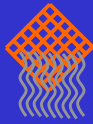


Cormetech



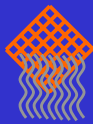
2001 Conference on SCR and SNCR

First Year's Operating Experience with
SCR on 600MW PRB Fired Boiler

May 17, 2001

New Madrid SCR Retrofit Project Overview

Cormetech



- ▶ Unit 2 Base Award (6/98);
Unit 1 Option Award (3/99)
 - ▶ Turnkey Project
 - ▶ Commercial Operation
 - Unit 2 - March 2000
 - Unit 1 - Fall 2001
- ▶ Joint Venture of Black & Veatch
and J. S. Alberici Construction
- ▶ Catalyst Supplied by
Cormetech as Subvendor to
Black & Veatch



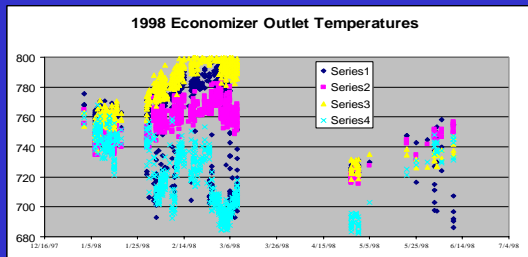
DOE 010517-2

New Madrid Units 1 and 2

Cormetech



- ▶ Plant Overview:
 - ▶ Owned and Operated by Associated Electric Cooperative, Inc.
 - ▶ 2 x 600 MW Cyclone Fired Boilers
 - ▶ Uncontrolled NOx = 1.50 lb/MBtu
 - ▶ 100% Powder River Basin Fuel (0.22% S; 4.5% Ash; 21.5% CaO)
 - ▶ Widely Varying Economizer Outlet Temperatures (680 to 800 F)
 - ▶ High Air Heater Gas Outlet Temperatures (350 to 360 F)



DOE 010517-3

New Madrid Project Guarantees

Cormetech



- ▶ NOx Removal - 93%
- ▶ Ammonia Slip - Less Than 3 ppm (PRB Coal)
- ▶ Catalyst Life and System Performance - 20,000 hrs
- ▶ SO2 to SO3 Oxidation Rate - 3% Max (PRB Coal)
- ▶ Pressure Drop - 2 in wg Reduction From Current System Losses
- ▶ Auxiliary Power Consumption
- ▶ Air Heater Outlet Temperature - 280 F
- ▶ Air Heater Leakage - 7%

DOE 010517-4

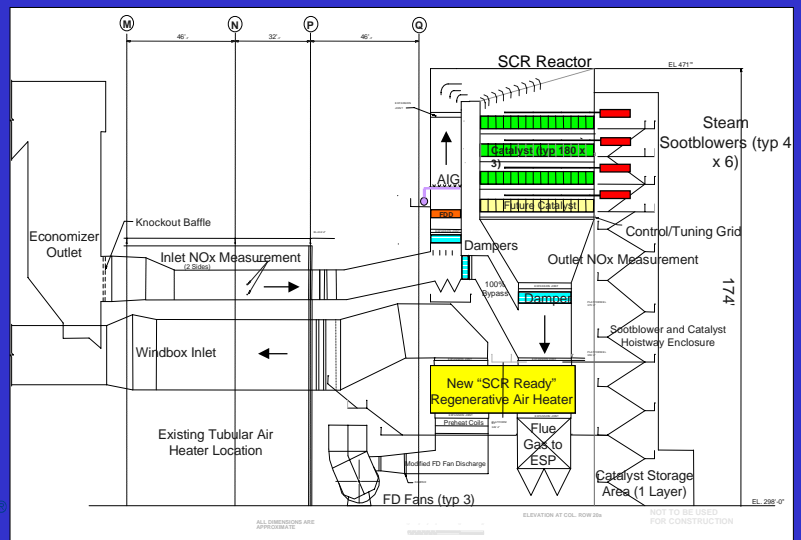
B&V/JSA Scope Was Comprehensive



- ▶ SCR Reactor
- ▶ Catalyst, Frames, and Seals
- ▶ Catalyst Loading System
- ▶ Ammonia Unloading & Storage
- ▶ Ammonia Vaporization
- ▶ Ammonia Injection Grid
- ▶ Sootblowers (Catalyst and Air Heater)
- ▶ Double Louver Dampers & Seal Air
- ▶ New "SCR Ready" Regenerative Air Heater
- ▶ Air Preheat Coils
- ▶ Modified FD Fan Casing
- ▶ Interconnecting Air & Gas Duct
- ▶ Tubular Air Heater Demolition
- ▶ Ash Hoppers
- ▶ Insulation & Lagging
- ▶ Expansion Joints
- ▶ Controls
- ▶ Gas Monitoring
- ▶ Electrical Modifications
- ▶ Structural Steel
- ▶ Enclosures
- ▶ Foundations
- ▶ Engineering
- ▶ Construction
- ▶ Startup and Commissioning

DOE 010517-5

New Madrid Unit 2 Arrangement



DOE 010517-6

New Madrid Unit 2 SCR System Retrofit



DOE 010517-7

Initial Operation



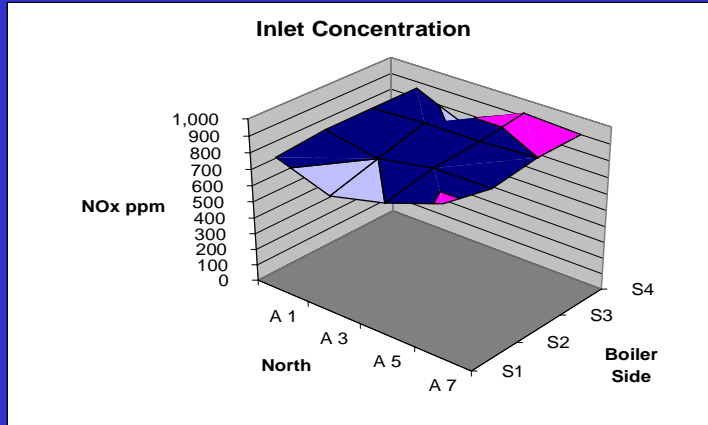
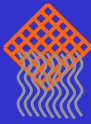
- ▶ 4 Day Tie-In Outage Completed February 6, 2000
- ▶ SCR System Startup (February 7-10, 2000)
 - ▶ Bypass Damper Closed
 - ▶ Ammonia System Started Up
 - ▶ Monitoring System Started Up
 - ▶ Catalyst Sootblowers Started Up
- ▶ Ammonia Injection Grid Tuned - March 3, 2000
 - ▶ Operating Up To 93% NOx Removal
 - ▶ Ammonia/NOx Distribution <3%



DOE 010517-8

Unit 2 NOx Inlet Distribution

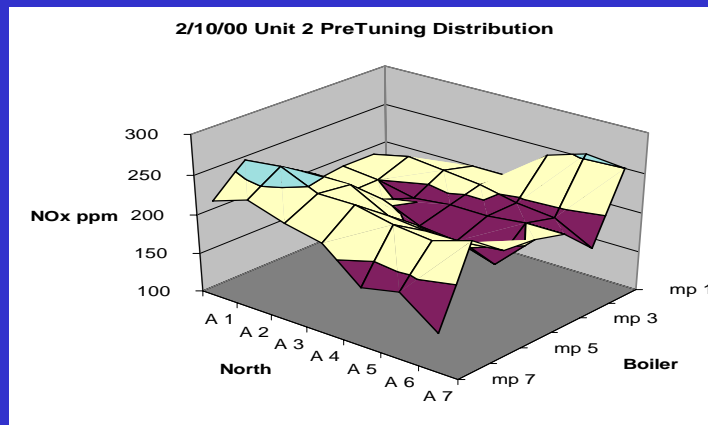
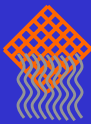
Cormetech



DOE 010517-9

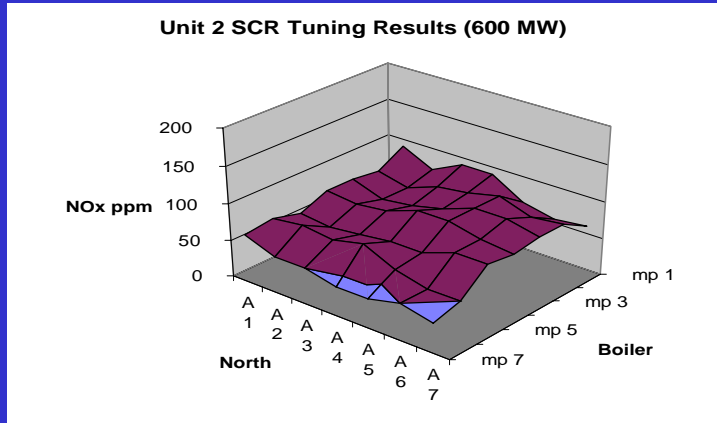
Initial Measurement Without AIG Adjustments

Cormetech



DOE 010517-10

Final Adjustment



DOE 010517-11

Performance Test Results



Associated Electric Cooperative, Inc. - New Madrid Unit 2
 Date: 5/02/2000 Load: 5% Over Pressure
 Measuring time: 6:15-8:20 pm

	NO downstream of last catalyst layer							NO [ppm]			Inlet Port	NOx ppm
	A 1	A 2	A 3	A 4	A 5	A 6	A 7	Mn.	Max.	Mean V.		
mp 7	68	80	91	94	92	90	64	64	94	83	1	1030
mp 6	81	45	51	56	84	50	60	45	84	61	2	1041
mp 5	45	35	50	64	57	48	55	35	64	51	3	1066
mp 4	61	34	40	36	48	67	56	34	67	49	4	1046
mp 3	82	76	80	24	33	30	58	24	82	55	5	1051
mp 2	79	62	47	51	54	67	60	47	79	60	6	1071
mp 1	79	54	50	22	80	95	84	22	95	66	7	1087
min.	45	34	40	22	33	30	55	22	Standard Deviation		Avg Inlet	1060.4
max.	82	80	91	94	92	95	84	95	19.28		Std Dev	21.99
mean v.	71	55	58	50	64	64	62	61			NOx Removal	94.3%

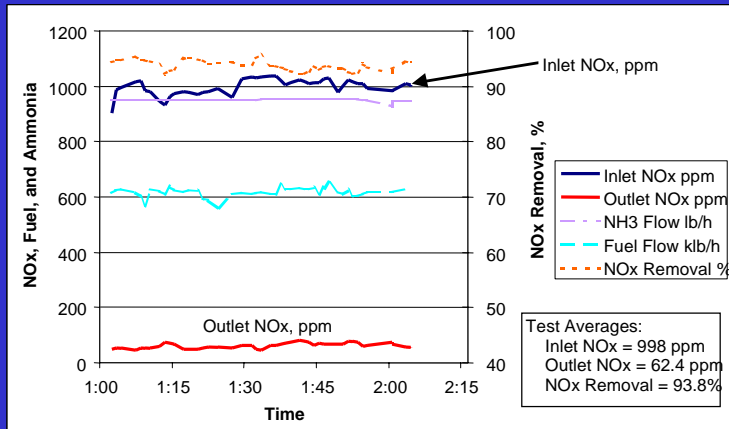
Test 1 = 94.3% NOx Removal
 Test 2 = 93.8% NOx Removal
 Test 3 = 94.4% NOx Removal

Std. Deviation is <2% of inlet NOx

DOE 010517-12

Unit 2 AIG Tuning Test Monitoring System Values (3/3/00)

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DOE 010517-13

Controls Issues

Cormetech



- ▶ Minimizing Ammonia Slip Requires Tight Control of Injection Rate
- ▶ Ideal Mode of Operation is Feed-Forward with Trim on Outlet NOx
 - ▶ Control is Dependent on Quality of Input Signals for NOx and Unit Load
- ▶ New Madrid Fuel Flow and NOx Concentration Swung Widely When Bringing Individual Cyclones Into/Out of Service

DOE 010517-14

Controls Solution

Cormetech



- ▶ Feed-Forward Control Algorithm Designed for Fail-Safe with Quick Recovery
- ▶ Controls Performance Criteria:
 - ▶ Avoid Over-Feeding Ammonia on Rapid Load Reduction
 - ▶ Individual Hourly Average NOx Outlet Not to Vary by More than 10 ppm
- ▶ Load Inputs Consolidated to Enhance Response and Tracking

DOE 010517-15

New Madrid Catalyst and Reactor Design

Cormetech



- ▶ Cormetech Honeycomb Catalyst
 - ▶ 9.2 mm Pitch
 - ▶ 16 Cell
 - ▶ Calcium Sulfate Masking Considered in Sizing
- ▶ 3 + 1 Reactor Design Developed by B&V
 - ▶ 180 Catalyst Modules per Layer
 - ▶ 12 x 15 Module Arrangement

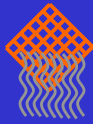


Component	New Madrid	Experience
Dust _{gr/dscf}	1.0	0.7 - 10
As _{fuel ppm}	1.5	1 - 25
Total CaO, %	18.0 - 26.3	2.4 - 12
Free CaO, %	11.9 - 17.4	0.9 - 8
Na ₂ O ₂ , %	0.9 - 2.7	0.05 - 1.6
P ₂ O ₅ , %	0.6 - 2.6	0.06 - 1.3
K ₂ O, %	0.2 - 0.8	0.1 - 4.0

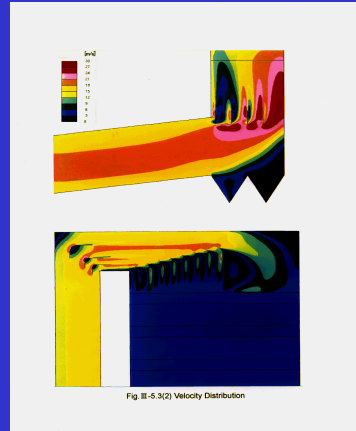
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Model Study Velocity Distribution Tests

Cormetech



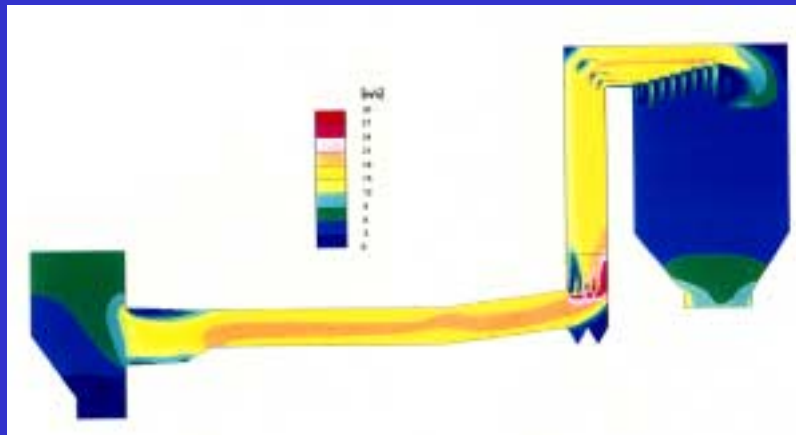
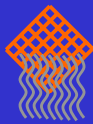
- ▶ Model Study Performed by Mitsubishi Heavy Industries in Nagasaki Japan
- ▶ Ammonia Injection Grid
 - ▶ Velocity Distribution Met Requirement
 - ▶ +/- 25% Over 90% of Area
 - ▶ +/- 30% Over 100% of Area
 - ▶ Required Installation of FDD
- ▶ Catalyst Inlet
 - ▶ Velocity Distribution Met Requirement
 - ▶ +/- 10% Over 80% of Area
 - ▶ +/- 20% Over 20% of Area



DOE 010517-18

Model Study Velocity Distribution Tests

Cormetech



DOE 010517-19

Catalyst Loading




The image collage illustrates the catalyst loading process. It includes: a large metal cage being hoisted by a crane in a warehouse; a white truck with a trailer parked in an outdoor lot; a large metal cage on a wooden pallet; and a close-up of a metal cage being lowered into a structure. The text 'DOE 010517-20' is visible in the bottom right corner of the collage.

Cormetech


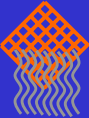


Behavior of PRB Ash



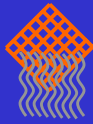
The image collage shows the behavior of PRB ash. It includes: a close-up of a white, crystalline ash deposit on a metal surface; and a photograph of a large, rectangular concrete structure, possibly a PRB, with a white ash deposit on its side. The text 'DOE 010517-21' is visible in the bottom right corner of the collage.

Cormetech



Catalyst Reactor at 4242 Hours

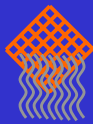
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DOE 010517-22

Catalyst Reactor at 4242 Hours

Cormetech

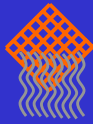


After Vacuuming

DOE 010517-23

Catalyst Reactor at 7966 Hours

Cormetech

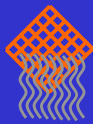


Catalyst Bottom View

DOE 010517-24

Catalyst Reactor at 7966 Hours

Cormetech



After Vacuuming

DOE 010517-25

AIG After 7,966 Hours

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DOE 010517-26

Catalyst Sampling

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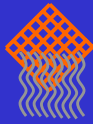


- ▶ Catalyst Test Coupons Included in Each Module
- ▶ Activity Testing Conducted at 850 and 4,242 Hours -- No Significant Deactivation
- ▶ Sample Testing at 7,966 Hours Underway

DOE 010517-27

Current Status

Cormetech



- ▶ No Significant Catalyst Deactivation
- ▶ Unit 2 Performance Tests Completed in May 2000
- ▶ Unit 1 Under Construction



DOE 010517-29