



**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



# 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



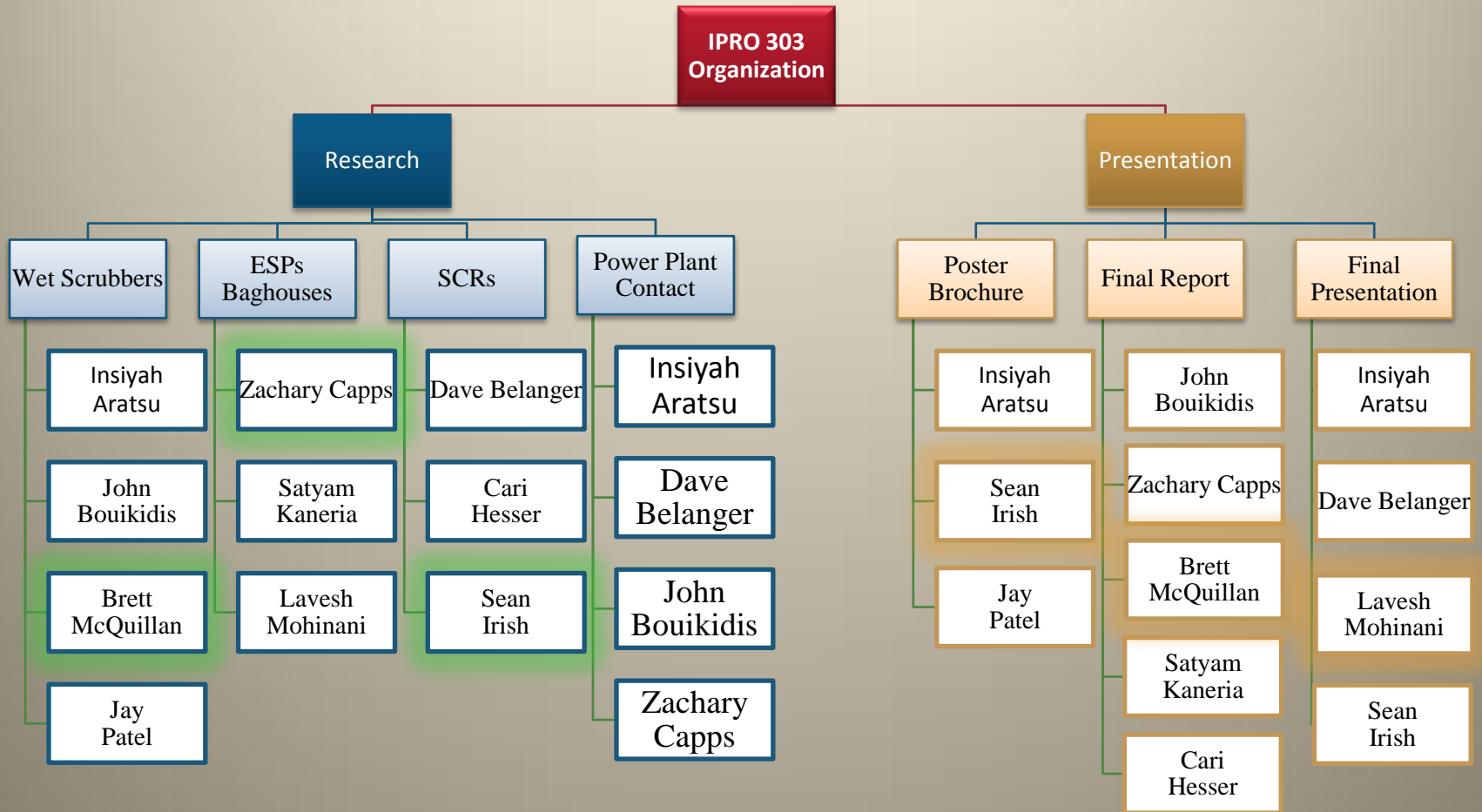


# Team Development

- Group Consensus
- Volunteer
- Subgroups
- Team Leader

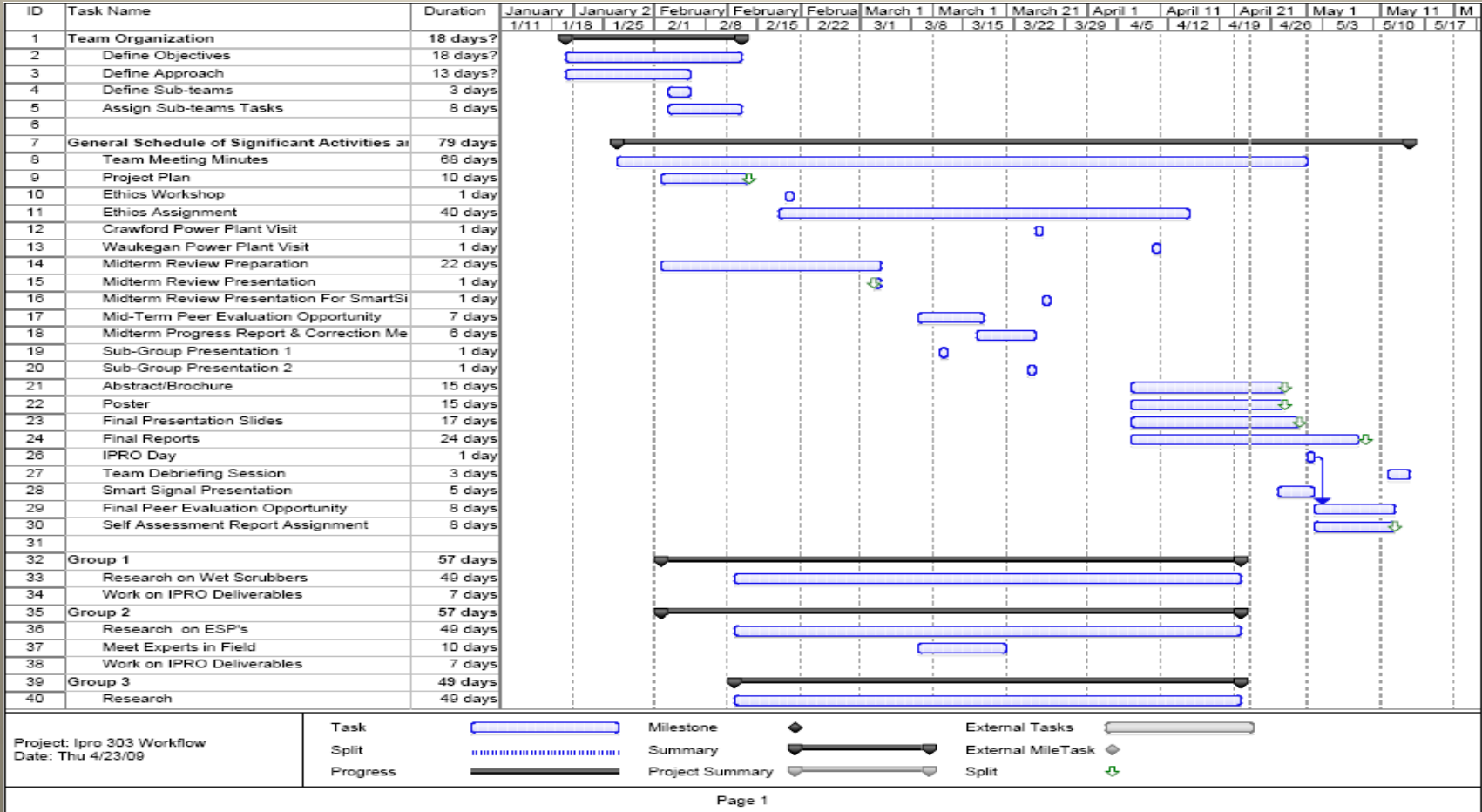


# Team Structure





# Gantt Chart



# Results

Electrostatic Precipitators

Baghouses

Selective Catalytic Reducers

Wet-Scrubbers

Overview

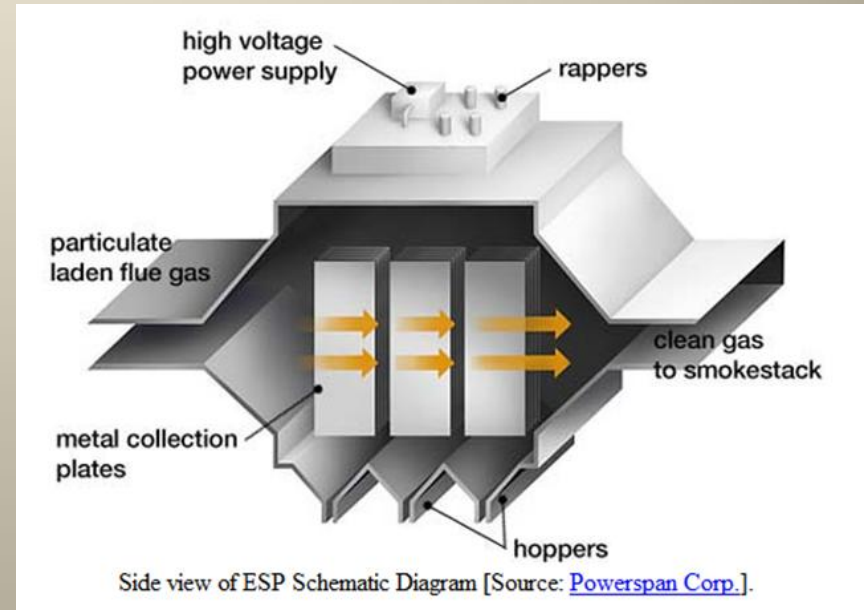
Instrumentation and Failures

Regulations



# Electrostatic Precipitators Overview

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



Results

# 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



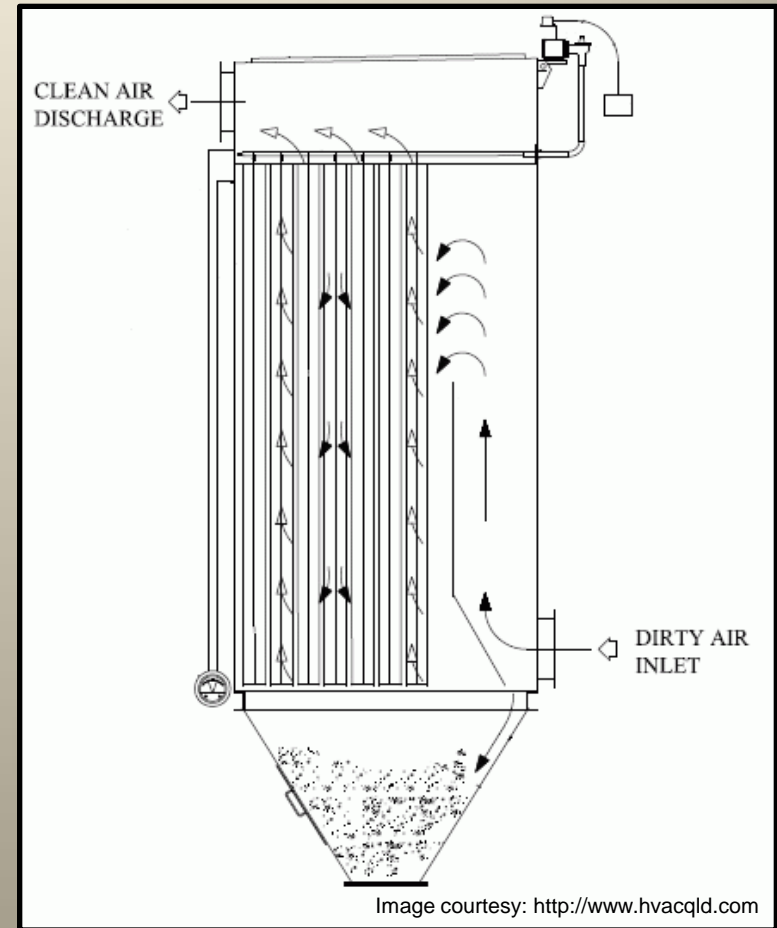
# Regulations

- 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





# Instrumentation & Failures

- Pressure Drop
- Fire
- Exiting air too opaque



Baghouses



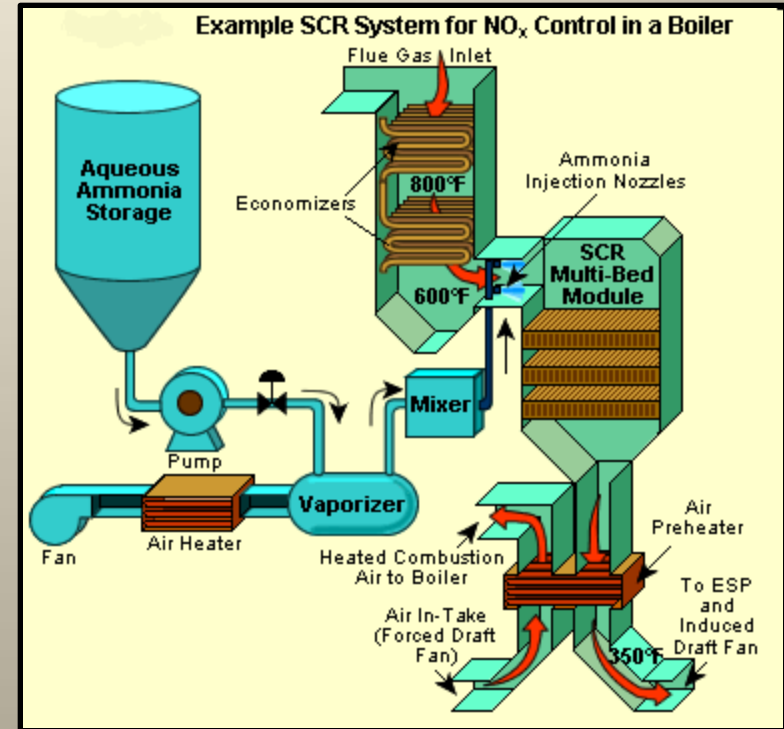
# Regulations

- 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](http://en.wikipedia.org/wiki/Selective_catalytic_reduction)

# Instrumentation and Failures

- Instrumentation
  - Temperature
  - Ammonia Slip



[www.cpsc.gov](http://www.cpsc.gov)



[www.sensidyne.com](http://www.sensidyne.com)

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

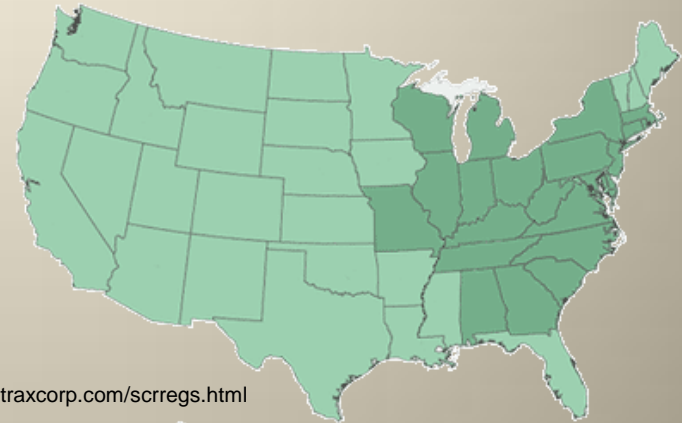


<http://fossil.energy.gov/programs/powersystems/p>

Selective Catalytic Reducers

# NOx Regulations

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



<http://www.traxcorp.com/scregs.html>

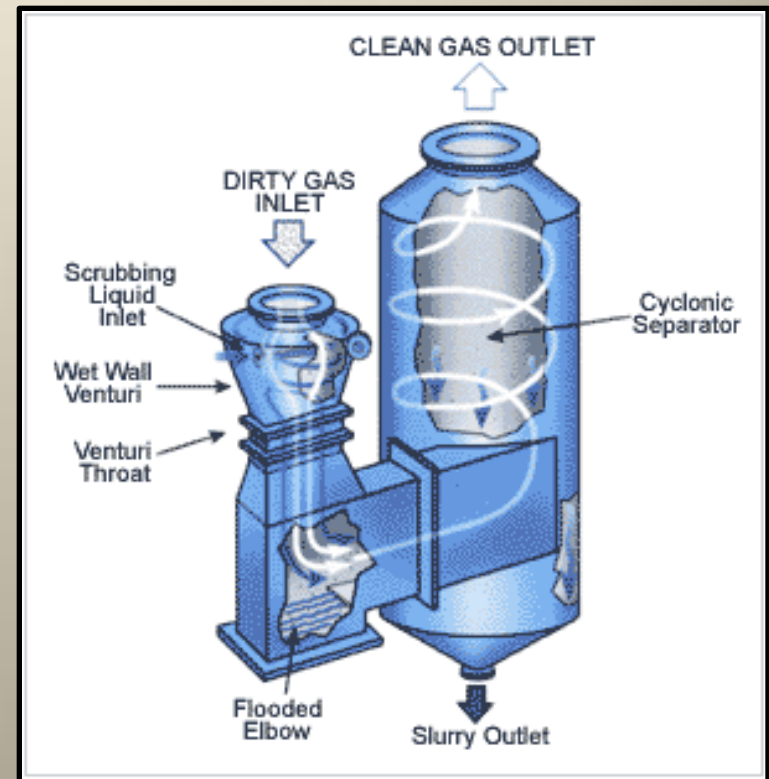
	Phase I NOx emissions (lbs/MMBtu) Effective January 1, 1996	Phase II NOx emissions (lbs/MMBtu) Effective January 1, 1996
Dry-Bottom Wall-Fired	0.5	0.46
Tangentially Fired	0.45	0.4
Wet-Bottom Wall-Fired	Not Applicable	0.84
Cyclone-Fired	NA	0.86
Vertically Fired	NA	0.8
Cell Burner	NA	0.68

Selective Catalytic Reducers



# Wet Scrubbers Overview

- Pollution Control Technology
  - Removes SO<sub>x</sub>, 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



# 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.



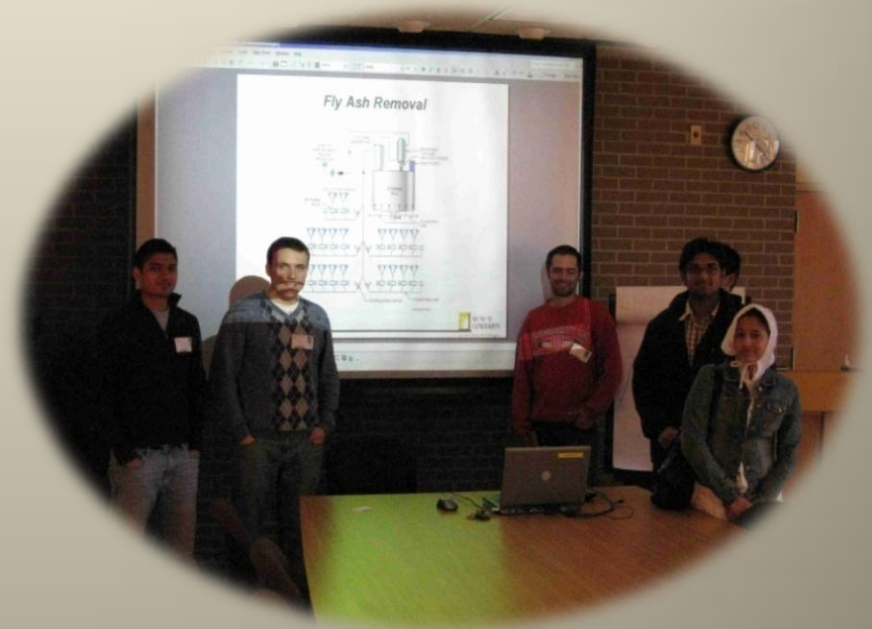
# Obstacles and Resolutions

- 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



Obstacles and Resolutions



# 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

