Ways to Improve Performance of Marginal ESP’s
BASICS

- Existing Equipment
- Existing Performance
- Present Operation
- Expected Performance
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
Realistic Goals

- Define marginal first
- Define expected performance
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
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”
Offline Evaluation

• Rapping effectiveness—not
Offline Evaluation

- Hopper evacuation
- Storage facility
Offline Evaluation

- Ash accumulation
- Gas distribution
- Duct design
- Poor velocity
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
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
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
Other Major Modifications

• Ash conditioning – $\text{SO}_3$
  – Safety
  – Operating costs
  – Initial costs of system
• Agglomeration