

On-line Particle Counters in the Thermal Power Plant

**Joe Zimmerman
Director of Power Industry Sales
Chemtrac, Inc.**



Introduction



Introduction

High Purity Water is Essential in the Power Plant

- Steam Cycle
- Make-up water

Pretreatment & Steam Cycle Chemistry Monitoring

- Grab samples
- Composite Sampling
- On-line Continuous Monitoring

Particle Detection

- Steam Cycle
- Make up water

Introduction

Overview

- I. Particle Detection Technology**
- II. Applications**
- III. Condensate Polisher Monitoring**
- IV. Conclusions**

Particle Detection Technology

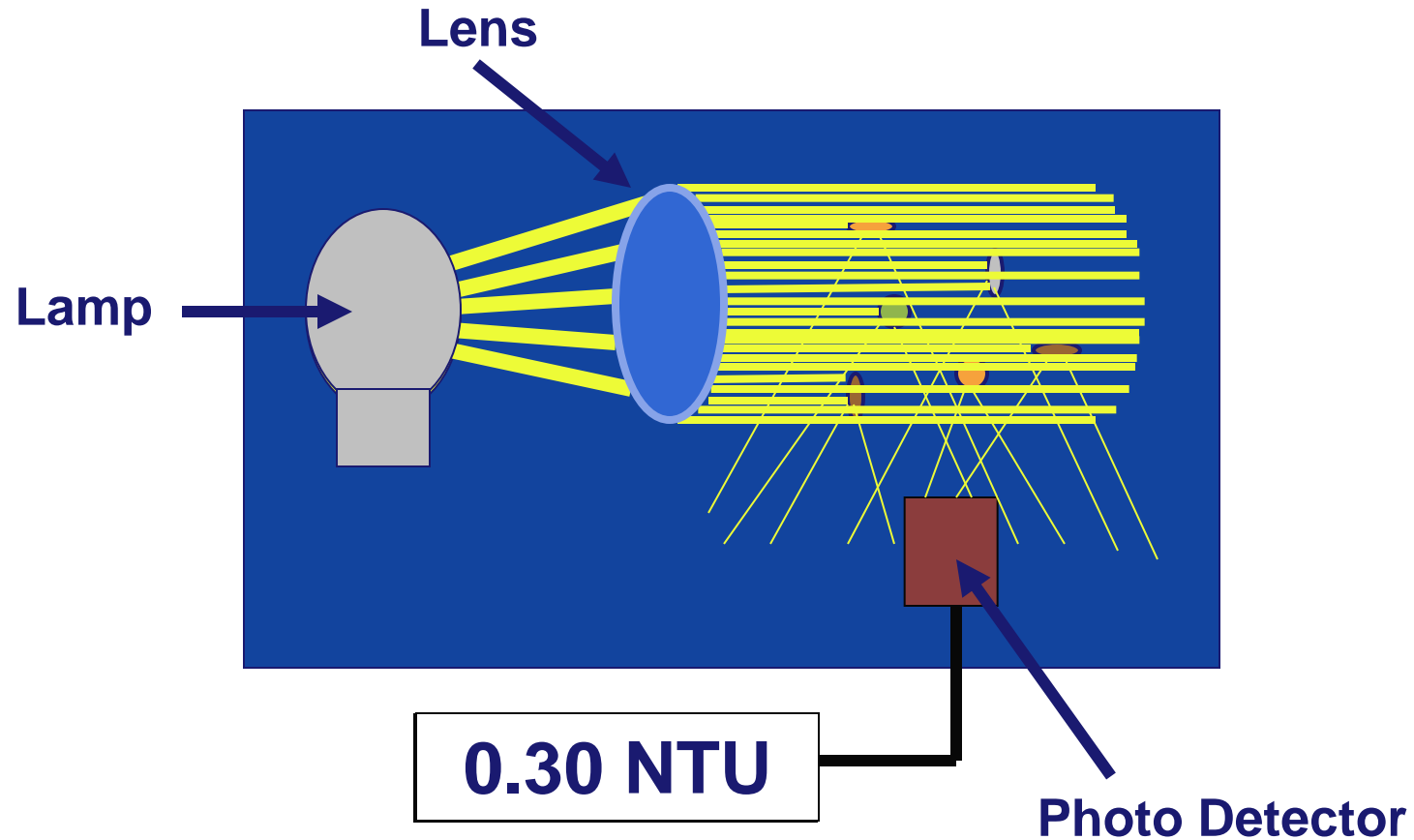


Particle Detection Technology

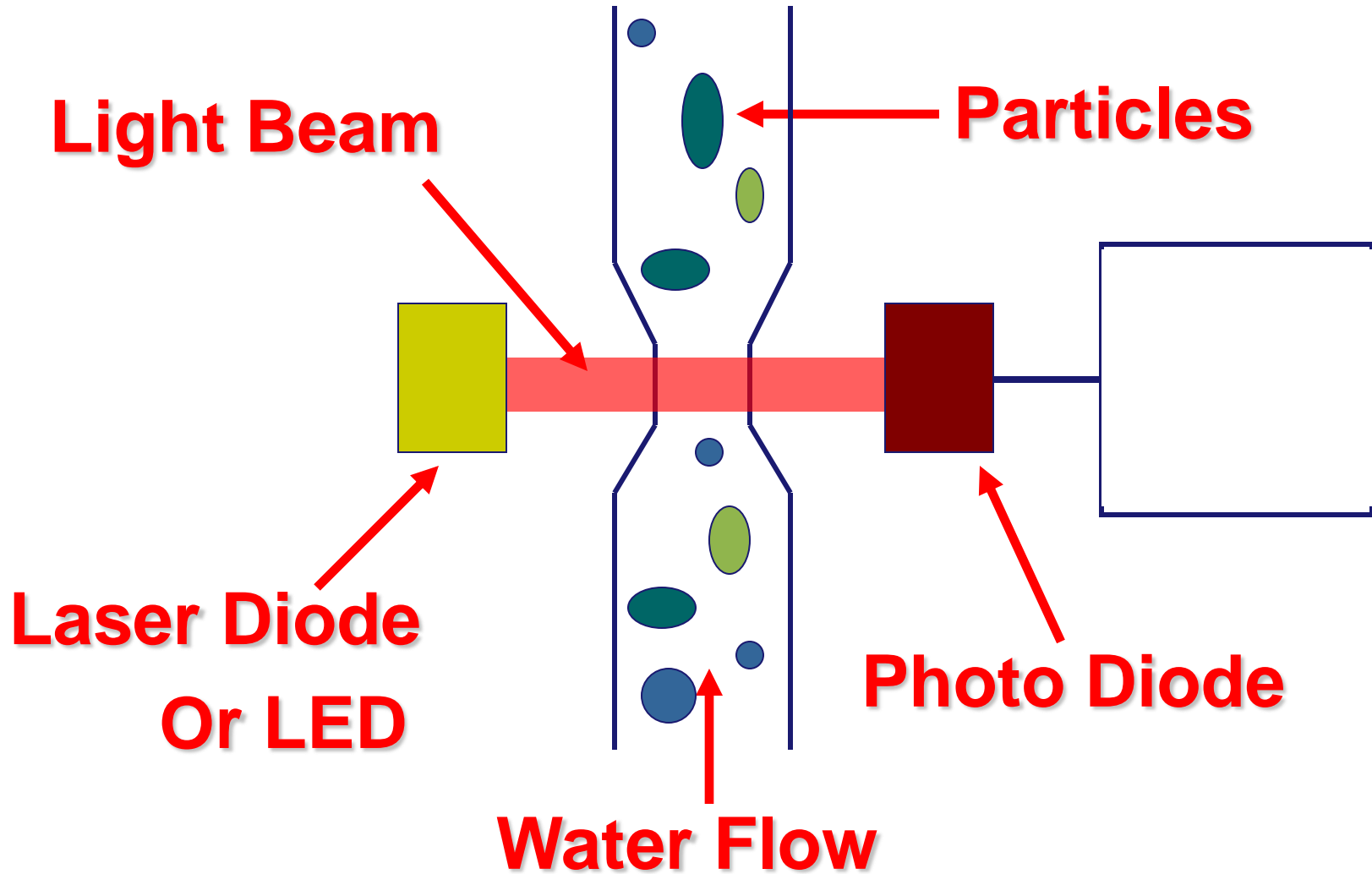
- Traditional Turbidity Monitors utilize a “light scattering” measurement
- Particle Counters & Particle Monitors utilize a “light blockage” measurement

Particle Detection Technology

Turbidity Monitor



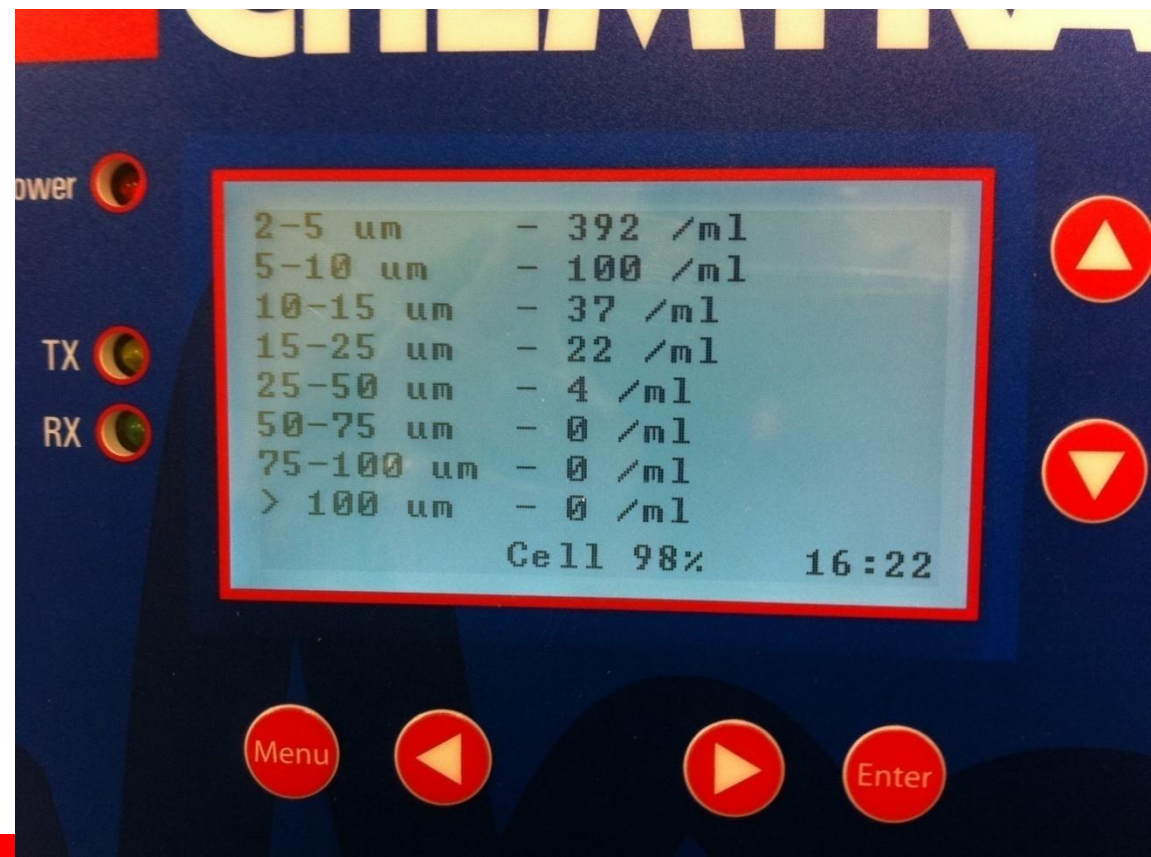
Particle Detection Technology



Particle Detection Technology

Particle Counter

- Detect particles $\geq 2 \mu\text{m}$
- Reports results in **particles/ml** for up to 8 size ranges



Particle Detection Technology

Particle Monitor

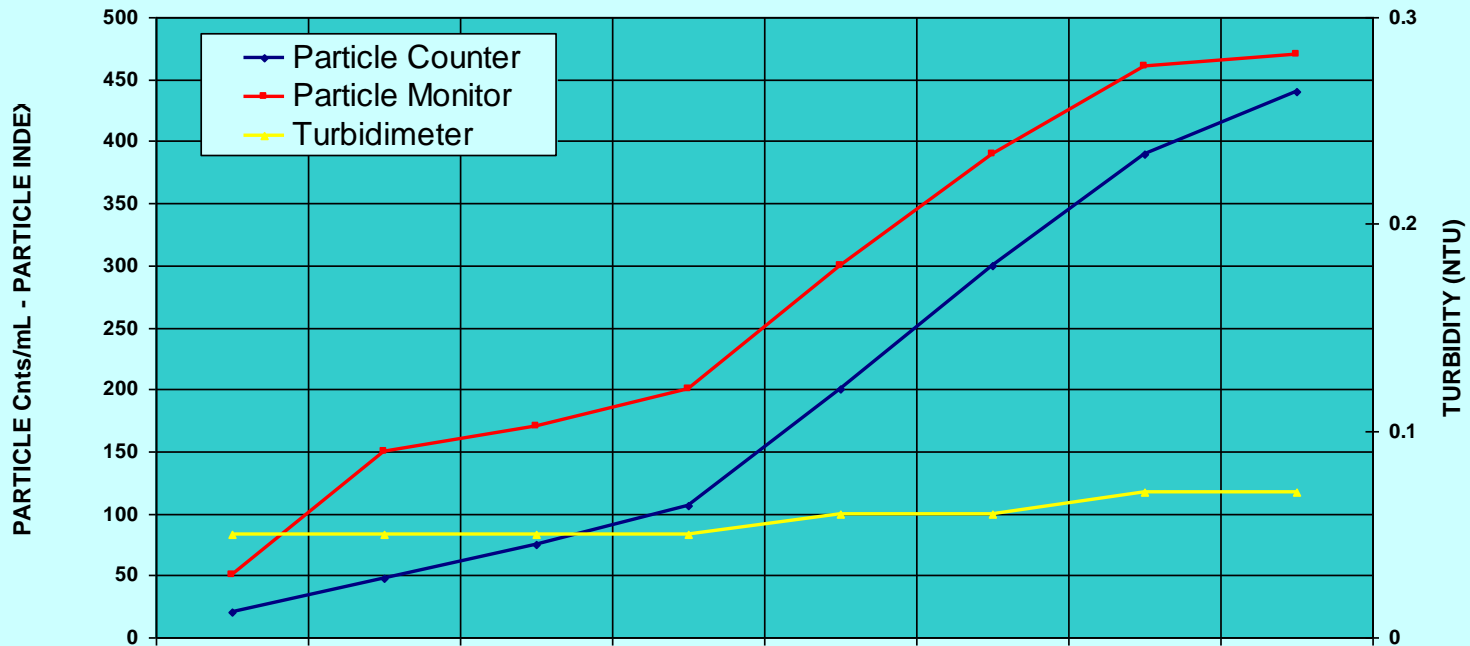
- Single channel device, producing a “relative” measurement called a **Particle Index (PI)**
- The PI will increase with both an increase in particle size and concentration



Particle Detection Technology

Particle Counter, Particle Monitor, Turbidity Monitor

INSTRUMENT COMPARISON USING AC FINE TEST DUST



Particle Counter	21	48	75	106	200	300	390	440
Particle Monitor	50	150	170	200	300	390	460	470
Turbidimeter	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.07

Particle Detection Technology

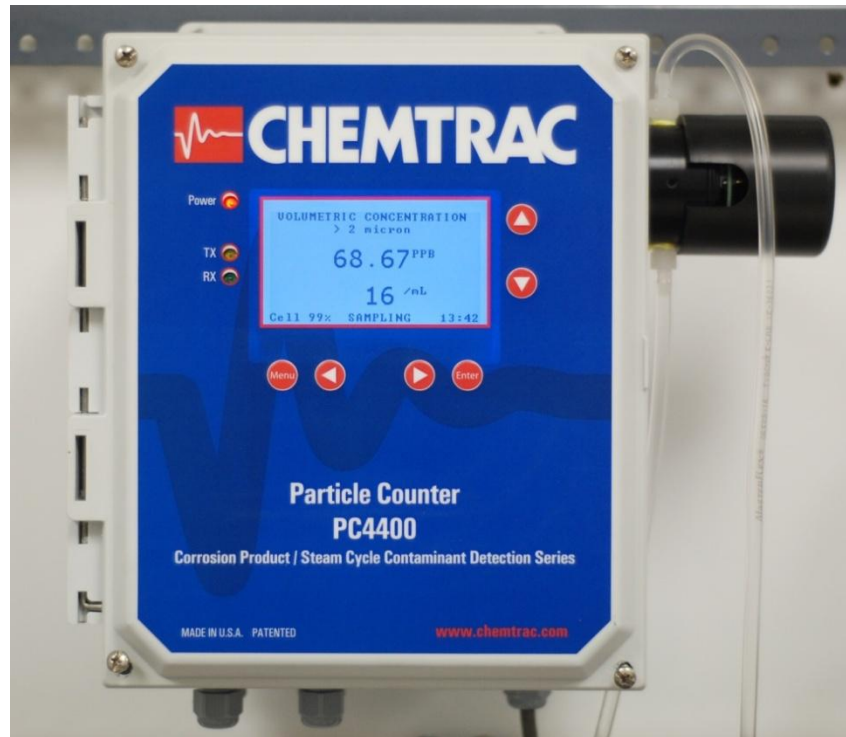
On-line Continuous Particle Detection

- Allows for seeing extremely low levels of insoluble particle contamination
- Real-time results
- Complements other measurements (pH, conductivity, DO, sodium, etc.)
- Limitations
 - Cannot see particles $<2\text{ }\mu\text{m}$
 - Cannot differentiate between types of particles
 - Bubbles cause interference because they are detected as particles

Particle Detection Technology

Particle Detection in the Thermal Power Plant

- For this presentation, focus on the particle counter
- New development: the ability to report volumetric concentration in **ppb** in addition to **particles/ml**



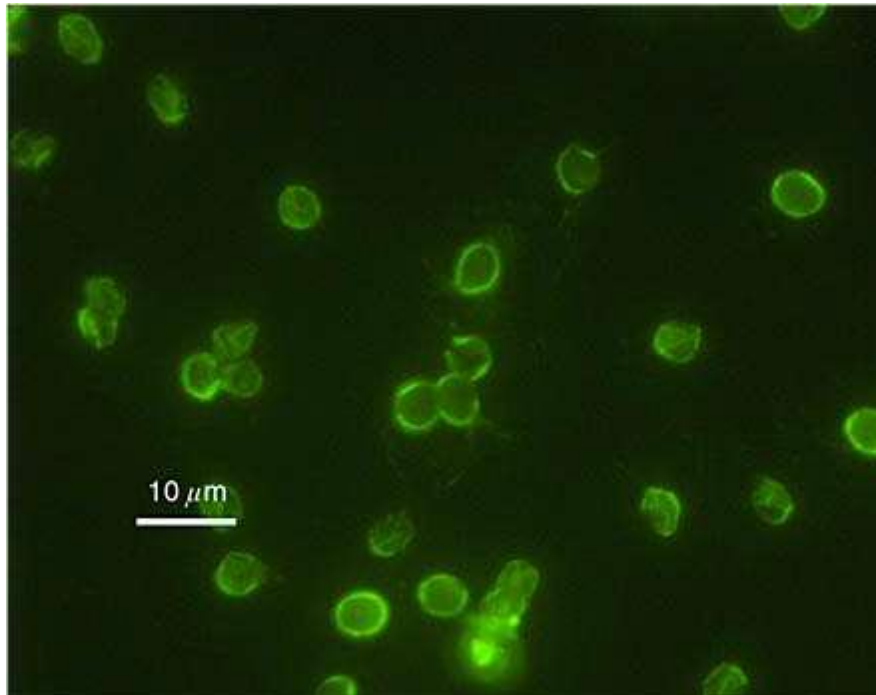
Applications



Applications

Water Treatment Plant

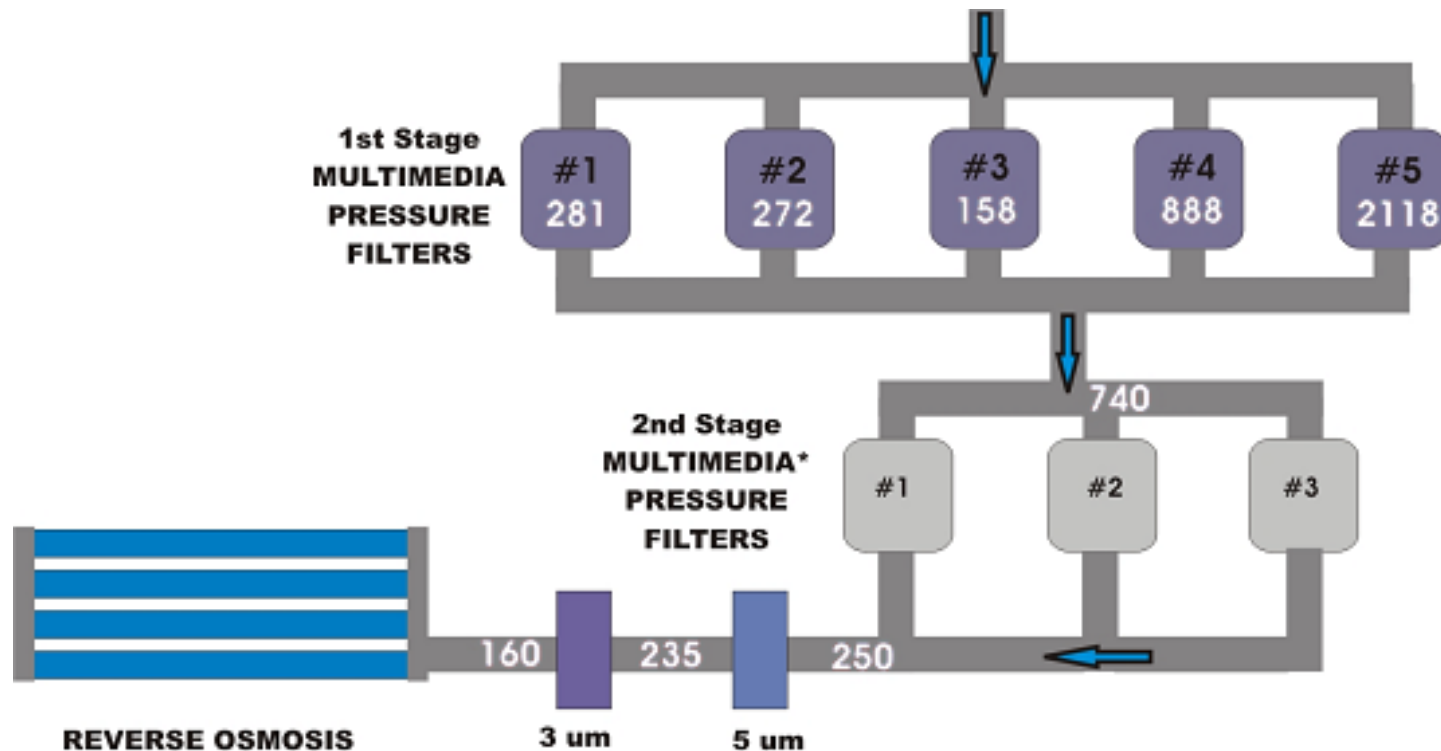
- Monitor filter performance
- Assure proper removal of pathogen-size particles (Cryptosporidium and Giardia)



Applications

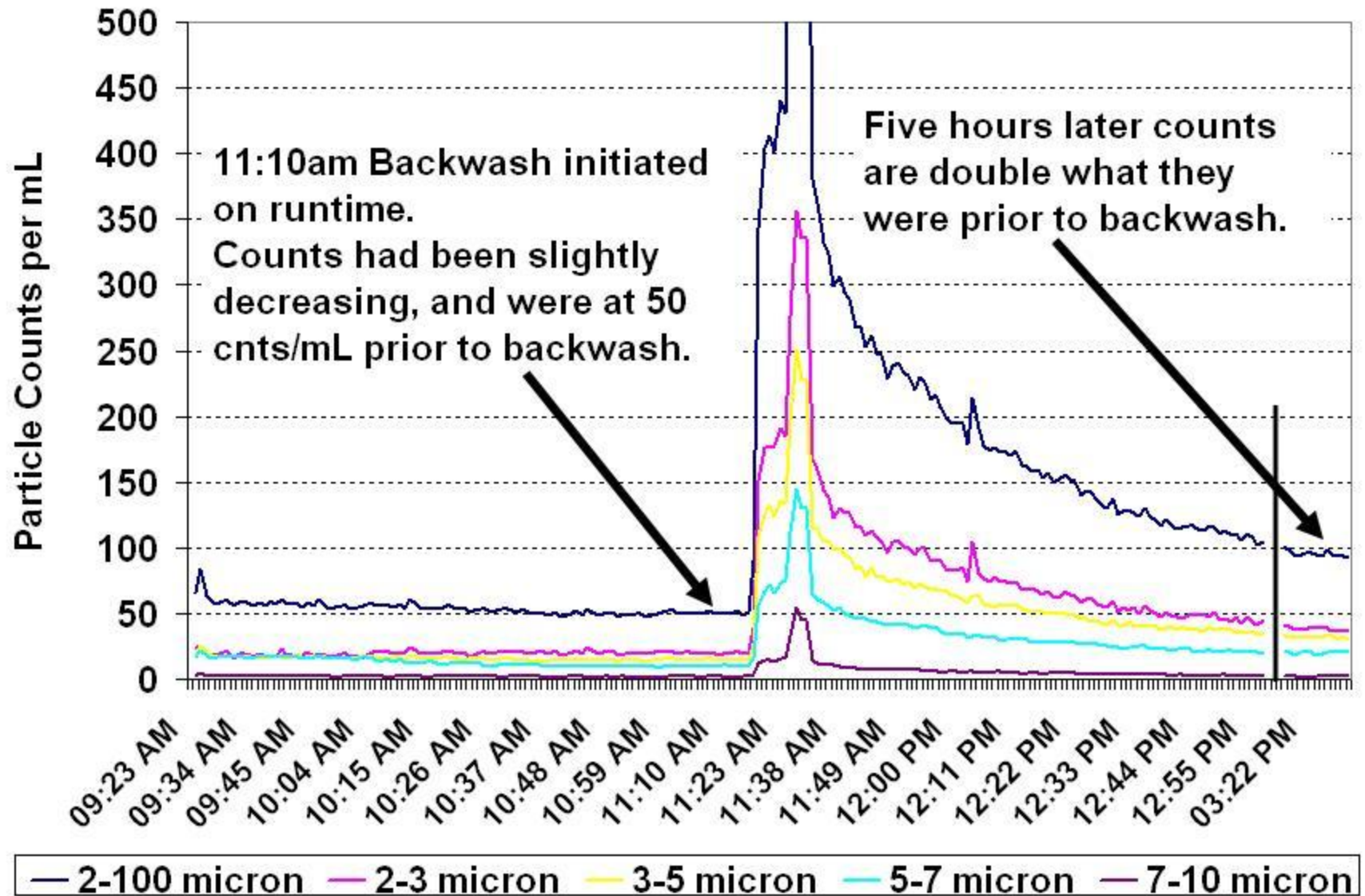
Pre-Treatment

- Monitor filter performance

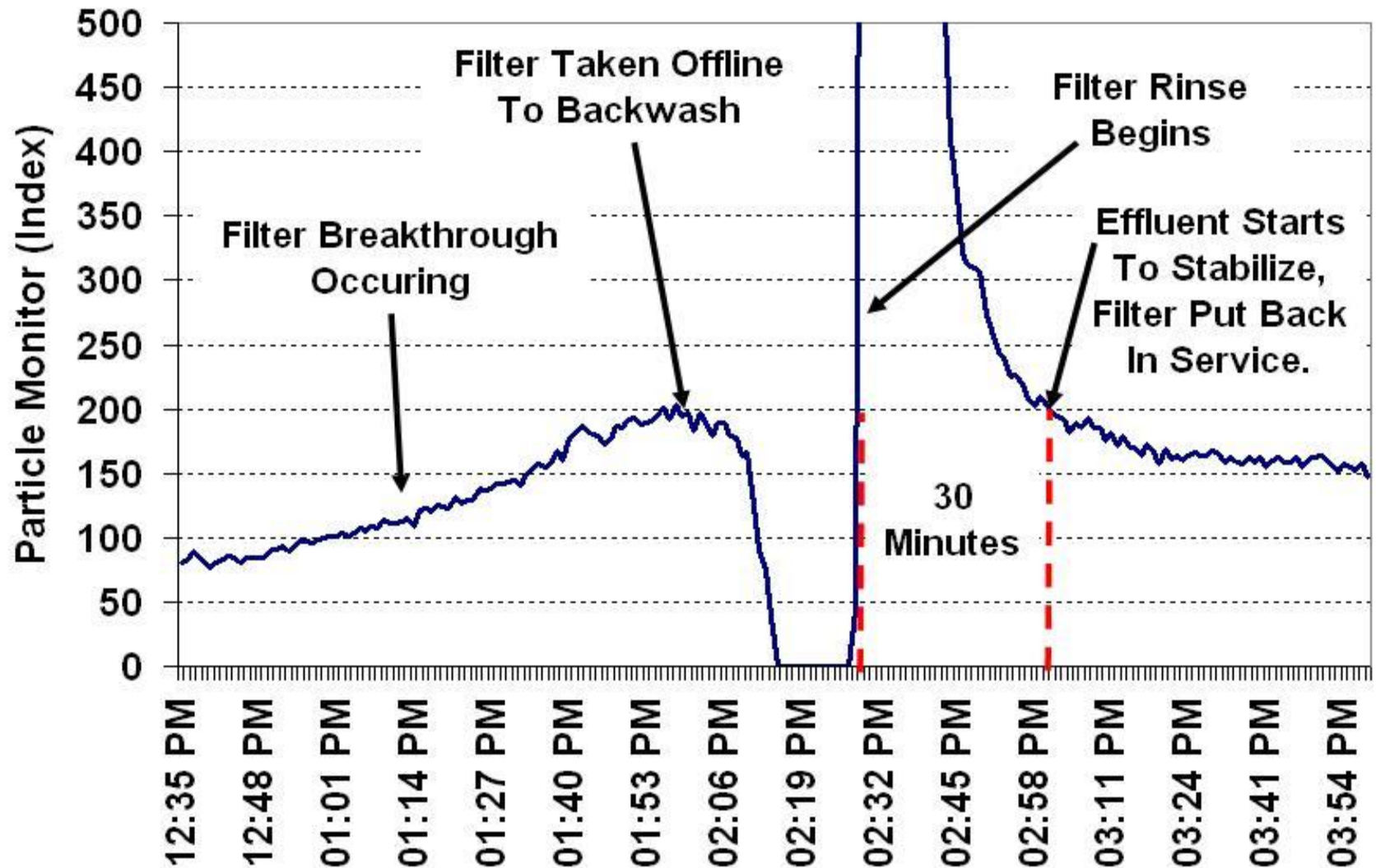


* The 2nd Stage filters were originally designed to be Carbon Filters, but were converted later to multimedia filters.

Common Backwash Results



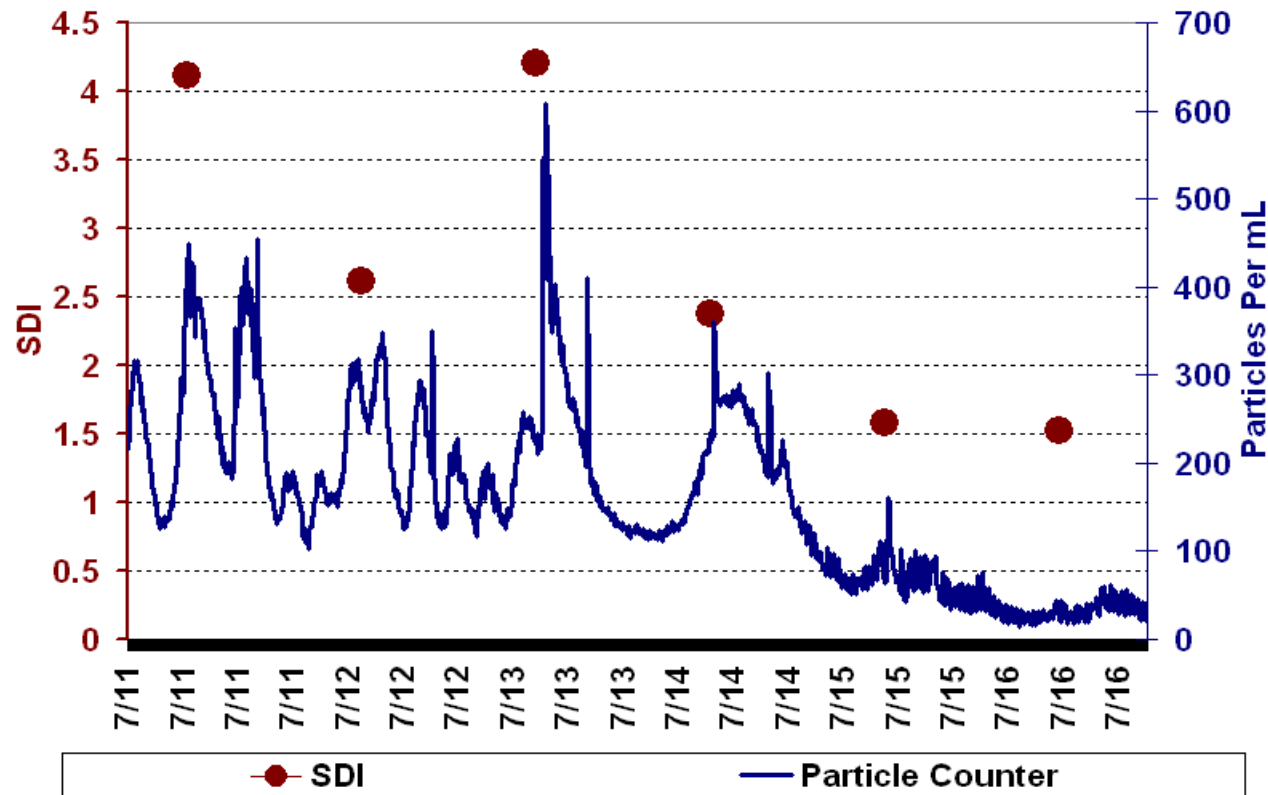
Backwash Based On Effluent Quality



Applications

Pre-Treatment

■ Monitor SDI

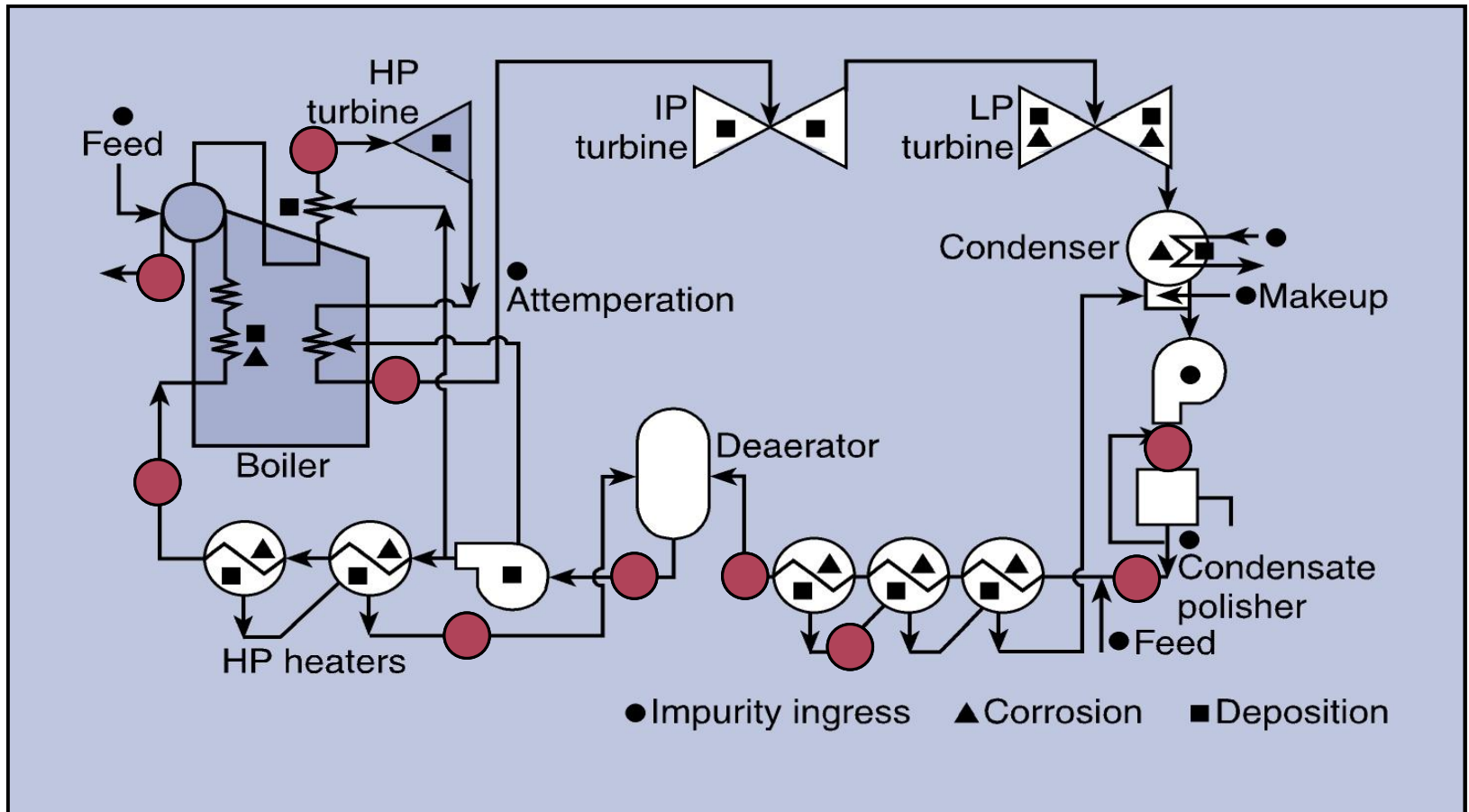


Applications

Steam Cycle Corrosion Product Monitoring

- EPRI corrosion monitoring research has confirmed that ~ 90%, or more, of Fe corrosion product transport is in the insoluble (particulate) form

Applications

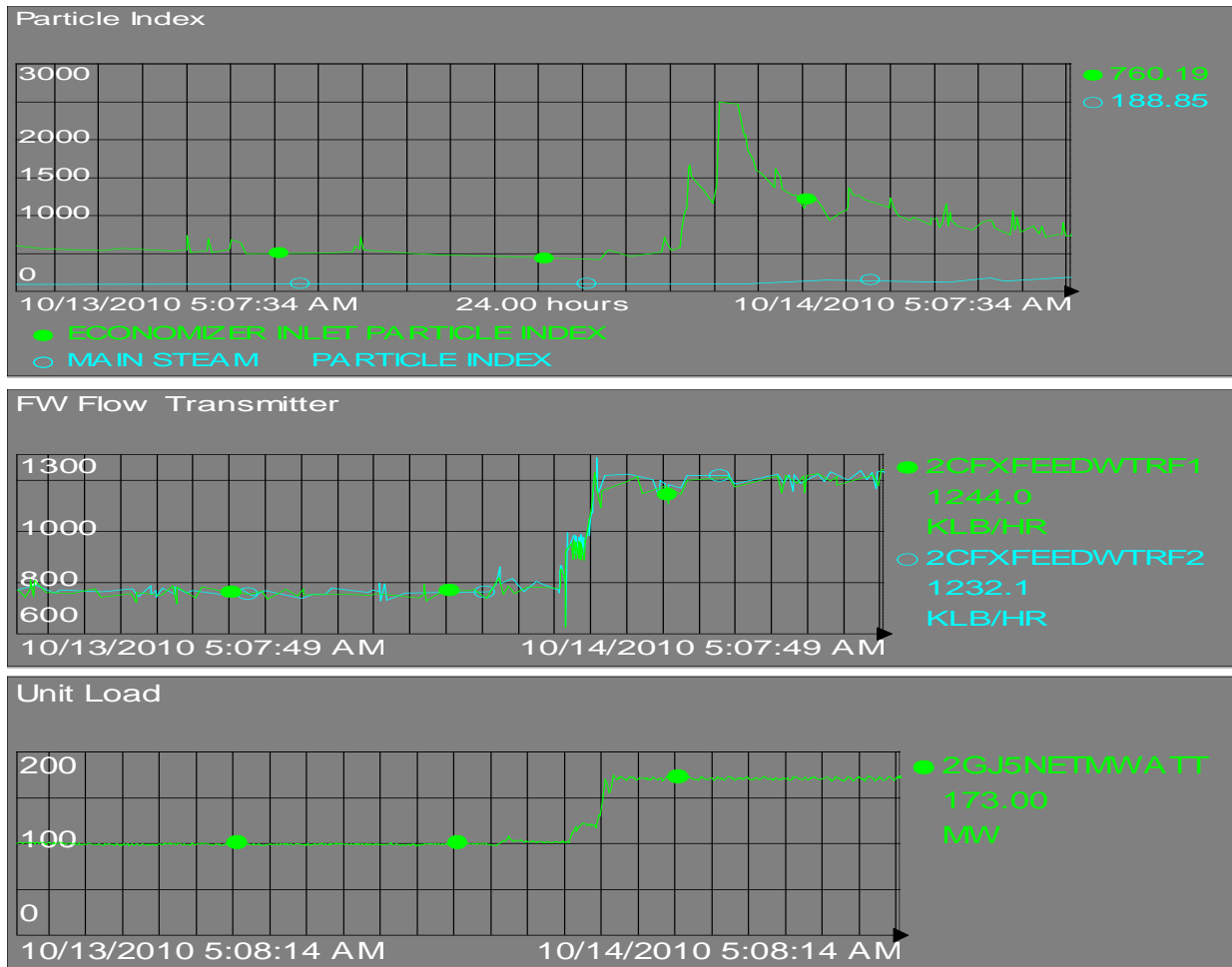


● CPT Monitoring

EPRI diagram

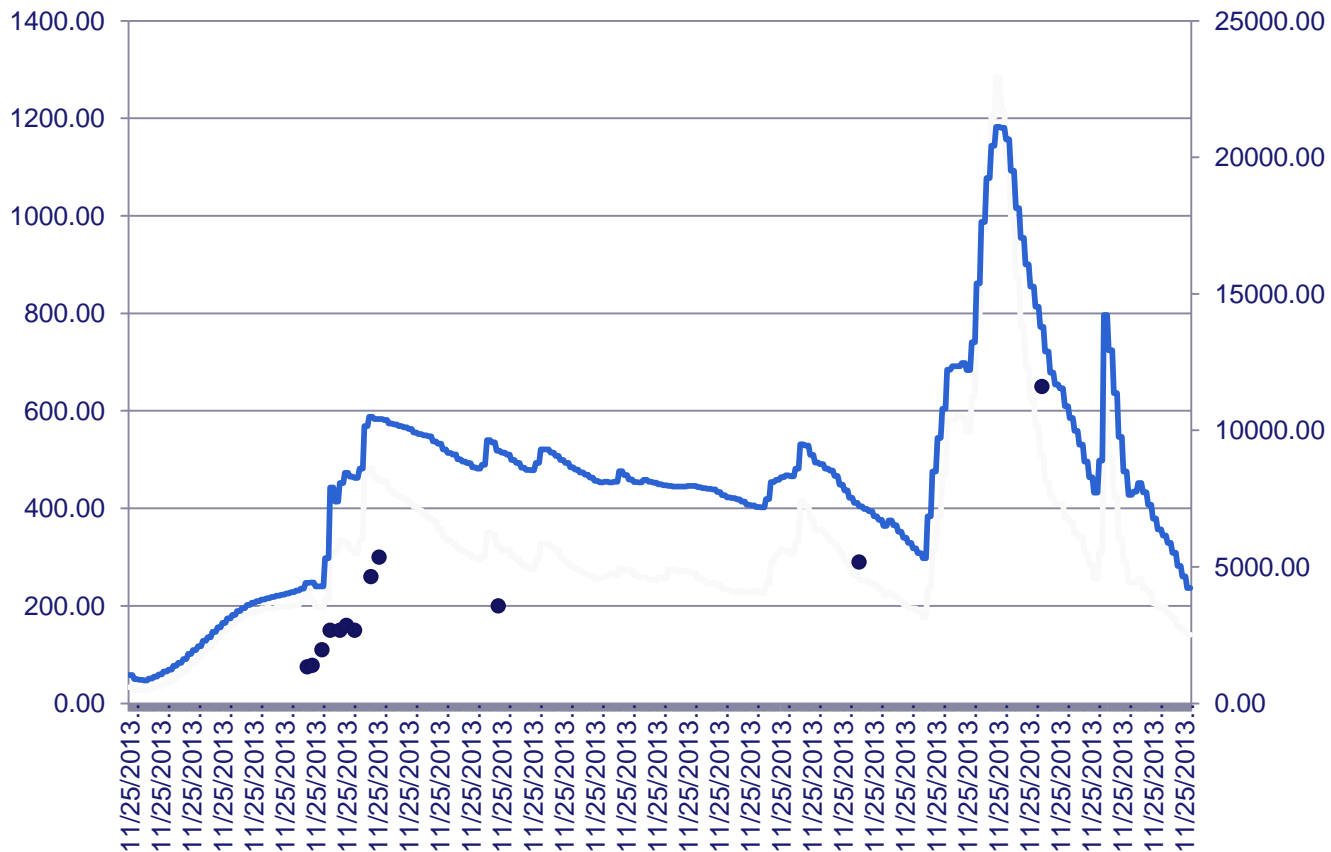
Applications

Econ Inlet PI, BFW Flow, Load



Applications

Volumetric ppb vs. Grab Sample Total Fe ppb

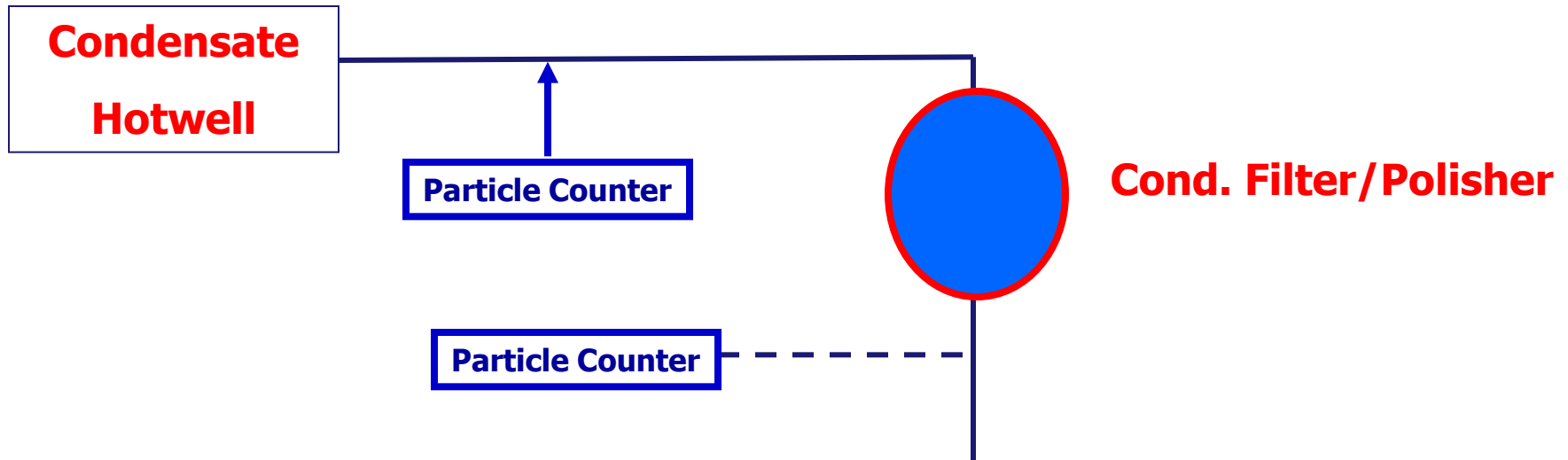


Condensate Monitoring -- Thermal Power Plant in Southeast US

Condensate Polisher Monitoring



Condensate Polisher Monitoring

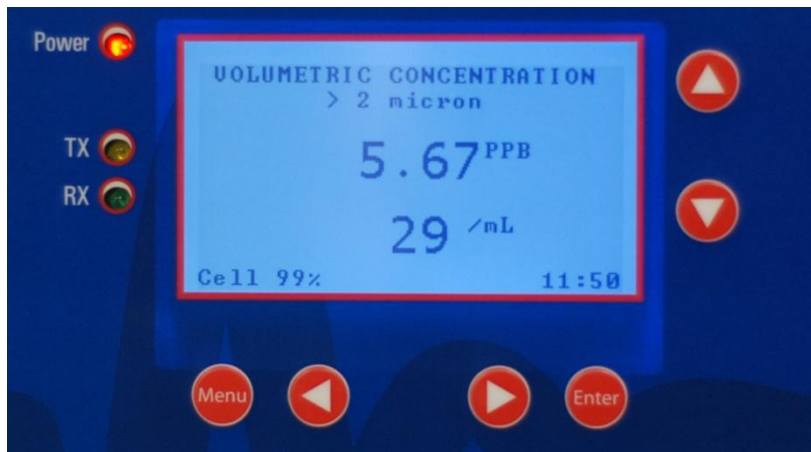


Particle Counters Upstream and Downstream

- See insoluble material reduction across the filter
- Better identify resin leakage

Condensate Polisher Monitoring

Upstream Polisher (Hotwell)



Downstream Polisher



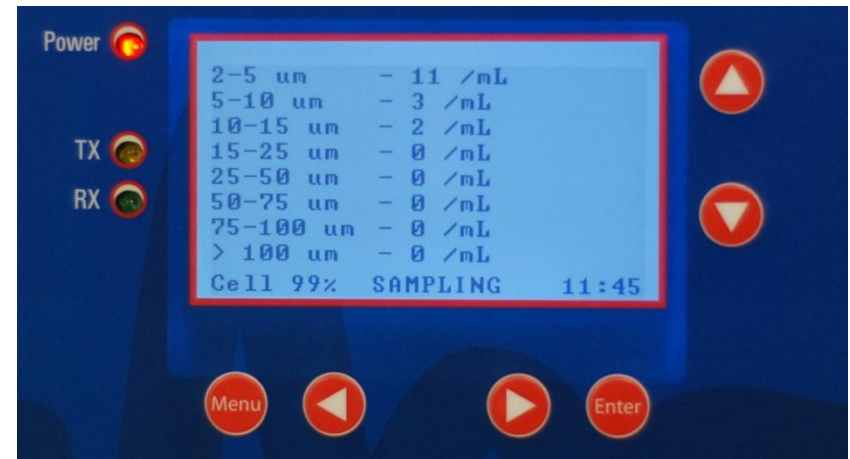
Decrease in insoluble ppb concentration across polisher.

Condensate Polisher Monitoring

Upstream Polisher (Hotwell)



Downstream Polisher



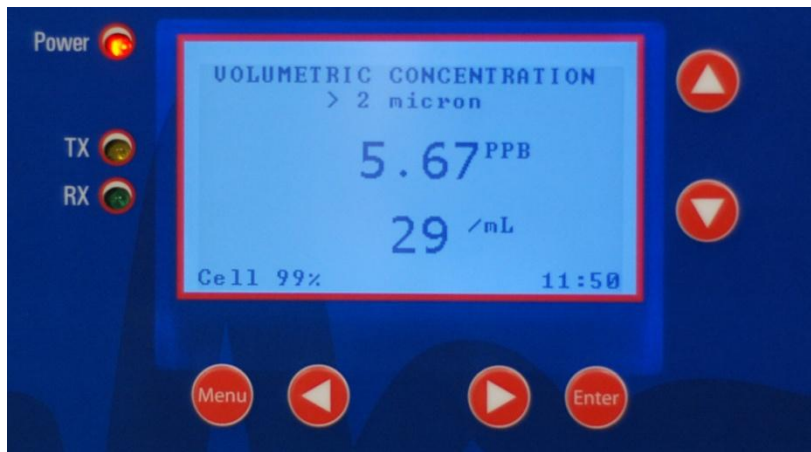
Typical reduction in particle concentrations across polisher.

Condensate Polisher Monitoring

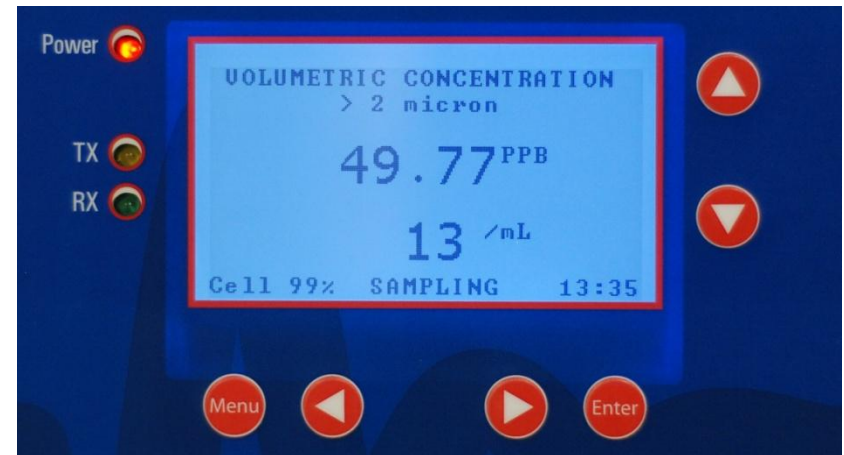
**Example of Particle Counter results when a there is a
Condensate Polisher Problem**

Condensate Polisher Monitoring

Upstream Polisher (Hotwell)



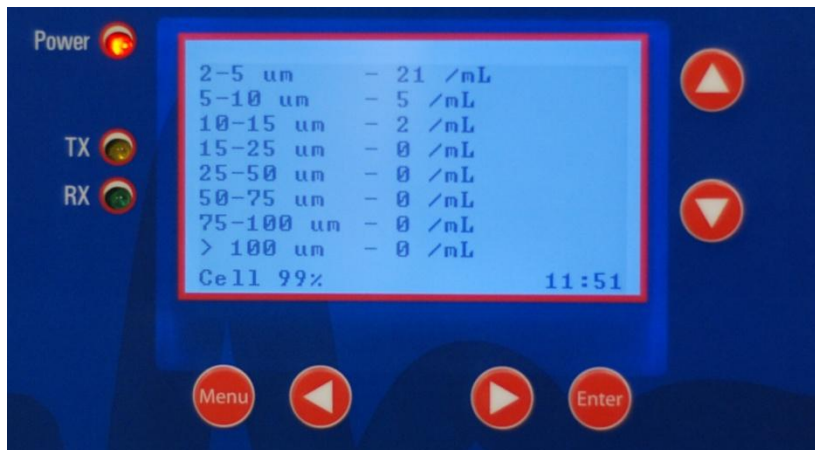
Downstream Polisher



Increase in insoluble ppb concentration across polisher.

Condensate Polisher Monitoring

Upstream Polisher (Hotwell)



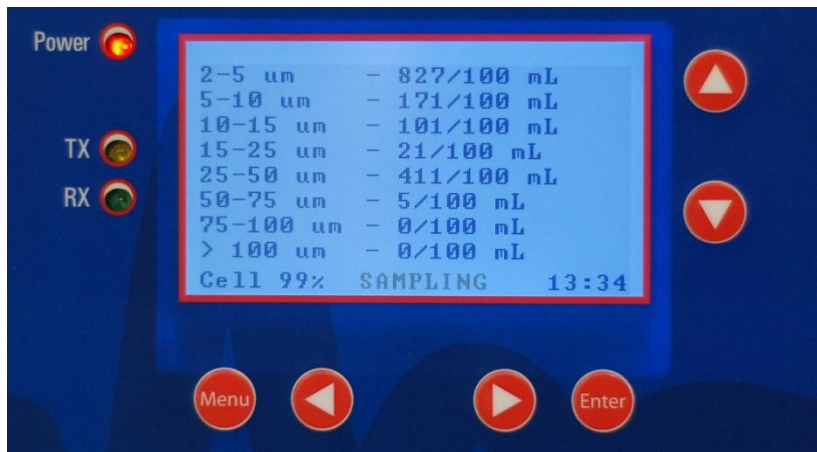
Downstream Polisher



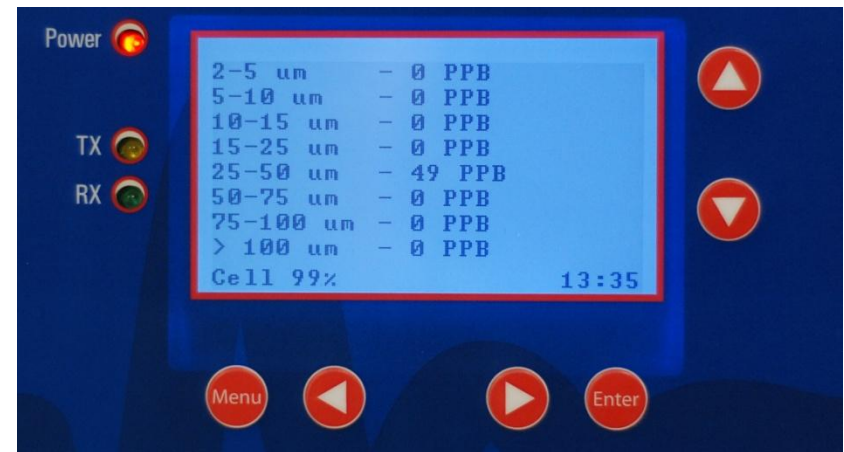
Addition of 30 um particles contributed significantly to total ppb concentration.

Condensate Polisher Monitoring

Other available diagnostic screen views.



Particles per 100 ml



ppb based on particle size

Conclusions



Conclusions

On-line Particle Monitoring:

- provides ***real-time*** indication of insoluble CPT particulate loading
- allows for ***continuous*** data collection & trending
- Events or upsets can be detected very quickly
- Pretreatment filter performance can be significantly improved using the proper tools and techniques
- Savings can be realized in energy costs, membrane cleaning costs, and in cartridge filter replacement costs.
- Upstream and downstream monitoring across the condensate polishers would offer additional comparative data

References

- *Comprehensive Cycle Chemistry Guidelines for Fossil Plants*, EPRI
- *Cycle Chemistry Guidelines for Combined Cycle/HRSGs*, EPRI
- *The Impact of Oxidizing Environment on Feedwater Corrosion and Metal Transport - New tools and Findings*, Daniel C. Sampson
- *Power Plant Particle Applications: Corrosion Product Monitor /Foreign Material / Water Treatment Control and Optimization* (presentation), Mike Caravaggio
- *A Method for Continuously Monitoring and Selectively Sampling Boiler Cycle Water for Metal Oxide Transport Analyses*, Richard A. Breckenridge, L. Joseph Hancock, Robert L. Bryant, John W. Clark
- *An Alternative to Silt Density Index (SDI)...Continuous Particle Counting*, Robert L. Bryant
- *Assessment and Development of Low-Pressure Membrane Integrity Monitoring Tools*, AwwaRF

Chinese Quotation

Chinese Quotation

欲穷千里目 更上一层楼

To enjoy a grander sight, climb to a greater height.





**"There's a way to do it better - find it."
-- Thomas Edison**

谢谢