Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Fabric Filter Maintenance for Performance

Getting the most out of your baghouse and filter media

Nick Macsata
John Darrow
T. J. Winalski

July 14, 2008
2:00 – 3:00 PM

GORE

ALSTOM

FilterSense
Advanced Solutions for Process Filtration

Agenda

Overview

System Optimization & Filter Media

Field Inspections & Laboratory Analysis

Discovering Problems Early

Overview – System Optimization

Baghouse system – A pollution control device for capturing particulate matter

- Consists of housing
- Inlet and outlet ductwork
- Filter media
- Instrumentation & controls

Filter Media Is the “Heart of the Baghouse”

Filter media selection effects

System pressure drop → power production

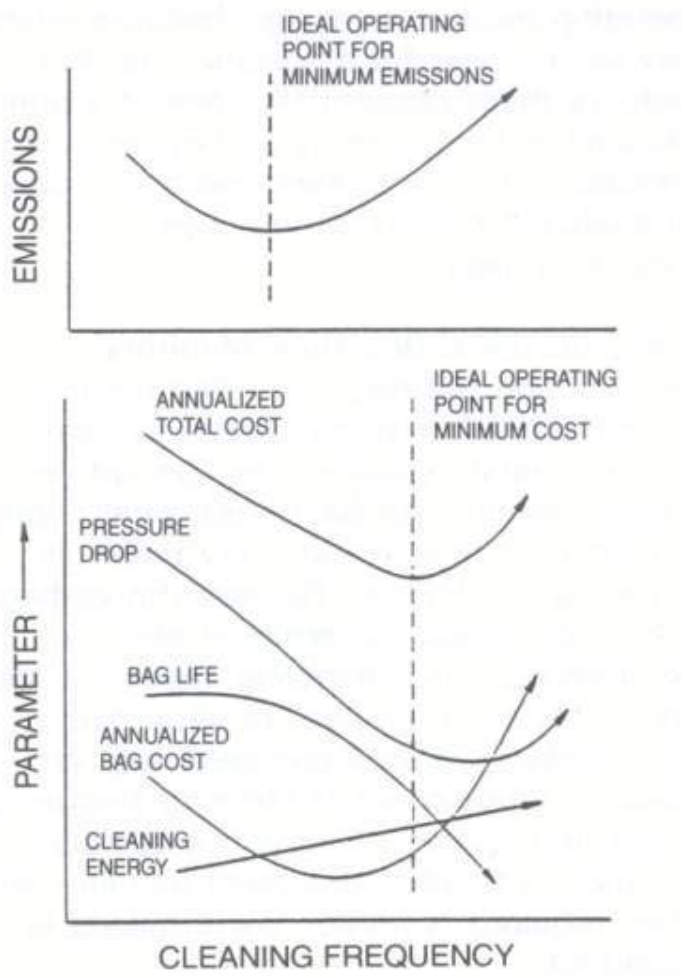
Particulate emissions

Cleaning energy

Bag life

Total annualized operating costs

System Optimization – Getting the Lowest Annualized Cost w/o Emissions Problems



System Optimization:

Bag Life

Emissions

Pressure Drop

Gas Flow/Throughput

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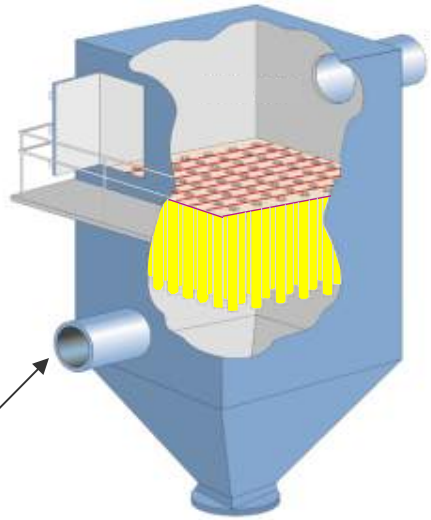
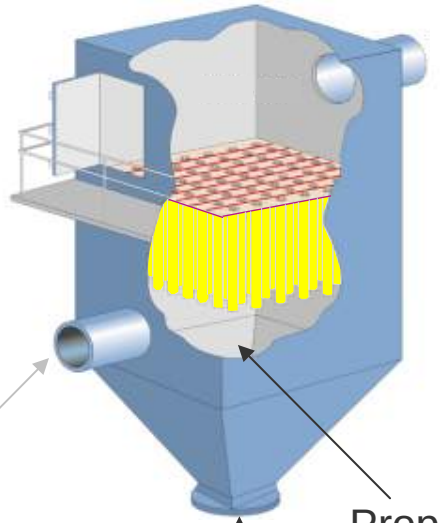
System Evaluation



Fan & ventilation
consultation & design
Gas flow measurements

System Evaluation

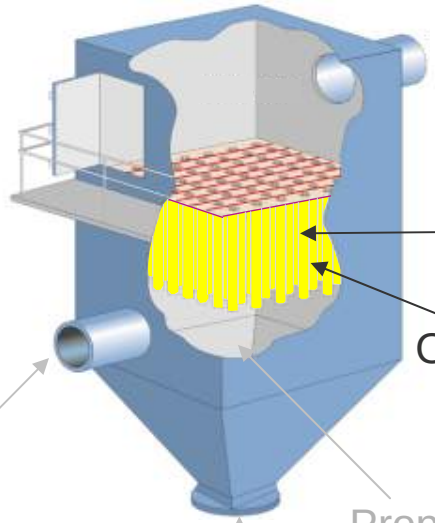


Fan & ventilation
consultation & design
Gas flow measurements

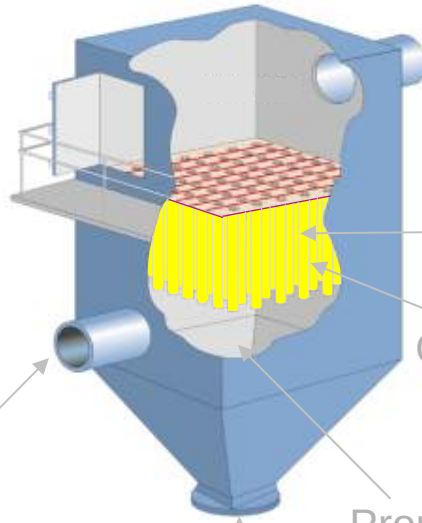
Proper inlet &
Baffle design

Hopper & discharge
consultation

System Evaluation



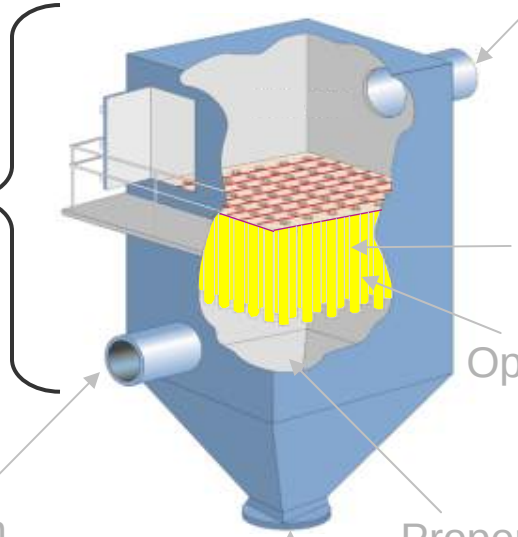
System Evaluation



System Evaluation

FilterSense

Monitoring
Capability
Pressure Drop
Gas Flow
Cleaning Frequency
Emissions



Reduced emissions

Filter analysis

Optimized filter design

Fan & ventilation consultation & design
Gas flow measurements

Proper inlet & Baffle design

Hopper & discharge consultation

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System Evaluation & Optimization

FilterSense

Monitoring
Capability
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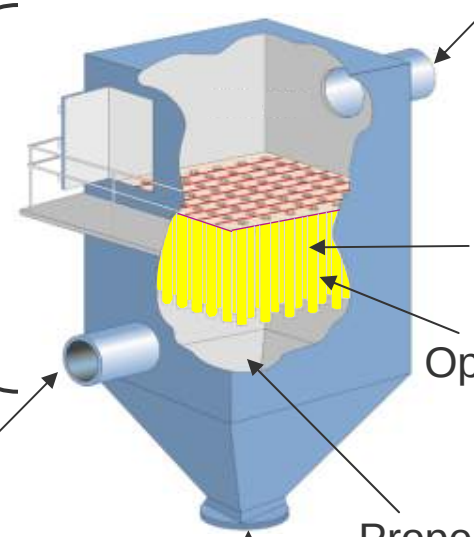

Reduced emissions

Filter analysis

Optimized filter design

Fan & ventilation consultation & design
Gas flow measurements

Proper inlet & Baffle design

Hopper & discharge consultation

Value Added Services

Knowledge of regulatory issues

Latest membrane & filtration technology

O & M support

Process & filtration integration consulting

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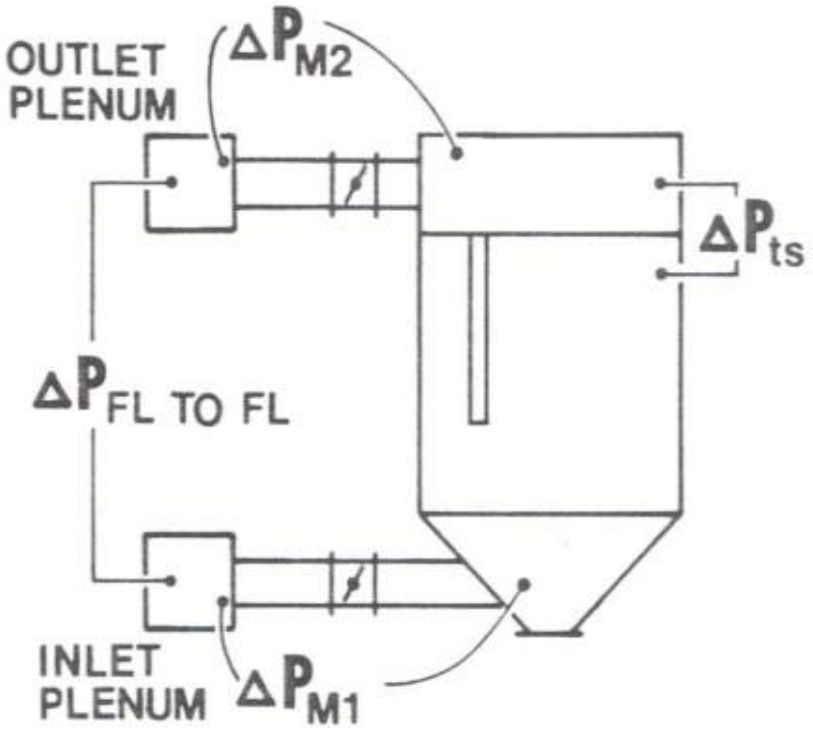
System Optimization - Pressure Drop (Δ P)



Components of Baghouse ΔP:

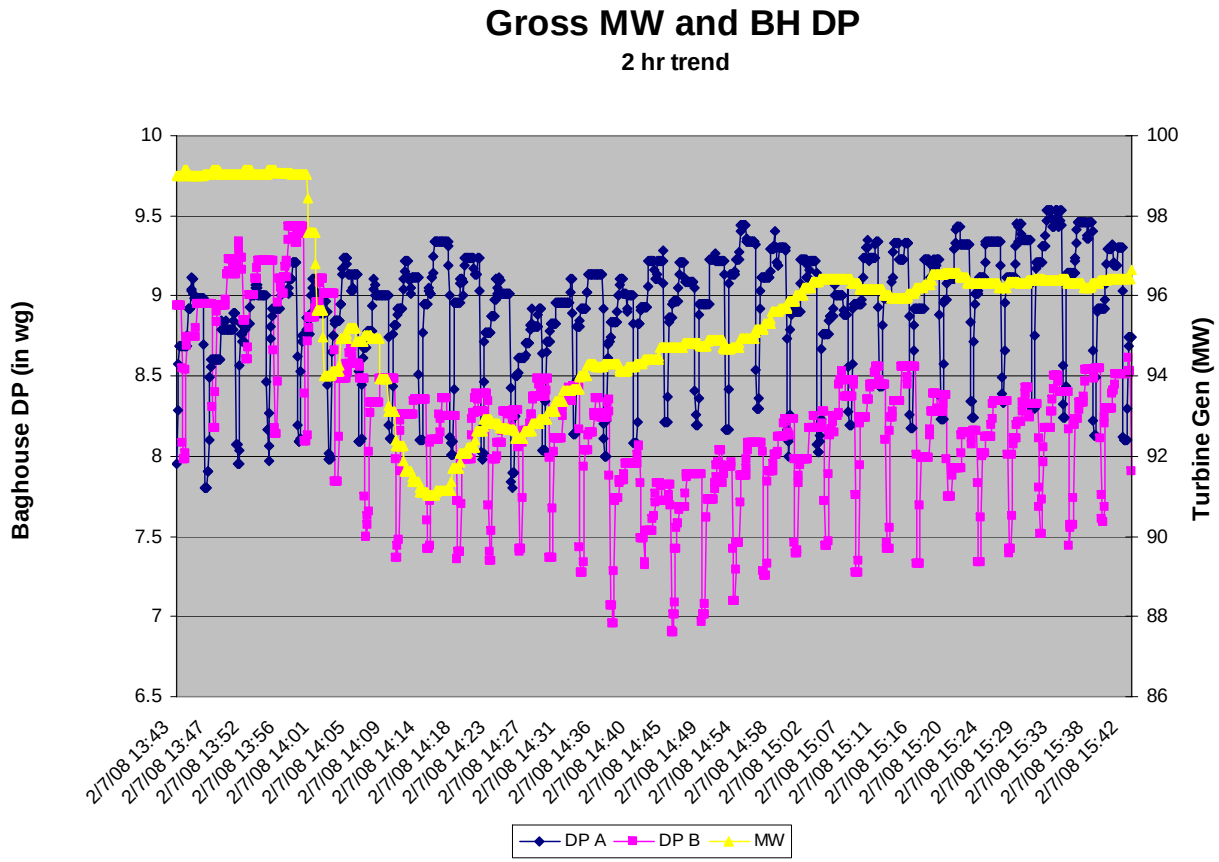
- Flange to Flange ΔP (ΔP_{FL-FL})
- Mechanical ΔP (ΔP_{M_0})
- Tubesheet ΔP (ΔP_{ts})

System Optimization – Flange to Flange Δ P

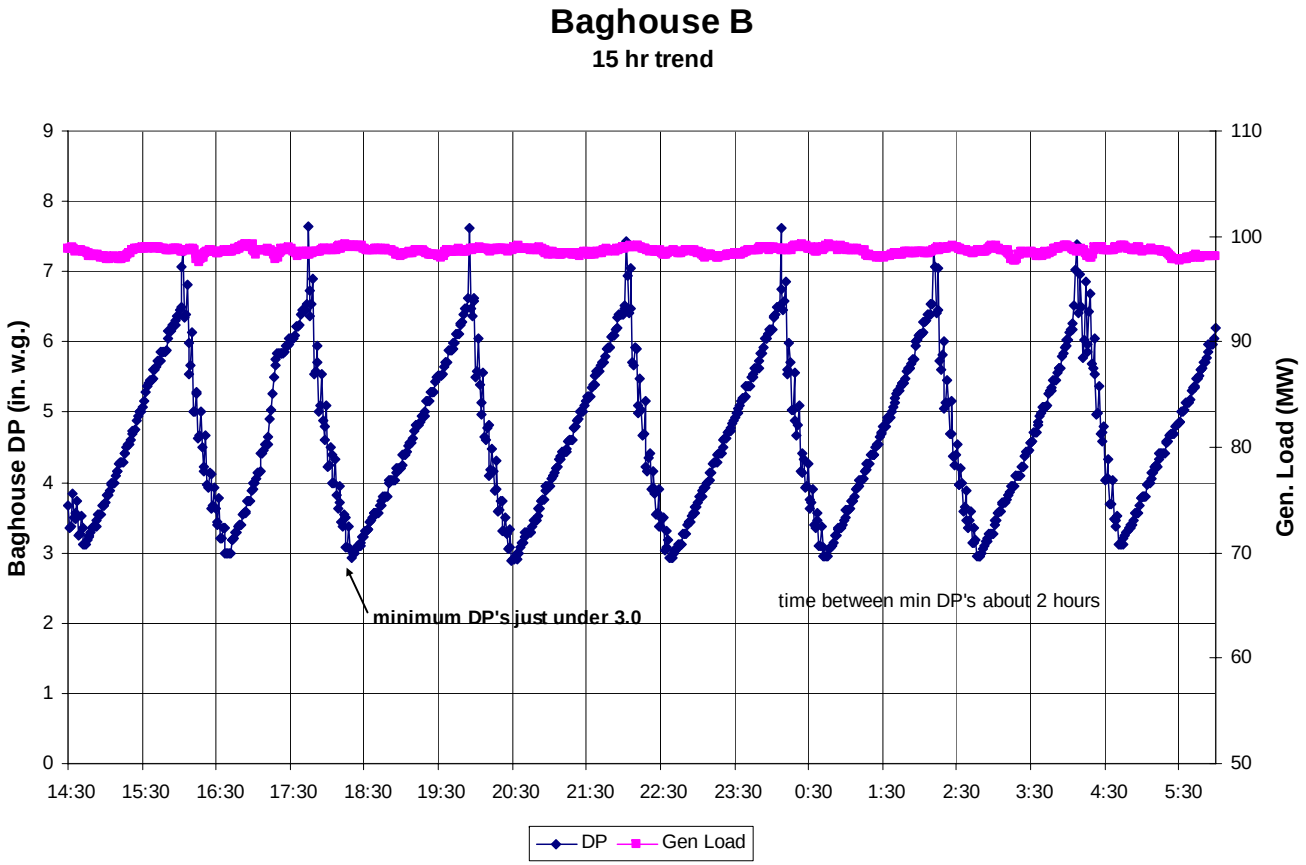
Data trends allow for detailed analysis

- Can indentify bag blinding
  - From process upsets or end of bag life
- Can evaluate effects of fuel changes
  - Changes in cleaning frequency or DP
- Opportunity to evaluate different cleaning strategies

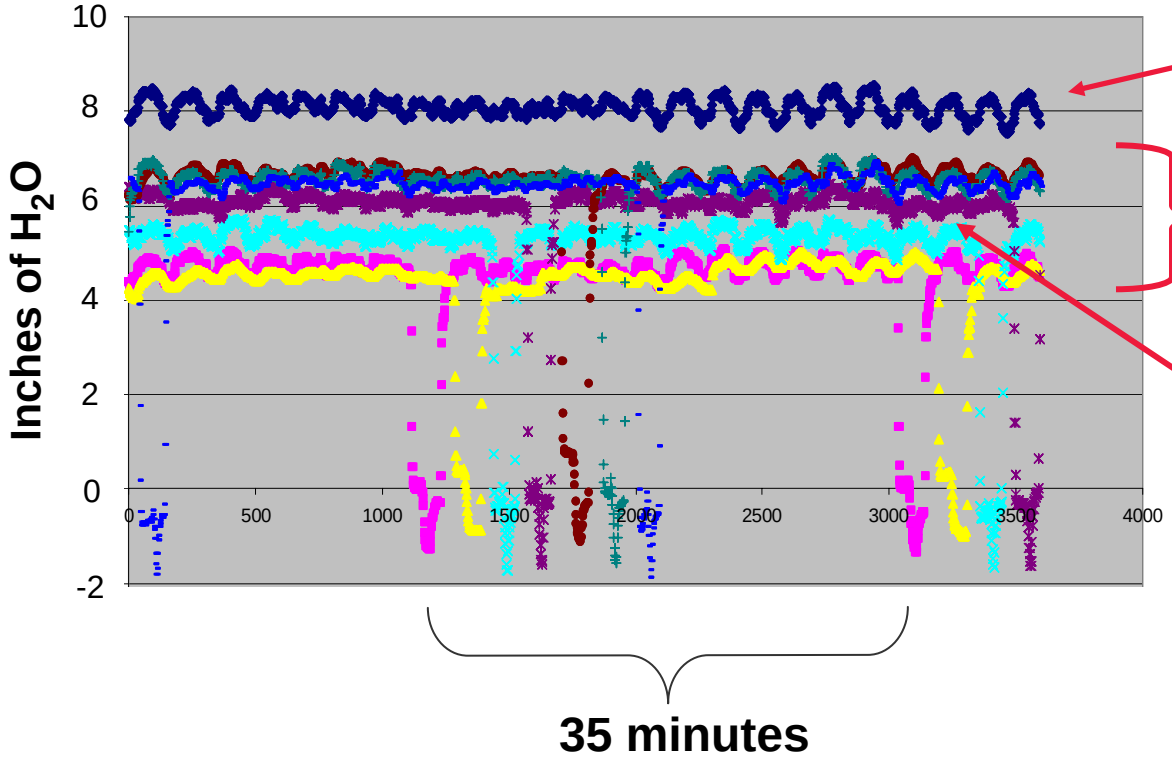
System Optimization – Flange to Flange Δ P



System Optimization – Cleaning Strategies



Data Analysis Is Key to Optimization



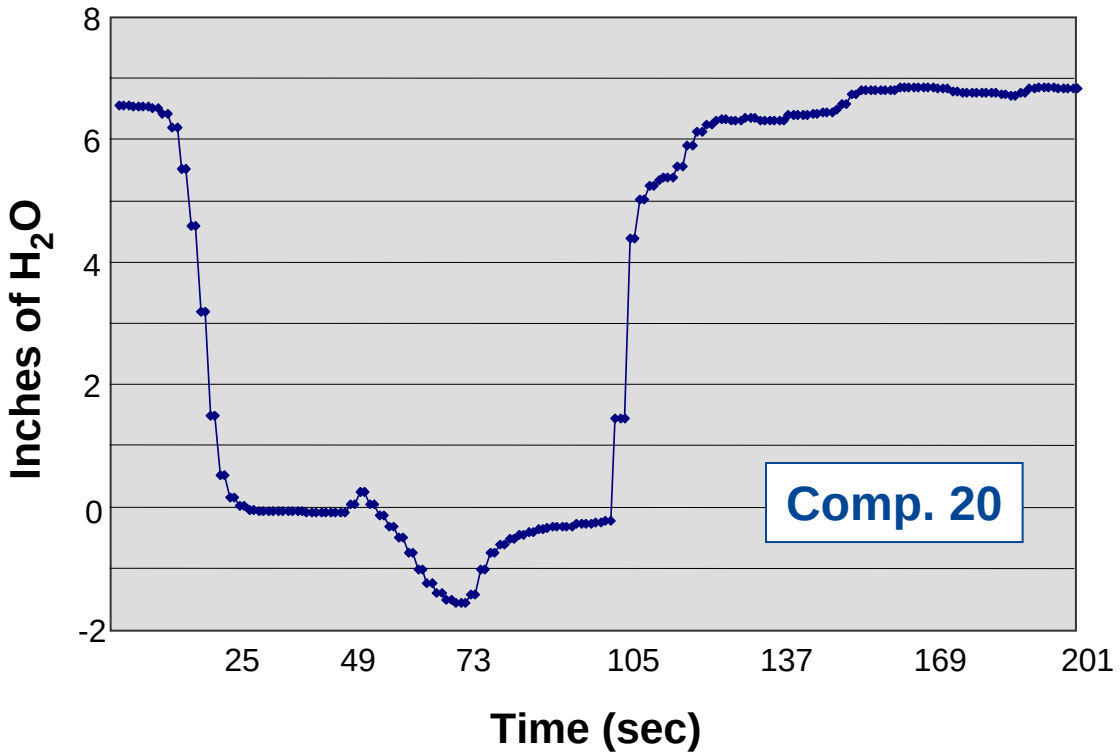
Flange – to Flange ΔP

Compartment ΔP provides insight:

- Variation in ΔP amongst compartments
- Some compartments are taking more flow
- Cleaning frequency

Instrumentation is critical for data collection

Frequent Data Collection Enables Detailed Analysis



Damper operation

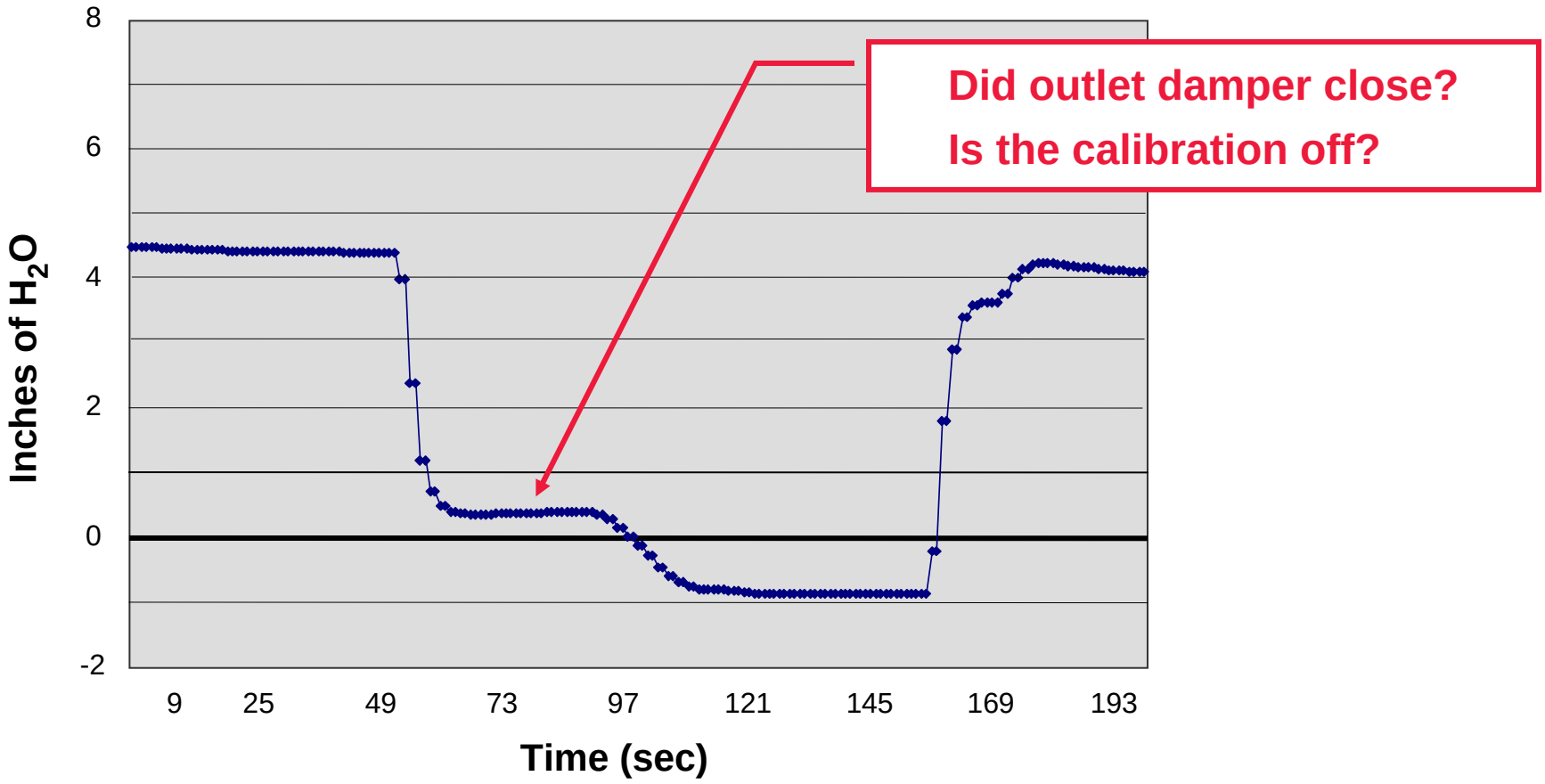
Settle time

Reverse gas on

Settle time

Terminal and residual DP
(i.e. cleaning effectiveness)

Frequent Data Collection Enables Discovery



Baghouses Designed to Capture Solid PM

Filter media enables the capture fine solid PM

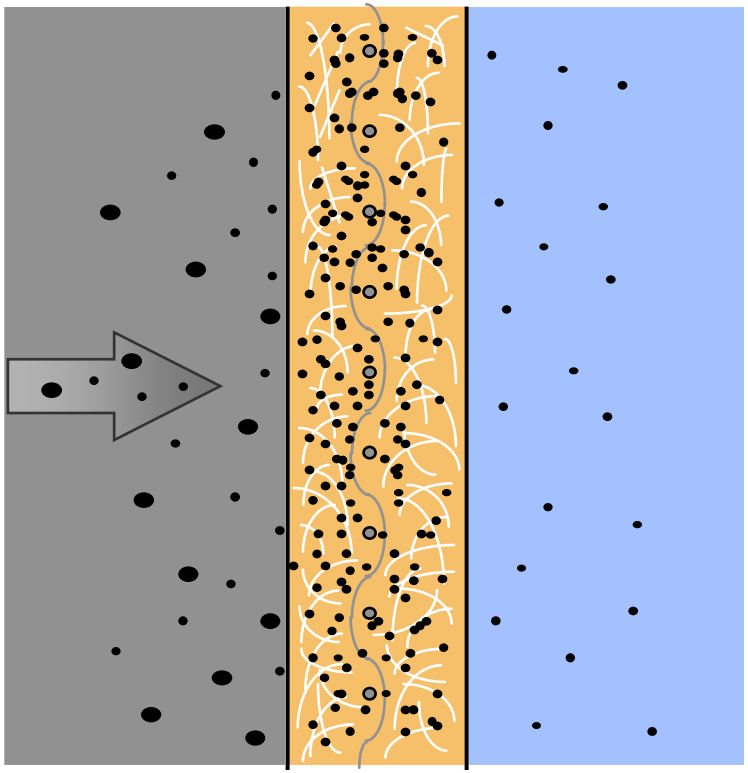
Conventional filter media relies on a dust cake (depth filtration)

Over-cleaning can result in increased emission

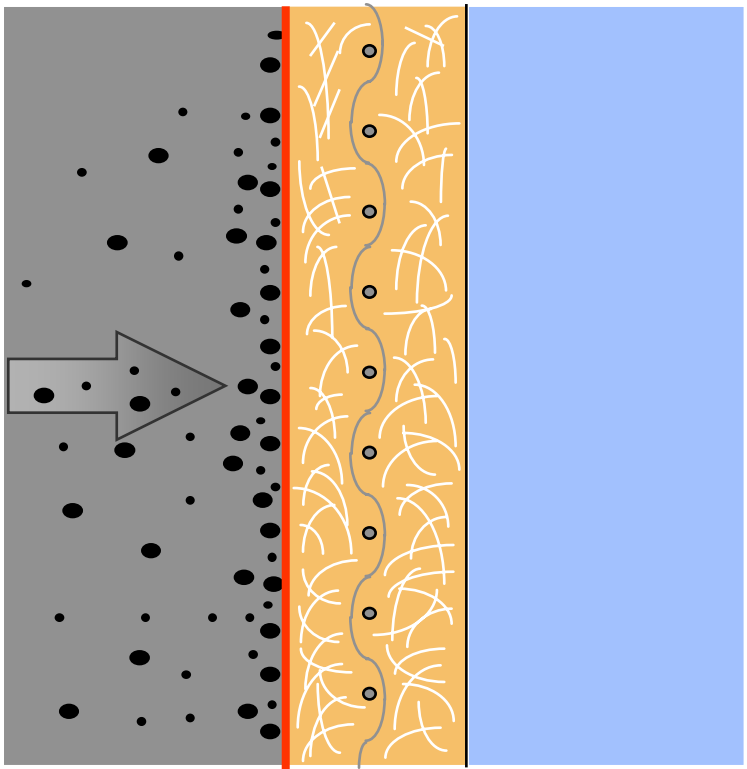
Membrane filter media captures fine PM without any dust cake (surface filtration)

Depth vs. Surface Filtration – Filtering Mode

Conventional Media



Membrane Media

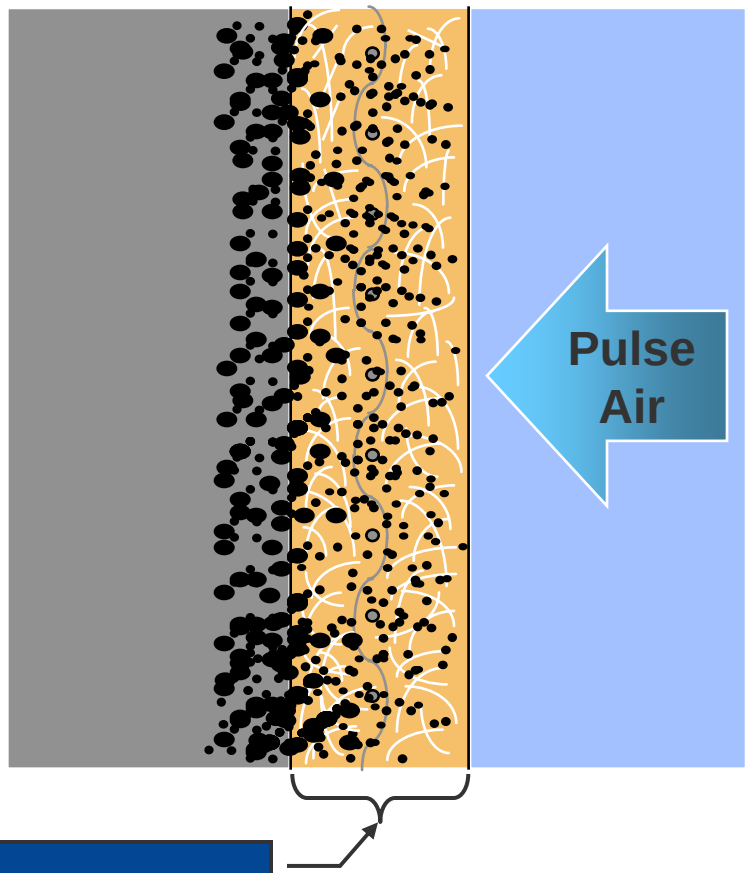


Depth filter media e.g. PPS felt

GORE™ Membrane

Depth Filtration - Cleaning Mode

Conventional Media



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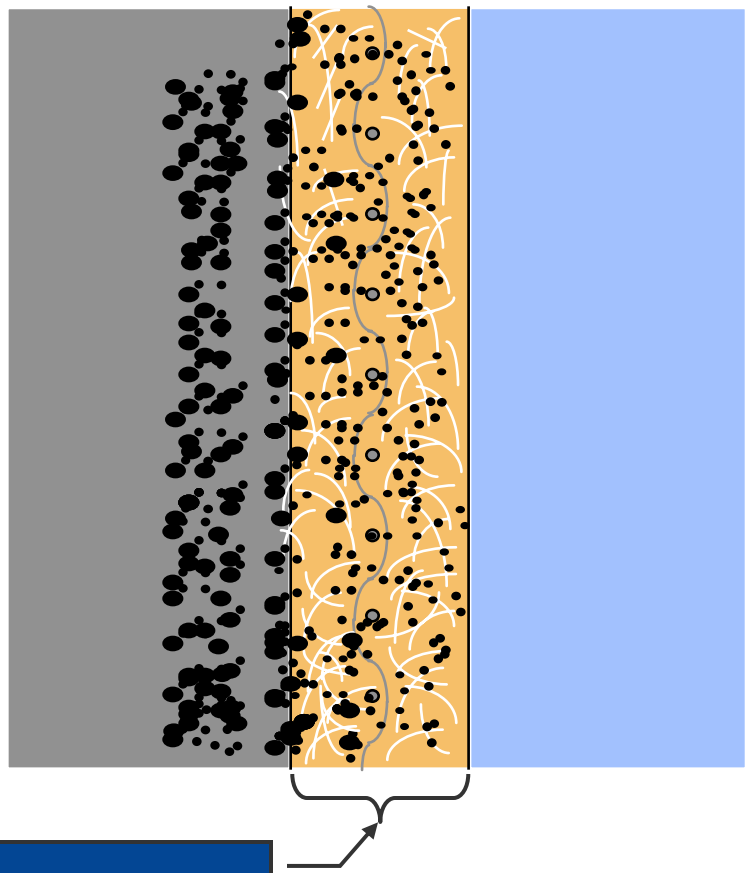

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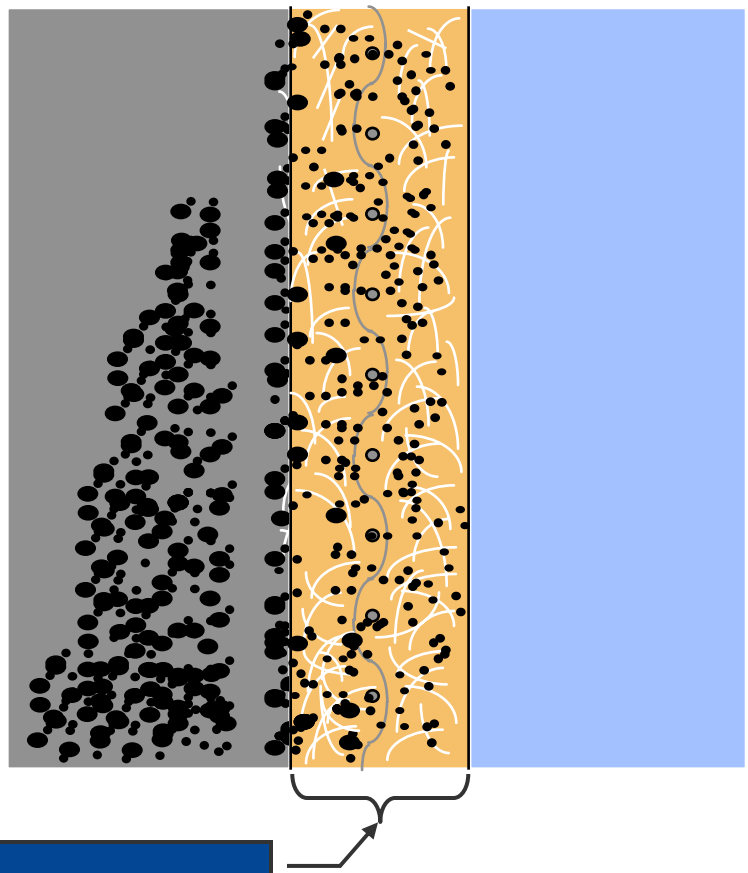

Depth filter media e.g. PPS felt

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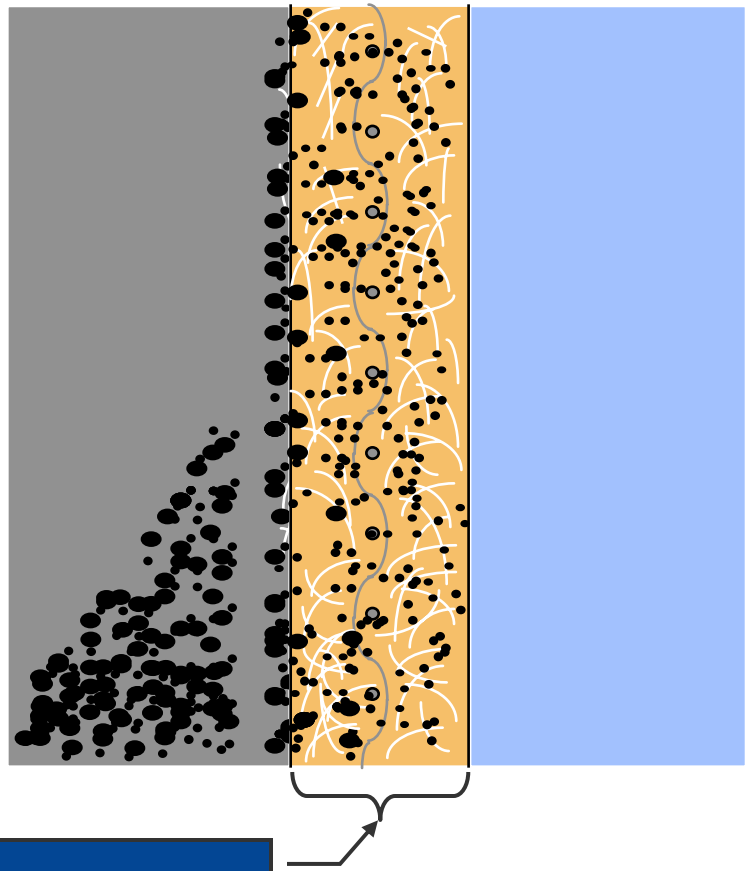

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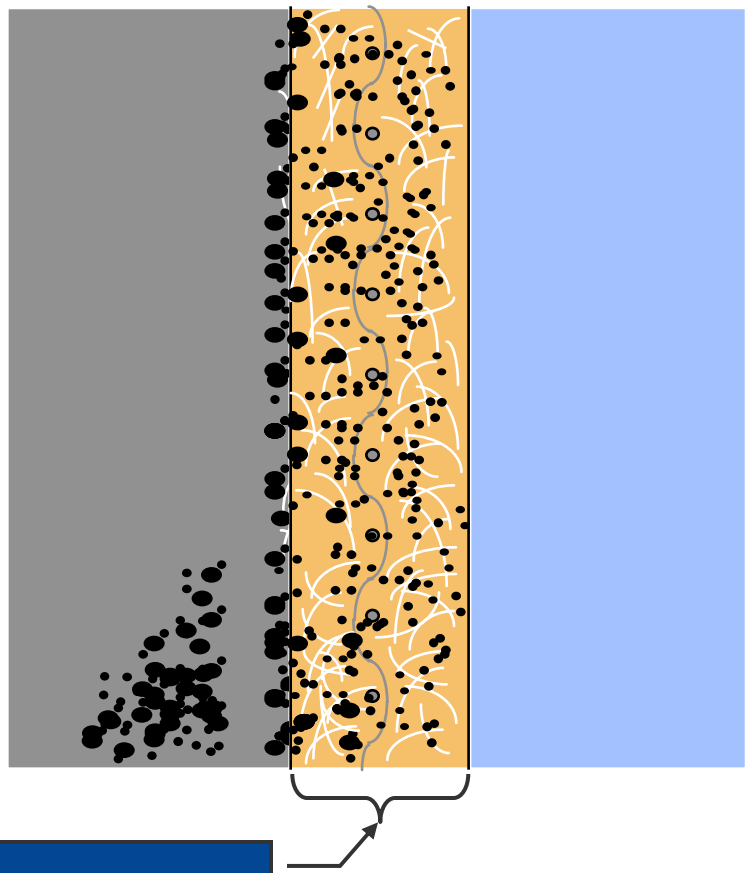

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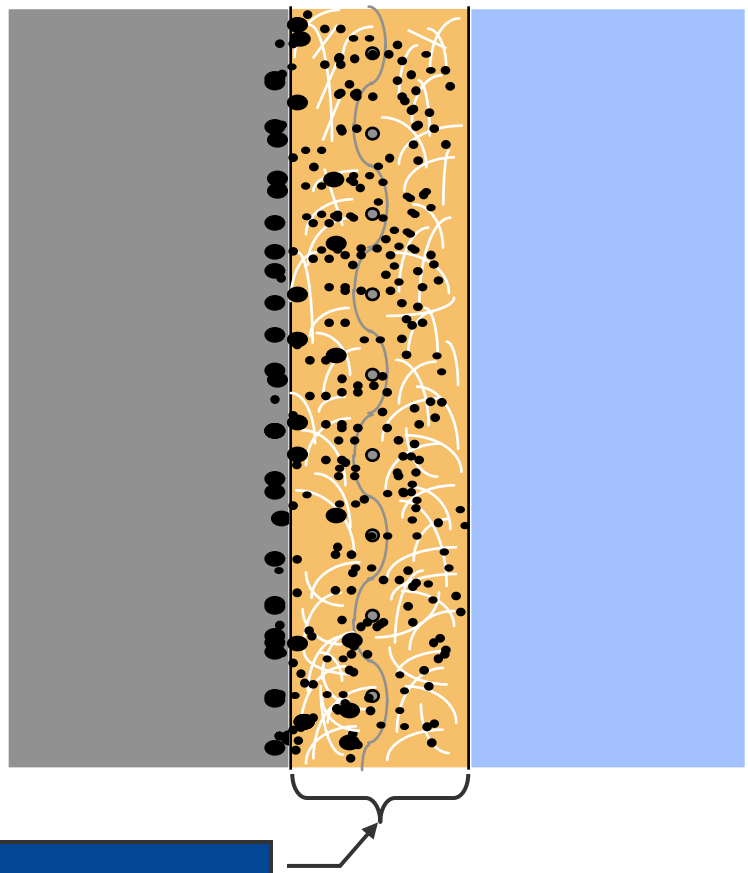

Depth filter media e.g. PPS felt

Depth Filtration - Filtering Mode

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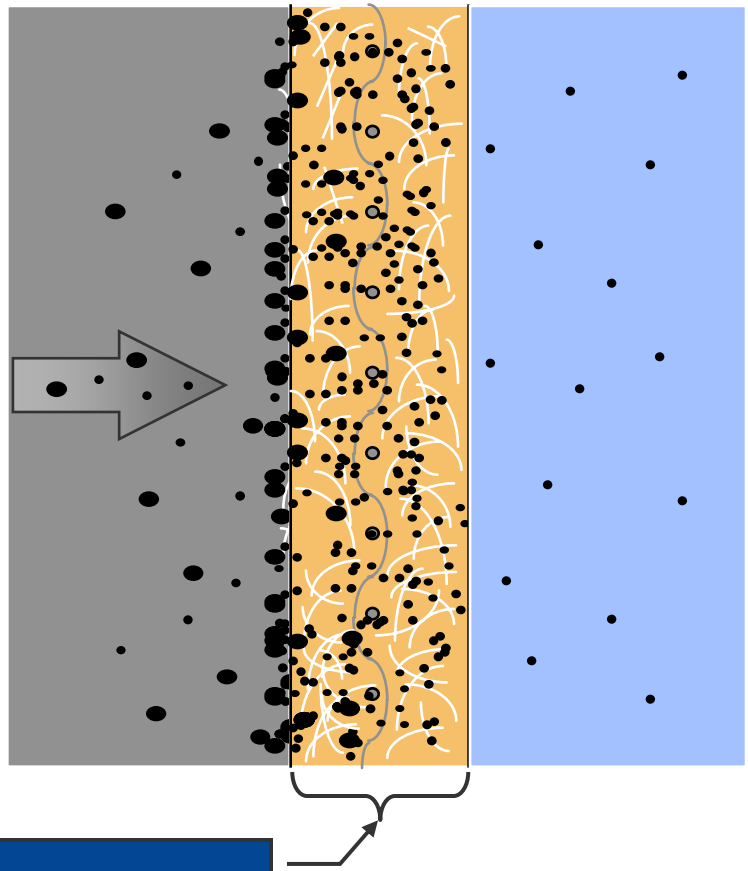
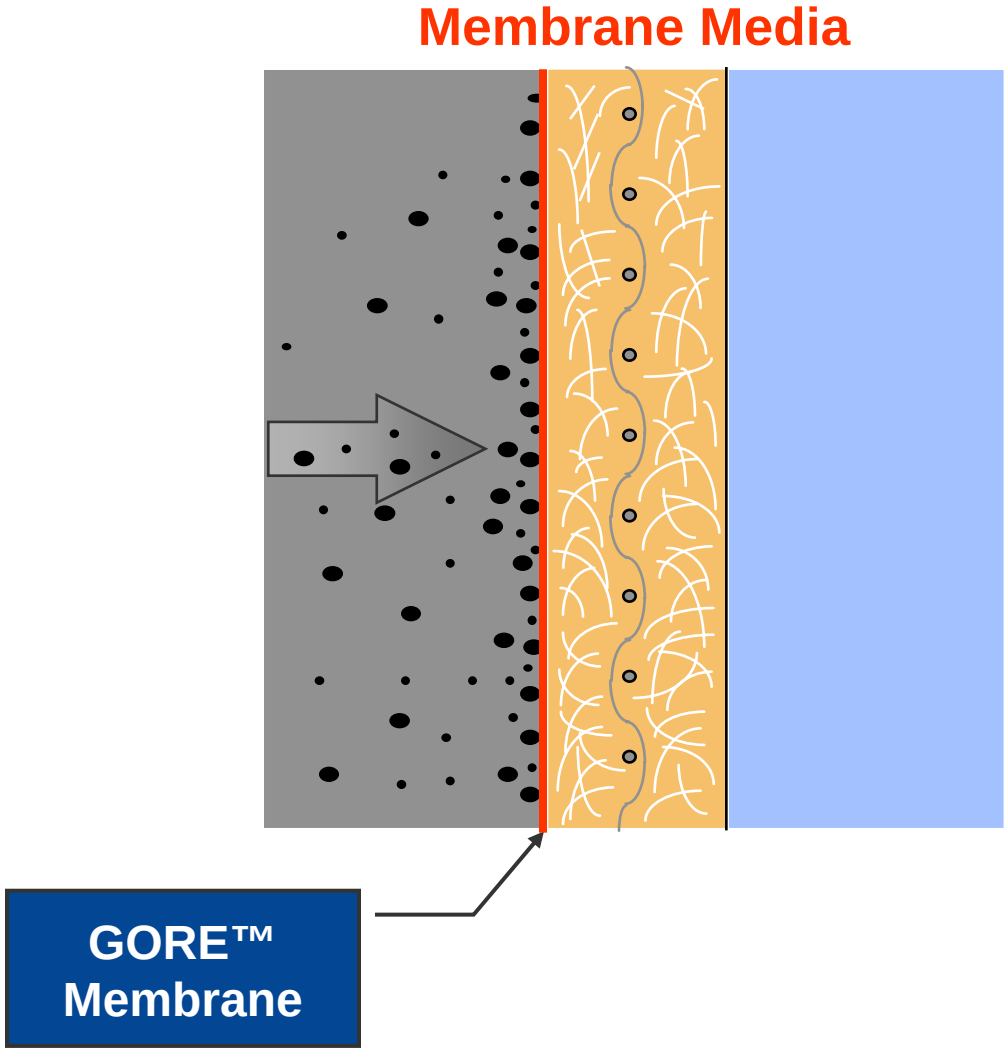
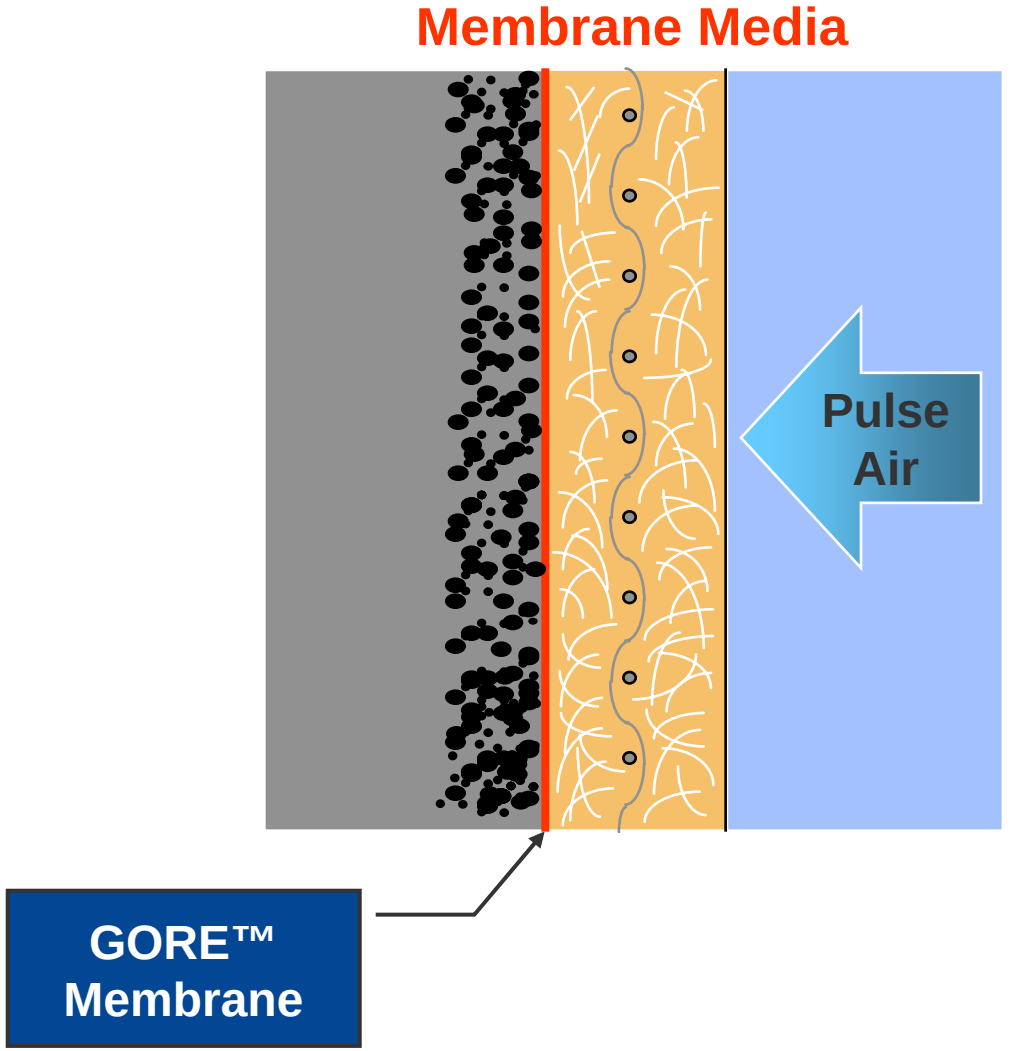


Depth filter media e.g. PPS felt

Surface Filtration – Filtering Mode



Surface Filtration - Cleaning Mode



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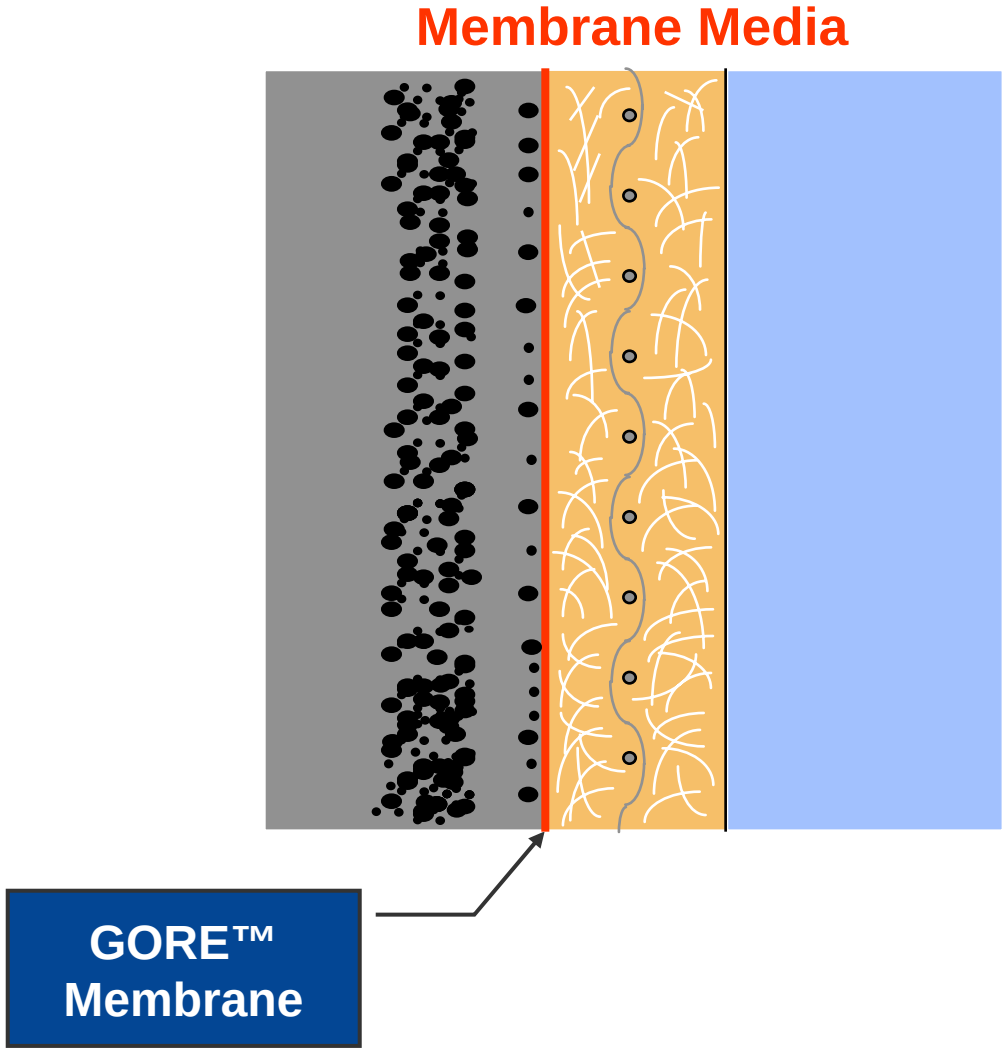

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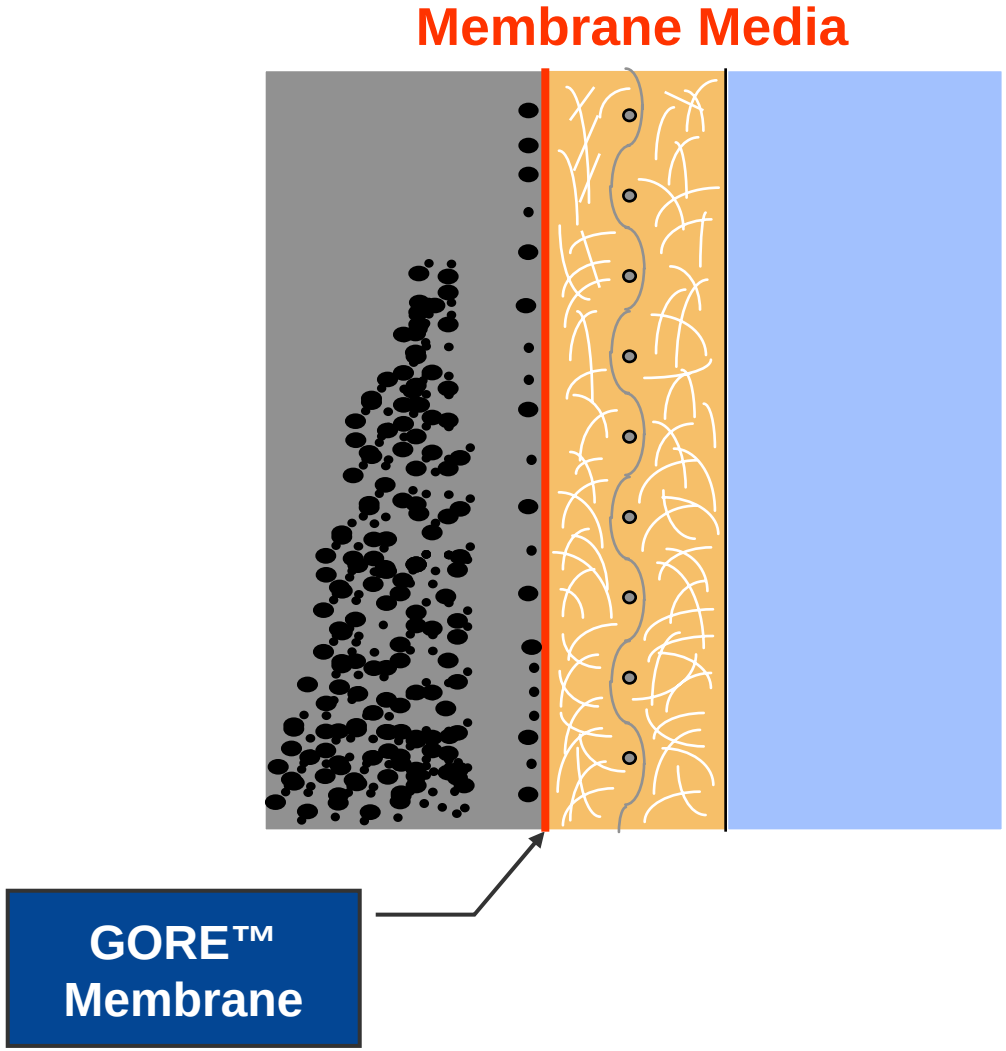

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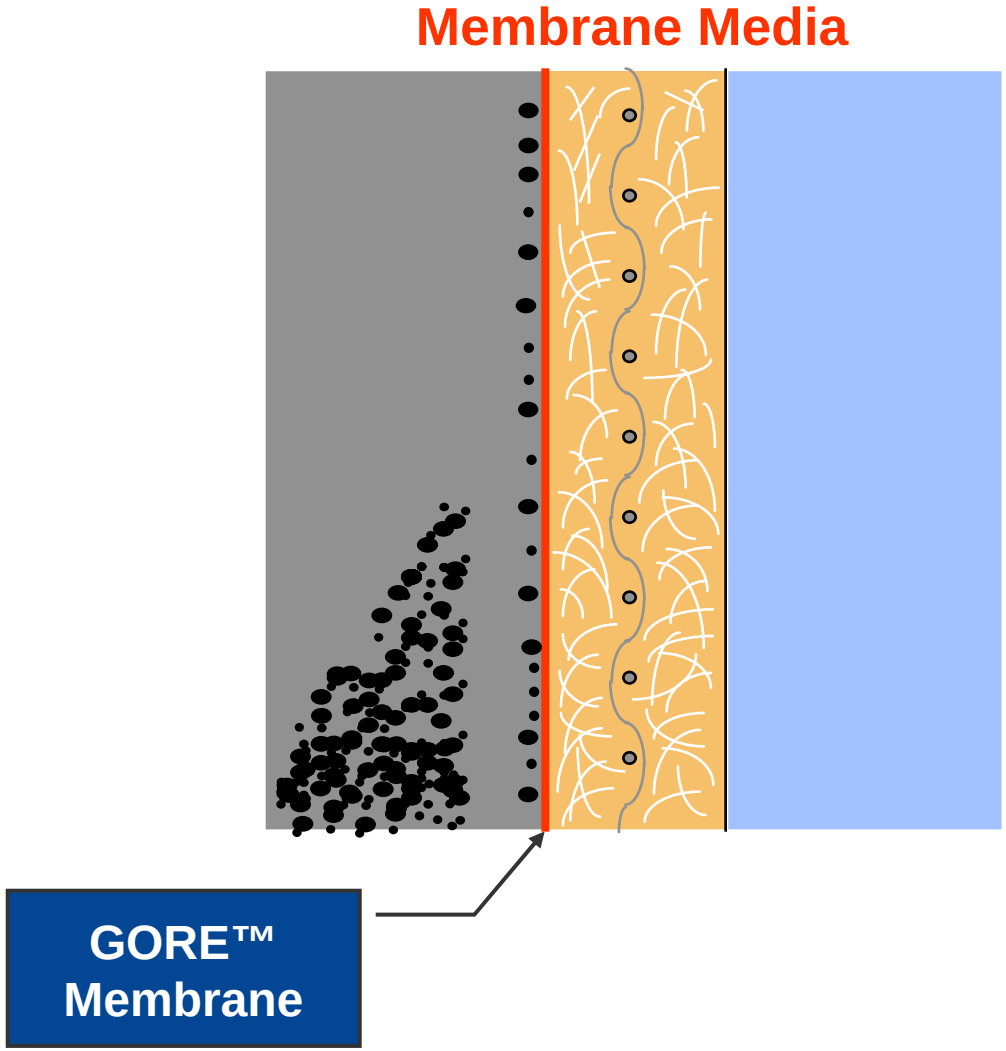

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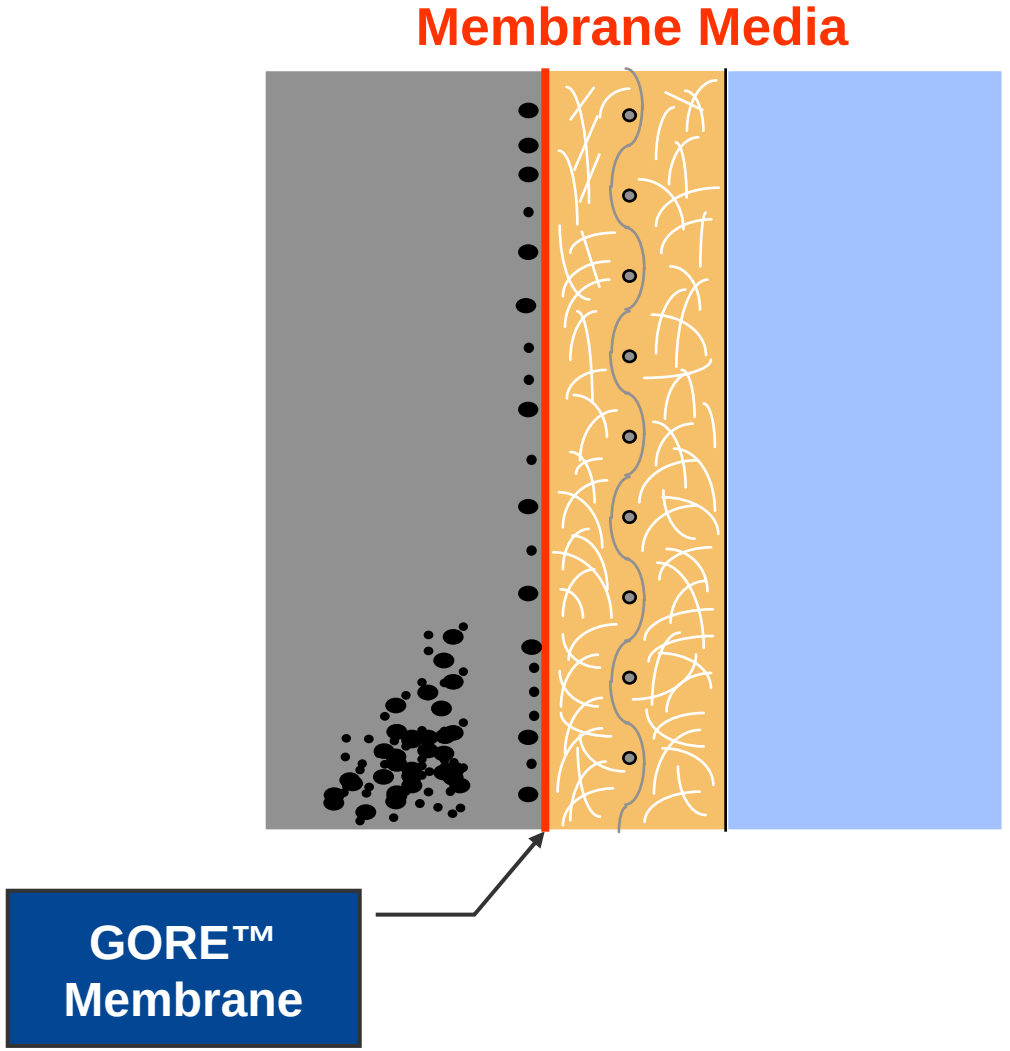

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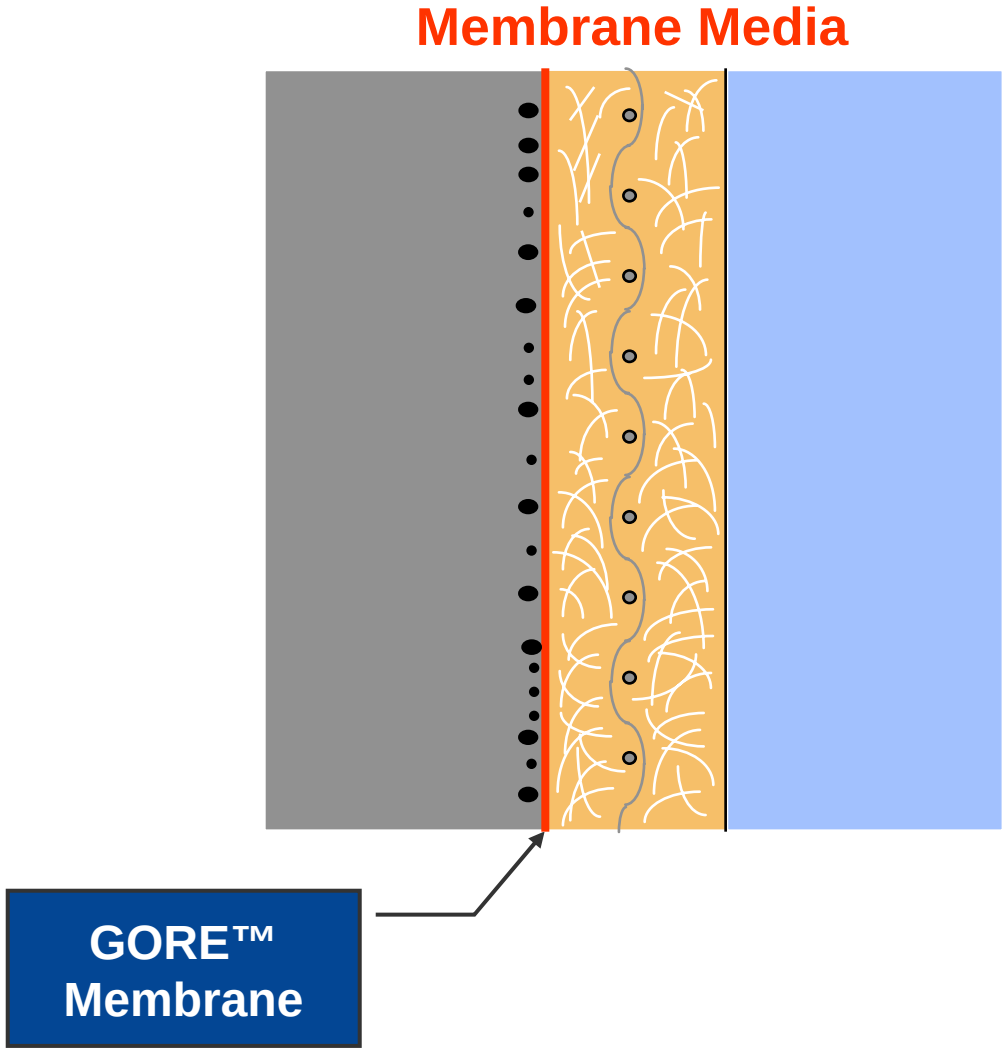
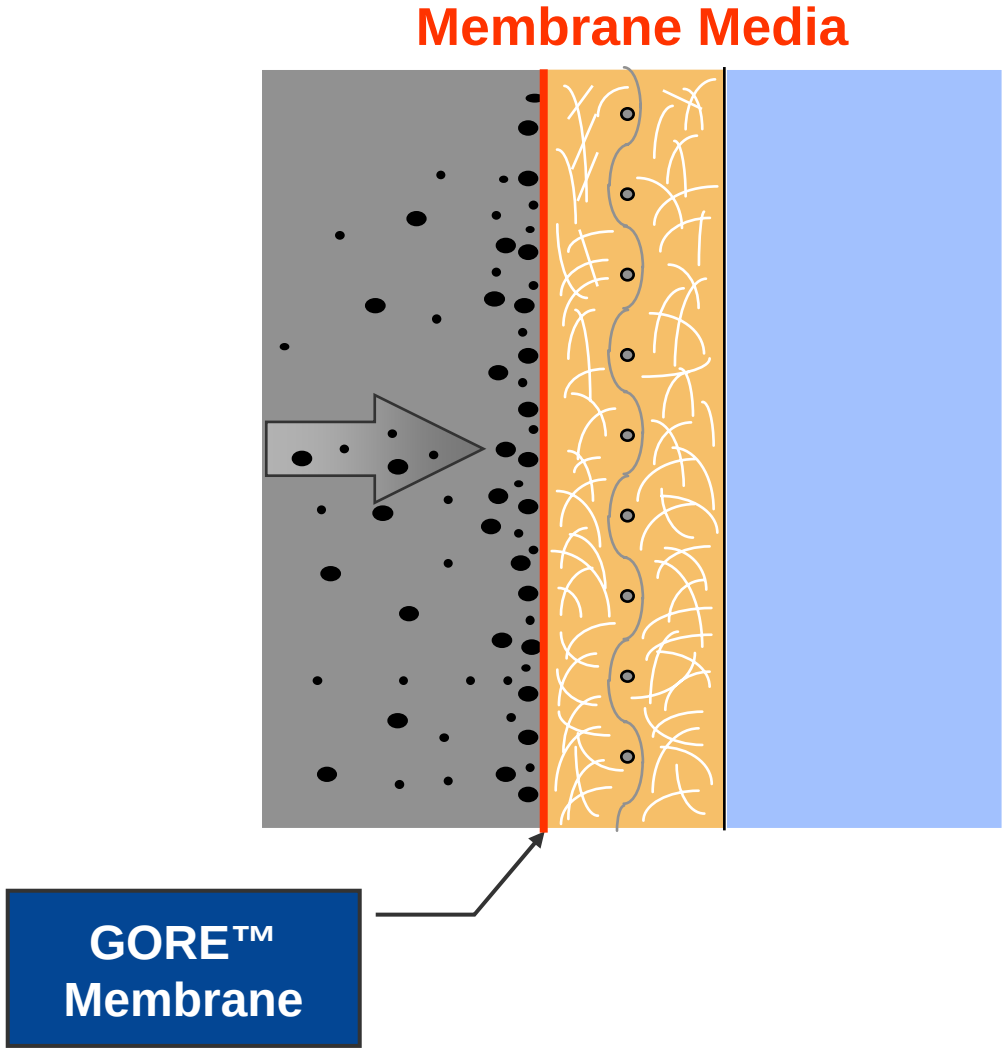
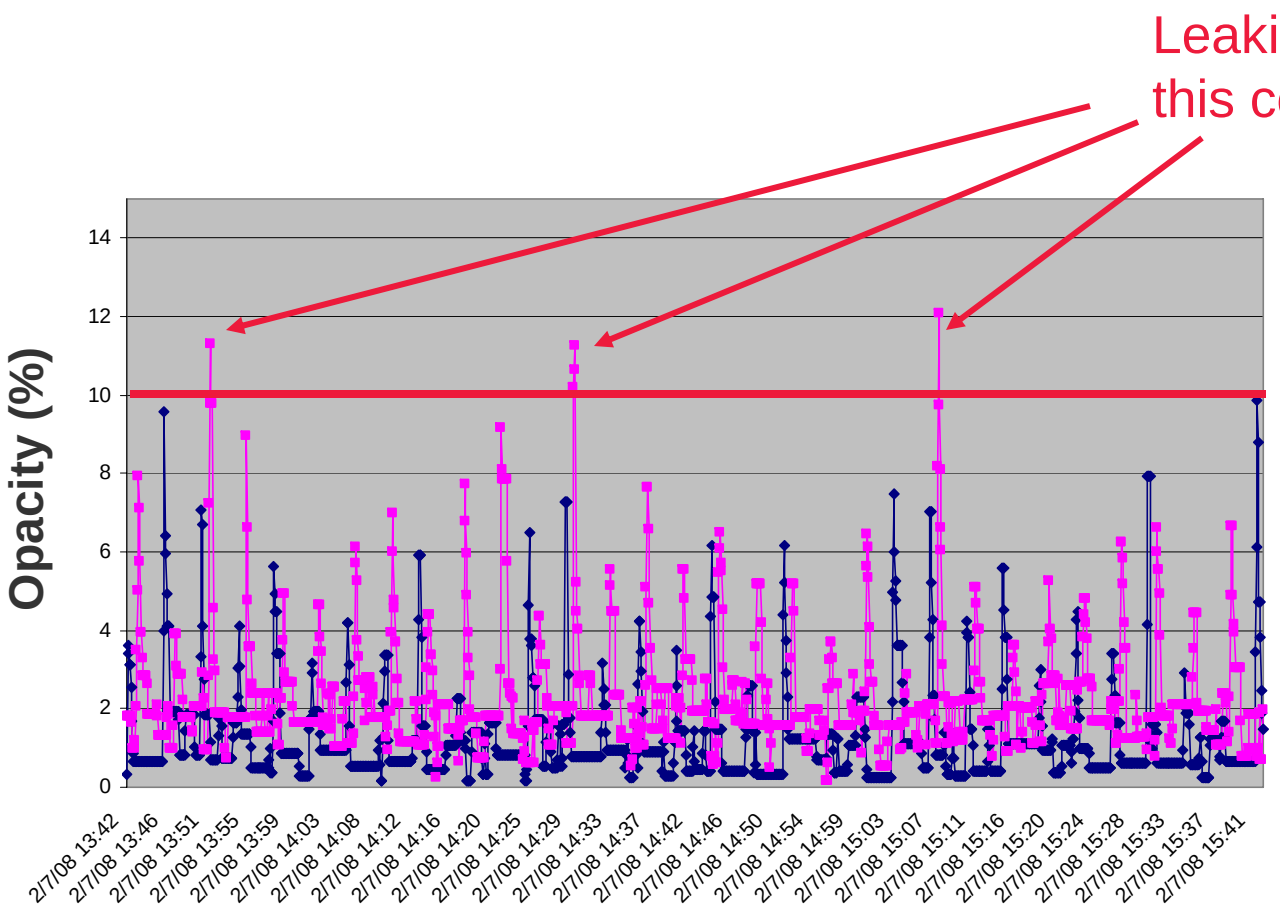


Surface Filtration - Filtering Mode



Opacity Trending – Particulate Emissions

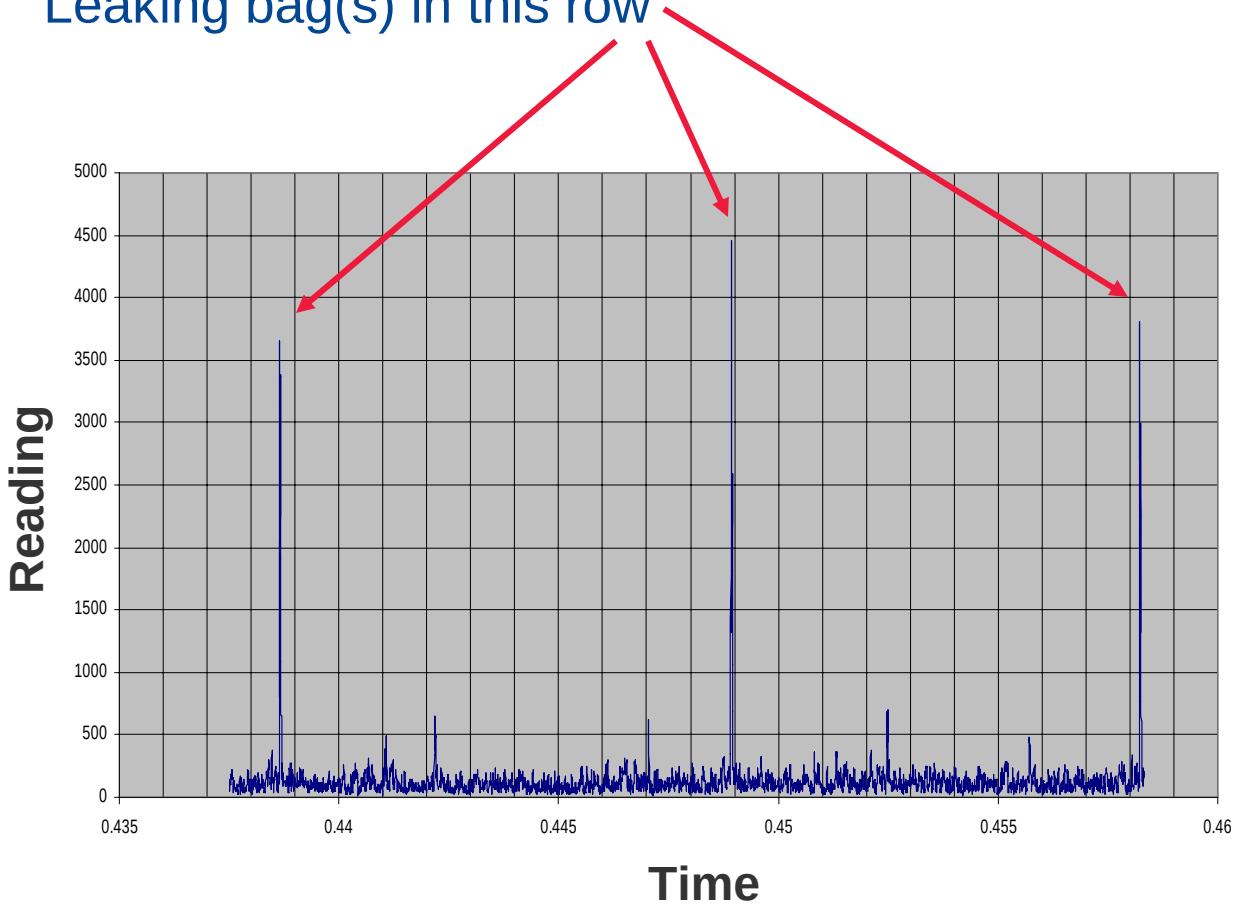


Opacity – 2 hour trend
Off-line cleaning mode

System Optimization – Particulate Emissions

Using the FilterSense™ Particulate Monitor

Leaking bag(s) in this row



GORE™ Membrane Media
On-Line cleaning mode

How & Why Does a Filter Bag Fail?

Some examples include:

- Mechanical (fatigue or abrasion)
- Thermal
- Chemical (acid attack/oxidation/hydrolysis)
- Blinding (high DP)
- Poor Quality
- Bad Installation
- Operational problems (fires/mist/etc)

Filter Bag Life

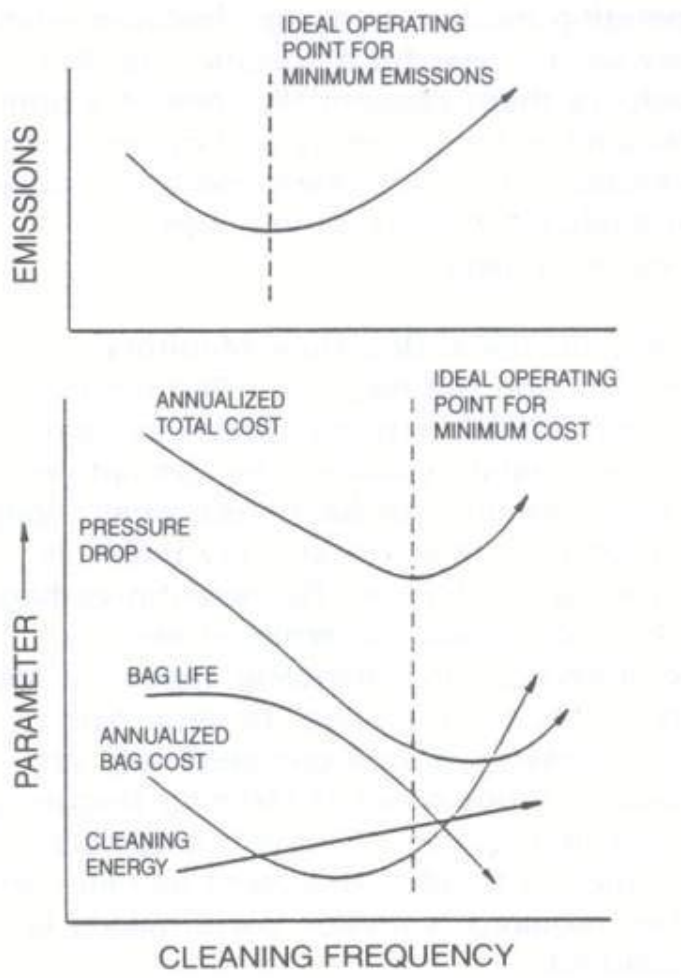
Ideally, a bag would eventually fail from fatigue

- Fatigue is related to cycles and applied loads
  - Cycles are cleaning cycles
  - Loads are forces from DP and cleaning energy

An optimized filter media would operate at a low DP with low cleaning energy

For more details stop by the Alstom booth # 42

System Optimization – Getting the Lowest Annualized Cost w/o Emissions Problems



System Optimization:

Bag Life

Emissions

Pressure Drop

Gas Flow/Throughput

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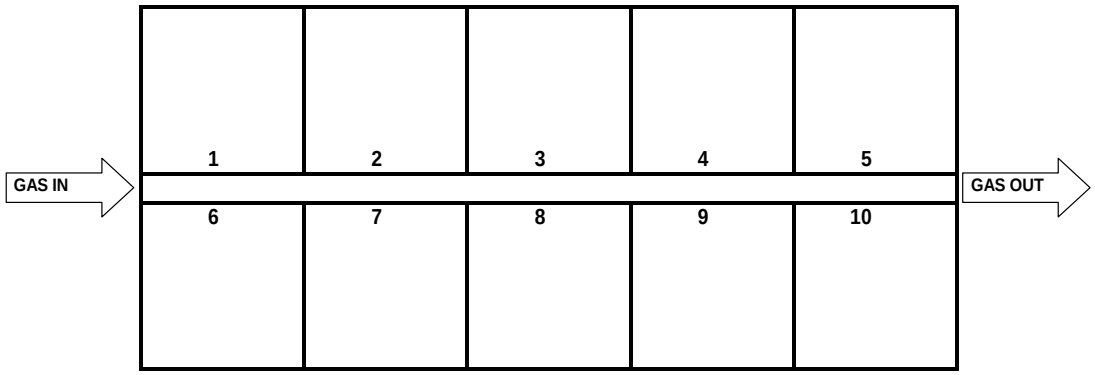
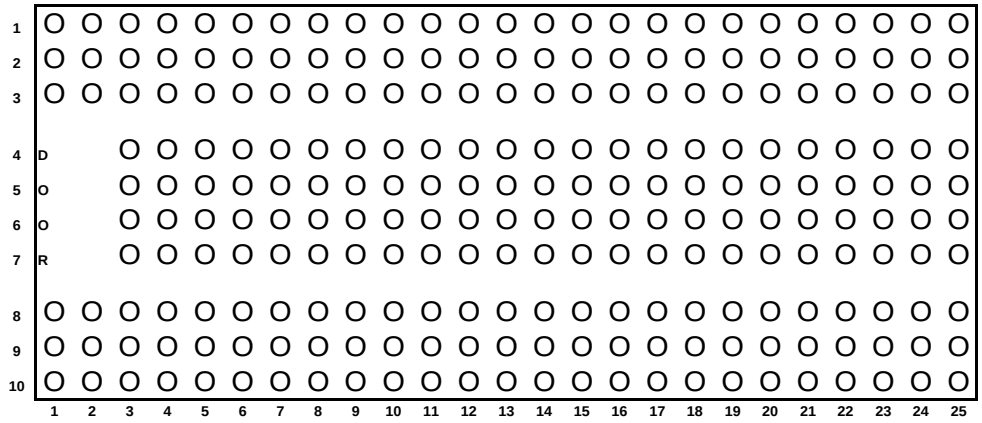
Field Inspection & Laboratory Analysis

Discovering Problems Early

Value of Field Inspection



Compartment Configuration



Tubesheet Configuration

Weekly

- Cleaning System
- Dust removal system
- Instrumentation

During compartment outage

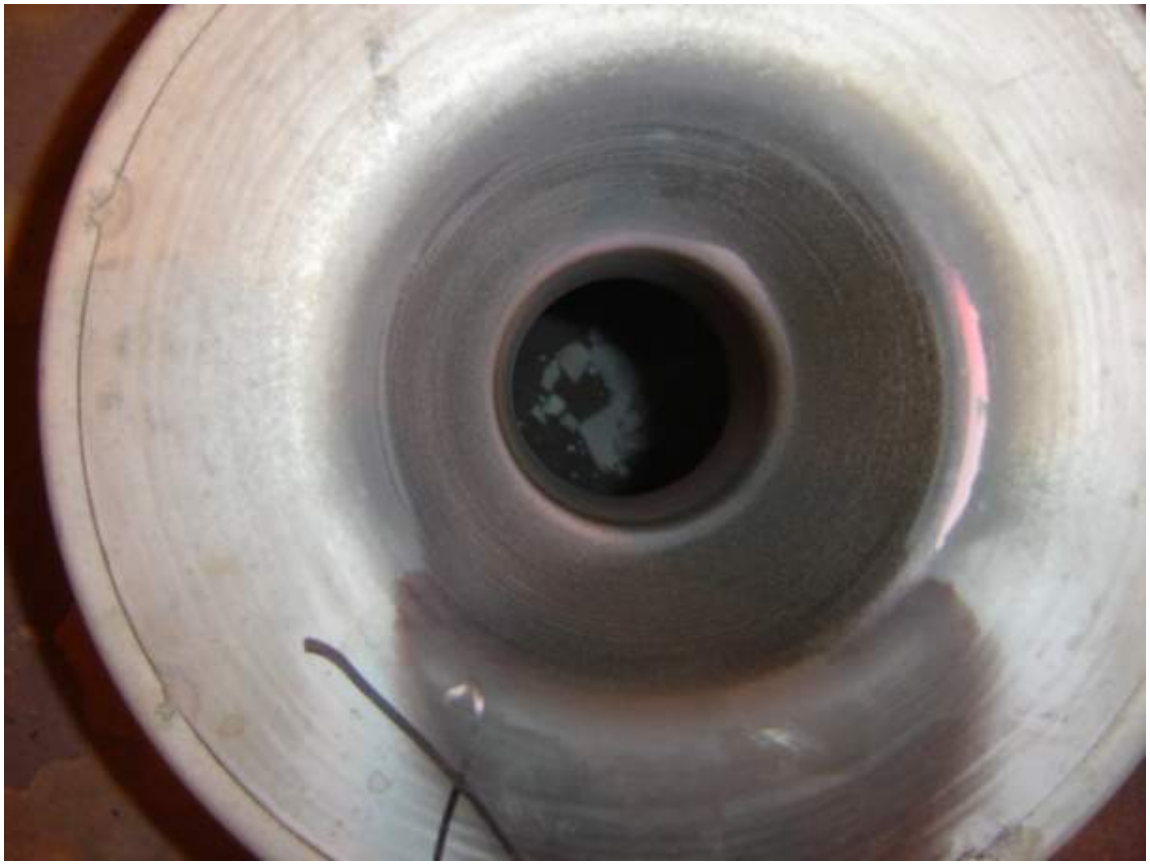
- Access doors
- Clean Air Plenum
- Hopper

Annual or extended outage

- Ductwork
- Dampers
- Pulse Jet Valves

Ash Build up in Corners

Bag Full of Ash



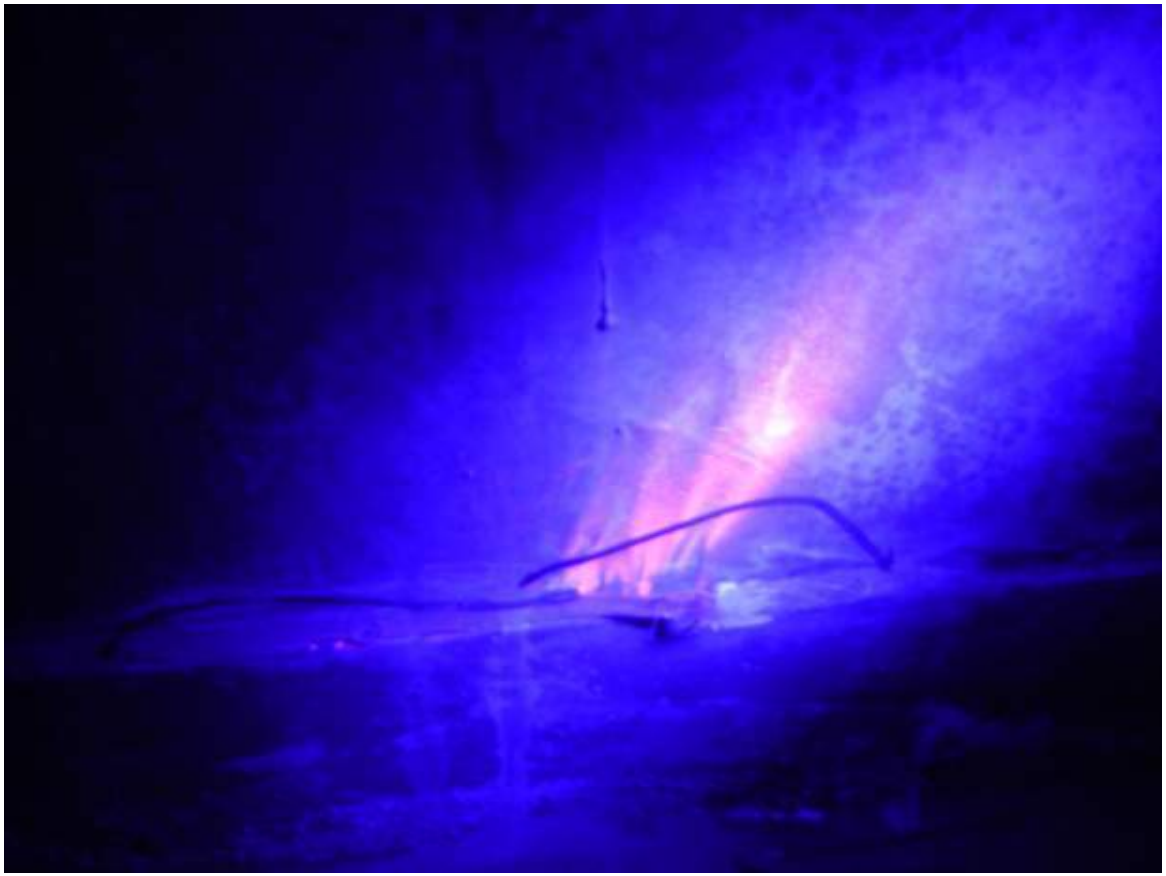
Wear From Misaligned Blowpipe

Missing Section of Blowpipe

Severe Corrosion and Ash Build up in Corner

Hole in Tubesheet Visible After Vacuum Cleaning

Leak at Weld Clean Air Plenum (Under UV Light)



Filter Bag Laboratory Analysis

Visual testing, including microscopic testing

Permeability testing } **Trend monitoring**

Strength testing

Thermal analyses (LOI, TGA)

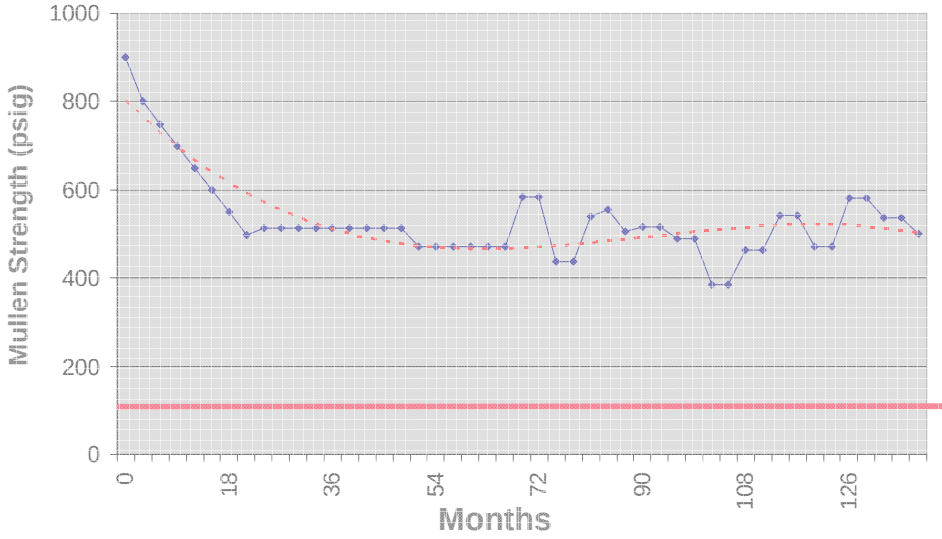
Physical & chemical testing of particulate

It's important to know the compartment and bag location

Value:

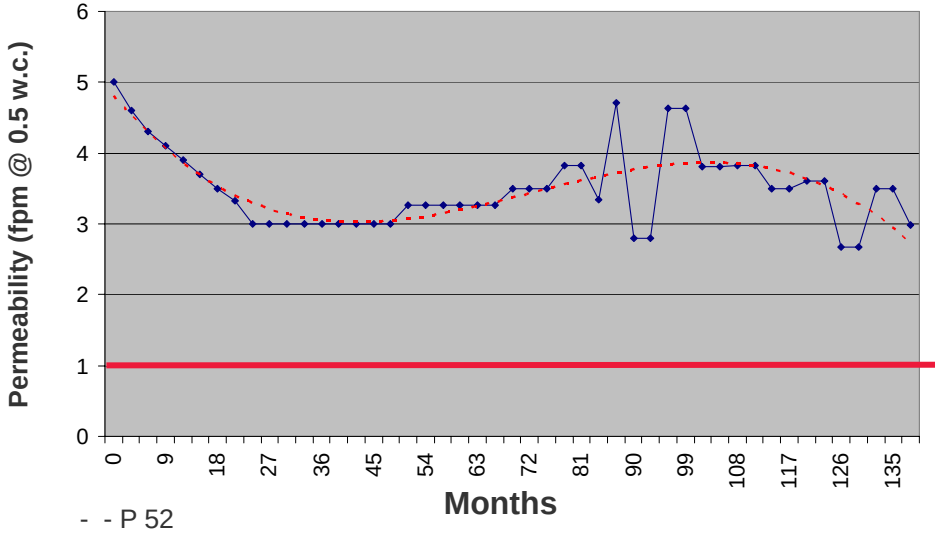
- Determine failure mode
- Project your operation (e.g., filter bag life)
- Help you plan for outages

Filter Bag Analysis – Value of Trending



Filter Bag Strength Trend

Critical at 100 psi



Filter Bag Flow Trend

Critical at 1 fpm

Reducing the Cost of Baghouse O & M

Evaluating system operations:

- Enables optimization of the cleaning system
- Minimize total cost of O & M

Field inspections:

- Identify operational issues
- Reduce costs of O & M

Laboratory analysis

- Insight on bag failures
- Improved bag life

What else can be done?

- Instrumentation for early discovery of problems

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Discovering Problems Early (T.J. Winalski)

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Advanced Solutions for Process Filtration

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Monitoring
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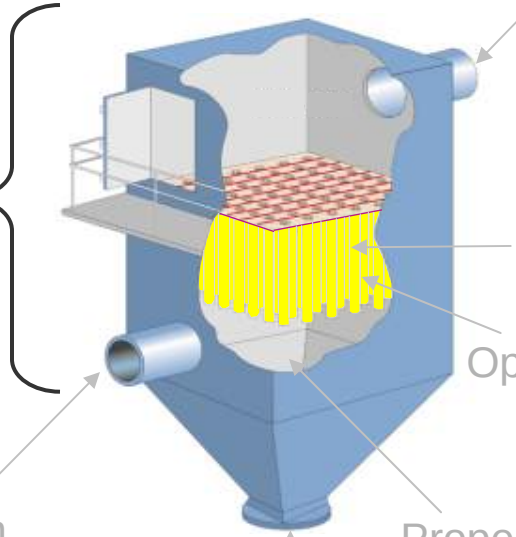


Reduced emissions

Filter analysis

Optimized filter design

Proper inlet & Baffle design

Hopper & discharge consultation

Fan & ventilation consultation & design
Gas flow measurements

Value Added Services

Knowledge of Regulatory Issues

Latest Monitoring Technology

O & M Support

Process & Filtration Integration Consulting

FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Monitoring Technology

Particulate Monitors Can Be Used As:

Maintenance Tool
Analytical Tool

FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

Single Monitoring Point

Common Outlet of Baghouse

Multiple Monitoring Points

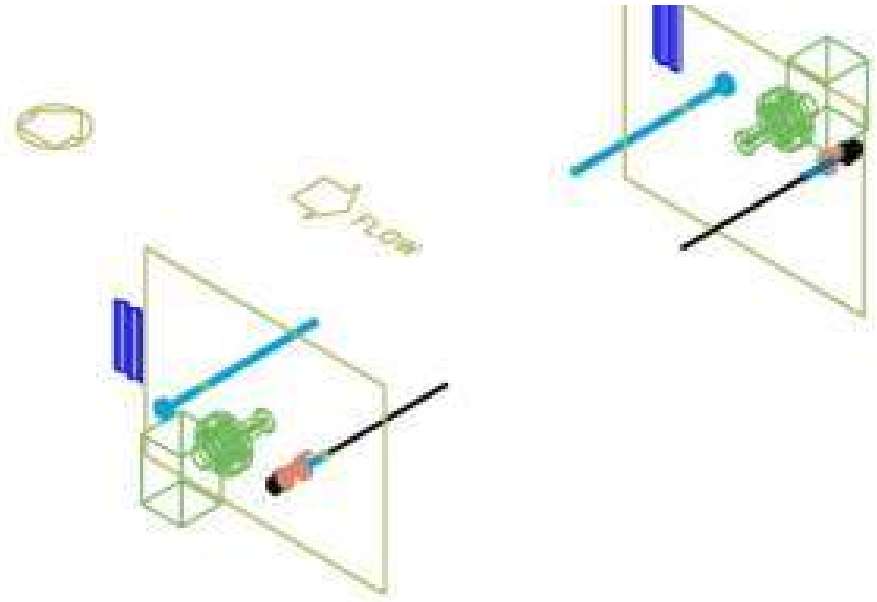
Outlet of Each Individual Compartment

FilterSense

Advanced Solutions for Process Filtration

Particulate Emissions – Monitoring Technology

Common Outlet of Baghouse – Typical Installation



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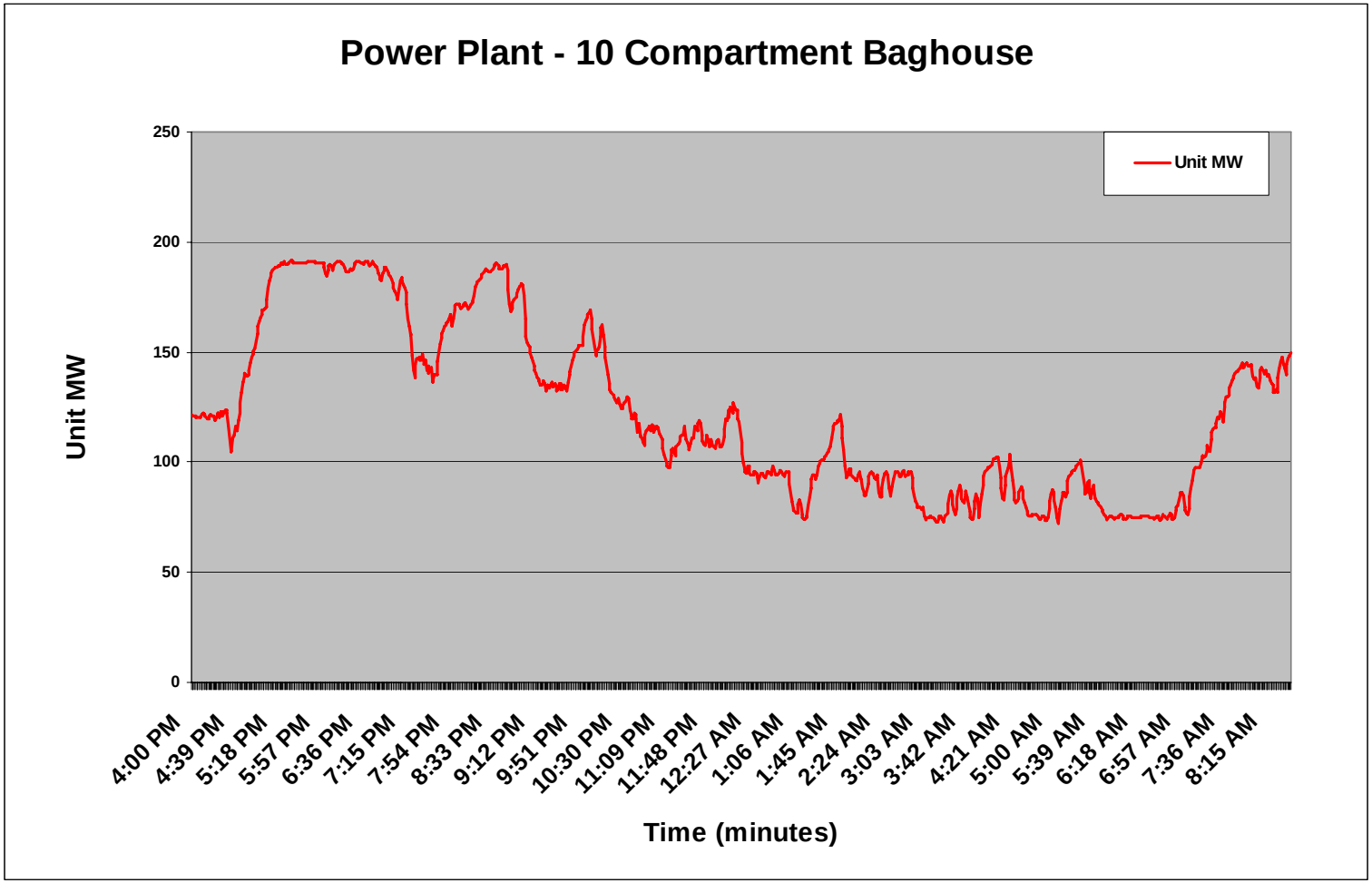
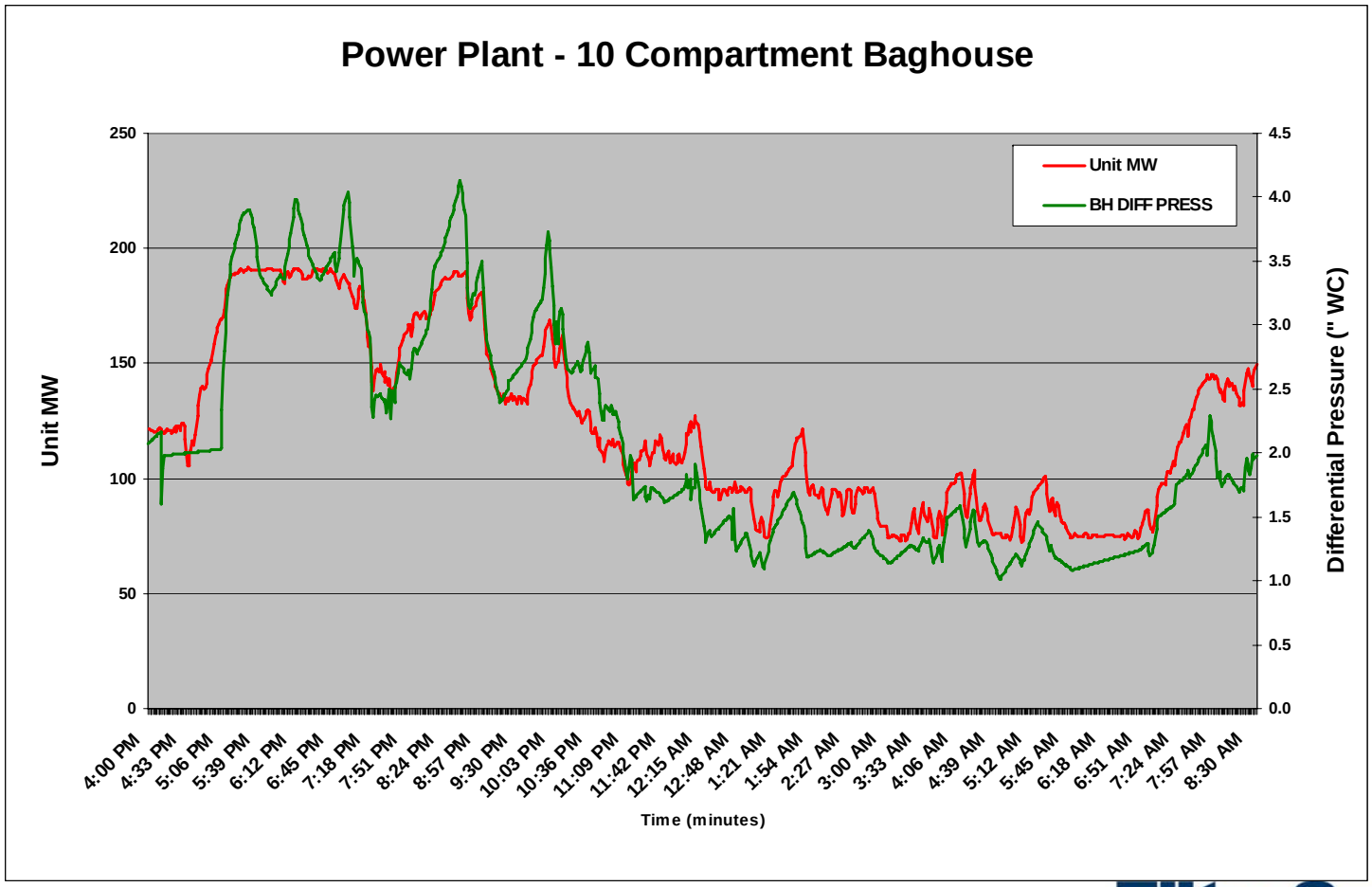
Particulate Emissions – Maintenance Tool



FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

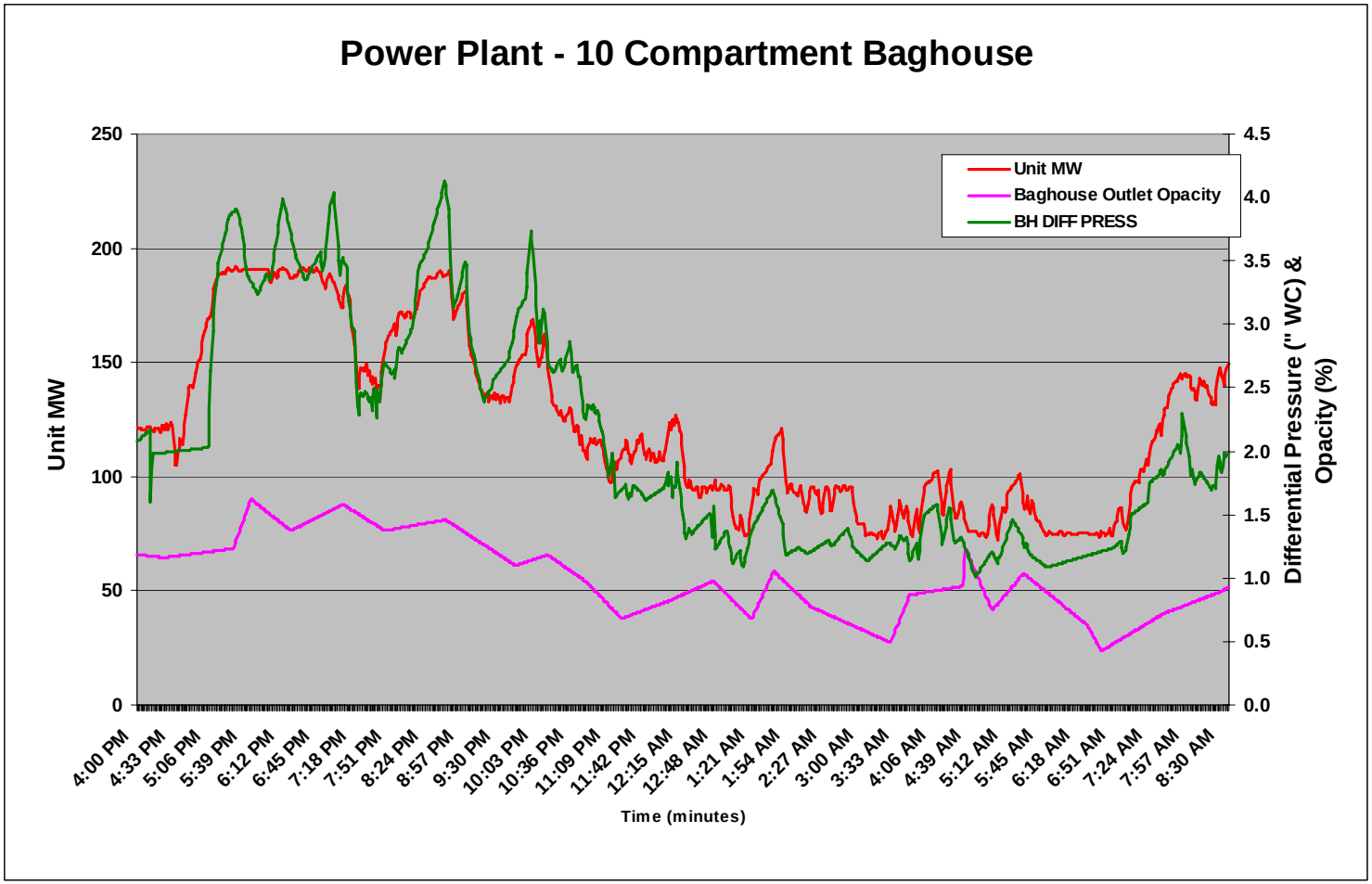
Common Outlet of Baghouse – Pressure Drop



FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

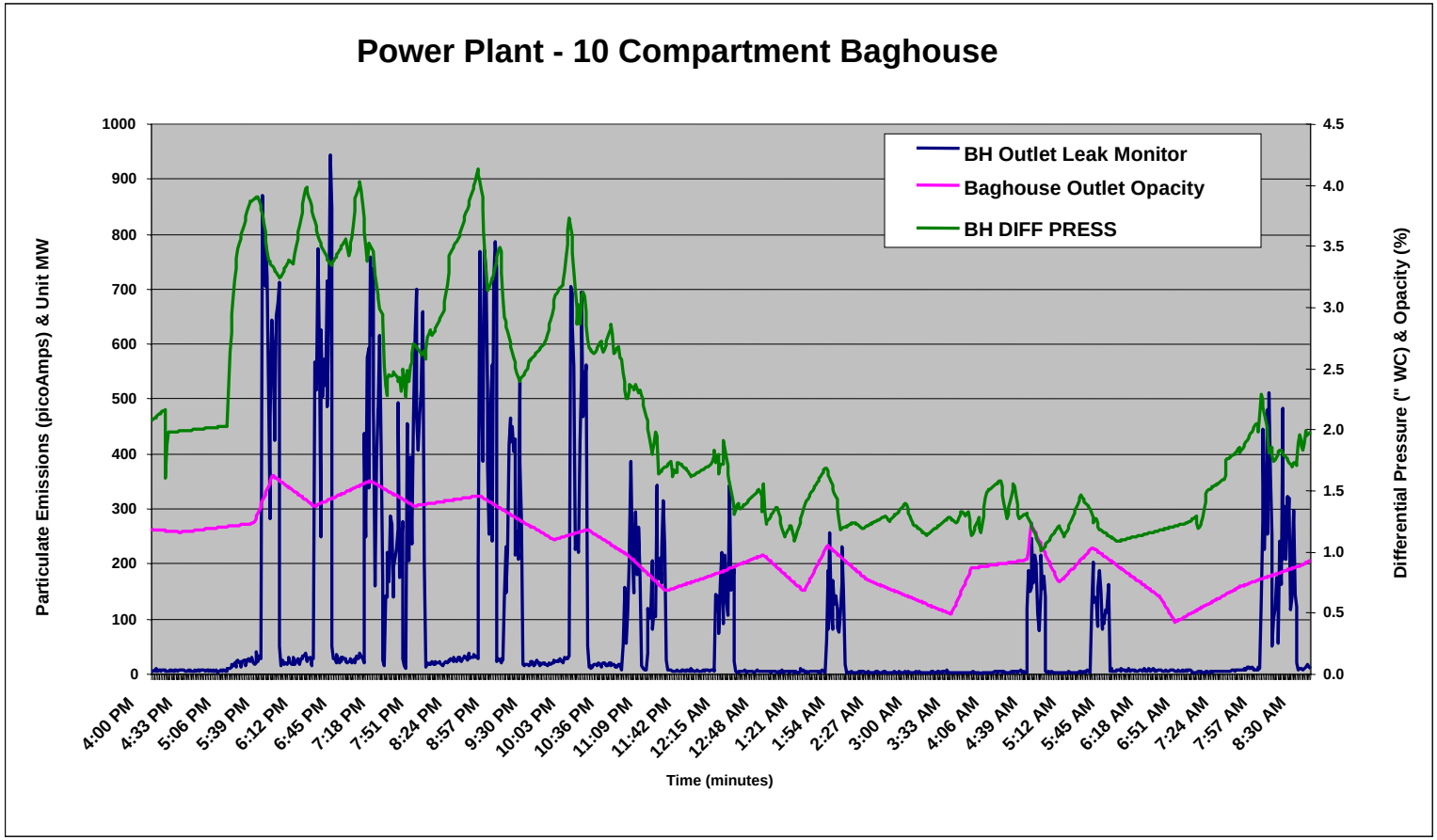
Common Outlet of Baghouse – Pressure Drop & Opacity



FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

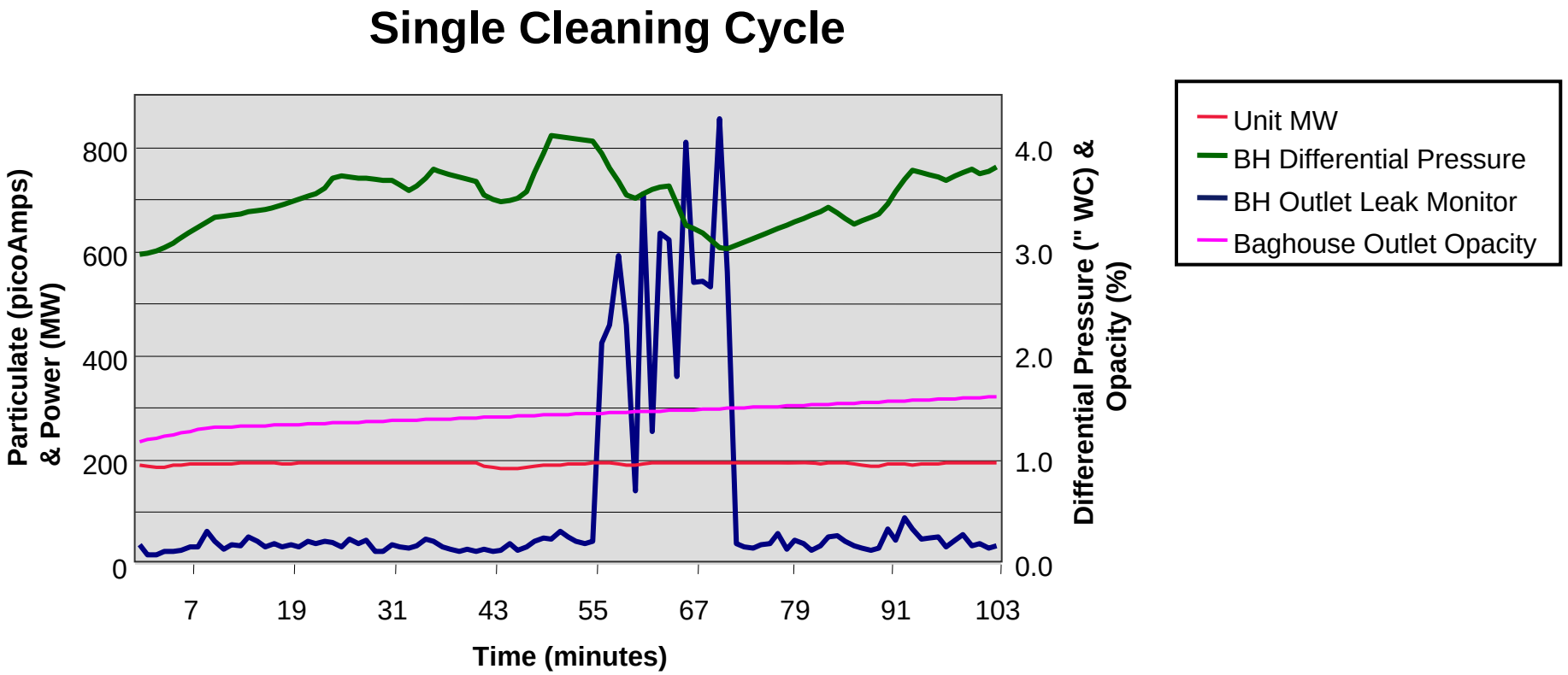
Common Outlet of Baghouse – Pressure Drop, Opacity, and PM Emissions



FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

Common Outlet of Baghouse – Particulate, DP and Opacity



FilterSense
Advanced Solutions for Process Filtration

Particulate Emissions – Maintenance Tool

Benefits of Particulate Monitoring at High Resolution?

Early Detection of a Problem

Optimize Maintenance

Lowest Material, Labor and Down-time

Proactive

FilterSense

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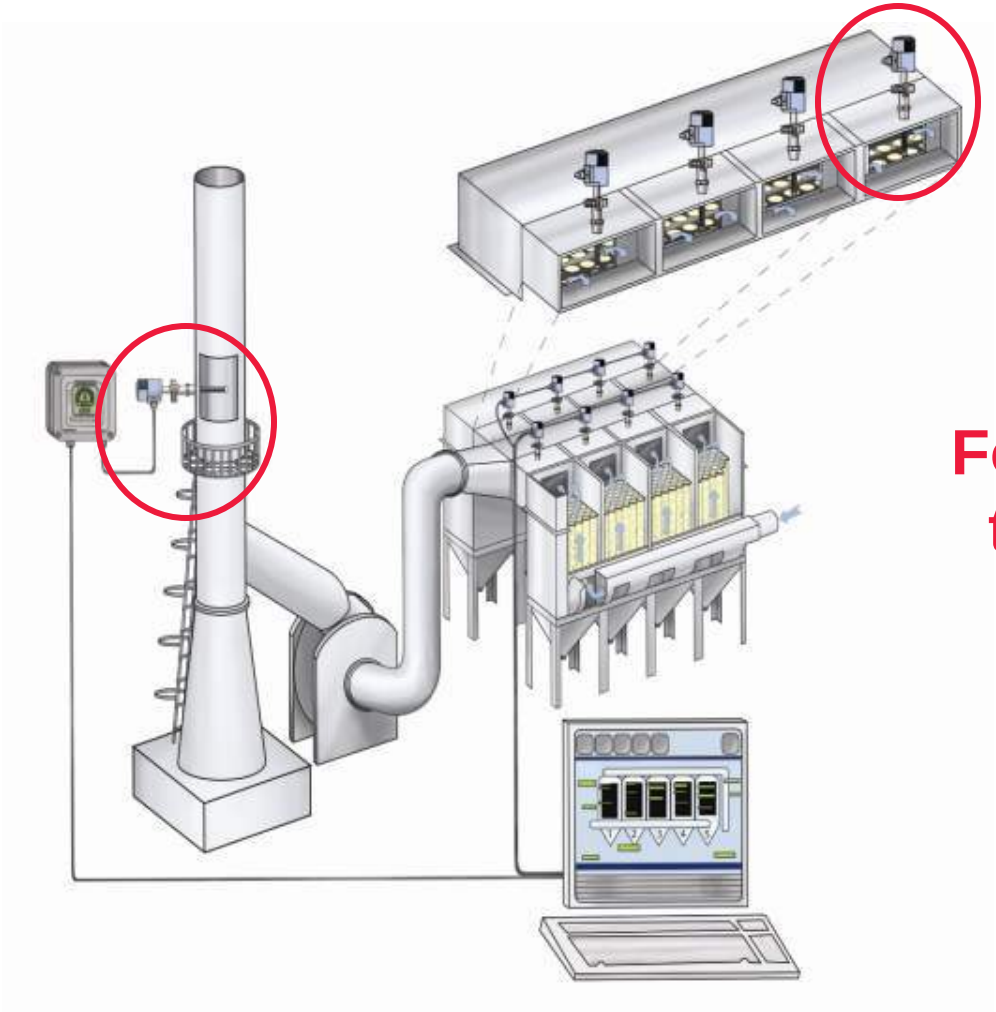
Particulate Emissions – Monitoring Technology



For more details stop by the Alstom booth # 42

FilterSense

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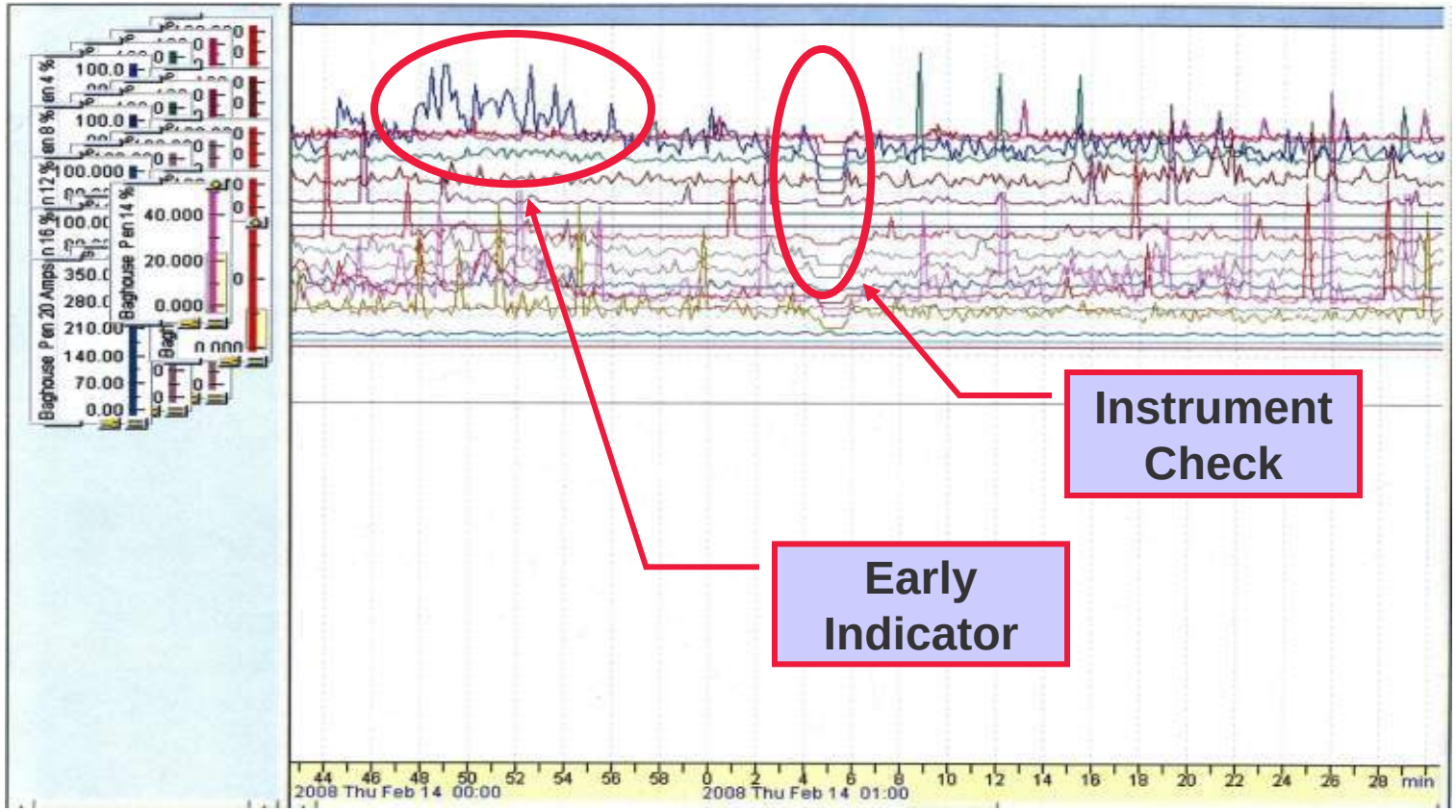
Particulate Emissions – Maintenance Tool

Outlet of Each Individual Compartment



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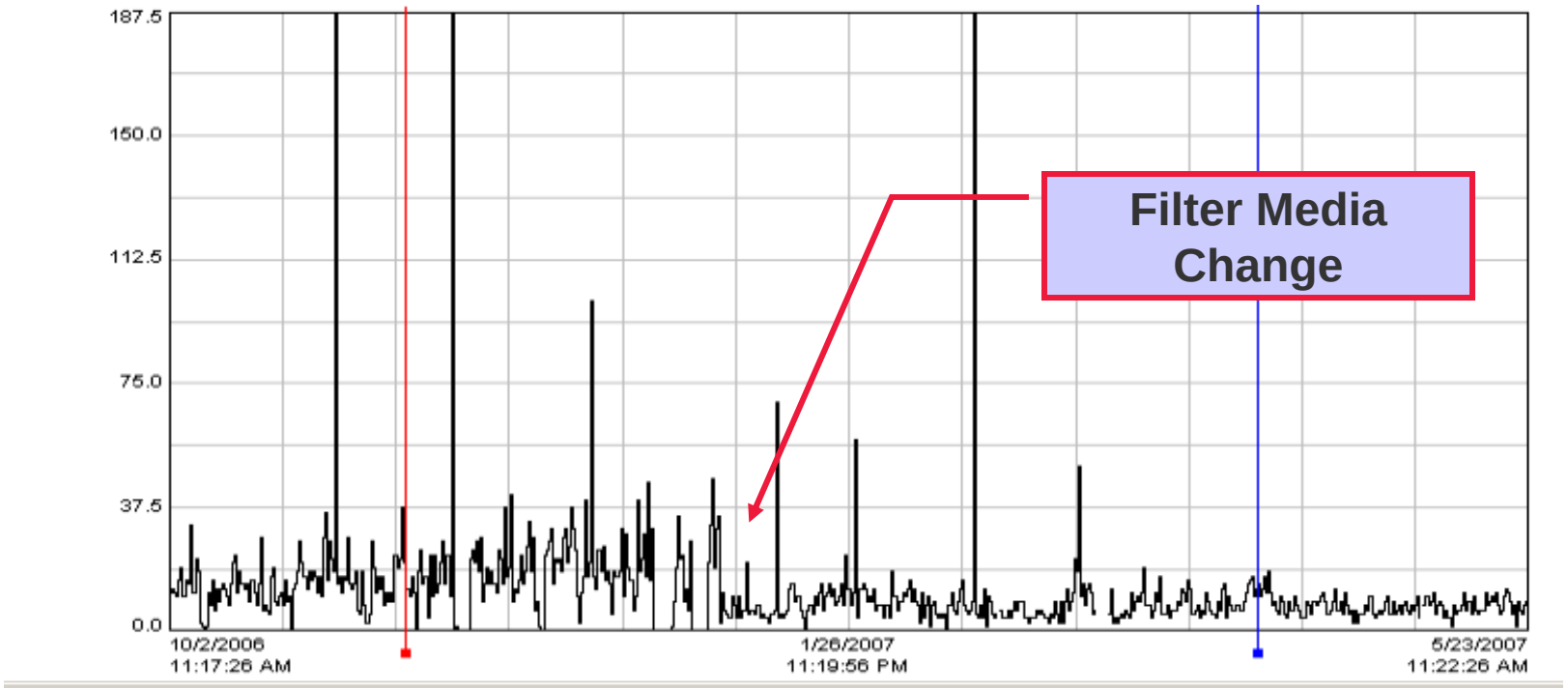
Particulate Emissions – Analytical Tool

Outlet of an Individual Compartment – New Media



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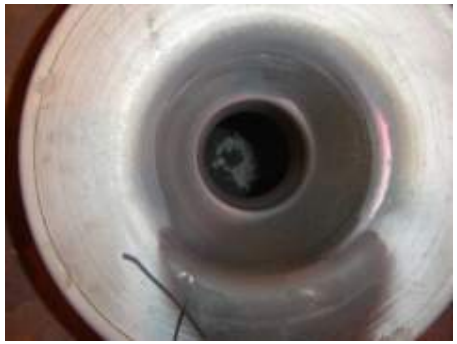
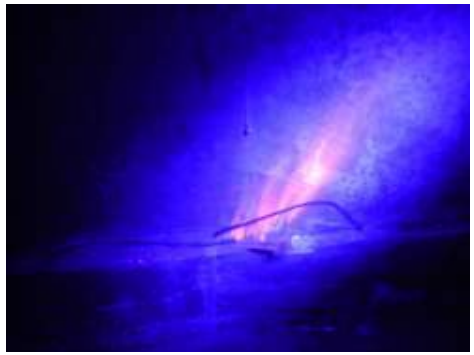
Particulate Emissions – Maintenance Tool





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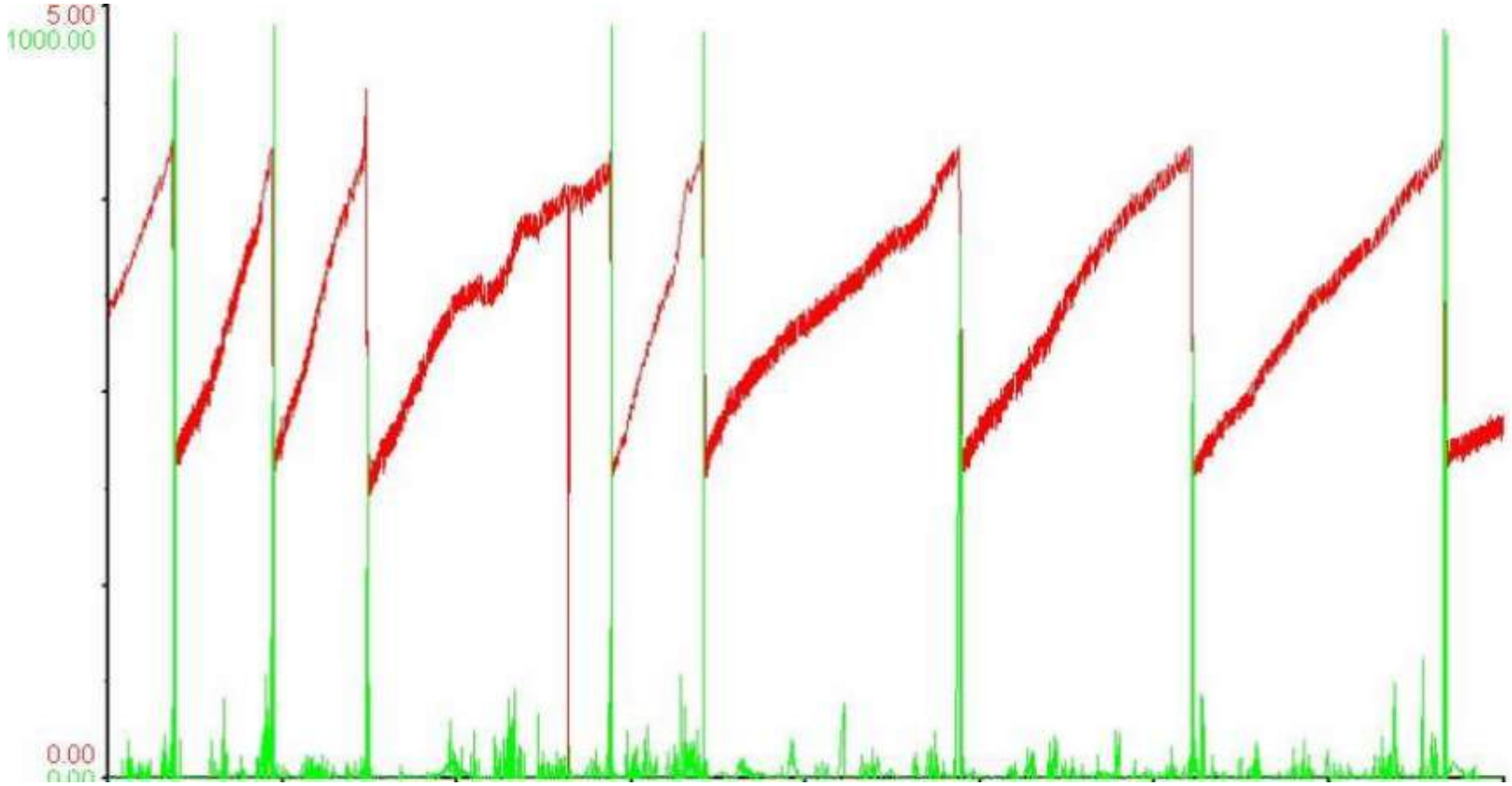
Particulate Emissions – Maintenance Tool

Outlet of an Individual Compartment

Micro Fractures in Tubesheet



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Optimize Baghouse O & M

Monitoring in Real Time, High Resolution is an Essential Tool to Assist in Optimizing the baghouse

Advanced Analysis:

Tool to Enhance Baghouse Operation

Maximum Performance for Minimal Costs

Maintenance:

Early Detection of Problems
ProActive

FilterSense
Advanced Solutions for Process Filtration

Questions and Answers

Thank You