Reinhold Environmental Ltd.

2007 NOx Round Table & Expo Presentation

February 5-6, 2007 in Cincinnati, OH

Breen Energy Solutions

Introduction to Optimized Sootblowing

Intelligent Sootblowing for the common plant

EMISSIONS CONTROL PROCESS ENHANCEMENT

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Presentation Outline

- **What is “Intelligent Sootblowing”**
- **What control components do you need**
- **What sensors are available**
- **Applications in older/smaller boilers**
- **New Sootblowing technology**

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What is "Intelligent Sootblowing"

?

Definition Background

- **Sootblowing has evolved from a basic, manual process controlled by the unit operator to a closed-loop control scheme driven by sensory feedback and aimed at achieving one of several plant objectives.**

- **Depending on which objective is king at the moment, the concept of blowing one or more sootblowers, "when, and where, needed" will vary considerably.**

ISB Drivers - 1

- **Temperature Control:**
  - **Better control of FEGT (Boiler Efficiency/NOx Generation)**
  - **Better control of SH and RH Steam Temperature (Turbine Efficiency)**
  - **Better control of side/side Temperature Imbalances (NOx Generation/LOI)**

ISB Drivers - 2

- **O & M Costs**
  - **Erosion via high gas velocity**
  - **Erosion via excessive sootblower activity**
  - **Corrosion**
  - **Steam Usage**
  - **Sootblower wear**
  - **Air Heater Cleaning vs. basket Corrosion**

ISB Drivers - 3

- **Particulate Emissions**
  - **Ash Resistivity vs. boiler location**
  - **Coordinating high particulate blowing actions**
  - **Coordinating sootblowing with ESP rapping**

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Definition

- **Intelligent Sootblowing then is:**

Operating sootblowers only if, when, and where they are needed to satisfy the most immediate plant driver!

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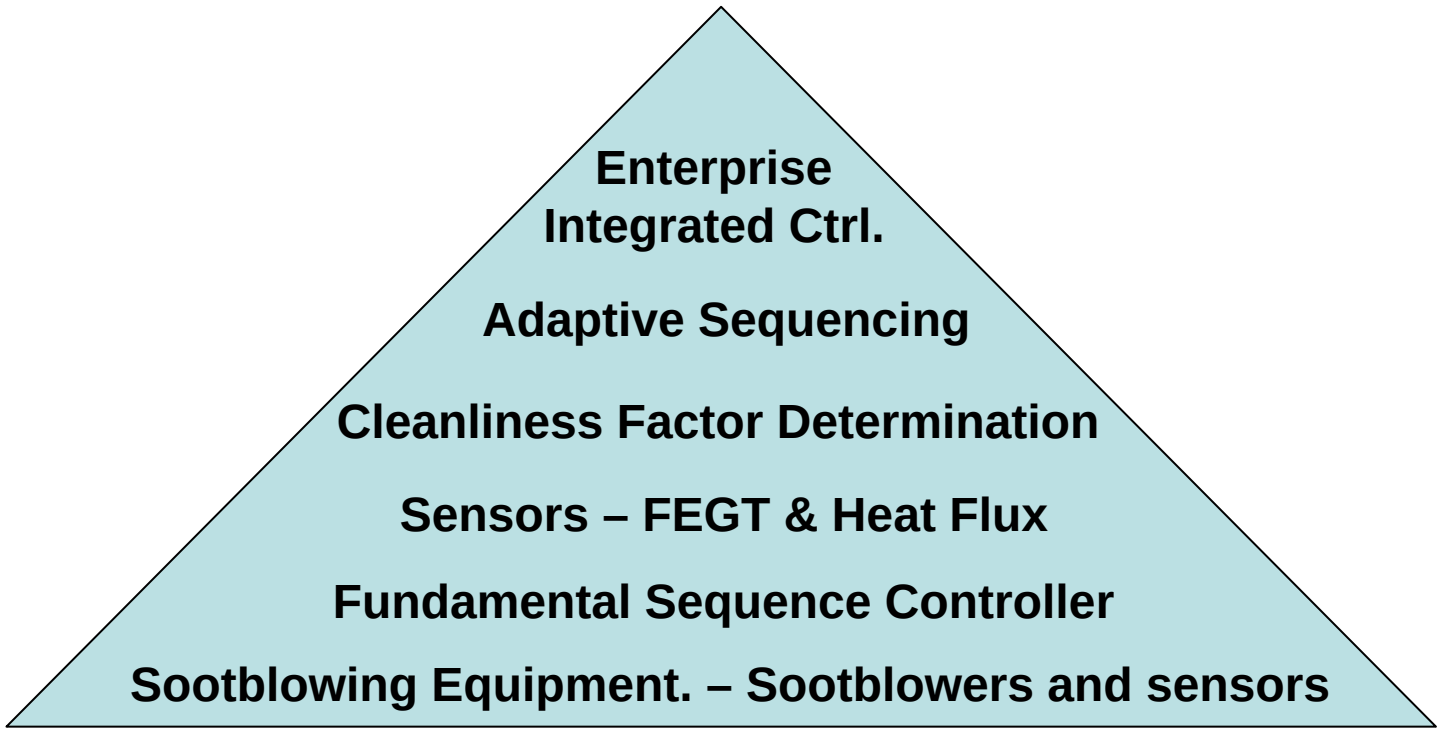
What do you need to do ISB?

Control Pyramid



Sootblowing Hardware

- **Without a doubt this is the most important component of any ISB system. If the sootblowers don't work, the system won't work. PERIOD!**

- **For any ISB system to perform effectively plant management must be actively supportive of sootblower maintenance.**

Fundamental Sequencing

- **Mandatory Features:**
  - **Sootblower Safety**
    - **Motor Current**
    - **Steam Flow**
  - **Editable Sequences**
  - **Multiple Groupings**
  - **Demand Driven Execution**
  - **Communication**
    - **External Sensors**
    - **Supervisory Intelligence**
    - **DCS**

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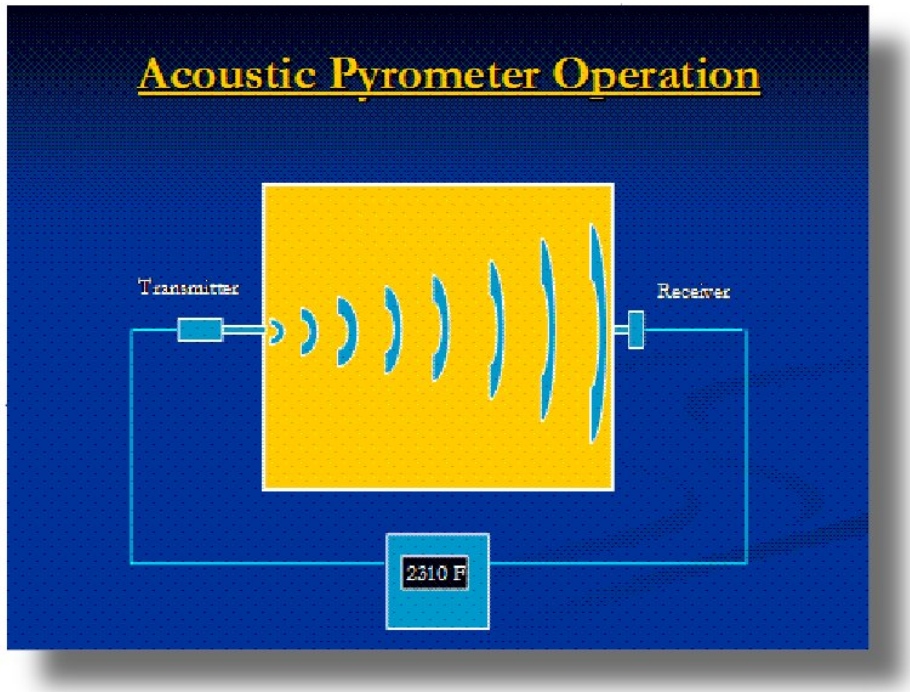
Sensors

- **Ash Deposition**
  - **Heat Flux**
    - **Invasive**
    - **Non-Invasive**
  - **Pendant Load Cell**
  - **Infrared Imaging**

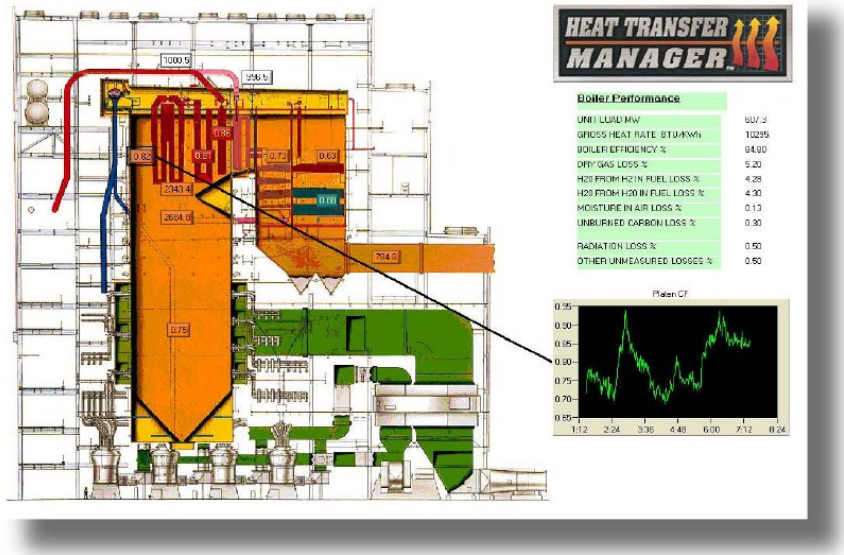
Sensors

- **FEGT**
  - **Infrared**
  - **Acoustic Pyrometry**
  - **Laser Pyrometry**



Cleanliness Factor

- **Based on Enthalpy conservation**
- **Determine level of cleanliness in each tube section**
- **Multiple Suppliers with different approaches**
- **All are reputable and good at what they do.**



Adaptive Sequencing

- **Adaptive Sequencing**
  - **Executes primary sequences but modifies timing or execution based on detected levels of cleanliness.**
  - **Executes modified sequences to maintain or optimize heat transfer into selected heat transfer regions (i.e., maintain reheat temperature within a preset range)**

Enterprise Integration

- **Neural Network Based**
- **Balances emissions and efficiency goals**
- **Supervises ISB systems**

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Sensor Technology

Traditional and Emerging

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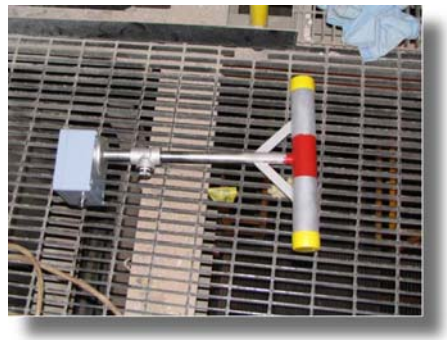
Heat Flux Sensors

- **Several Designs:**
  - **ASI**
  - **CBI**
  - **Alstom**
  - **B&W**
  - **Breen**



Heat Flux Sensors

- **Developed initially to monitor the presence of an ash layer before water deposition in water cleaning of PRB boilers**

- **Newer Low-cost/Pt. Technology provides:**
  - **Contour map representation of slagging patterns**
  - **Detection of reducing atmospheres leading to localized corrosion**

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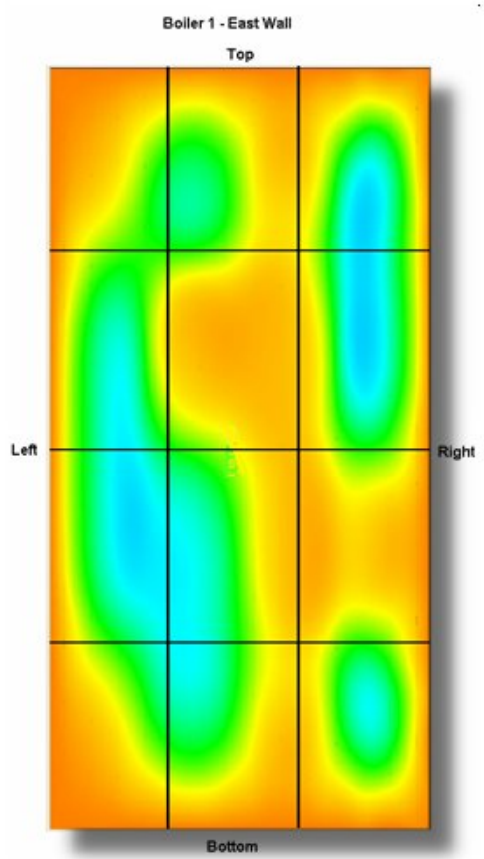
Contour Mapping

- **High Speed Data Analysis gives multi-point representation of slagging patterns**



Transition ID

Ash Components

- SiO_2 → 2500°F
- Al_2O_5 → 2500°F
- Fe_2O_3 → 2500°F

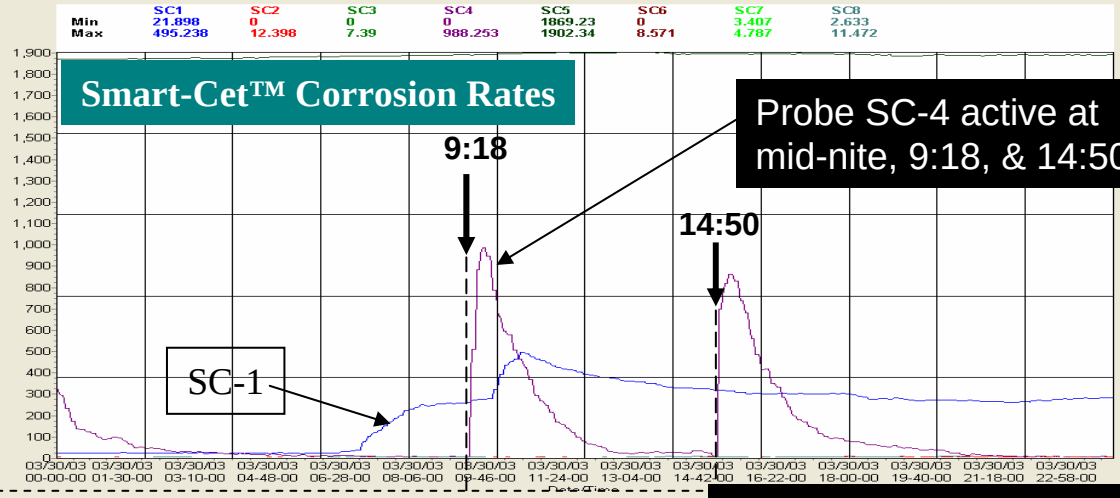
Oxidising

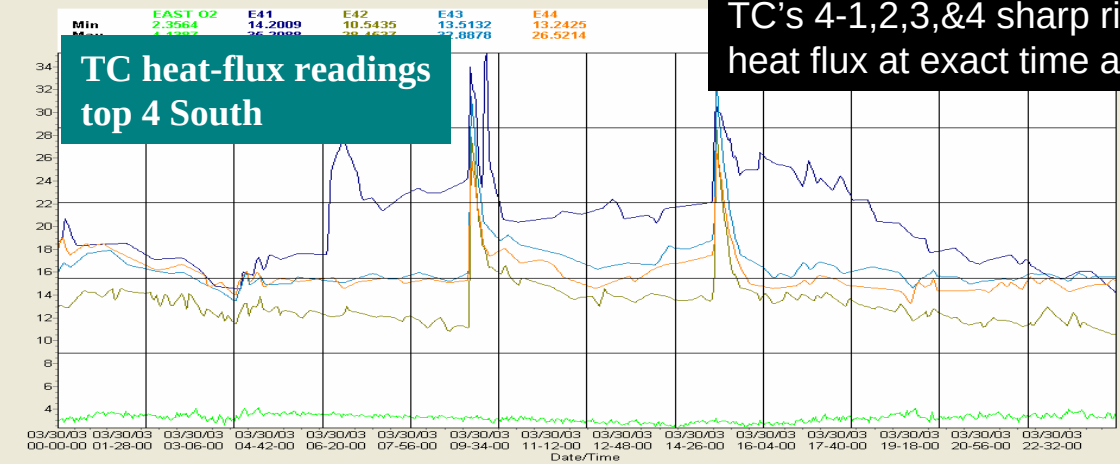
- SiO_2 → 2500°F
- Al_2O_5 → 2500°F
- FeO → 1800°F

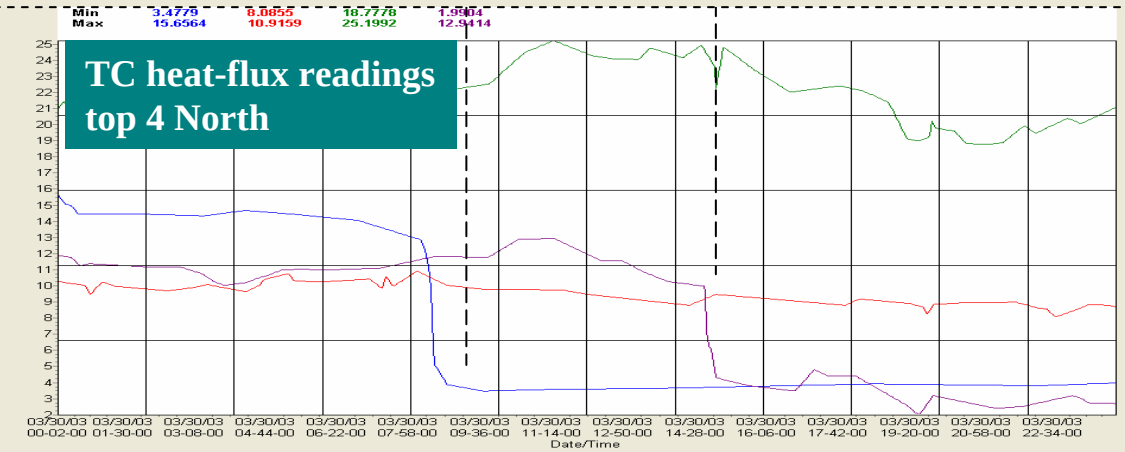
Reducing

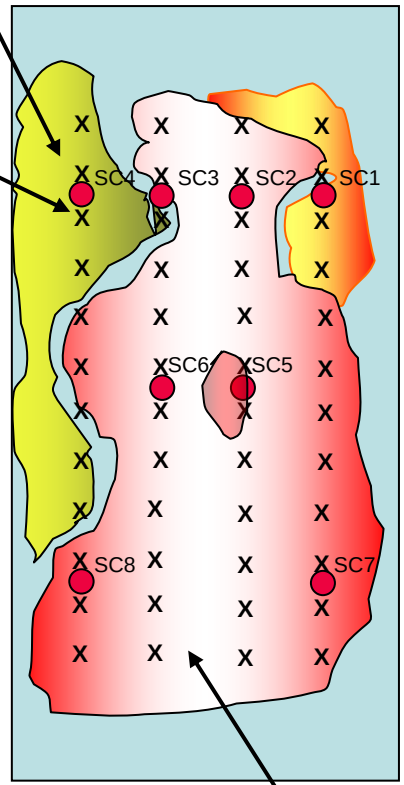
$Fe_2O_3 \rightarrow FeO$

$C \rightarrow CO \rightarrow CO_2$









All other probes and TC's show stable ash accumulations through-out day

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Evolutionary ISB

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Background

- ISB has become big business
- EPRI sponsors:
  - ISB Conference
  - Heat Rate Conference
- DOE has sponsored at least 1
- Many major projects but not a lot of attention to the small plants

Evolutionary

- **ISB for the common plant should be evolutionary:**
  - **Start with a commitment to sootblower performance & maintenance**
  - **Equip the plant with sensory feedback initially used for combustion optimization**
  - **Add a solid, fundamental sequencer**
    - **Stand Alone**
    - **DCS based**
  - **Layer Intelligence on an application basis always allowing for upward migration**

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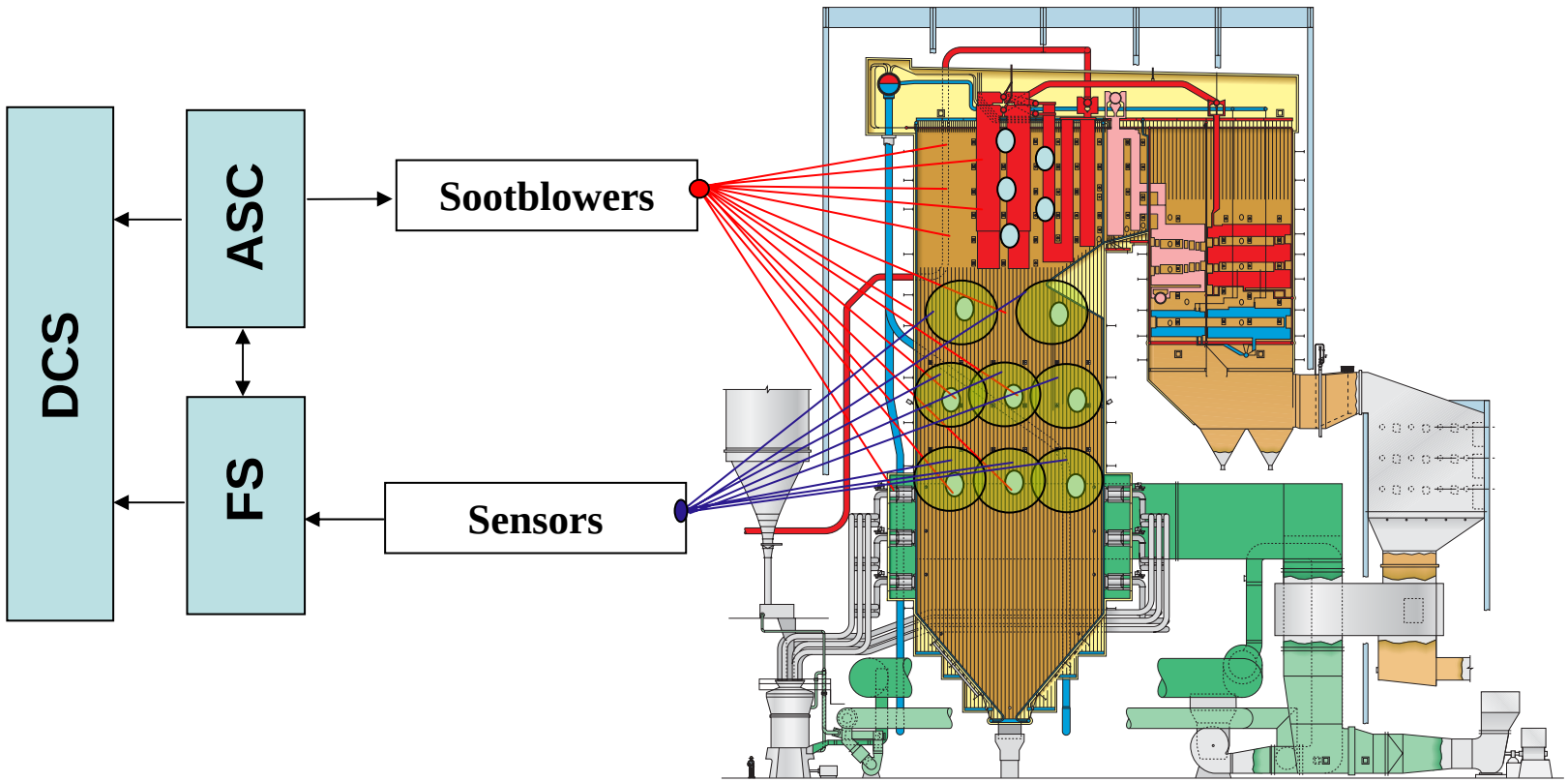
Foundation



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Typical Applications

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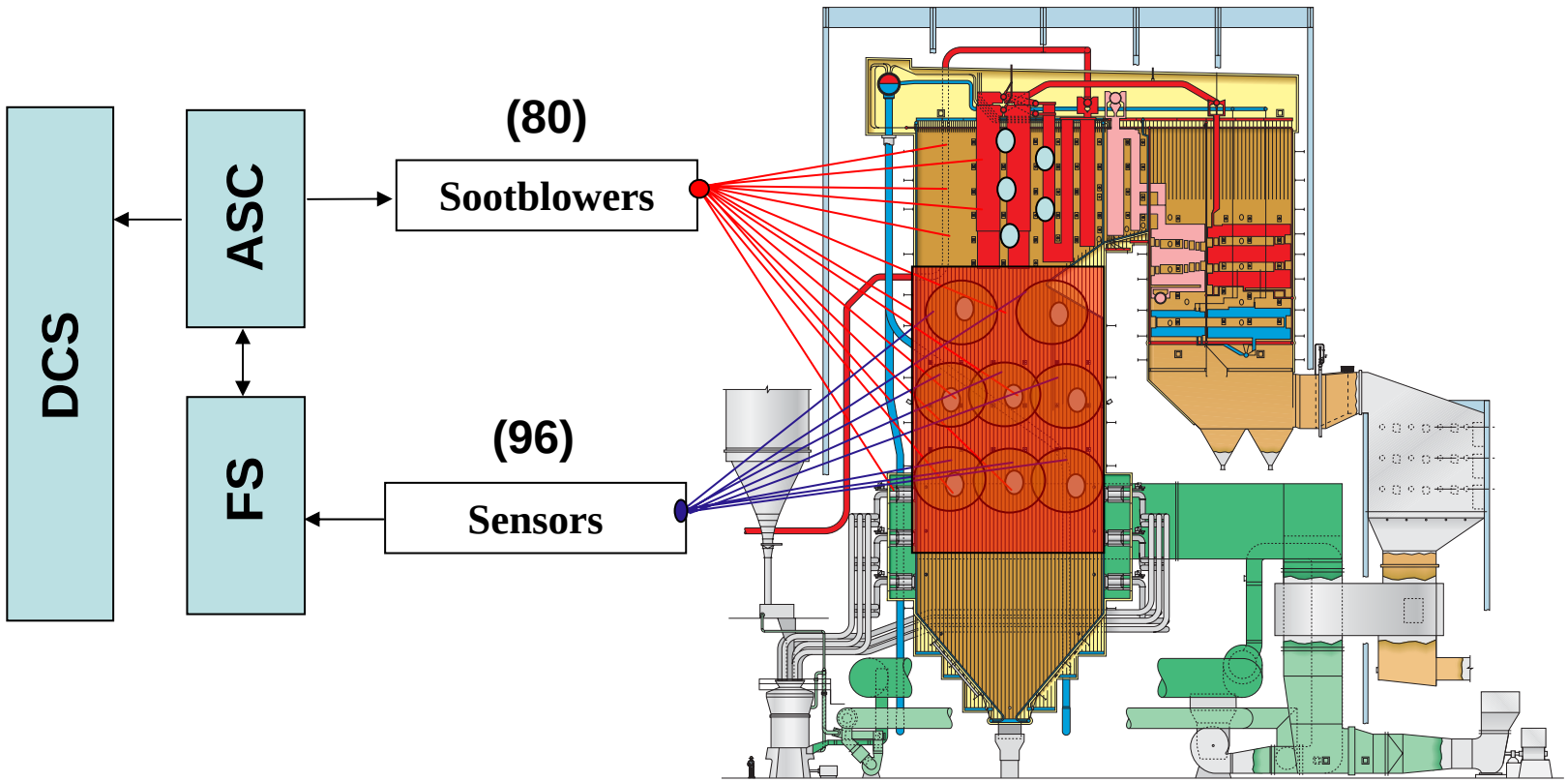
Project 1

Wall Erosion

Wall Erosion

- A change of fuels leads to increased wall slagging,
- To keep heat the boiler in balance, wallblowing is increased,
- Increased wallblowing leads to increased tube wear,
- Tube wear leads to leaks and forced outages

Wall Erosion



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Project Analysis

- **Total cost to implement = $65,000**
- **Result**
  - **50% reduction in wallblowing cycles**
  - **No tube leaks reported as of yet (3 months operation)**

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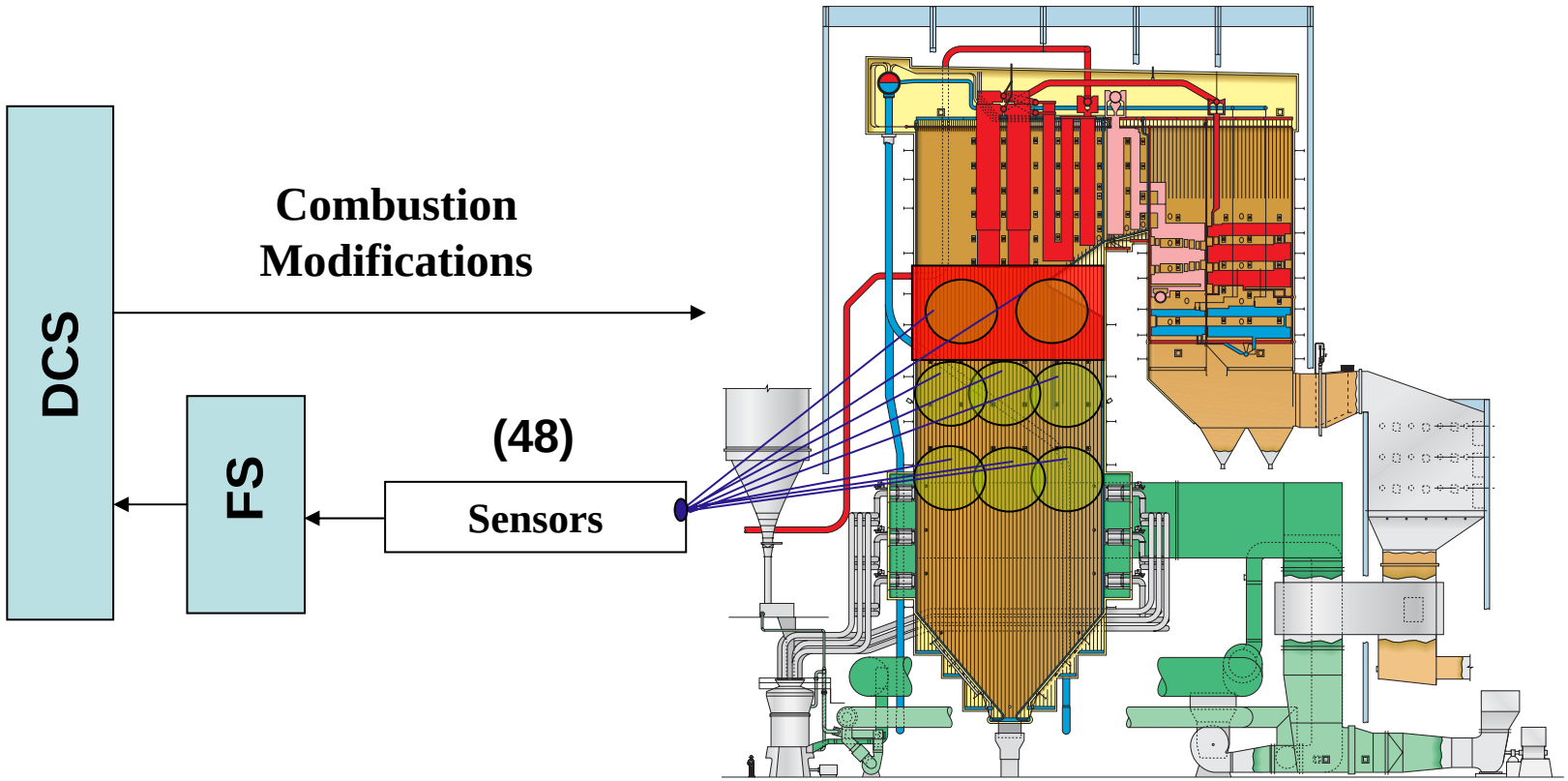
Project 2 – Wall Slagging

Wall Slagging leads to Reheat Temp Problems

- **Heavy slagging above the furnace lead to problems making reheat temperature**
- **Slagging was in an area not covered by sootblowers**

Wall Slagging



Project Analysis

- **Initial data suggests that the pulverizers vary in performance and slagging is related to particles sizing (T-Fired boiler)**
- **Combustion modifications (staging) and mill maintenance are in process.**

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Issue 3

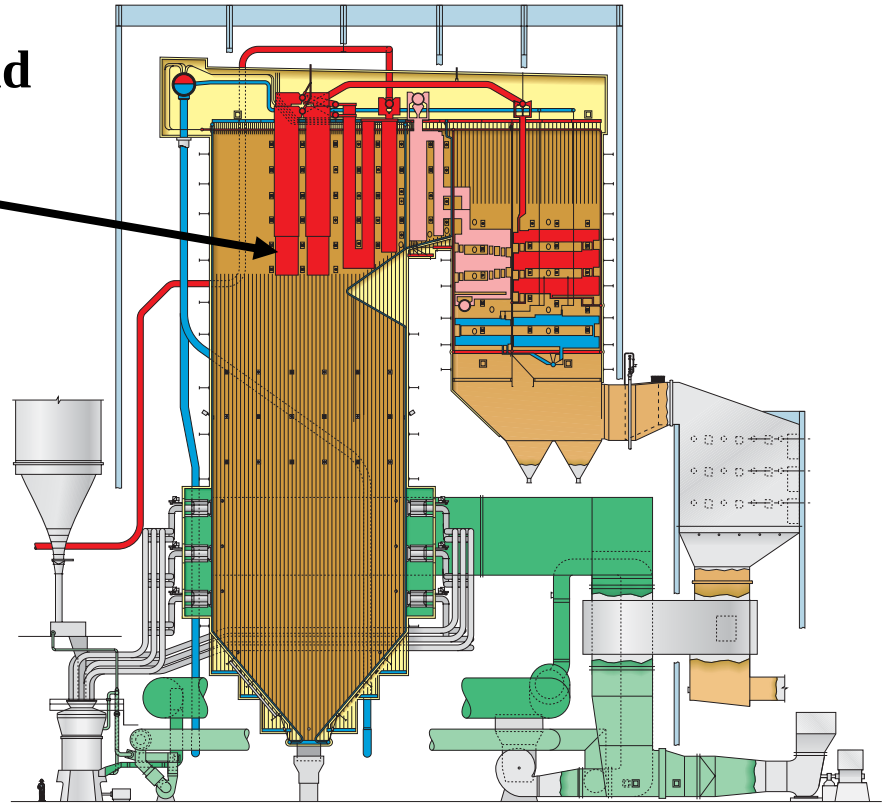
Superheat Slagging

Superheat Slagging

- **Fuel changes lead to an increase in FEGT followed by superheat and reheat slagging**

Superheat Slagging

Slagging and Bridging



The basic problem is insufficient steam to cycle through the superheat sootblowers rapidly enough to keep them clean

Superheat Slagging

- **The current approach is to monitor ash buildup on the pendants,**
- **Monitor the cleanliness factor of each convective section, and clean only where needed.**

- **However, in many cases the problem still comes down to insufficient steam.**

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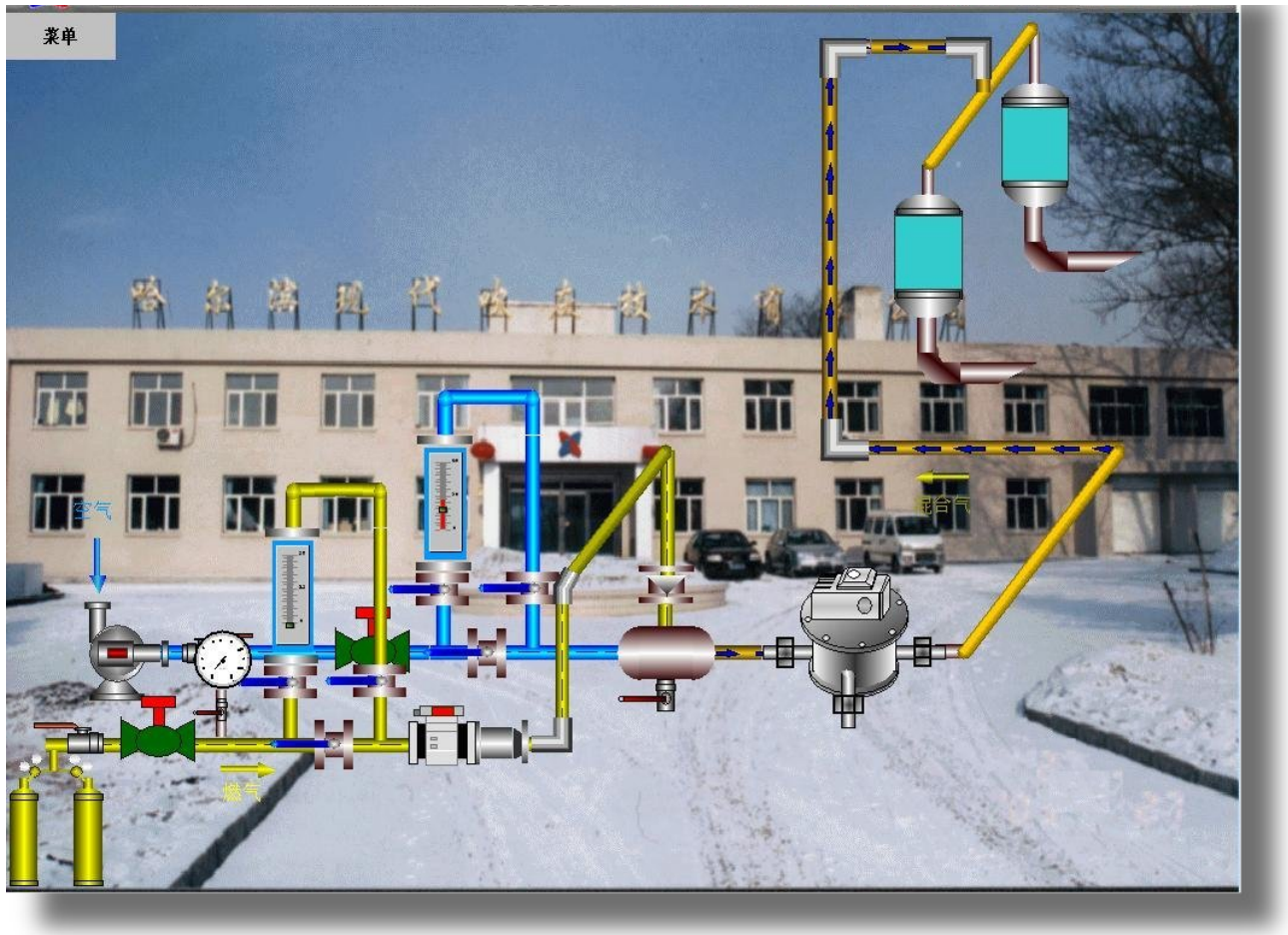
Impact Detonation Sootblowing



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Gas/Air Control

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Multiple Head Installation

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Rotating Head

Impact Detonation Use

- **ID has over 300 installations in China with patents dating back nearly 20 years.**
- **Very effective for RH zone and back.**
- **Work is being done to explore the effectiveness in keeping SH deposits minimized until steam sootblowers can return to the area.**
- **Capable of ash removal every 15 seconds with effective range of up to 50 feet.**

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Conclusion

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Conclusion

- **ISB can be commercially feasible at any unit regardless of size.**
- **ISB should be conceived as a layered, modular approach**
  - **Sootblower Maintenance**
  - **Fundamental Sequencer**
  - **Sensors**
  - **Integration**
- **Before you begin an ISB program, get management buy-in to aggressive sootblower maintenance!**

Thank You

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