Reduction of Water Use in Wet FGD Systems

Project Kickoff Meeting
Mercury Research Center
Plant Crist
Pensacola, FL
September 21, 2006

NETL Project DE-FC26-06NT42689
COR: Sara Pletcher

Agenda

- 8:00 am Introductions
- 8:15 am NETL Program Overview and Objectives- Sara Pletcher
- 8:30 am Project Overview and Objectives- Milton Owen
- 8:45 am Test Plan Review- David Rencher
- 9:45 am Break
- 10:00 am MRC Tour- SRI
- Noon Lunch
- 1:00 pm Discussion- Keys to a Successful Project- All
- 1:30 pm Future Activities and Action Items- Milton Owen
- 2:00 pm Adjourn

Project Overview and Objectives

- **Project Goal** – Demonstrate the use of heat exchange to reduce flue gas temperature and evaporative water consumption in wet FGD systems. Additional potential benefits for new and retrofit applications:
  - Improve ESP performance: reduced gas volume & improved ash resistivity
  - Reduced gas volume results in smaller FGD system and stack requirements
  - Control SO_3 emissions through condensation on ash
  - Avoid need to install wet stacks or provide flue gas reheat
  - Potential to use recovered heat to increase turbine output (alternative)
  - Potential to increase Hg removal across ESP and FGD system
- **Technical Approach** – Conduct pilot scale tests of integrated air pollution control (APC) system, determine heat exchanger corrosion rates in long-term tests, and assess benefits and costs.
- **Expected Benefits** – Reduced FGD system water consumption, improved APC performance, and reduced capital and O&M costs.

Project Schedule

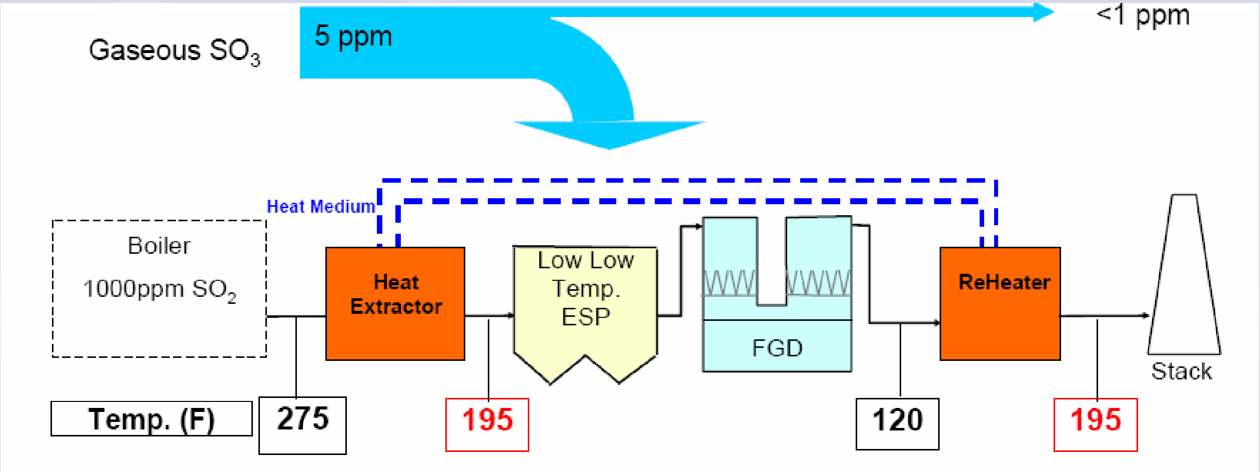
Task	Schedule
1- Project Planning	July-September, 2006
2- Pilot Plant Assembly	October 2006- July 2007
3- Integrated Pilot Tests	August 2007- November 2007
4- Corrosion Tests	December 2007- May 2008
5- Cost/Benefit Analysis	February 2008-August 2008
6- Management and Reporting	July 2006- August 2008

Test Plan Review

David M. Rencher, URS Corporation

Effects of Lower Flue Gas Temperature

- Regenerative heat exchange used in Europe and Japan
- Mitsubishi Heavy Industry (MHI) High Efficiency System in Japan (US Patents 5282429 & 6149713)



Effects of Lower Flue Gas Temperature- Continued

- Potential benefits
  - Lower water consumption in FGD system
  - Control of SO_3 by condensation on ash
  - Improved particulate control by ESP due to reduced gas volume and lower ash resistivity
  - Avoided costs for flue gas reheat or wet stacks
  - Potential reduction in native Hg removal in ESP
- Not demonstrated commercially in US
  - Concerns on cost effectiveness, and
  - Potential increased corrosion rates

Effects of Lower Flue Gas Temperature- Continued

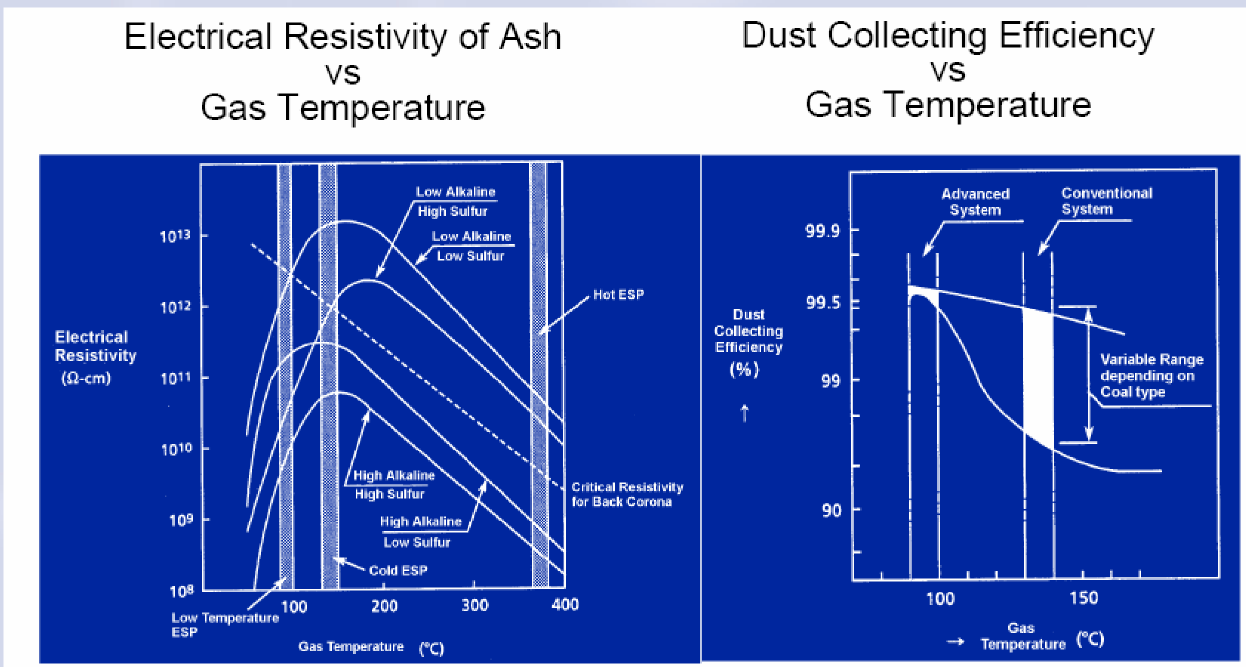
- Minimum flue gas temperature ~120^{o}F (FGD outlet) eliminates water evaporation
- Practical limit to reduction of FGD evaporation
  - ESP performance (re-entrainment)
  - Cost of regenerative heat exchanger
    - Materials of construction (carbon steel)
    - Larger size required to lower temperature
- May limit flue gas temperature reduction to ~200^{o}F or reduce water consumption by half
- Trade-offs will be investigated in this project

Effects of Lower Flue Gas Temperature- Continued

- Condensation of SO_3 on fly ash
  - Avoid opacity problems
  - Reduce SO_3 without additives or stand-alone controls
  - Inhibit corrosion rates in SO_3 dew point environment
  - Carbon steel heat bundle can be used
- Corrosion tests to be conducted in pilot program to collect corrosion data

Effects of Lower Flue Gas Temperature- Continued

- Improved ESP performance at lower temperature
  - Lower gas velocity and higher specific collection area
  - Lower fly ash resistivity



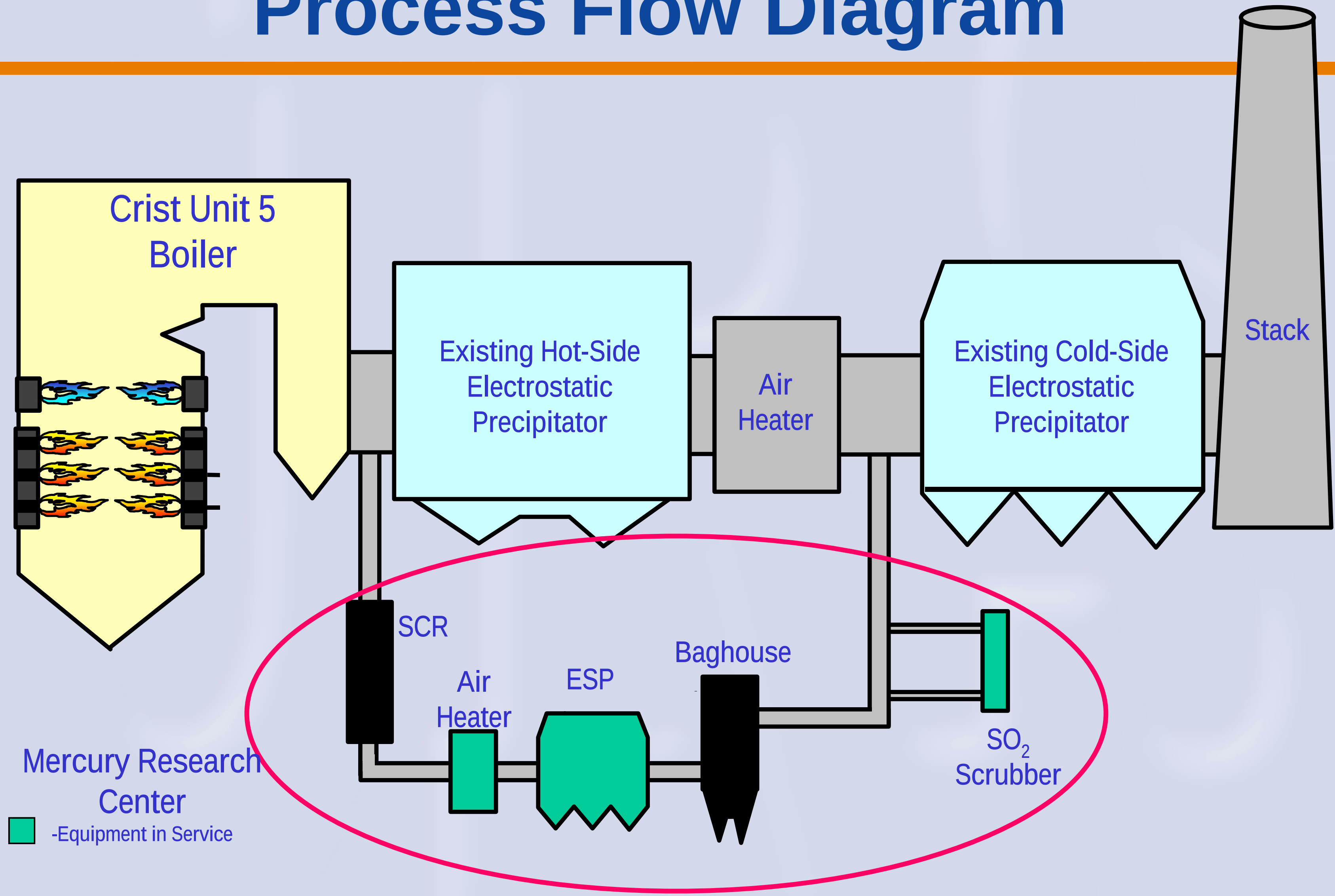
Effects of Lower Flue Gas Temperature- Continued

- Theoretical ESP performance
  - Particulate collection could improve in retrofit applications
  - Greatest benefit could be for low-sulfur coals which typically have higher resistivity ash
- Non-ideal ESP Performance (Cannot be modeled)
  - Re-entrainment of fly ash at lower resistivity
    - Flue gas flow “scrubbing” collected particles from plates
    - Re-entrainment during rapping
    - Ash resistivity below “ideal” range

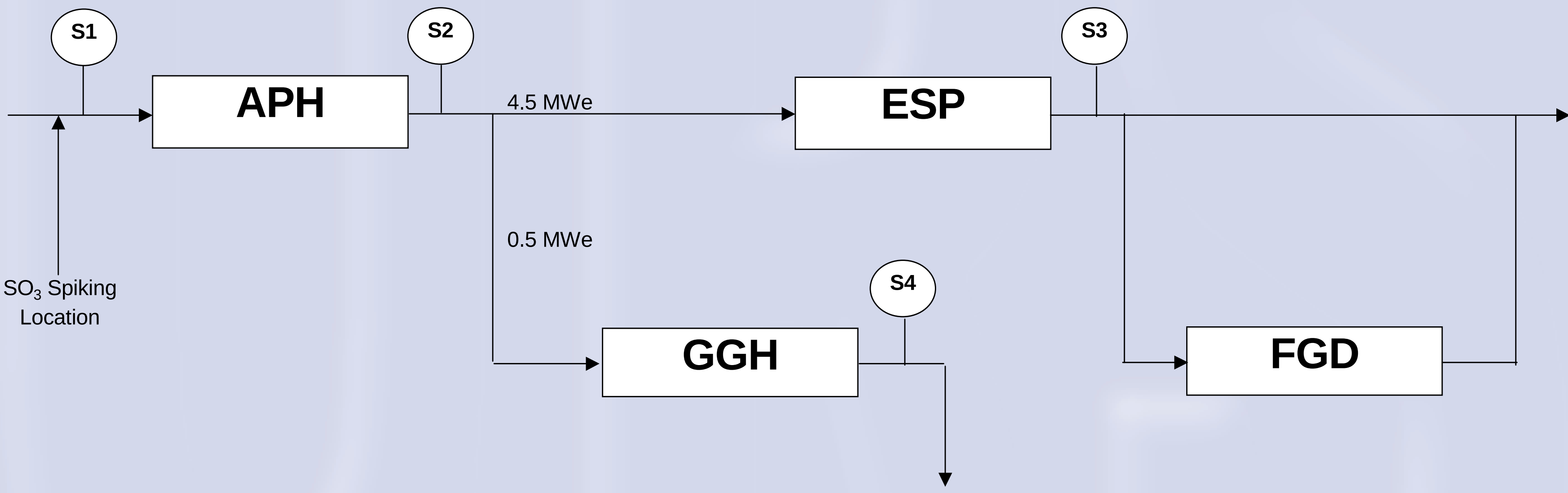
Project Technical Approach

- Pilot Testing to be conducted at Southern Company's Mercury Research Center (MRC)
  - Located at Gulf Power's Plant Crist near Pensacola, FL
  - Operated by SRI
- MRC processes flue gas slipstream from Unit 5
  - Firing low-sulfur Columbian coal
  - Flue gas flow rate 50,500 lb/hr (5-MW)
  - Ljungstrom air heater
  - Four-field ESP
  - Wet FGD
  - Capability to Inject SO_3 (simulate high-sulfur operation)
- Construct smaller skid-mounted heat exchanger for long-term corrosion tests

Mercury Research Center Process Flow Diagram



Pilot Tests Set-Up



Pilot Tests Set-Up (Cont)

- Measurements across the ESP (S2 vs S3):
  - Change in resistivity and ESP performance due to SO_3 condensation on the fly ash
  - Important mercury information
- Measurements across the GGH (S2 vs S4):
  - SO_3 condensation as a function of temperature
  - Provides dust to sulfur (D/S) ratio vs SO_3 to evaluate effectiveness of SO_3 capture on ash
  - Demonstrates corrosion control

Parametric Considerations

- SO_3 can cause corrosion, particularly at low temperatures
- SO_3 can pass through scrubbers and increase a plant's opacity
- Reducing SO_3 is challenging

Assess the impact of cooling the flue gas by the regenerative heat exchanger on SO_3 removal at different SO_3 concentrations anticipated to be encountered at plants firing higher sulfur coals or equipped with SCR units.

Parametric Considerations (Cont)

Sulfur

- Low sulfur coal, no SCR (<5 ppm)
- Low sulfur coal, with SCR (~10 ppm)
- High sulfur coal, no SCR (~25 ppm)
- High sulfur coal, with SCR (~50 ppm)

Represents the range of typical SO_3 concentrations

Parametric Considerations (Cont.)

Temperature

- 320°F: Typical baseline operation of the ESP and FGD
- 260°F: Dew point of SO_3, still reduce water evaporation but without SO_3 deposit on the ash or equipment
- 190°F: Anticipated minimum temperature to avoid corrosion in Hx. Water evaporation in the FGD is reduced ~50% at this temperature

Assess the impact of various reductions in flue gas temperature on water evaporation rates in the FGD system, ESP performance for particulate removal, and Hg reduction across the ESP and FGD systems

Integrated Pilot Tests

- Baseline test
  - Most typical flue gas conditions
  - Low sulfur coal with no SCR
  - 320°F at APH Outlet
  - 190°F at GGH Outlet
  - Full data collection

Integrated Pilot Tests (Cont)

Parametric Test	APH Outlet	GGH Outlet	Coal / Plant	Data Points
Test 2	•320˚F	•190˚F	Low Sulfur, with SCR	S1, S2, S3, S4
Test 3			High Sulfur, no SCR	
Test 4			High Sulfur, with SCR	
Test 5	•320˚F	•260˚F	Low Sulfur, no SCR	S1, S2, S3, S4
Test 6			Low Sulfur, with SCR	
Test 7			High Sulfur, no SCR	
Test 8			High Sulfur, with SCR	
Test 9	•260˚F	Bypassed	Low Sulfur, no SCR	S1, S2, S3
Test 10			Low Sulfur, with SCR	
Test 11			High Sulfur, no SCR	
Test 12			High Sulfur, with SCR	
Test 13	•190˚F	Bypassed	Low Sulfur, no SCR	S1, S2, S3
Test 14			Low Sulfur, with SCR	
Test 15			High Sulfur, no SCR	
Test 16			High Sulfur, with SCR	

Corrosion Tests

- Small pilot heat exchanger- carbon steel
- Long-term test- 6 months
- Select test conditions from Integrated Tests
- Determine if corrosion rates are excessive at low flue gas temperatures
- Collect data on corrosion rates and SO_3 levels

Pilot Measurements

Location	Samples Collected
S1 – AH Inlet	SO3 (CCS)
S2 – ESP Inlet / GGH Inlet	SO3 (CCS) Particulate (M17) Total Hg (Carbon Tubes) (Baseline & Steady State ONLY) Speciated Hg (Using MRC Monitor)
S3 – ESP Outlet	SO3 (CCS) Particulate (M17) Total Hg (Carbon Tubes) (Baseline & Steady State ONLY) Speciated Hg (Using MRC Monitor)
S4 – GGH Outlet	SO3 (CCS) Particulate (M17) Ash Resistivity Hg (Only if Budget Available or MRC Could Provide Monitor)
Coal	LOI Ultimate/Proximate (Baseline and Steady State) Total Hg (Baseline and Steady State Only)
ESP Hopper	Resistivity (If Needed) LOI Total Hg (Baseline and Steady State Only)
FGD	Monitor Water Rates and Evaporation Hg in FGD Solids (Baseline and Steady State Only) Hg in FGD Liquors (Baseline and Steady State Only) Wt% Solids (Baseline and Steady State Only)

Assess the Benefits

- Reductions in evaporative water loss from the FGD system
- Commercial alternatives for regenerative heat exchangers
- Additional particulate removal from the ESP
- Potential to eliminate costs to reheat flue gas or a wet stack in retrofit situations
- Impacts of regenerative heat exchange on Hg control