

Identifying a New Source of Wood Pulp for Manufacture of Nitrocellulose

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Background

Opportunity: Most propellants for the U.S. DoD rely on high quality cellulose as a critical raw material for the production of nitrocellulose.

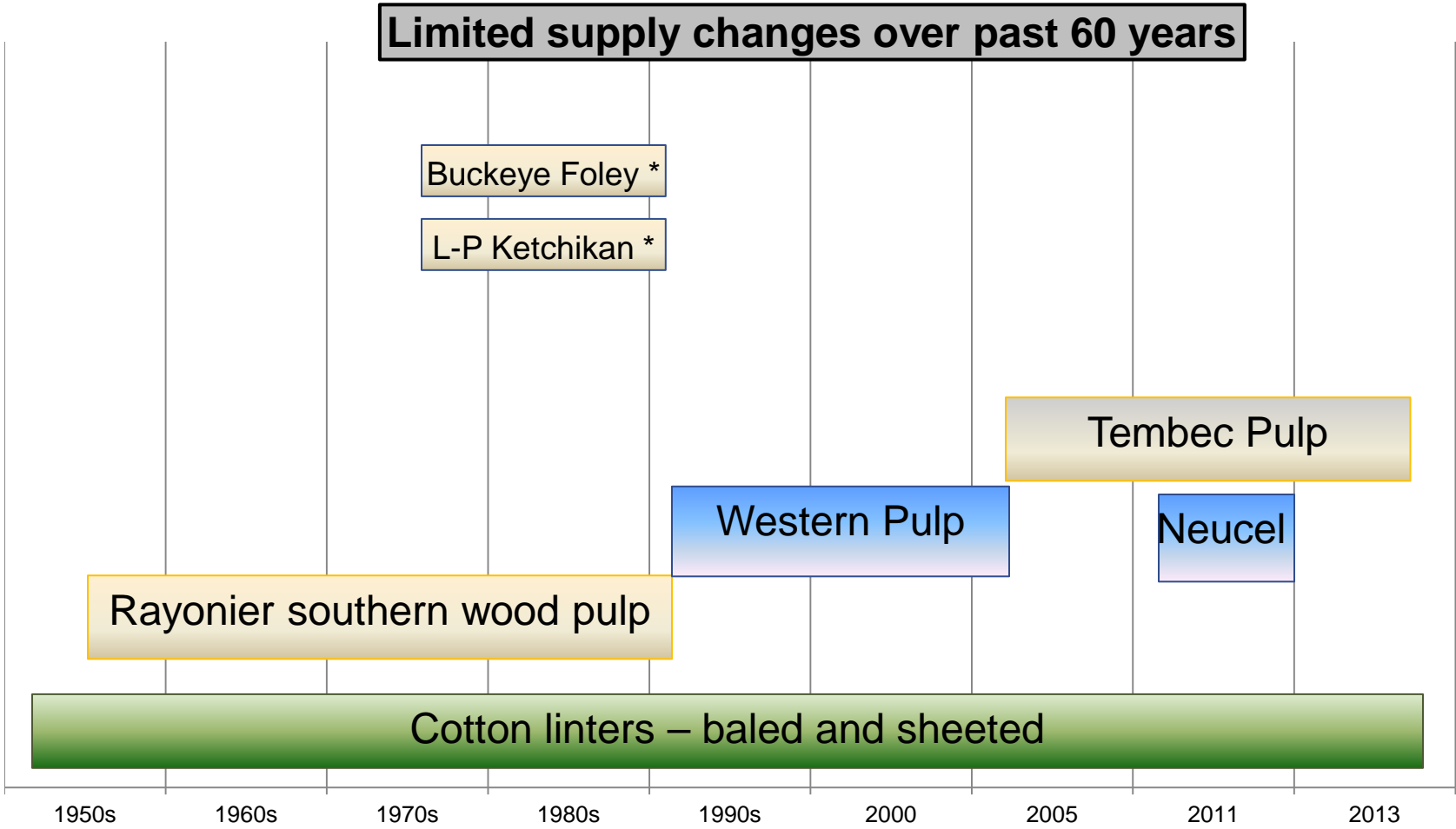
Single Point Failure: Current single qualified Canadian sulfite wood pulp source has potential for supply interruption. Strategic sourcing requires new qualified wood pulp suppliers.

Project Goal: To investigate the use of Kraft cellulose for the production of military grade NC and propellants in order to reduce risk associated with single point failure and provide opportunities to source cellulose from domestic sources.

Outline for Discussion:

- RFAAP cellulose supply history and global pulp supply
- Difference between sulfite and sulfate wood pulp
- RFAAP wood pulp sources - criteria for wood pulp and available suppliers
- Risk assessments for new wood pulps
- Current NC Production Process
- Modernization Effort

RFAAP Cellulose Supply History 1950 - 2013



* Intermittent suppliers

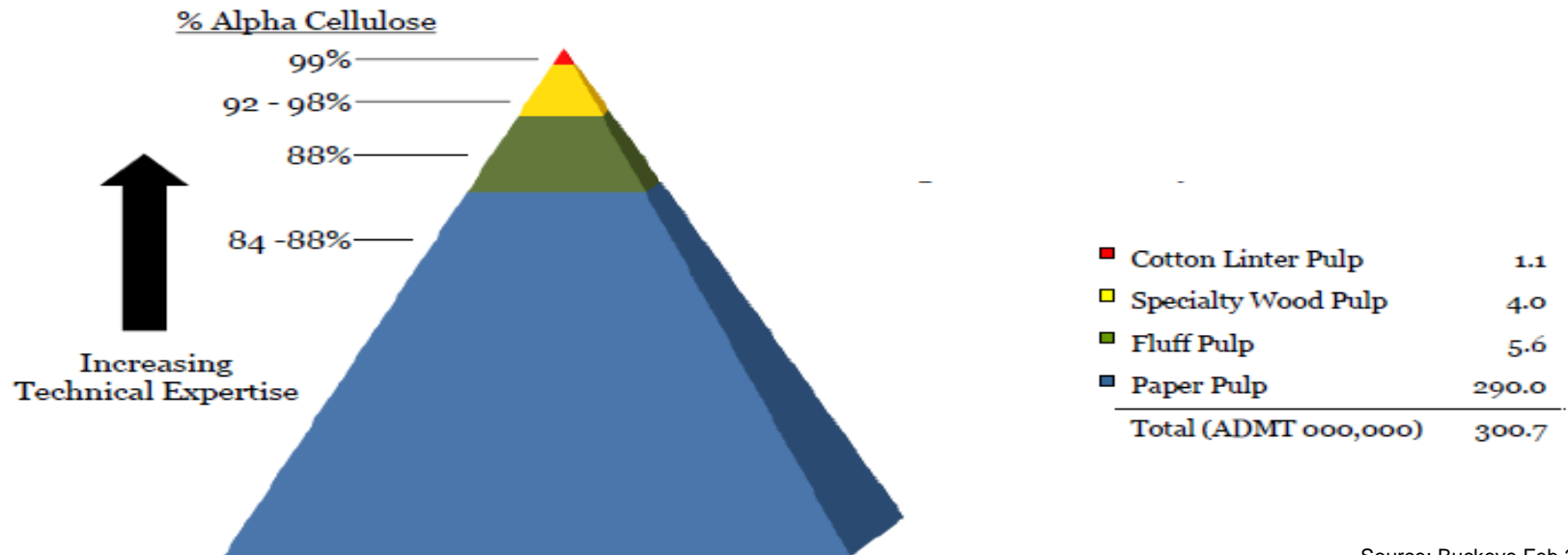
Recent RFAAP Wood Pulp Suppliers

Company	Mill location	Wood pulp	Recent RFAAP supply history
Neucel (previously known as Western Pulp)	Port Alice, British Columbia	Western hemlock	<ul style="list-style-type: none"> •several owners over the past 10 years •mill stoppages put RFAAP NC at risk (10/22/2004) •Feb 2010 Chinese firm bought 20% of mill, the remaining 80% in Feb 2011, <u>stopped</u> pulp sales to RFAAP
Tembec	Temiscaming, Quebec	Eastern spruce	<ul style="list-style-type: none"> •unable to fill all RFAAP wood pulp orders short-term in past 3 years <ul style="list-style-type: none"> - Sept 2010 mill operating problems - Jan 2011 digester tank failure

Global Pulp Supply

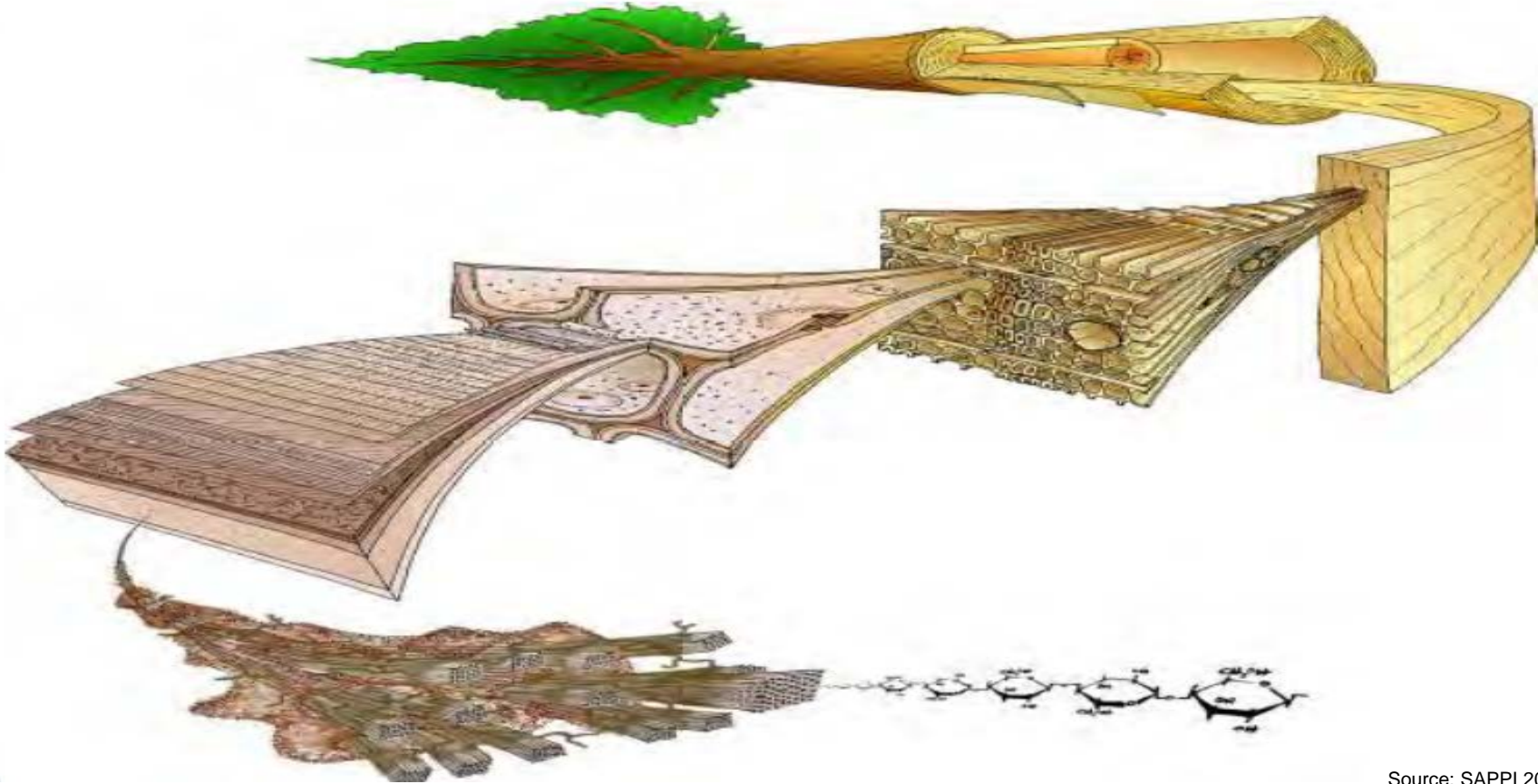
<u>Global pulp</u> (Million Tons)	<u>Specialty wood pulp</u>	Global Nitrocellulose	RFAAP NC
300.7 (100%)	4.0 (1.3%)	0.14 (0.046%)	0.006 (0.002%)

Total Pulp Market Worldwide Usage (Captive & Market 2011)



Source: Buckeye Feb 2013

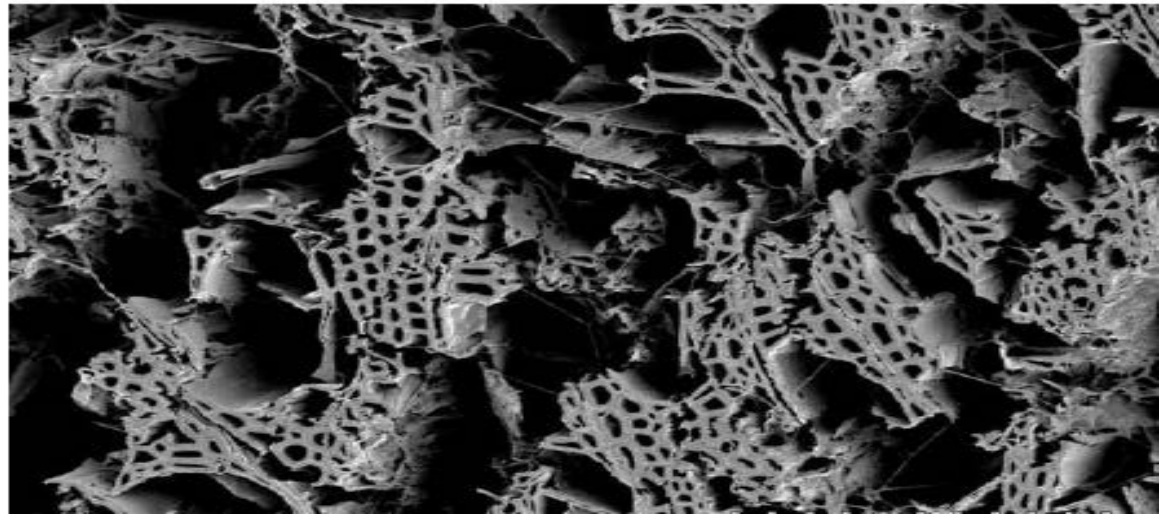
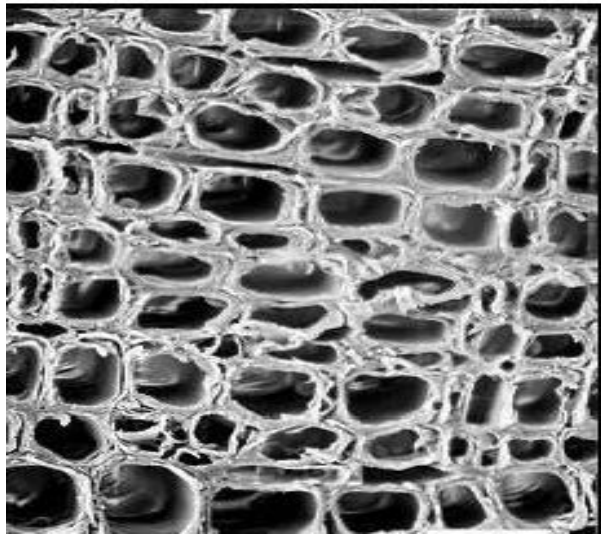
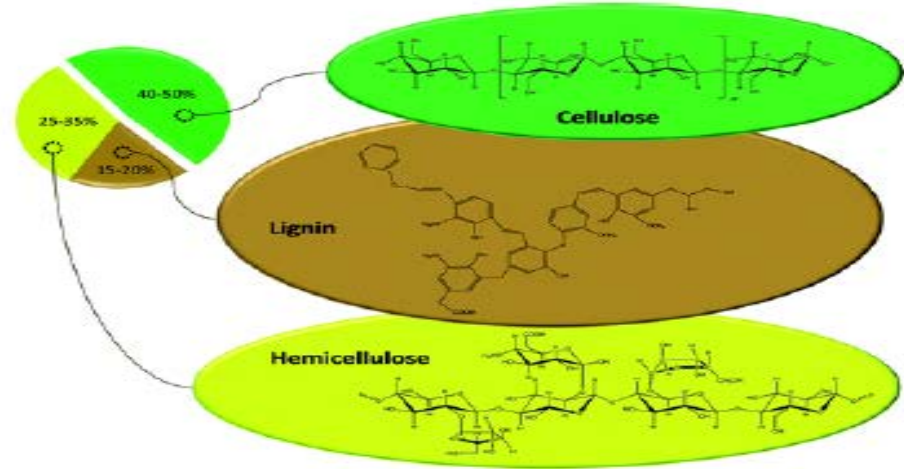
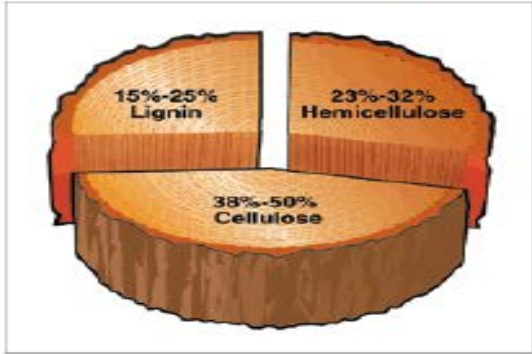
Evolution: From Tree to Molecule



Source: SAPPI 2012

Pulping Process Removes Lignin: Acidic (Sulfite) or Caustic (Sulfate)

The pulping process



Source: SAPPI 2012

Cellulose Markers for Successful NC Production

Cellulose Key Parameters

- Chemical Purity
 - Alpha Cellulose
 - Contaminants (Lignin, Hemicellulose, Iron, Silica, etc.,)
- Acid Wettability in Fibers (Mass Transfer)
- Physical Characteristics
 - Fiber Length/Wall Thickness
 - Sheet Bulk Density/Basis Weight
 - Sheet Thickness
 - Mullen/Tear Strength
 - Sheet Shear Properties
 - Cuttability & Dusting

NC Key Requirements

- Chemical Reaction & Predictability
 - % Nitrogen
 - Solubility (AI, EAI)
 - Viscosity
 - Stability
- Physical Characteristics
 - Particle Size Morphology
 - Fiber Aggregates/Bundles
 - Fines
 - Particle Size Distribution
- Solvent Wettability/Dough Rheology

US Mills - RFAAP Alternative Sulfate Pulps

Southern pine

- **Buckeye** **Foley, Florida**
 - **Has dissolving pulp that meets military specification**
- **Rayonier** **Jesup, Georgia**
 - **Has dissolving pulp that meets military specification**
- **Weyerhaeuser** **Port Wentworth, Georgia**
 - **Lower alpha content**
- **RockTenn** **Panama City, Florida**
 - **Lower alpha content**

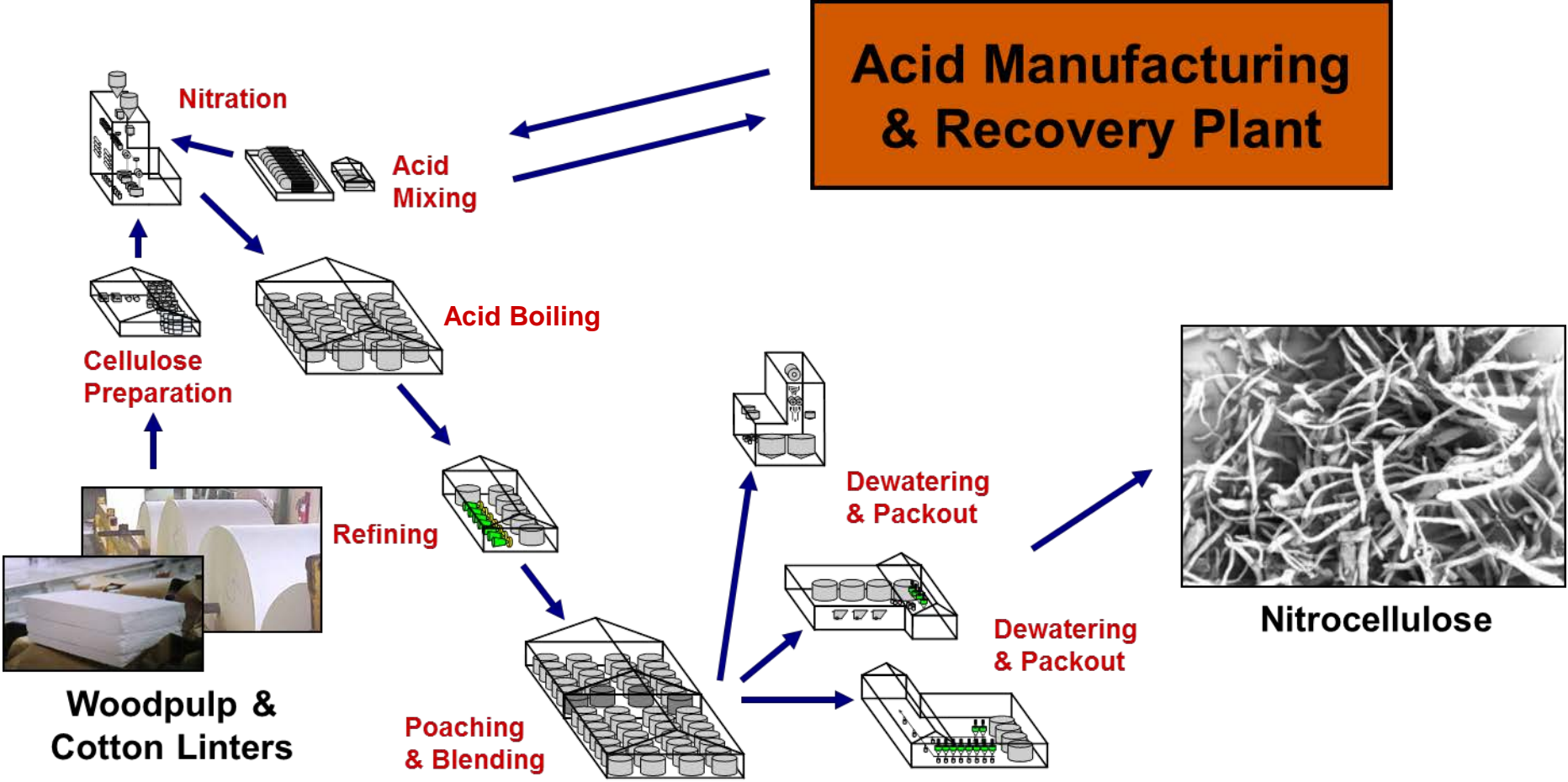
Northern Pine

- **SAPPI** **Cloquet, Minnesota**

Risk Assessment for New Sources of Cellulose

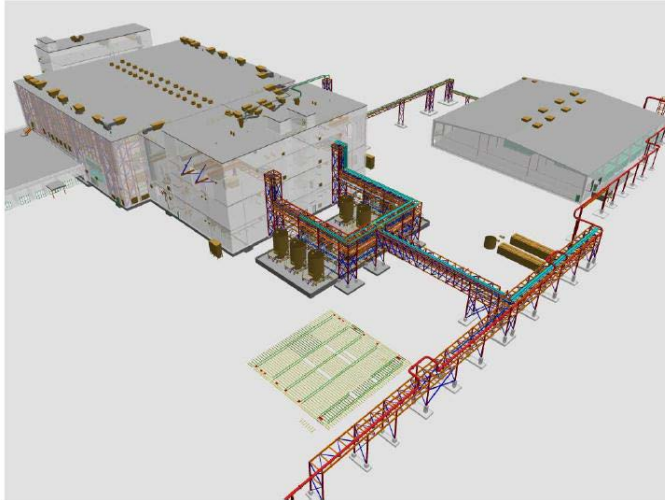
- **Fiber wettability with acid and washing/centrifuging**
- **Fiber density as cut fiber in reactor**
- **Residuals from higher hemicellulose/lignin levels and effect on stability/poaching**
- **Overall yield based on variations in alpha content**
- **Viscosity control**
- **Nitration set points, ratio of nitric, sulfuric and water**
- **Fiber handling in cutting and air-veying**
- **Dough rheology and solubility**

Nitrocellulose Manufacturing



Nitrocellulose is the energetic binder for all RFAAP propellants

Modernized NC Facility Coming to RFAAP



Plant Iso View (looking Southeast)



Project Description:

- Design, Procurement and Construction of a New NC Facility
- 20M lb/yr NC with a surge capacity of 28M lb/yr

Performance / Benefits:

- Two nitration trains capable of producing Grades A, B, & C IAW MIL-DTL-244B
- Increased operational efficiencies, reduced emissions, reduced energy consumption

Projected Commissioning: 4th Quarter 2016

Questions??

Thanks For Your Attention!

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