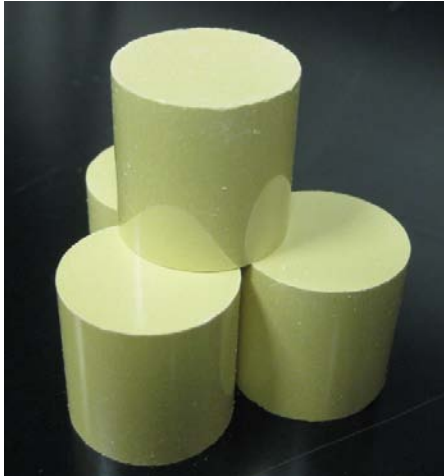


Phase 3: PBXN-7 and PBXW-14 Production Formulation

- PBXN-7 and PBXW-14 formulated using reclaimed TATB:
 - Standard production building (G-6) utilized for these products
 - Batches produced using a 500 gallon vacuum still.
 - PBXW-14: 1,500 lbs of material produced (3 batches)
 - PBXN-7: 1,500 lbs of material produced (3 batches)

- Material Qualification:
 - All batches passed acceptance testing and initial FAT Testing
 - Bulk Density, granulation, and pressed density excellent for all of the batches.
 - Finalizing 6-month aging and cold-temperature SSGT

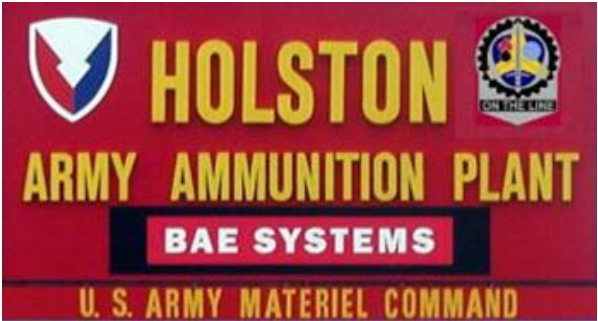
- PBXN-7 and PBXW-14 sent to customer for further evaluation and formal DoD qualification





Summary

- The reclamation process of TATB from PBX-9502 and LX-17 was initially developed and optimized on the lab-scale at HSAAP.
- The process was then scaled to full-scale production. The developed reclamation process was optimized to use existing infrastructure at HSAAP.
- Reclaimed TATB was formulated into PBXN-7 and PBXW-14 using existing procedures and infrastructure. BAE Systems and DOD conducted full qualification testing on both materials.
- Reclaimed TATB is available and can be provided at a reduced cost compared to Benziger TATB. DOD customers have already expressed interest for some applications.





Additional TATB Presentations

Session 6A (10:40 AM Wednesday):

“Establishment of TATB Manufacturing Process at Holston Army Ammunition Plant”
– Mike Ervin (BAE Systems)

Session 7A (1:00 PM Wednesday):

“Manufacture of Wet-Aminated TATB at the Holston Army Ammunition Plant”
- Dr. Jacob Morris (BAE Systems)

Session 7A (1:40 PM Wednesday):

“Comparison of DOTC and Legacy Benziger Dry-Aminated TATB and PBX-9502”
- Dr. Mark Hoffman (LLNL)



The Joint DOD/DOD/BAE TATB Team

