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# GRI's Fibrous Filler Technology

April 5<sup>th</sup>, 2006

Presented by:

Dr. Vijay Mathur, GR International

32918 6<sup>th</sup> Avenue SW, Federal Way, WA 98023

Ph: 253-924-6070

[Vijay.mathur@griinc.org](mailto:Vijay.mathur@griinc.org)

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## **AGENDA**

**April 5<sup>th</sup>, 2006**

- 1. Background and Acknowledgements**
- 2. Statement of Problem**
- 3. GRI Technology Solutions and Innovation**
- 4. Project Objective and Schedule**
- 5. Status of Milestones / Key Issues**
- 6. Project Output / Key Accomplishments**
- 7. Commercialization Barriers / Economics**
- 8. Commercialization Plan and Strategy**
- 9. Energy Efficiency**
- 10. Current Status**

- ◆ **Project Title:** **Fibrous Fillers to Manufacture Ultra-High Ash / Performance Paper**
  
- ◆ **Project Number:** **DE-FC07-0131D14439**
  
- ◆ **Principal Investigator:** **Dr. Vijay K. Mathur**
  
- ◆ **Industrial Partners:**
  - **Weyerhaeuser Company**
  - **Grays Harbor Paper Company**
  - **Lawrence Livermore National Laboratories**
  - **Pennsylvania State University**
  - **University of Washington**

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# Statement of Problem

- ◆ **The Paper Industry currently uses fillers to reduce manufacturing cost and energy consumption**
- ◆ **The problem is that the current fillers causes a Loss in Paper Strength**
  - **This is due to their size, shape, and aspect ratio**
- ◆ **This strength loss limits the amount of filler added into paper to ~15% to 18%**

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# GRI Technology Solutions and Innovations

**I. “Fibrous Fillers:” Patented Calcium Silicate Products**

- Silicate nano-fibers (SNF / Tech-8) - ultra-high opaque pigment
- Silicate macro-particle (SMP / Tech-4) - ultra-high bulk pigment
- Silicate macro-particle low-drying demand (SMF-LDD / Tech-6) – lower drying demand and ultra-high stiffness (intrinsic stiffness)

**II. “Super” PCC / Tech-2: Patented High Pressure Process**

**III. Chemical Pretreatment for Fillers  
(Licensed from Weyerhaeuser)**

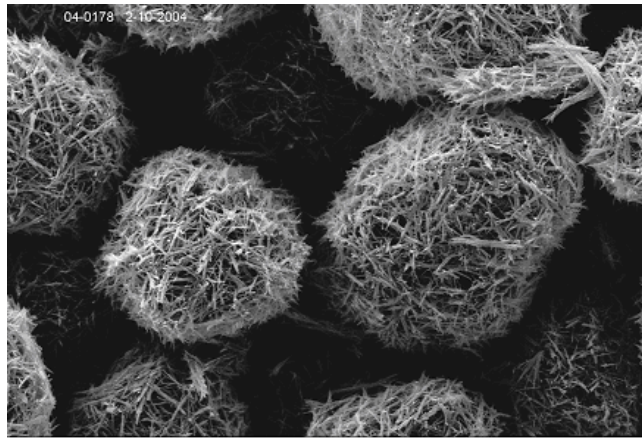
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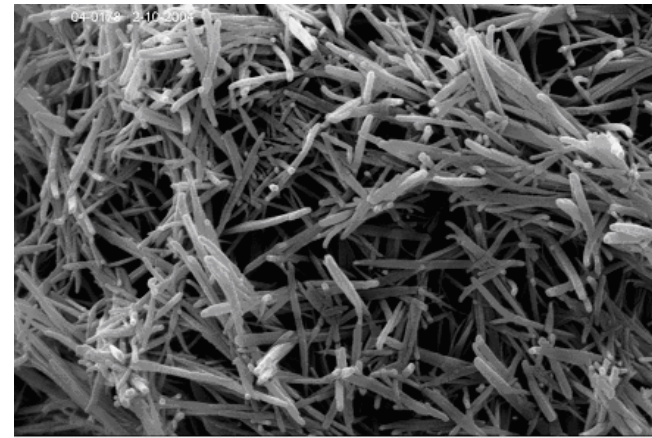
**Products**

**Tech-8 SEMs**

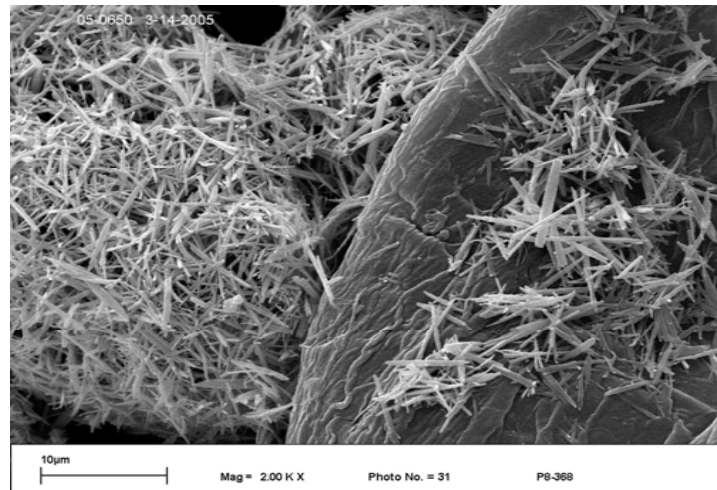
**Silicate Nano-Fibers (SNF)**



10  $\mu\text{m}$  | 10 $\mu\text{m}$  | Mag = 2.00 K X | Photo No. = 8 | WX064



1  $\mu\text{m}$  | 1 $\mu\text{m}$  | Mag = 10.00 K X | Photo No. = 7 | WX064



10  $\mu\text{m}$

10 $\mu\text{m}$  | Mag = 2.00 K X | Photo No. = 31 | PB-368

**Confidential**

**Proprietary**

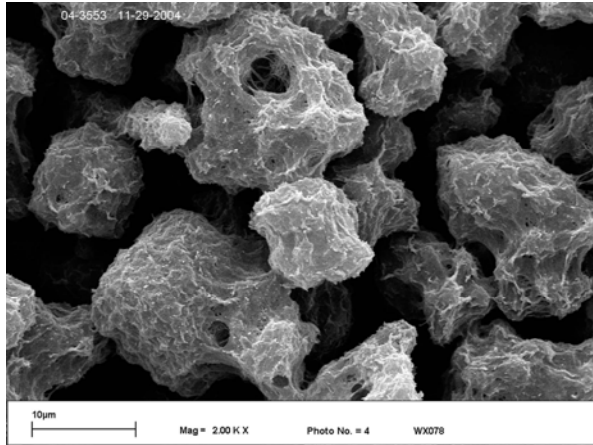


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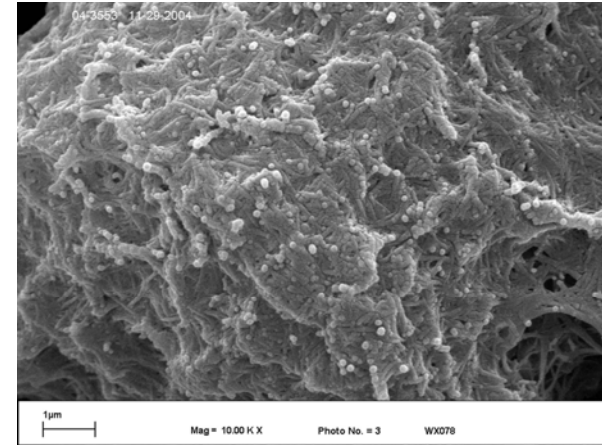
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**Products**  
**Tech-4 SEMs**

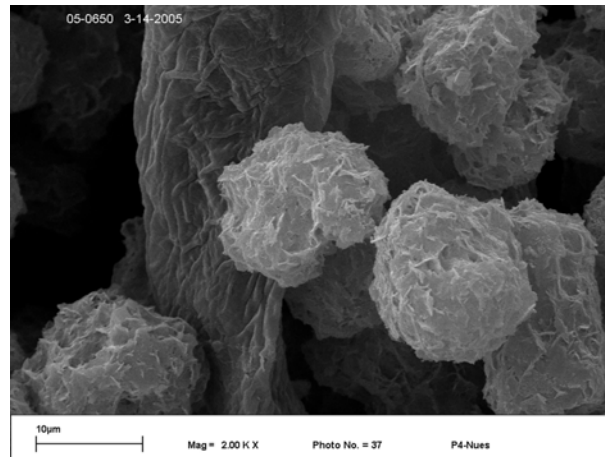
## Silicate Macro-Particle (SMP)



10 µm



1 µm



10 µm

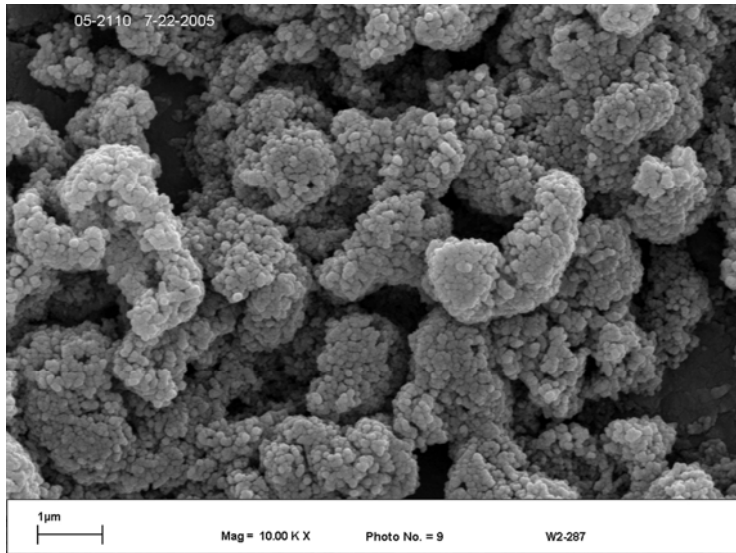
**Confidential**

**Proprietary** 9

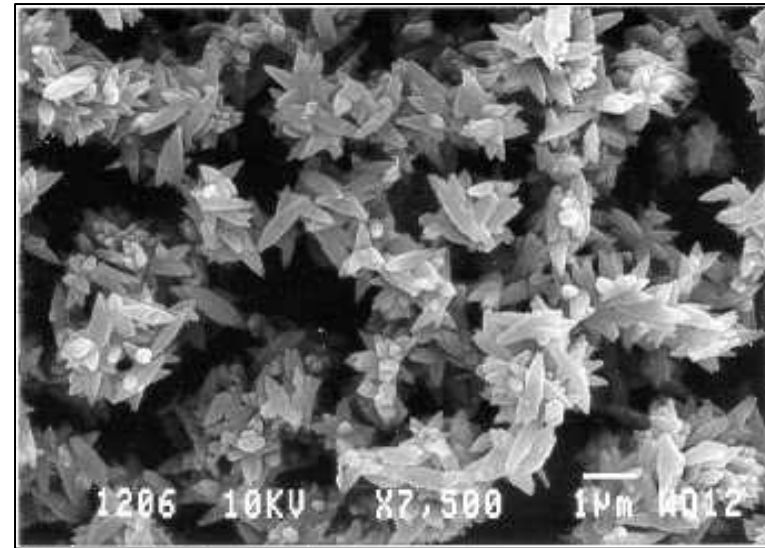
“Fibrous Fillers”

**GRI’s Technology**

“Super” PCC for Fillers

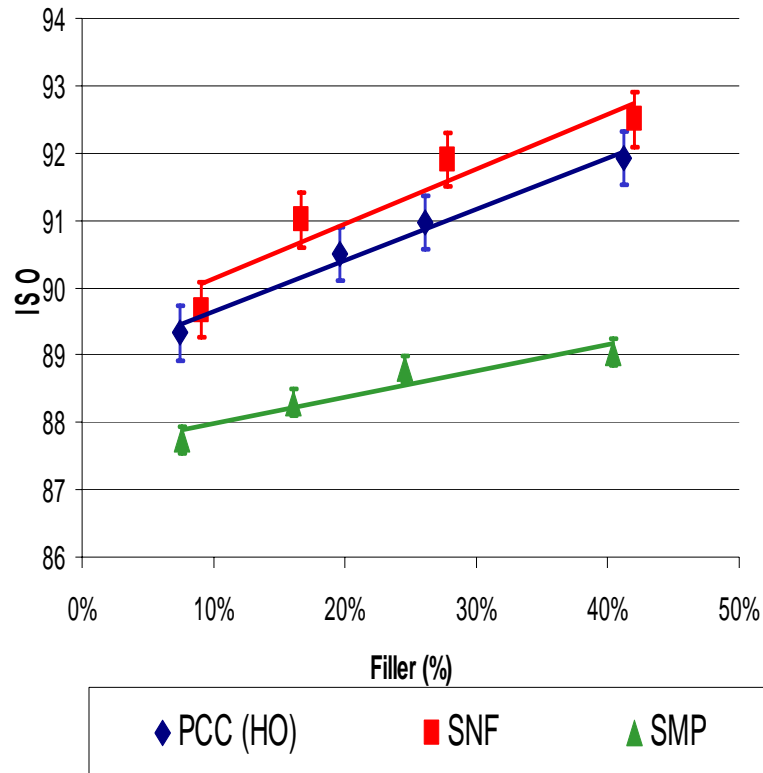


Nano-Clustered PCC

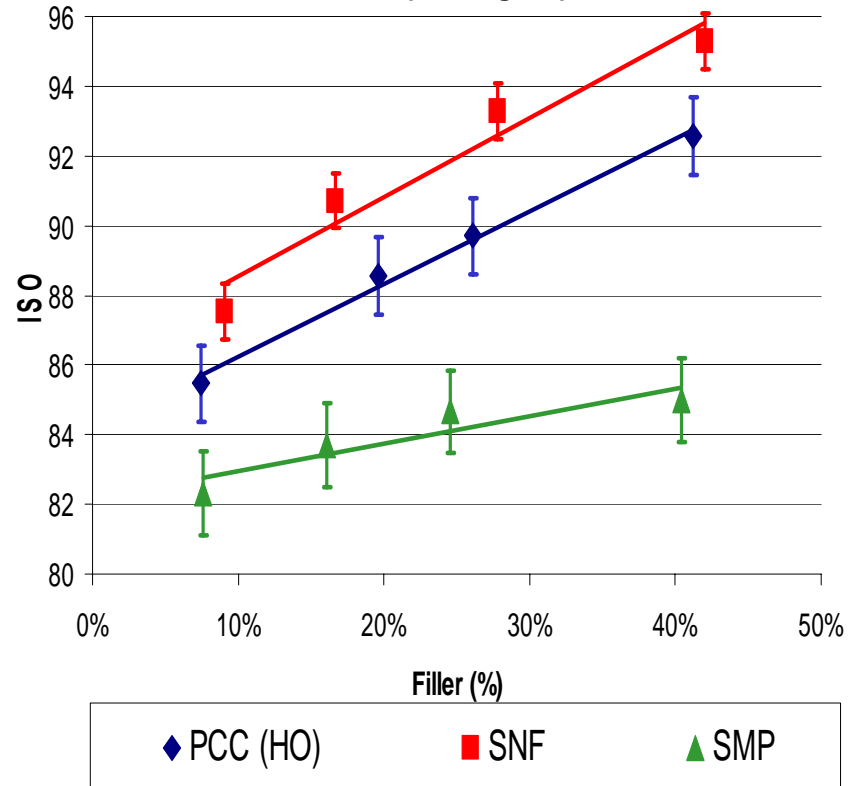


Scalenohedral

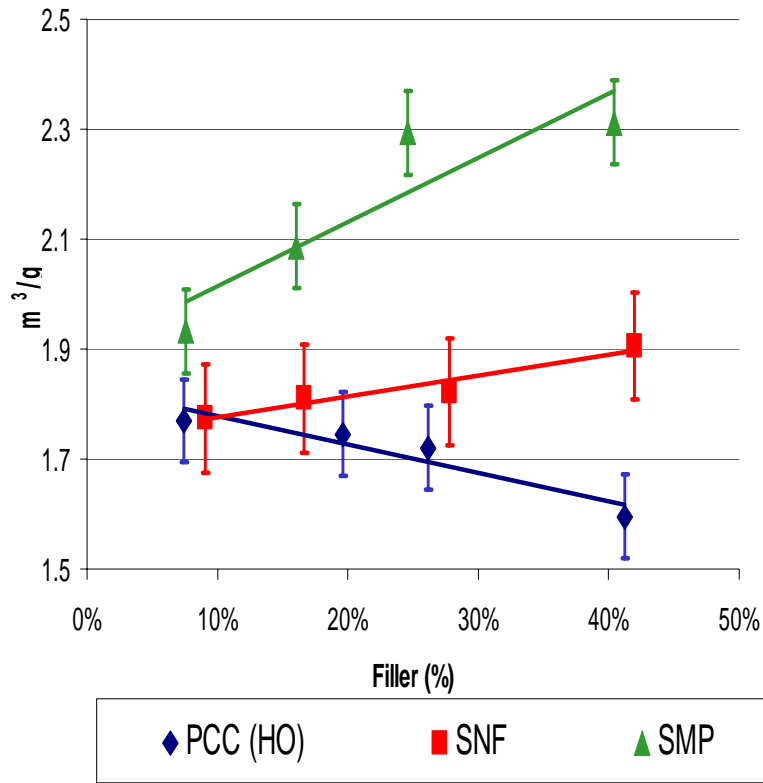
Brightness



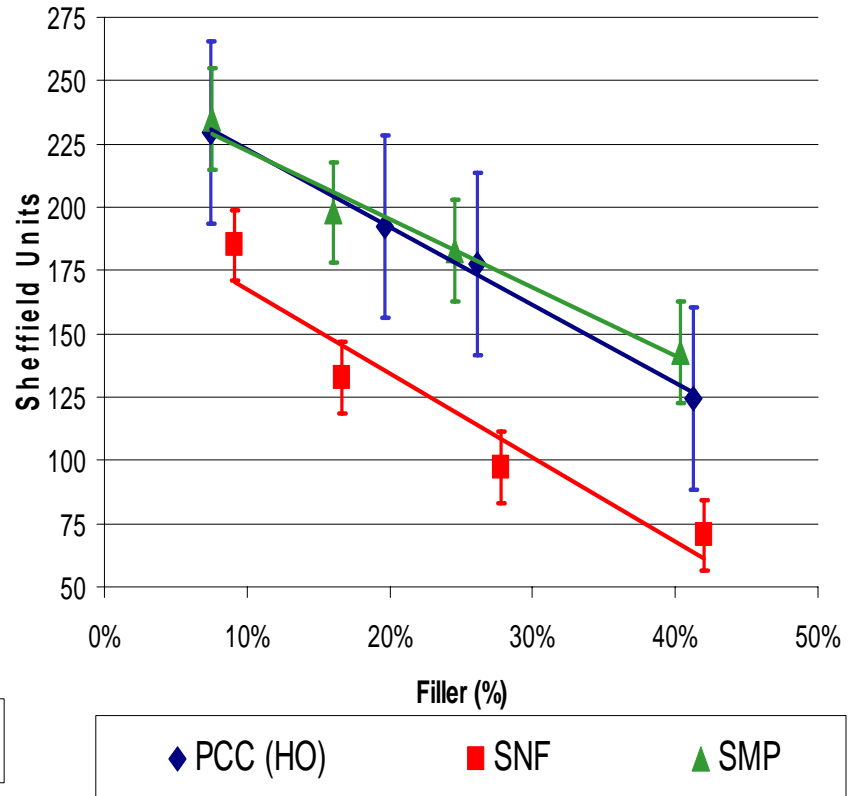
Normalized Opacity (to 74 gsm)



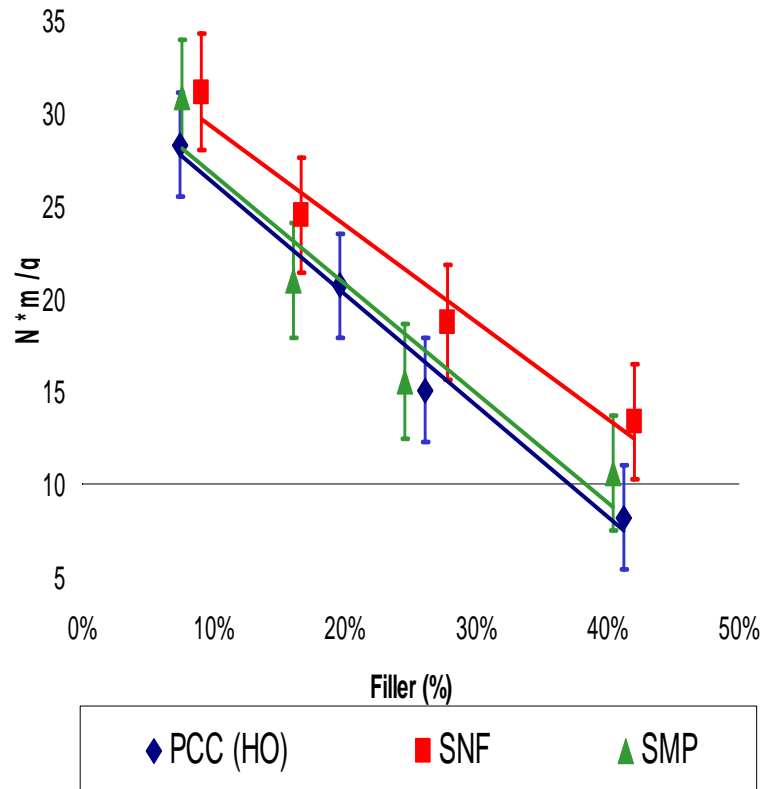
Bulk



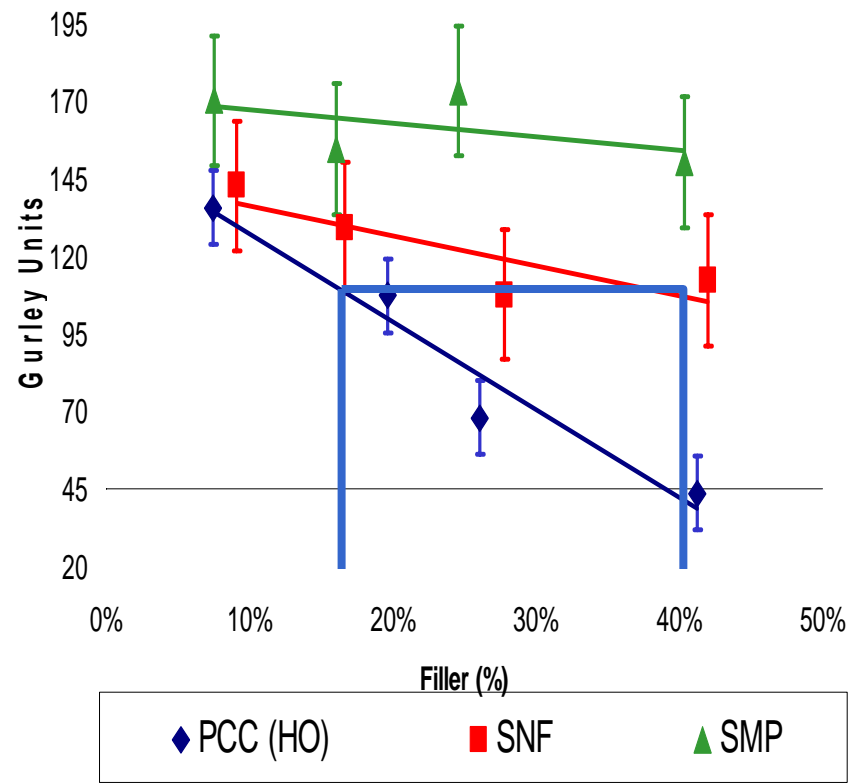
Smoothness (Felt-Side)



Tensile Index

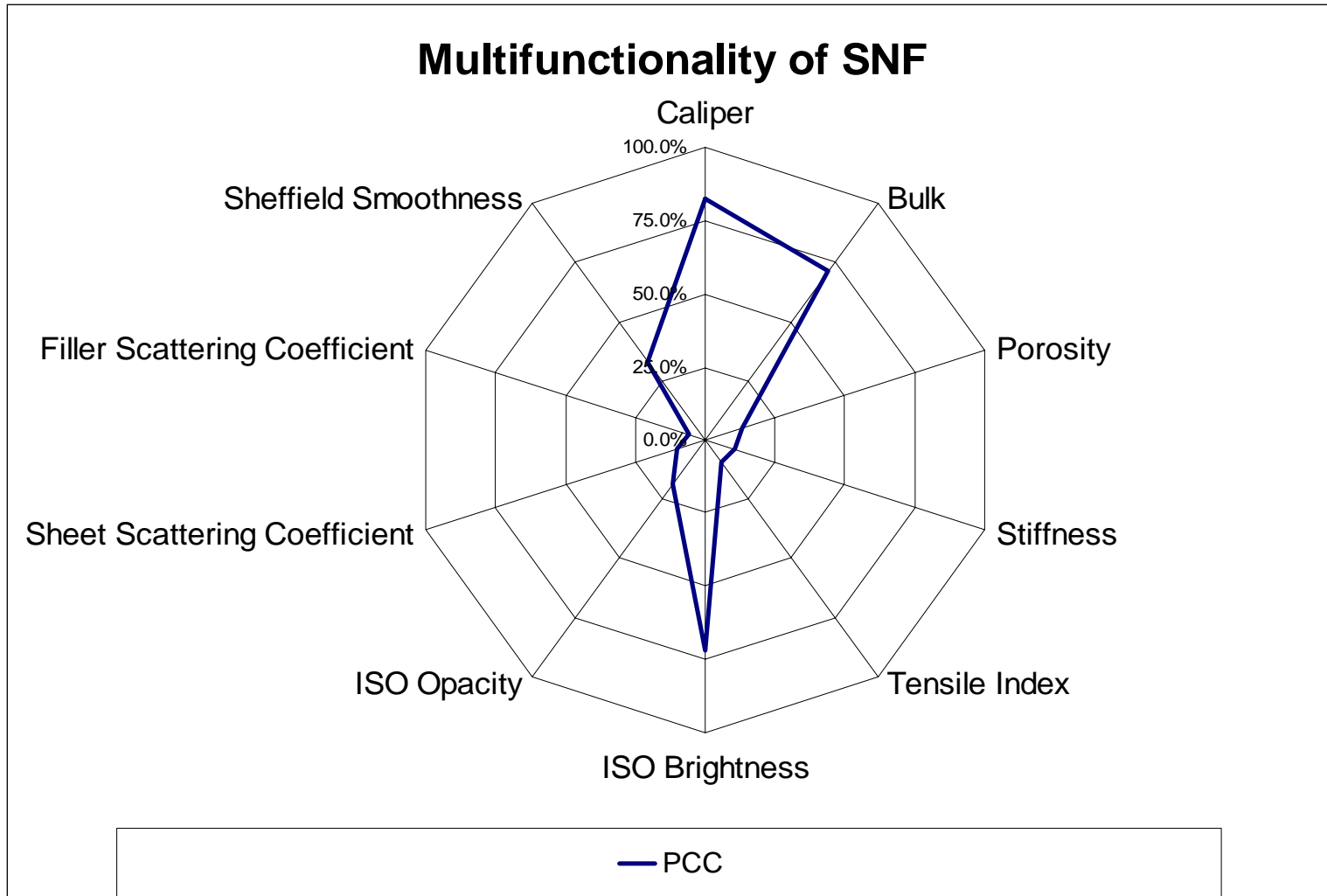


Stiffness (Gurley)

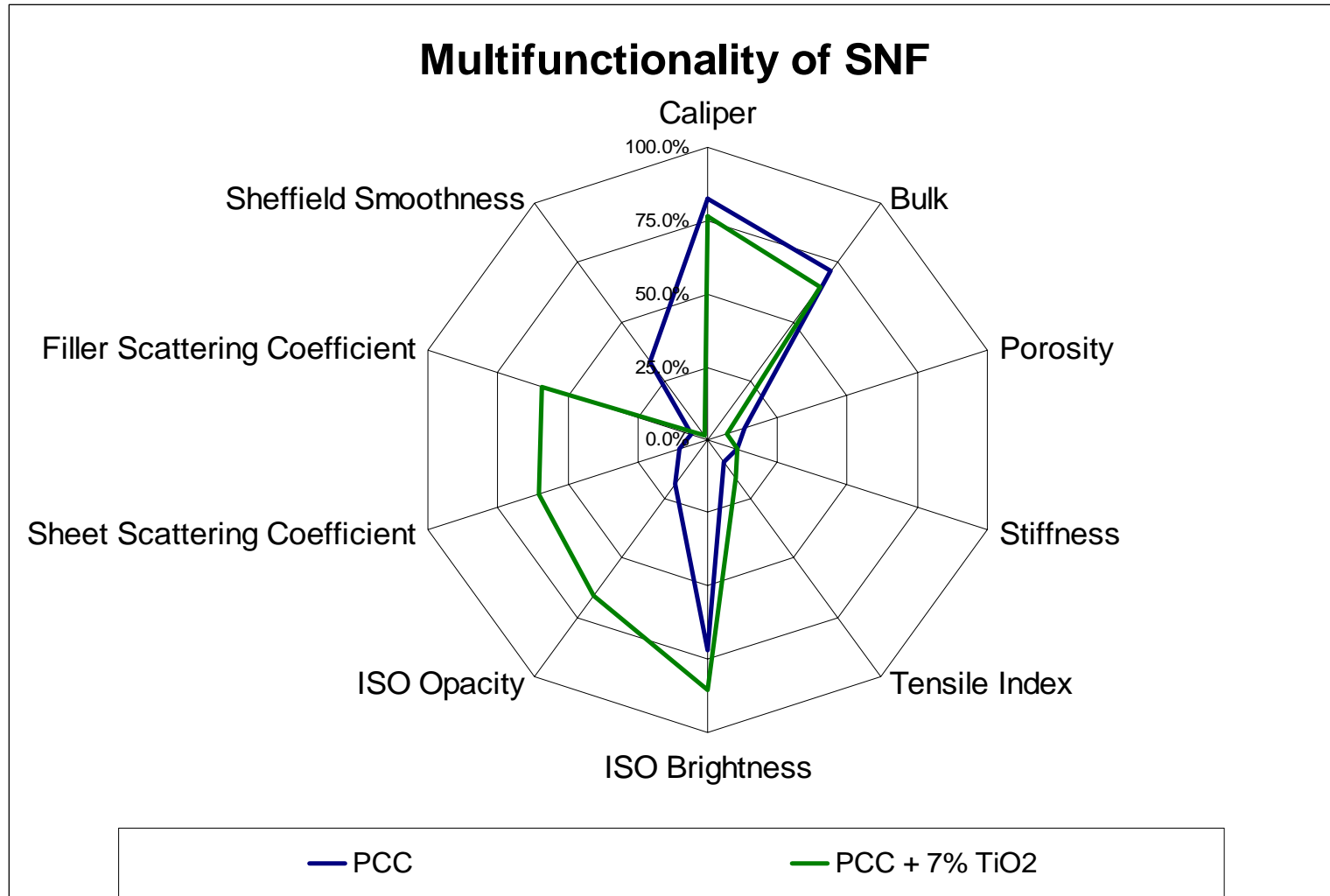


Calendared

### Multifunctionality of SNF

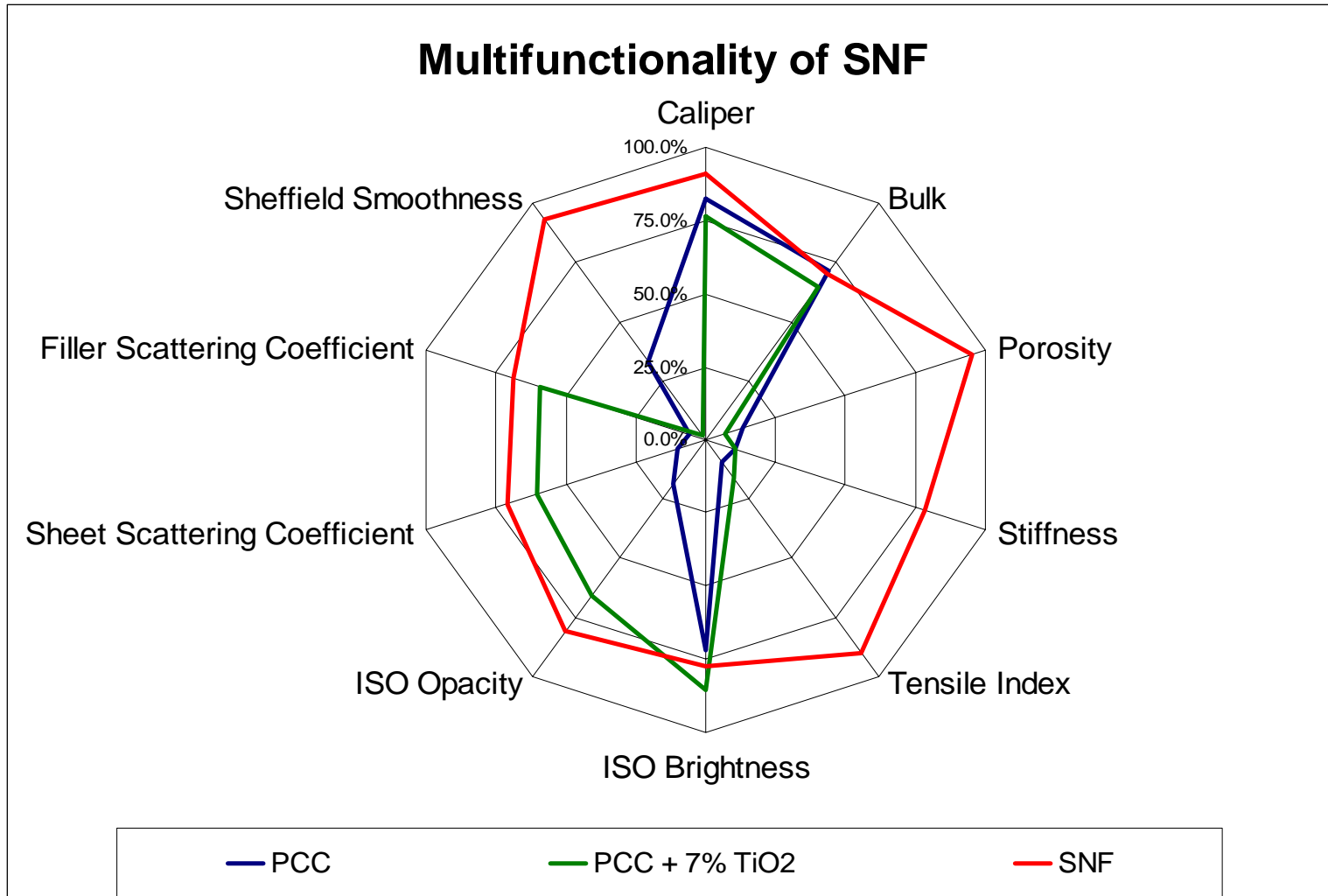


**Calendared**



Calendared

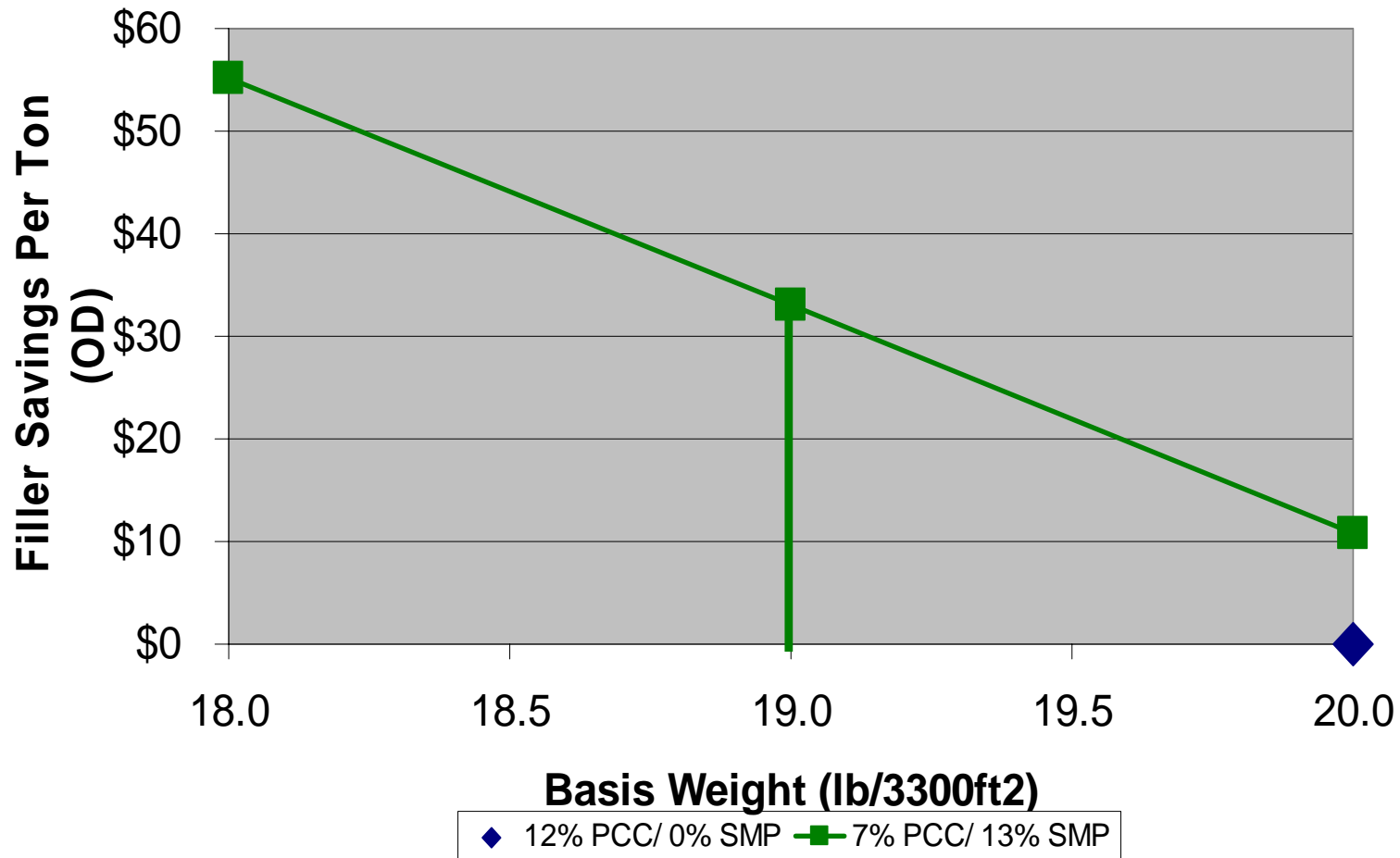
### Multifunctionality of SNF



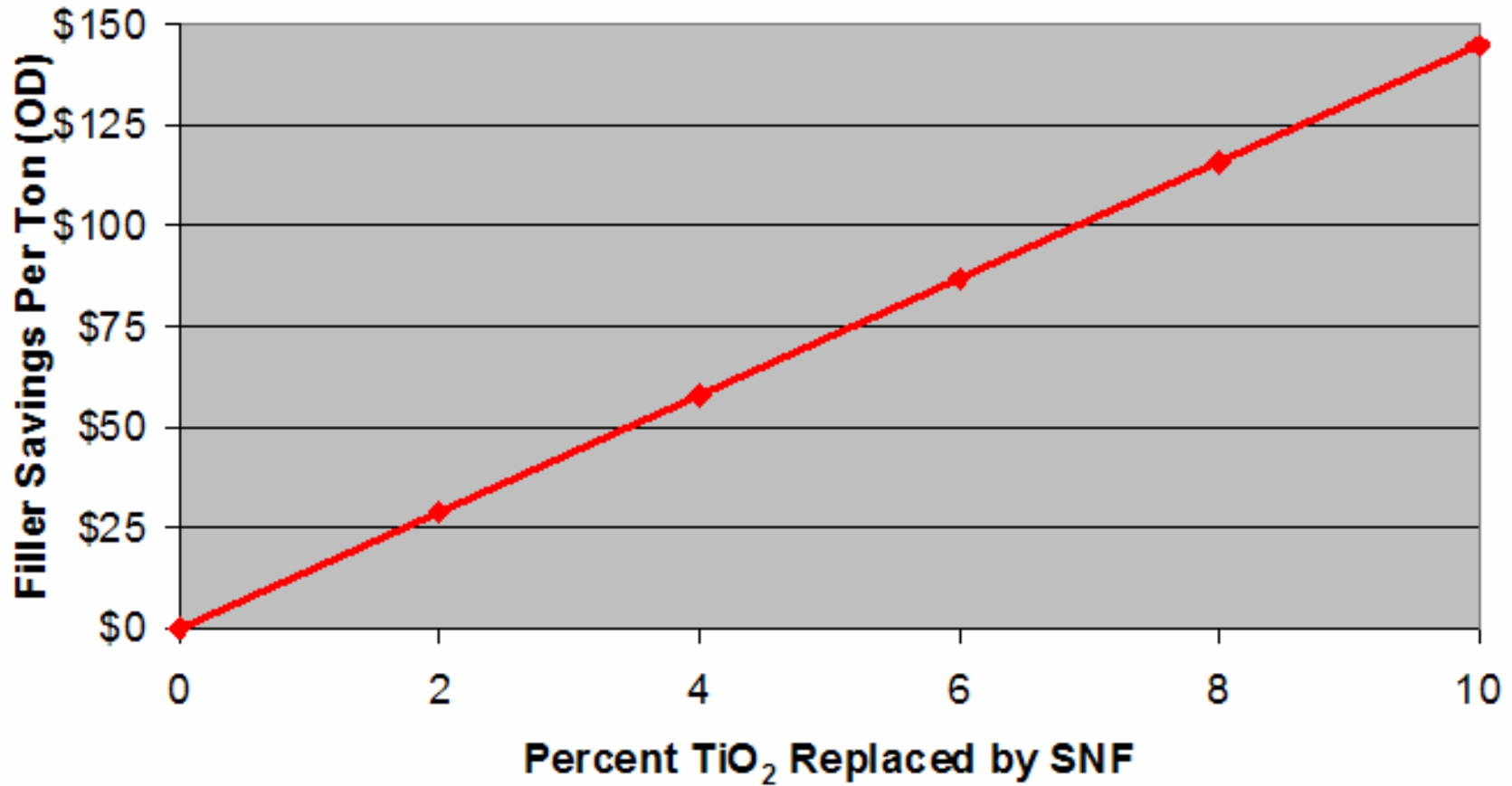
Calendared



### Basis Weight Reduction Economics



### TiO<sub>2</sub> Reduction Economics (Total Ash: 20%)



**The Key Innovations are:**

- ◆ **Fibrous Crystals from Inorganic Materials (Calcium Oxide and Silica)**
  - US Patent #: 6,726,807B1
- ◆ **Multifunctional Performance of “Fibrous Fillers”**
  - Improves Sheet Bulk, Porosity, Smoothness, Optical, and Strength Properties Simultaneously
- ◆ **Pressure Carbonation System to Produce Super Precipitated Calcium Carbonate at 400% to 600% Higher Reaction Rates**
  - US Patent #: 6,251,356
- ◆ **Producing Multiple Pigments, “Fibrous Fillers” and Calcium Carbonates, From a Common Reactor**
  - US Patent Allowed, Serial # 09/797,173

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# Project Objectives and Schedule

◆ **Objectives:**

- **Techno-Economic Viability of Manufacturing “Fibrous Filler”**
- **Low Cost Super Precipitated Calcium Carbonates (S-PCC) or Tech-2**
- **Protoytp e Plant for Scale-Up of Fibrous Filler Technology**

◆ **Schedule**

- **Initiation Date: 4/14/03**
- **Original Expected Completion Date: 9/30/06**
- **Revised Expected Completion Date: 4/13/06**

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# Status of Milestones / Key Issues

**The Key Issues are:**

- ◆ **Could Not Complete the Work on Interfacial Interaction, Paper Structure, and Paper Properties**
  - Task I: University of Washington
- ◆ **Partially Completed the Mechanism of Formation of “Fibrous Fillers”**
  - Task II: Lawrence Livermore National Laboratories
- ◆ **Partial Completion of Application of “Fibrous Filler” in Surface Treatment Formulations**
  - Task V: Western Michigan University

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# Projects Output / Key Accomplishments



◆ **Objective I Accomplishments:**

- **Development and Validation of Techno-Economic Viability**
- **Techno-Economic Viability Manufacturing Demonstration of:**
  - **Silicate Nano-Fibers (SNF) or Tech-8**
  - **Silicate Micro-Fibers (SMF-LDD) or Tech-6**
  - **Silicate Micro-Particles (SMP) or Tech-4**

◆ **Objective II Accomplishments:**

- **Development and Validation of S-PCC or Tech-2**

◆ **Objective III Accomplishments:**

- **Designed, Engineered, and Erected the Prototype Plant to Produce Multiple Pigments**
  - **Tech-6, Tech-4, and Tech-2**

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# Commercialization Barriers / Economics

## **Barriers to Commercialization**

- ◆ **Market Resistance to New Silicate Technology**
  - ◆ **1st Commercial Validation of Technology**
- 

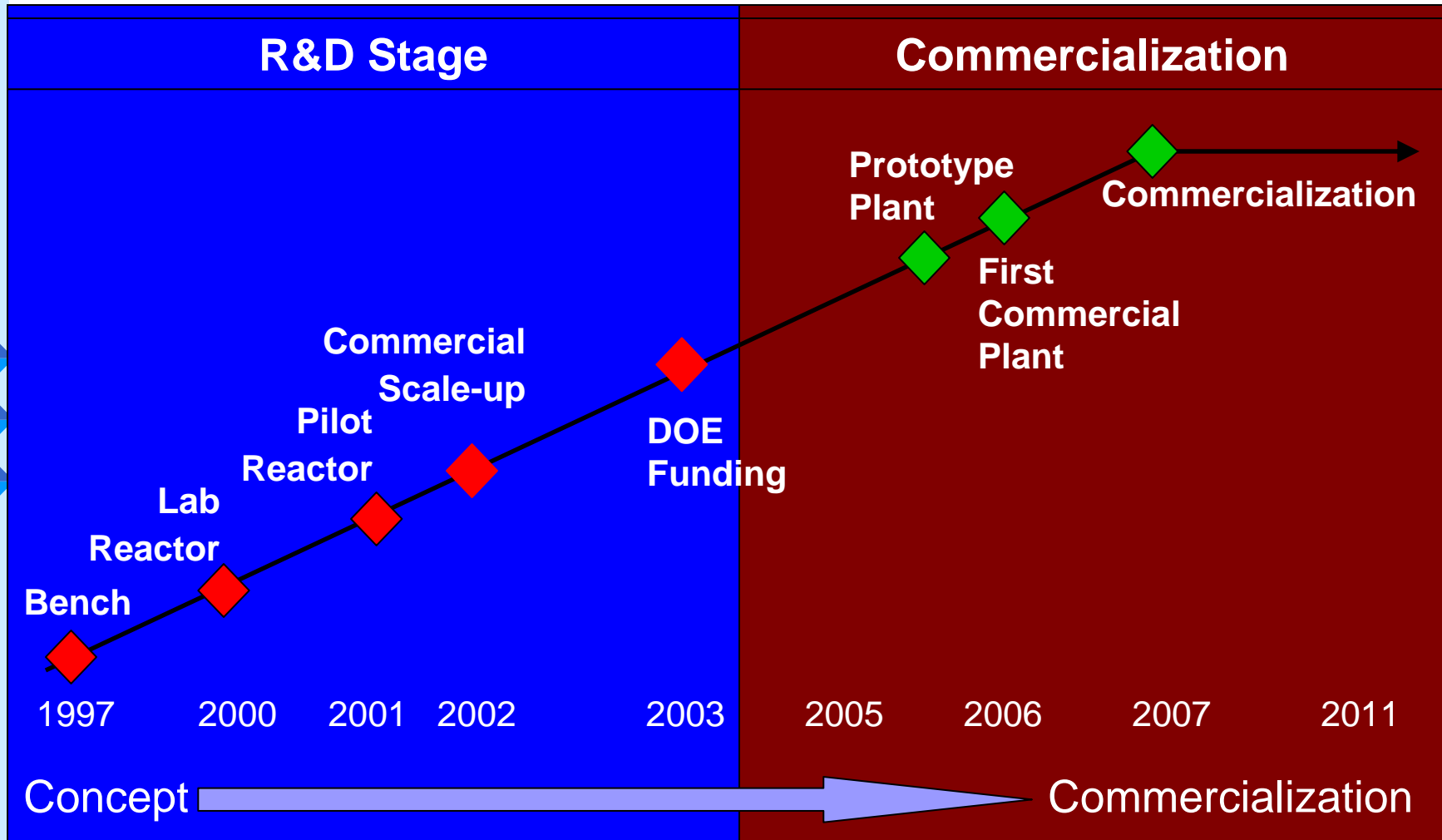
## **Economics of a Typical Multiple Pigment Plant**

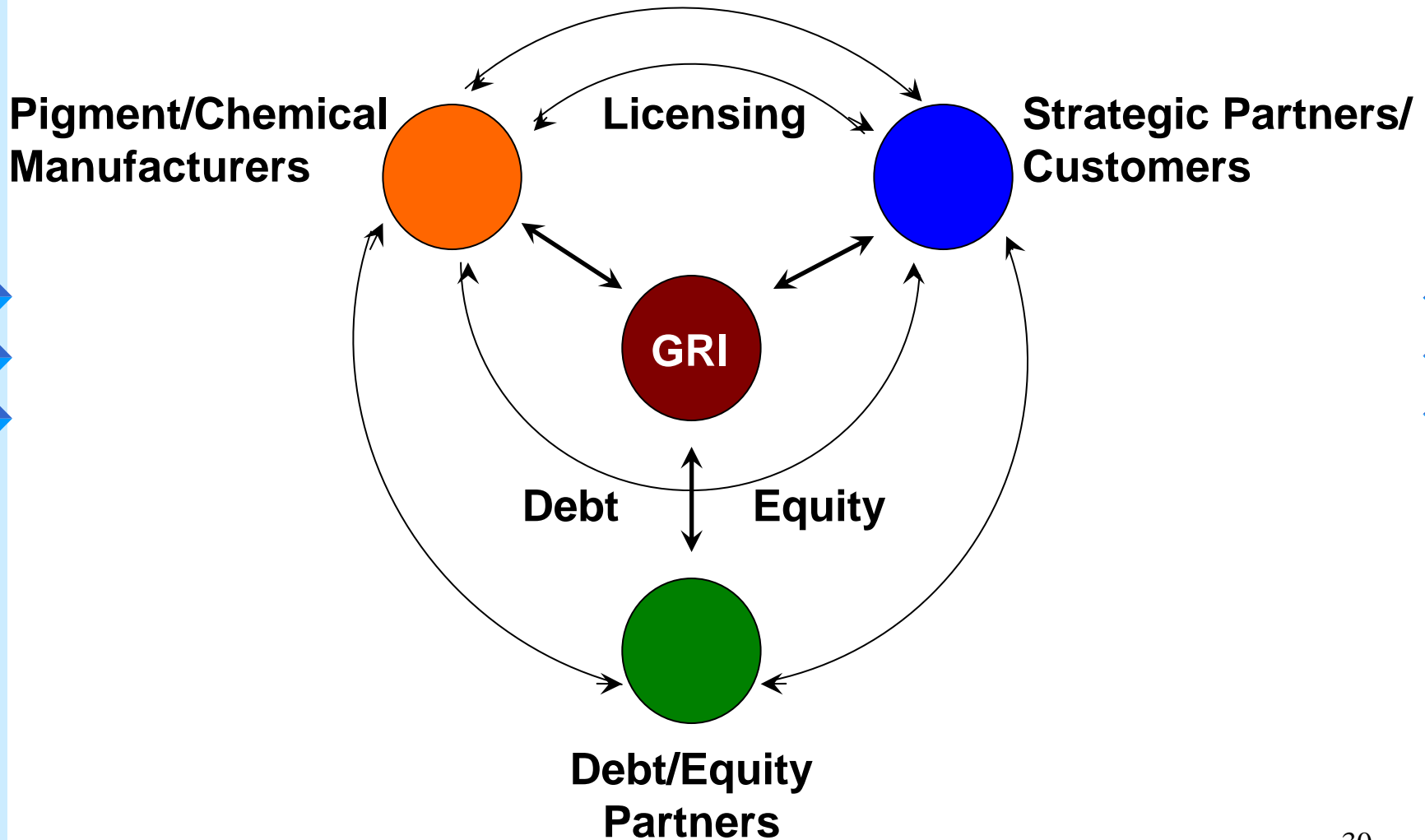
<b>Capital (millions):</b>	<b>~7.0</b>
<b>Revenue (millions):</b>	<b>~13.5</b>
<b>ROI(%):</b>	<b>~31.0</b>

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# Commercialization Plan and Strategy

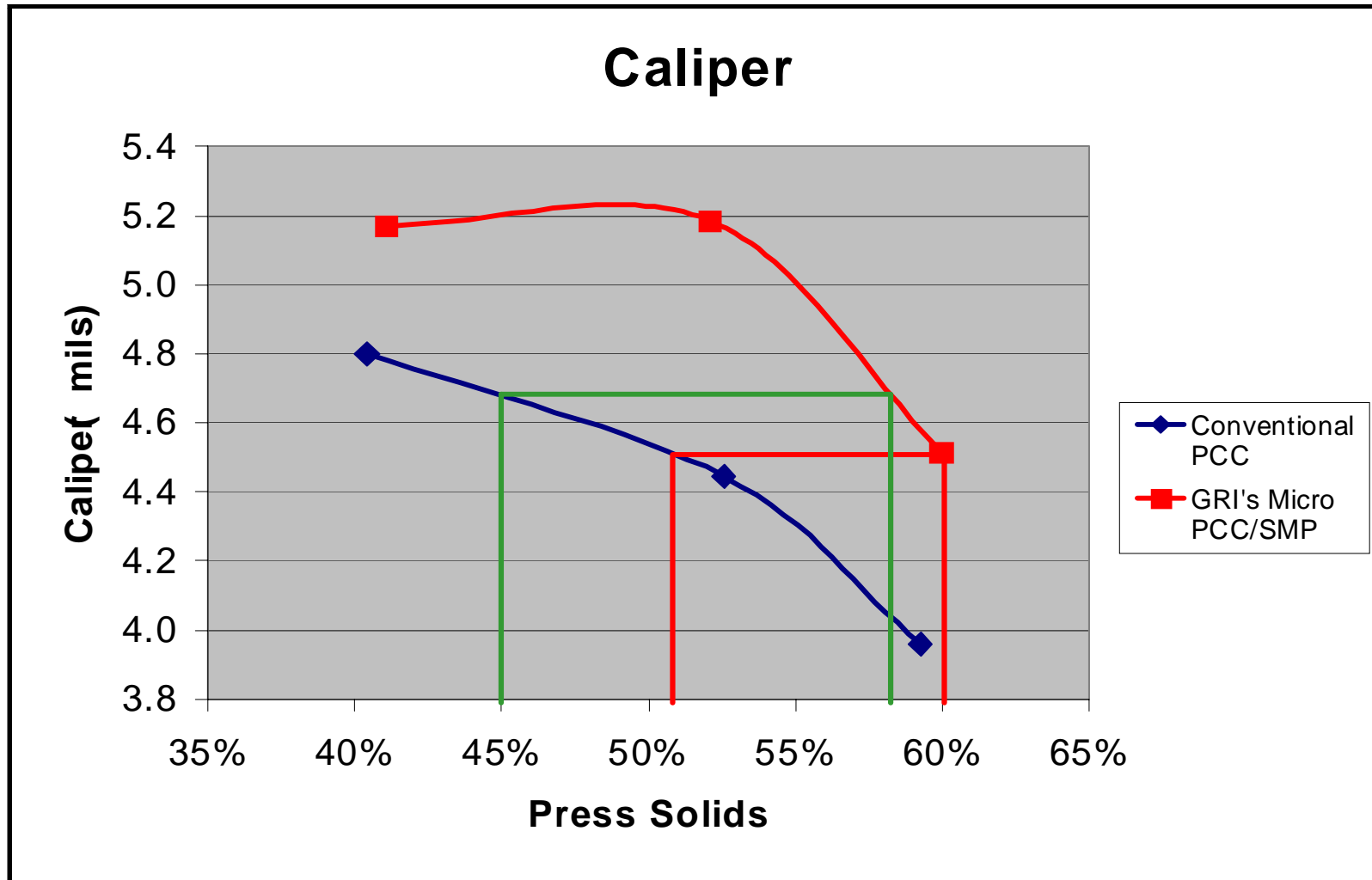




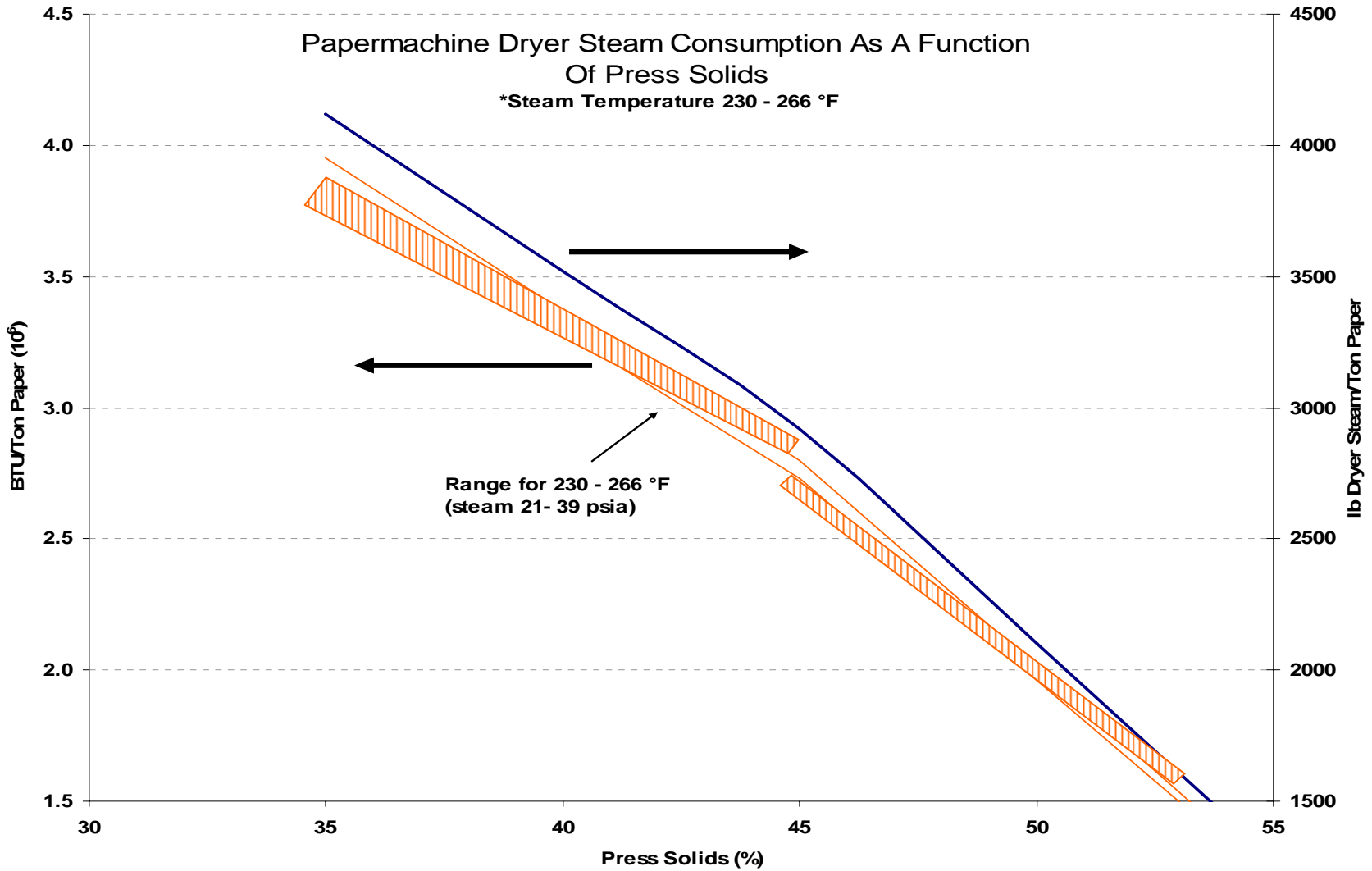
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# Energy Efficiency







## Energy Savings (Trillions BTU/yr)

Pulp Mill*	31.5
<u>Paper Mill**</u>	<u>11.5</u>
Total	43.0

\*: 1000 ton pulp mill vs. 600 ton pulp mill and 400 ton “Fibrous Filler” mill

\*\* : Press Solids increased from 45% to 55%

**Potential Savings To U.S. Industry**

<b>Product</b>	<b>Attainable Savings \$/ton</b>	<b>Industry Usage (tons)</b>	<b>Total Attainable Savings (per year)</b>
<b>SNF</b> <b>(TiO<sub>2</sub> Reduction)</b>	<b>\$900</b>	<b>90,000</b>	<b>\$81 million</b>
<b>SMP</b> <b>(Bulk, Stiffness, Basis Weight Reduction)</b>	<b>\$15</b>	<b>20,000,000</b>	<b>\$300 million</b>
<b>Energy Savings</b> <b>(Paper Mill)</b>	<b>\$12</b>	<b>20,000,000</b>	<b>\$240 million</b>
<b>Incremental Pulp Profits</b> <b>(10% Filler Increase)</b>	<b>\$200</b>	<b>1,000,000</b>	<b>\$200 million</b>
<b>PCC</b> <b>(Lower Cost)</b>	<b>\$20</b>	<b>1,000,000</b>	<b>\$20 million</b>
<b>Total</b>			<b>\$841 million / Year</b>

# Current Status

- **Building The Prototype / Commercial Plant**

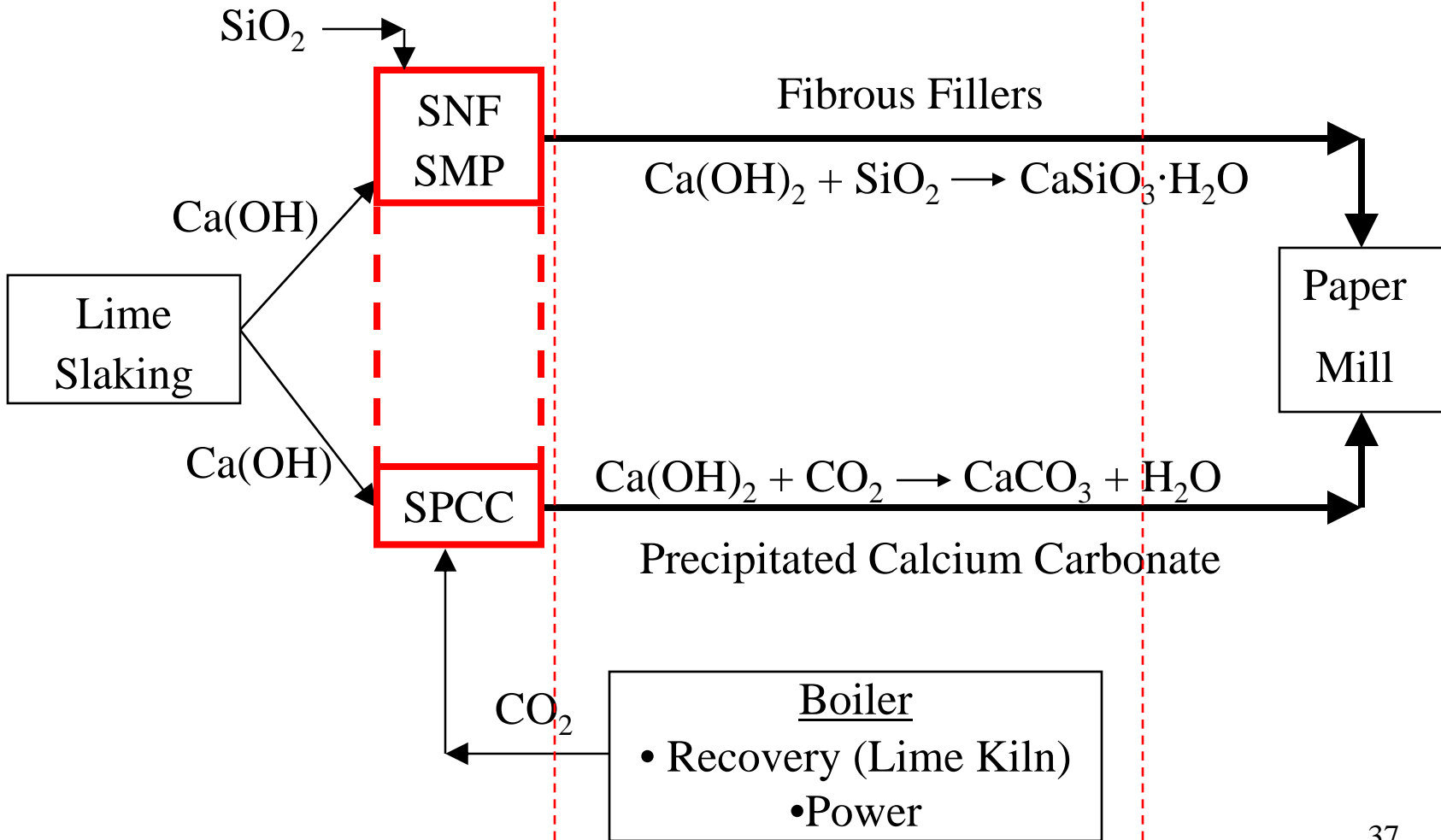
“Fibrous Fillers”

**Multiple Pigments From a Single Plant**

Pigment Mill

Pulp Mill

Paper Mill



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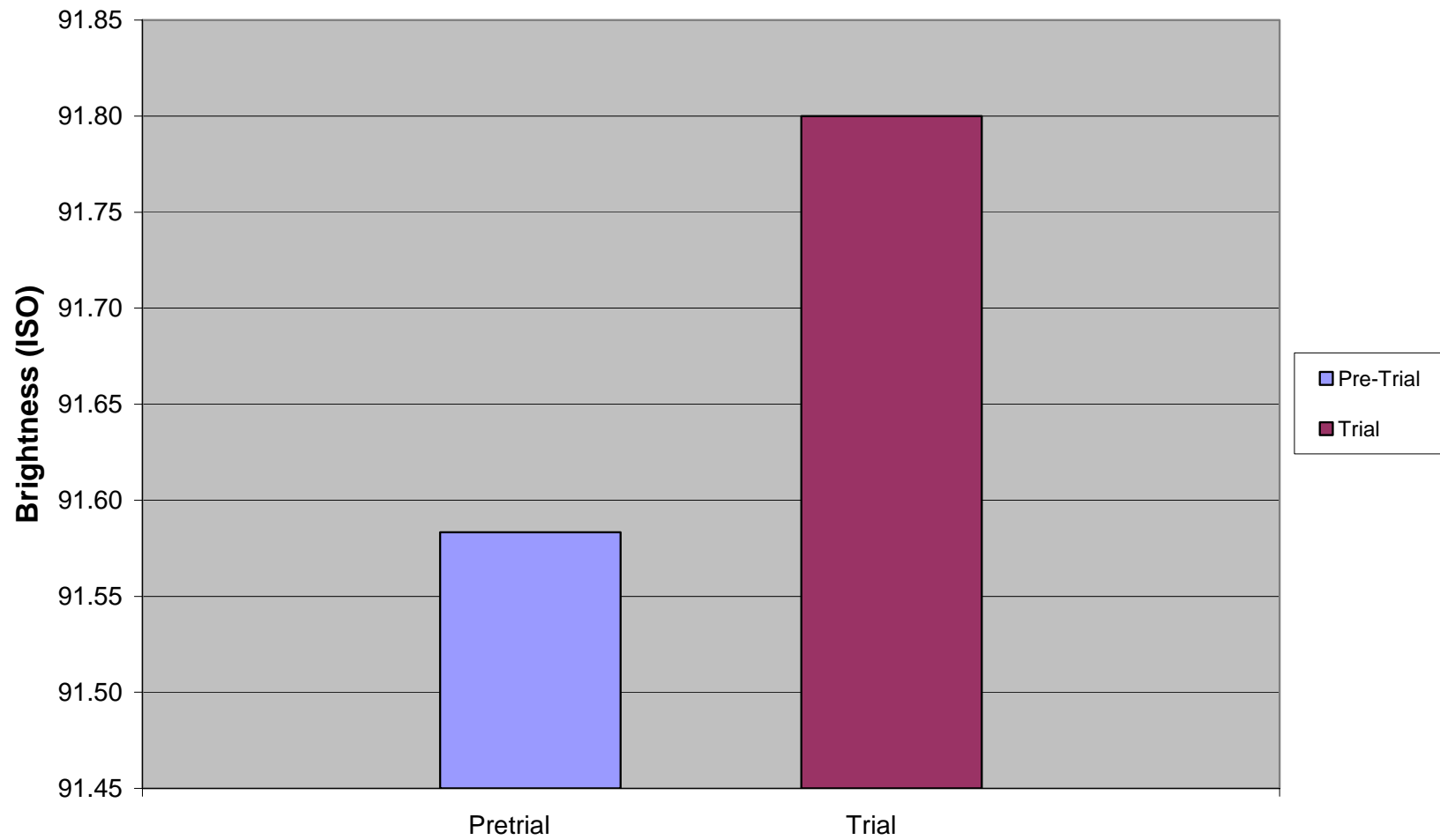
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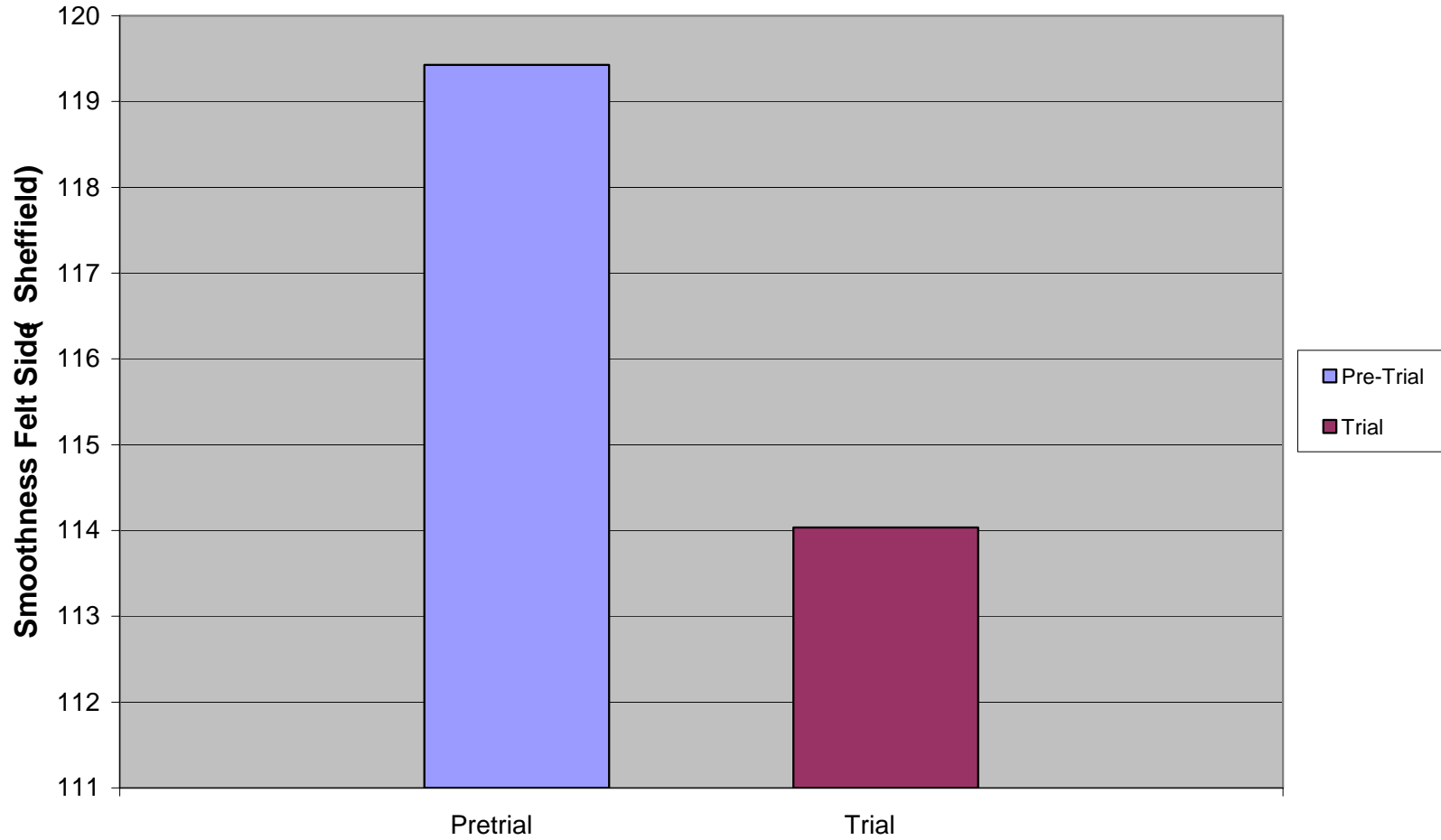
## 50# GH Offset HiBright SM PM#1 Grays Harbor Paper - March 28th, 2006



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## 50# GH Offset HiBright SM PM#1 Grays Harbor Paper Trial - March 28th, 2006

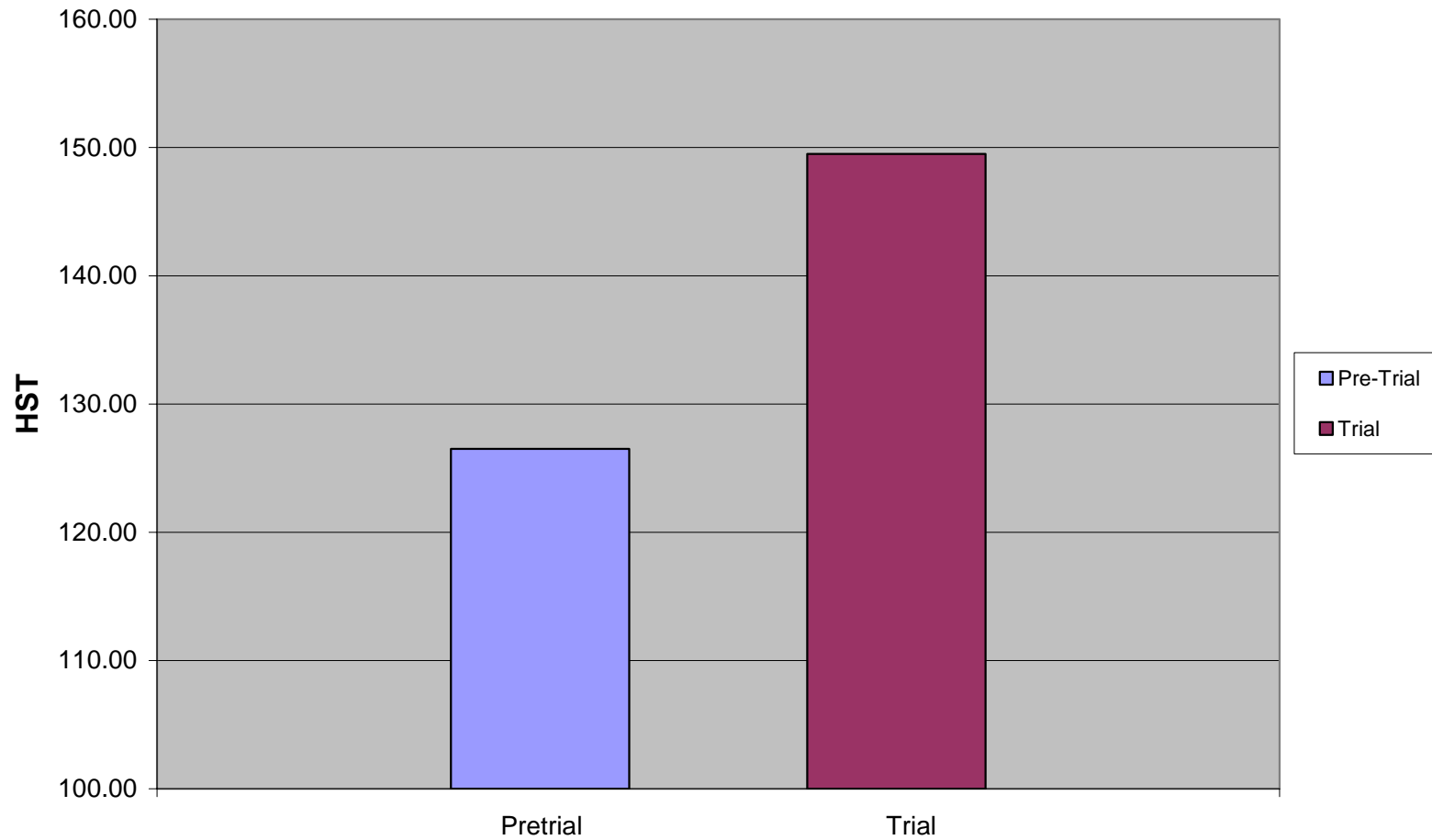




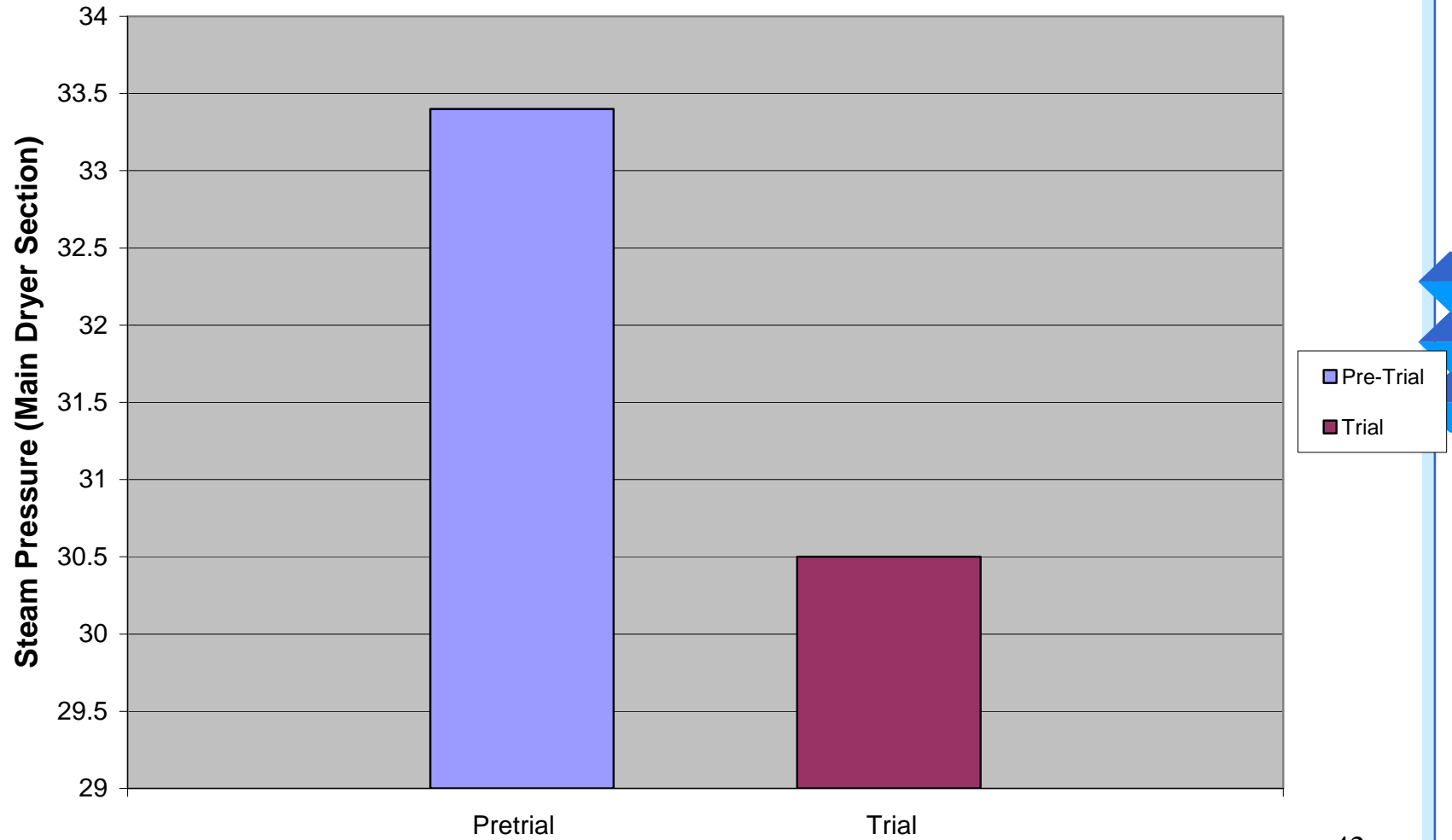
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## 50# GH Offset HiBright SM PM#1 Grays Harbor Paper Trial - March 28th, 2006



**50# GH Offset HiBright SM PM#1  
Grays Harbor Paper Trial - March 28th, 2006**



# Spirit of **INDEPENDENCE**



Date: April 4, 2006  
From: Bob Brennand  
To: Operations  
Subject: Preliminary GRI S-PCC Trial Results

801 23<sup>rd</sup> Street  
Hoquiam, WA 98550  
Phone: 360-538-5742  
Cell: 360-310-0747  
bbrennand@ghplp.com

## **Summary**

Though we have not trialed the S-PCC on a wide variety of products yet, the following properties improved on both machines during the second (March 28<sup>th</sup>) trial: Steam Usage, Brightness, HST, and Sheffield Smoothness. Several other properties (CD Stretch, CD & MD Tensile Energy Absorption, Burst, and Porosity) improved on one of the two machines, and some properties deteriorated on one of the two machines (Caliper/Bulk, Porosity, and MD & CD Stiffness). Considering the short time the GRI reactor has been operating, the results to date are very encouraging, and I think there is room left for fine tuning the S-PCC manufacturing process. Further trials in the future should be performed on a wider variety of paper products, but the data so far indicates the S-PCC is very close to being “qualified” at GHP.

# Path Forward

**GRI and our industry partners are requesting an extension of the project by one year, so that we can:**

- 1. run extended trials**
- 2. continue research on energy savings**
- 3. continue research on cost reduction**
- 4. meet original program objectives**