Worldwide Pollution Control Association

WPCA-Duke Energy FGD Wastewater Treatment Seminar

March 7, 2013

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Trends & Observations from a WFGD Effluent Characterization Study

FGD Wastewater Treatment Seminar

March 7, 2013
Duke Energy Corporate Headquarters, Charlotte, NC

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Siemens Environmental Systems & Services (SESS)

Outline

- Background
- Characterization and Why It is Important
- SESS Study
- Methodology
- Trends & Observations
- Recap

Background - Regulatory

- National Effluent Guidelines last revised (1982)
- Significant deployment of WFGD since due to tighter air quality regulations
- Stricter local, NPDES, and regional water quality limits
- Federal concern over power plant waters and discharges → WFGD
- EPA "Steam" Study (2009) & ICR (2010) → Hg, Se, As, Cd, V, B, N, Organics
- New Guidelines - Review (2012), Implementation (2014)

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Characterization and Why It Is Important

- Critical design criteria for WWT strategy is influent composition
- FGD effluent is dynamic and difficult to benchmark
- Mercury and Selenium chemistry affected by FGD effluent composition
- Waste water treatment performance can be significantly impacted
- More knowledge and data to inform the rulemaking
- Helps to ensure sound guidelines are not over reaching of WWT technology

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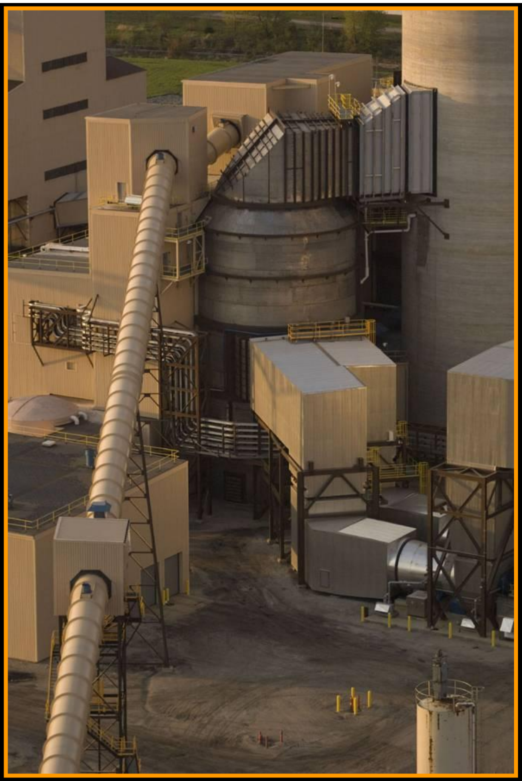
SESS Motivation



Over 14 GW of WFGD installations since 2006

SESS Study - Goals

- Better understanding of complex chemistry with respect to operations & WWT
- Assess relative impact from coal, reagents, APC, operations, other factors
- Robust data set for inclusion in USEPA review
- Sound basis for A&E's to specify required APC & WWT equipment

SESS Study - Design

- Planning began in late 2007
- Launched as an exploratory R&D project (2008)
- Targeted sample stream “to” WWT (e.g. SHOF, chlorides purge)
- Expanded (2010) to also include diagnostic sampling events from startups
- Sampled absorber slurry samples from diagnostic sampling events
- Differs only significantly in % solids. Relatively same in liquor phase
- Would increase data confidence and aid in determination of reliable ranges

SESS Study - Overview

WFGD	15 (covering 15 different power plants)
Sampling Events	18 (3 plants sampled 2x under different chemistry) Plant A – w/o and w/ SCR Plant I & L – different limestone
Sampling Dates	2008 through 2012
Project Milestones	MEGA 2008 (I) : Preliminary Findings & Study Design MEGA 2010 (II): Trends Electric Power 2011: Case Studies WFGD/WWT Optimization MEGA 2012 (III): Study Update, Data Summary (Percentiles)

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Methodology – Sampling

- Adequate line flushing prior to collection
- “Clean” sampling techniques
- Elements & Hg : Filtered sample on-site
  or
  Shipped immediately & filtered upon receipt
- Clean sample bottles provided by lab
- Preservation when required
- Protective cooler and chain of custody

Methodology – Analytical

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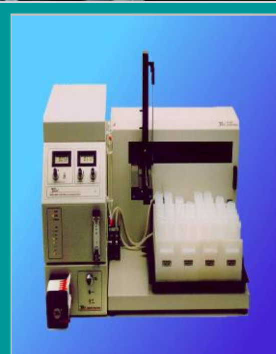
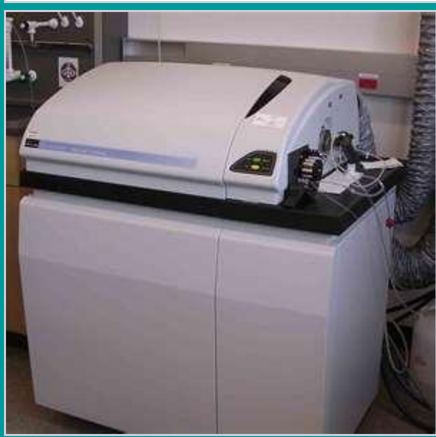


Parameter	Analytical Method
pH, Temperature	Meter
BOD5	EPA 405.1, SM 5210B
TSS	EPA 160.2, SM 2540D
TDS	EPA 160.1, SM 2540C
Alkalinity, Bicarbonate	EPA 310.1, SM 2320B, SM 4500CO2
COD	EPA 410.4, SM 5220B
TOC	EPA 415.1
NH_3 (N)	EPA 350.1
TKN	EPA 351.2
Cl^-, Br^-, NO_3^-, NO_2, SO_4^{2-}	EPA 300.0
F^-	EPA 340.2, SM 4500 F C
Orthophosphate	EPA 365.1
Hexane Extractiable Materal (HEM)	EPA 1664A
Total Hardness	SM 2340B
Specific Conductance	SM 2510B
Dissolved Organic Carbon	SM 5310B
Dissolved Elements: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, K, Ni, Se, Si, Ag, Sr, Na, Tl, Ti, V, Zn	EPA 200.7, DRC-ICP-MS, EPA 200.8
Dissolved Hg	EPA 1631E, EPA 245.1

Photos: PerkinElmer, Dionex, Tekran, SciencePhoto.com

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SESS Study vs. EPA "Steam" Study

	SESS	EPA[1]
Samples	18 ★ (*8 events were absorber slurry*)	5
Classicals & Dissolved Ions	Yes	Yes
Elements	Dissolved Elements	Dissolved Total *Routine & Low Level*
Elemental Methods	Combination of ICP, ICP-MS, DRC-ICP-MS, CVAF (Hg), and CVAA (Hg)	Combination of ICP, ICP-MS, DRC-ICP-MS, CVAF (Hg), and CVAA (Hg)
Plant Monitoring Data Included	No. Only SESS generated data	Yes from 4 plants

[1]Steam Electric Power Generating Point Source Category: Final Detailed Study Report

Trends & Observations – Mercury

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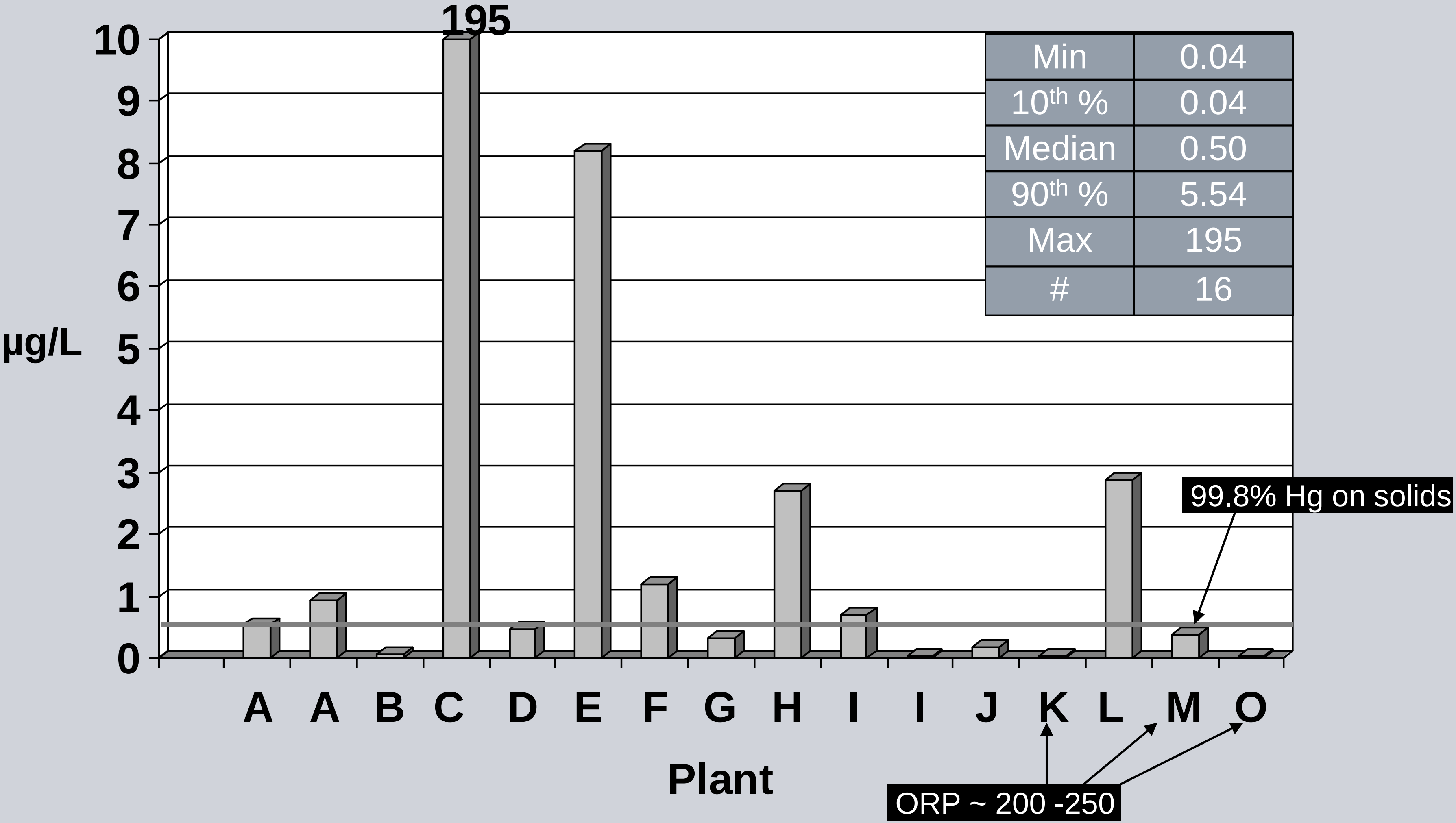
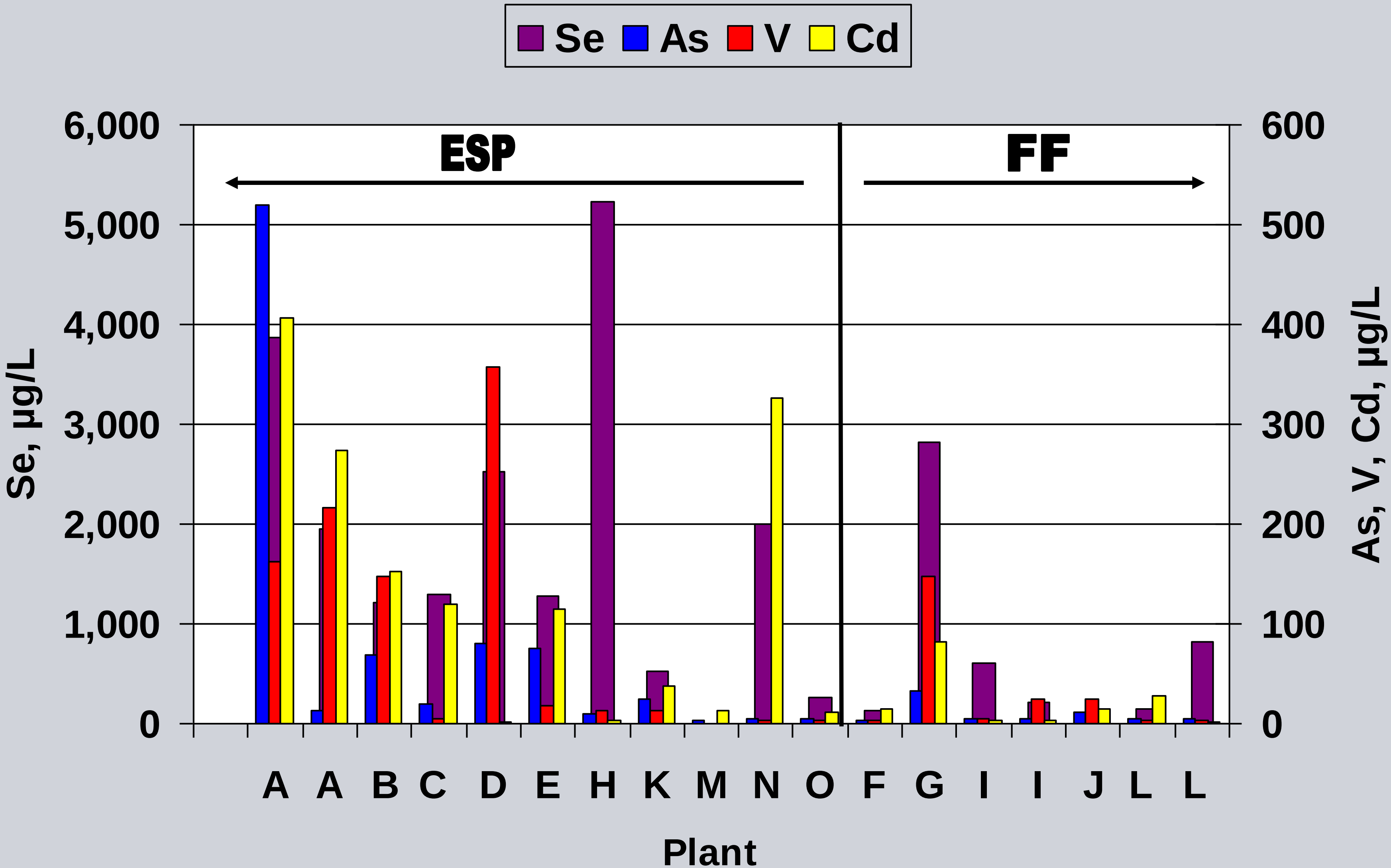
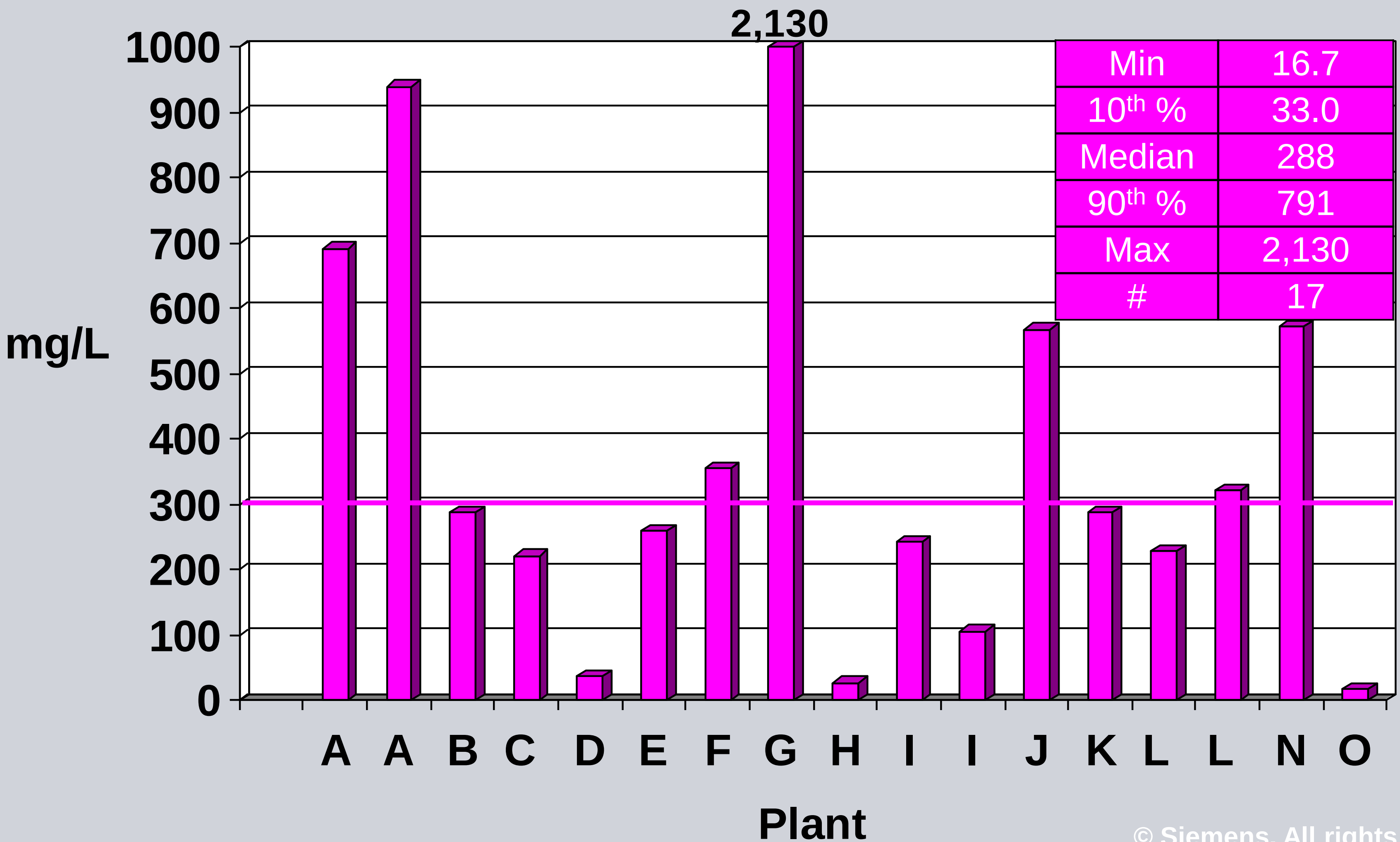


Min	0.04
10th %	0.04
Median	0.50
90th %	5.54
Max	195
#	16

Trends & Observations - Se, As, V, Cd

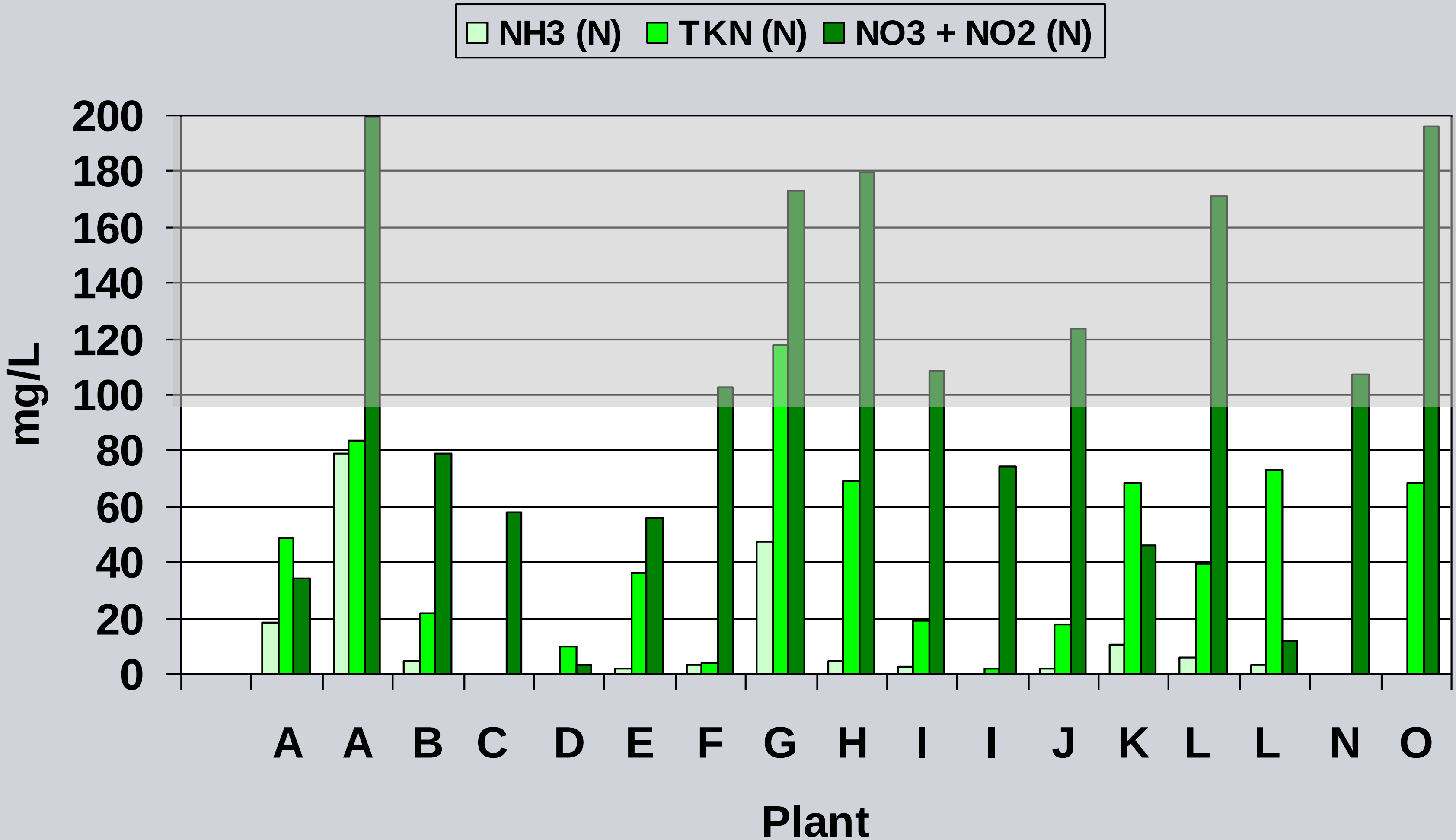


Trends & Observations - Boron

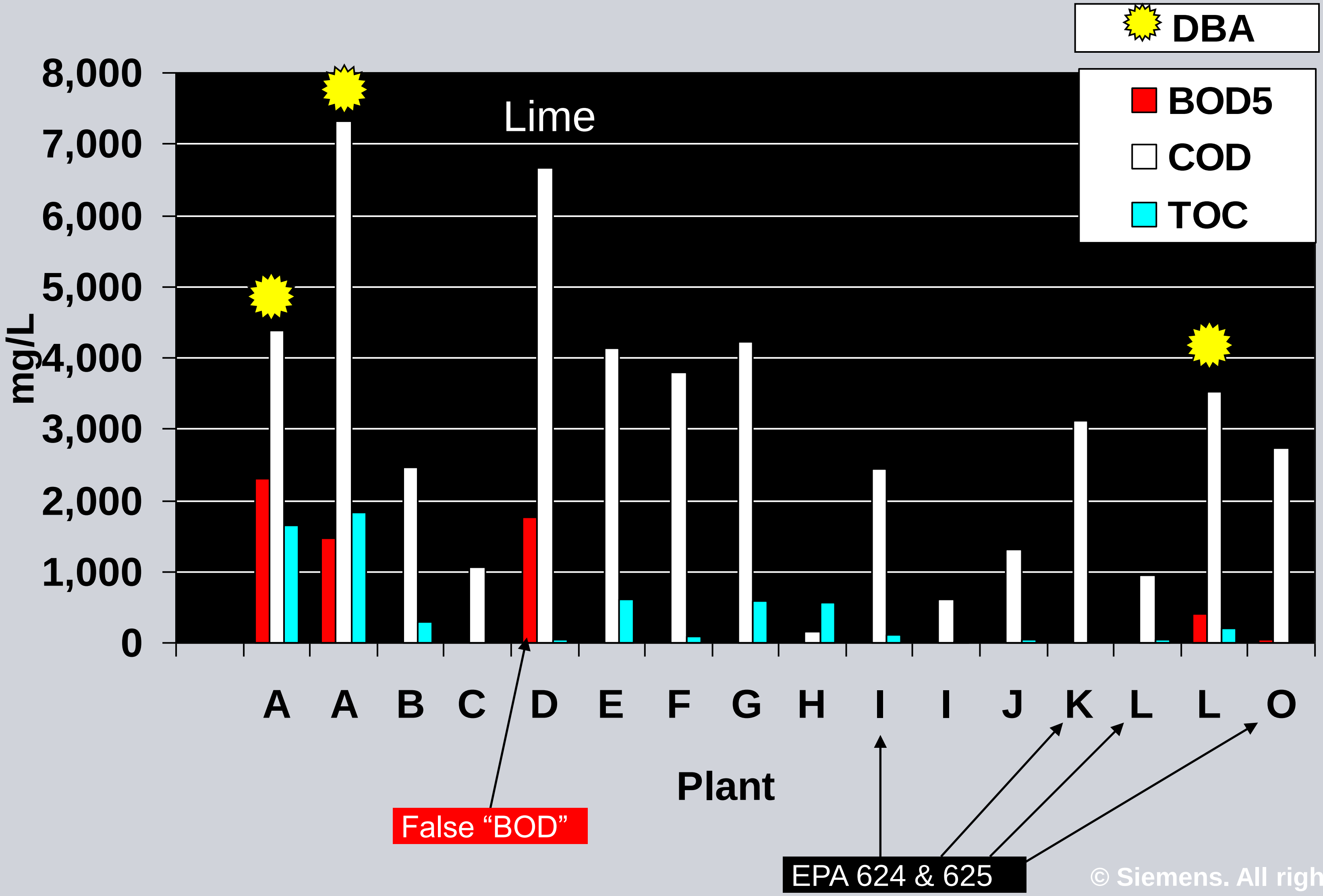


Min	16.7
10th %	33.0
Median	288
90th %	791
Max	2,130
#	17

Trends & Observations - Nitrogen



Trends & Observations - Organics



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Trends & Observations – Limestone

Plant I (Limestone 1)		
		Sr
Result	ug/L	171,000
SESS Study 90th %	ug/L	38,360
SESS Study Median	ug/L	6,320

Plant L		
	Limestone 1	Limestone 2
TDS	58,200	34,900
Ions (mg/L)		
Cl	7,220	8,700
F	117	68.1
Br	58.2	63.9
NO3	123	3.79
NO2	42.3	non detect
SO4	32,000	12,400
Dissolved metals (µg/L)		
Al	non detect	3,970
Ba	24.0	174
B	228,000	321,000
Cd	28.0	non detect
Ca	534,000	797,000
Cu	non detect	152
Fe	non detect	1,040
Mg	9,870,000	5,070,000
Mn	90,300	21,900
Mo	303	112
K	194,000	125,000
Se	147	817
Si	7,990	39,400
Sr	5,500	2,990
Na	2,320,000	1,440,000
Tl	137	39.0
Zn	58.2	2,740

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Recap

- **Hg**
  1. Relatively low liquor phase mercury concentrations across SESS fleet
  2. Other measurements (ORP & % Hg in solids) suggest ideal partitioning for effective Hg removal
  3. Design strategy contribute (I.e. larger recycle tanks & longer retention times)?

- **Se, As, Cd, V**
  1. Considerably lower concentrations in WFGD effluent with a FF vs. ESP
  2. FF offers reduced load on WWT for key regulatory elements (plus overall solids($) to WWT)
  3. Is FF (or an upgraded ESP) part of the solution for MATS + Revised Effluent Guidelines?

- **Boron**
  1. No observable trends

- **Nitrogen**
  1. No observable trends
  2. Possible correlation between N concentration and foaming? Further investigation required

- **Organics**
  1. BOD5 (and maybe TOC) not COD corresponds to organics in WFGD effluent

- **Limestone Quality – Impact on WFGD effluent**
  1. Can severely disrupt WFGD and WWT with operational problems
  2. Can change liquor chemistry significantly (dissolved ions and elements)
  3. High levels of inerts can add to solids load to WWT

Thanks

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