# Manufacture of Triaminotrinitrobenzene (TATB) by the Benziger Method at Holston Army Ammunition Plant

## 2012 Insensitive Munitions & Energetic Material Technology Symposium


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|---|---|
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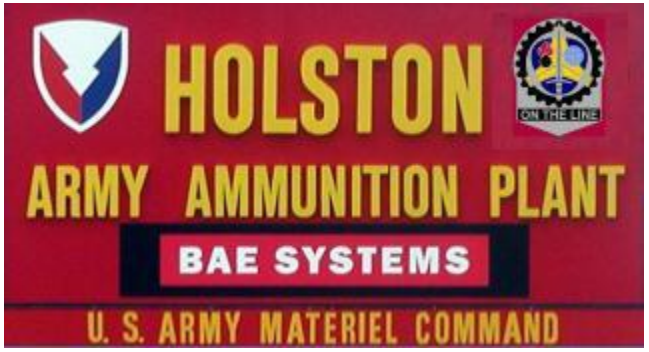
# Briefing Outline

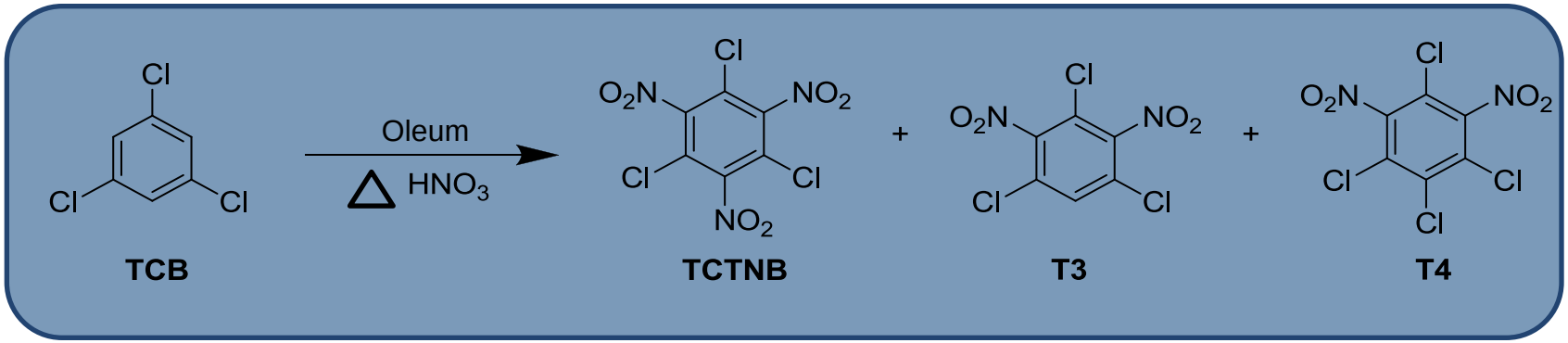
- Review of Benziger TATB Synthesis Process
- Needs and Recent History on TATB Requirements & Manufacture
- TATB Program Overview
- Qualification of TATB and PBX Formulations from Holston Army Ammunition Plant (HSAAP)
- TATB Facilitization and Qualification Schedule
- Conclusions and Way Forward
- Acknowledgements





# Review Benziger Synthesis for TATB

## First Step - Nitrate TCB to TCTNB

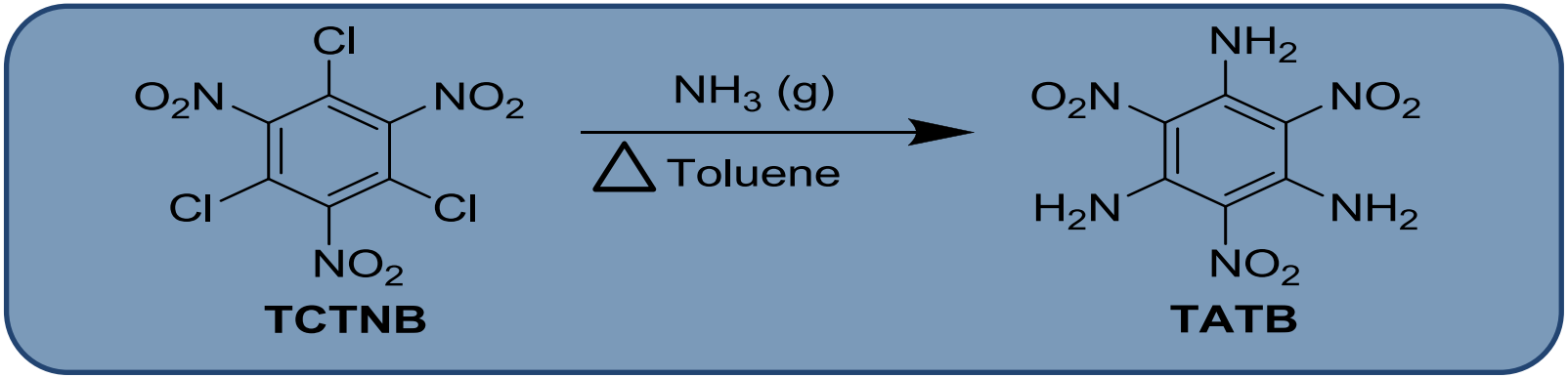



- **1,3,5-Trichlorobenzene (TCB) is used as the starting material for both Wet-aminated and Dry-aminated TATB**

- **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):

| | |
|---|---|
| General Purpose Bombs | 2.75 HE Warhead |
| Penetrator Bombs | Quickstrike Mine |
| Tactical Tomahawk | 60mm Mortar |
| SLAM ER | 81mm Mortar |
| JSOW FTB | 120mm Mortar |

- DOE applications are both tactical and strategic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# TATB History

- 1993 - CONUS production of TATB ceased
- 1999 - DOD began OCONUS TATB procurement from UK
- 2005 - Last qualified TATB source ceased production (and closed in 2006)
- 2007 - DOD / DOE Joint Working Group established
  - Identify service requirements
  - Develop plan for US source for TATB / TATB formulations
- 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 to BAE Systems at Holston AAP

# Benziger TATB: Truly a "Joint" Program

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

| | |
|---|---|
| OUSD (AT&L) / PSA / LW&M | Rock Island Contracting Com. |
| NAWC China Lake | 679th ARSS, Eglin AFB |
| NSWC Indian Head | DOE, HQ NNSA |
| NAWCAD Pax River | DOE, LANL |
| PD Joint Services | DOE, LLNL |
| PM CAS | DOE, Pantex |
| ARDEC | DLA, Strategic Materials |
| Joint Munitions Command | BAE Systems, Holston AAP |

# Pilot Scale-up of Benziger TATB at HSAAP

- **Benziger TATB Synthesis Successfully Demonstrated on Lab-scale (both dry and wet aminated)**
- **In 2010, Multiple Pilot Batches Generated (100-gallon scale) for Dry Aminated TATB**

**100-gallon Pilot Reactor Used for TATB Synthesis**

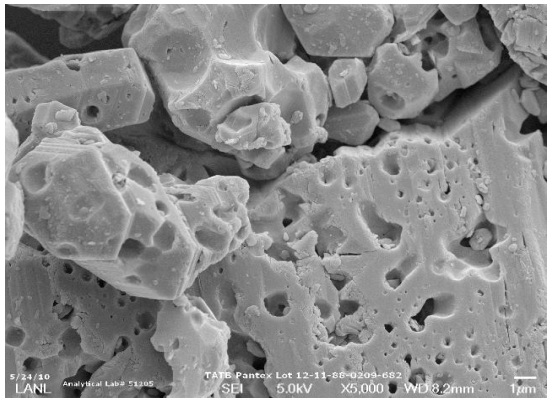
**500-gallon HSAAP Vacuum Still for PBX**

- **Fully Compliance with TATB Military Specification (WS23158) and with draft joint DOD / DOE Specification (MIL-DTL-32337)**
- **TATB Successfully Converted to PBXN-7 (Production-scale) and PBXW-14 (Lab-scale)**
- **HSAAP TATB was "drop-in" replacement for legacy product**

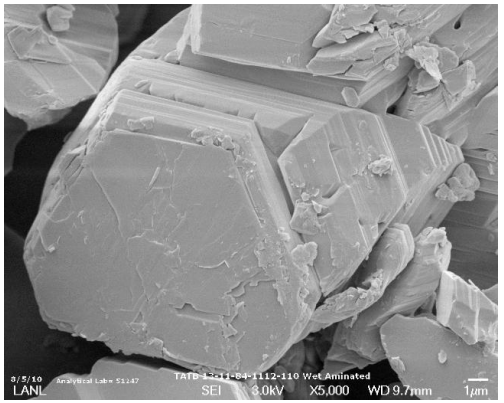
# Pilot Scale-up of Benziger TATB at HSAAP

- **Synthesis Conditions Can Effect the Physical Characteristics of the TATB. Ex.**

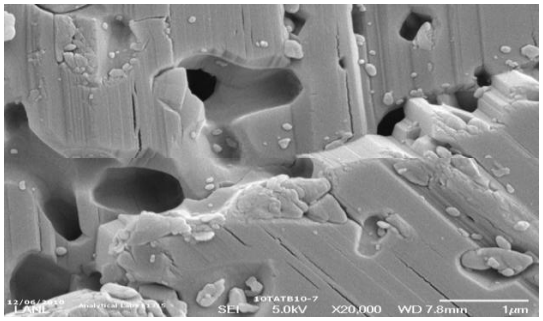
**Dry Aminated TATB**



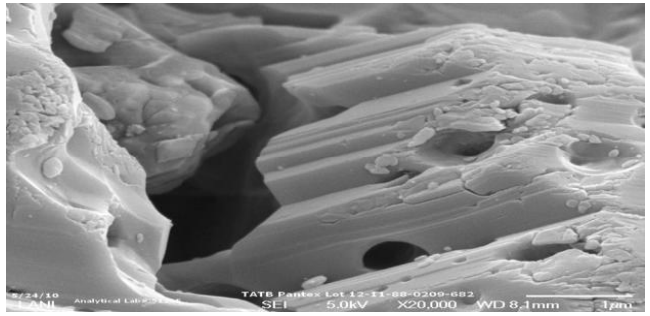

**Wet Aminated TATB**




- **The HSAAP Pilot TATB Matched Critical Attributes of the DOE (Pantex) Legacy TATB. SEM photos from LANL (20,000x mag.)**

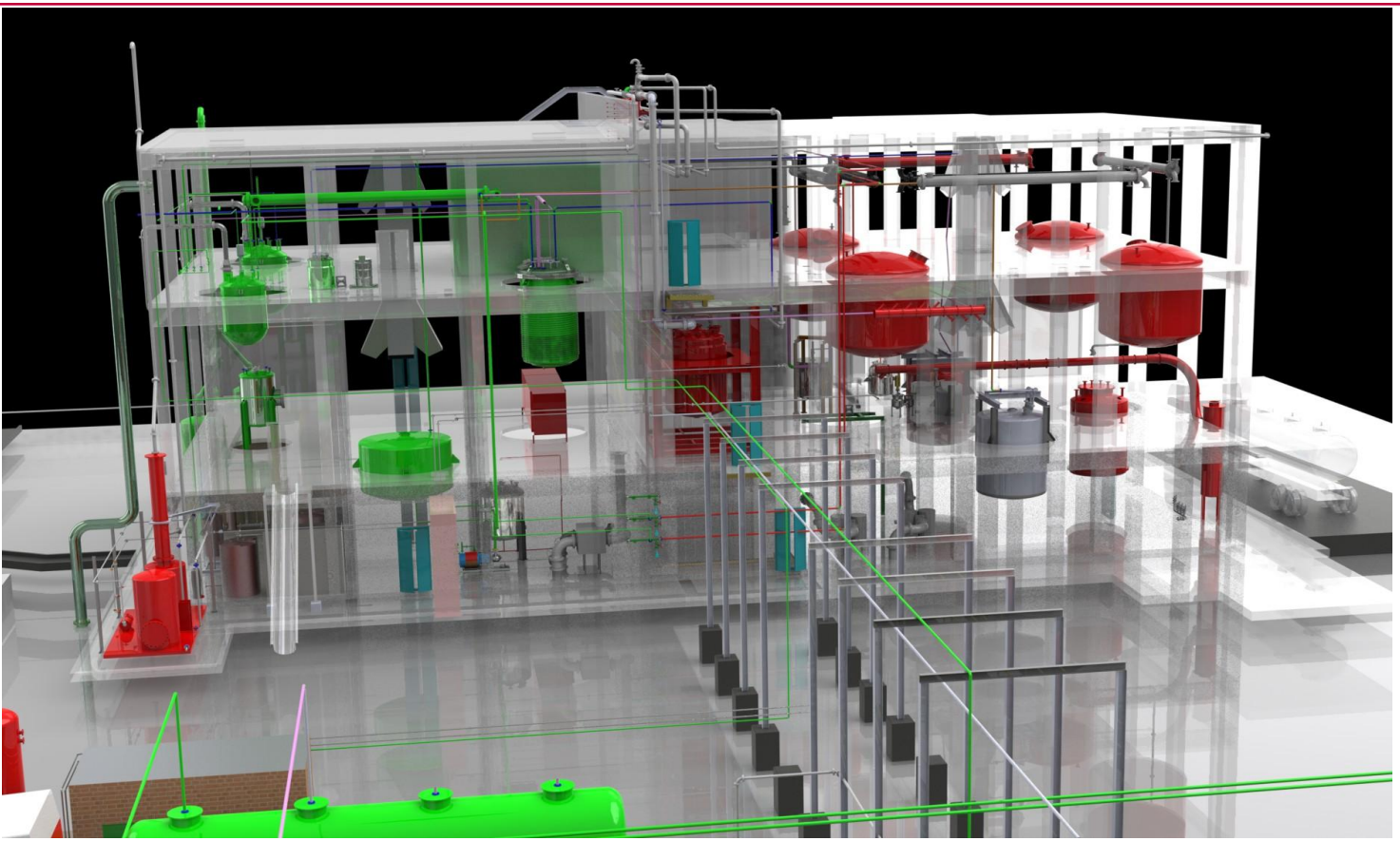



**Holston AAP Dry Aminated TATB**




**Typical Pantex Dry Aminated TATB**

# Schematic of Designed TATB Facility



**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 Facility designed to use much of the existing infrastructure in Agile Plant**
- **The new equipment added for TATB will enhance overall Agile Plant capabilities**

# Details of TATB Facility Design / Construction

- **Design Completed In-house by BAE Systems at HSAAP**
  - ***Designed with separate nitration and amination trains***
  - ***Multiple nitration and amination batches are achievable daily***
  - ***Ability for Concurrent (24-Hour) Operations which are Consistent with Normal Plant Functionality at HSAAP***
- **Building G-10 Building Preparation and Demolition Tasks are Complete**
- **All Equipment Procurement Activities Completed**
- **All Equipment Installation Subcontracts Awarded**
- **Equipment Installation / Final Construction Activities Initiated in May 2012 ("On-Schedule")**

# Equipment Staged for TATB Facility

- **TATB Facilitization Started Week of May 14, 2012**
- **All Major Equipment Staged In Readiness at HSAAP**



# Planned Program Activities

- **Program Construction Phase Completed by October 2012**
- **Facility Commissioning Initiated in October 2012**
- **TATB Qualification Batches Produced in Nov-Dec, 2012**
- **PBXN-7 and PBXW-14 Batches Produced in December, 2012**
- **TATB and Formulations DOD FAT and Qualification Trials to be Complete by June 2013**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# Conclusions / Summary

- **TATB Synthesis via Traditional Benziger Process has been Effectively Demonstrated on Lab and Pilot Scale at HSAAP (Full Compliance with DOD and DOE Specifications)**
- **Facilitization Program for Large-Scale Manufacture of TATB in the Agile Manufacturing Plant at HSAAP is On-Schedule**
- **Large-Scale Manufacture of TATB Available from HSAAP by 4$^{th}$ Quarter CY-2012**
- **DOD Qualification of TATB, PBXN-7, and PBXW-14 to be Completed by End of June 2013**
- **New, Jointly Developed DOD and DOE Specification for TATB (MIL-DTL-32337) to be Finalized in 2012**

# Acknowledgements


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- US Army, ARDEC
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- US Air Force, 679th Armament Systems Squadron, Eglin AFB