So... You're Going to Perform a Stack Test

WRBA Annual Meeting March 10-12, 2015

Bob Morrow – Detroit Stoker Co.
• Established 1898 – Monroe, Michigan USA
  – Solid Fuel Combustion Systems
  – Solid Fuel Feeding/Metering Systems
  – Rotary Seal Feeders/Double Flap Airlocks
  – Low NOx Gas/Oil Burners
  – Aftermarket Parts & Services
  – Engineering Studies
Preparing For A Stack Test
Preparation – Before Hand

- Boiler Drawings & Design Data Sheets
  - Equipment Conditions
- Reports (Inspection & Operational)
- Fuel Analysis
- Permit Requirements and Reports
- Controls & Data Acquisition
Avoiding Surprises

What's Are Those???
Getting Started

• Current Boiler Load and Steam Load Conditions
  – MCR or less?
  – Grate conditions & Fuel Distribution
  – Excess Oxygen
  – Secondary air conditions
  – Boiler design conditions
    • Temperatures, draft, pressure drops

• Auxiliaries
  – Post combustion SNCR, SCR, Bag Houses, ESP

• CEMS
January 2015 Example

- 1987 - 174 KPPH Steam flow (MCR)
- Spreader Type Traveling Grate System
- Hogged wood and sludge
- ESP, Economizer
- Air heater – Steam Coil @ F.D. fan Discharge
- OFA, Primary air, Distribution air & Reinjection air are all preheated
- Two rear wall gas burners
- OFA modified in 2006
Establish baseline data
Determine capabilities of existing equipment
Determine and prioritize steps to be taken both short term (2015) and long term (2016) and beyond

Government requires equivalent of Boiler MACT tune up along with reduced Emissions

<table>
<thead>
<tr>
<th>Emission</th>
<th>Current values</th>
<th>2016 Required Values</th>
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<tbody>
<tr>
<td>CO lbs/MMBtu</td>
<td>0.243</td>
<td>0.162 (200 ppm @3% O2)</td>
</tr>
<tr>
<td>NOx lbs/MMBtu</td>
<td>0.487</td>
<td>0.243</td>
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Viva La France
Preliminary Evaluation/Considerations

• Items of Interest
  – Operational Investigation/Audit
  – Combustion Tuning
    • Fuel Handling, Metering, Distribution
    • Tramp Air Leakage
    • Combustion Air(s)
Fuel and Handling

• Fuel type and mixture being fired
• Fuel preparation and sizing
  – Introduce sludge at metering bin
  – Shredder screens
• Fuel Quality
  – Ash and moisture
• Fuel Metering – Screw biases necessary?
• Fuel Mixing and Segregation
Fuel Type

Hogged/Chipped Wood Waste and Sludge

- 40 – 50% moisture Wood waste
- 2 TPH maximum input sludge
- >50% less than ¼” sizing
- 10% by heat input gas firing minimum at all times
Fuel Particle Size Distribution

**Detroit Stoker Company - Recommended Sizing For Wood Or Bark - For Spreader Stoker Firing**

Recommended sizing is indicated by the red line. Acceptable sizing is between the black lines. 100% should pass through a 6" [127mm] grid.

The below sizing are 3 dimensional sizes although 5% streamers or stringers up to 12" [305mm] long in one dimension is acceptable.

**Percent Through Sieve**

**Round Screen Mesh [Inches]**

**US Standard Sieve Designation**
Metering Bin Arrangement

Straight side and rear walls
Fuel Chute Arrangement

- Center line of Screws
- Steep angle pushes fuel to outside of distributor
- Short Vertical Drop
Recommendations for Fuel Chutes

12 - 16 ft recommended

ACCEPTABLE

NOT ACCEPTABLE
Recommendations for Fuel Chutes

ACCEPTABLE

12’, 0” MINIMUM

NOT ACCEPTABLE
Fuel Chute Examples

If you have to

Max. Recommended Chute Angle ≤15°
• Large single bin design
• Single screw feeding three (3) air swept spouts
• Short vertical drop into distributor (<10’)
• Steep angles to outside distributors off of metering bin
  – Pushes fuel to side walls without necessary vertical drop to disperse across width at distribution plate
Balanced Damper Modifications

Blow back damper that was added by plant. Restricts bark flow to 1 – 2” opening across chute.

Diverter plate added by plant to divert bark to center of Chute

Balance damper has been modified to remain 100% open
Fuel Distribution

• Plant operating with distribution pressures from 8” w.c. – 25” w.c. as found
  – Considered high given fuel and grate length
  – Operators fighting with piling and uneven distribution
  – Adjusted distribution to 5” w.c. to 12” w.c.
  – Continued fuel distribution to rear wall with substantial reduction in piling observed
Air Seals and Leaks

- Stoker to boiler air seals in disrepair
- Leakage around distributor openings and extension fronts
- Important to seal any sources of air in-leakage
• Originally commissioned wet bottom drag
• Been running dry to minimize moisture in ash for agricultural use of ash
• Substantial tramp air induction with negative draft
Burner Cooling Air Requirements

• Old vintage burner design
• Requires excessive cooling air
• No provision for throat gate
Burner Throat Gates

Burner Refractory Throat Shut-Off Gate Assembly:

- Minimizes Tramp/Excess Air in Furnace for Optimal Emissions when Auxiliary Burners Are Off
• 10” line off of FD duct
• Blows air across open space into burner fan inlet
• Intention to keep fan from icing over

Starves left hand side of grate and creates imbalance in combustion air
Cinder Reinjection System

- Air leakage above and below lines
- Excessive air for conveying re-injected material
Reinjection Air In-Leakage

- Slide gates in poor condition
- No rotary air locks on reinjection lines
- Tramp air leaks in reinjection box generate CO
Steam Coil Air Heater

- Typical fuel moisture of 45 – 50%
- Recommend 450 - 500°F preheated air
- Current SCAH limited to ≈400°F Max
- Steam leak detrimental to efficiency
Combustion Tuning

• Primary/Secondary Air Ratio
• Automatic Control
  • Found to be operating unit mostly in manual control
  • Controls system overview
• Excess air level
  • O2 Trim Adjustments
• Preliminary Emissions Baseline
Useful OFA Pressures

Initial Emissions and OFA Adjustments

- CO and NOx Emissions - ppm
- Time
- Initial Emissions and OFA Adjustments

Increased OFA Pressure from 3” w.c. to 5” w.c.
Impact of Reinjection on CO

01-08-2015 Boiler #8 Boiler Outlet Emissions
9:06 AM to 10:13 AM

Reduced reinjection pressures
Distribution Air Adjustment

01-08-2015 Boiler #8 Boiler Outlet Emissions
1:45 PM to 4:49 PM

Reduction in distribution air pressures noted previously
Tuning Lessons Learned

• Increase in OFA pressure actually lowered O2
  – Primary air flow was maintained

• O2 levels unstable as O2 trim control is not tuned and operated in manual

• Reduction in distribution air and reinjection air helped stabilize firing conditions

• Observed high frequency of soot blowing
  – Operators reasoning was for controlling drum pressure
Once Upon a time Firing Coal...

Boiler A

Decrease FD
Soot Blow

Average Boiler Outlet O2 (%)
CO (ppm corrected to 3% O2)

Boiler A

Decrease FD
Soot Blow

Average Boiler Outlet O2 (%)
CO (ppm corrected to 3% O2)
During Soot Blow
Operators increase
draft from -0.05 “ w.c.
to -0.14 “ w.c

Ruh-Roh…

Sucked the Coal out of
the Feeders !!!!!!!!!!
Thank You

Live Long and Compliant