



# Development of a Production Scale Process for the Manufacture of New IM Pressable PAX-46 Explosive

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# PAX-46 Briefing Outline

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- Background - The Need for a Low-cost IM Pressable Explosive
- Development and Scale-up Program
- PAX-46 Test Results
- 2010 Program Goals
- Lessons Learned and Observations from PAX-46 Scale-up
- Conclusions
- Acknowledgements

## Background

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- Pressable Compositions widely used in U.S. DoD Applications
  - Examples: Comp A-3, Comp A-5
  - GMLRS, M430A1 40mm, submunitions, shape charges and boosters
  - Waivers issued to meet DoD 5000.2-R Guidelines
- Comp A-5
  - Pressing Issues
  - High NOL Card Gap
  - Fails IM Tests
- ARDEC Performed Modeling Calculations on Candidate Desensitizing Agents to Match Performance of Comp A-5 Explosive
  - Chlorinated binder systems selected to desensitize RDX
    - Low cost and commercially available

## Summary of PAX-46 Development Program - 2007

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- ARDEC finalized chlorinated binder system for Comp A-5 replacement
    - Conducted pressing/machining studies on molding powder billets
    - Optimized PAX-46 formulation: RDX (Cl. 3 & FEM grades) and chlorinated waxes
  - HSAAP tasked with laboratory development of slurry coating process
    - Processing Parameter Evaluation
      - Agitation Rate
      - Coating Cycle Time
      - Temperature
      - Addition Rate
      - Binder Solubility
      - Water/Solvent Ratio
    - 2 “Grades” (Particle Size) of PAX-46 Product Generated
      - Fine
      - Coarse
  - 50 lbs of Evaluation Material Manufactured
    - Shipped to ARDEC for Evaluation
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## General Observations from PAX-46 Test Results

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- Composition Analysis
  - Screen Fractions Show Uniform Coating
- Bulk Density
  - >0.95 g/cc
- Flow
  - Free flowing
  - 7-12 (Flowdex measurement)
- ERL Impact
  - >35 cm typical



# Test Results

- Pressing

Parameters	LX-14	PAX-46
Press Load (F/LBS)	40,000	26,500
Temp (°F)	210	150
Cycle	1 min ON -30 sec OFF-1 min ON-30 sec OFF-1 min ON	2 min
TMD (%)	98.5%	99%+

- Wall Velocity / Gurney Energy

Formulation	Wall Velocity (km/s)		Gurney (km/s)	
	2	7	2	7
PAX-46	1.469	1.796	2.418	2.955
PAX-2A	1.031	1.340	2.129	2.767
Comp A-5	1.087	1.363	2.333	2.925
LX-14	1.590	1.797	2.482	2.986



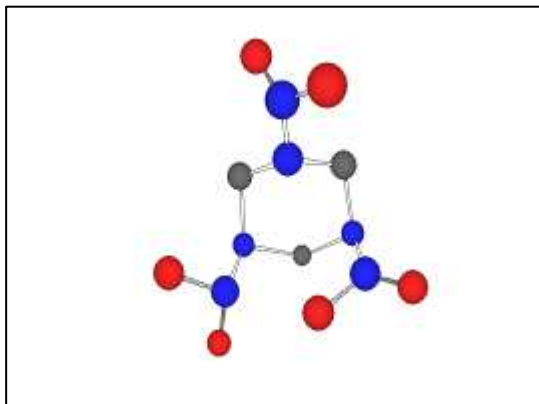
# Bullet Impact

- Type V Reaction – Burn
  - Explosive material recovered after test



## PAX-46 - 2010 Program Goals

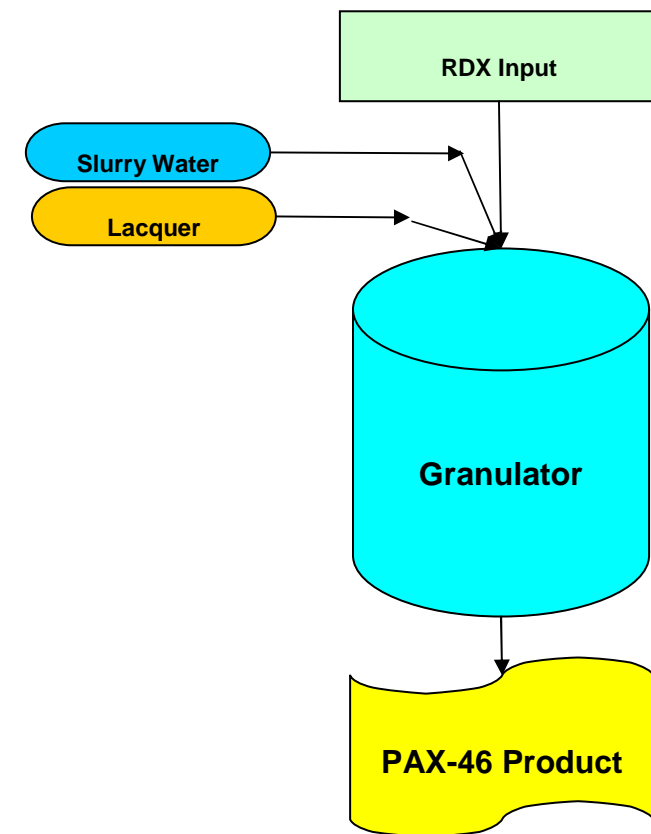
- Effective Transfer of Lab-scale Process to HSAAP Manufacturing
- 2,000 lb PAX-46 Production Campaign
- 4 x 500 lb Batches
  - Pilot Vacuum Still (Bldg G-6)





## PAX-46 Manufacture

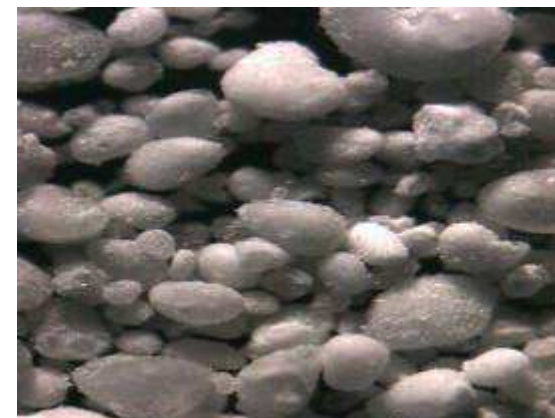
- Traditional HSAAP “Slurry Coating” Technique
  - RDX Slurry in Water
  - Chlorinated Binder Dissolved in Organic Solvent (Lacquer)
  - Lacquer Charged to Slurry to induce Granulation
  - Solvent Distilled and Recovered
  - Product Filtered and Dried



## PAX-46 Product

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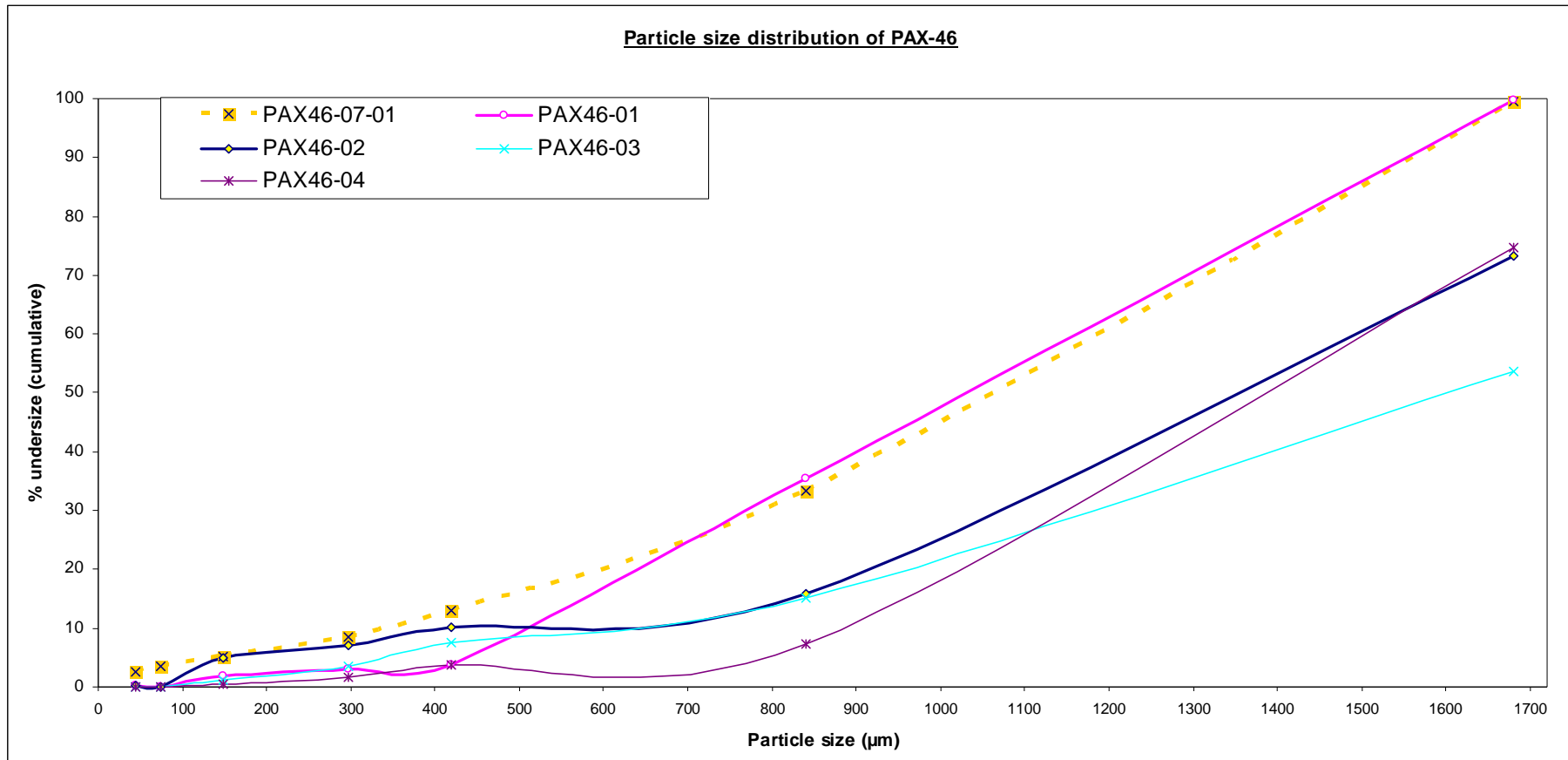
- All 4 Batches Targeted Customer Specifications
- Coating Technique Fits Traditional Processing and Infrastructure at HSAAP
- Fast Production Cycle Times ~ 1.5hr
  - Compared to 3-4hrs for most PBX's
  - Good production robustness & efficiencies
- Estimated Product Costs Near Legacy Explosive Targets



# Select Analytical Results from PAX-46 Production Batches

Batch #	Bulk Density (g/cc)	Flowdex (#)	Co-eff. Friction	% passing USSS #						ERL Impact (cm)
				12 (1680µm)	20 (841µm)	40 (420µm)	50 (297µm)	100 (149µm)	325 (44µm)	
PX46-01	1.0471	7	179.58	99.7	35.5	3.7	3	1.9	0.3	39.05
PX46-02	1.0695	9	235.8	73.2	15.8	10.2	7	4.9	0.3	36.17
PX46-03	1.1236	9	247.8	53.6	15.2	7.6	3.6	1.3	0	34.15
PX46-04	1.0582	8	207.41	74.6	7.4	3.7	1.7	0.4	0	34.15

# Production Results



## PAX-46 Production - Observations & Lessons Learned

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- PAX-46 Production Batches
  - Production material coarser than targeted lab-scale parameters
  - Increase efficiency in high speed pressing application
- Lessons Learned - Key Processing Parameters
  - Agitation Rate
    - Coating efficiency sensitive to “turnover” rate of the slurry medium
  - Temperature
    - “Solvent swelling” of the binder system observed at higher temps
  - Distillation Time
    - Resonance time during distillation affected particle size distribution

## Conclusions and Way Forward

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- PAX-46, a Promising IM Replacement for Comp A-5, has been Successfully Scaled at HSAAP (500-gallon capacity)
- 2,000 lbs Manufactured in Program
- Pressing, Performance, and IM Testing in Progress at ARDEC
- PAX-46 Appears Suitable for High-Speed Pressing Operations
- Product Meets Objective of “Low-Cost” IM Pressable Explosive
- Planned Munitions Evaluations
  - M430A1 HEDP 40mm Grenade
  - Bangalore Torpedo
  - M2A4/M3A1 Cratering Charges
- Future Effort
  - DOE of production process (6,000-gallon scale)
  - Engineering efficiency of distillation cycle



# Acknowledgement

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