



Innovation ... Delivered.

**NC Quality Characterization
Improvement and Its Impact on
Single Base Propellant
Manufacturing and Performance**

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Acknowledgments



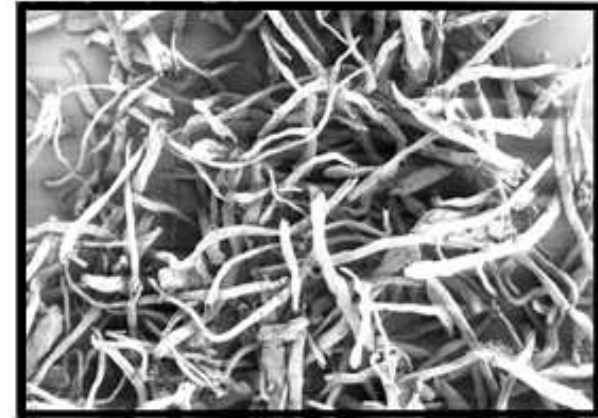
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Discovered in the mid-1800's

- First synthesized by Schönbein, highly unstable
- Abel perfected the purification process allowing “safe” manufacture
 - First Application: Black powder replacement
 - Celluloid – photographic film, table tennis balls, knife handles, fountain pens



Current Applications

- All extruded gun and small rocket propellant products across entire DoD
 - Flake and spherical powders in small caliber
 - Granular propellant in medium and large caliber (direct and indirect fire)
 - Extruded rocket motors (MK-90 Hydra 70mm, M7-TOW/SMAW, Javelin)

RFAAP is the Sole NC Manufacturing Plant in North America

Nitrocellulose Modernization Program



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US Army Funded “Process Improvement” Project

- Installation of new cellulose cutting technology
- Installation of full scale deflaking process
 - Building on success of ATK pilot scale process

Full Scale Deflaking Process

- Consists of two conditioning tanks, feed control system, and two Deflakers in series
- Additional process step remains labor cost neutral through process automation
- Innovative recirculation loop that provides:
 - More mechanical work than traditional “feed tank” circulation with less processing time
 - Easily tailorable for a variety of customer requirements

Cellulose Sheet Cutter



Deflaker



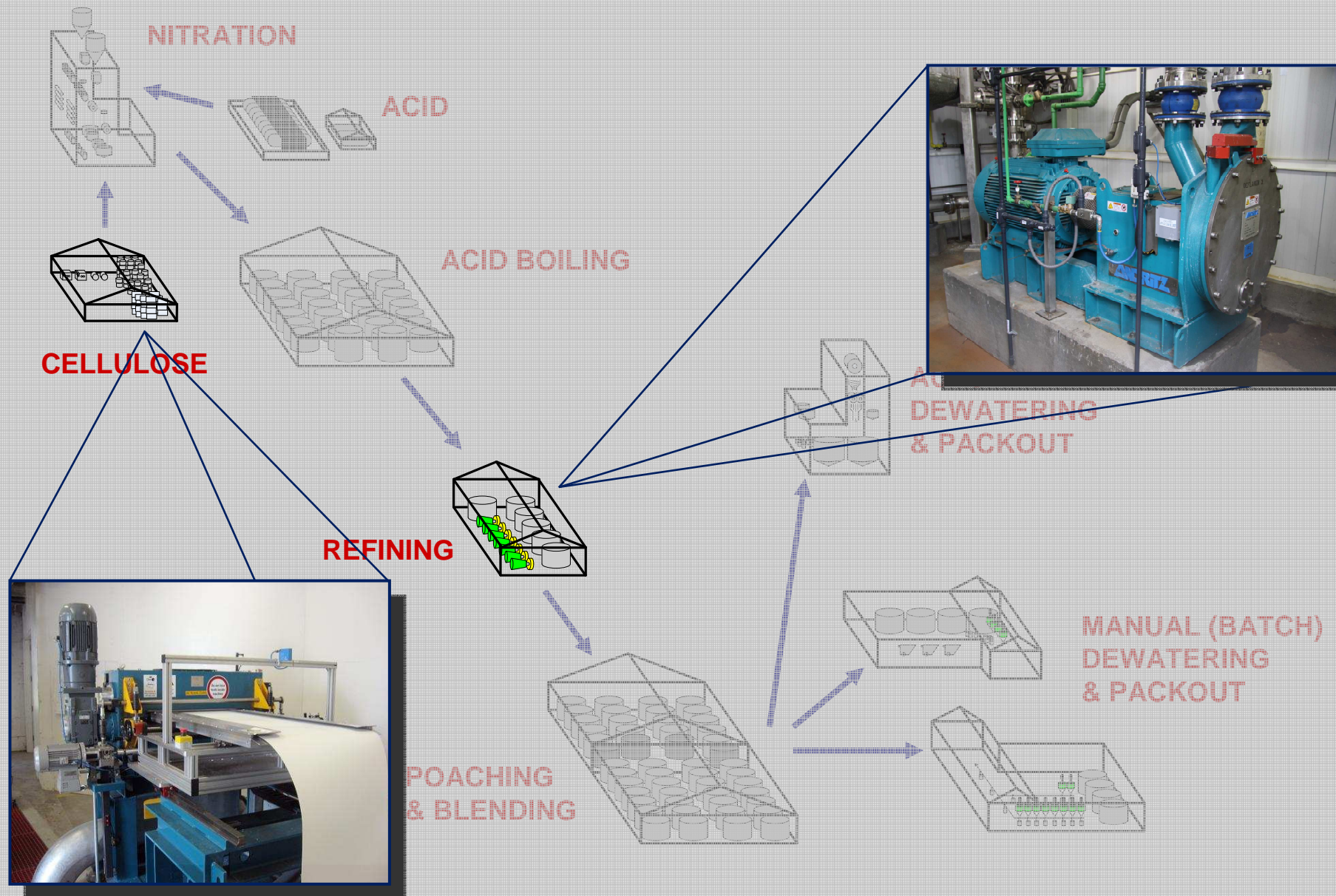
Successful Integration of Modernized Process within Existing Infrastructure

NC Manufacturing Process Flow at RFAAP



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NC Improvement Program Justified with Data

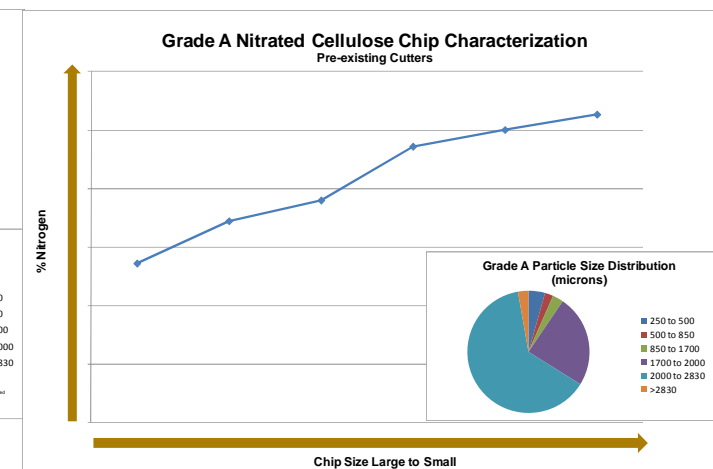
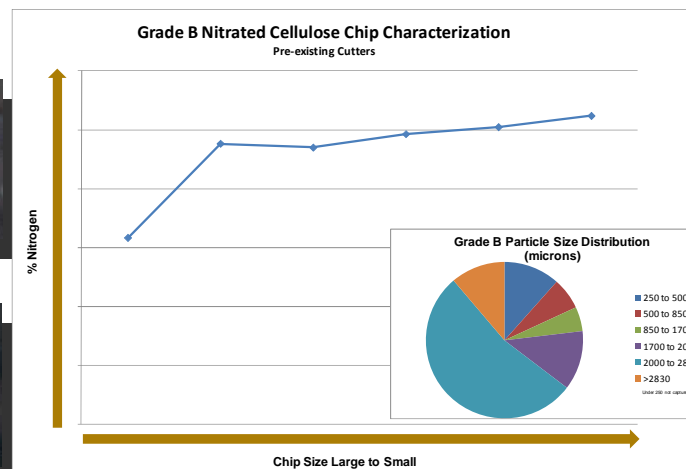
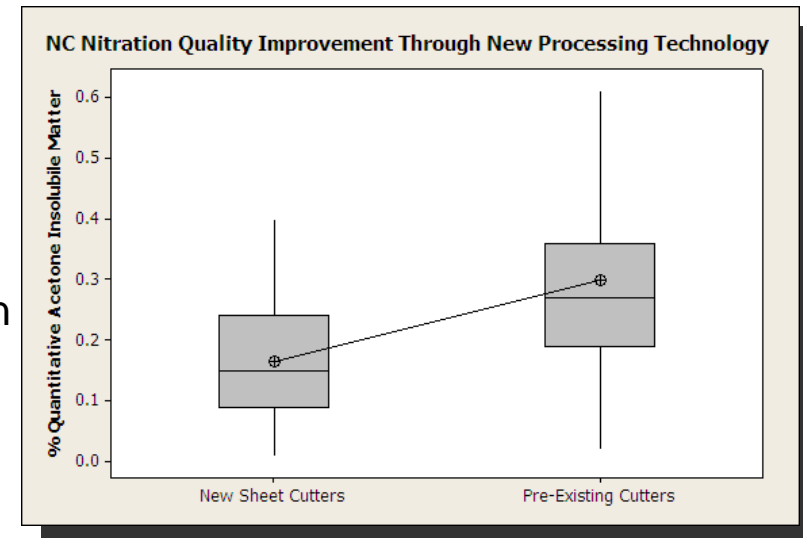


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NC Process Improvement Program – Nitration Quality

- New cellulose sheet cutters provide
 - More uniform chip size
 - Improved Chip Dimensional Control
- Improved cellulose dimension consistency at nitration improves nitration distribution
 - 45% Reduction in Acetone Insoluble Matter
 - 43% Reduction in Acetone Insoluble Variability



Improved Cellulose Dimension Control Improves Nitration Quality

NC Improvement Program Justified with Data

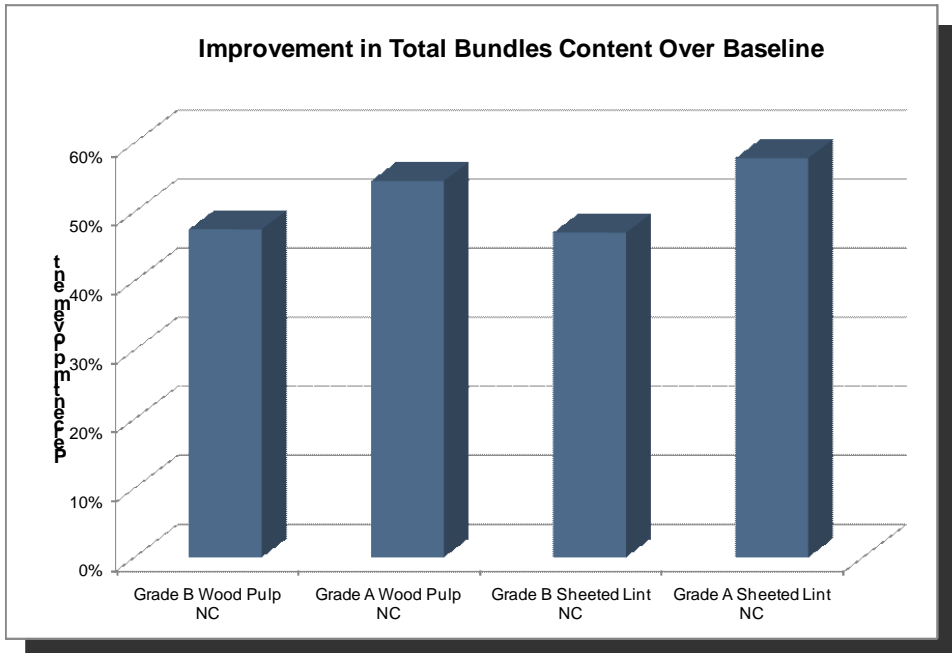


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NC Process Improvement Program – Fiber Quality

- Deflaker commissioning completed July 2009
- Select propellants qualified
- Full scale Deflaker Process bundles characterization validates:
 - Significant bundles reduction
 - Improved NC Fiber Quality
 - Improved propellant processing and performance
 - Reduction in propellant variability



50% Reduction in Final Product Agglomerate Content

M14 Propellant Processing Improved



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Improved NC Results in Improved Single Base Propellant Processing on 1st Production Lot!

- Improvements in Direct Fire Propellant Processing Results
 - 40% Reduction in NC Alcohol Variation at Dehydration
 - Improved propellant mixing/consolidation.
 - No secondary solvent adds required to control dough consistency and press pressure
 - Improvement in granulation process yields to >99%
 - 60% Reduction in Scrap/Waste
 - Improved Solvent Recovery in Propellant Finishing Process
 - 33% reduction in final propellant residual solvent content
 - Improved safety inside M1 Abrams Tank – solvent fire risk



**Single Base Propellant Processing Improvements with Modern
NC Processing Technology**

M14 Propellant Performance Improved



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Improved NC Results in Improved Single Base Propellant Performance on 1st Production Lot!

- Improved Direct Fire Propellant Ballistics
 - Improved grain-to-grain uniformity
 - 14% improvement in grain OD variation
 - More ballistically efficient propellant
 - Lower charge weight to maintain velocity with no impact on pressure
 - Improved charge weight performance
 - Improvement adds margin, minimizing loadability and supply continuity risk



Improved Ballistic Performance Minimizes Supply Risk

Summary



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- Successful integration of modern processing technologies within the existing NC manufacturing process
 - Joint effort between PM-Joint Services, ATK, and Bowas-Induplan Chemie GmbH
- New process technologies provide improved NC quality
 - Improvements in NC quality characterized
 - NC Quality effects on M14 single base propellant manufacture quantified
 - Propellant Processing Improvements
 - Propellant Ballistic Improvements
- New NC process equipment qualified and in production



**Continuous Improvements In Manufacturing Technologies
Delivering Improved Performance to the Warfighter**