

Reinhold Environmental Ltd.



***2007 APC Round Table & Expo
Presentation***

***July 8-10, 2007
Chattanooga, TN
Hosted by TVA***

GE Powerwave+™

Study into the Effects of Cleaning on PRB Ash



imagination at work



Agenda

Problem Identification

Ecomagination Facts

Technology Background

Product Specifications

Customer Results

Contact Information



The Problem

Slag buildup on heat exchanger surfaces can cause:

- Reduced heat transfer
- Increased pressure drop resulting in loss of flow
- Both scheduled and unscheduled outages
- Higher fuel usage
- Overall efficiency loss
- Higher cleaning and maintenance cost



Ecomagination Facts

If efficiency of a 268 MW boiler is increased by 0.50%:

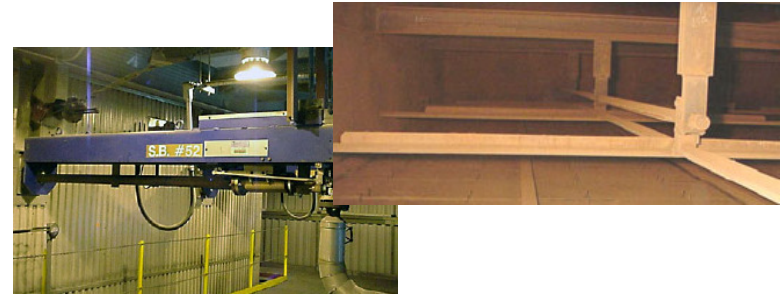
- Save 5300 tons of coal/yr (equivalent of 14,400 MWhr/yr)
- Cut CO₂ emissions by over 11,000 tons/yr (equivalent of 2000 US passenger cars)
- Reduce SO₂ emissions by over 50 tons/yr



a product of
ecomaginationSM

Traditional Cleaning Methods

- Sootblowing
- Rapping
- Manual shaking
- Acoustic cleaning
- Binary explosive charges
- Hammers, chisels, etc.
- Shock cleaning



GE Energy's Powerwave® Acoustic Cleaning Systems

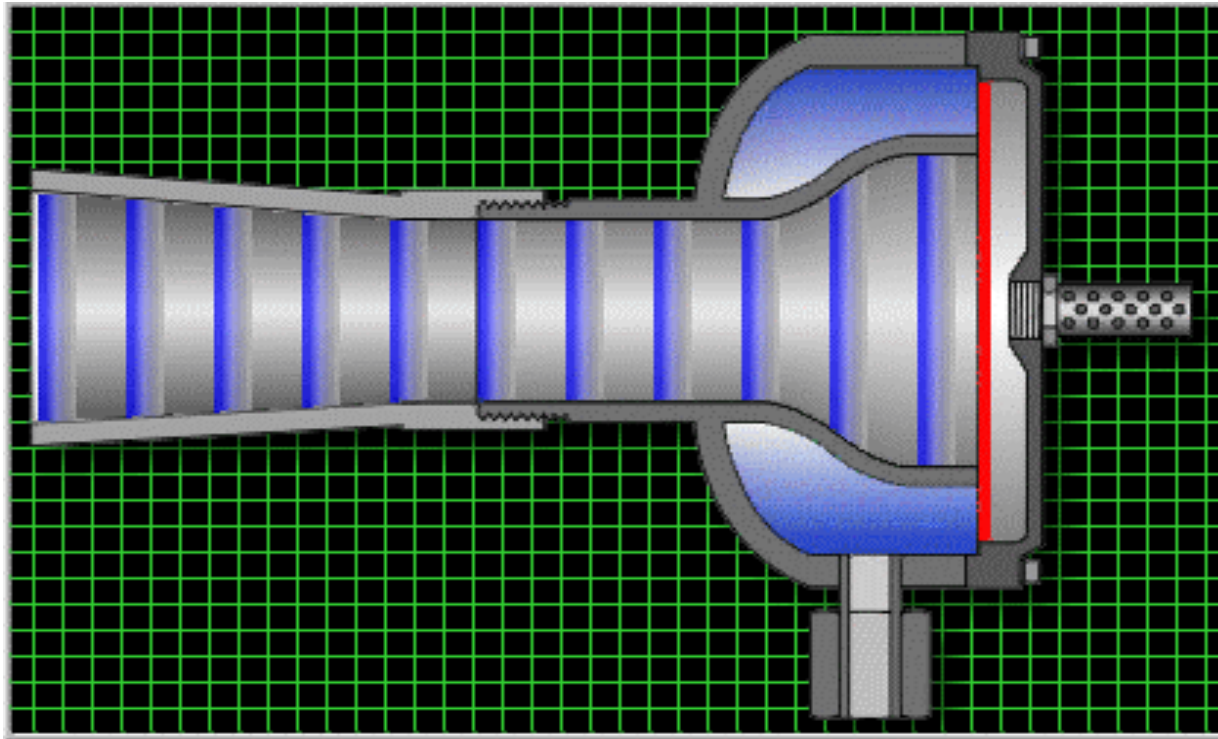
Facility Requirements

- 70-90 psi air
- 60-80 SCFM



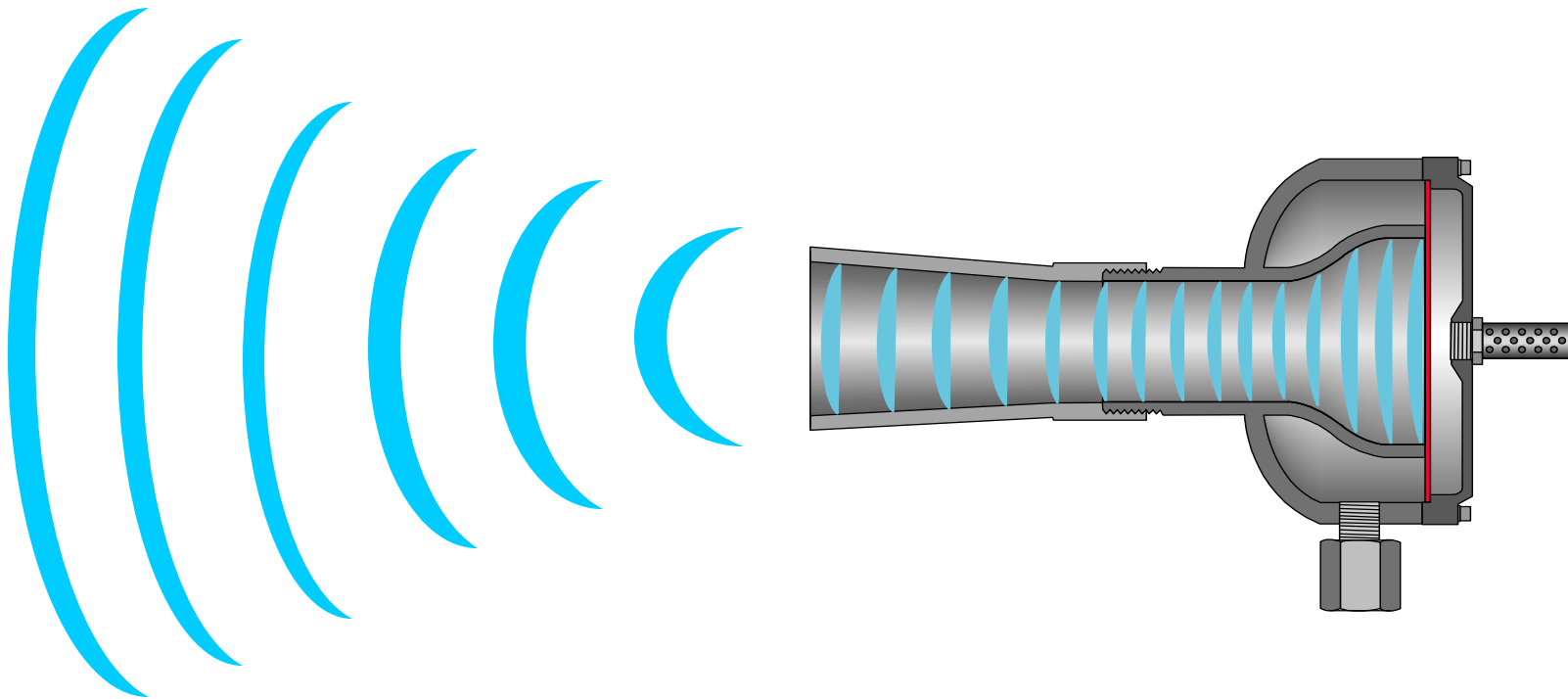
imagination at work

Acoustics Driven By Air



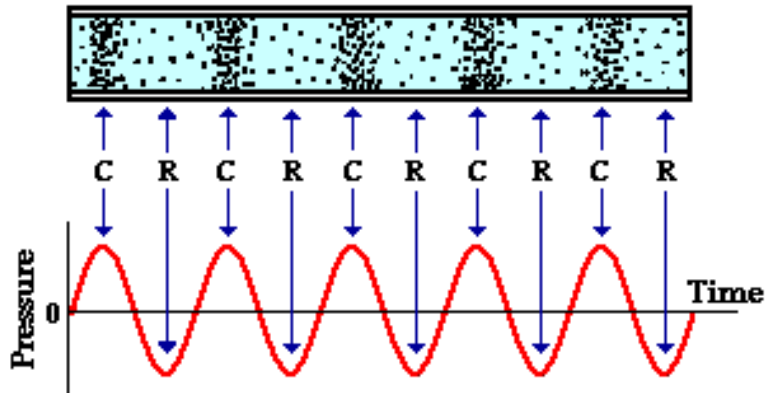
Air operated cleaners produce low frequency, high energy sound waves

How do Acoustics Work?



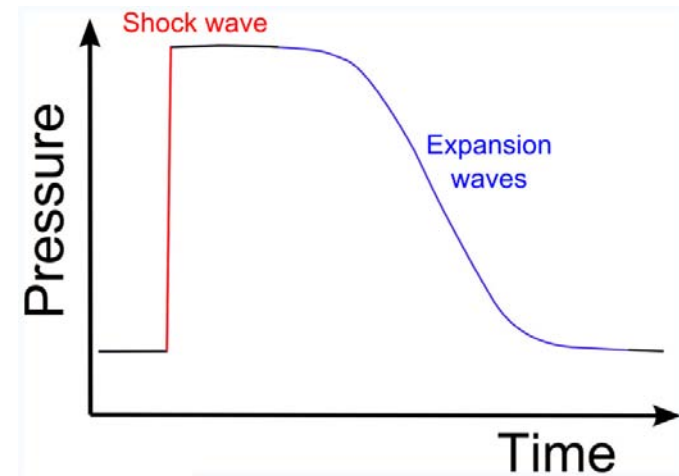
Sound waves resonate and dislodge particulate deposits from structural and dust collection surfaces. Acoustic cleaners perform this without causing damage because the range of frequency is well above the resonant frequency of the structure.

Sound Wave vs. Impulse Wave



NOTE: "C" stands for compression and "R" stands for rarefaction

<http://www.glenbrook.k12.il.us/GBSSCI/PHYS/CLASS/sound/u11l1c.html>



http://en.wikipedia.org/wiki/Image:Pressure_plot.png

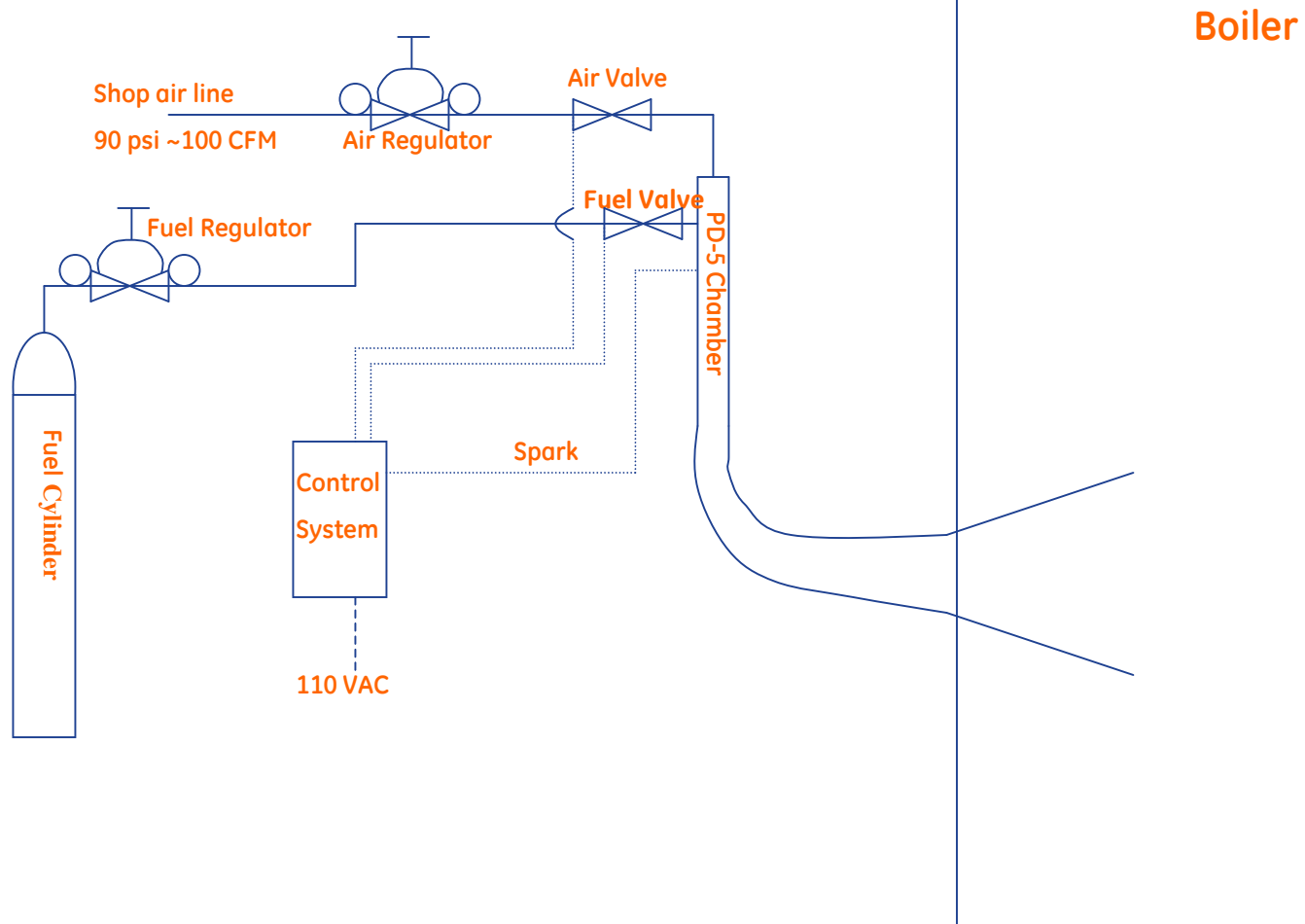
An impulse wave is characterized by a discontinuous increase in pressure and temperature across a boundary.

- Higher magnitude peaks
- Excites numerous frequencies in slag

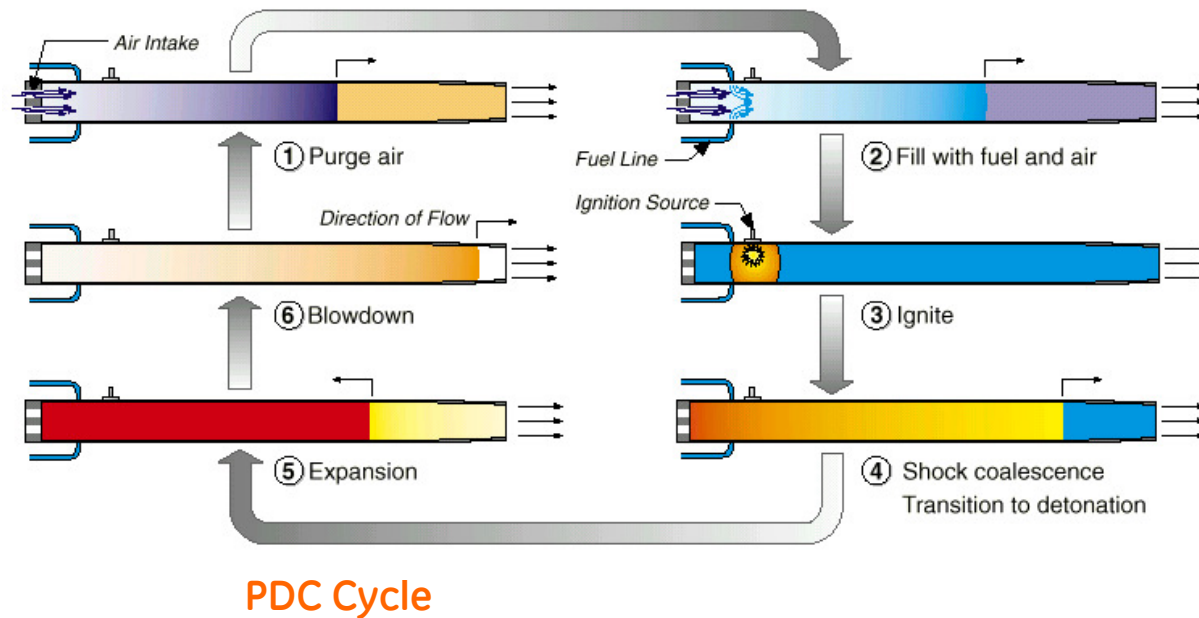
Powerwave+ Facility Requirements

- Electrical: 110 VAC
- Air: ~80-100 SCFM (90 psi), plumbed to location
- Fuel: Ethylene Gas (C_2H_4) high pressure cylinder
- Mounting: Access door with at least 16" diameter clearance and bolt circle machined (provided)

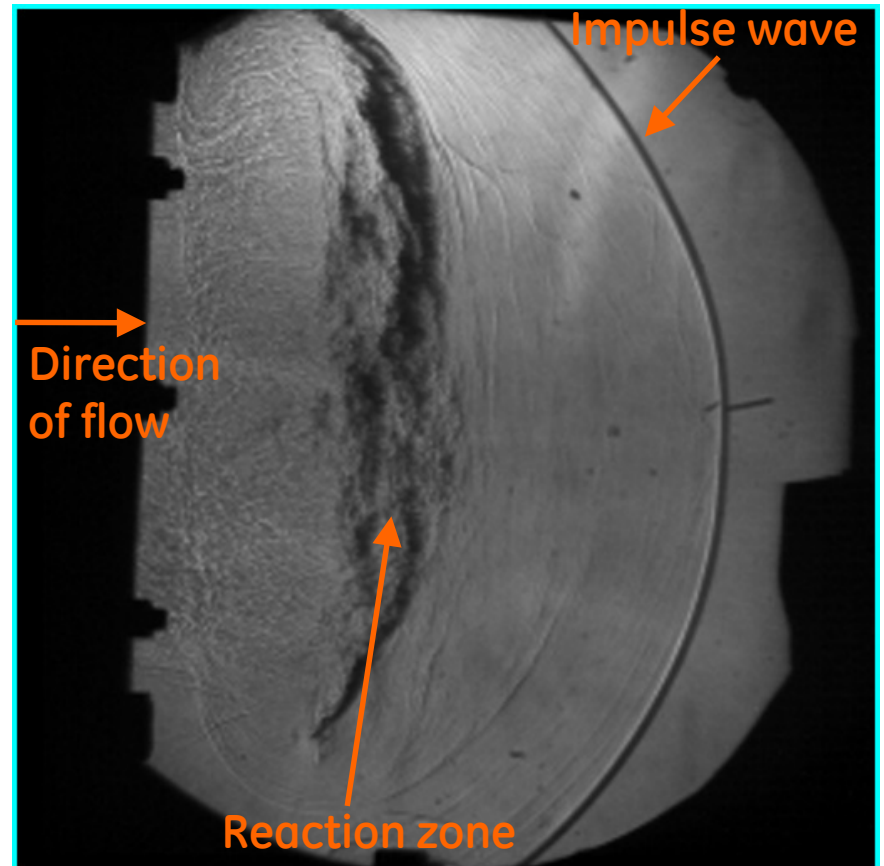
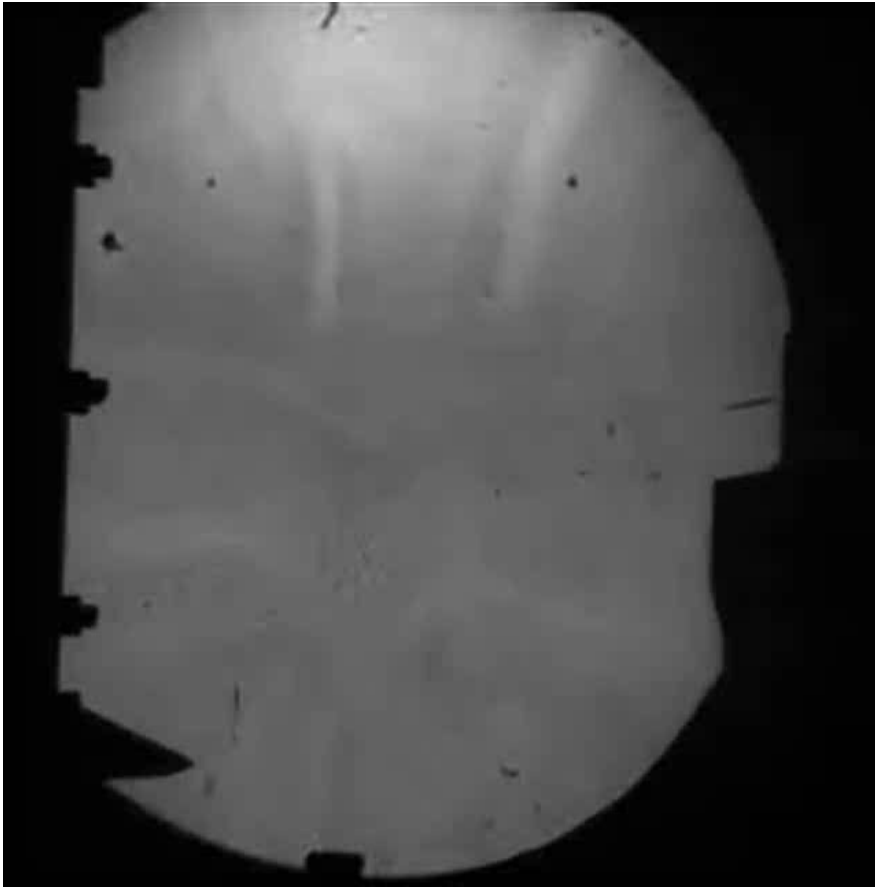
Process Diagram of Installation



Background – Shock formation through combustion



Additional Results

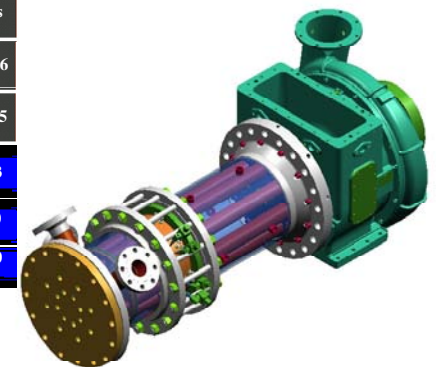
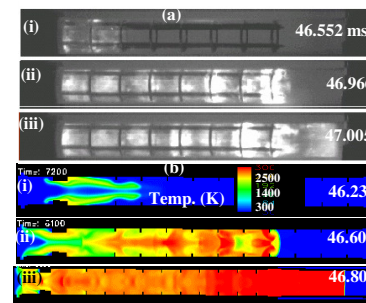
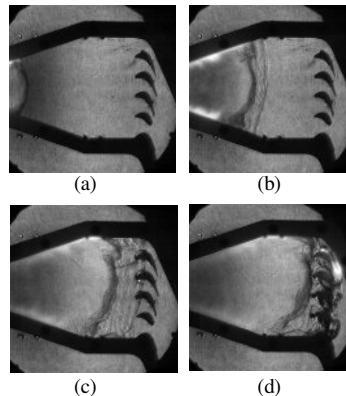
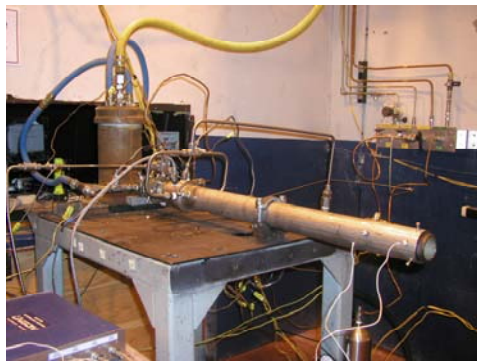


Cleaning Wave Structure

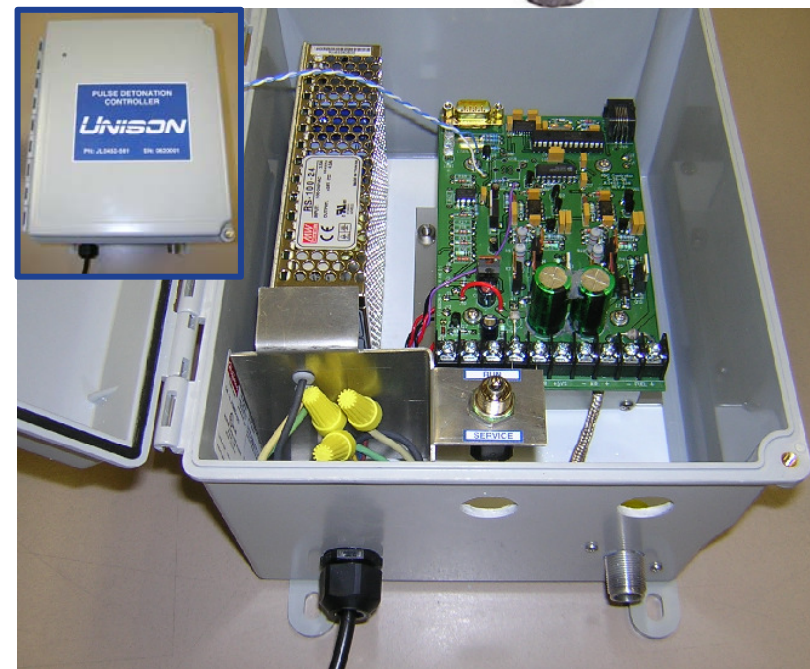
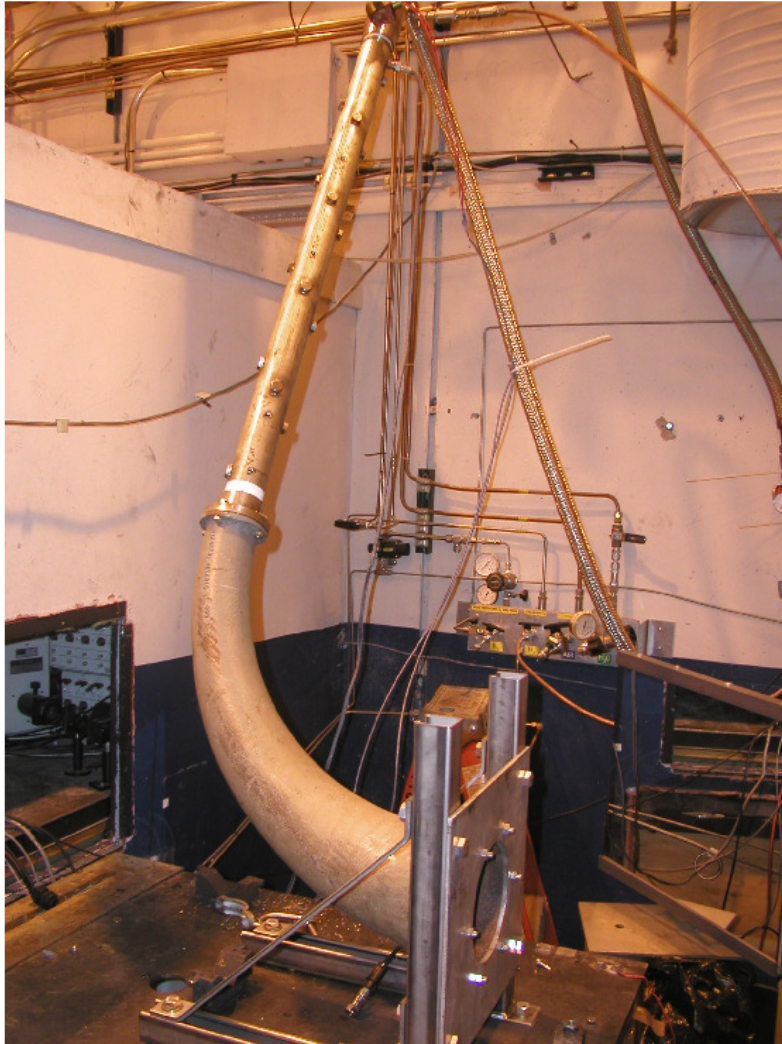
GE's Advanced Propulsion Program

6th Year of PDE Advanced Technology Program

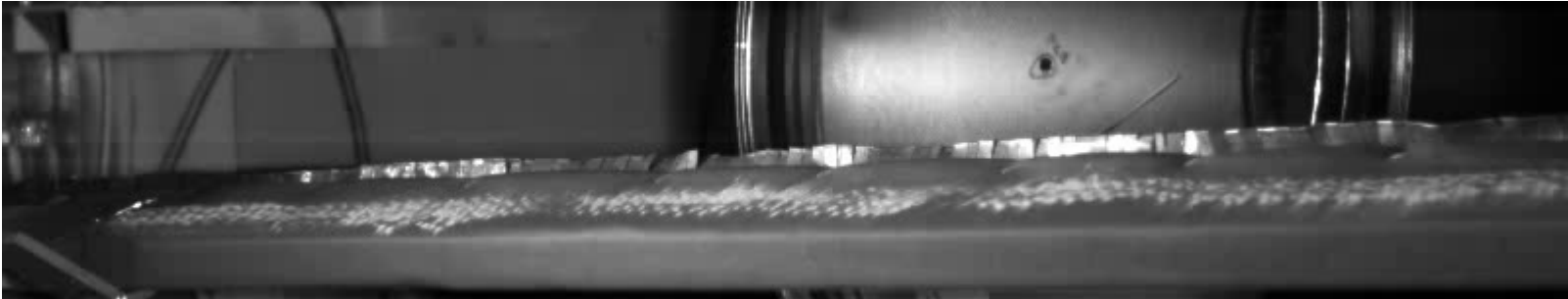
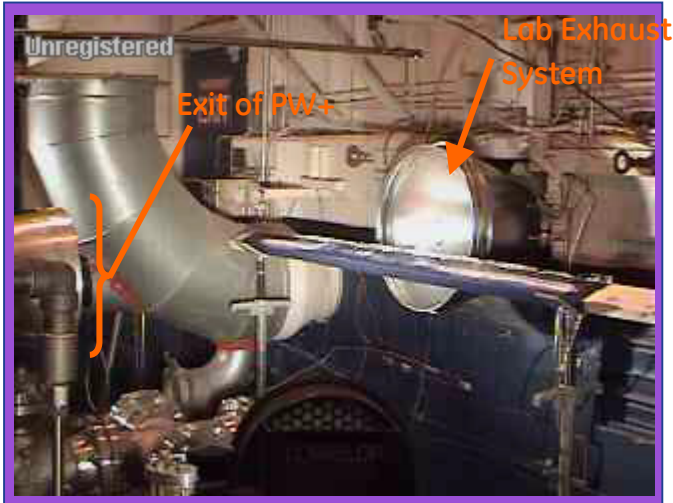
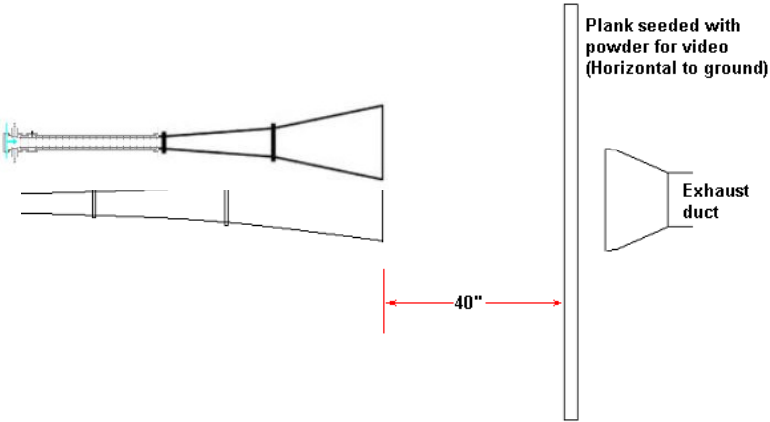
- Small-scale, single tube, detonation fundamentals
- High pressure/temperature
- Turbine interaction, multi-tube scale-up, mechanical analysis
- Liquid fuels (aviation fuels), application studies



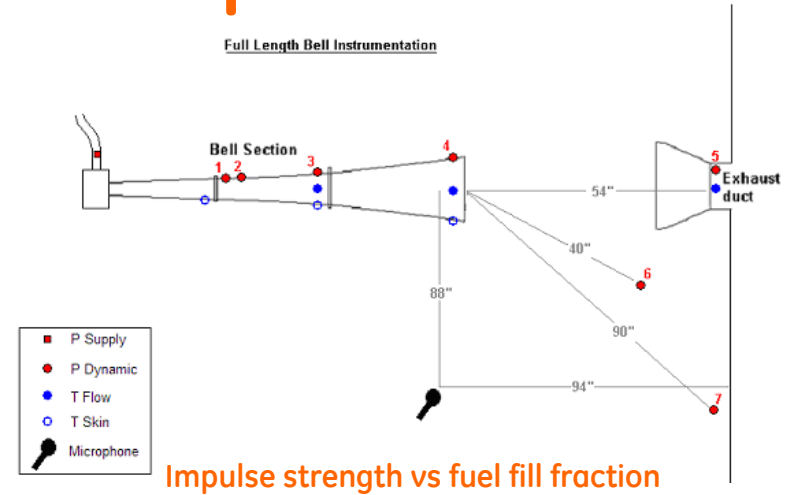
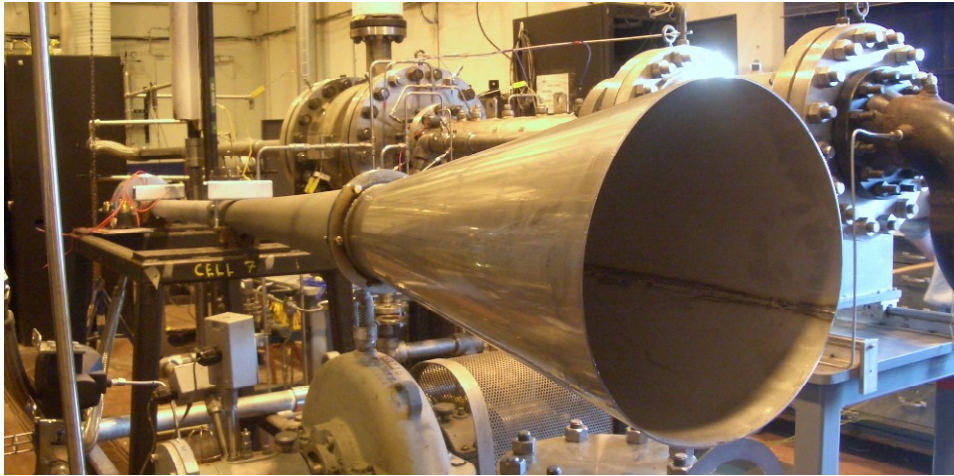
Powerwave+ Laboratory Setup



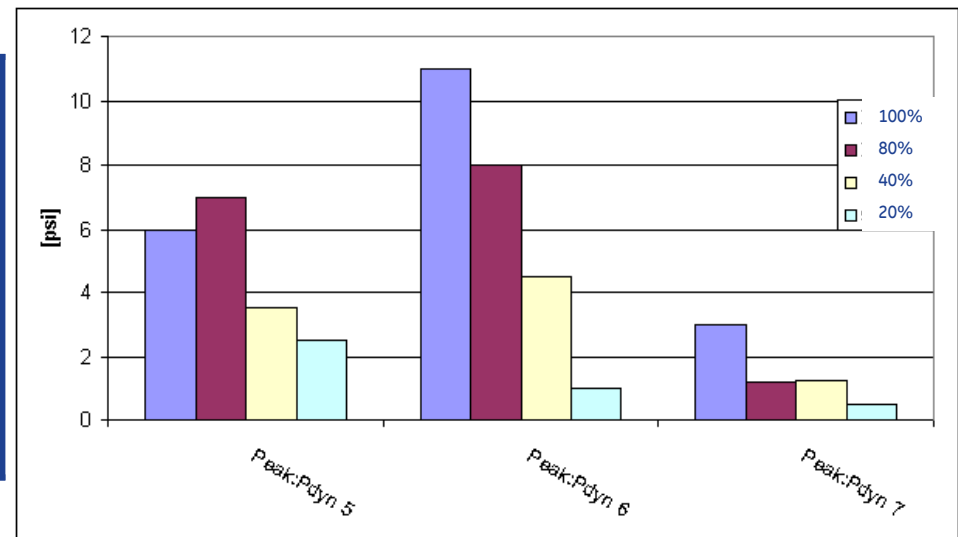
Powerwave+ Cleaning Action



Cleaning Technology Comparison



	Acoustic Horn (DC-75)	Powerwave+
dB level (average over 3 seconds)	130	142
Dynamic Pressure Peaks [psi]	<.25	13



Benefits of Impulse Cleaning

- High magnitude/energy shock impulses
- Multi-directional penetration of wave
- Non-line of site cleaning
- Deeper penetration of stronger pressure waves
- Size allows for multiple installation points with minimal intrusion

Customer Results

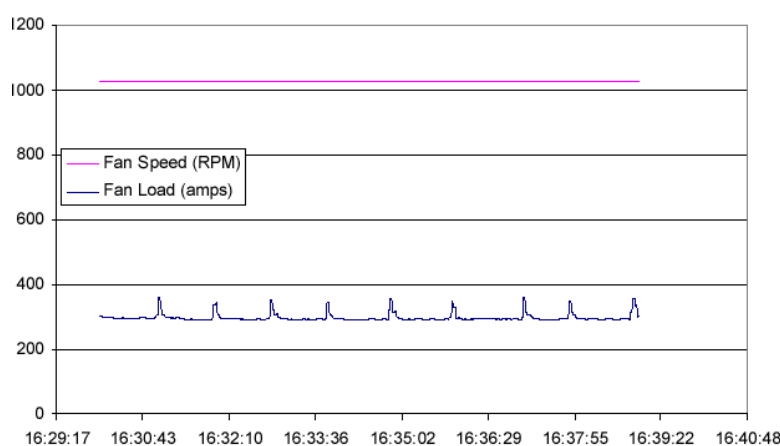


Cement plant in California

Results

Successful Site Visit Completed:

- Installed two PD combustion units
- 5-30F reduction in exhaust temperature
- Reduced the fan loading



PD Operation: Acceptable variation in fan load

July 2006

Down Time Hours	233.38
Flush Down Time	78.50
Flush % of Down Time	33.64%

August 2006

Downtime	148.30
Flush Down Time	33.07
Flush % of Down Time	22.30%

September 2006 through October 18

Downtime	35.07
Flush Down Time	1.38
Flush % of Down Time	3.94%

Summary

- Drastically decreased unplanned outages due to problem area of boiler
 - Plant manager claims that production rates have never been higher, and the Powerwave+ units have become integral to their efficient operation.
- Continues to be a critical cleaning system to their process

Customer Results

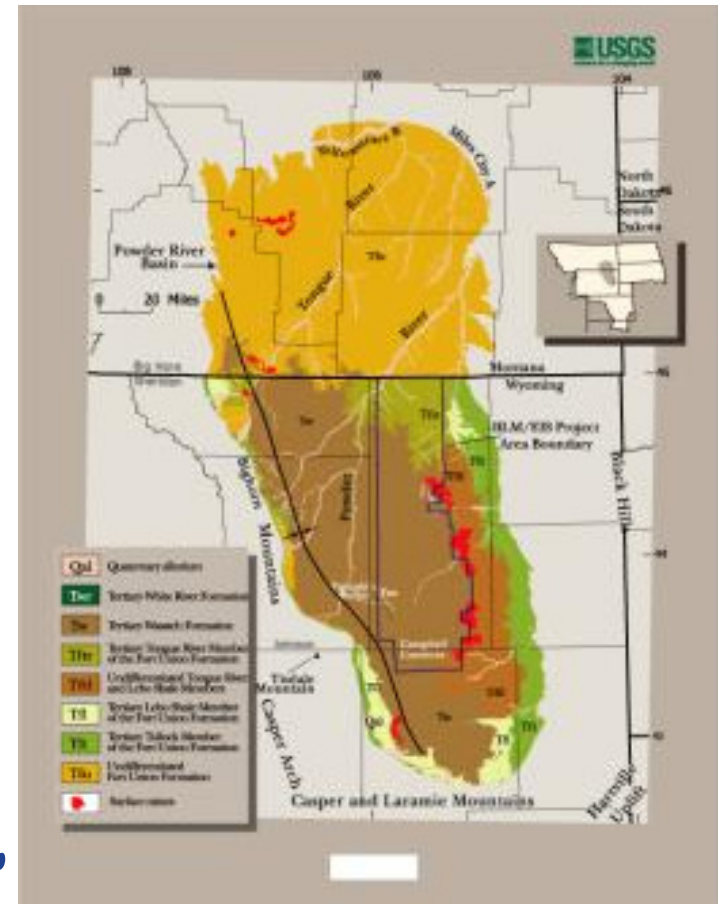


 Coal Fired Industry – Plant 1
imagination at work

PRB Coal

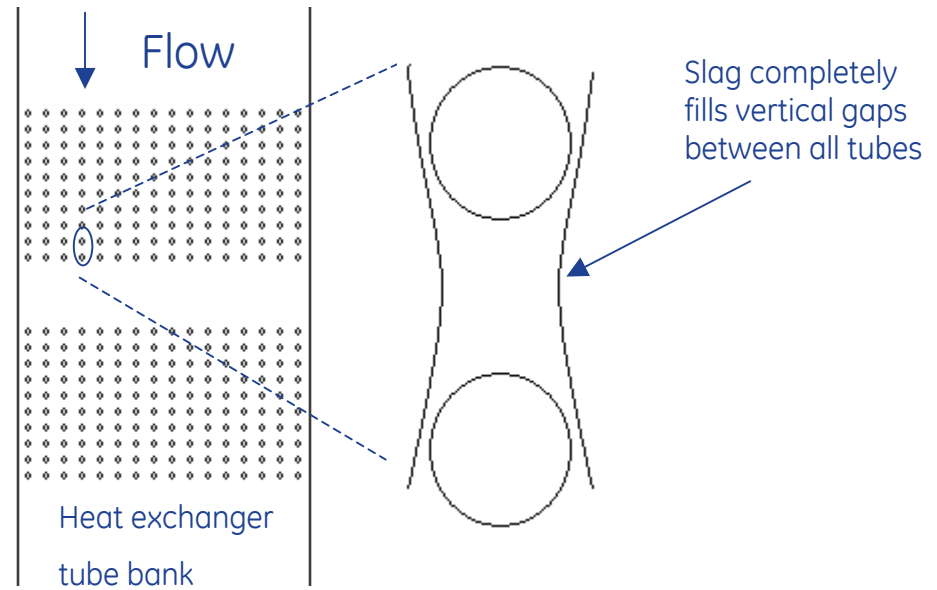
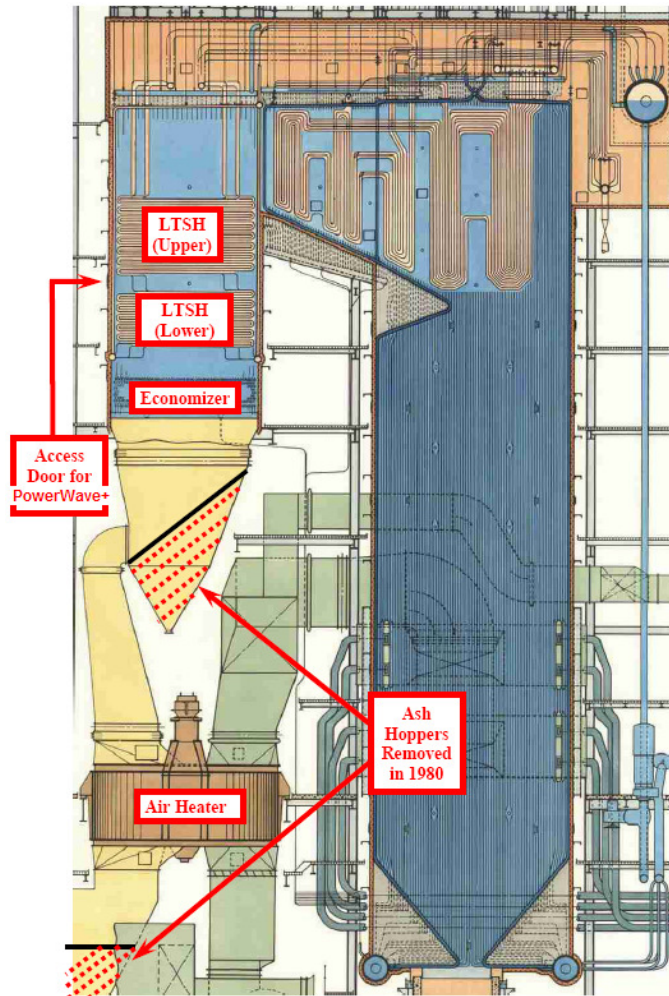
To maintain competitive edge, electric utilities must reduce costs while maximizing availability:

- PRB has lower cost, lower sulfur content, better availability
- Also has higher moisture content, lower energy content, more tenacious ash deposits



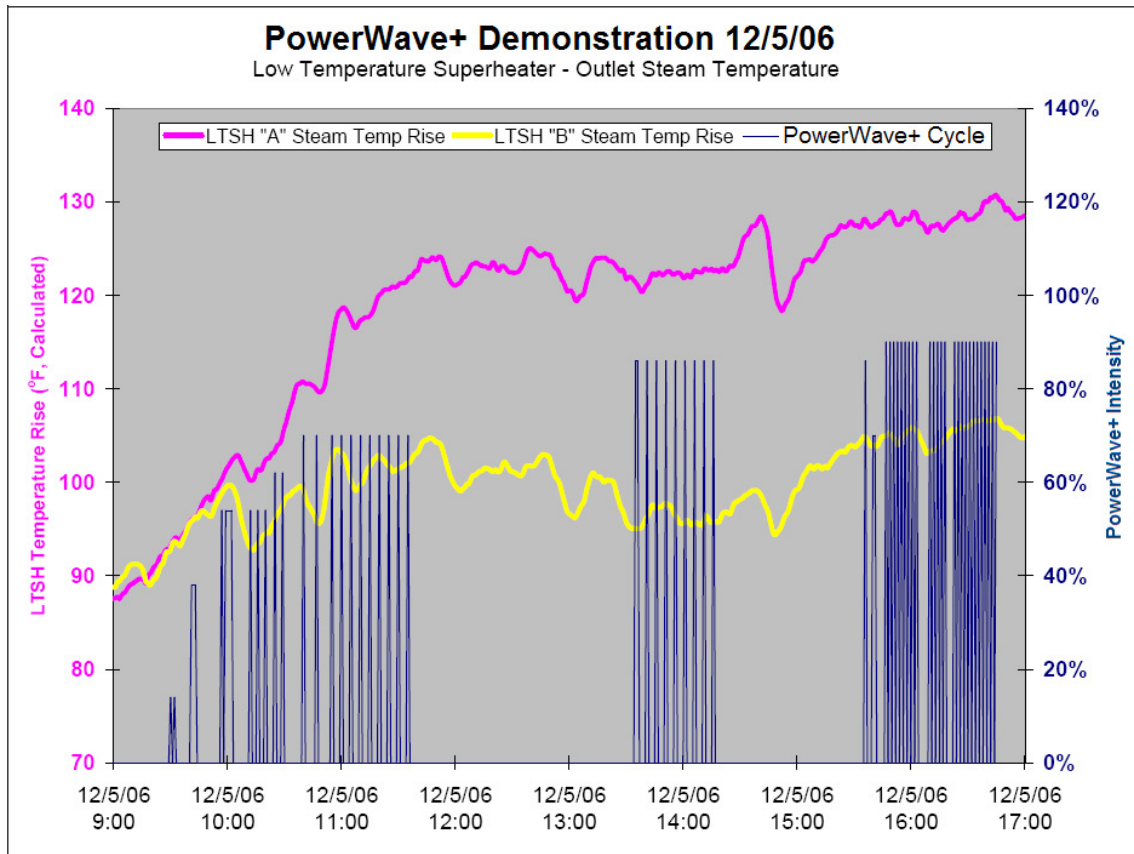
http://geology.usgs.gov/connections/blm/energy/coal_methane.htm

Layout and Problem



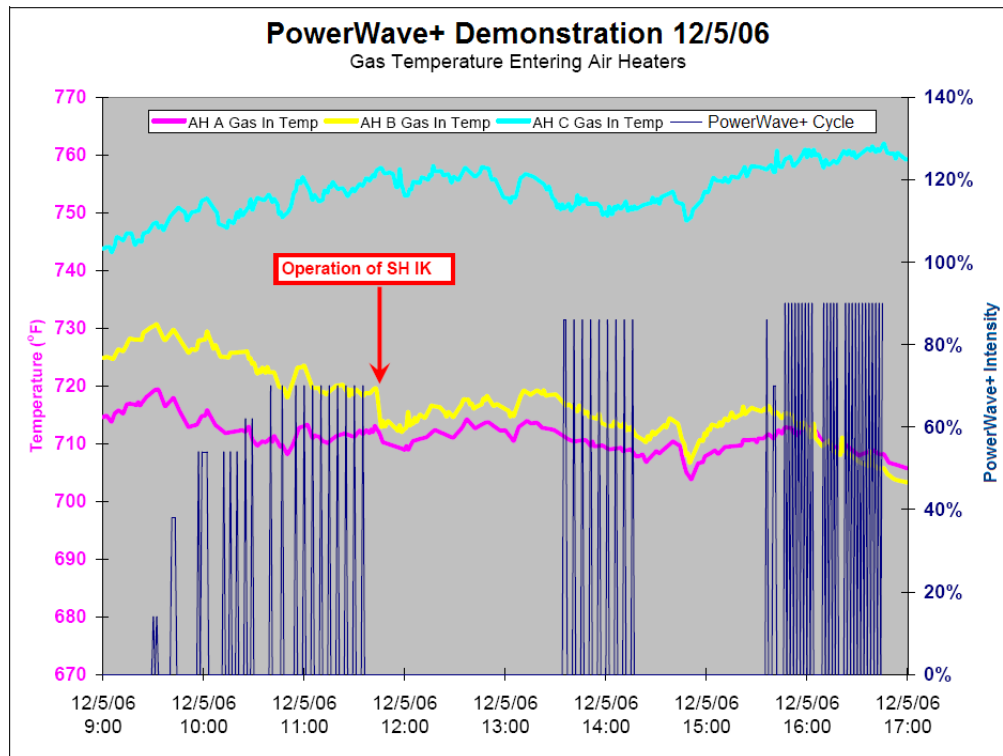
PRB coal leading to platenization in back passes

Results



Over 20 degree increase in steam outlet temp across LTSH

Results



- Noticeable improvement in gas temp at inlet to air heater
- Rise in C-side may be attributed to pluggage of A and B sides

10-20 degree improvement in inlet gas temp to airheaters

Summary

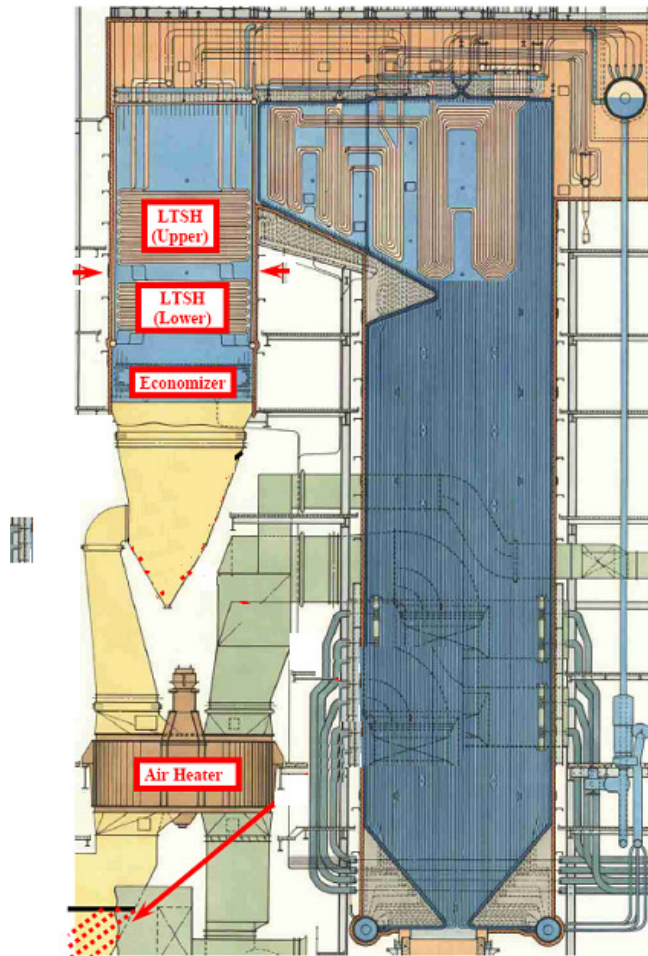
- 20 degree improvement in LTSH steam temperature
- 10-20 degree improvement in inlet gas temp to air heater
- Obvious dislodging of slag from surfaces

Customer Results



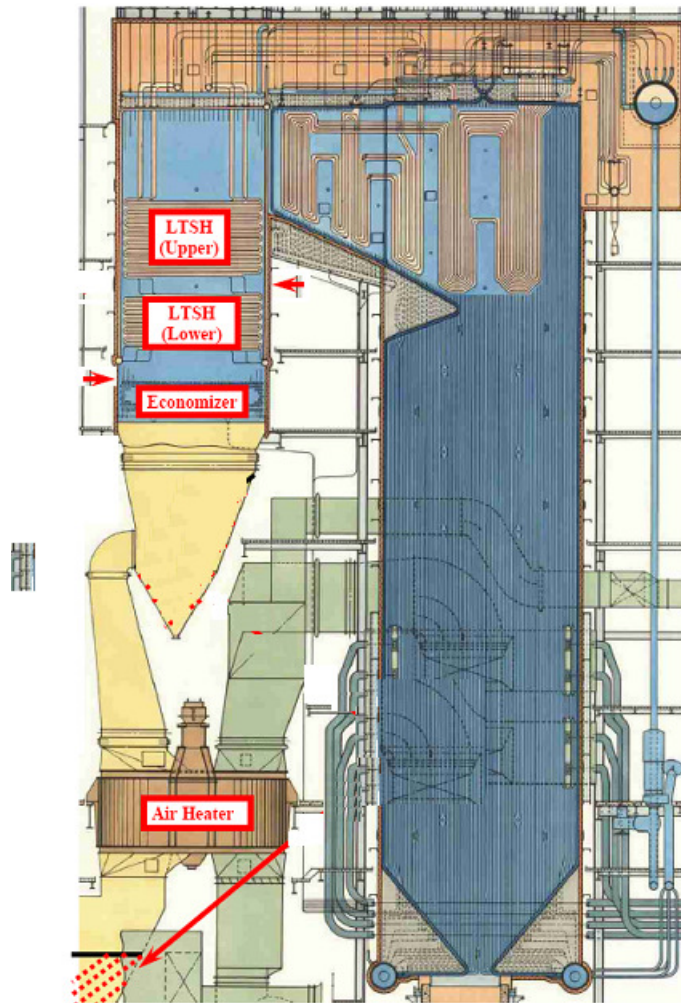
 Coal Fired Industry – Plant 2
imagination at work

Day 1 – two units in Reheat LTSH



Fin Tube Installation:
Plugging in backpasses
Results:
Evidence of debris
cleaning during startup

Day 2 – Economizer and LTSH



Improvements in feed water temps
in economizer

Video showing cleaning effects

Later found out we plugged up ash
hoppers



Images from Plant 2



Typical Economizer Fouling



Economizer with Powerwave+



58 days of Powerwave+ operation

This installation also has four 75Hz acoustic horns Installed

Images from Plant 2



Fouled upper bank LTSH



Upper bank LTSH with Powerwave+

Back-passes noticeably cleaner after 58 days operation

Summary

Currently have 6 units installed at First Energy Plant 2. Have been installed and operating since March 2007.

Have visually noticed a cleaner back pass since they have been installed and are actively monitoring progress.

Proactive Cleaning approach

Have shown promise in cleaning of fouled boilers, however recommendation is to clean proactively to help maintain clean boiler longer

Work with individual customers to define a product placement plan



Summary

- Powerwave+ technology has shown large potential benefit
- GE has in-depth knowledge of boilers and utility industry
- Customize solutions are available based on broad knowledge of cleaning technologies

Contact information

Product Line Leader, ESP Products

- Terry Farmer (816) 313-4409

Email: terry.farmer@ge.com

Product Manager, Powerwave+

- Dave Chapin (816) 356-8400
- Email: david.chapin@ge.com

Senior Sales Representative, Fabric Filter Combustion

- Robin Linton (816) 313-4339
- Email: robin.linton@ge.com