REINHOLD ENVIRONMENTAL Ltd.

2013 NOx-Combustion Round Table & Expo Presentations

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DSI Experience Injecting Hydrated Lime Upstream of an Air Heater

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Sorbacal®

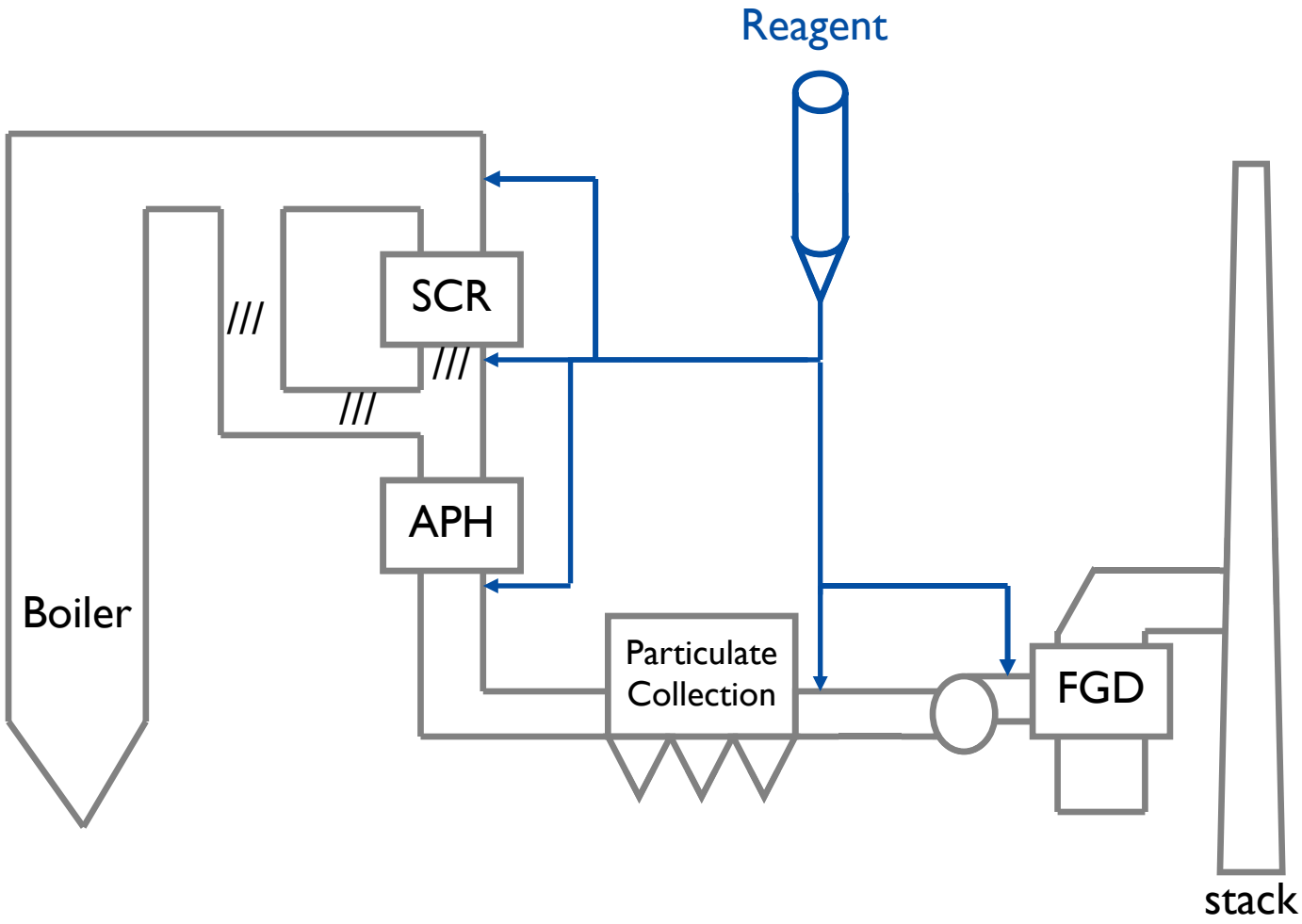
Lhoist

Reinhold NOx Combustion Mtg
February 19, 2013

Workshop Topics

- **WHO** – is injecting hydrated lime upstream of their air heater
- **WHAT** – is Dry Sorbent Injection (DSI)
- **WHY** – should this topic be of interest to you, and why are those that are doing it doing it
- **WHERE** – is upsteam hydrate injection being done
- **WHEN** – should you be considering this option

DSI Flow Diagram



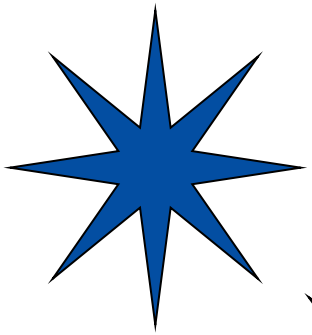
DSI – Background

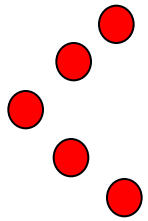
- Late 60's – TVA experimented with limestone boiler injection
- 1970's and 1980's – Nahcolite and trona injection
- 1984 – 1991 LIMB Project sponsored by EPA & DOE
  - ✓ Technology basically abandoned due to no commercial interest
- 2003 – The need for SO_3 control revived interest in duct injection
  - ✓ Early technology concerns/issues
    - Fouling of utility ducts/downstream equipment
    - Injection equipment issues
  - ✓ Technology concerns have basically been resolved and DSI is widely used commercially for SO_3 mitigation
- MATS has resulted in need for HCl and Hg control data
- CSAPR has renewed interest in SO_2 control
- European and Asian MSW experience has shown high removal levels for both HCl and SO_2

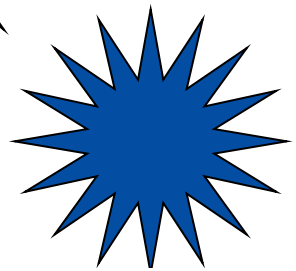
Factors Affecting DSI Effectiveness

Moisture Content

Surface Area and Pore Size







Temperature

Available Calcium

Available Sodium

SO_3 Removal – Sorbent Choice?

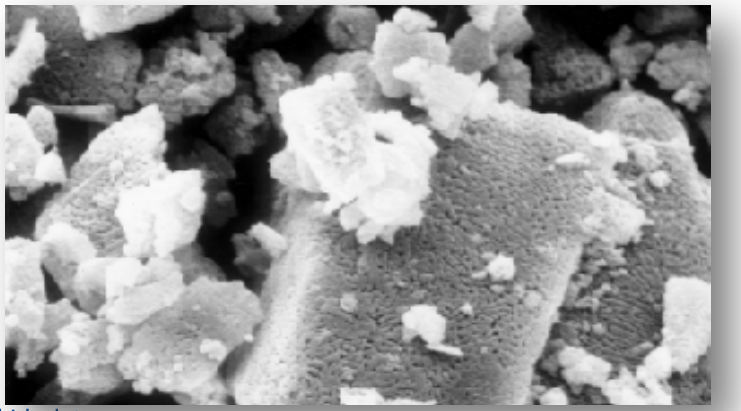
Trona

- Use when:
  - Need very high removals (> 90%)
  - ESP can't handle hydrated lime without a particulate increase
  - Ash sales not a concern
  - Have high levels of SO_3
    - Milled trona injection lowest injection rate/operating cost

Courtesy of UCC

Hydrated Lime

- Use when:
  - Need to preserve ash sales
  - Relatively low SO_3 and, therefore, low injection rates
  - Want to inject at FGD inlet and scrubber chemistry concerns
  - Want to inject at AH inlet without sodium bisulfate formation risk



Reagents are NOT all the same

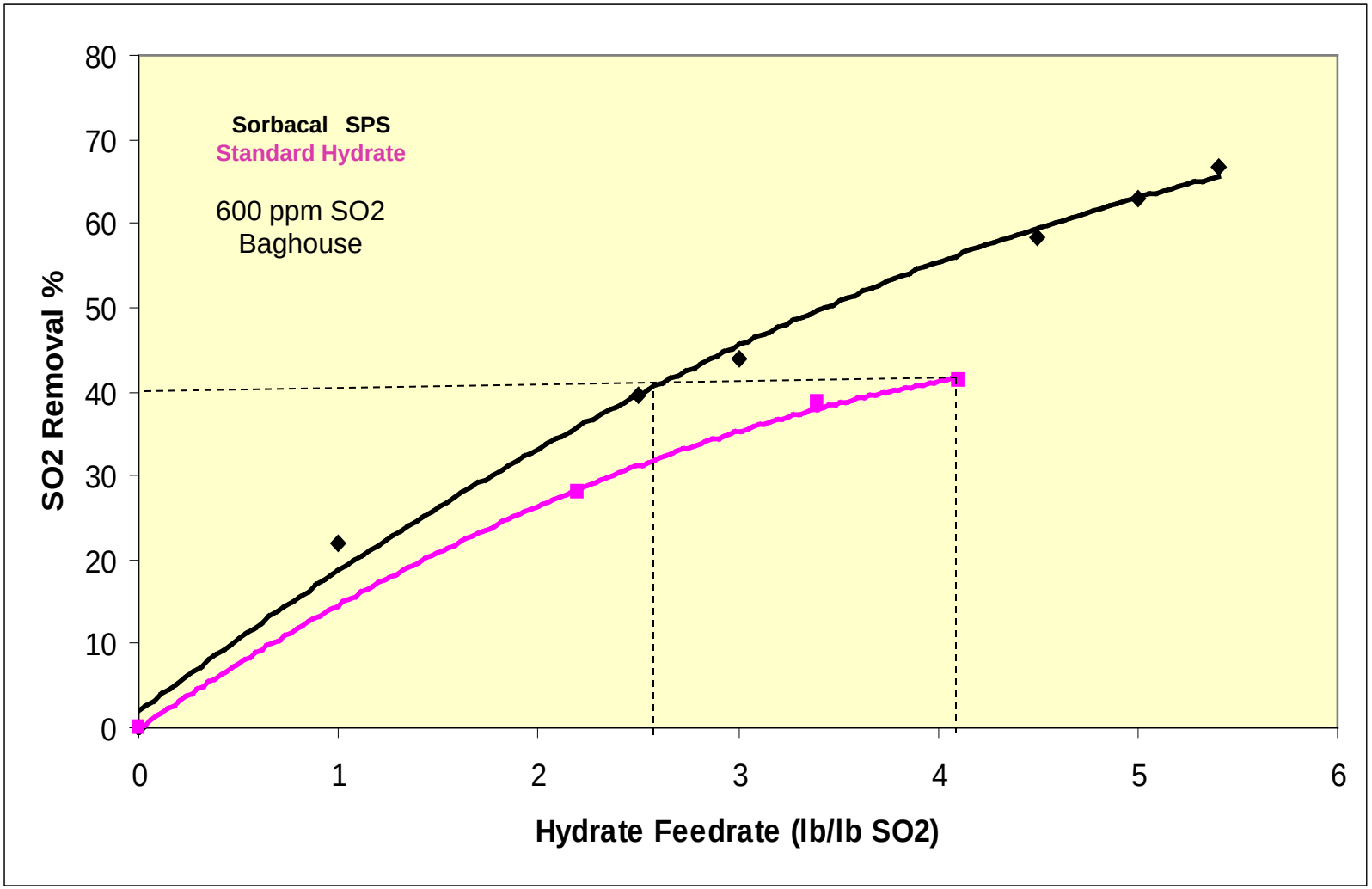
- Hydrate
  - ✓ Surface area
  - ✓ Porosity
- Trona
  - ✓ Unmilled
  - ✓ Milled

Physical Properties of Two Hydrates

- Chemically the hydrated limes are basically the same
- Their difference lies in their physical properties

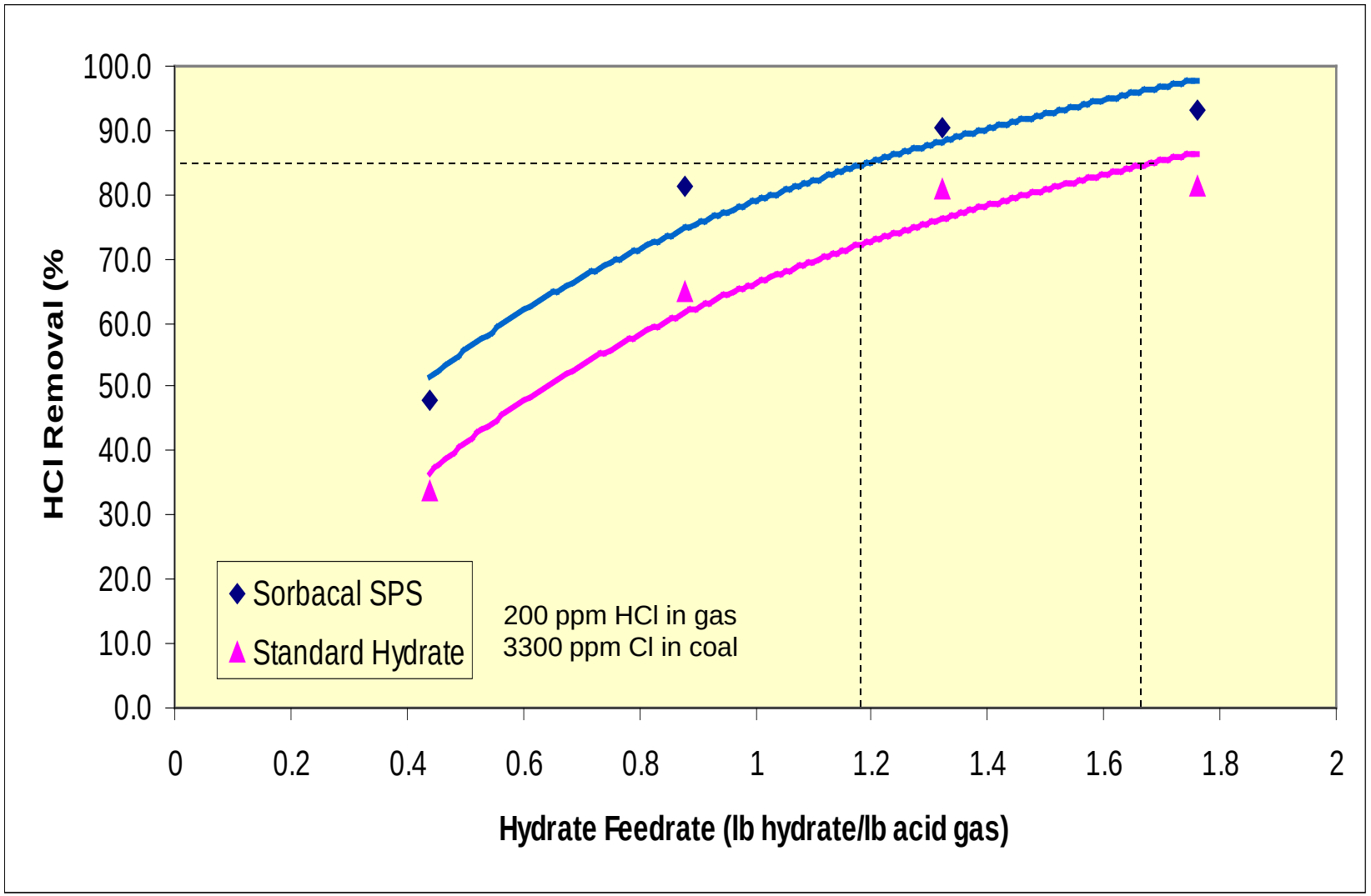
Sorbacal	Standard Hydrate
	SSA - ~20 m^2/g
	Porosity - ~.07 cm^3/g

SO_2 Removal @ Air Heater Inlet T



HCl Removal With ESP

ESP Operations @ 350°F

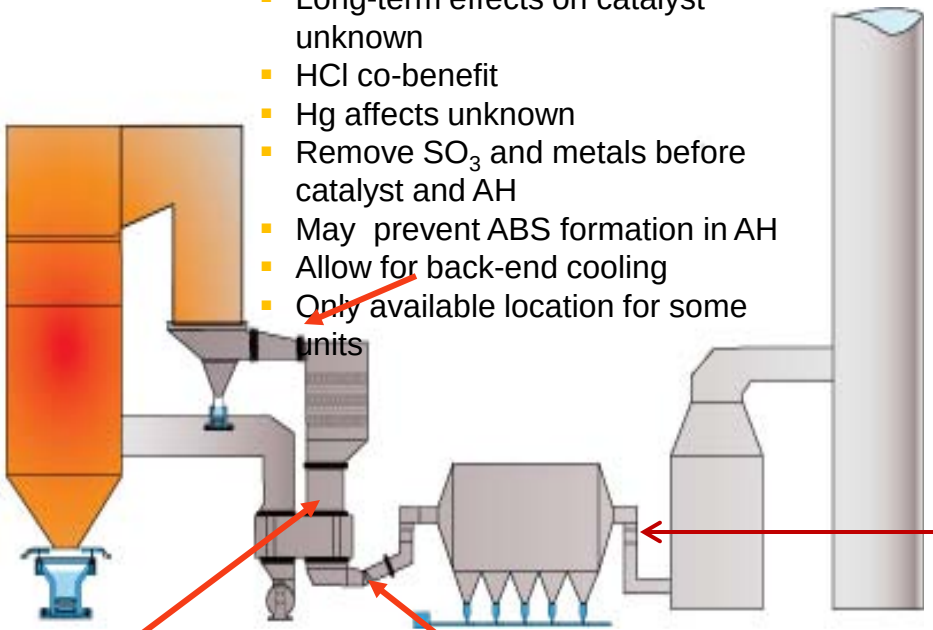


SO_3 Removal Injection Locations?

Sorbacal®

SCR Inlet

- Demonstrated successfully
- More sorbent needed (due to reaction w/ SO_2 for trona or CO_2 for hydrated lime)
- Long-term effects on catalyst unknown
- HCl co-benefit
- Hg affects unknown
- Remove SO_3 and metals before catalyst and AH
- May prevent ABS formation in AH
- Allow for back-end cooling
- Only available location for some units



FGD Inlet

- Injection rates somewhat limited – good location for lower sulfur coals
- Lose benefits of upstream SO_3 removal, but no risk of ESP effects
- Lose HCl/Hg co-benefits

SCR Outlet/Air Heater Inlet

- Demonstrated Successfully
- More sorbent needed
- HCl/Hg co-benefits may prevent ABS formation in AH
- Allow for Back-end cooling
- Only available location for some units

Courtesy of UCC

Air Heater Outlet

- Most common location
- Lowest sorbent use
- Most economical location if only need plume mitigation
- Sorbent may affect ESP, but low risk
- HCl/Hg co-benefits

WHY Have DSI Upstream of Your Air Heater?

- New REGIONAL HAZE Regulations can require SCR systems for NOx control and this will increase SO_3 in the flue gas
- DSI is to remove SO_3
- Benefits of SO_3 removal
  - ✓ Improved air heater performance
  - ✓ Corrosion control
  - ✓ Enhanced mercury removal performance

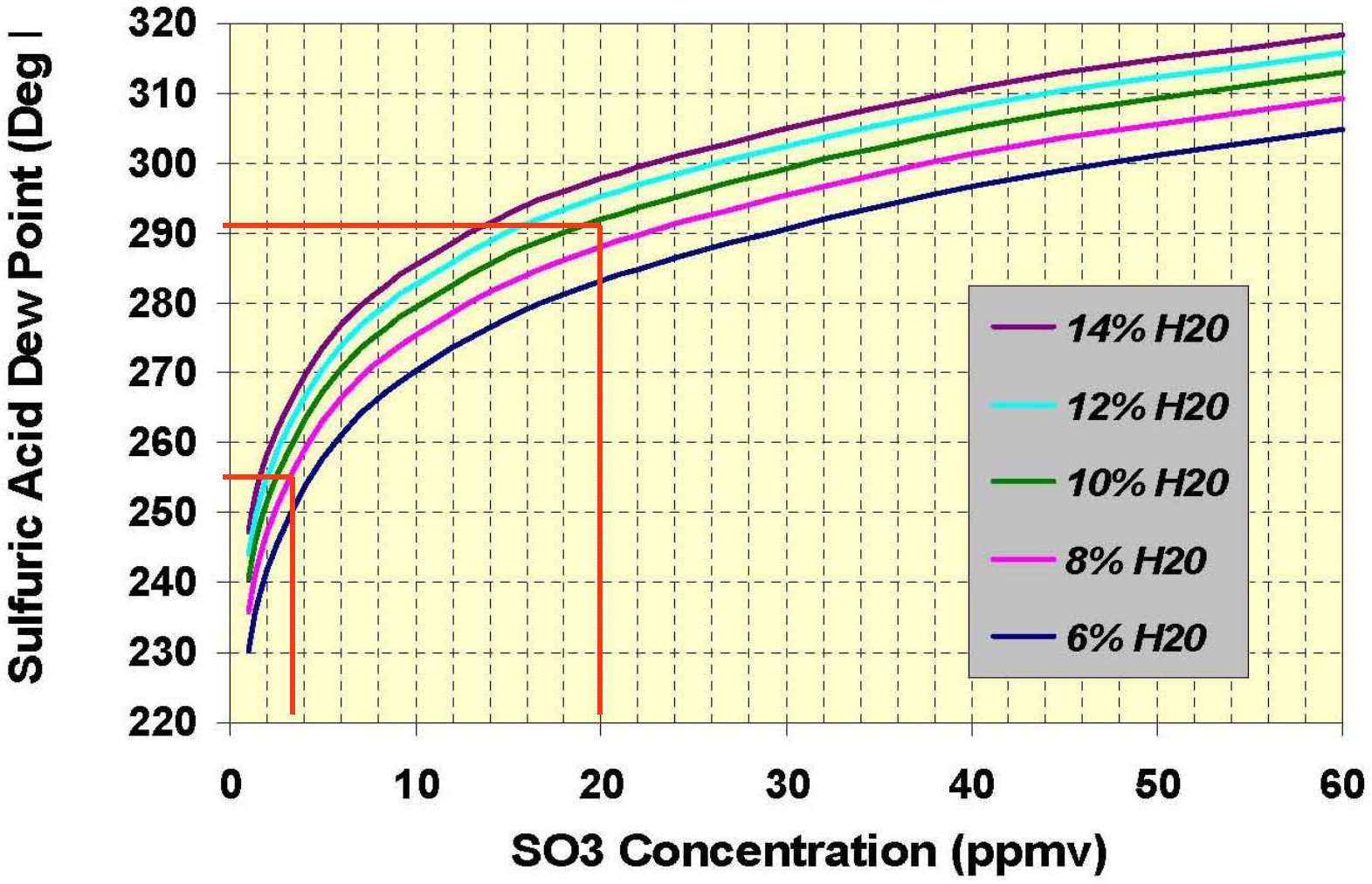
Improved Air Heater Performance

- Both SCR and SNCR systems have some NH_3 slip
- SO_3 can react with NH_3 to form Ammonia bisulfate (ABS)
- ABS can attach to air heater surfaces, it will build up and increase the ΔP
- Removing SO_3 prevents ABS from forming, plus it allows better performance of SCR & SNCR by allowing larger amounts of NH_3 slip

Reduced Corrosion

- SO_3 can condense on downstream equipment and will increase corrosion
- DSI removes SO_3 and prevents corrosion in downstream equipment
- Reduced SO_3 also reduces the acid dew point which can allow the boiler to operate at a lower outlet T
  - ✓ Improves boiler heat rate
  - ✓ Reduces gas volume and ash resistivity for better ESP performance

Acid Dew Point as a Function of SO_3 Concentration



Impact of Decreased Air Heater Temperature

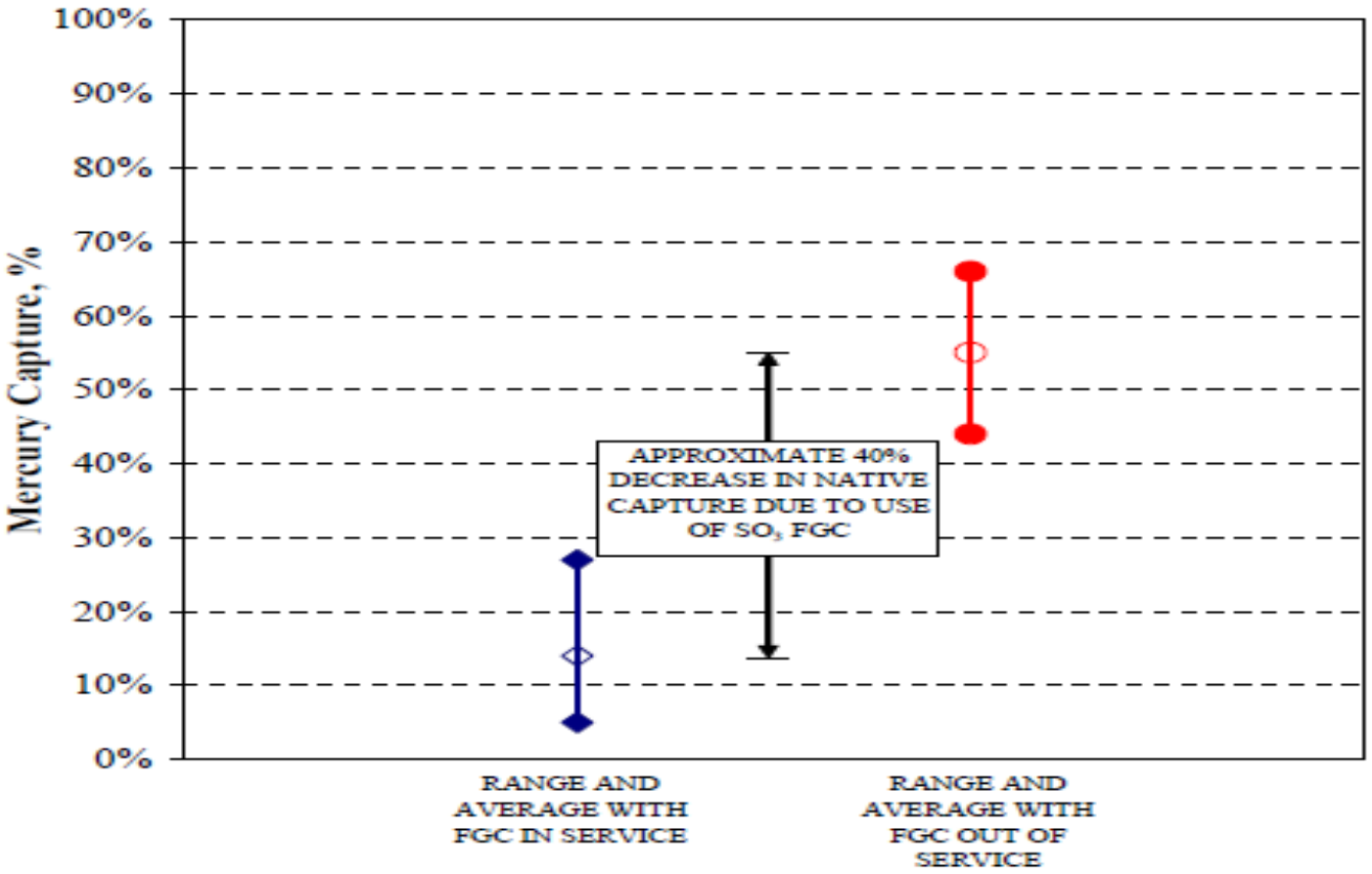
Rule of thumb – a 10ºF temperature change at the air heater = 0.25% efficiency impact

- Calculation Basis
  - ✓ 500 MW boiler
  - ✓ 10,000 BTU/kw-hr heat rate
  - ✓ 8600 BTU/lb coal
  - ✓ 0.5% S
  - ✓ 100% capacity factor
  - ✓ Coal price = $25/ton delivered
- A 10ºF temperature reduction improves the heat rate to 9,975 BTU/kw-hr
- Base amount of coal –
  - ✓ 2,546,512 tons/yr
- Coal use at improved heat rate
  - ✓ 2,540,145 tons/yr
- Annual coal reduction
  - ✓ 6,367 tons
- **Annual savings = ~$150,000**

Improved Mercury Removal Performance

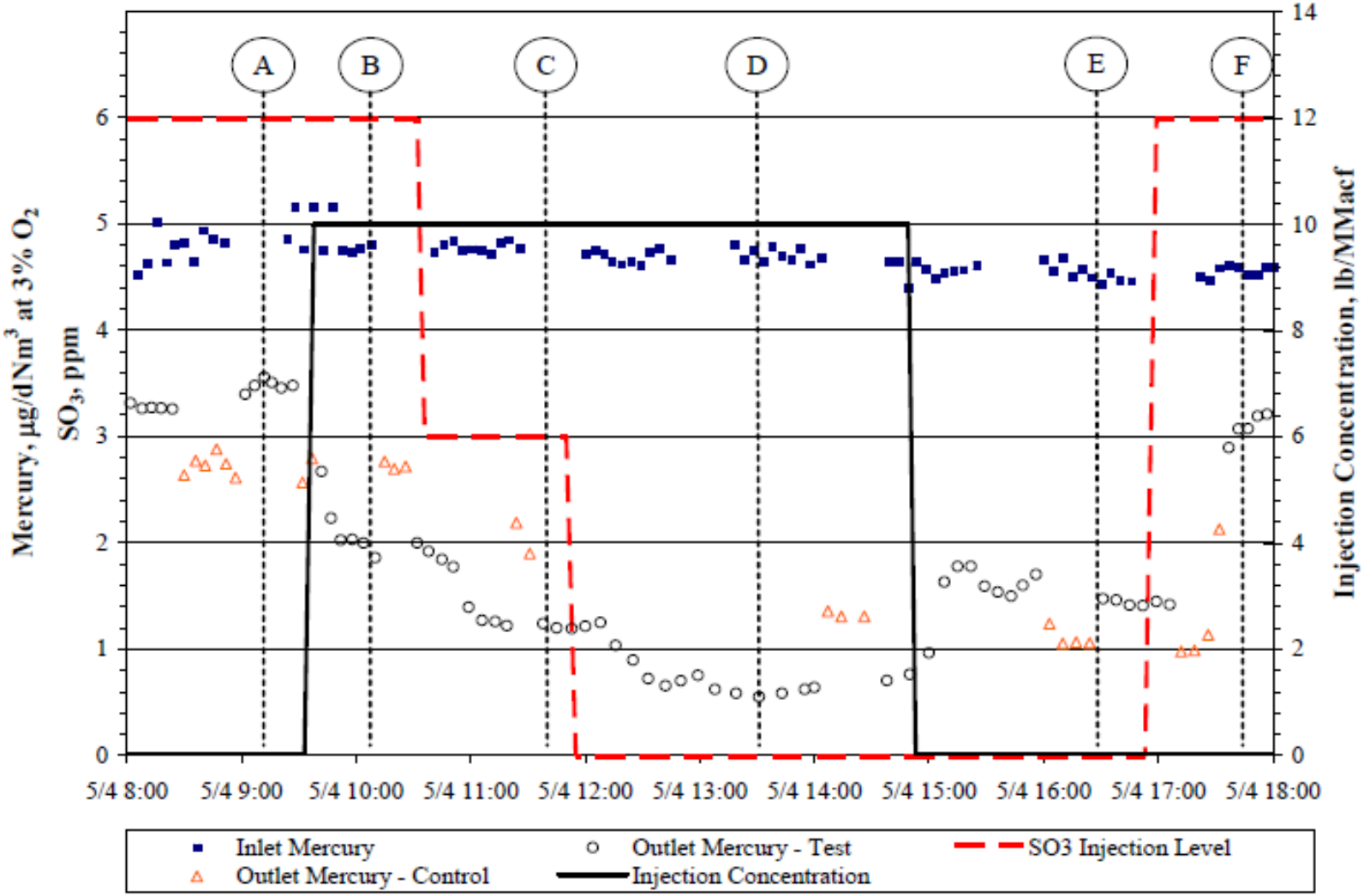
- Data show that small amounts of SO_3 (3 – 5 ppm) greatly impact the performance of ACI Mercury Control Systems
- When SO_3 is removed upstream of ACI injection – the Mercury removal performance is improved by 40+%

Impact on Native Hg Capture with 6 ppm SO_3



Data Courtesy of Southern Company

Variable SO_3 and Sorbent Injection Test Data



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Plant Daniel Schematic

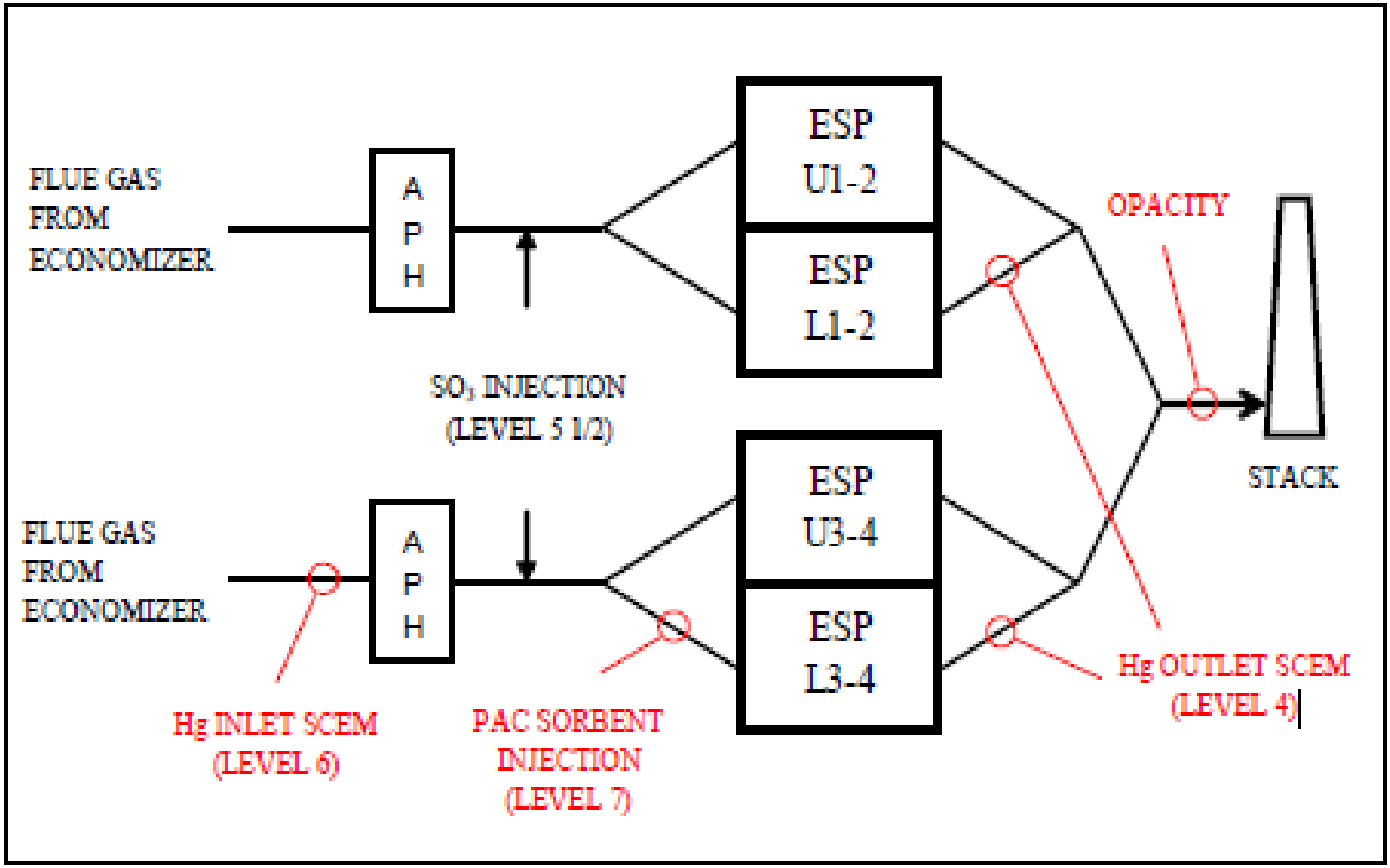
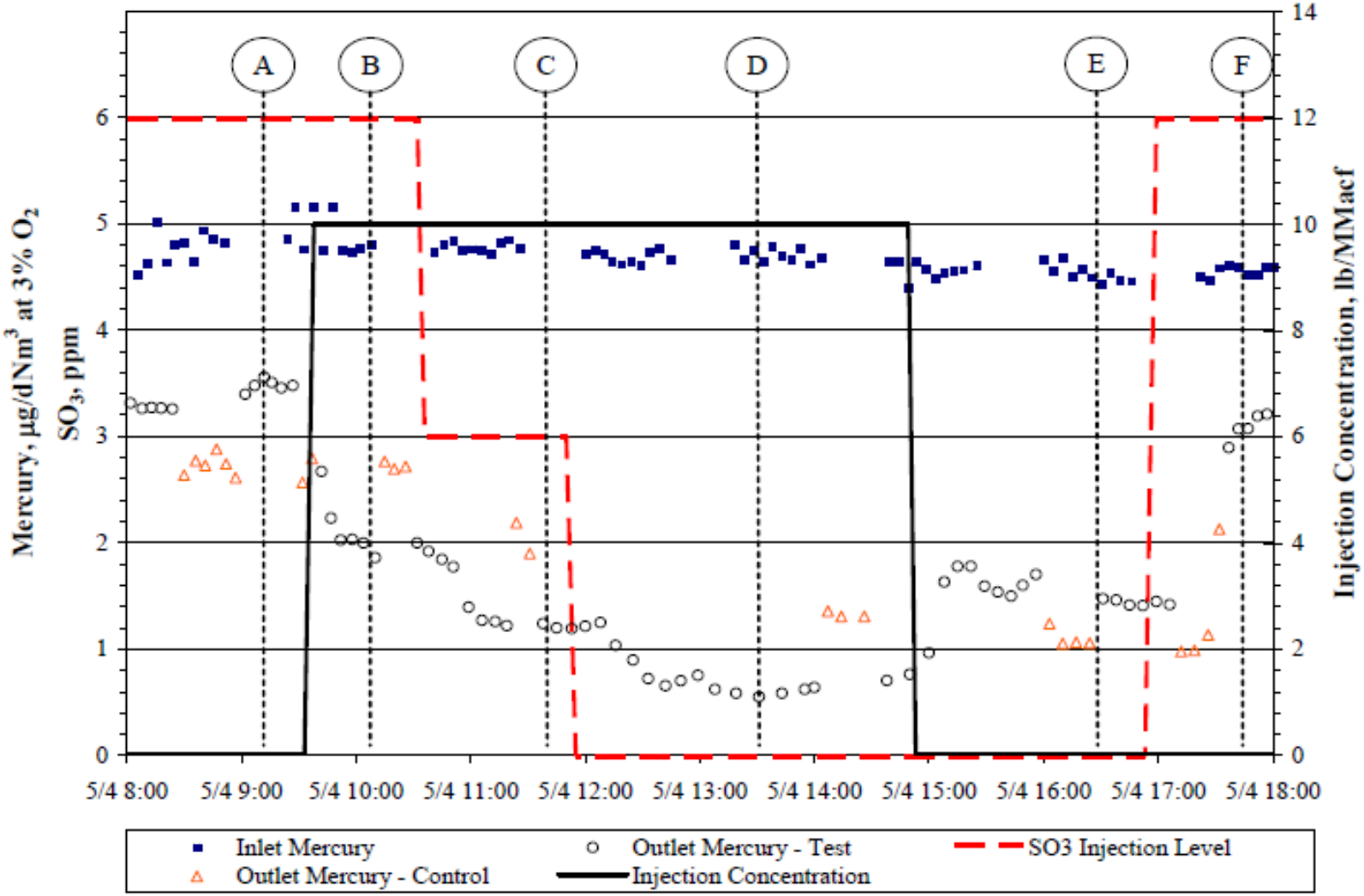


Figure Courtesy of Southern Company

Variable SO_3 and Sorbent Injection Test Data



Data Courtesy of Southern Company

Plants With (or planning for) Hydrated Lime Injection Upstream of Their Air Heaters

Plant	Size
Asheville - 1	191 MW
Asheville - 2	185 MW
Roxboro - 1	369 MW
Roxboro - 2	671 MW
Roxboro - 3	685 MW
Roxboro - 4	700 MW
Mayo -1	736 MW
Crystal River - 4	739 MW
Crystal River - 5	739 MW
Ghent - 1	550 MW
Trimble County - 1	550 MW
Trimble County - 2	750 MW

Plant	Size
Belews Creek -1	1080 MW
Belews Creek - 2	1080 MW
Orlando Util Comm. - 1	465 MW
Orlando Util Comm. - 2	465 MW
Wateree - 1	370 MW
Wateree - 2	370 MW
Hammond - 4	578 MW
Bowen - 1	800 MW
Bowen - 2	789 MW
Bowen - 3	952 MW
Bowen - 4	952 MW
Wansley - 1	952 MW
Wanslet - 2	952 MW

Boilers Injecting Upstream of Air Heater

- Rationale for injecting upstream of air heater vs. downstream
  - ✓ Increased residence time
  - ✓ Increased time between air heater washes
  - ✓ Mercury removal
- All systems are targeted on SO_3 removal, not HCl or SO_2
- Some have run for over 2 years, and some are in design/planning stage

Experiences with Upstream Injection

- Have seen slower increase in ΔP resulting in longer times between air heater cleaning – from every 6 – 8 weeks to several months.
- Some report they clean air heaters anytime they can when the boiler is down so there is not good records of savings
- **Buildup of hydrated lime on air heater surfaces has not been a problem**