Reinhold Environmental Ltd.

2008 NOx-Combustion Round Table & Expo Presentation

February 4-5, 2008 in Richmond, VA

Mixed Catalyst Layer

CATALYST MANAGEMENT STRATEGY

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Belews Creek Steam Station

PCUG 2008

February 4, 2008

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CATALYST MANAGEMENT STRATEGY

CONTENTS

- Introduction
- Clarification
- Definition of Success
- Operating Issues
- Design Specification
- Logistics
- Considerations
- Conclusions

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INTRODUCTION

- What is mixed catalyst?
  - *Different catalyst types, such as:*
    - Plate type catalyst
    - Honeycomb catalyst
    - Corrugated-plate catalyst
  - *Different pitch catalyst*
  - *Different activity catalyst*
- What are the issues associated with mixing catalyst layers?
- How do these issues effect a Successful Catalyst Management Strategy?

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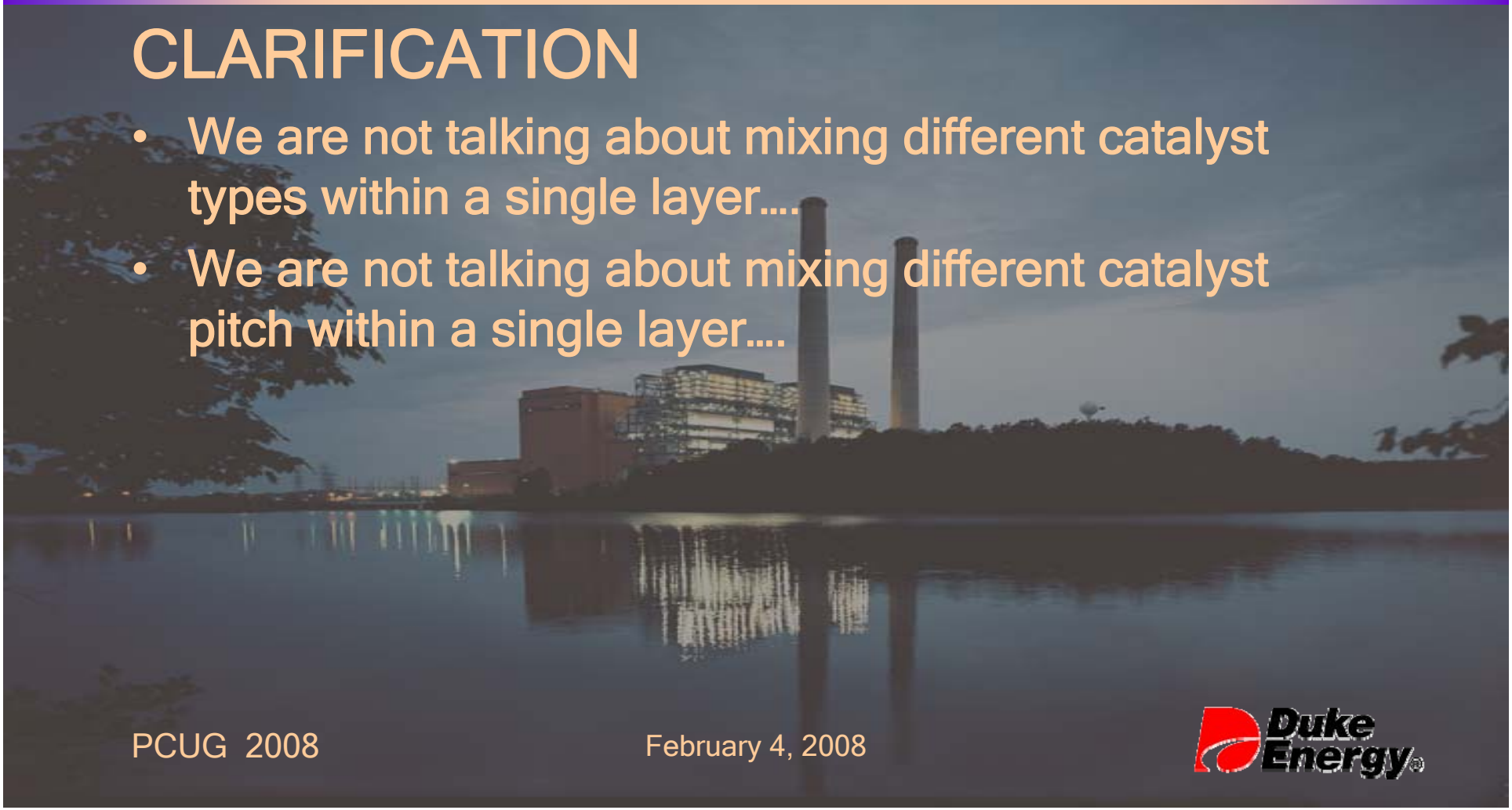

CLARIFICATION

- We are not talking about mixing different catalyst types within a single layer….
- We are not talking about mixing different catalyst pitch within a single layer….

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DEFINITION OF A SUCCESSFUL CATALYST MANAGEMENT STRATEGY

- Excellent De-NOx Performance
- Low SCR Capital and O&M Cost
- Catalyst Activities Aligned with Unit Planned Outages
- Unit Operating Flexibility
- Fuel Flexibility
- No Forced Outages or Derates due to SCR Pluggage

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CATALYST MANAGEMENT @ BCSS

Unit 1

BC1 Catalyst Layers	2003	2004	2005	2006	2007	2008
1	CAT 1 (Initial fill)	Empty CAT 1 Retired	Empty	CAT 7	CAT 7	CAT 7
2	CAT 2 (Initial fill)	CAT 2	CAT 2	CAT 2	CAT 8 CAT 2 Retired	CAT 8
3	Empty	CAT 5	CAT 5	CAT 5	CAT 5	CAT 10 CAT 5 Retired
4	Empty	Empty	Empty	Empty	Empty	Empty

Unit 2

BC2 Catalyst Layers	2003	2004	2005	2006	2007	2008
1	Empty	CAT 3 (Initial fill)	CAT 3	CAT 3	CAT 3	CAT 9 CAT 3 Retired
2	Empty	CAT 4 (Initial fill)	CAT 4	CAT 4	CAT 4	CAT 4
3	Empty	Empty	CAT 6	CAT 6	CAT 6	CAT 6
4	Empty	Empty	Empty	Empty	Empty	Empty

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Unit 2 SCR Catalyst DeActivation Worksheet

January 29, 2008

Revision 11

By: Wayne Whitaker

UNIT 2 SCR: **OPTION: 1 Layer Spring, 2008 2 Layers Spring, 2009 As ~ 10 ppm Avg. Pluggage 20%**

		Calculated Catalyst Activity							
	Hours in Fluegas	Layer 1	Layer 2	Layer 3	Layer 4	Total	SO2 → SO3 %	De-NOx Value	
March, 2004	0	**0.500**	**0.500**	0	0	1.000	0.500	$ 506,813	
	1,000	0.4950000	0.4950000			0.990	0.500	$ 501,744	
June, 2004	2,000	0.4900000	0.4900000			0.980	0.500	$ 496,676	
	3,000	0.4850000	0.4850000			0.970	0.500	$ 491,608	
September, 2004	4,000	0.4800000	0.4800000			0.960	0.500	$ 486,540	
	5,000	0.4750000	0.4750000			0.950	0.500	$ 481,472	
December, 2004	6,000	0.4700000	0.4700000			0.940	0.500	$ 476,404	
	7,000	0.4650000	0.4650000			0.930	0.500	$ 471,336	
March, 2005	8,000	0.4600000	0.4600000	**0.450**		1.370	0.600	$ 694,333	Add CAT 6
	9,000	0.4550000	0.4550000	0.4435714		1.354	0.600	$ 686,007	
June, 2005	10,000	0.4500000	0.4500000	0.4371429		1.337	0.600	$ 677,681	
	11,000	0.4450000	0.4450000	0.4307143		1.321	0.600	$ 669,355	
September, 2005	12,000	0.4400000	0.4400000	0.4242857		1.304	0.600	$ 661,028	
	13,000	0.4350000	0.4350000	0.4178571		1.288	0.600	$ 652,702	
December, 2005	14,000	0.4300000	0.4300000	0.4114286		1.271	0.600	$ 644,376	

As Average = 10

90% de-Nox

% Pore Pluggage 20%

K/Ko Threshold = 0.90

Assume:

1) 10,000 MBTU/HR
2) 85% CF
3) 0.53 lbs/MBTU Baseline

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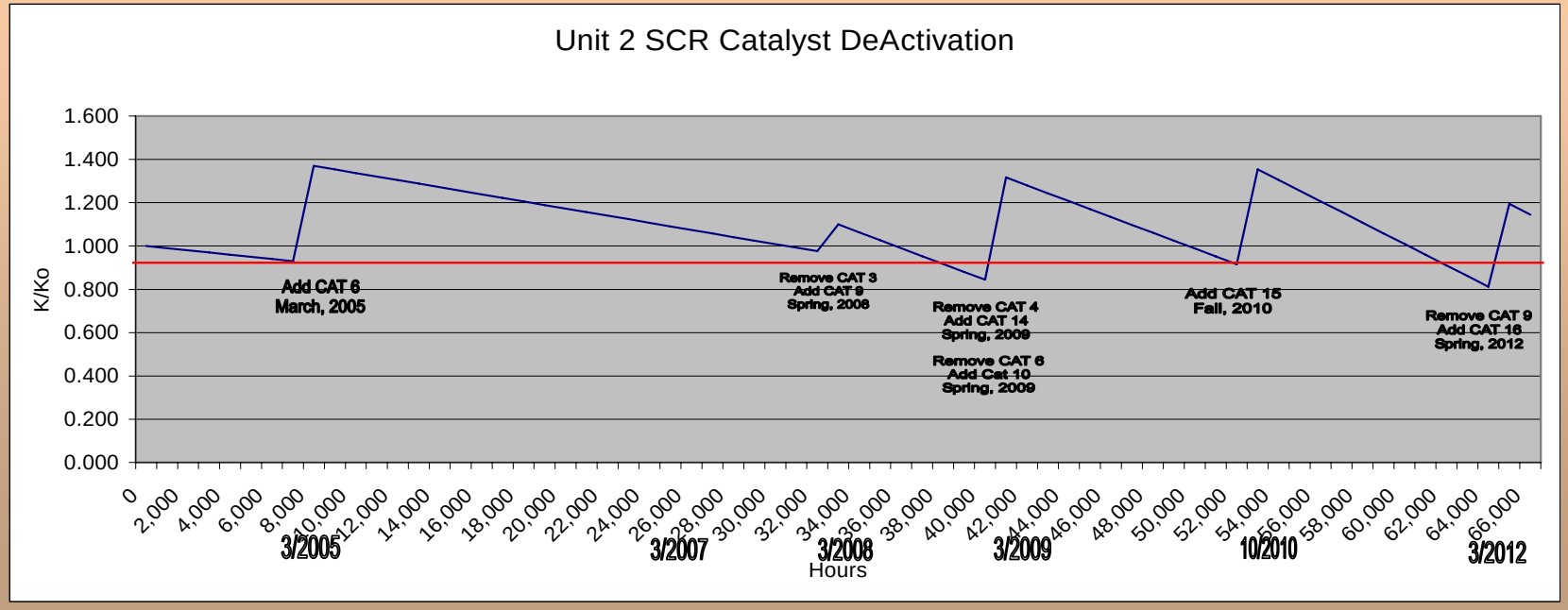

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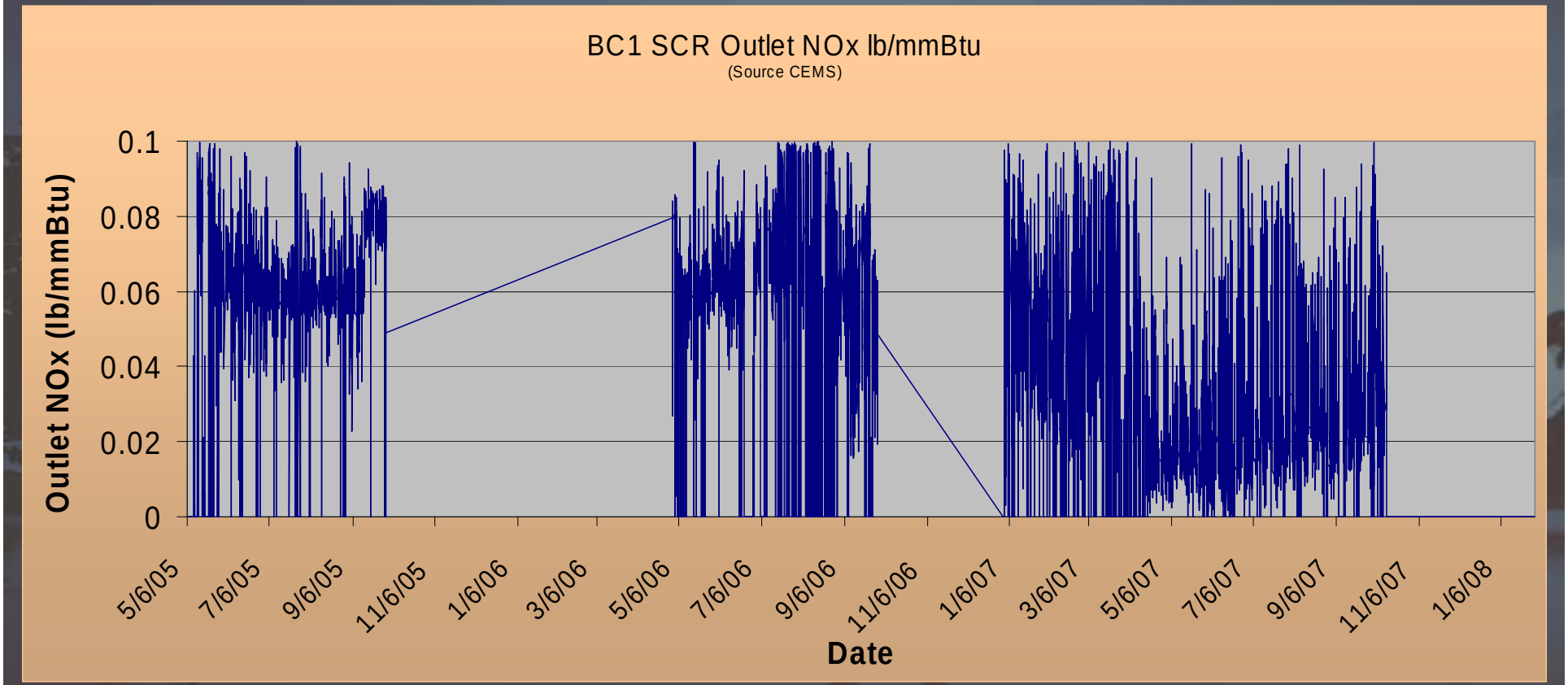

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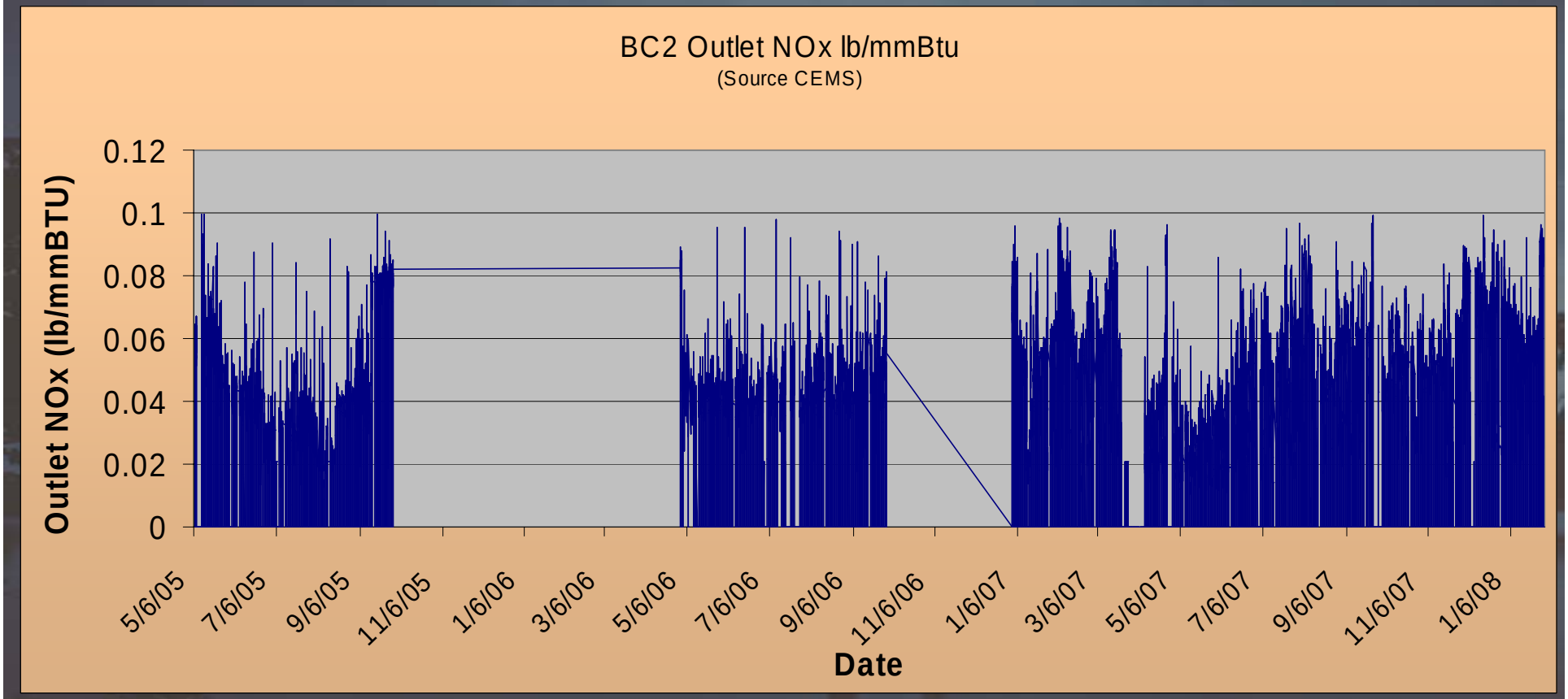

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SCR Availability

Unit 1

Unit 2

Year	Unit 1	Unit 2
2004	100%	100%
2005	100%	96%
2006	100%	100%
2007	100%	100%

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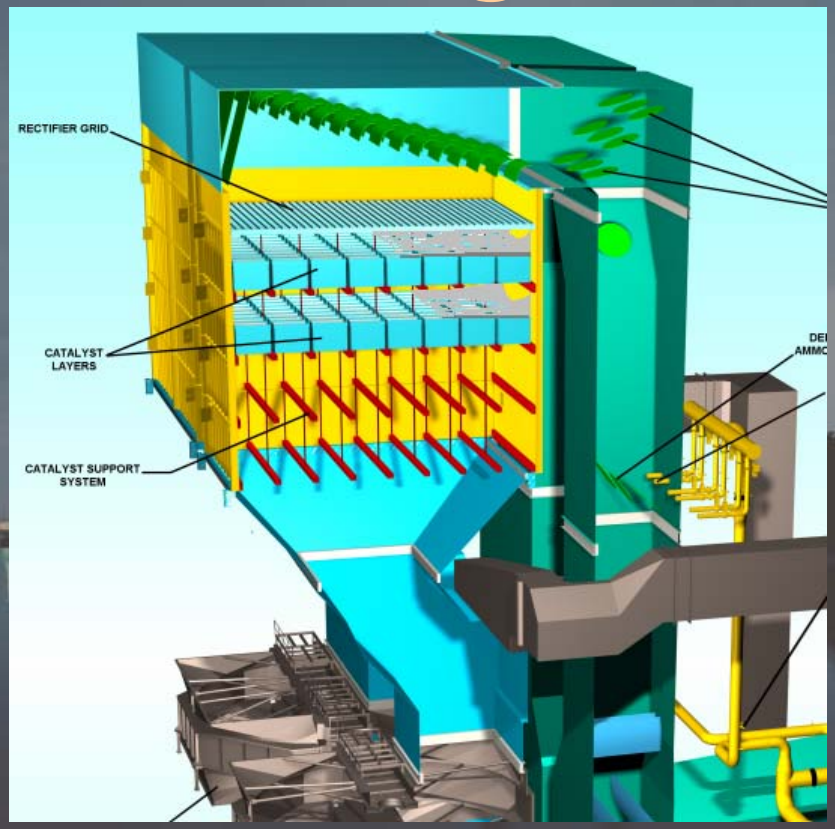
Typical Ash Fallout Profile @ BCSS

Unit 1

Unit 2



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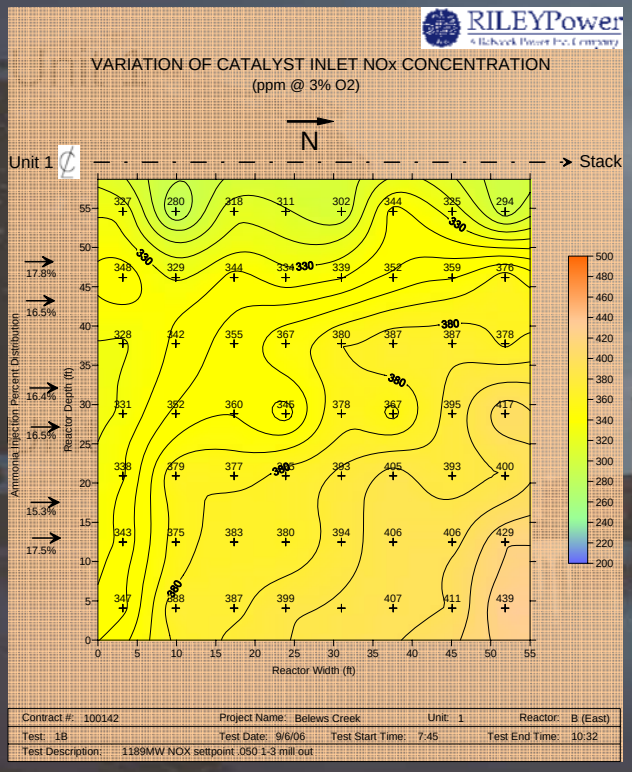
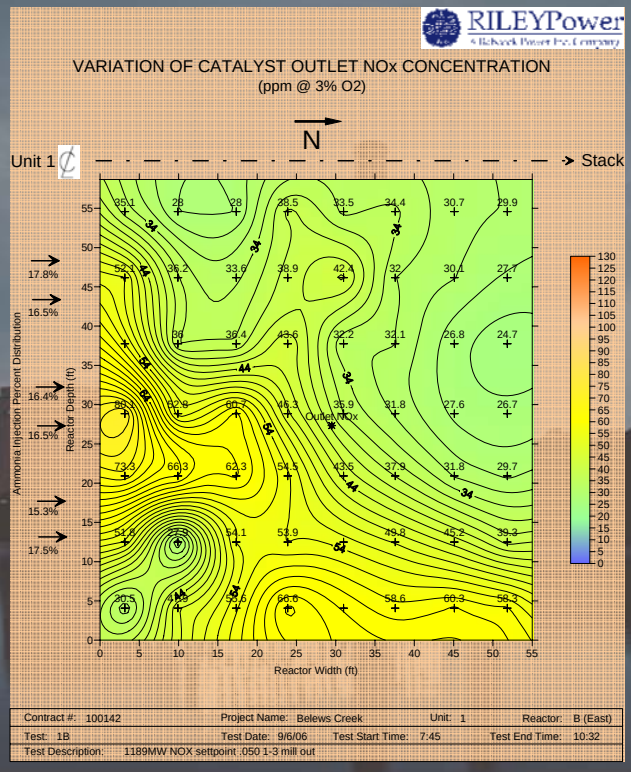
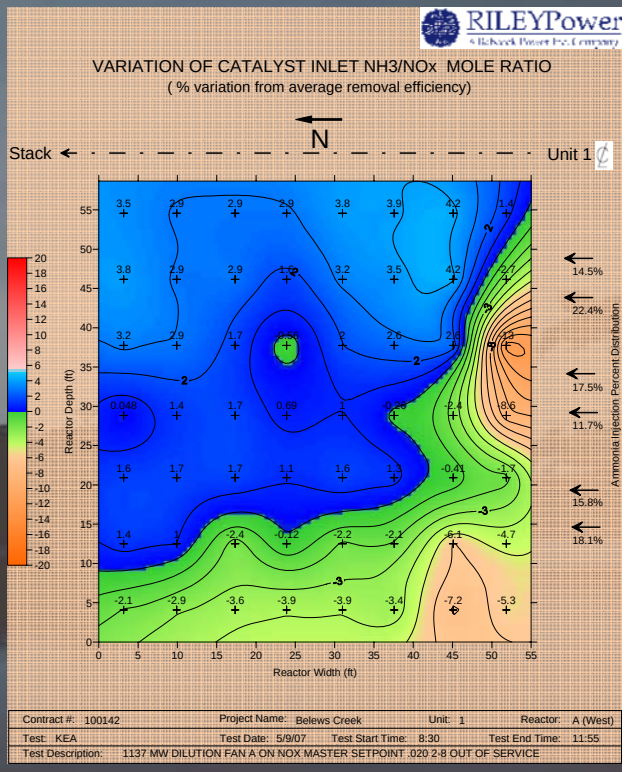
Typical SCR NOx Profile @ BCSS







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OPERATING ISSUES

- **Pluggage**
  - *Pluggage in the Top Catalyst Layers will distort the flow patterns n the lower layers.*
  - *Pluggage in the Top Layers will increase the velocities in the lower layers*
- **Erosion**
  - *Distorted flow will increase acute angle erosion*
  - *Increased velocities will result in increased erosion rates*
- **Performance**
  - *Pluggage decreases available catalyst surface area*
  - *Increased velocities decreases catalyst residence time*

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DESIGN ISSUES

- Catalyst Pitch
- Module Screen Pitch
- $SO_2 \rightarrow SO_3$ Conversion
- Pressure Drop
- Fuel Specification
- De-NOx Guarantee Life
- Catalyst Mechanical Life
- Low-temperature Operation

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INSTALLATION ISSUES

- Module Dimensions and Weights
- Module Lifting and Handling Equipment
- Seal Design and Installation
- Alignment of Sample Elements
- On-site Technical Support

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LOGISTICAL ISSUES

- Delivery Logistics
  - *Sample Modules*
  - *Non-sample Modules*
  - *Lifting Yokes, Beams, Carts, etc.*
  - *Seals - Intermodular and Perimeter*
- Loading Brand A while Unloading Brand B
- Allow for In-transit Damage
- Reuse / Disposal of Catalyst, Seals, Frames, etc.
- Replacement Sample Elements

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THINGS TO CONSIDER

- Layer Flexibility
- Mixed Catalyst vs. Alliance Agreement
- Single Layer Performance Testing
- Cleaning – Acoustic, Steam Blowing, Air Blowing, Vacuuming

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CONCLUSIONS

- A Successful Mixed Catalyst Layer Strategy is Achievable
- A Mixed Catalyst Layer Strategy "may" or "may not" result in lowest cost
- "You" Own the Problems

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