REINHOLD ENVIRONMENTAL Ltd.

2015 APC Round Table & Expo Presentation

July 13 & 14, 2015, in Atlanta, GA / Hosted by Southern Company

Reinhold APC July 2015

Operational Improvement with High Reactivity Hydrated Lime DSI– 7/13/2015

Chad Donner – Sorbent Injection SME

Think about it…

“Everything Affects SO3 and SO3 Affects Everything”

For Example…

- "Everything effects SO3 and SO3 effects everything"
  - Boiler/SCR SO2 Oxidation, O2%, SCR MOT, Nox Removal, ABS Formation/AH Pluggage, Heat Rate, HCl Removal, Mercury Capture, Precipitator Performance, FGD, Blue Plume
  - Quantifying all benefits of Heat Rate improvement, less coal, less ash, less landfill, credits etc…
  - No DSI requirements…hmmm…
- DSI systems need to be thought of as an integrated control technology not just a Sorbent Injection System as they have potential to impact the entire plant both positively and negatively.
  - Siloed vs. Holistic
- Typically sorbent injection systems have fallen short on effective means of control and long term reliability
  - If plants begin rely on these systems in order to operate, are they up to the challenge
- SO3 reacts quickly to changing conditions and doesn't react the same all the time
  - Sporadic events
- How do we get to the point where we don't have to constantly watch and adjust to changing conditions as future regs push for increased performance of all pollution control devices…Pattern Recognition Software???

Overview

- System Performance
- Dry Sorbent Injection Reliability

BIG New Ideas

Distribution Benefits

Cayuga

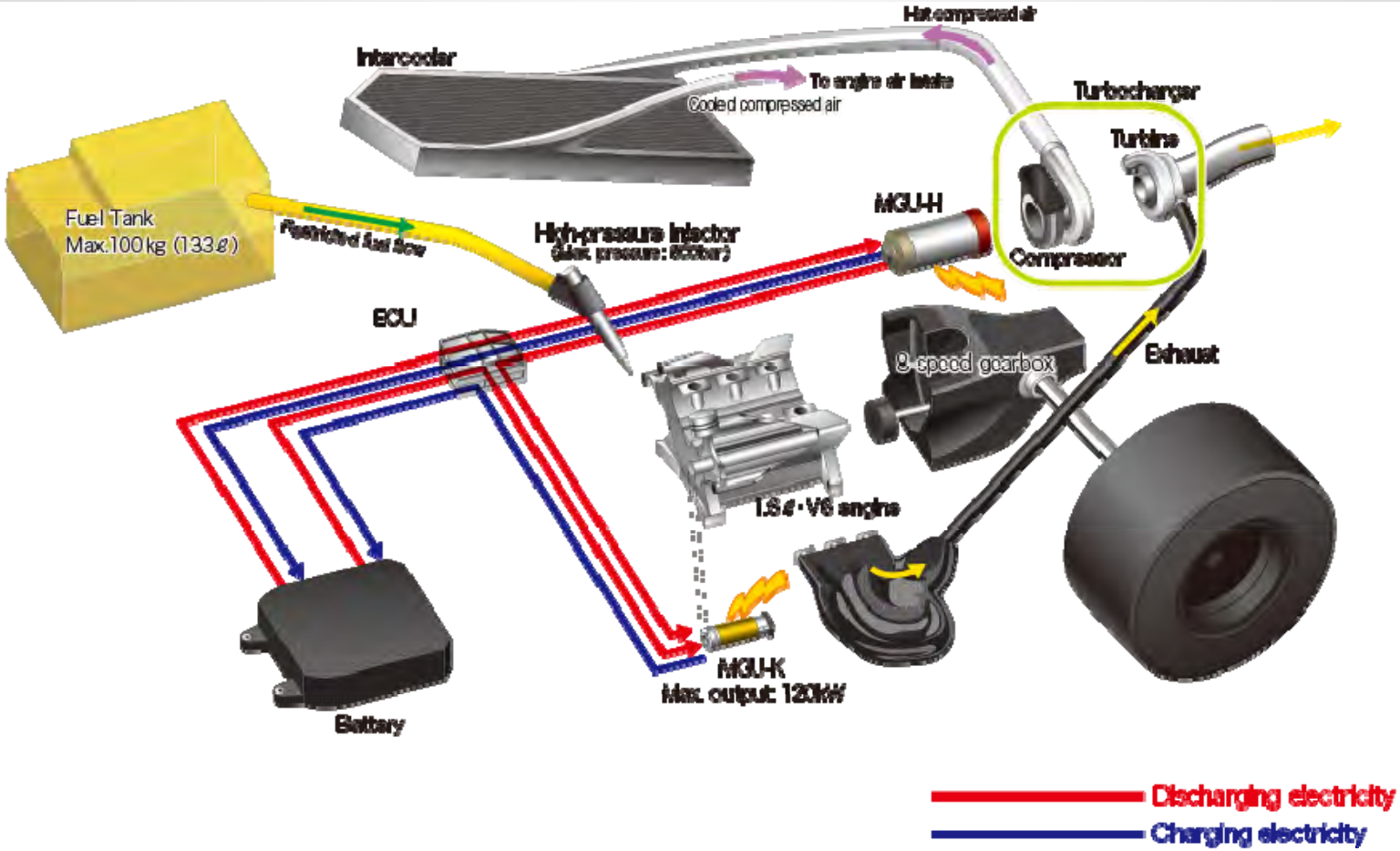
Air Heater Fouling

Heat Rate Improvement

System Performance

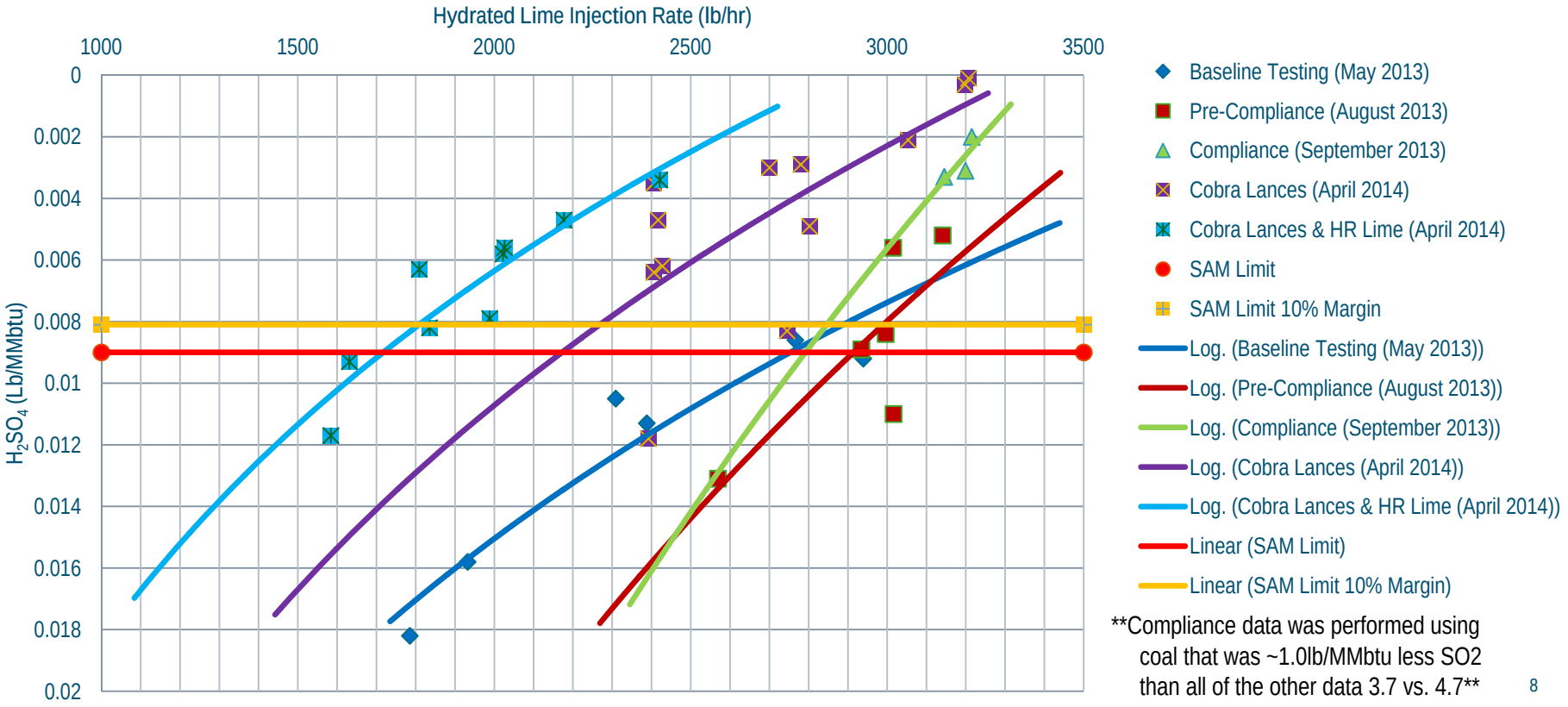
BIG New Ideas

BIG New Ideas



Distribution Benefits

Crystal River Unit 5 DSI Performance Improvements



Compliance data was performed using coal that was ~1.0lb/MMbtu less SO2 than all of the other data 3.7 vs. 4.7

Distribution Benefits

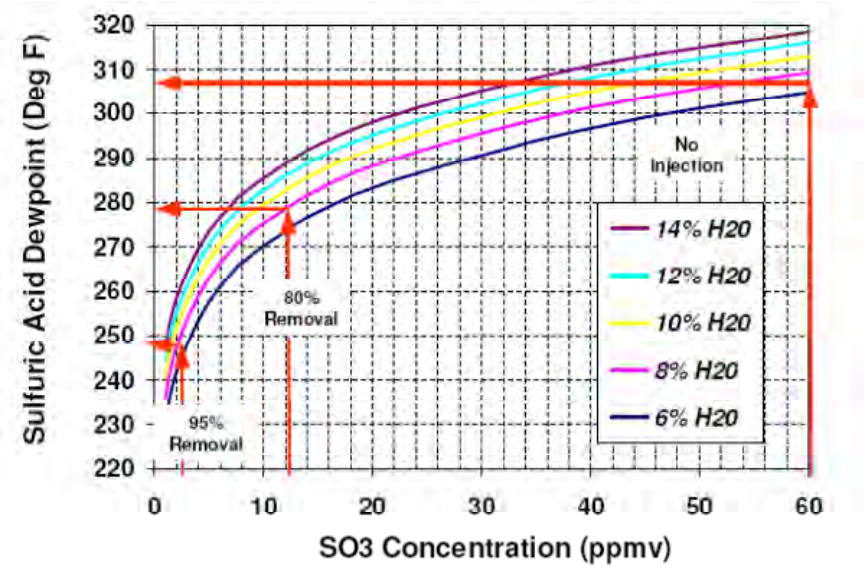
- UCC Cobra lances were installed on unit 5 at SCR outlet/ESP outlet at time of testing and ESP outlet only for unit 4
- CFD modeling was performed at the SCR outlet
- Lances were limited to installation in existing number and location of ports which still leads to less than ideal mixing
- SCR outlet injection still limited by chloride removal and chlorides in ash, fan issues and possible gypsum purity issues related to ESP outlet
- Test data was compared at full load conditions/stable operating parameters, however, compliance data was measured using a 3.7lb/Mmbtu fuel which contributed to the higher performance. All others were 4.7lb/Mmbtu

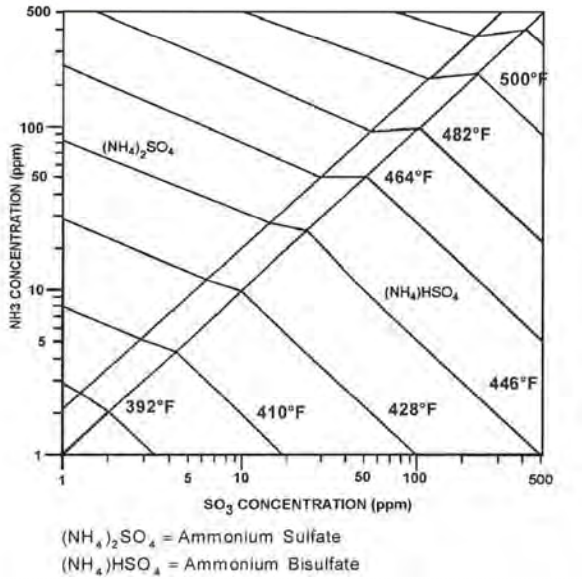
	As-Built	Cobra Lances	Cobra Lances & HR Lime
Injection Rate Required (lb/hr)	3,200	2,400	1,800
Reagent Reduction (%)	0%	25%	44% (19% over Cobra's)
Reagent Cost ($/Yr, 90% CP FLI)	$2,396,736 ($XXX/TN)	$1,797,552 ($XXX/TN)	1,823,569 ($XXX+/TN)
Cost Savings ($/Yr, 90% CP FLI)	$0	$XXX,XXX	$XXX,XXX-

Cayuga

- Pre SCR / No DSI, 5.0 lb/MMBTU SO2 Coal
- Post SCR / DSI, 3 Layers, no Ammonia, 5.0 lb/Mmbtu SO2 Coal, Mass Ratios ~3.25 lb Hydrate / Lb SO3

Air Heater Fouling





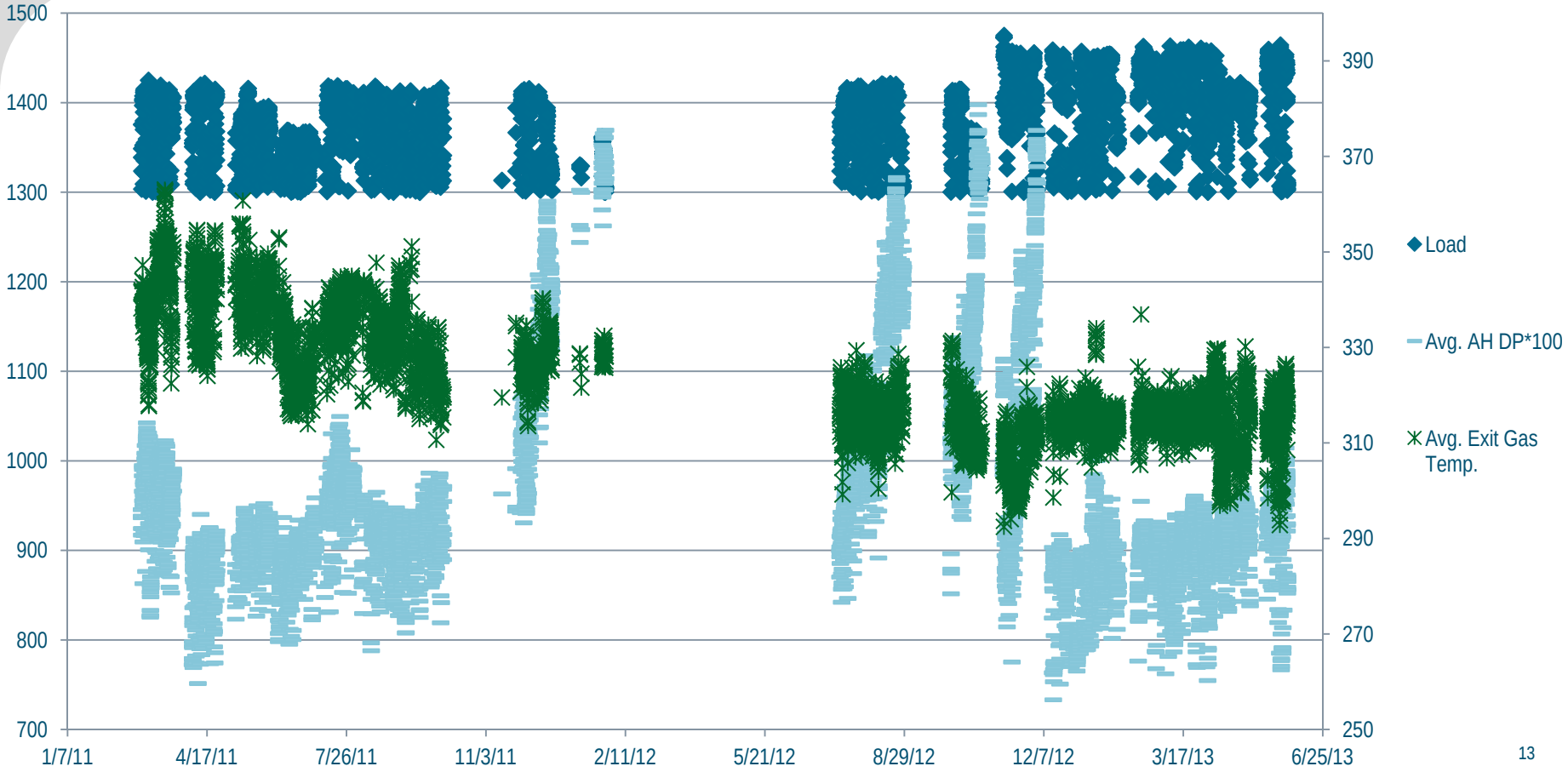
- Two different fouling mechanisms as a function of SO3
  - Ammonia & Sulfuric Acid
- Sorbent Injection works to reduce or eliminate air heater fouling by reducing the SO3 in the flue gas
  - Assuming SO3 is neutralized prior to the air heater
- Testing at Zimmer has shown Sulfuric Acid dewpoints down to 220-230F measured on Breen Probe with high injection rates

Air Heater Fouling

- Installed 4th layer in Fall '11, removed 3rd layer in Spring '12
  - Later discovered the 4th layer that was installed had double the SO2 oxidation rate, increasing SO3 to the AH
- Air heater rebuild with new seals and partial basket replacement
  - Tightened AH's and dropped outlet temp
  - Started having significant sulfuric acid pluggage
- Fuel flexibility drove decision to reverse direction of rotation on tri-sector air heater for more PA temp
- Installation of an intermediate reheater reduce economizer outlet temps
  - Further reduced AH outlet temps
- Made the decision to move the current Sorbent Injection upstream of the SCR/AH to mitigate air heater pluggage

Air Heater Averages	Pre 2012 Outage	Post 2012 Outage	Δ
Primary Air Temp.	504	574	+70
Secondary Air Temp.	553	546	+7
Gas Inlet Temp.	653	644	-9
Gas Outlet Temp.	335	313	-22

Air Heater Fouling



Heat Rate Improvement

- A reduction of 30 degrees F on air heater exit gas temp is approximately a 1% savings in unit heat rate
- Improved heat rate has benefits beyond coal cost
  - Decreased fuel handling
  - Decreased ash & waste handling and stabilization
  - Decreased CO2 emissions
  - Better native Hg capture
  - Better precip performance
  - Decreased emissions overall
- Sustainability
  - People, Planet, and Profits

	Baseline	Less 1% HR	Savings
Heat Rate (BTU/KWh)	10,000	9,900	100
Yearly Fuel (TN's)	1,368,750	1,355,063	13,688
Yearly Ash (TN's)	109,500	108,405	1,095
Coal & Ash Cost ($'000)	87,600	86,724	876
CO2 Emissions (TN's)	3,367,125	3,333,454	33,671

Assumptions:

500 MW Unit
12,000 BTU/lb fuel heating value
75% Capacity Factor
$60/ton coal cost
10% ash content
$50/ton ash processing cost
205 lb/Mmbtu CO2 Emissions per EIA

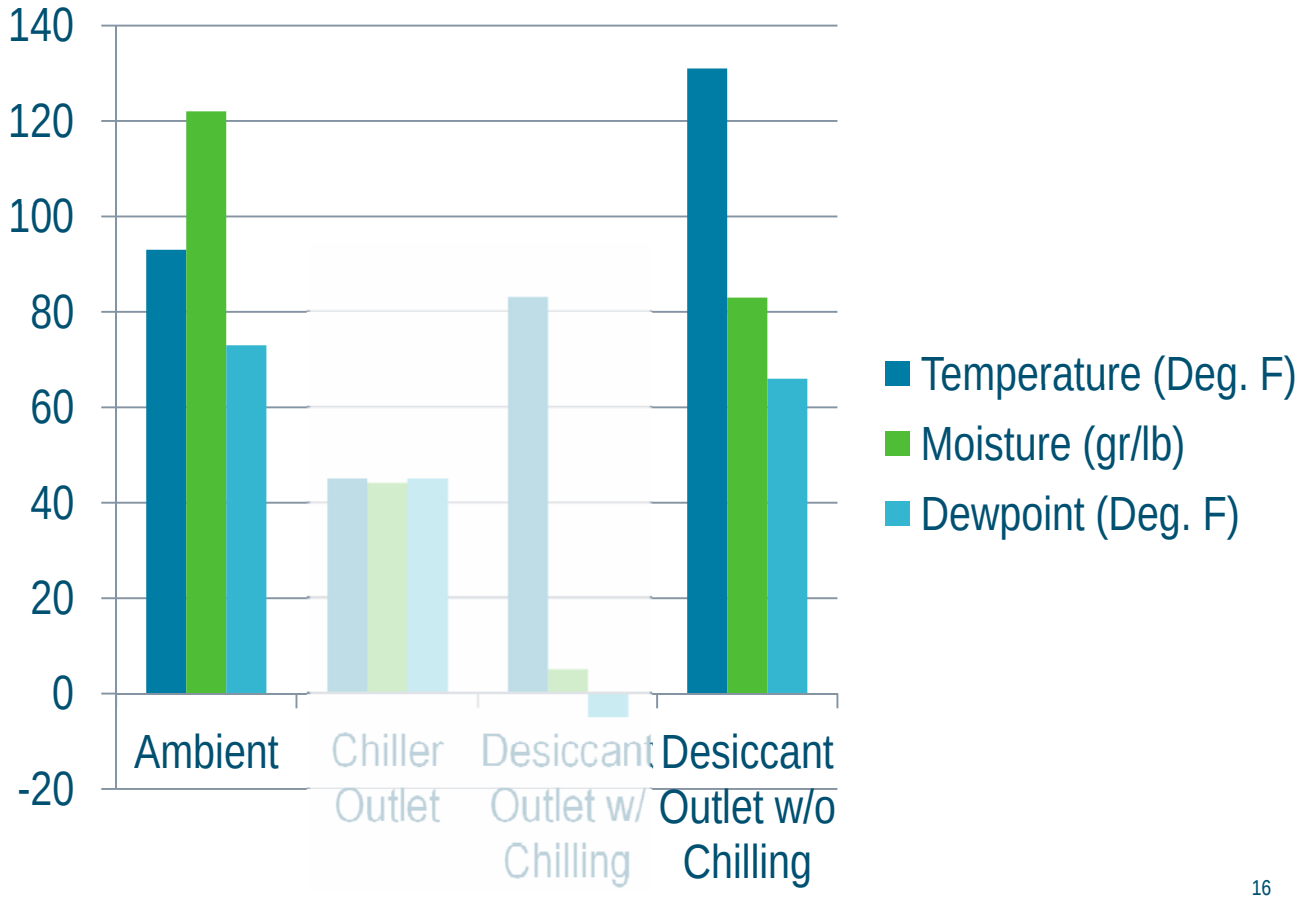
Conveying Air Quality

Cayuga

Dry Sorbent Injection Reliability

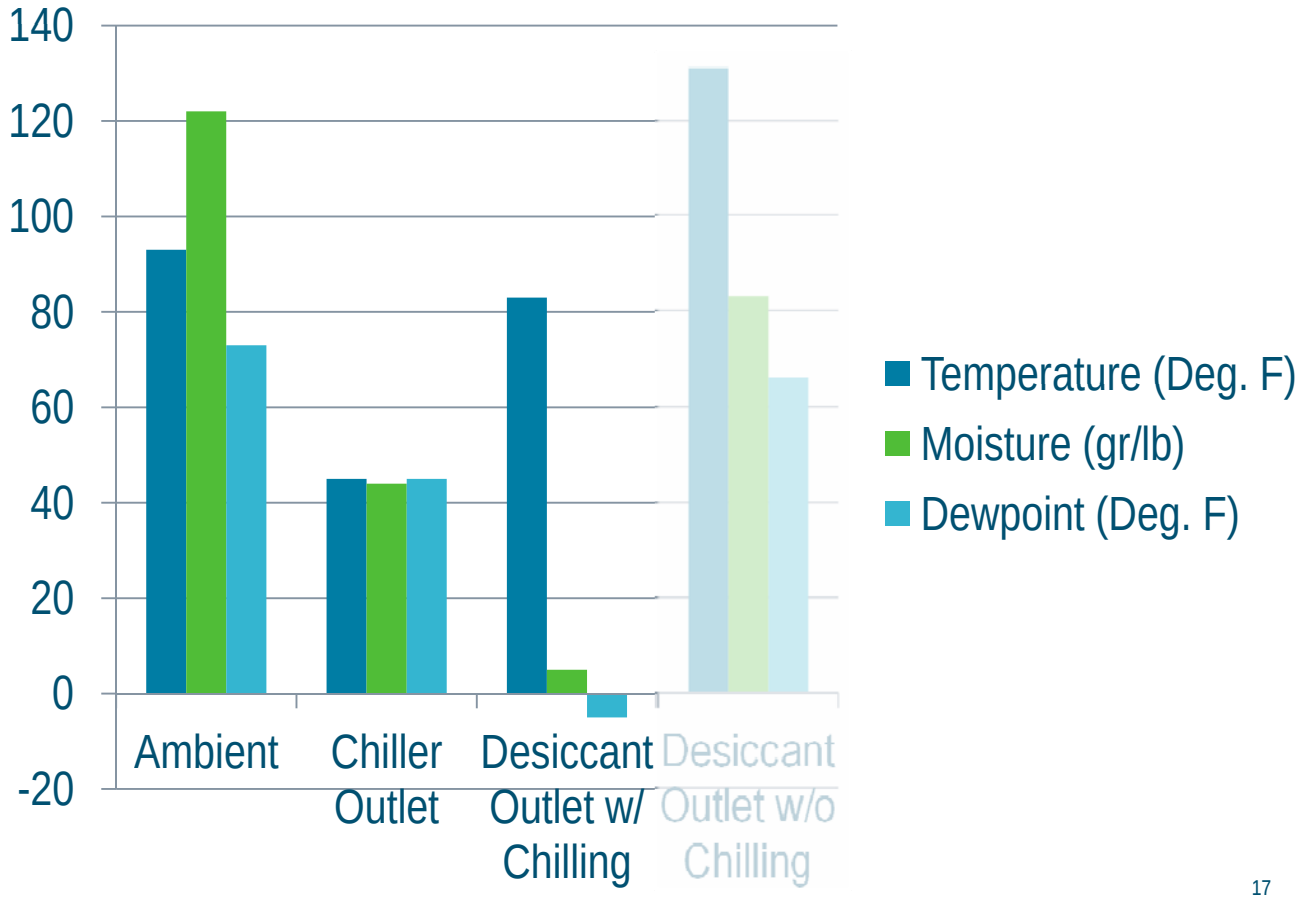
Conveying Air Quality

- Calcium Carbonate scaling is a function of moisture (RH) & temperature
- Desiccant dryer alone can cause more issues than no dryer at all due to increased temperature
- Sites using desiccant dryer only are prone to increased pluggage and “Condensation Events”
- Carbonation reduces effectiveness of Hydrated Lime



Conveying Air Quality

- Pre-chilling in combination with a desiccant dryer is the only effective means of moisture removal
- Dewpoints using this option are near dry compressed air usage
- Greatly reduces the possibility of having a “Condensation Event”



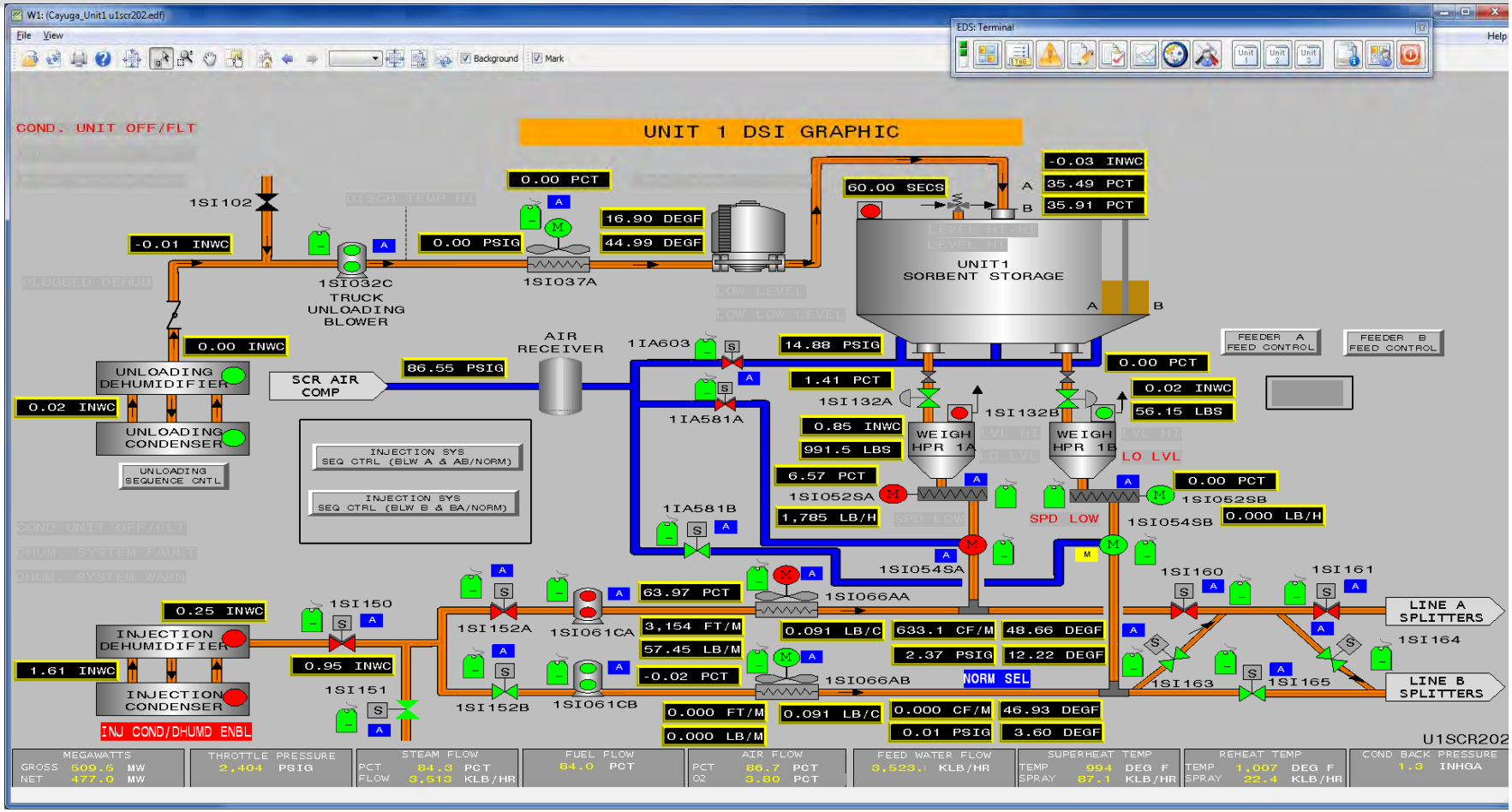
Cayuga

- System in operation for ~6 months
- Designed with many “Lessons learned”
- Considered industry leading technology
- Performance testing scheduled for August
- Very long conveying distance ~1,200 ft
- Design basis was 4,000 lb/hr and currently only inject 1,000-1,500 lb/hr

Cayuga

Cayuga

Cayuga


W1: (Cayuga_Unit1 u1scr202.edf)
File View
Background
Mark
EDS: Terminal
Help
COND. UNIT OFF/FLT
UNIT 1 DSI GRAPHIC
1SI102
-0.01 INWC
0.00 PCT
0.00 PSIG
16.90 DEGF
44.99 DEGF
1SI032C
TRUCK
UNLOADING
BLOWER
1SI037A
60.00 SECS
-0.03 INWC
35.49 PCT
35.91 PCT
UNIT1
SORBENT STORAGE
0.00 INWC
UNLOADING
DEHUMIDIFIER
0.02 INWC
UNLOADING
CONDENSER
UNLOADING
SEQUENCE CNTL
SCR AIR
COMP
86.55 PSIG
AIR
RECEIVER
1IA603
14.88 PSIG
1IA581A
1.41 PCT
1SI132A
1SI132B
0.85 INWC
991.5 LBS
WEIGH
HPR 1A
WEIGH
HPR 1B
LO LVL
0.00 PCT
0.02 INWC
56.15 LBS
FEEDER A
FEED CONTROL
FEEDER B
FEED CONTROL
INJECTION SYS
SEQ CTRL (BLW A & AB/NORM)
INJECTION SYS
SEQ CTRL (BLW B & BA/NORM)
6.57 PCT
1SI052SA
1,785 LB/H
1IA581B
SPD LOW
1SI052SB
0.000 LB/H
1SI054SB
1SI054SA
1SI160
1SI161
0.25 INWC
INJECTION
DEHUMIDIFIER
1.61 INWC
INJECTION
CONDENSER
INJ COND/DHUMD ENBL
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1SI152B
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1SI061CB
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2.37 PSIG
12.22 DEGF
NORM SEL
0.000 FT/M
0.000 LB/M
0.091 LB/C
0.000 CF/M
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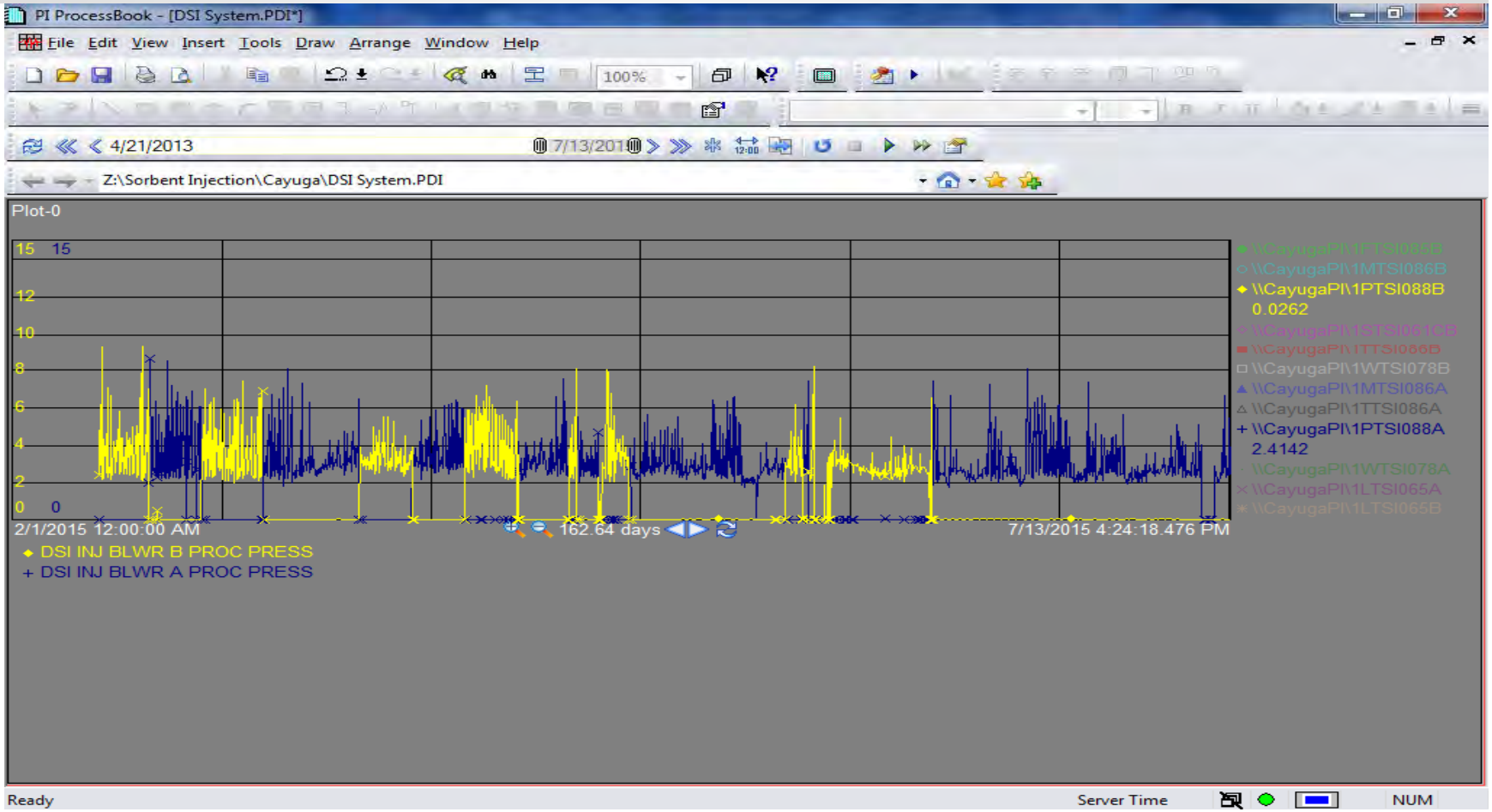
0.01 PSIG
3.60 DEGF
1SI163
1SI164
1SI165
LINE A
SPLITTERS
LINE B
SPLITTERS
U1SCR202
MEGAWATTS
GROSS 509.5 MW
NET 477.0 MW
THROTTLE PRESSURE
2,404 PSIG
STEAM FLOW
PCT 84.3 PCT
FLOW 3,613 KLB/HR
FUEL FLOW
84.0 PCT
AIR FLOW
PCT 86.7 PCT
O2 3.80 PCT
FEED WATER FLOW
3,623. KLB/HR
SUPERHEAT TEMP
TEMP 994 DEG F
SPRAY 87.1 KLB/HR
REHEAT TEMP
TEMP 1,007 DEG F
SPRAY 22.4 KLB/HR
COND BACK PRESSURE
1.3 INHGA

Cayuga

- System has run ~6 months without any trend up in system pressure
- Typically sites have struggled with pluggage events during “Shoulder” months where DSI systems operate during near saturated ambient conditions
- Dewpoint monitoring during these weather conditions indicated 12 degrees F

Cayuga

Cayuga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DSI INJ BLWR A PROC PRESS
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Ready
Server Time
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Questions?


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