

# Recent Advancement on Enhanced Blast Explosives Manufacturing at Holston Army Ammunition Plant

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# Briefing Outline

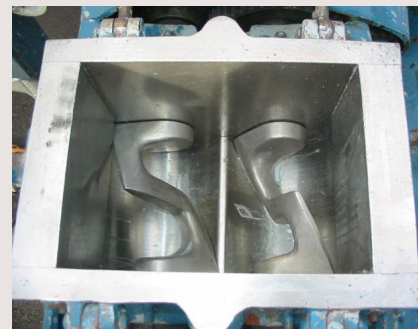
- Background - EB Explosive Overview
- Background – EB Explosive Processing
- EB Explosive Process Development
- EB Explosive Manufacturing at HSAAP
- EB Explosive Manufacturing Capabilities
- Other EB Explosive Manufactured at HSAAP
- Summary
- Acknowledgements

## Background – Enhanced Blast Explosives Overview

- Enhanced Blast (EB) Explosives offer performance characteristics of both aluminized and non-aluminized formulations for target defeat
- Incorporation of aluminum powder achieved high shock overpressure for longer duration than non-aluminized composition
- EB Explosive is formulated to optimize the balance of detonation velocity and total mechanical energy, resulting in desirable metal pushing capability as well as high blast energy
- EB Explosives are typically selected for multi-purpose warheads in shoulder-launched weapon or direct-fire applications
- EB Explosives of interest:
  - PBXIH-18 (Aluminized HMX Based EB with plasticizer)
  - PAX-3 (Aluminized HMX Based EB with plasticizer)
  - PAX-30 (Aluminized HMX Based EB with plasticizer)
  - PAX-42 (Aluminized RDX Based EB with plasticizer)

## Background – EB Explosive Processing Techniques

- **Granulation via Aqueous Slurry Coating with organic lacquer**
  - One step process similar to standard Holston pressed explosive process
  - Production equipment readily available
- **Twin Screw Extrusion (TSE)**
  - Multi-steps process; incorporation of aluminum powder with nitramine precursor; granulator
- **High Shear Mixer**
  - Multi-steps process; dry or coating nitramine required
  - High Shear Mixer not available at HSAAP



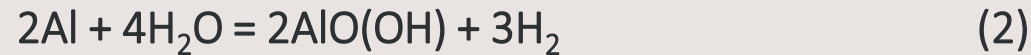
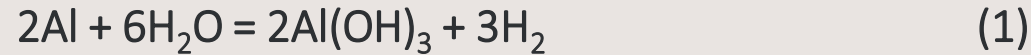
## Background – EB Explosive Processing (2)

- **Aqueous Slurry Coating** is preferred at HSAAP
  - Most efficient and cost effective process
    - Most suited for existing infrastructure without major investment
    - All processing steps conducted at HSAAP
- Choice between Water Replacement (WR) Fluid & Water
  - **WR Fluid**
    - Non reactive with aluminum powder
    - similar boiling point as water
    - High cost (purchase/recovery) for Production
  - **Water**
    - Significantly lower cost than WR Fluid
    - No special delivery or handling equipment
    - Standard aqueous source for HE manufacturing at HSAAP



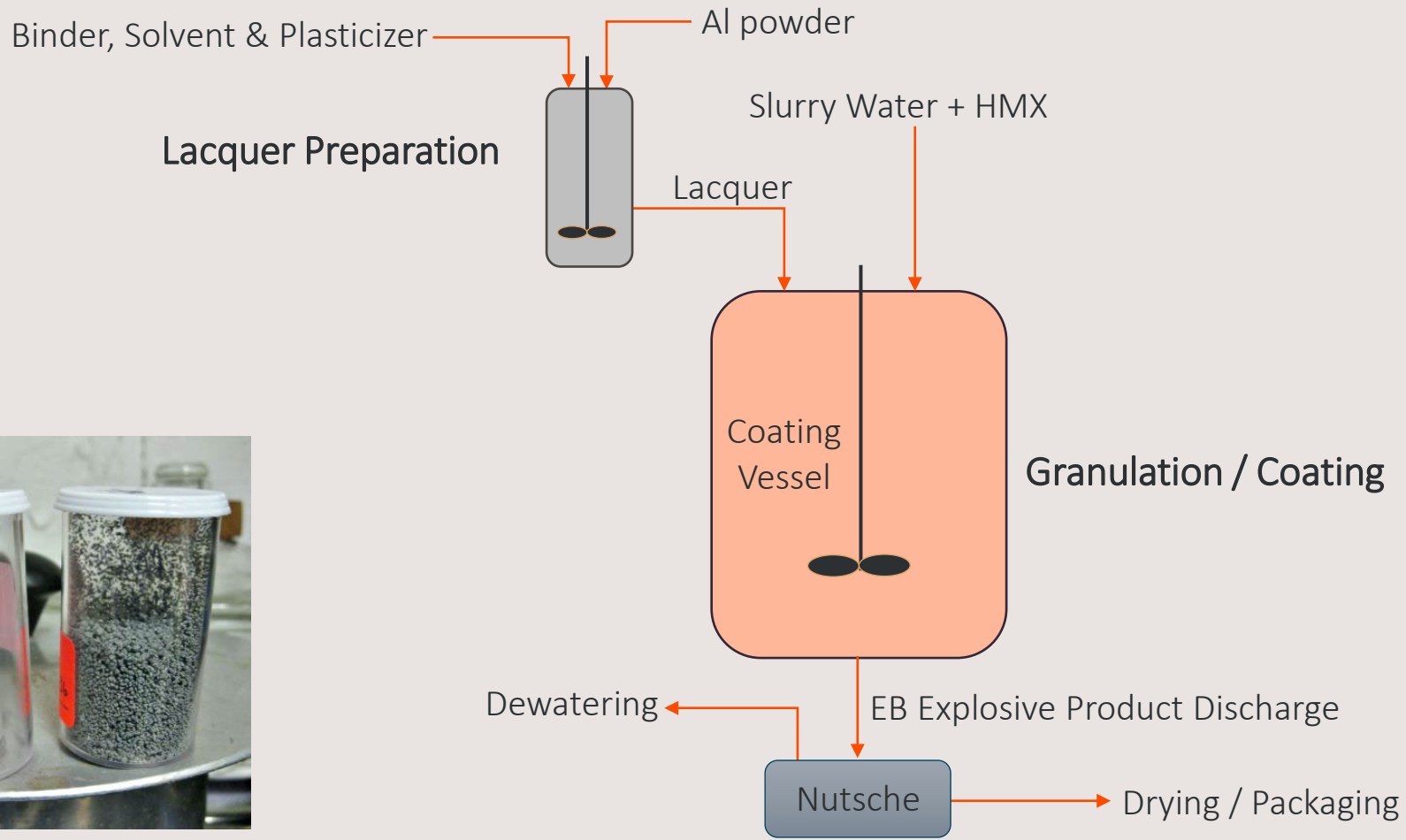
## EB Explosive Process Development

- H<sub>2</sub> Generation from Aluminum/Water Interaction



- BAE Systems developed a water slurry coating process to address potential Hydrogen generation via
  - Suitable additives
  - Specific temperature at key stages (granulation & distillation)
  - Process Configuration Changes (e.g. solvent removal / lacquer preparation)
- H<sub>2</sub> monitoring conducted throughout the process
- The new EB Explosive Water Slurry Process was successfully scaled from Lab (5 lbs.), Pilot (100 - 150 lbs.) to Production (300 – 350 lbs.)

# EB Explosive Water Slurry Process - Overview



# EB Explosive Manufactured in Production at HSAAP (1)

## PAX-3

- Developed & Qualified by US ARMY DEVCOM at Picatinny Arsenal
- HMX based EB with aluminum and energetic plasticizer
- Previously manufactured via Slurry Coating with WR Fluid & TSE
- Robust Process for Slurry Coating with Water developed in 2015
  - PAX-3 made via this technique known as Type III
- Over **25,000 lbs.** manufactured in Production to date
- Fielded/Qualified in the 120mm Advanced Multi-Purpose (AMP), M1147 Tank Cartridge
- Under evaluation in the other weapon systems

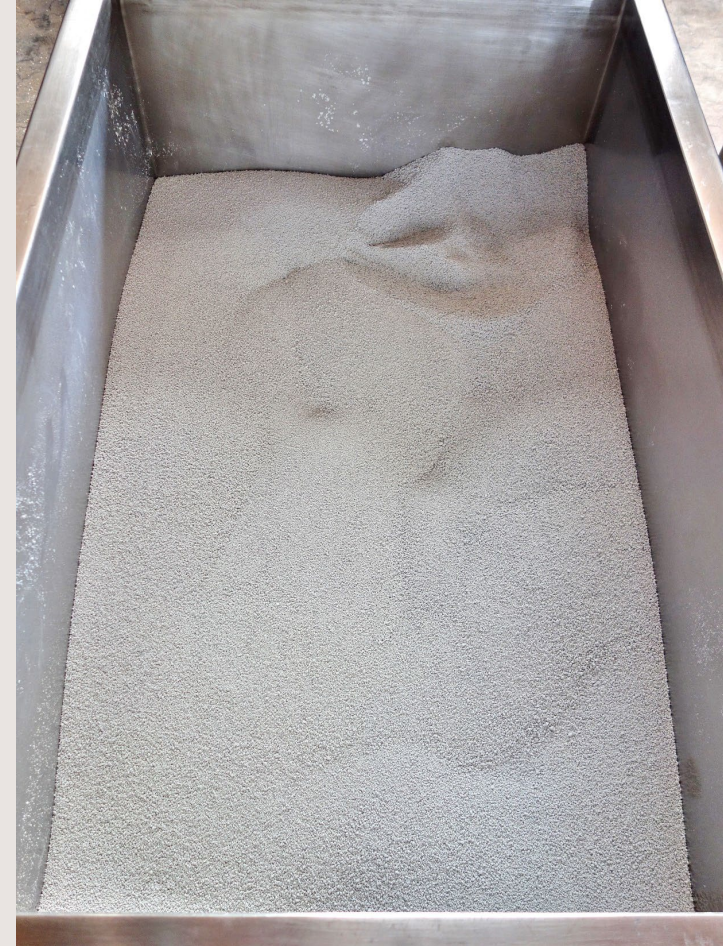
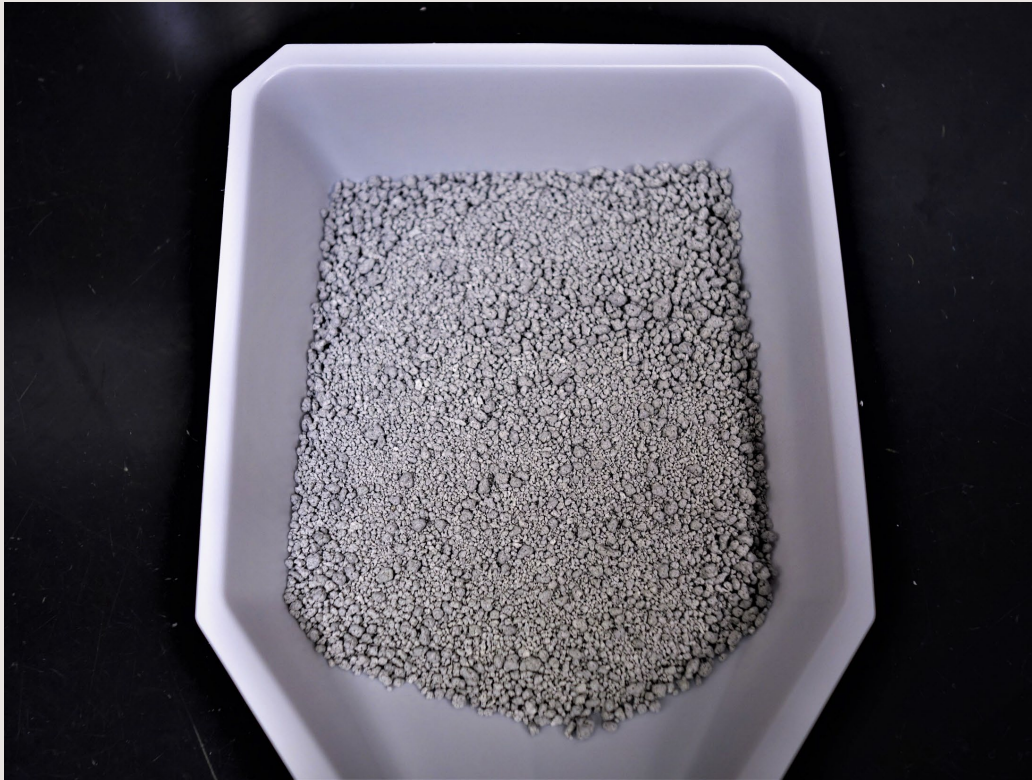


M1147 Photo courtesy of Northrop Grumman



## EB Explosive Manufactured in Production at HSAAP (2)

PAX-3 (from 2017 Production Campaign)



## EB Explosive Manufactured in Production at HSAAP (3)

PAX-3 vs. PBXN-9



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## EB Explosive Manufactured in Production HSAAP (4)

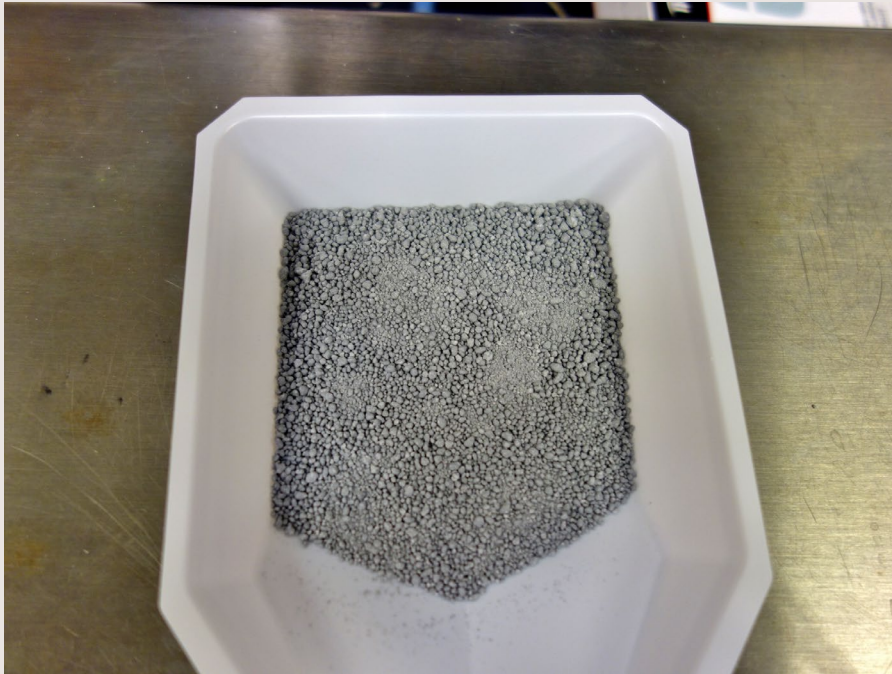
### PBXIH-18

- Developed & Qualified by US NAVY Indian Head
- HMX based EB with aluminum and inert plasticizer (DOA)
- Previously manufactured at HSAAP via Slurry Coating with WR Fluid
- Current process involved Twin Screw Extrusion (3<sup>rd</sup> party facility) of precursor (e.g. PBXN-9)
- Robust Process for Slurry Coating with Water developed in 2016
- Over **2,100 lbs.** manufactured in Production to date
- BAE Systems water slurry material performed identically to WR slurry material (presented at IMEMTS 2016)



## EB Explosive Manufactured in Production HSAAP (5)

PBXIH-18 (from 2017 Production Campaign)



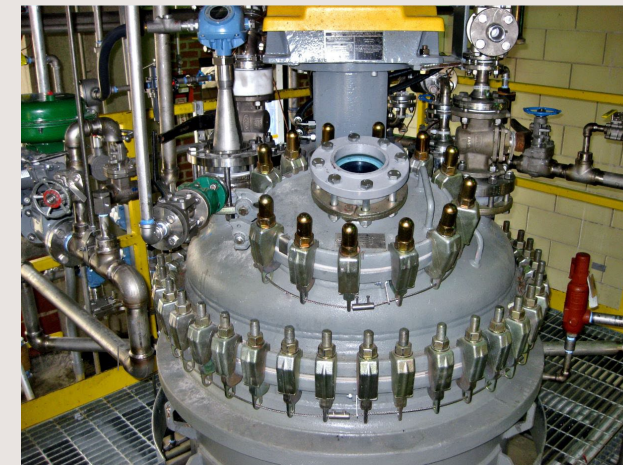
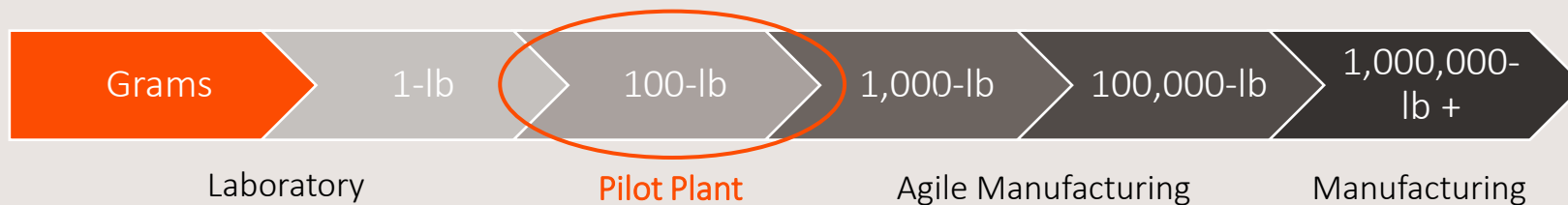
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## EB Explosive Manufacturing Capability at HSAAP (1A)

### R&D Energetics Pilot Plant

- 50-, 100-, 200-Gallon glass-lined reactors (ingredient synthesis)
- 100- and 400-Gallon Formulation Coating Still (pressed explosive)
- Commissioning completed Fall 2013
- Over **74,000-lbs.** of explosives produced in the pilot plant (2013-2022 YTD)
- 38 different materials/products, more expected in 2023 and beyond
  - Energetic Ingredients (e.g. LLM-105, DNP, PYX, NTO, TATB)
  - Formulations (e.g. PAX-3 & PAX-30, reduced sensitivity PBXN-9 and LX-14, LX-17, PBX-9502)

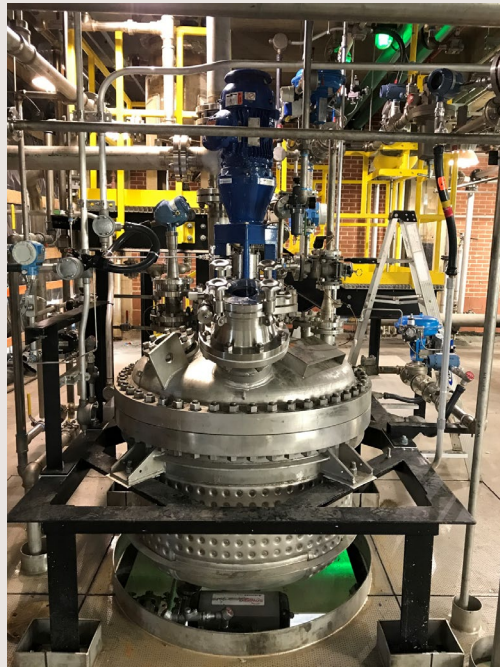


# EB Explosive Manufacturing Capability at HSAAP (1B)

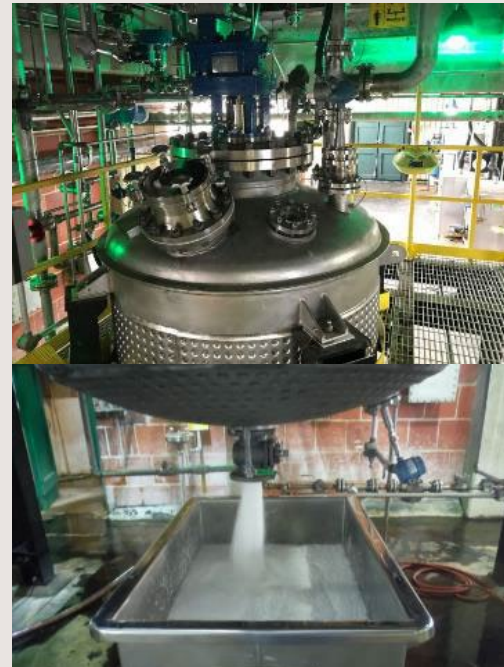
## PAX-3 Manufacturing at the R&D Pilot Plant



Lacquer Preparation Vessel



Coating/Granulation Vessel (Small)  
~ 50-100 lbs.



Coating/Granulation Vessel (Large)  
~ 300 lbs. or more



Dryer / Oven

## EB Explosive Manufacturing Capability at HSAAP (2)

### Manufacturing Equipment – Production Facility

- Continuous PAX-3 manufacturing (24/7 operation)



Lacquer Preparation Vessel



Coating/Granulation Vessel (Large) ~ 300 lbs. or more



Material Handling

## Other EB Explosive Manufactured at HSAAP

### PAX-3 with Alternative Energetic Plasticizer

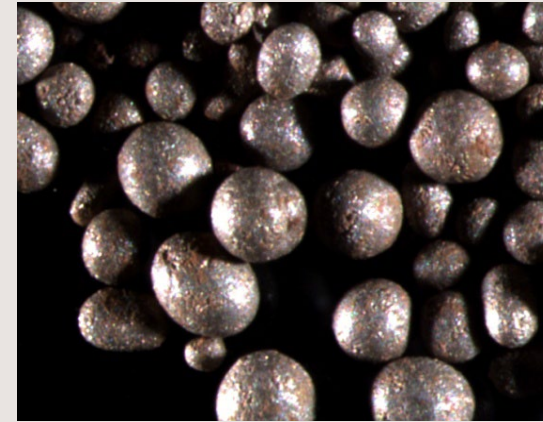
- ~ 2,000 lbs. manufactured with water slurry coating production process (pilot plant)
- Alternative plasticizer replacing current plasticizer (readily available – HSAAP product)

### PAX-30

- High HMX Content (>75%) EB Explosive
- BAE Systems developed lab-scale coating process
- ~ 1,500 lbs. manufactured with water slurry coating production process (pilot plant)

### PAX-42

- High RDX Content (>75%) EB Explosive
- Robust lab scale process developed under IRAD effort
- 2 lbs. batches made successfully in lab; “scale-up ready” at the pilot plant



PAX-3 w alt. plasticizer (Production)



PAX-30 (Pilot Plant)



## Summary

- BAE Systems had developed a **ROBUST, SAFE & COST EFFECTIVE** one-step water slurry coating process to manufacture aluminized EB Explosive at HSAAP
- PAX-3, PBXIH-18, PAX-30 and PAX-3 w alt. plasticizer have been successfully manufactured with Production Equipment
- PAX-3 Type III already qualified; PBXIH-18 made in this process will be qualified in 2023
- PAX-30 scale-up process proven; ready to transition to large campaign
- R&D Pilot Scale Coating Vessel available for Process Development and Optimization with current and new EB Explosives
- Other pressed EB Explosive such as PAX-42 ready to “Scale-Up”



# Acknowledgements

## BAE Systems OSI – Holston Army Ammunition Plant

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