IPRO 303

Failure Prediction Modeling of Power Plant Emission Control Systems
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Presentation Outline

- Project Sponsor
- Goals and Objectives
- Ethics
- Team Development
- Summary of Results
- Obstacles and Resolutions
- Conclusions and Achievements
- Recommendations
- Acknowledgements
Project Sponsor

- SmartSignal
  - Failure Prediction Modeling
  - Power Plant Generation
  - Expand to Emission Controls
  - David Farrell, Product Manager

http://www.smartsignal.com
Goals and Objectives

- Regulations
- Emission Control Systems
- Failures and Degradation
- Instrumentation
- Detection of Failures
Ethics

• Confidentiality
• Team Contribution
• Team Diversity
• Perspectives
  – Seven Layers of Integrity
  – Ethics, It’s Good Business
  – Professional Engineering Code of Ethics
Team Development

- Group Consensus
- Volunteer
- Subgroups
- Team Leader
Team Structure

Research
- Wet Scrubbers
  - Insiyah Aratsu
  - John Bouikidis
  - Brett McQuillan
  - Jay Patel
- ESPs Baghouses
  - Zachary Capps
- SCRs
  - Dave Belanger
- Power Plant Contact
  - Insiyah Aratsu
  - Dave Belanger
  - John Bouikidis
  - Zachary Capps

Presentation
- Poster Brochure
  - Insiyah Aratsu
  - Sean Irish
  - Jay Patel
- Final Report
  - John Bouikidis
  - Zachary Capps
  - Brett McQuillan
  - Satyam Kaneria
  - Cari Hesser
- Final Presentation
  - Insiyah Aratsu
  - Dave Belanger
  - Lavesh Mohinani
  - Sean Irish

Team Development
Results

Electrostatic Precipitators
Baghouses
Selective Catalytic Reducers
Wet-Scrubbers

Overview
Instrumentation and Failures
Regulations
Electrostatic Precipitators Overview

- Ionization
- Migration
- Collection
- Charge Dissipation
- Particle Dislodging and Removal
Instrumentation and Failures

- **Instrumentation**
  - Primary and Secondary Voltages
  - Current sparks and Arcs per minute
  - Power input and output
  - Actual conditions versus programmed
  - Current parameters versus transformer ratings

- **Failures**
  - Broken Electrodes
  - Back Corona
  - Relatively low Input voltage
  - Inadequate rapping
  - Sparking
Regulations

• Federal Laws
  – Clean Air Mercury Rule
  – Where we currently stand?
• State Laws
  – Connecticut first state to pass regulations on mercury emissions
Baghouses Overview

- Three Types of Baghouses
  - Mechanical Shaker
  - Reverse Air
  - Reverse Jet

Image courtesy: http://www.hvacqld.com
Instrumentation & Failures

- Pressure Drop
- Fire
- Exiting air too opaque
Regulations

- Same as Electrostatic Precipitators
- Federal Laws
  - Clean Air Mercury Rule
  - Where we currently stand
- State Laws
  - Connecticut first state to pass regulations on mercury emissions
Selective Catalytic Reducers Overview

- Injection of Ammonia
- Mixing of polluted air and Ammonia
- Reaction across catalyst surface

http://en.wikipedia.org/wiki/Selective_catalytic_reduction
Instrumentation and Failures

- Instrumentation
  - Temperature
  - Ammonia Slip

- Failures
  - Catalyst Deactivation
  - Catalyst Deterioration
  - Ammonia Slip
  - Mechanical Issues

Selective Catalytic Reducers

www.cpsc.gov
www.sensidyne.com
http://fossil.energy.gov/programs/powersystems/p
NOx Regulations

- Federal Laws
  - Clean Air Act
    - 1990 Acid Rain Program
- State Laws
  - “Ozone Season”
    - May 1–September 30

http://www.traxcorp.com/scrregs.html

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<th>Phase II NOx emissions (lbs/MMBtu)</th>
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<tr>
<td></td>
<td>Effective January 1, 1996</td>
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Selective Catalytic Reducers
Wet Scrubbers Overview

• Pollution Control Technology
  – Removes SOx, Fly Ash, and pollutants from gas streams
  – Capture pollutants through liquid droplets

• Scrubbing Liquid
  – Spraying
  – Pool of liquid
  – Other methods
Instrumentation and Failures

- Pressure Gauge (gas flow)
- Pressure Gauge (nozzle line)
- Temperature Monitor
- pH Probe
- Humidity Sensor
- Vibration/Acoustic Monitors

Wet Scrubbers
SOx Regulations

- Federal Laws (EPA)
  - The level of the annual standard is 0.030 parts per million (ppm), not to be exceeded in a calendar year.
  - The level of the 24-hour standard is 0.14 parts per million (ppm), not to be exceeded more than once per calendar year.
Obstacles and Resolutions

• Initial Organization
  – Team Leader

• Contacts
  – Aggressive Calling/Other Sources

• Ethical Issues
  – Ethics Discussion

• Lack of Information
  – Documentation and Teamwork
Problem Solving Techniques

- Background information
- Review
- Interviews/First-Hand Experience
- Review and Analysis
- Filling in the Gaps
Conclusions and Achievements

- Failure Indication Charts
- Contacts Lists
- Instrumentation Varies
- Electrostatic Precipitators
- Baghouses
- Selective Catalytic Reducers
- Wet Scrubbers
- Other Control Techniques Used
Recommendations

- Power Plants  
  “Inundated with Information”
- SmartSignal Technology
- Improve Power Plant Maintenance
- Save Industry Money
Acknowledgments

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Professor Noll
Questions