From Worst ESP to Best

Santee Cooper Winyah Station
Unit # 3 ESP Upgrade 2011

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Clyde Bergemann Power Group
Santee Cooper Winyah Unit 3
Precipitator From “Worst to Best”

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WINYAH UNIT 3 POLLUTION CONTROL EQUIPMENT
FLOW DIAGRAM

Coal Input

BOILER

Bottom Ash Removal

Fluegas Flow

SCR

NO\textsubscript{x} Removal

Fluegas Flow

ESP

Flyash Removal

Fluegas Flow

Wet FGD

SO\textsubscript{2} Removal

< 0.03 lbs/MBTU Particulate

< 20% OPACITY
## Winyah 3 Precipitator, Existing Configuration

<table>
<thead>
<tr>
<th>TR Sets</th>
<th>Wire Rappers</th>
<th>Plate Rappers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="TR Sets" /></td>
<td><img src="image2" alt="Wire Rappers" /></td>
<td><img src="image3" alt="Plate Rappers" /></td>
</tr>
</tbody>
</table>

### NOTES:

1. NO. OF PLATES = 576
2. SIZE OF PLATES = 30 FT x 9 FT.
3. SPACING OF PLATES = 9 IN.
4. TYPE OF DISCHARGE ELECTRODES: WIRES
5. NO. OF DE’S = 6720
6. VOLTAGE OF DE’S = 45 KV
7. NO. OF T/R SETS = 8
8. MECHANICAL SECTIONS = 16 (4 WIDE x 4 DEEP)
9. ELECTRICAL SECTIONS = 8 (2 WIDE x 4 DEEP)
10. NO. OF PLATE RAPPERS = 128
11. NO. OF DE RAPPERS = 36
12. NO. OF PERF PLATE RAPPERS = 8

### Gas Flow Arrow:

- Upward arrow indicating the direction of gas flow through the precipitator.
176 Plate Rappers
48 DE Rappers
83 kV DE Voltage

336 Collecting Plates
1920 RDE
15.75” Plate Spacing
Design Comparison

Original Internal Design

New Upgraded Internal Design
16 inch plate spacing and direct rapped collecting plates
Customized Rigitrodes

| STAGGERED PIN ARRANGEMENT | OPPOSED PIN ARRANGEMENT |

- PIN LENGTH
- DIRECTION
- TUBE DIAMETER
• Electric Single Impulse (ESI) Rapper
  – Gravity Impact Type
  – One Piece Construction
  – Stainless inserts
  – Fully Adjustable
  – Intensity
  – Cycle time
  – Up to 20 ft. lbs.
  – Multiple Rap
NWL Rapper Panel
NWL Power Plus High Frequency Switch Mode Power Supplies
NWL Power Plus

[Graph showing voltage (kV) over time (ms) comparing Conventional T/R and PowerPlus]

- Conventional T/R
- PowerPlus
NWL PCAMS remote work station
1980 Original Air Flow Design

Baseline Results
Side View: TP21

Airflow Sciences Corporation
Final Design Results
Side View: TP21

Velocity Magnitude (ft/s)
0.00 1.80 3.60 5.40 7.20 > 9.00
Pre Assembled Penthouse
First Day of the Outage
Demolition of Penthouse
Demolition Continues
Demolition of hot roof
Demolition Nearly Complete
Day 8 Water Wash Casing Start Modifications for New Internals
3 Support Girders were found to be corroded and were replaced.
New collecting and discharge electrode and one of three new girders
Modifications completed new collecting plates being installed
Discharge electrodes being installed and final Quality Inspections of the pins
New collecting plates nearly complete and hot roof on one chamber.
Model study results being installed
Penthouse section being lifted into place
Penthouse Completed
Completed rebuild 5 days ahead of schedule
## Precipitator Test Results

<table>
<thead>
<tr>
<th>YEAR TESTED</th>
<th>PARTICULATE RESULTS (Lbs/MBTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0.045*</td>
</tr>
<tr>
<td>2007</td>
<td>0.058*</td>
</tr>
<tr>
<td>2008</td>
<td>0.012*</td>
</tr>
<tr>
<td>2009</td>
<td>0.025*</td>
</tr>
<tr>
<td>Post Outage Performance 2011</td>
<td>0.023**</td>
</tr>
</tbody>
</table>

* - Indicates test samples taken from Stack CEMS level which receives additional PM removal by Wet FGD.
** - Indicates test samples taken from outlet of ESP.

Permit Limit = 0.100 Lbs/MBTU
2013 CD Limit = 0.030 Lbs/MBTU
Conclusions

- Performance guarantee for particulate was achieved
- Installation was completed 5 days ahead of schedule
- Total Organic Compounds (TOC) levels for gypsum quality are the lowest of all the units on the site. Previously, to the rebuild at times it was not in acceptable ranges which is above 1250 ppm. The new TOC levels since the rebuild average 300 ppm. This indicates that a very high percentage of carbon is being removed as well as other particulate.
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