

REINHOLD ENVIRONMENTAL Ltd.



**2019 REINHOLD Round Table  
Presentation**

June 24 & 25, 2019, in Birmingham, Alabama / Hosted by Southern Company

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# Sulfite Control with WFGD Systems

## 2019 Reinhold Round Table

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Rita Mardini

GE Power  
GE Power

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**June 24, 2019**

# A Global Leader in Providing Limestone WFGD Systems



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# Agenda

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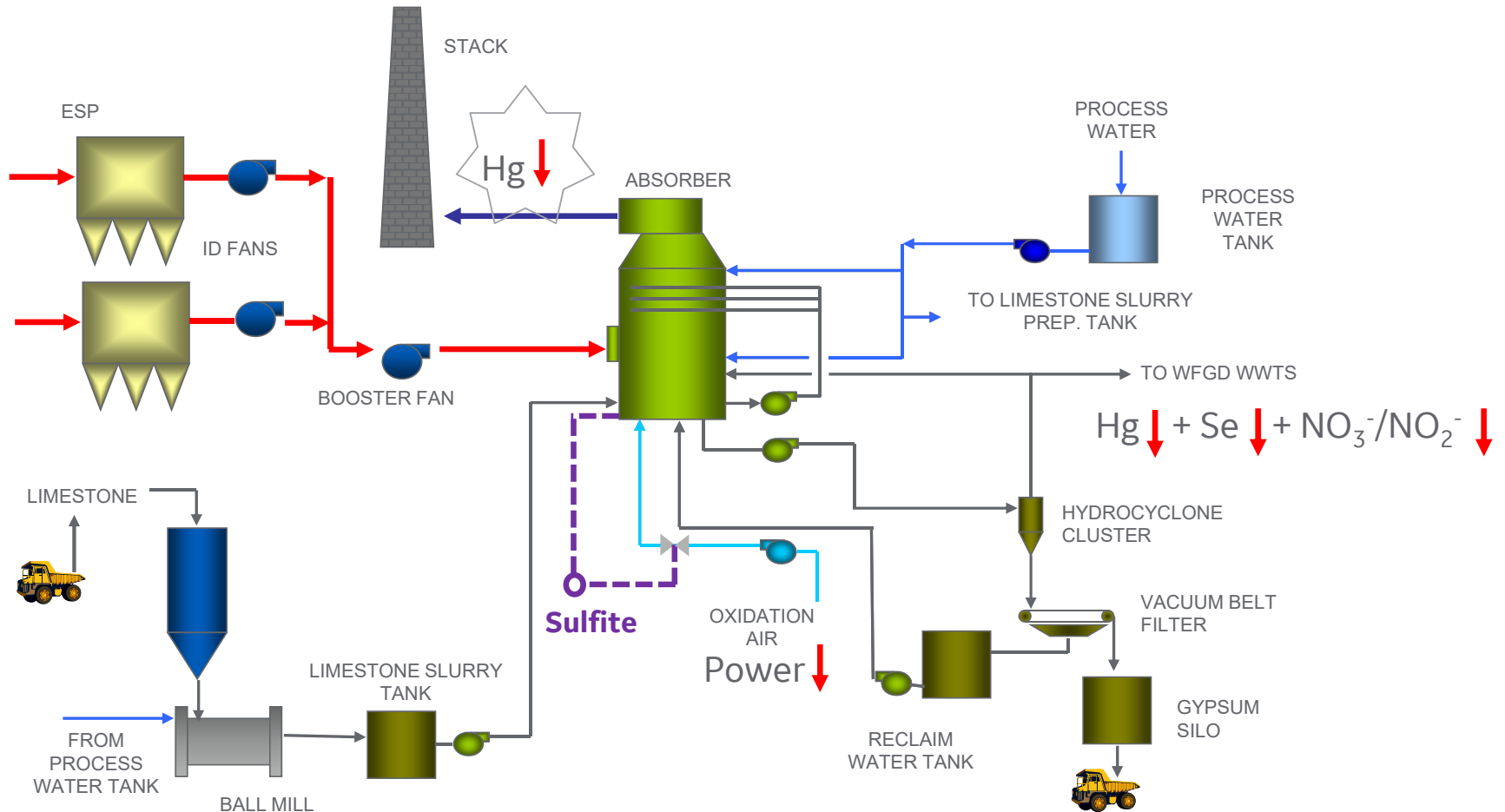
1. WFGD Sulfite Control
2. Equipment and Installation
3. Testing and Results
4. Power Consumption
5. Summary



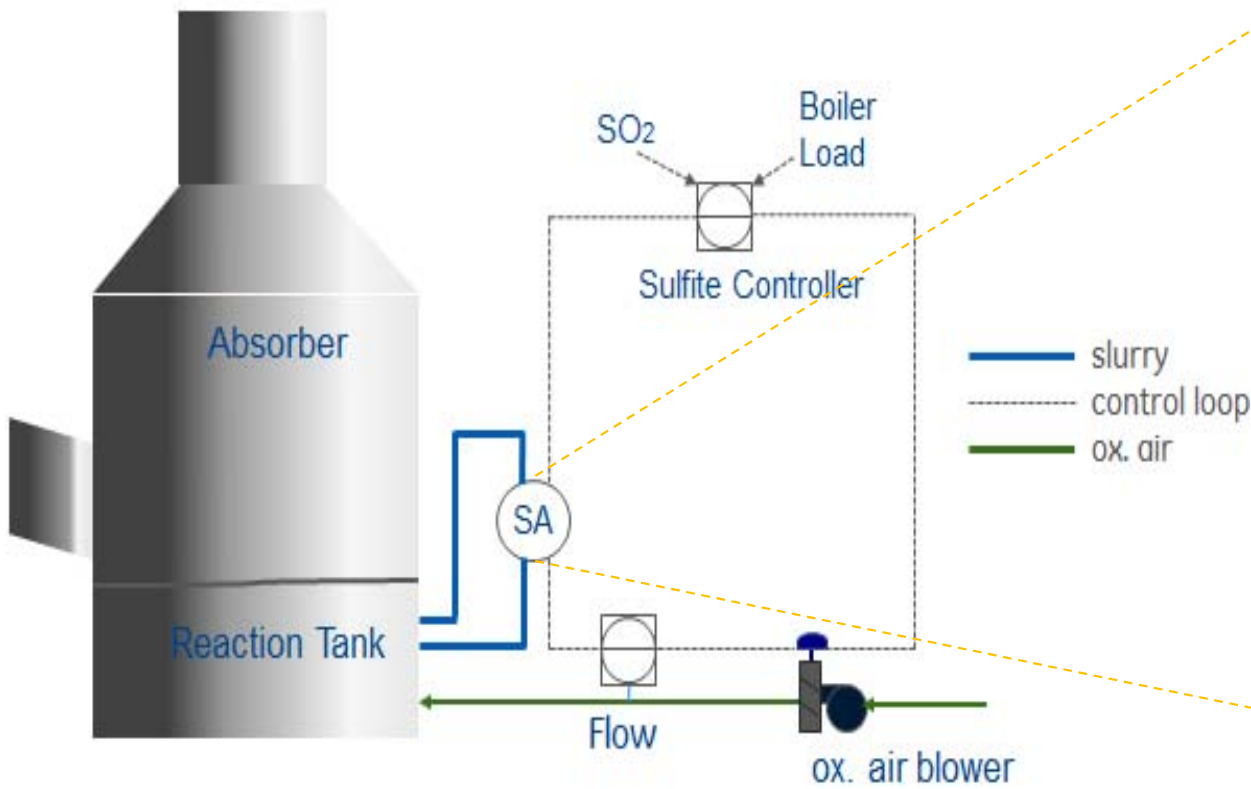
# WFGD Sulfite Control



# Limestone **Controlled-Oxidation** Process Diagram



# GE's SulfiTrac™ Sulfite Analyzer



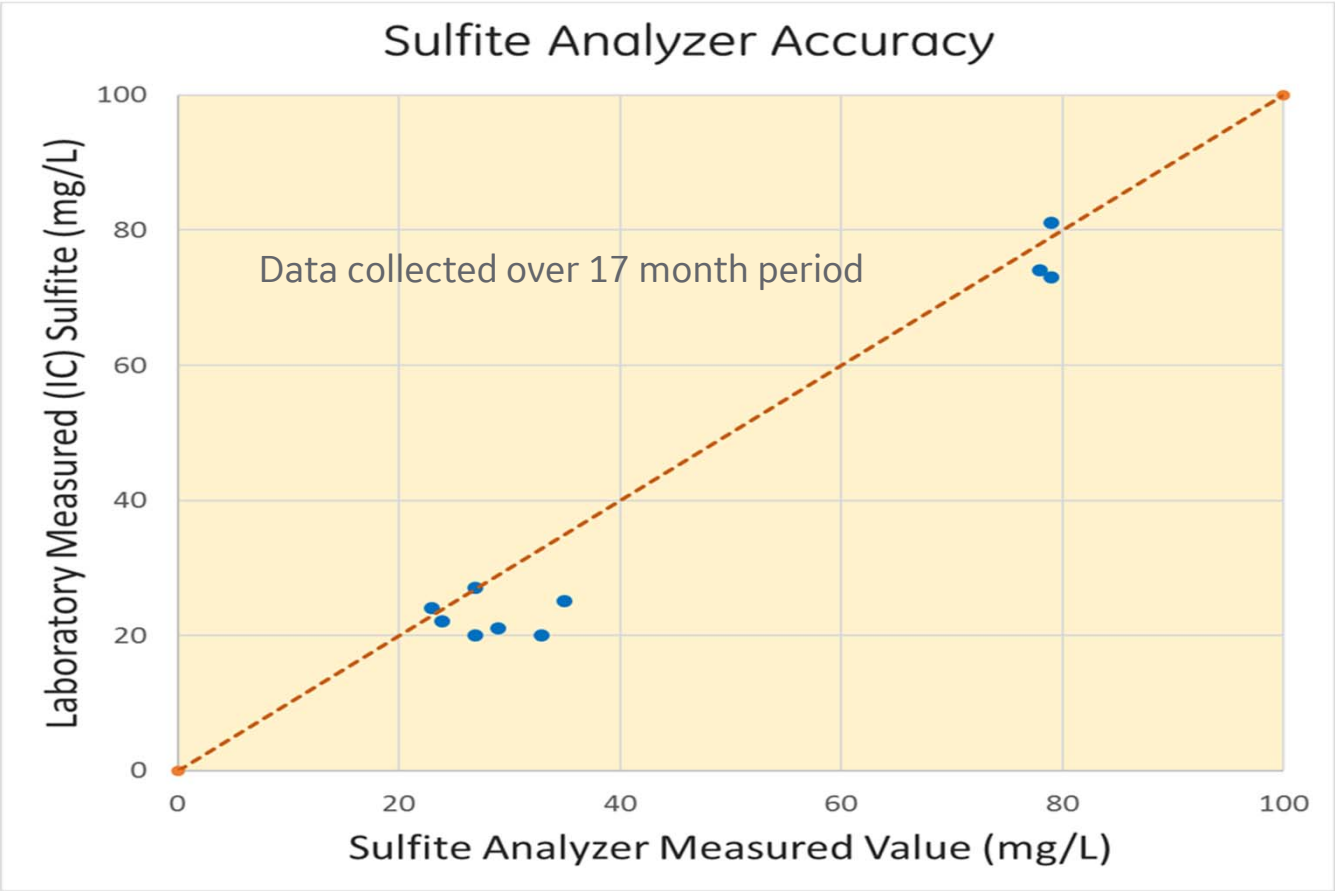
Sulfite Analyzer and sample sink



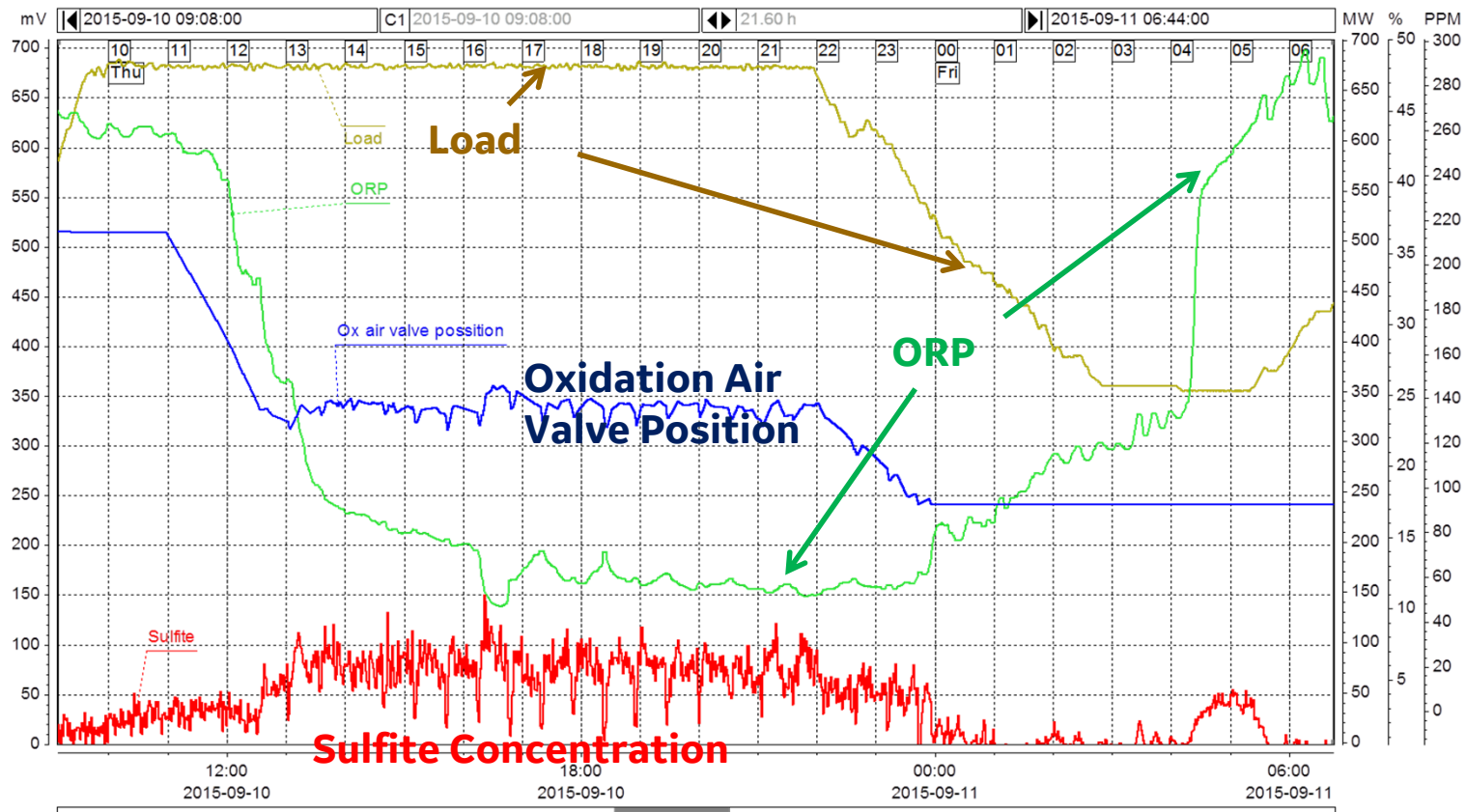
Probe  
(including slurry  
cleaning device)



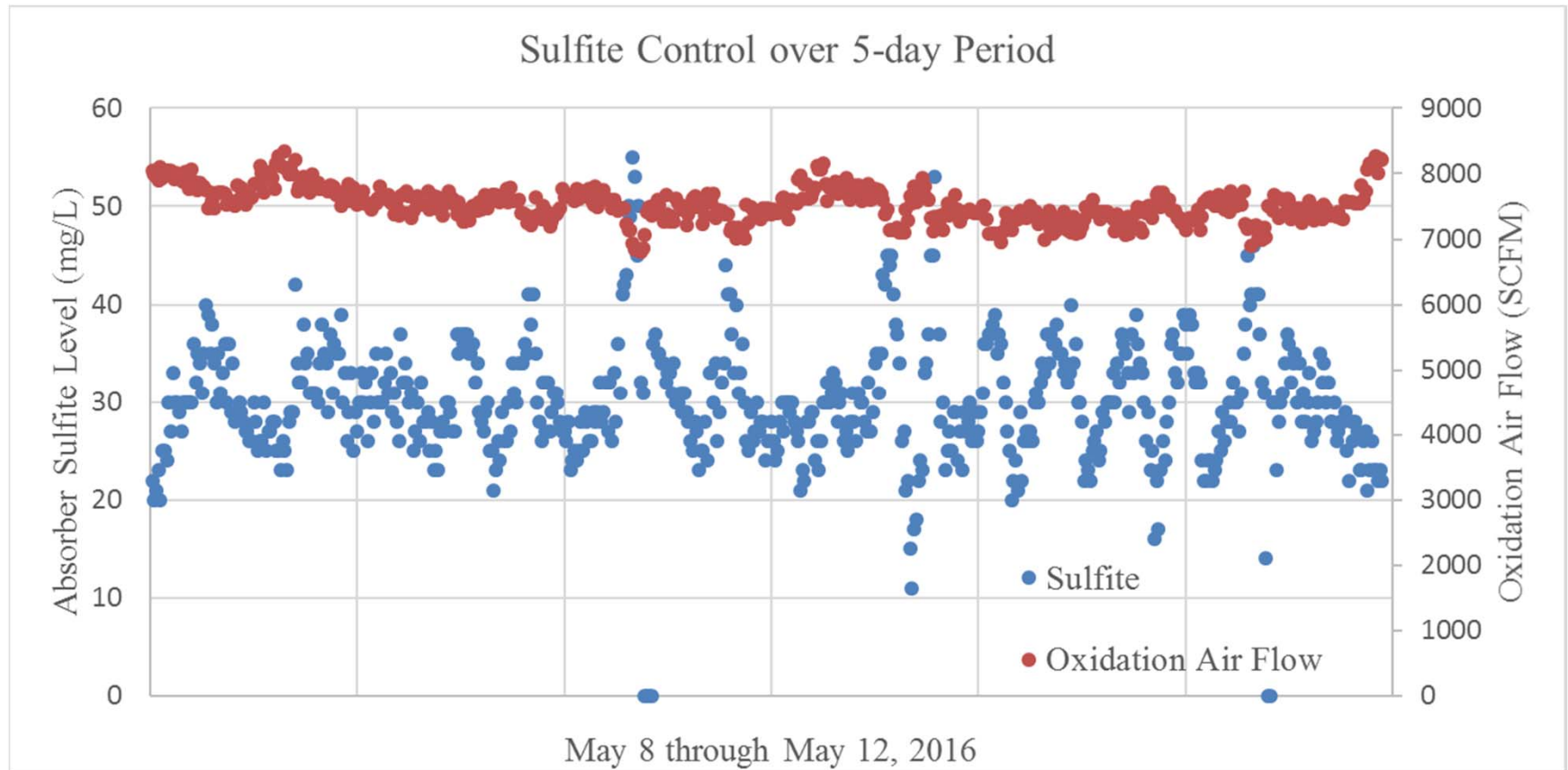
# Representative sulfite analyzer accuracy (EPRI)



# WFGD Sulfite Control – Air Turndown Limited (SGS)



# WFGD sulfite control – continuous for 5-day period (EPRI)



# Equipment and Installation



# GE SulfiTrac™ Sulfite Analyzer

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## Product Specification

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<b>Physical Size</b>	Approximately 12" diameter x 44"H
<b>Weight</b>	50 lbs.
<b>Casing</b>	C-PVC, Stainless steel
<b>Control Box</b>	NEMA 4 rated
<b>Scraper Assembly</b>	C-PVC/Zirconium/Stainless steel
<b>Operating Temperature</b>	15°F to 160°F (-10°C to +70°C)
<b>Ambient Temperature</b>	40°F to 150°F (5°C to +65°C)
<b>Power Supply</b>	24 VDC, ~25 W
<b>Output Signal</b>	4-20 mA output, RTD

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Robust construction for industrial applications



# Installation of sulfite analyzer and sample sink

- Slurry sample line (1 in.) with isolation valve(s) from reaction tank, 15 to 30 gpm
- Low head pump feed is alternative
- Cam lock connector for slurry feed included
- Gravity drain via 2 in. NPT/pipe connection, typically drain to trench or sump



Gravity drain to trench/sump



Slurry to sink

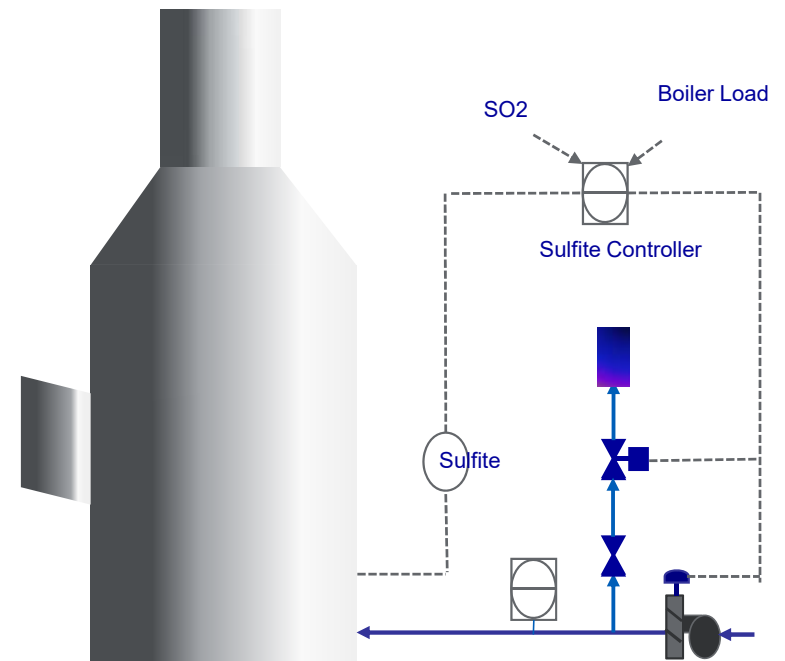


# Oxidation air control and turndown

- Air control needed to maintain sulfite with varying load and inlet  $\text{SO}_2$
- Design to consider max. and min. range for load and  $\text{SO}_2$  levels

## Air control and turndown options

- Use blower installed inlet and out vanes
- Add air blow-off valve(s)
- Add blower inlet vanes
- Add variable speed drive
- Change blower impellor or change blower

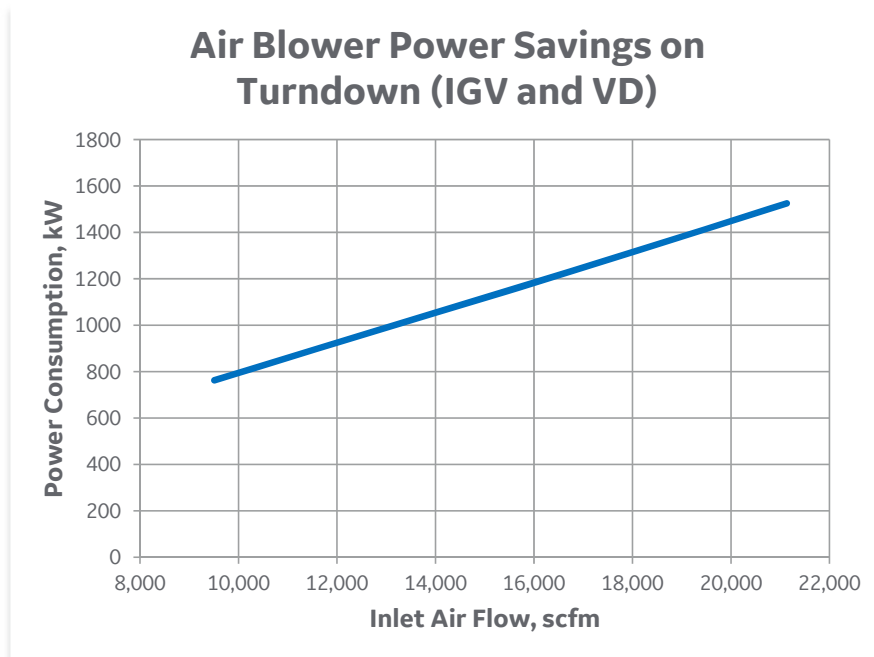


# Oxidation Air Blowers

- Sized for maximum boiler load, maximum SO<sub>2</sub> , conservative margins added
- Typical size range
- 5000-25,000 scfm
- 500-2,500 Hp motors
- Single stage centrifugal typical
- Rotary
- Multi-stage blower



# Centrifugal Oxidation Air Blower



Example here for Turblex centrifugal blower with variable diffusers (VD) and inlet guide vanes (IGV)



# Options to extend oxidation air control

- Blow-off valve(s) with silencers
  - Performance butterfly-type valves
  - No help with power savings
  - Lower initial cost option
- Variable speed drives (VSD)
  - Require controlled space in electrical equipment area
  - Extends power savings
  - Higher initial costs



Dual blow-off valves with silencers



VSD



# Air dispersion in reaction tank

## Air lance system

- Excellent turndown capability
- Less likely to have plugging
- Easy inspection

## Horizontal air spargers

- Potential for flooding/plugging on low air velocity
- Use sparger isolation valves to maintain air velocity on turndown
- Add water flushing to minimize maintenance



# Summary of scope to add sulfite control to an existing WFGD system

- Sulfite analyzer/sample sink for each WFGD absorber
- Oxidation air system modifications to allow automatic control and air turndown
- Control description and logics
- DCS/PLC programming and tuning
- Possible addition of I/O capacity
- Miscellaneous (wiring, plumbing, site provisions, etc.)



# Testing and Results



# Testing summary

## **SGS - Seminole Generation Station**

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2 x 650 MW units  
Eastern US bituminous coal  
5 WFGD absorbers per unit  
4 absorbers per unit normally operate  
Sulfite control testing on absorber 1A  
7 days testing period in 2015  
Air turndown limited – sulfite control maintained during medium to high load periods

## **EPRI - Sulfite control testing**

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Large boiler  
Eastern US bituminous coal  
3 WFGD absorbers per unit  
Sulfite control installed on absorber 1A  
Baseline testing – Oct. 2015  
Sulfite control testing:

- May 2016 – 30 ppm sulfite
- June 2016 – 70-80 ppm sulfite
- Feb. 2017 – 30 ppm sulfite



# Major results – both **SGS** and **EPRI**

## Sulfite control and accuracy

### Mercury in flue gas

- Inlet and outlet of absorber
- Speciated sorbent traps (US EPA method 30B)

### Mercury in slurry (liquid and solids)

### Selenium in slurry (liquid and solids)

- Total selenium and speciated selenium (**EPRI**)

### Gypsum quality

- Gypsum purity and limestone content
- Mercury in gypsum solids by size fractions



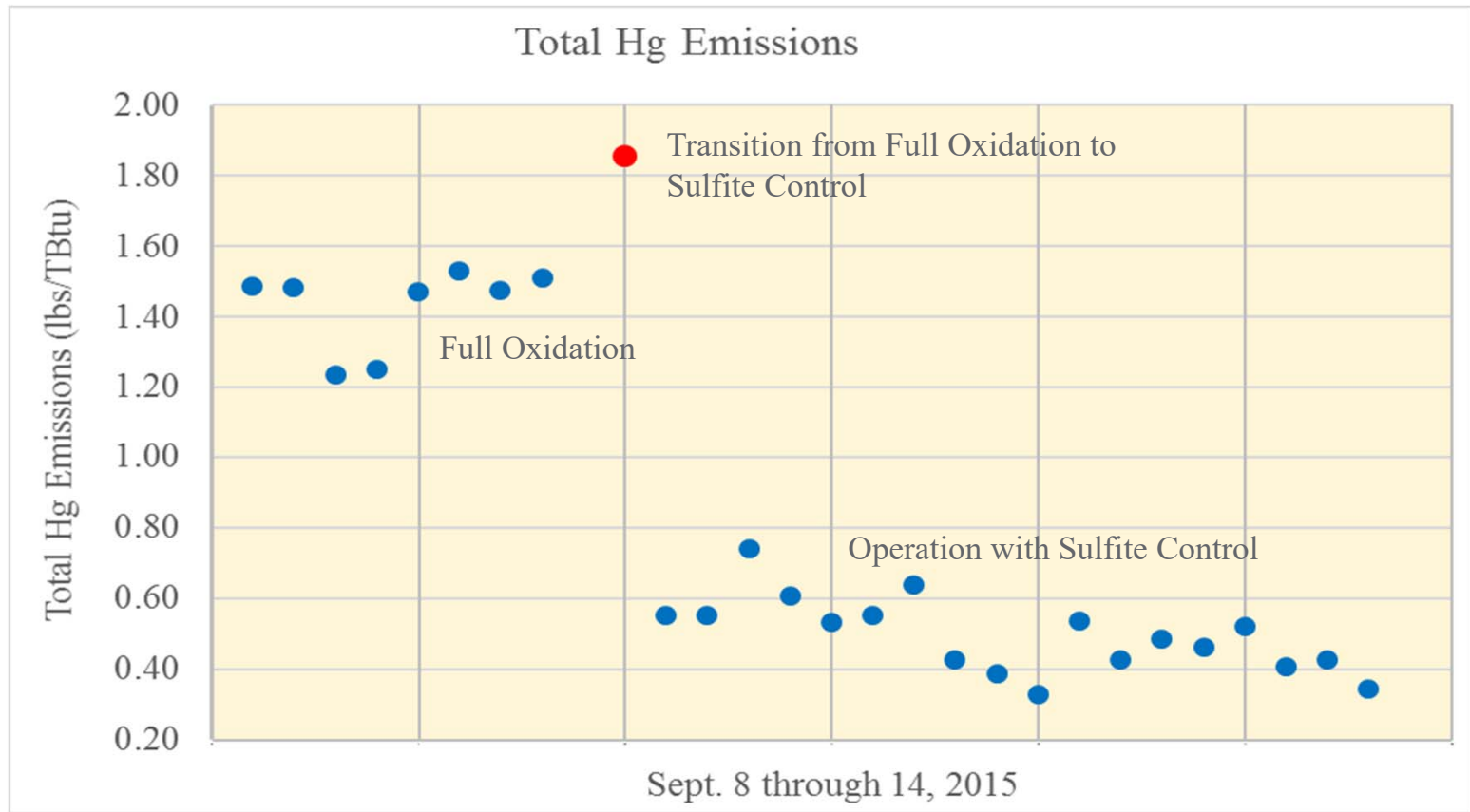
# EPRI – Flue Gas Mercury Removal in WFGD Absorber

Condition	Inlet Hg % Hg <sup>2+</sup>	Hg <sup>2+</sup> Removal across Absorber %	Total Hg Removal across Absorber %	Hg Re- Emission % of Inlet Hg <sup>2+</sup>	Outlet Hg Lbs/TBtu
Baseline – Fully Oxidized	98	99.6	60	38	1.0
Sulfite Control 20 - 30 mg/l May 2016	97	99.8	98	0	0.2
Sulfite Control 20 - 30 mg/l Feb. 2017	99	99.8	99	0	0.1
Sulfite Control 70 - 80 mg/l	95	98.2	96	0	0.1

No re-emissions seen with continuous sulfite control



# SGS - Total mercury emissions



## EPRI – Mercury in slurry phase partitioning results

Condition	Dissolved Hg, ng/L	% of total Hg in slurry liquor	% of total Hg in slurry solids
Baseline, full oxidation	75,000	70	30
Sulfite control, 20-30 mg/L May 2016	90	0.09	99.91
Sulfite control, 20-30 mg/L Feb. 2017	50	0.05	99.95
Sulfite control, 70-80 mg/L June 2016	160	0.15	99.85

Dissolved mercury very low with sulfite control



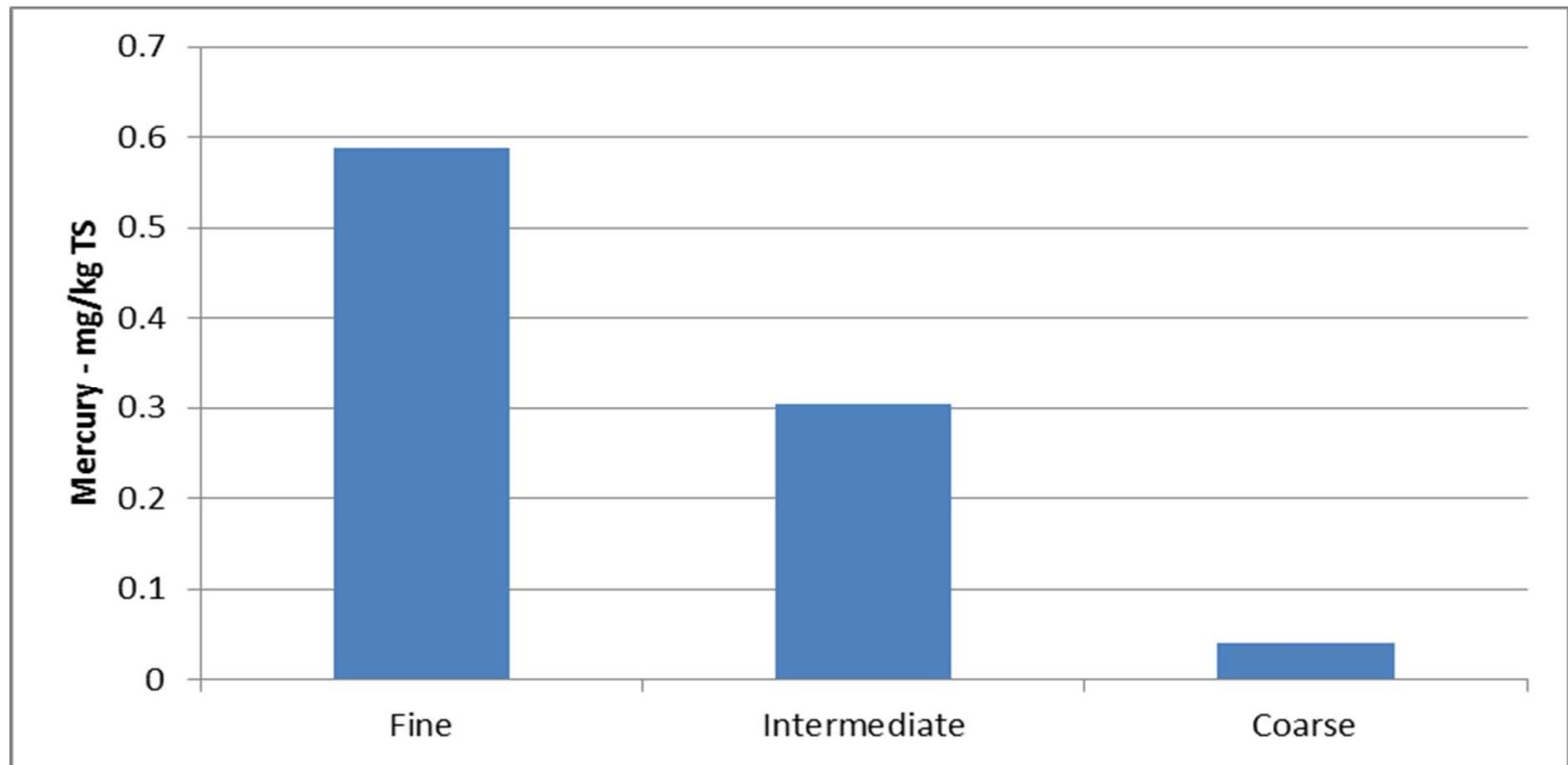
## SGS – Mercury in slurry phase partitioning results

Condition	Dissolved Hg, ng/L	% of total Hg in slurry liquor	% of total Hg in slurry solids
Baseline, full oxidation	89,000	71	29
Sulfite control, 20 mg/L 4-day avg.	256	0.4	99.6
Sulfite control, 200 mg/L	977	1.3	98.7

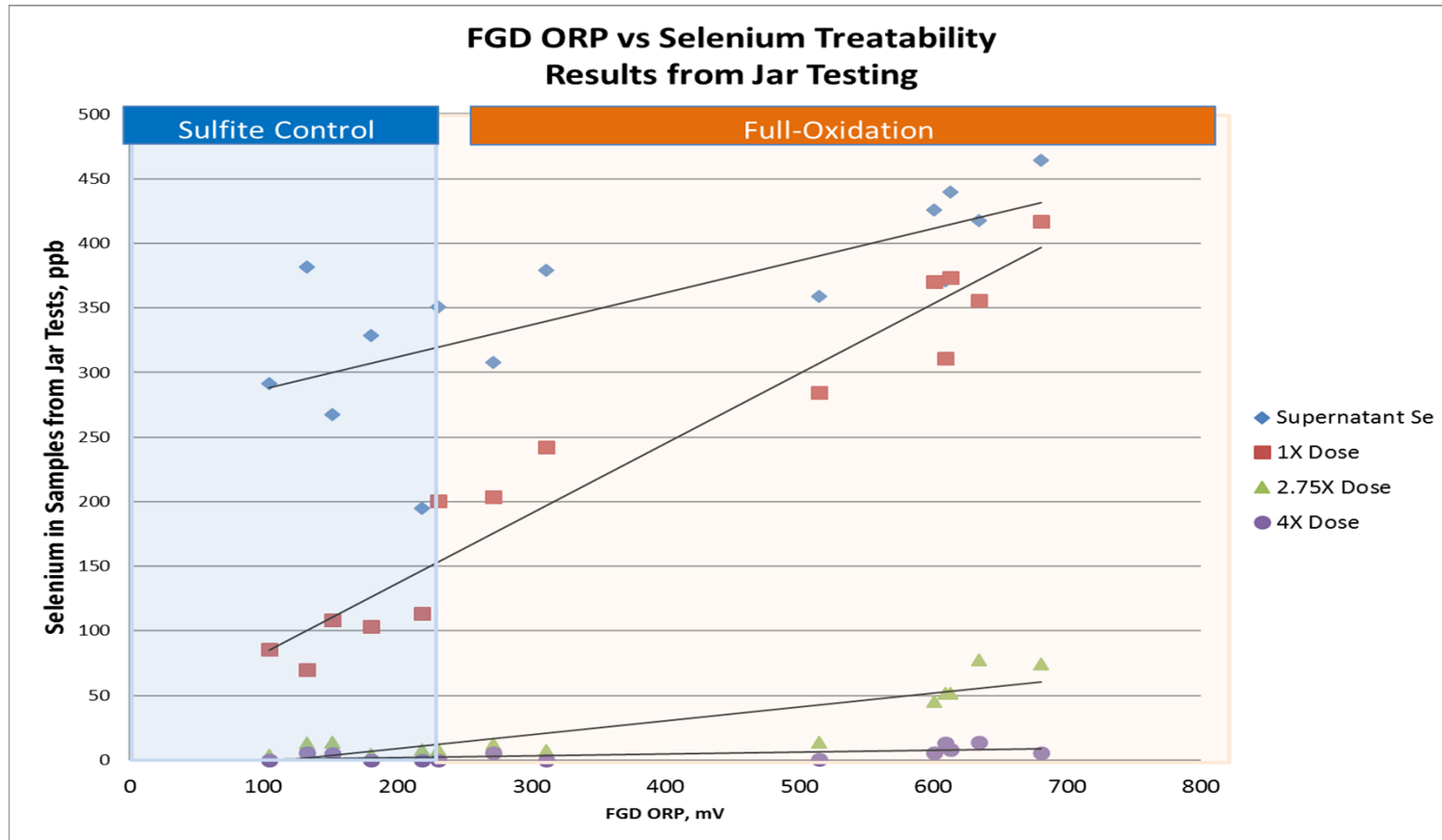
Dissolved mercury low with sulfite control



## SGS - Mercury in FGD gypsum by particle size



# SGS - Total dissolved selenium decreases with sulfite control and simulated WWT (jar testing)



## EPRI – Selenium in Slurry Phase Partitioning Results

Condition	Dissolved Se, µg/L	Se in slurry solids, µg/g	% of total Se in slurry liquor	% of total Se in slurry solids
Baseline, no sulfite control	610	1.6*	67	33
Sulfite control, 20-30 mg/L, May 2016	290	3.4*	29	71
Sulfite control, 20-30 mg/L, Feb. 2017	140	2.3	25	75
Sulfite control, 70-80 mg/L	340	2.8*	39	61

Dissolved selenium reduced with sulfite control

\*Result is above MDL but below reporting limit, estimated result

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## EPRI – Dissolved selenium speciation results

Condition	% Selenite Se IV	% Selenate Se VI	% Other Selenium Species
Baseline, fully oxidized	-	~99*	-
Sulfite control, 20-30 mg/L	93	6	1
Sulfite control, 70-80 mg/L	97	3	<1

Remaining dissolved selenium is mainly selenite with continuous sulfite control

\*Previous data from the same FGD system at baseline operation



## EPRI – Total Nitrate/Nitrite Results for WFGD Slurry

Condition	ORP, mV	Total $\text{NO}_3^-/\text{NO}_2^-$ , mg/L	Apparent S/N species, mg/L as $\text{SO}_4^{=}$
Baseline, no sulfite control	560	16	80
Sulfite control, 20-30 mg/L	140	5	620
	90	5	NA
Sulfite control, 70-80 mg/L	100	2	260

Greater than 50% reduction in nitrates/nitrites measured



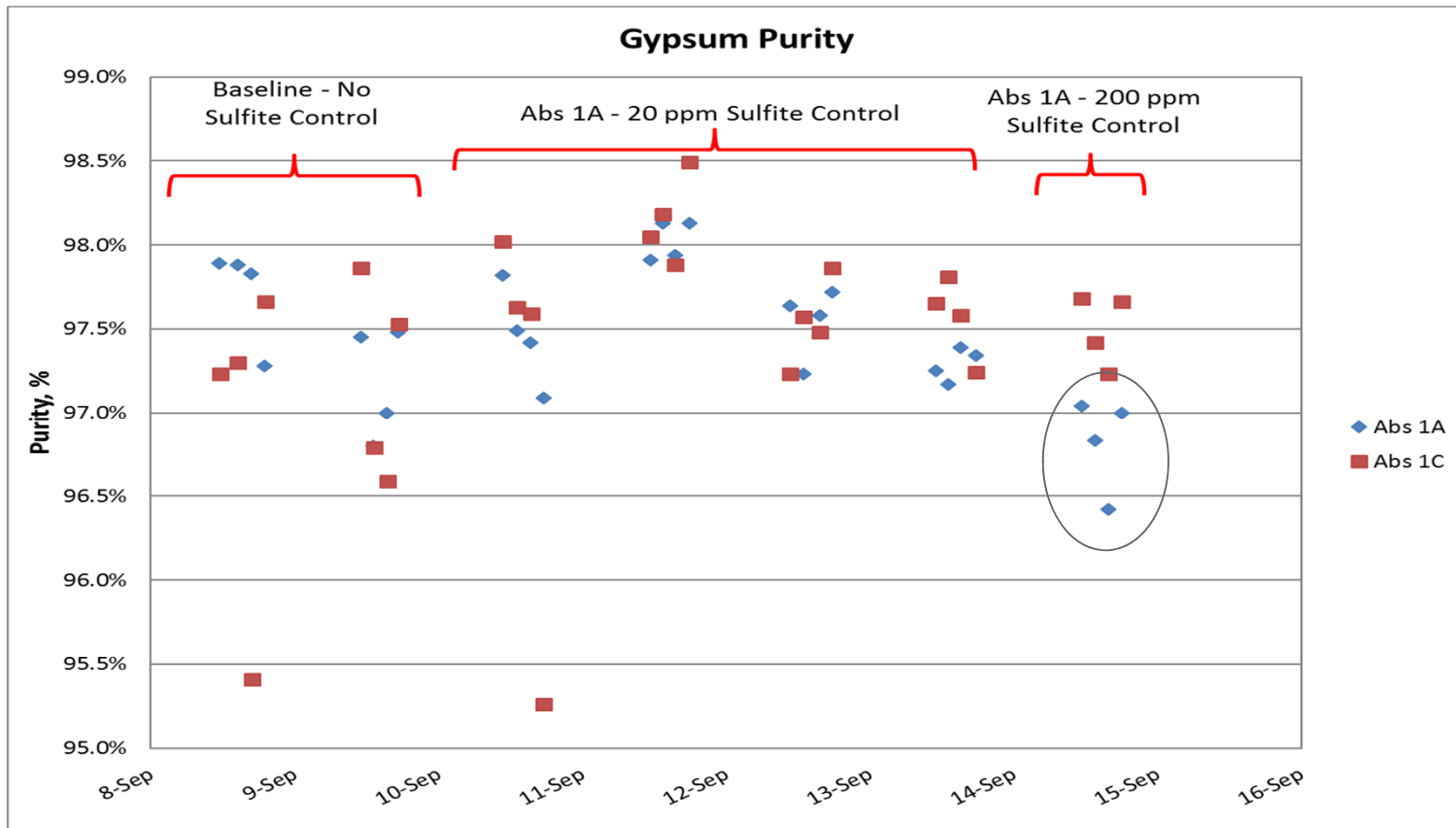
## EPRI – Manganese in Slurry Phase Partitioning Results

Condition	Dissolved Mn, $\mu\text{g/L}$	Mn in slurry solids, $\mu\text{g/g}$	% of total Mn in slurry liquor	% of total Mn in slurry solids
Baseline, no sulfite control	50	22	1	99
Sulfite control, 20-30 mg/L, 2016	3800	3.5	86	14
Sulfite control, 20-30 mg/L, 2017	5600	4.1	88	12
Sulfite control, 70-80 mg/L	3700	4.7	81	19

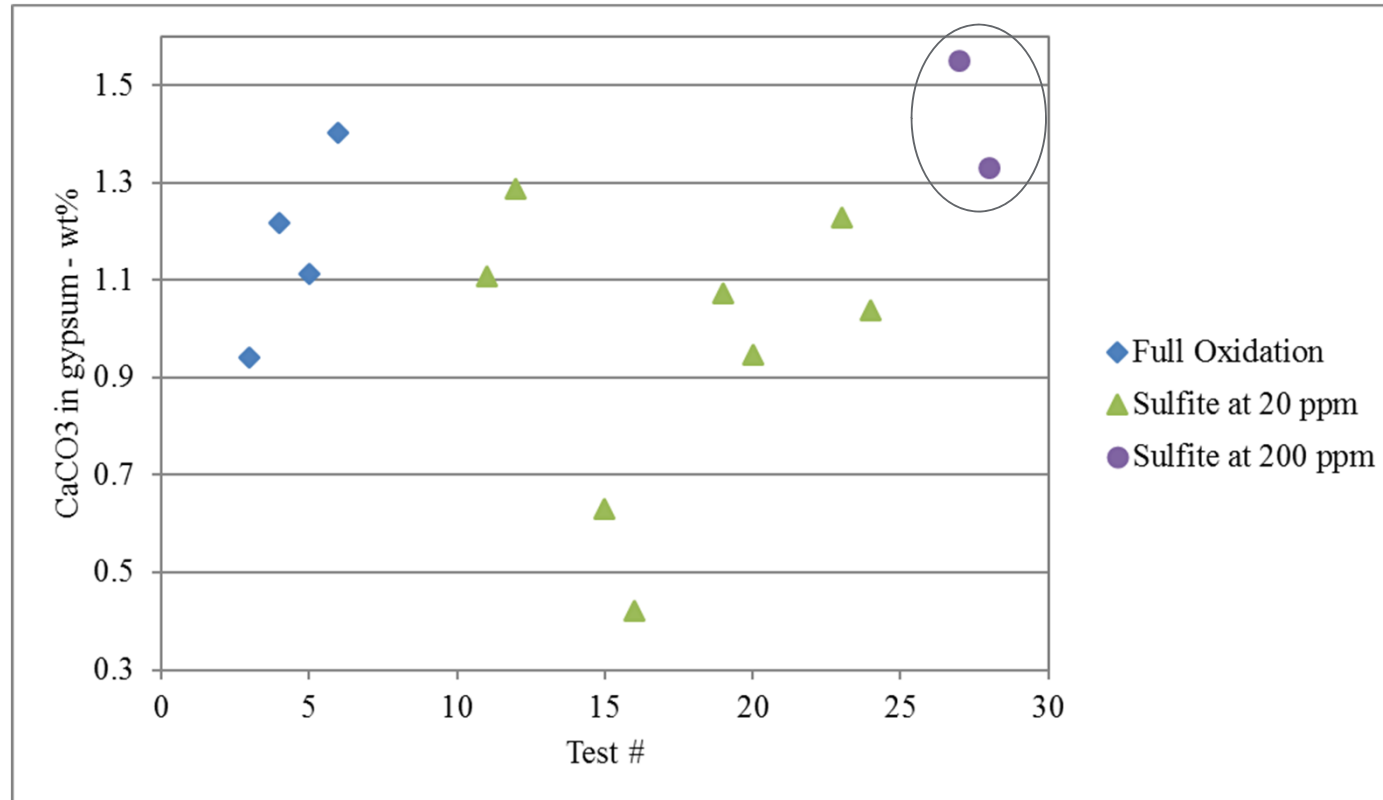
Mn is much more soluble with sulfite control,  
Helps avoid Mn scale on alloys that can worsen under-deposit corrosion



# SGS – Gypsum Purity Results



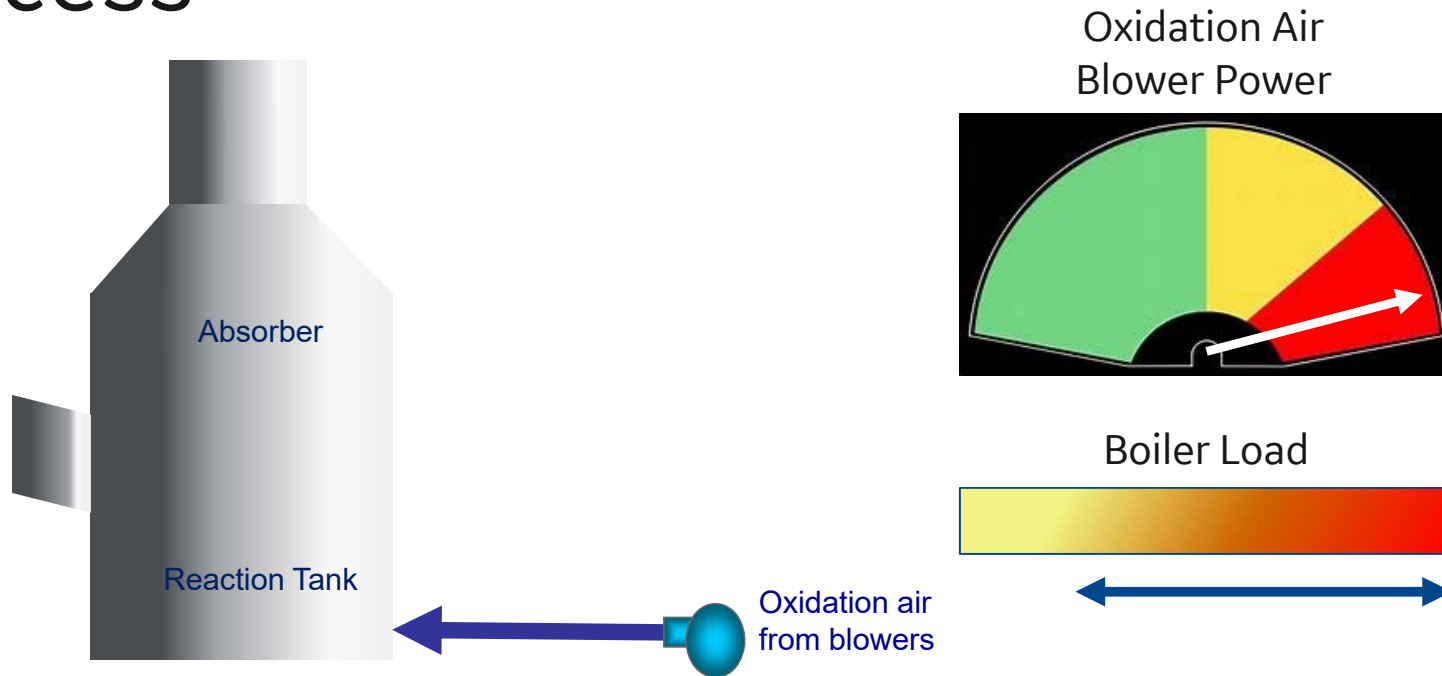
# SGS - Excess Limestone in Gypsum



# Power Consumption



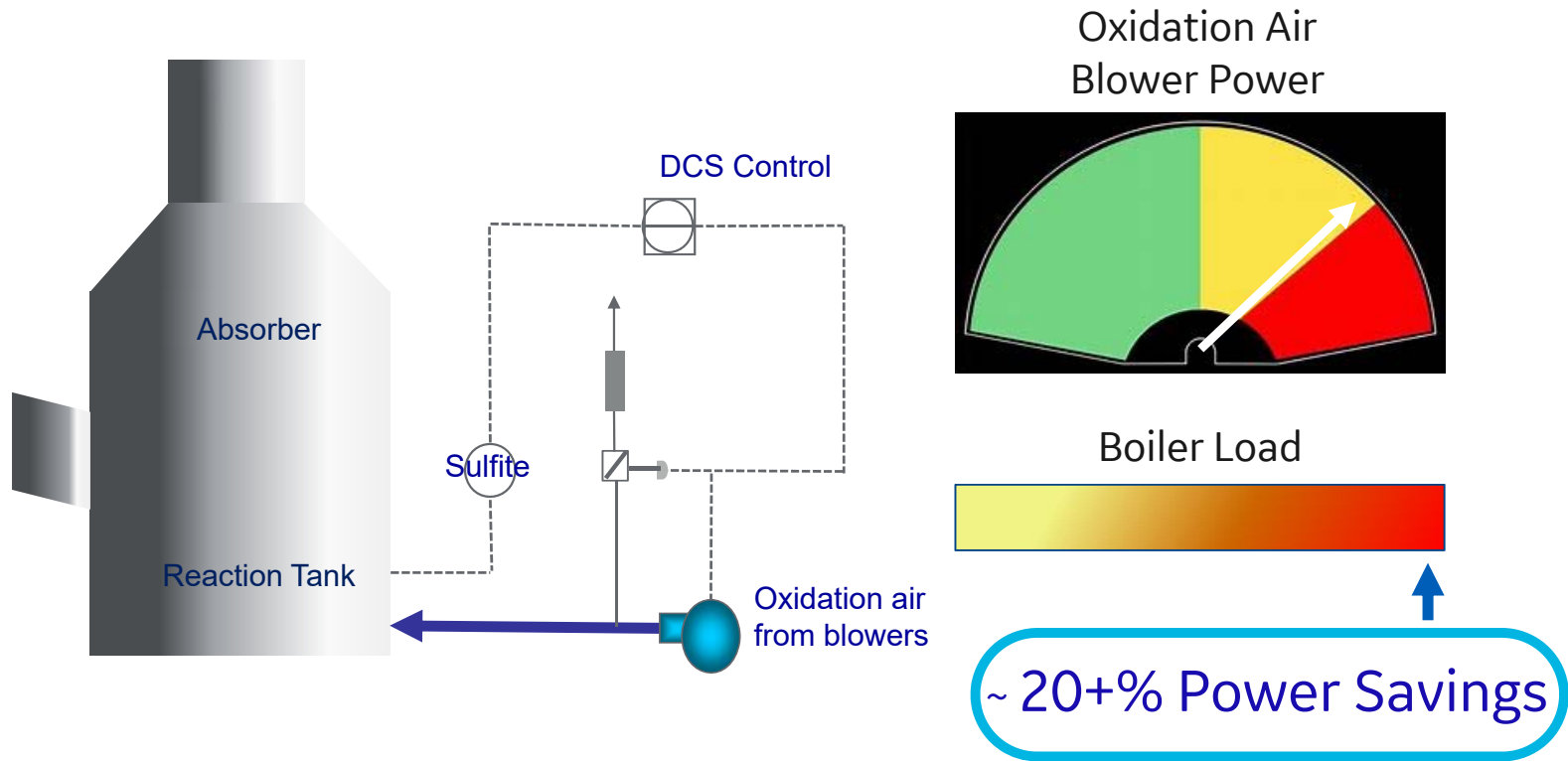
# Typical Limestone Forced Oxidation Process



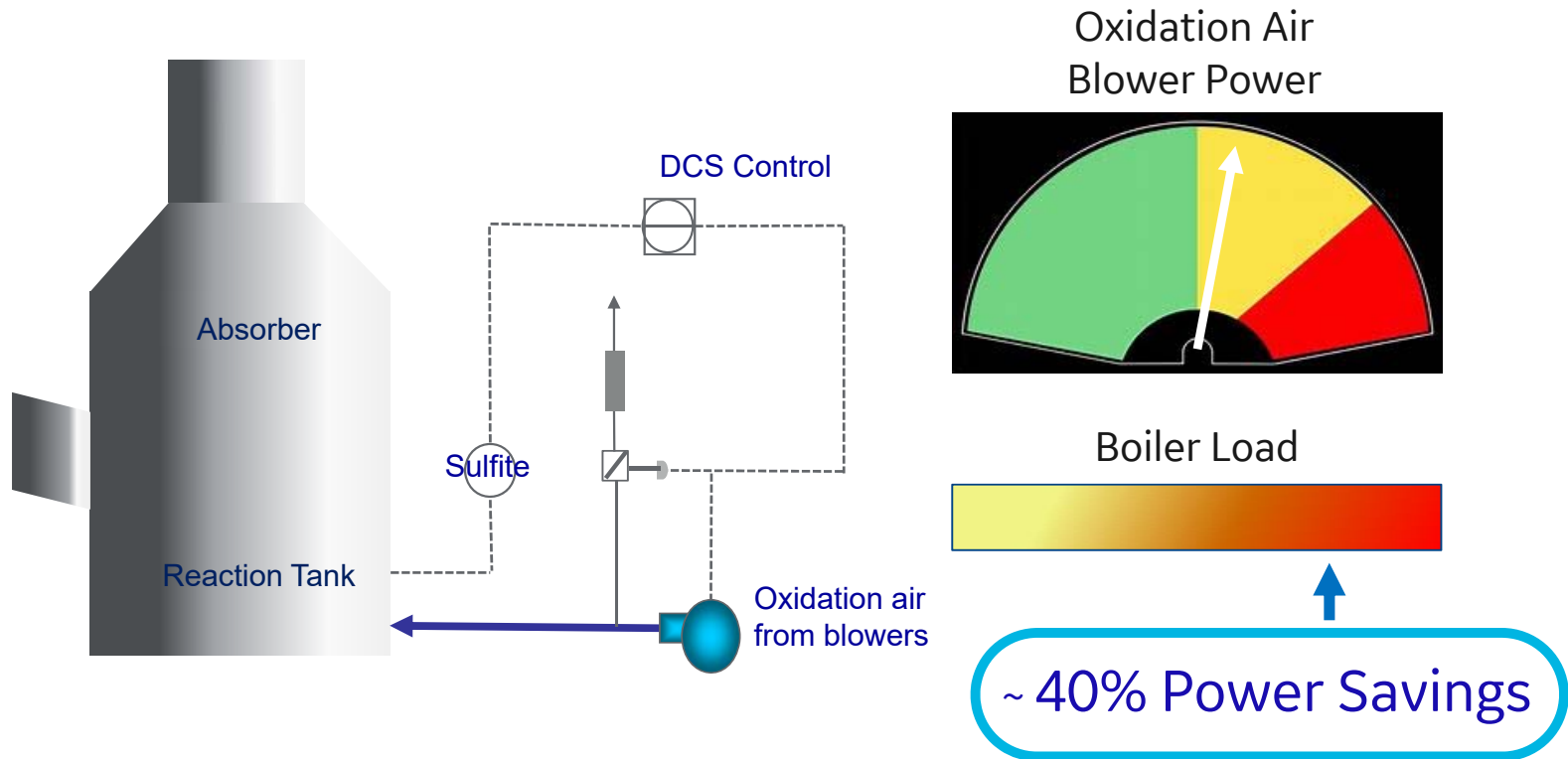
Oxidation air blowers set for full load and maximum sulfur



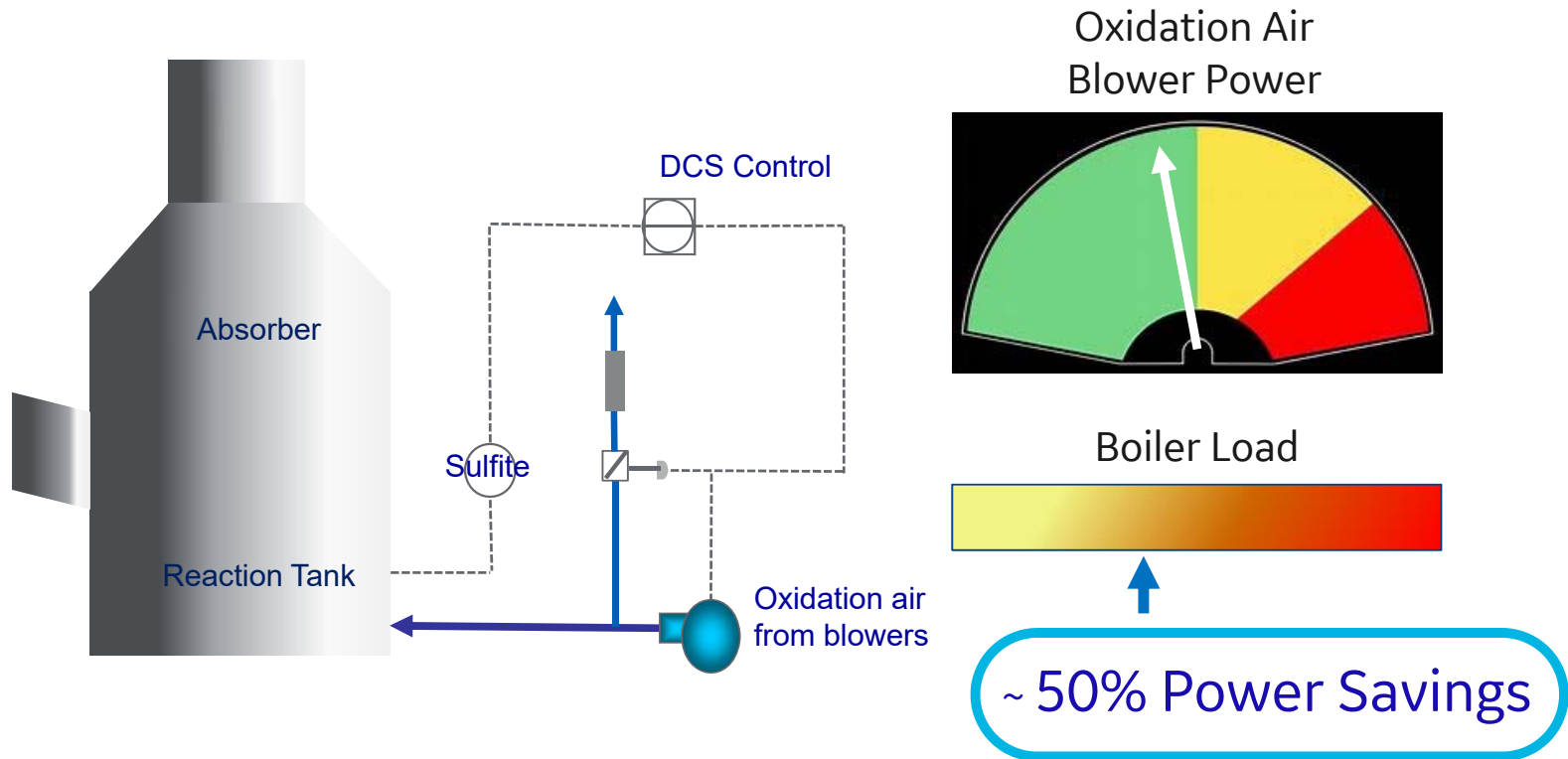
# GE's Limestone Controlled Oxidation Process



# GE's Limestone Controlled Oxidation Process



# GE's Limestone Controlled Oxidation Process



Power savings limited to blower turndown using inlet/outlet vaning and/or VSD



# Summary



# Key Benefits of Operation with Sulfite Control

- Minimizes mercury “re-emissions”
- Dissolved mercury in WFGD purge water reduced from >75 µg/l to <<1 µg/l
- Total selenium in WFGD purge water reduced >45%
- Remaining dissolved selenium >93% present as selenite (Se IV)
- Nitrates/nitrites in purge reduced >50%
- WFGD purge water easier and less costly to treat for Hg/Se/nitrates/nitrites
- Increased Mn solubility reduces scale/corrosion potential
- Gypsum purity maintained with sulfite control
- Reduce power consumption of the air blower



# Acknowledgments

## Seminole Generating Station

**Troy Patton** was the customer champion and provided planning, site coordination, and evaluation of results.

**Roger Murray** helped with the installation for the analyzer tested, and continues to support the full-scale installation on 10 WFGD absorbers

## EPRI and EPRI Host Site

**Nanda Srinivasan** coordinated to overall EPRI program for this effort

**Gary Blythe** of AECOM led the development of the test plan, and provided his substantial overall expertise and evaluation of the results



# Happy to answer your questions?



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Sulfite analyzer can be seen at our booth. Please stop by.