REINHOLD ENVIRONMENTAL Ltd.

2016 NOx-Combustion-CCR Round Table Presentation

February 1 & 2, 2016, in Orlando, FL / Hosted by OUC

Belews Creek 10 yrs On-Line Cleaning SAH

Scott Thomas, P.E.

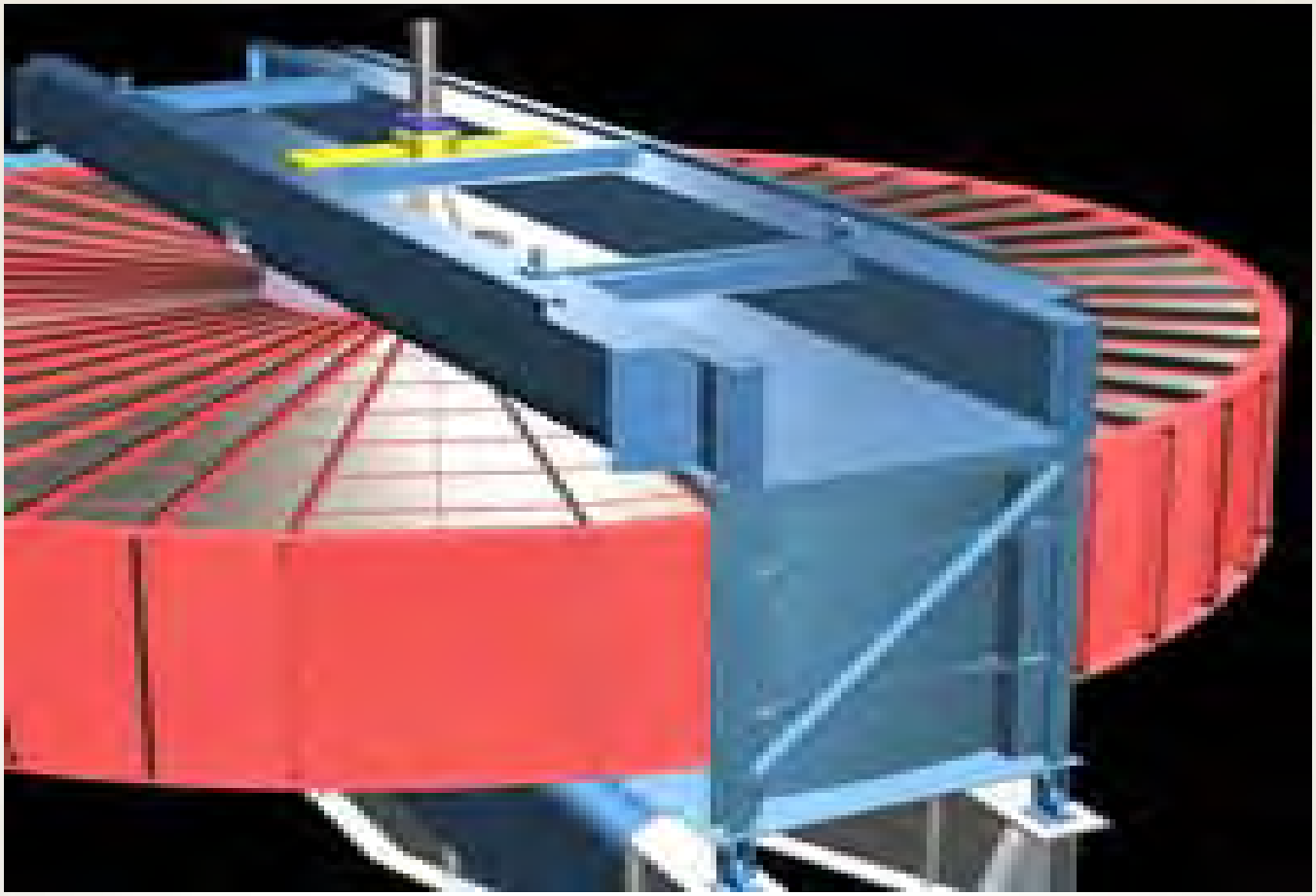
Duke Energy

Belews Creek station

Duke Energy – Belews Creek Steam Station
Carolinas East Region

- 2- 1650MW Units - Super Critical B&W Wall Fired Boiler
- Two Howden (Ljungström® Design) Vertical Shaft Regenerative air heaters (SAH)
- 33VN - approx 45’ dia w/ 48 element (pie) sections - 21.5’ x 80”
- 29” CS hot end
  - 41” Corten Closed Channel cold end (2011) – U1
  - 41” Epoxy coated DU cold end (2003) – U2
- Shaft driven APH with VFD control

DUKE ENERGY

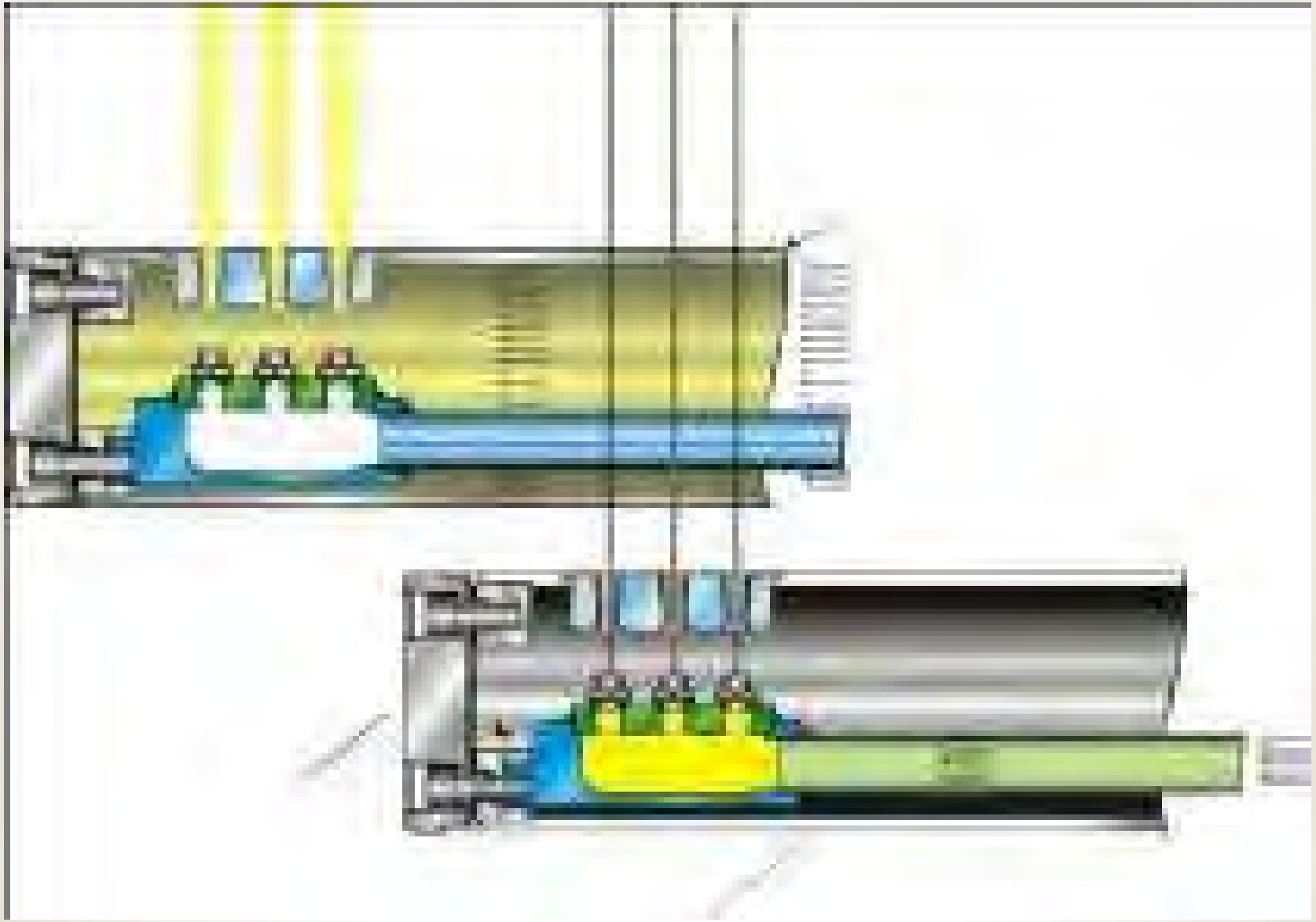


DUKE ENERGY.

APH Sootblowers

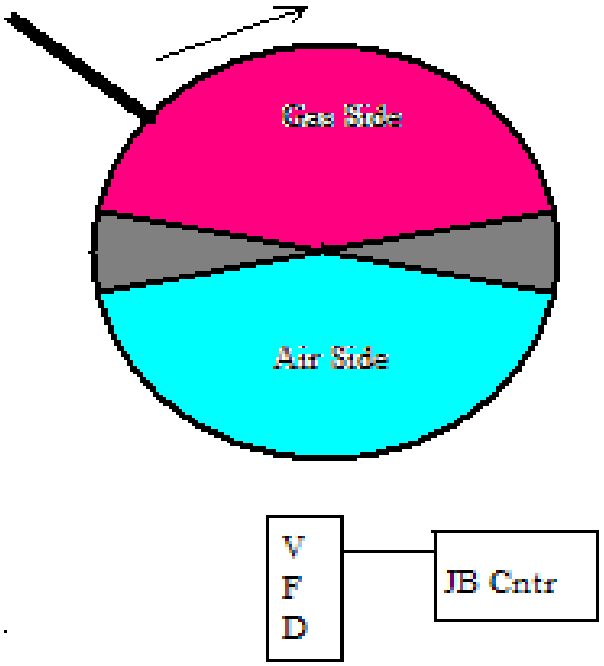
* Two Clyde Bergman Multible Fluid Retractable Soot-blowers (JetBlower®)
  * Top blower - Steam / LP (100 psi) Service water
  * Bottom blower - Steam / HP Water (2400psi @ 30 gpm)
  * Supplied by service water HP Pump Skid – Delivers max 72 gpm @2900 psi - positive displacement pump (one or two blower operation)

DUKE ENERGY.

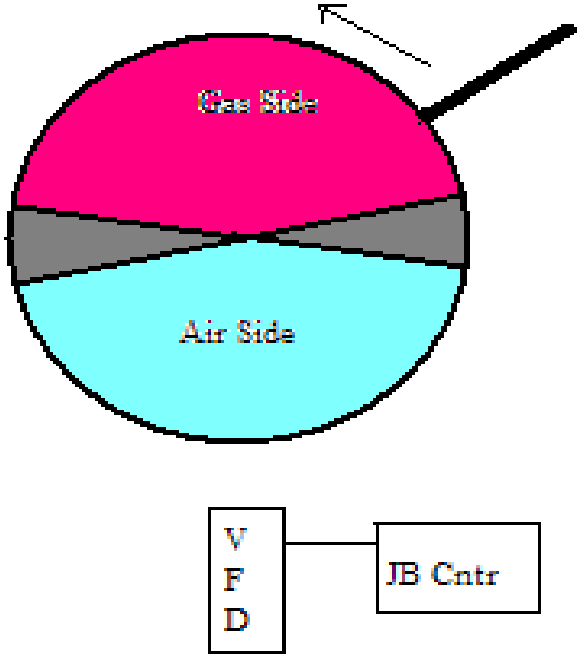


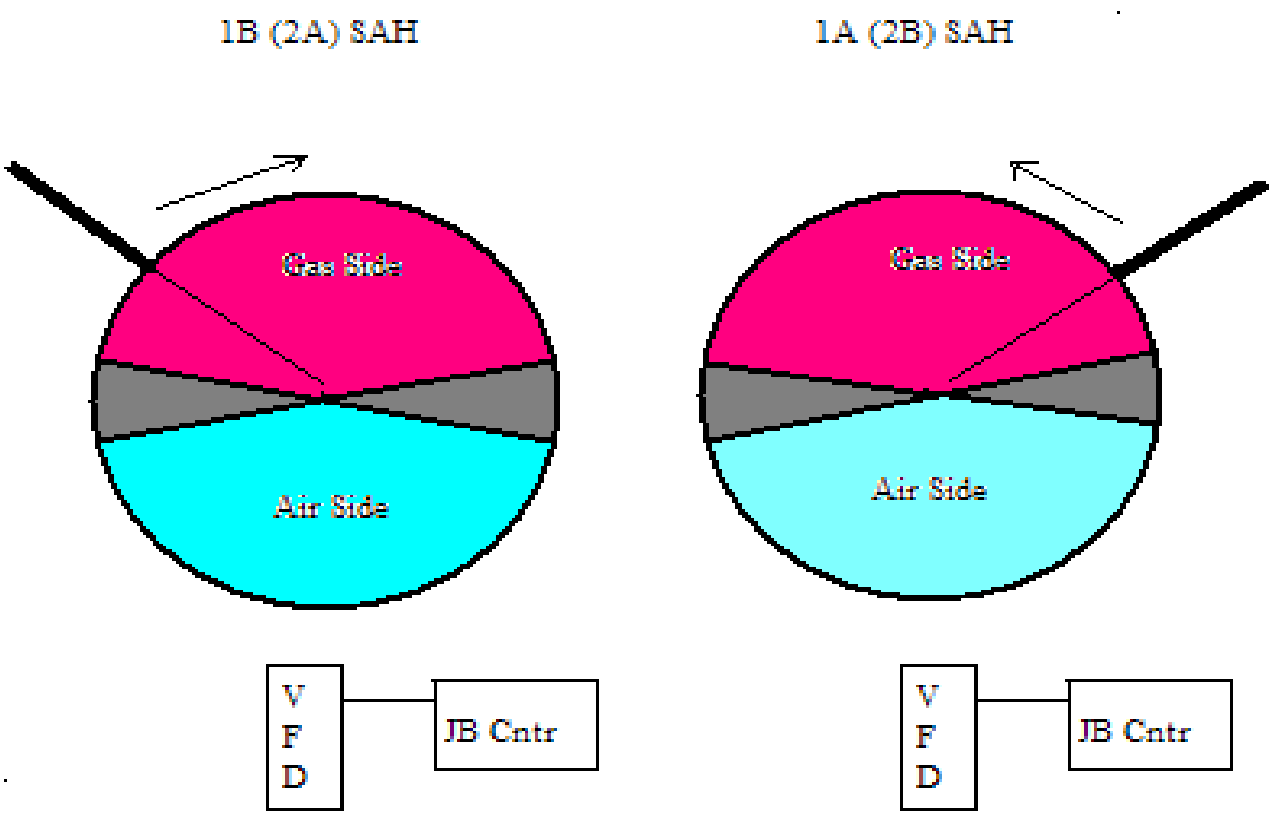

2

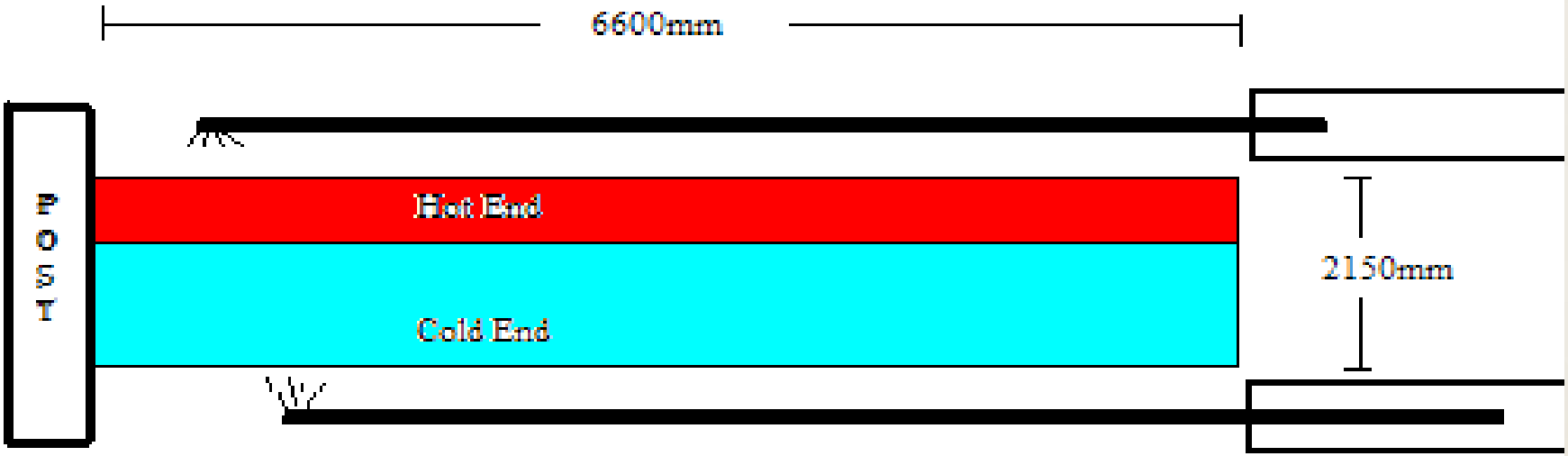
1B (2A) SAH



1A (2B) SAH



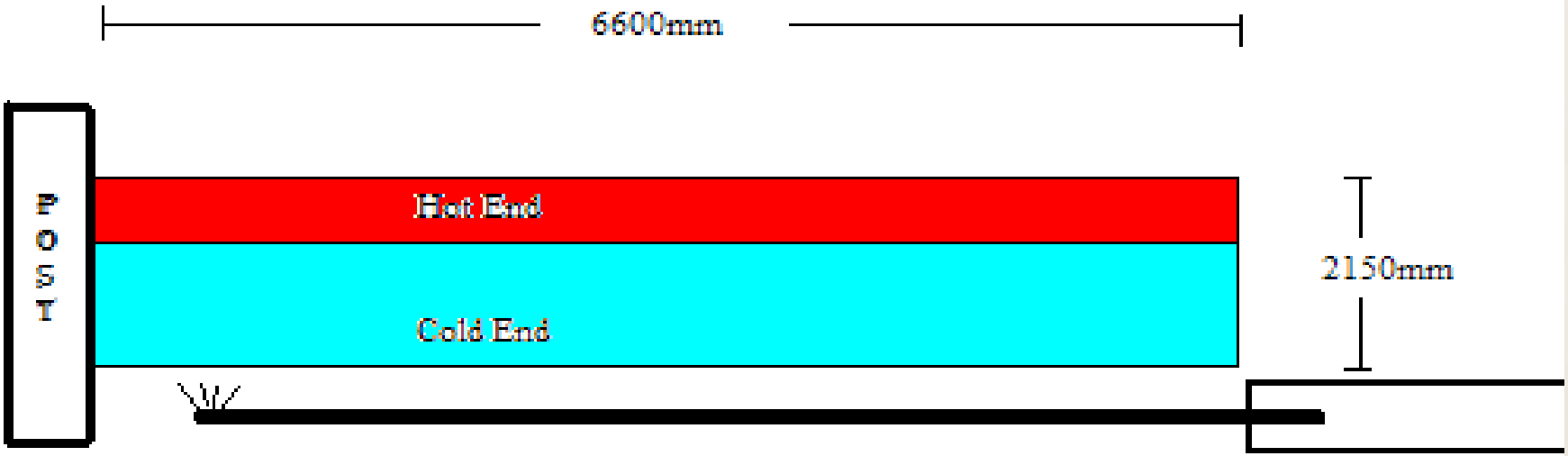

1B (2A) SAH
Gas Side
Air Side
V
F
D
JB Cntr
1A (2B) SAH
Gas Side
Air Side
V
F
D
JB Cntr

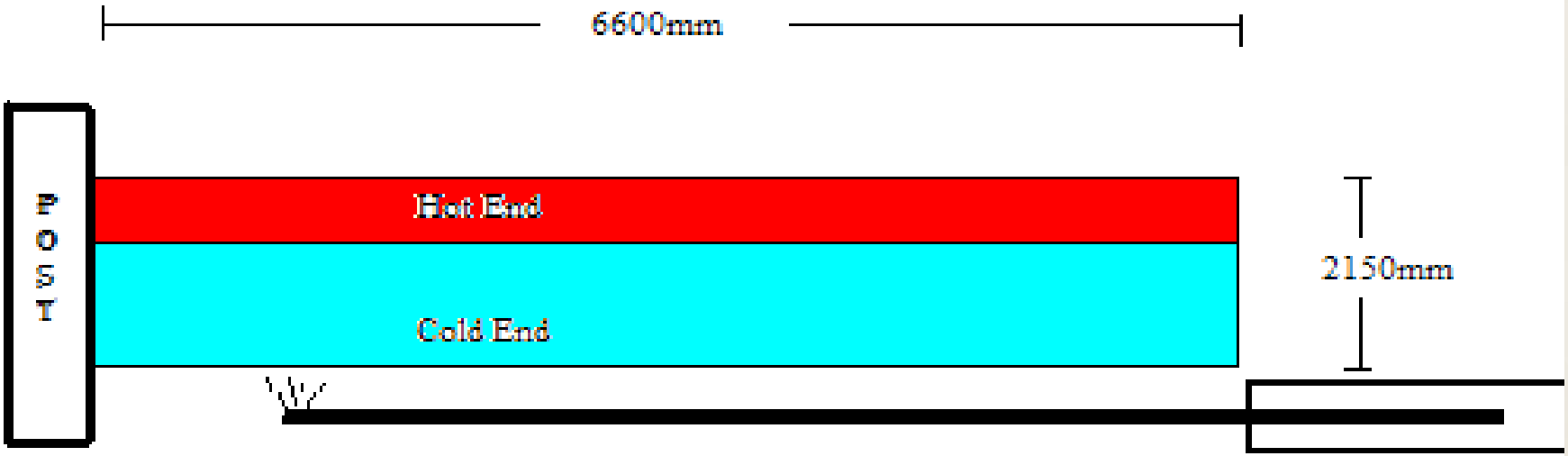

6600mm
POST
Hot End
Cold End
2150mm

Change in Off line Wash Strategy

* 2003-2005 – We learned that ABS is not our friend – Experienced High Secondary Air Pre-heater (SAH) dH – Traditional off line cleaning methods did not work
* Started experimented with slowing down SAH during off line washes - resulted in significant cleaning improvements
  * Bottom HP spray (steam flow) fully penetrates the rotors
* Automated by starting wash sequence at normal SAH rpm (1.25) lance fully inserted (retract type – 21')
* As the soot-blower steps out of the SAH (15mm 'step' - OLW ; 60mm 'step' – SB) rotor rpm is reduced to maintain constant angular velocity (0.2 rpm off-line ; 0.33 rpm on-line)

DUKE ENERGY.

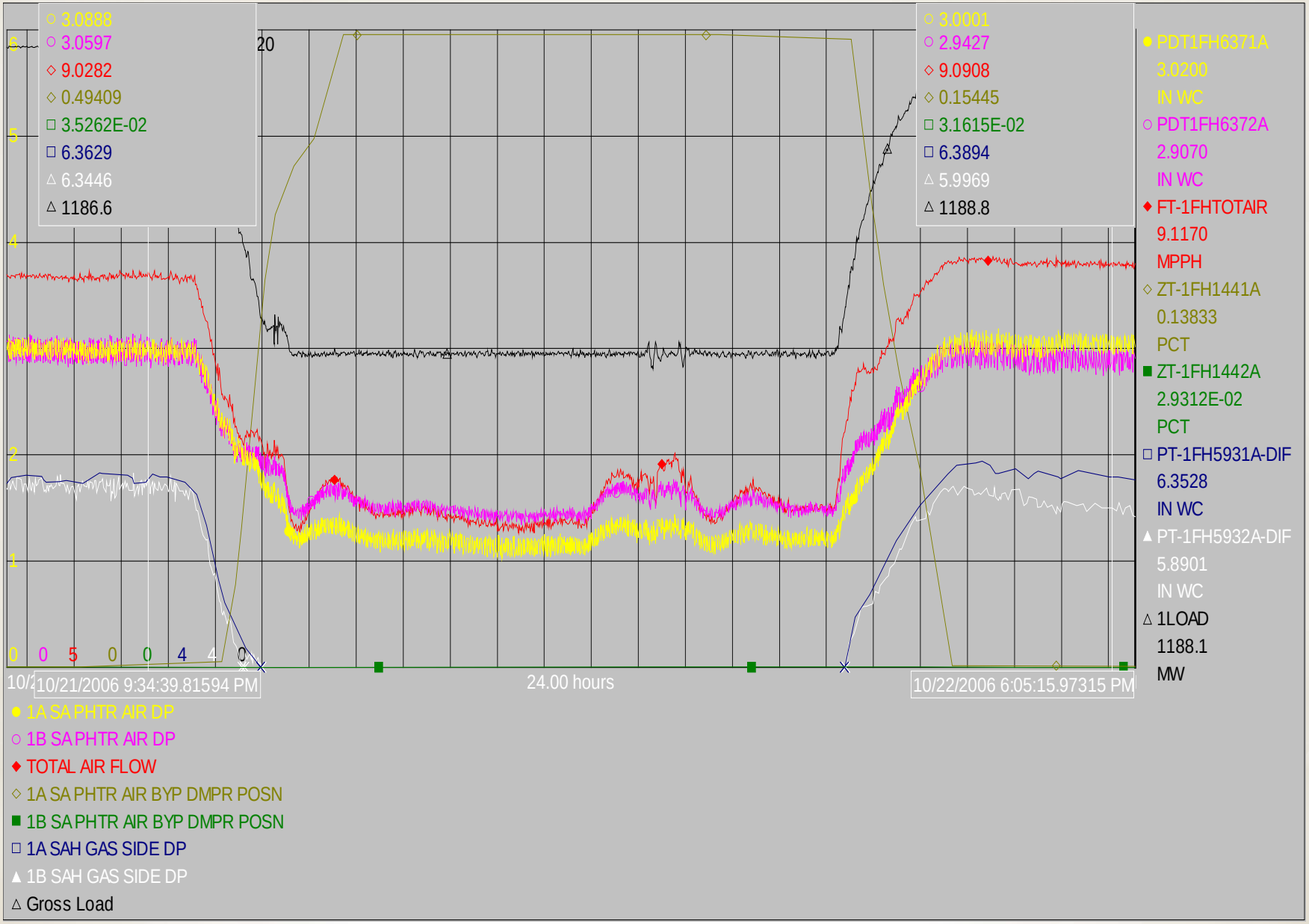

6600mm
POST
Hot End
Cold End
2150mm


6600mm
POST
Hot End
Cold End
2150mm

Continued SAH Fouling Issues

* 2005 – Discussion with Howden Engineering
* 2006 (March) – Starting experimenting with on-line cleaning using Off line clean algorithm
  * 1m was cleaned **on-line in March in front of U2 Spring outage – no issues noted during off-line inspection**
* 2006 (Sept) -Completed full radius HP wash on the 1B SAH HP in front of U1 Fall outage – no issues noted during off-line inspection and rotor look cleaner

DUKE ENERGY.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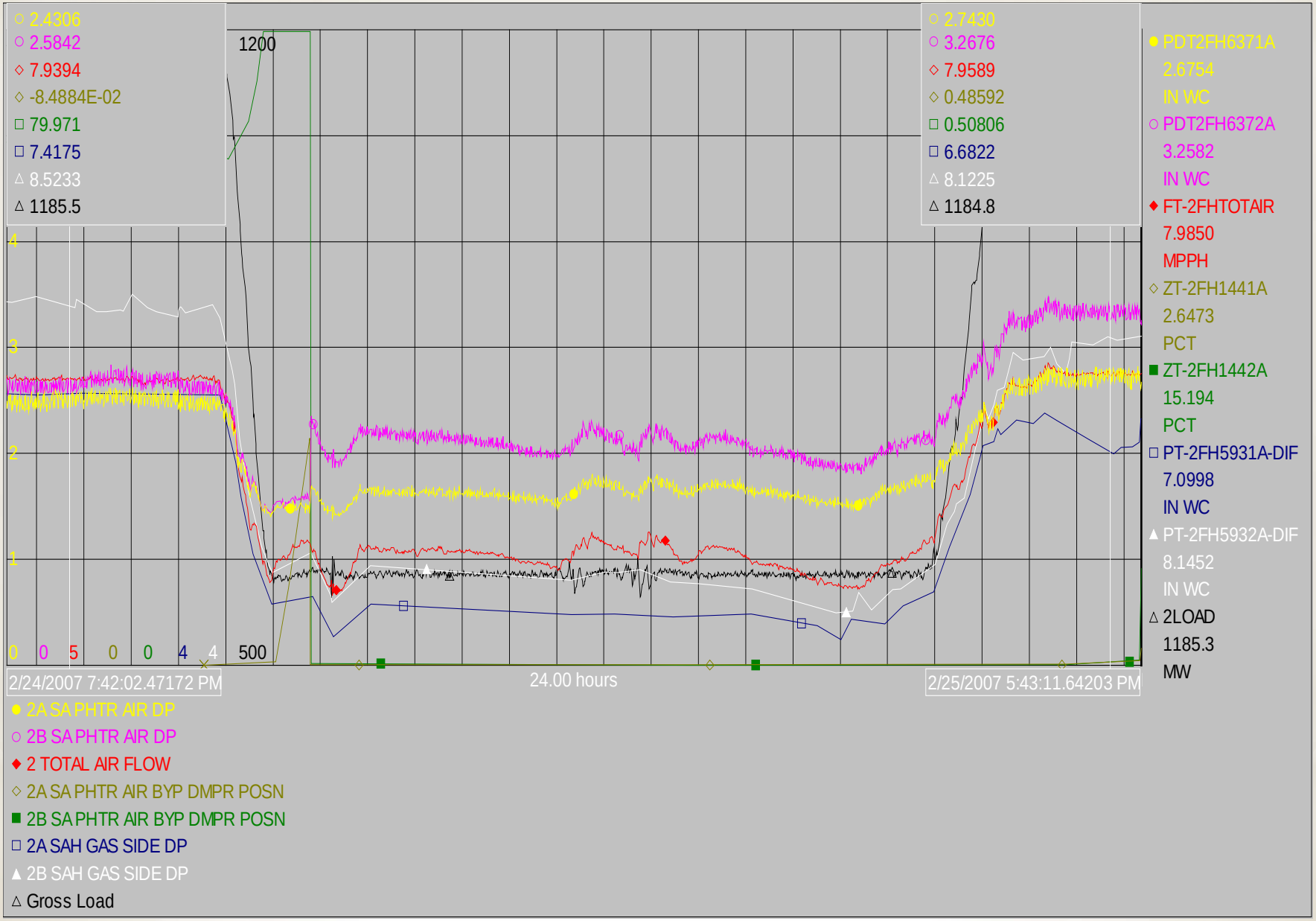
3.0597
9.0282
0.49409
3.5262E-02
6.3629
6.3446
1186.6
3.0001
2.9427
9.0908
0.15445
3.1615E-02
6.3894
5.9969
1188.8
PDT1FH6371A
3.0200
IN WC
PDT1FH6372A
2.9070
IN WC
FT-1FHTOTAIR
9.1170
MPPH
ZT-1FH1441A
0.13833
PCT
ZT-1FH1442A
2.9312E-02
PCT
PT-1FH5931A-DIF
6.3528
IN WC
PT-1FH5932A-DIF
5.8901
IN WC
1LOAD
1188.1
MW
10/21/2006 9:34:39.81594 PM
24.00 hours
10/22/2006 6:05:15.97315 PM
1A SA PHTR AIR DP
1B SA PHTR AIR DP
TOTAL AIR FLOW
1A SA PHTR AIR BYP DMPR POSN
1B SA PHTR AIR BYP DMPR POSN
1A SAH GAS SIDE DP
1B SAH GAS SIDE DP
Gross Load

Continuous Testing

* 2007 – (Jan) - U2 Both SAH HP on-line wash completed with lowered brake RPM 1/3 rpm but 18mm step
  * U2 SAH inspected during spring outage – no issues noted

DUKE ENERGY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2.5842
7.9394
-8.4884E-02
79.971
7.4175
8.5233
1185.5
1200
2.7430
3.2676
7.9589
0.48592
0.50806
6.6822
8.1225
1184.8
PDT2FH6371A
2.6754
IN WC
PDT2FH6372A
3.2582
IN WC
FT-2FHTOTAIR
7.9850
MPPH
ZT-2FH1441A
2.6473
PCT
ZT-2FH1442A
15.194
PCT
PT-2FH5931A-DIF
7.0998
IN WC
PT-2FH5932A-DIF
8.1452
IN WC
2LOAD
1185.3
MW
4
3
2
1
0 0 5 0 0 4 4
500
2/24/2007 7:42:02.47172 PM
24.00 hours
2/25/2007 5:43:11.64203 PM
2A SA PHTR AIR DP
2B SA PHTR AIR DP
2 TOTAL AIR FLOW
2A SA PHTR AIR BYP DMPR POSN
2B SA PHTR AIR BYP DMPR POSN
2A SAH GAS SIDE DP
2B SAH GAS SIDE DP
Gross Load

On Line Wash Results

* 2007 (May) –Full U1 SAH on-line wash using Jetblower VFD control 1/3 rpm but with 15mm step

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3.5511
2.9269
8.1171
0.12973
-0.19206
7.6804
7.1507
1187.1
1220
3.2249
2.8397
8.1680
0.12707
0.15654
7.1495
6.6932
1185.7
PDT1FH6371A
3.2785
IN WC
PDT1FH6372A
2.9725
IN WC
FT-1FHTOTAIR
8.1996
MPPH
ZT-1FH1441A
0.11691
PCT
ZT-1FH1442A
0.15044
PCT
PT-1FH5931A-DIF
7.2080
IN WC
PT-1FH5932A-DIF
6.8596
IN WC
1LOAD
1190.0
MW
4
2
1
0 0 5 0 0 4 4 0
5/25/2007 9:14:10.47097 PM
24.00 hours
5/26/2007 5:26:32.4797 PM
1A SA PHTR AIR DP
1B SA PHTR AIR DP
TOTAL AIR FLOW
1A SA PHTR AIR BYP DMPR POSN
1B SA PHTR AIR BYP DMPR POSN
1A SAH GAS SIDE DP
1B SAH GAS SIDE DP
Gross Load

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On Line Wash Results

* 2007-2011 – Continued on-line washing (2-3 per unit per year). Outage inspects revealed no basket, diaphragm or sector plate issues. Did note steam soot blower erosion at sector plate to diaphragm interface
* 2011 (Sept) – U1 complete basket replacement. No structural issues found. All diaphragms and sector plates were in great condition
* 2014 – Load restriction were removed from wash procedure

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PI ProcessBook - [BC 2 SAH dPE2.PDI]
File Edit View Insert Tools Draw Arrange Window Help
44%
1/12/2016
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3.5011
9.2680
0.0366
9.1891
298.80
304.84
100.09
99.987
-0.4136
3.2143
3.3278
9.2649
0.0315
8.0905
299.54
295.64
100.08
100.01
-1.6210
3.2516
3.3510
9.2265
0.0851
8.1361
310.41
306.54
100.09
100.03
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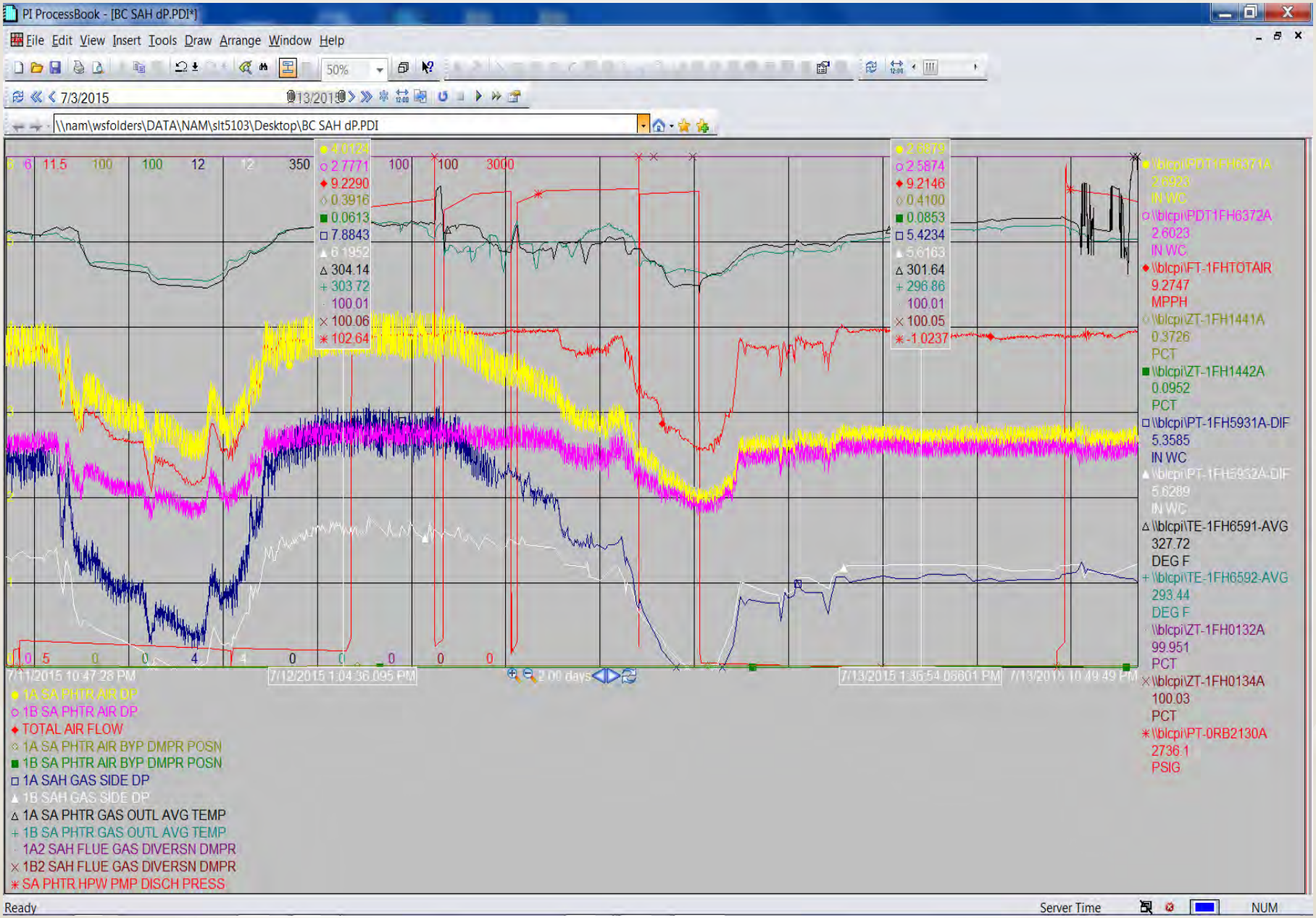
2.00 days
6/20/2015 10:49:31 AM
4:00 PM
Server Time
NUM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7/3/2015
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7/12/2015 1:04:36.095 PM
2.00 days
7/13/2015 1:36:54.06601 PM
7/13/2015 10:49:49 PM
1A SA PHTR AIR DP
1B SA PHTR AIR DP
TOTAL AIR FLOW
1A SA PHTR AIR BYP DMPR POSN
1B SA PHTR AIR BYP DMPR POSN
1A SAH GAS SIDE DP
1B SAH GAS SIDE DP
1A SA PHTR GAS OUTL AVG TEMP
1B SA PHTR GAS OUTL AVG TEMP
1A2 SAH FLUE GAS DIVERSN DMPR
1B2 SAH FLUE GAS DIVERSN DMPR
SA PHTR HPW PMP DISCH PRESS
\\blcpi\PDT1FH6371A
2.6923
IN WC
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2.6023
IN WC
\\blcpi\FT-1FHTOTAIR
9.2747
MPPH
\\blcpi\ZT-1FH1441A
0.3726
PCT
\\blcpi\ZT-1FH1442A
0.0952
PCT
\\blcpi\PT-1FH5931A-DIF
5.3585
IN WC
\\blcpi\PT-1FH5932A-DIF
5.6289
IN WC
\\blcpi\TE-1FH6591-AVG
327.72
DEG F
\\blcpi\TE-1FH6592-AVG
293.44
DEG F
\\blcpi\ZT-1FH0132A
99.951
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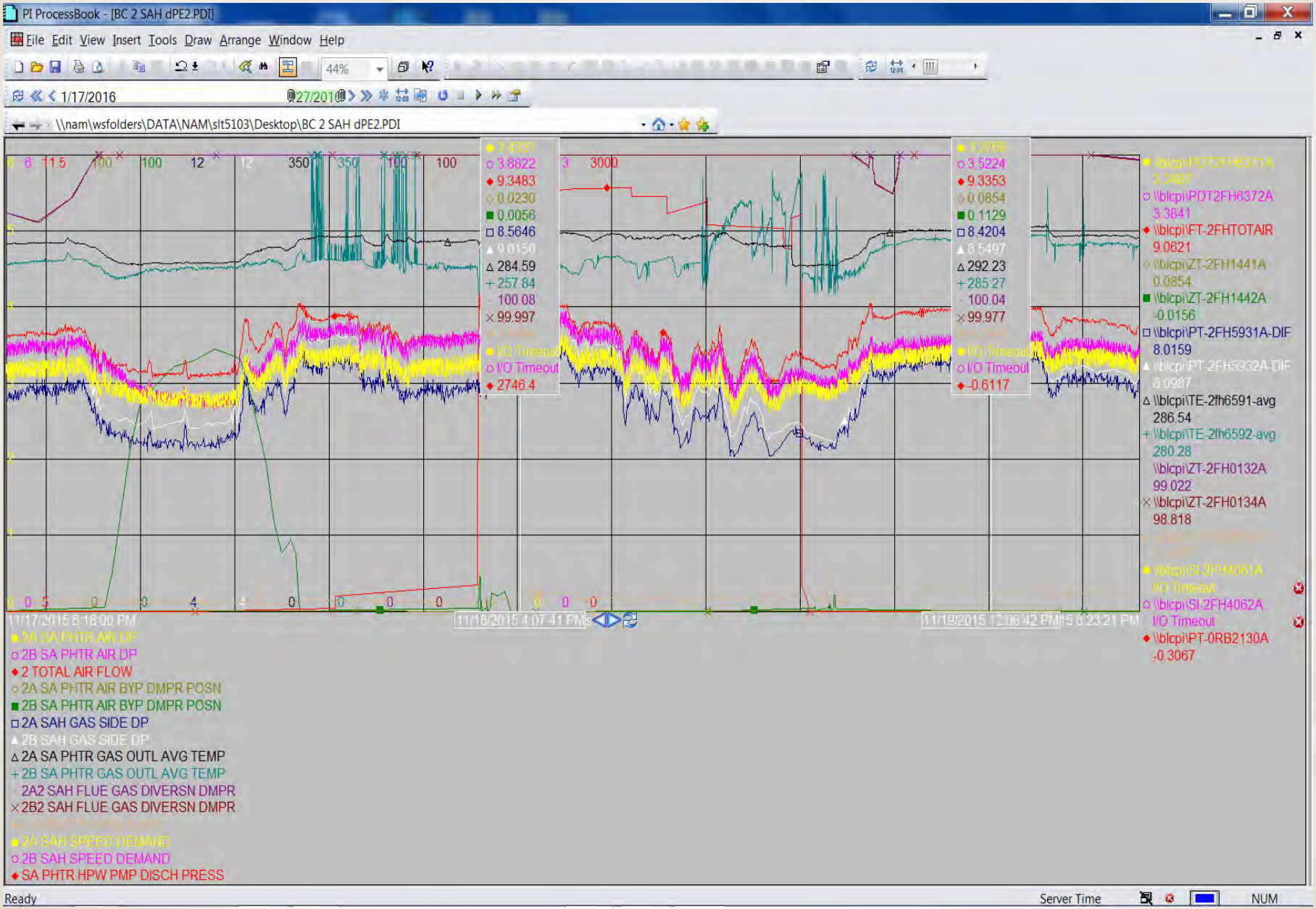
PSIG
Ready
Server Time
NUM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11/17/2015 6:18:00 PM
11/18/2015 4:07:41 PM
11/19/2015 12:06:42 PM
2A SA PHTR AIR DP
2B SA PHTR AIR DP
2 TOTAL AIR FLOW
2A SA PHTR AIR BYP DMPR POSN
2B SA PHTR AIR BYP DMPR POSN
2A SAH GAS SIDE DP
2B SAH GAS SIDE DP
2A SA PHTR GAS OUTL AVG TEMP
2B SA PHTR GAS OUTL AVG TEMP
2A2 SAH FLUE GAS DIVERSN DMPR
2B2 SAH FLUE GAS DIVERSN DMPR
2A SAH SPEED DEMAND
2B SAH SPEED DEMAND
SA PHTR HPW PMP DISCH PRESS
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Ready
Server Time
NUM

Belews Creek OLW - What was the Benefit

* Eliminated one unplanned outages per year
* Reduced forced outage time – SAH cleaning not mandatory (36 hrs FO time - one shift to clean drain hoppers – 2 shifts to wash)
* Off-line cleaning is more efficient – 24 hrs vs 48 hrs
* Lowered CCE setpoint - reduced DGL
* Reduction in NOx – Raised NH3 slip

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