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International, Ltd.

Ways to Improve Performance of Marginal ESP's

BASICS

- Existing Equipment
- Existing Performance
- Present Operation
- Expected Performance

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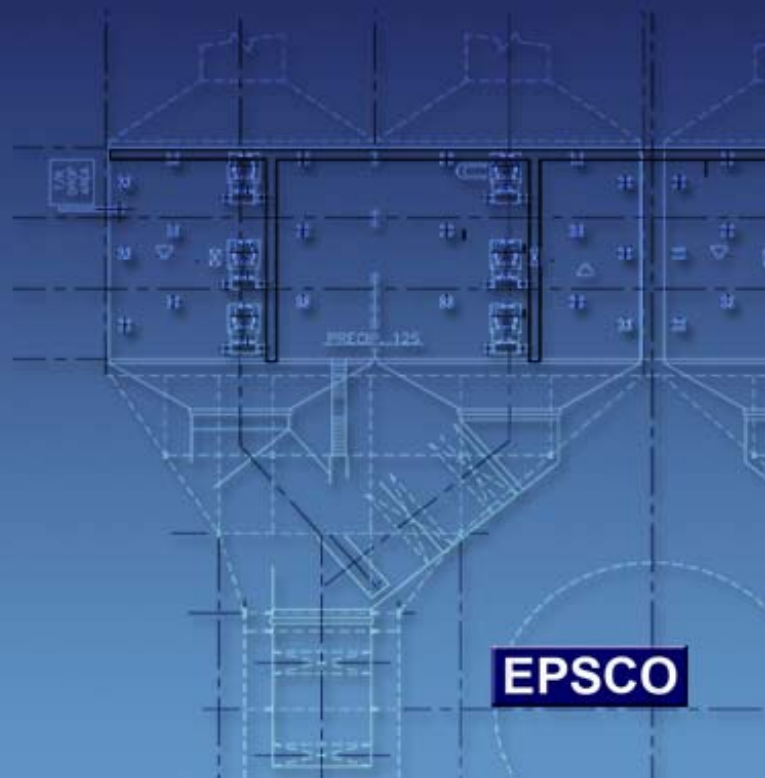
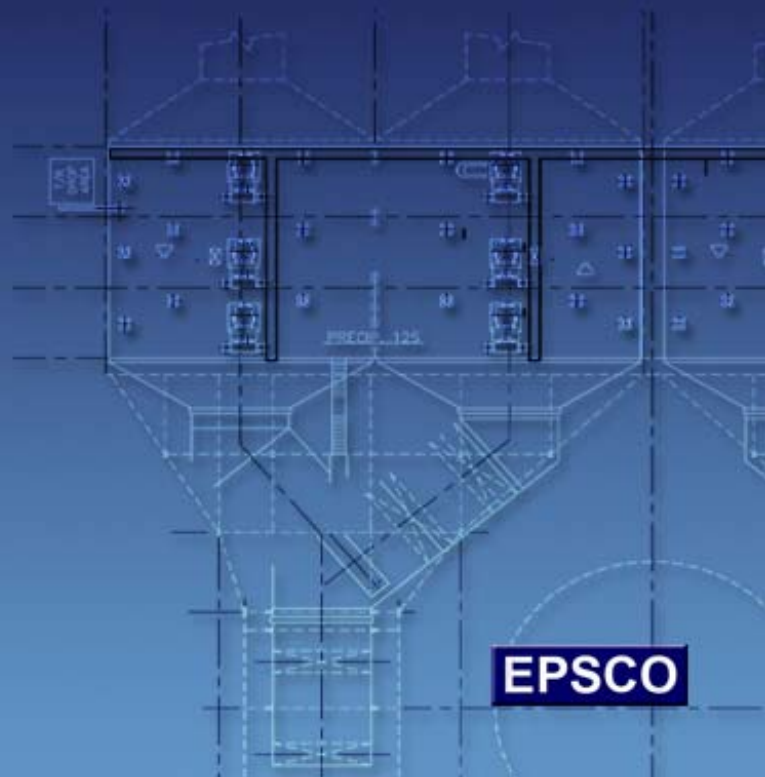
Existing Equipment

- Define the existing equipment - Initial
  - Size description
  - SCA
  - Volume
  - Velocity
  - Aspect ratio
  - Treatment time



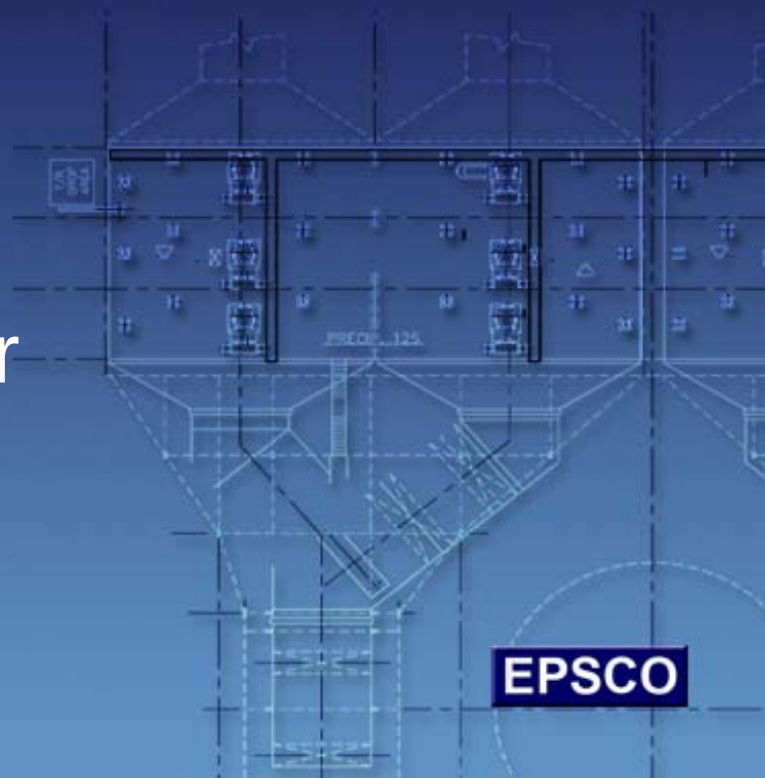
Existing Performance

- Determine present day conditions
  - Volumes
  - Dust loadings
  - Velocity profiles
  - Ash chemistry
  - Coal analysis
  - Precipitator efficiency



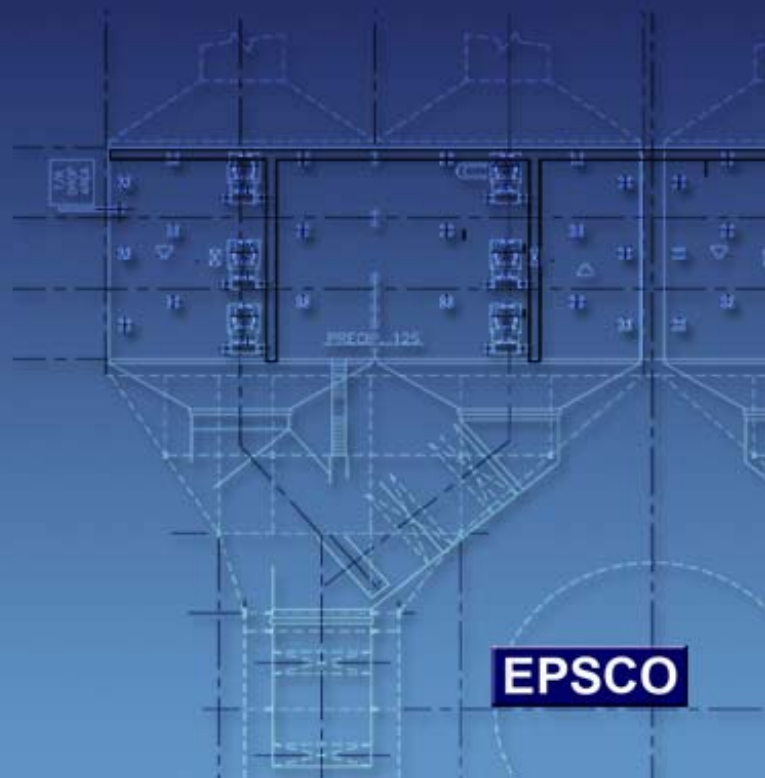
Present Operation

- Low NOx Burners
- Blended and/or PRB fuel
- Excess air
- SCR
- Scrubber
- New tube surface in boiler



Expected Performance

- Define the parameters
  - Coal type
  - Ash loading
  - Volumes
  - Ash loadings
  - Anticipated efficiencies
  - Special conditions



Realistic Goals

- Are performance goals achievable ?
  - Degree of probability
  - Sustained performance
- Will the equipment support the goals?
  - Condition
  - Age
  - Design
  - Reliability

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Realistic Goals

- Define marginal first
- Define expected performance

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Decision 2006

- Work with existing equipment
- Modify or rebuild existing equipment with newer design components

Existing Equipment

- Online evaluation
- Offline evaluation
- Field testing
- Equipment design parameters
- Equipment operational parameters

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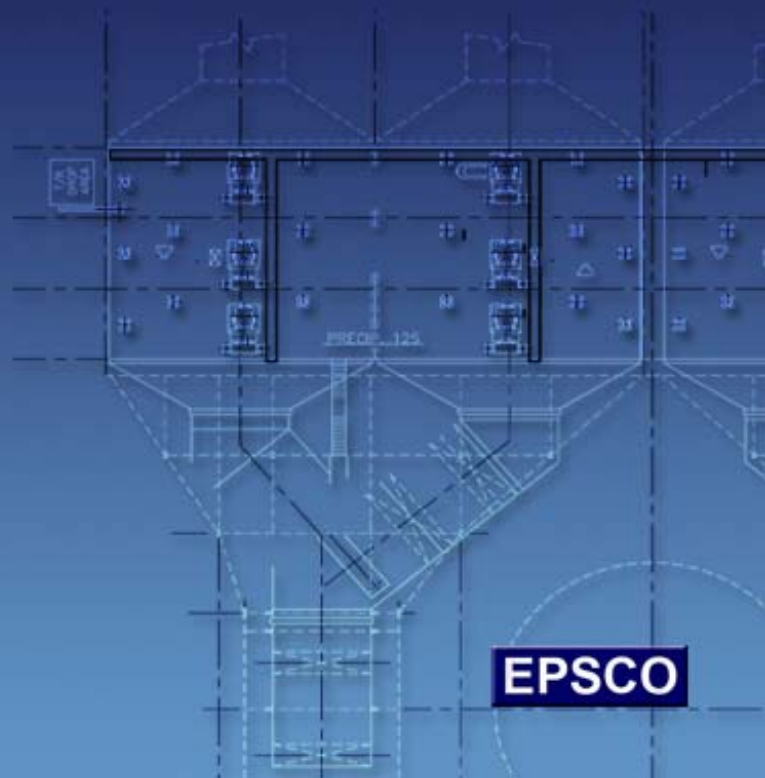
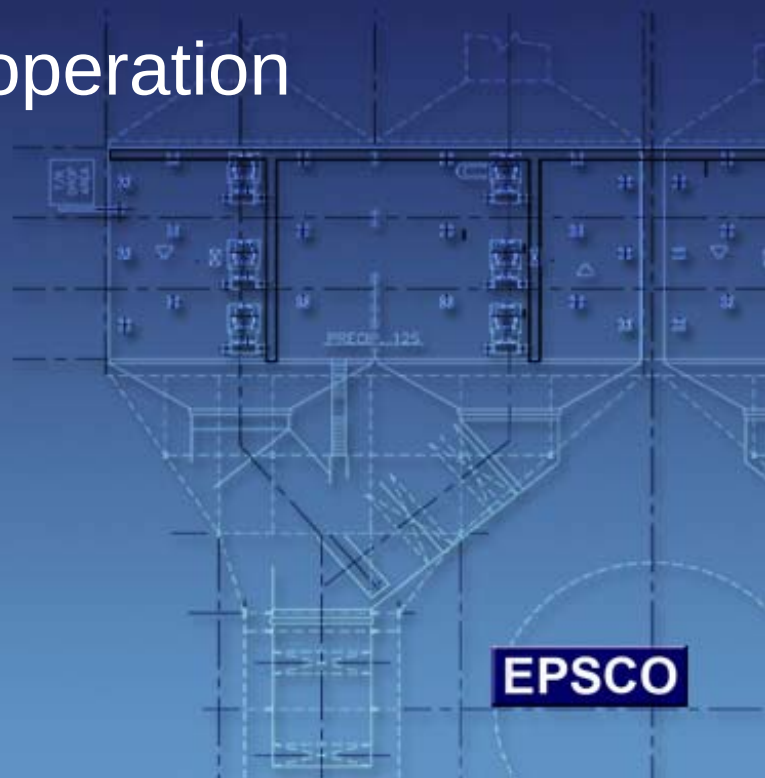
Online Evaluation

- Electrostatic Precipitator
  - Control operation
  - Limits or sparking
  - TR sizing
  - Waveshape analysis
  - Rapper cycling
  - Rapper impacting



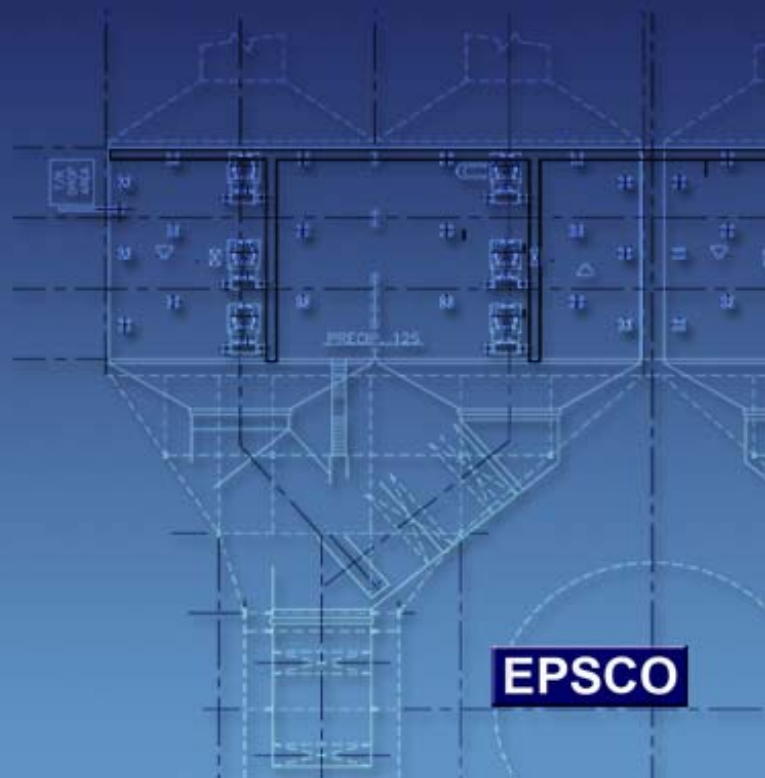
Online Evaluation

- Boiler operation
  - O_2 Levels
  - Sootblowing
  - Economizer - ash system operation
  - Coal firing rate
  - Fuel analysis



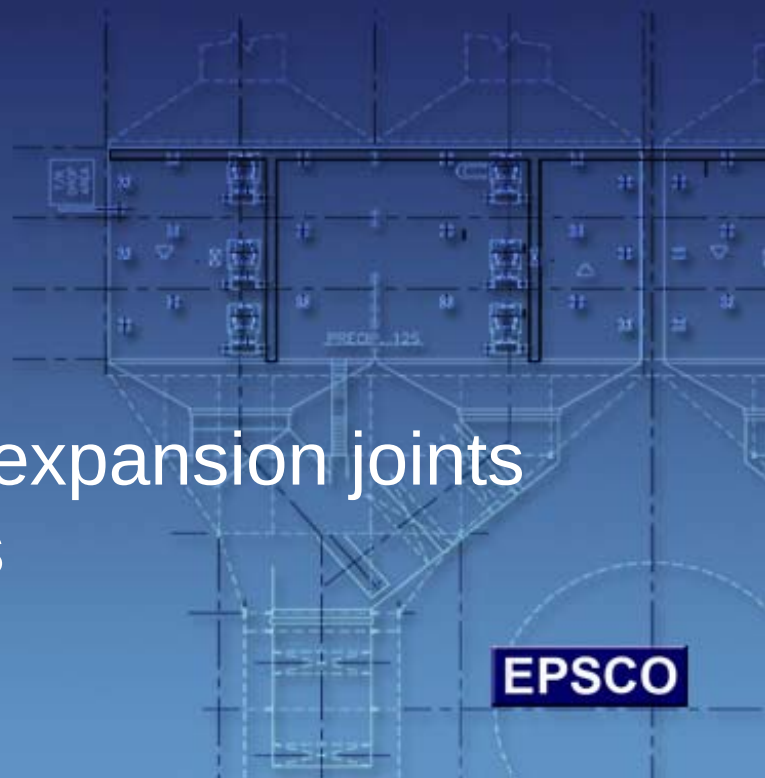
Online Evaluation

- Auxiliary equipment
  - Flyash system
  - CEMS
  - Opacity monitors



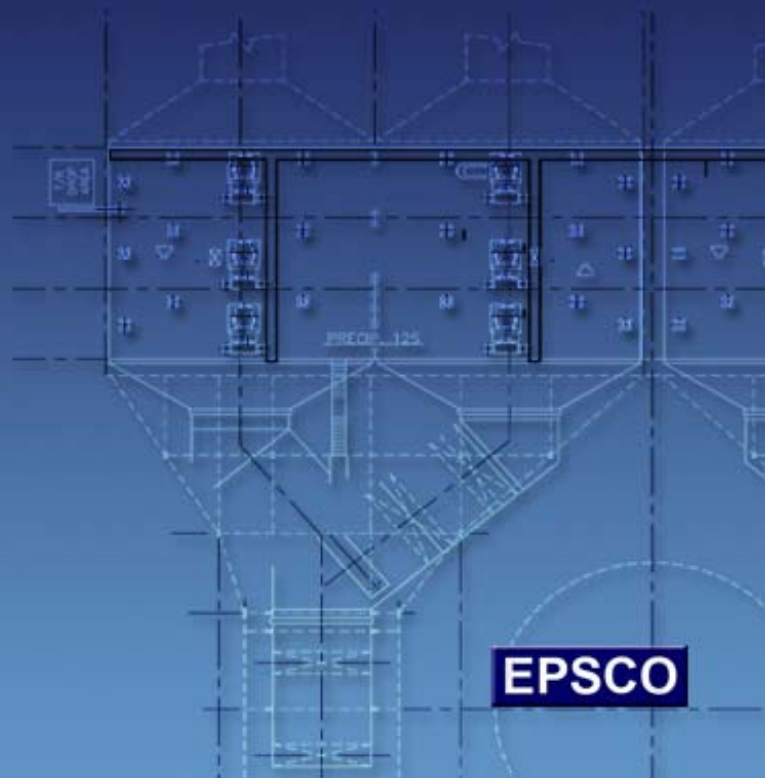
Offline Evaluation

- Ductwork inspection
  - Erosion, corrosion, accumulation
  - Likelihood of stratification
- ESP inspection
  - Alignment
  - Distribution
  - Erosion
  - Corrosion
  - Inleakage – doors, welds, expansion joints
  - Sneakage – fields,hoppers



Offline Evaluation – cont.

- ESP inspection
  - Rapping effectiveness - CE, DE
  - Rapping sectionalization
  - Ash accumulations
  - Structural deformation
    - Nozzle connections
    - Hopper connections
    - Lubrite plates



Offline Evaluation

- Distribution
- Ash accumulation
- Changes from "as built"

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Offline Evaluation

- Rapping effectiveness-not

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Offline Evaluation

- Hopper evacuation
- Storage facility

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Offline Evaluation

- Ash accumulation
- Gas distribution
- Duct design
- Poor velocity

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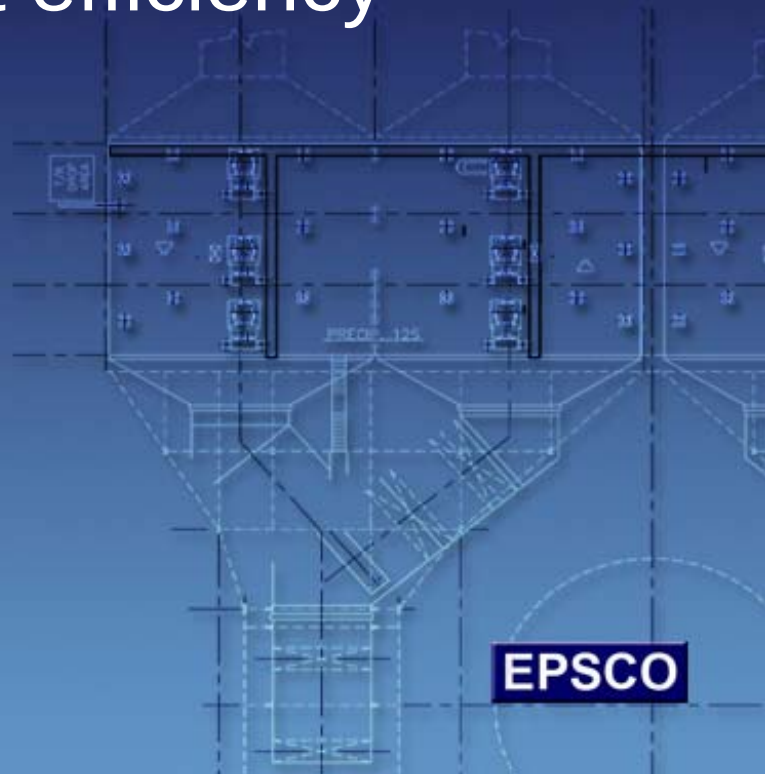
Field Testing

- Current performance data
- Volumes
- Grain loading
- Volume splits
- Velocity profiles
- Current boiler operating data
- Ash chemistry
- Size analysis

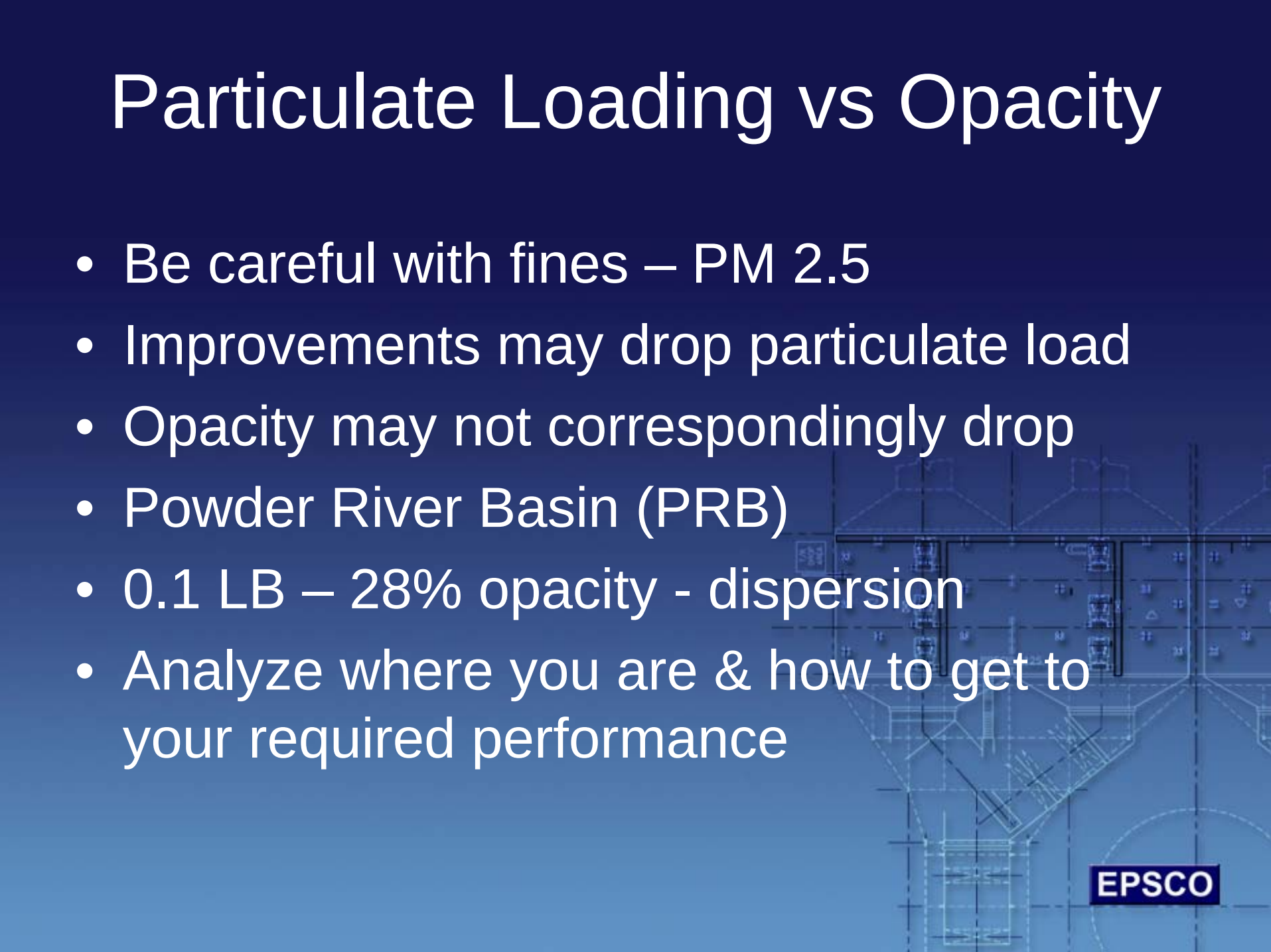
Field Testing - Review

- ESP design - w w_k
- ESP operating – w w_k
- Original guarantee vs test efficiency
- Changes in process
- Deterioration



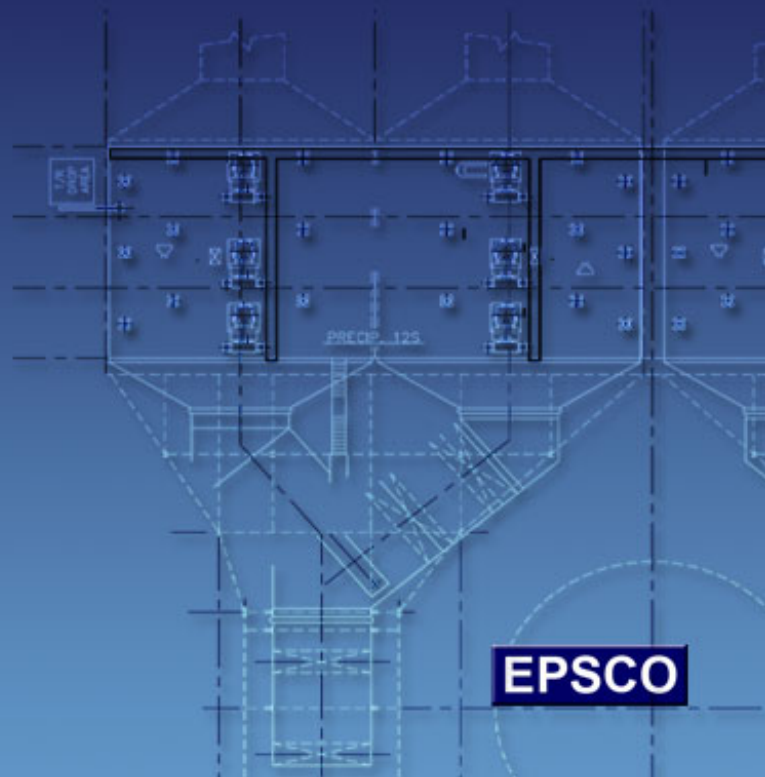
Particulate Loading vs Opacity

- Be careful with fines – PM 2.5
- Improvements may drop particulate load
- Opacity may not correspondingly drop
- Powder River Basin (PRB)
- 0.1 LB – 28% opacity - dispersion
- Analyze where you are & how to get to your required performance



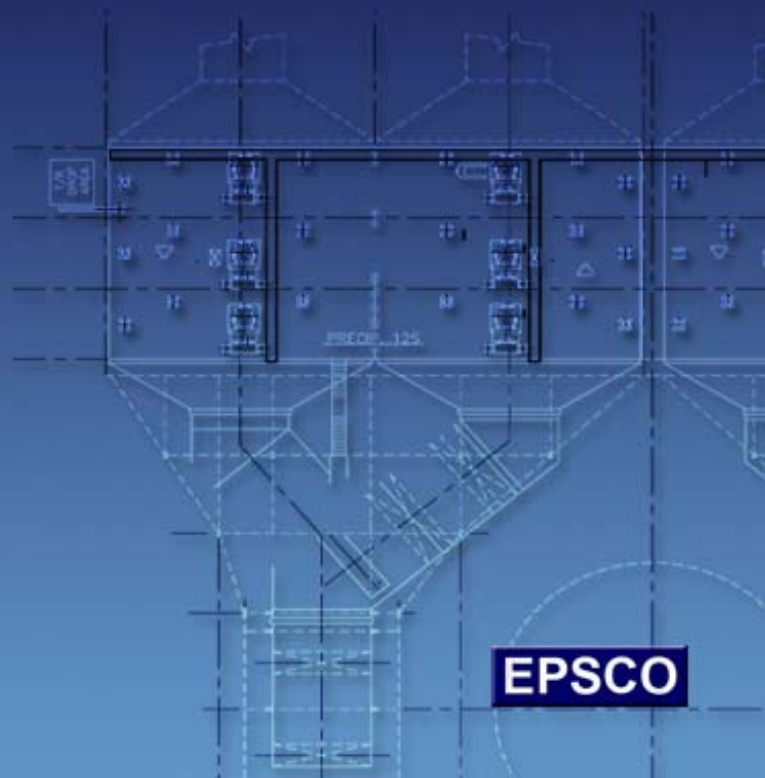
Existing Equipment Modifications

- Gas distribution
- Transformer Rectifiers
- AVC controls
- Rapping systems
- Casing
- Hoppers
- Ash systems



Gas Distribution

- Improvements
- Model study
- CFD model
- Field testing
- Anti sneakage baffling



Transformer Rectifiers

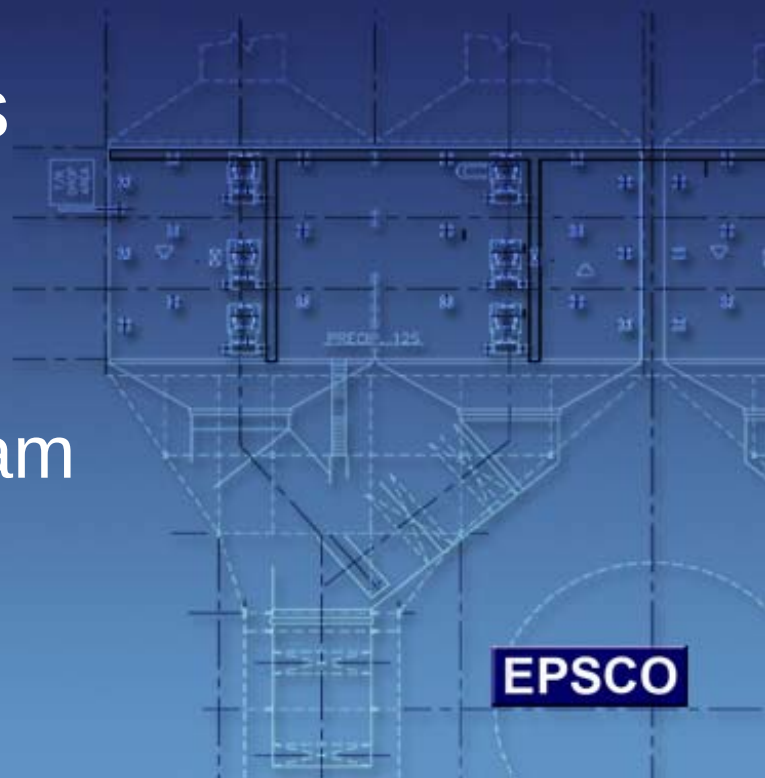
- Sized for the bus section and field
- Upgrade for useful life and reliability
- Power Plus – compact design
- More sectionalization

AVC Controls

- Microprocessors
- Linear reactors
- Central control system
- Data acquisition
- Be sure the internals are ready

Rapping Systems

- MIGI's
- Microprocessor controls
- Mounting methods
- Tapered rapper insulators
- Sectionalize
  - less Ft^2 per rapper
  - more rappers per anvil beam

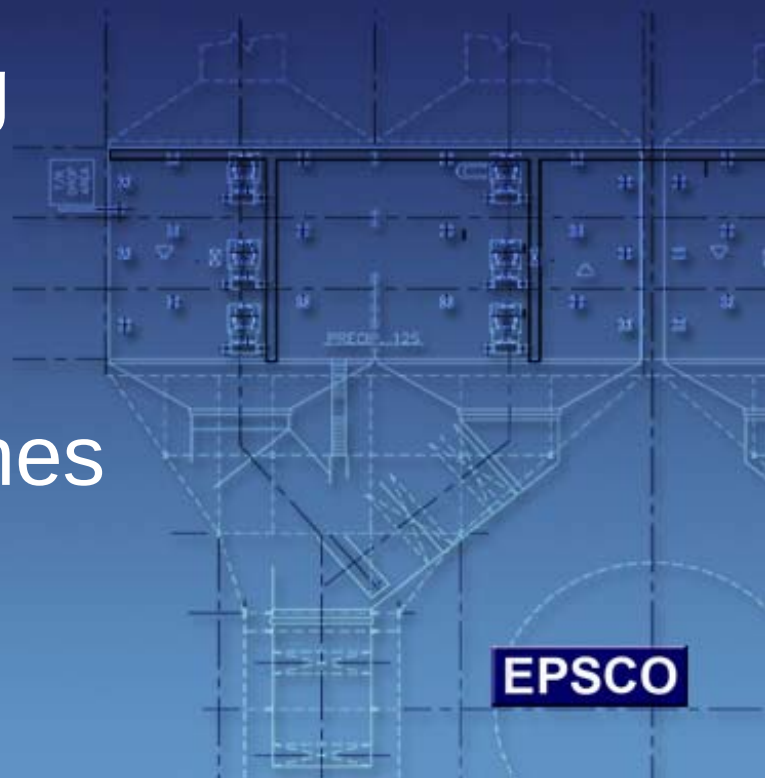


Casing

- Doors – gaskets – inleakage
- Casing integrity – welded connections
- Ductwork integrity – welded connections
- Expansion joint frames, connections, material
- Leaking instrument and test ports

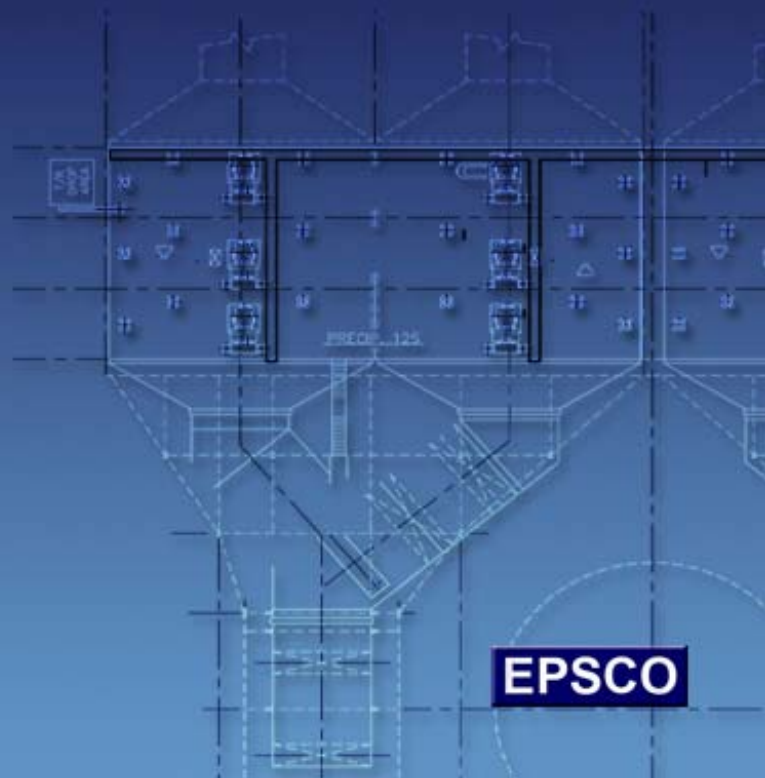
Hoppers

- Hopper heating evaluation repair / replace
- Hopper vibrators
- Hopper doors and sealing
- Level detection devices
- Ash system vent pipes
- Ash system fluidizing stones



Ash System

- Control system for more flexible operation
- Thorough system component review
  - Gates-operation-seating
  - Air system – dry air
  - Fluidizing stones



Precautions

- Sort through the information for real problems and solutions
- Look for the solution – not just equipment improvements
- Focus and categorize improvements
- Review particulate vs opacity
- Watch fuel characteristics

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Major Modifications - Upgrades

- Rebuild with new internals
- Increase collecting surface
- Increase field height
- Effective increase in SCA
- Add a walk-in penthouse
- Increase plate spacing
- Replace weighted wires with RDE’s
- Decrease square foot of plate per rapper
- Decrease electrode length per rapper

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Major Modifications-cont.

- Utilize walkway area to increase plate area
- Redesign as top and bottom access
- RDE’s can support limited access
- Must have extreme QA/QC on components

Major Modifications – cont.

- Parallel chamber – lower velocity
- Sectionalization in direction of flow
- Sectionalization across flow
- Consider wide plate spacing
- Deal with volume increases over time

Boiler Considerations

- Particle size – grind of pulverizers
- Air heater temperature stratification
- Tube surface – outlet temperature-volume
- Temperature – resistivity
- Duct profiles may be detrimental to distribution of particulate and temperature
- Inleakage in system

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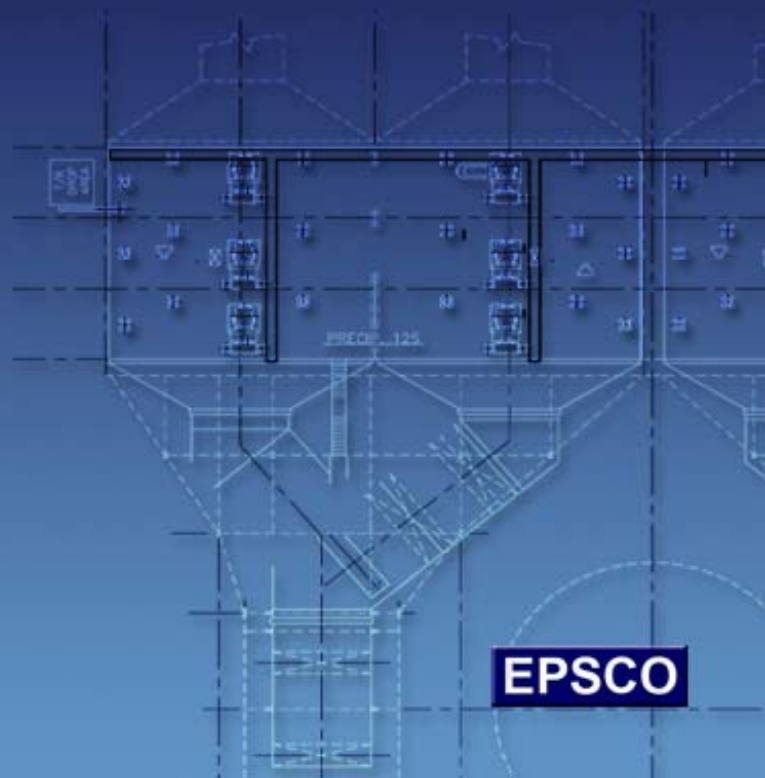
Other Major Modifications

- Ash conditioning – SO_3
  - Safety
  - Operating costs
  - Initial costs of system
- Agglomeration



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