2013 Dry Scrubber Users Association

Scrubber Optimization Project Principles, Actions and Results

Logan Generating Plant
Swedesboro, NJ

John Kersch, PE
Maintenance Manager
Commercial Operation – September 1994

- 245 MW Westinghouse Turbine
- Foster Wheeler Boiler burning Pulverized Coal
- ABB supplied scrubber, extensively modified by owner since startup
- Original design <1.5% sulfur, present operation at 2.0% with successful tests at 2.5%
- Permitted SO2 emission: 3 hour avg. = 75 ppm, 30 day average = 61 ppm.
Current operation is mostly up/down on load with frequent transient conditions
• Calcium to Sulfur Ratio in 2012 was 1.23, better than average for dry scrubbers…

STOICHIOMETRIC PERFORMANCE OF SEMI-DRY FGD SYSTEMS AT U.S. COAL FIRED FACILITIES
SOURCE: EIA-767 & OWNER PROVIDED DATA

STOICHIOMETRIC CaO / S RATIO (CaO moles / Coal S moles)
Joint Venture Optimization (JVO) Project

Agreement signed April, 2012

**Purpose:** Optimize Scrubber Performance

**Goals:**

- Reduce Ca/S Ratio from 1.23 to 1.00
- Reduce combined expenditure for lime supply and flyash disposal by $1.00 / ton of coal, approximately equal to $0.50 / MW-hr
- At 50% capacity factor, projected operating cost savings = $400,000 per year
Both Parties Bring Value to the Table

NAES/PPMS
- The Opportunity
- O & M Capability
- Inside Knowledge
- Planning/Engineering
- Capital

PRIMEX
- Opportunity Identification
- Proprietary Technology
- Outside Knowledge
- Planning/Engineering
- Capital

$$
1. FGD Performance Optimization Training

Goal: Discuss goals, plan and expected results with all Ops personnel. Completed May 2012
2. Improve SDA Outlet Temperature Stability

August 2011, Std. Dev. = 8 °F

Gas Path Changes

August 2012, Std. Dev. = 1 °F
2. Improve SDA Outlet Temperature Stability
   - Modified Thermocouple/Logic changes/Tuning
3. Improve SO2 Control and Optimize Setpoint

**JULY 2011**
- **Setpoint**: 60 PPM
- **Actual AVG**: 52 PPM
- **Permit Limit**: 75 PPM

**OCTOBER 2012**
- **Setpoint**: 65 PPM
- **Actual AVG**: 64 PPM
- **Permit Limit**: 75 PPM
4. Measure & Control Approach Temperature

Joint Venture Optimization
Actions & Results

LOGAN GENERATING PLANT

INLET FLUE GAS

SPRAY DRY ABSORBER

SPRAY DRY ABSORBER

BAGHOUSE

ID FAN

FLYASH

STACK

CLEAN FLUE GAS

CORROSION COUPON

Corrosion Coupon
LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

Logan Generating Plant

<table>
<thead>
<tr>
<th>Location</th>
<th>2-Aug-12</th>
<th>14-Aug-12</th>
<th>2-Oct-12</th>
<th>16-Nov-12</th>
<th>17-Dec-12</th>
<th>26-Dec-12</th>
<th>5-Feb-13</th>
<th>5-Apr-13</th>
<th>26-Jun-13</th>
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<td>4.4</td>
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<td>Baghouse- B, Top</td>
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<tr>
<td>Baghouse- B, Bottom</td>
<td>5.0</td>
<td>11.0</td>
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<tr>
<td>Baghouse- M Top</td>
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<td>6.5</td>
<td>2.3</td>
<td>0.7</td>
<td>3.5</td>
<td>4.4</td>
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<td>Baghouse - M Bottom</td>
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<td>0.3</td>
<td>0.2</td>
<td>0.7</td>
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<td>Baghouse Outlet</td>
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<td>3.7</td>
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<td>6.7</td>
<td>13.1</td>
<td>5.8</td>
<td>16.7</td>
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**FGD SYSTEM CORROSION COUPON ANALYSIS RESULTS**

Average Corrosion (mils/yr): 7.5, 9.0, 16.3, 2.7, 2.1, 1.6, 3.7, 2.8, 10.0

3 Period Weighted Moving Avg. (mils/yr): 10.6, 9.4, 8.6, 8.4, 7.8, 7.1, 7.4

| CI from Coal (lb/hr)      | 55       | 57       | 58       | 61       | 54       | 65       | 55       | 56       | 60       |
| CI from Brine (lb/hr)     | 47       | 49       | 54       | 43       | 43       | 44       | 44       | 41       | 51       |
| Total CI in (lb/hr)       | 103      | 106      | 111      | 104      | 97       | 109      | 99       | 97       | 111      |
| Total CI in (lb/ton coal) | 2.6      | 2.6      | 2.7      | 2.4      | 2.5      | 2.4      | 2.5      | 2.4      | 2.6      |
| Average Approach Temp (F) | 49       | 48       | 53       | 57       | 48       | 44       | 43       | 40       | 37       |
| Approx. Cap. Factor (%)   | 43       | 45       | 45       | 48       | 42       | 51       | 43       | 44       | 47       |

**Legend**

<table>
<thead>
<tr>
<th>Color Legend</th>
<th>% Rank</th>
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<tr>
<td>1.0</td>
<td>66%</td>
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<tr>
<td>2.0</td>
<td>80%</td>
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<tr>
<td>4.0</td>
<td>90%</td>
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<tr>
<td>6.0</td>
<td>93%</td>
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</table>
LOGAN GENERATING PLANT

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Actions & Results

Graph: FGD System Coupon Corrosion vs. Chlorine Input from Brine

- Average Corrosion (mils/yr)
- Cl from Brine (lb/hr)

Timeline: 2-Aug-12 to 26-Jun-13

Graph shows the correlation between FGD system coupon corrosion and chlorine input from brine over a period from August 2012 to June 2013.
4. Measure & Control Approach Temperature

- SDA Outlet Dewpoint Temperature Transmitter (Patent Pending)
- Corrosion Coupon
- Clean Flue Gas
- Inlet Flue Gas
- Spray Dry Absorber
- Baghouse
- ID Fan
- Stack
- Humidity Analyzer
- HE-V5 Harsh Environment Humidity Analyzer
4. Measure & Control Approach Temperature

TYPICAL TRANSIENT LOAD PROFILE
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4. Measure & Control Approach Temperature

DEWPOINT VARIES CONTINUOUSLY 5-20 °F
4. Measure & Control Approach Temperature

INDIVIDUAL SDA OUTLET DEWPOINTS VARY DIFFERENTLY

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4. Measure & Control Approach Temperature

BEFORE: APPROACH TEMP VARIES HOURLY 5-20 °F
4. Measure & Control Approach Temperature

AFTER: APPROACH TEMP CONSTANT +/- 1°F PRECISION
5. Reduce Ambient Air Inleakage

Cold Air Inlet Issues:
- Corrosion
- Condensation + Ash + Lime = Cement
- Temp & Humidity Interference
- $O_2$ Raises corrected $SO_2$ Emission
5. Reduce Ambient Air Inleakage
5. Reduce Ambient Air Inleakage

Cold Air Inlet Issues:
- Corrosion
- Condensation + Ash + Lime = Cement
- Temp & Humidity Interference
- $O_2$ Raises corrected SO$_2$ Emission

21% $O_2$ 20-80 °F
5. Reduce Ambient Air Inleakage

Cold Air Inlet Issues:
- Corrosion
- Condensation + Ash + Lime = Cement
- Temp & Humidity Interference
- $O_2$ Raises corrected $SO_2$ Emission

FLUE GAS RECIRCULATION SYSTEM
U.S. Patent No. 8,329,125
5. Reduce Ambient Air Inleakage
- Flue Gas Recirculation Duct
5. Reduce Ambient Air Inleakage

- Flue Gas Recirculation Duct
6. Optimize Performance (Ongoing 3 yrs)

$\text{COST} = \text{CORROSION COST} + \text{LIME + FLYASH COST}$

- **Too low**
- **Optimum**
- **Too high**

Approach Temp

Combined Cost
# Dec 2012 Performance Test Results

<table>
<thead>
<tr>
<th></th>
<th>BASELINE - ACTUAL 2012</th>
<th>PROJECTED FOLA (AFTER JVO)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Mini load</td>
<td>Full Load</td>
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<tr>
<td>Coal in (2012 tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>226632</td>
<td>90426</td>
<td>317057</td>
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<tr>
<td>Coal Sulfur (%)</td>
<td>1.18</td>
<td>1.18</td>
</tr>
<tr>
<td>Sulfur in (tons)</td>
<td>2674</td>
<td>1067</td>
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<tr>
<td>Approach Temp (F)</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>SO2 Emission Limit (ppm)</td>
<td>75</td>
<td>75</td>
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<tr>
<td>Ca/S Ratio</td>
<td>1.23</td>
<td>1.23</td>
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<tr>
<td>Lime in (tons)</td>
<td>6254</td>
<td>2495</td>
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<tr>
<td>FGD Byproduct (tons)</td>
<td>15635</td>
<td>6238</td>
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<tr>
<td>Lime Cost ($/ton)</td>
<td>$147</td>
<td>$147</td>
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<tr>
<td>Lime Spend (k$/yr)</td>
<td>$919</td>
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<td>Flyash Disp. Cost ($/ton)</td>
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<td>FGD Byproduct Disp. Spend (k$/yr)</td>
<td>$516</td>
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<td>TOTAL SPEND (k$/yr)</td>
<td>$1,435</td>
<td>$573</td>
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<tr>
<td>FGD Cost ($/ton coal)</td>
<td>$6.33</td>
<td>$6.33</td>
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**Joint Venture Optimization**

**Actions & Results**

**25% REDUCTION**  
**$492k/yr SAVINGS AT 40% C.F.**

**$1.55 / TON REDUCTION**

ALL GOOD – PROVIDED THAT INCREMENTAL CORROSION IS LESS THAN $492,000 /YEAR
But wait, there’s more:

- **December 2012:** Mandatory reduction of SO2 emission limits take effect per NJDEP RACT. The limiting parameter decreases from 75 ppm to 61 ppm.

- **January 2013:** New coal supplier, % sulfur increases from 1.2% to 2.0%, with potential up to 2.5% in 2013.

- The plant was designed and permitted for a maximum of 1.5% Sulfur. To change the permit, NJDEP required compliance to be demonstrated at full load at 2.0% and 2.5 % sulfur

- The highest sulfur reported by any U.S. dry scrubber was 2.1%. Some said 2.5% couldn’t be done....
....however:

- On February 11, 2013 Logan successfully achieved full load operation (237 MW gross) with 2.54% coal in compliance with permitted emission limits on a limited test basis.
Logan Generating Plant

Operational Issues

- Running both Slakers to meet 2.5% sulfur scrubbing demands
- Running multiple Filtered Water pumps to meet capacity for slaking
- Needed larger capacity slaking water heater for winter operation and increased slaking water flow
- Temporary modifications to Recycle Ash system to replace brine water with lime slurry
- Flyash disposal – volume and moisture %
- Extended run times on 2.5% sulfur coal at full load (Only three 2 hour tests completed)
LOGAN GENERATING PLANT

BAILEY COAL TEST RESULTS DEC 18-22, 2012

CALCIUM TO SULFUR RATIO AT VARIOUS OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>SO2 SETPOINT (PPM)</th>
<th>50</th>
<th>60</th>
<th>50</th>
<th>60</th>
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<tbody>
<tr>
<td>AP. TEMP SETPOINT (F)</td>
<td>40</td>
<td>45</td>
<td>40</td>
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<tr>
<td>UNIT LOAD</td>
<td>Mini Load</td>
<td>Full Load</td>
<td></td>
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EFFECT OF AP. TEMP AT CONSTANT SO2 EMISSION
EFFECT OF SO2 EMISSION AT CONSTANT AP. TEMP
Logan Generating Plant

**Ca/S Ratio Target**

- **Full load**
- **Mini Load**

Coal % Sulfur

0.8% to 2.5%
2013 Performance

- Capacity Factor – 32%
- Calcium/Sulfur Ratio – 1.28%
- Average Sulfur – 1.76%
- Operating Savings through 2Q - $174,000
- Scrubber Operating at 35F Approach Temperature and a 60 ppm set point for SO2
Senior Management Sponsorship (NAES/PPMS)

Shared Risk / Shared Reward – All Parties

Clear, measurable goals

Everybody on board from Day 1 (training) with opportunities to contribute

Team Leader – Inside, Authorized & Available

New Technology – FGR and HE-V5
Questions?