

# Layered NOx Reduction on a 500 MW Cyclone-Fired Boiler



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# Presentation Overview

- **Project Objectives**
- **Technology Background**
- **Pre-Test Activities**
- **Test Results**
- **Conclusions**



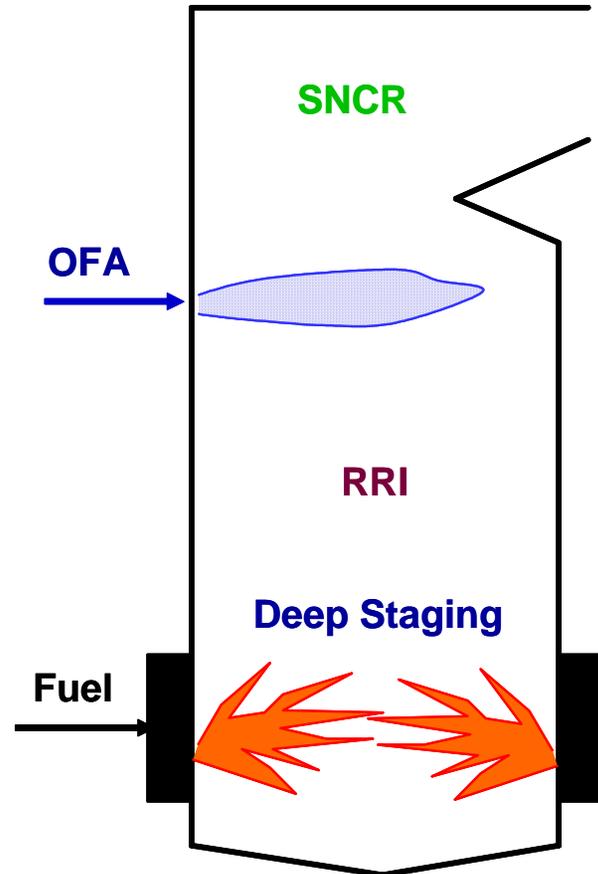
# Project Objectives

- **Field Test NO<sub>x</sub> Reduction Technology for Cyclone-fired Boilers That Provides:**
  - **NO<sub>x</sub> < 0.15 lb/MBtu**
  - **Minimal BOP impacts including LOI, slag tapping, and NH<sub>3</sub> slip**
  - **Levelized cost below 75% of current state-of-the-art SCR**



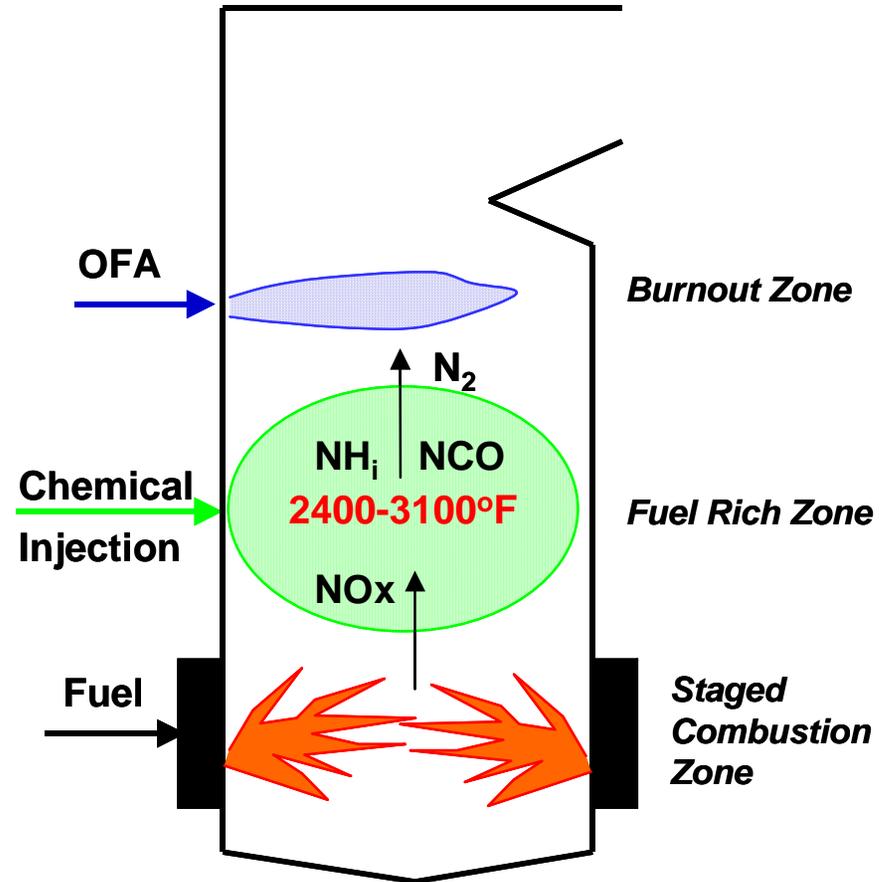
# ALTA Technology Background

- ALTA = Advanced Layered Technology Approach
  - Deep Staging of Cyclone Barrels & Lower Furnace
  - Rich Reagent Injection (RRI)
  - SNCR



# Rich Reagent Injection

- Staging creates hot, fuel rich lower furnace
- $\text{NH}_3$ /urea accelerate the rate of  $\text{NO}_x$  reduction
- Insignificant  $\text{NH}_3$  slip
- Co-developed by REI and EPRI
- CCA and FuelTech are licensed implementers



# Project Team

- AmerenUE Sioux Plant – Host
- REI – Project Lead
- FuelTech – RRI and NOxOut SNCR equipment supply; testing
- EPRI - Field support and continuous NH<sub>3</sub> monitoring (UC-Riverside)



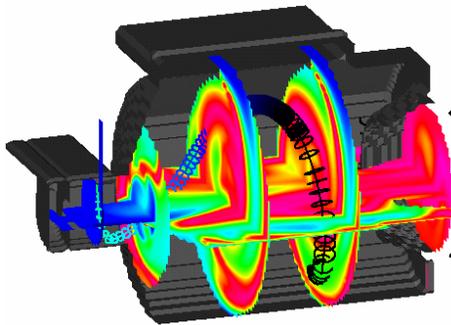
# AmerenUE's Sioux Plant

- **Two Units – 500 MW each**
- **Supercritical**
- **10 cyclone barrels**
- **Fires ~80% PRB blended with Illinois bituminous**
- **FGR and GT for steam temperature control**
- **Fine grind crushers**
- **First application of cyclone OFA in unit 2 in 1997**

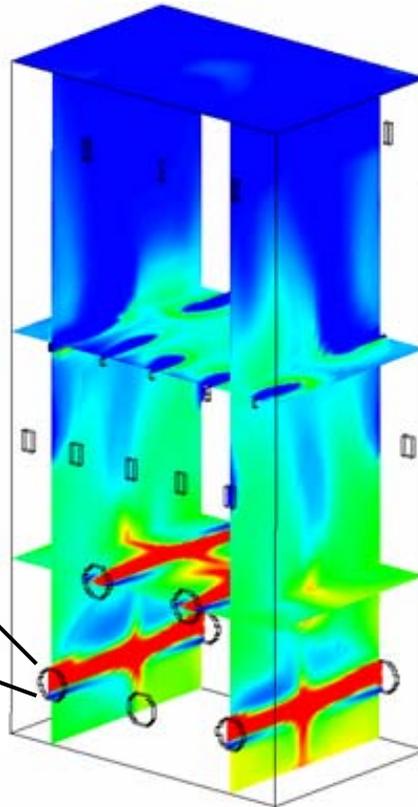


# ALTA Modeling Approach

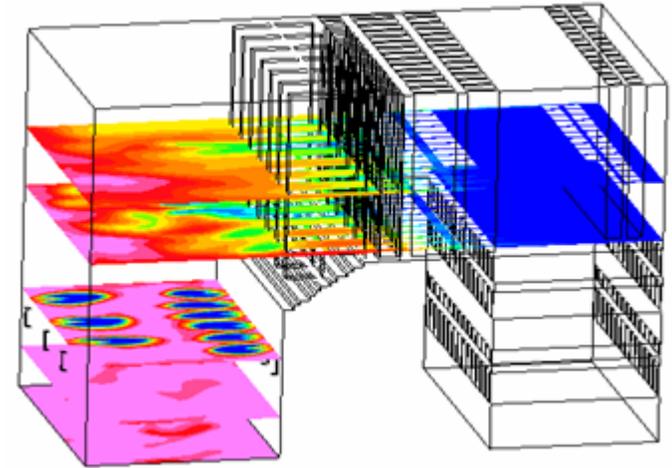
- Guide design
- Assess performance
- Evaluate BOP impacts



**Cyclone Barrel Model  
(staging, coal blend)**



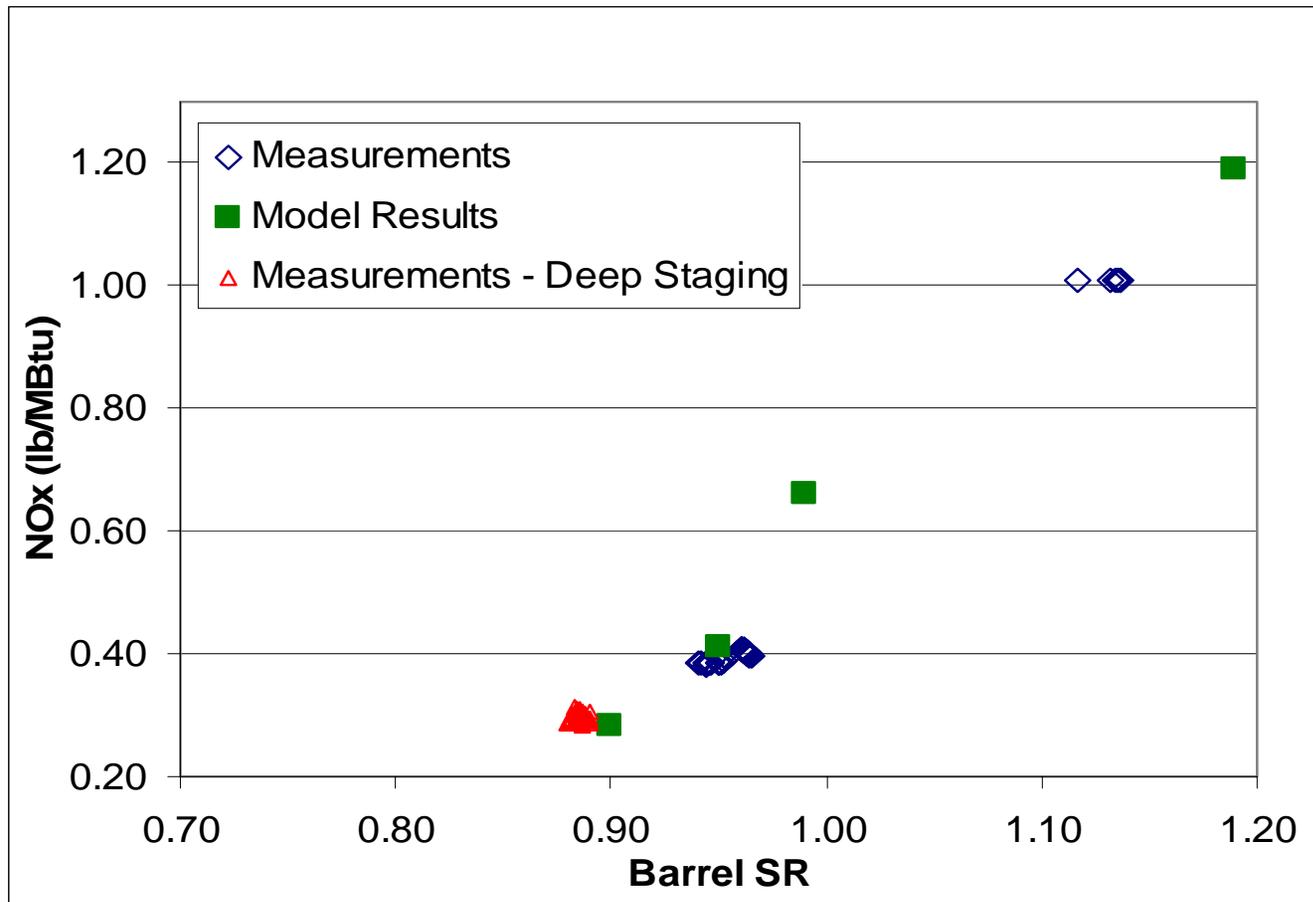
**Lower Furnace  
Model (OFA, RRI)**



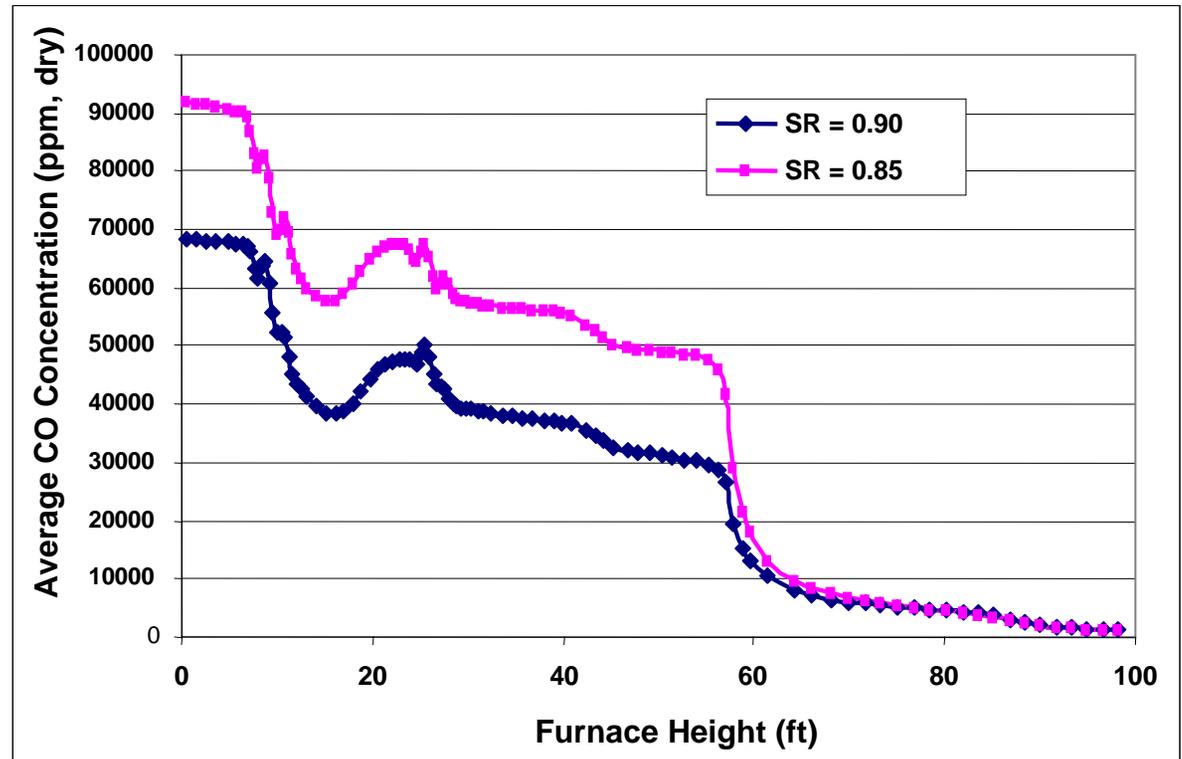
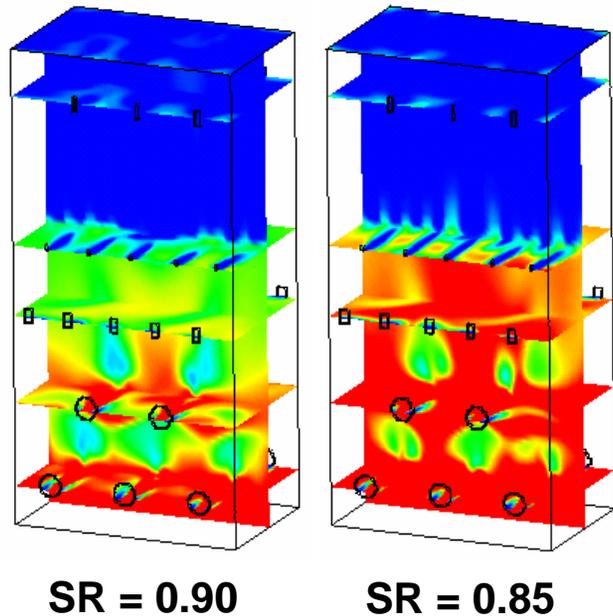
**Upper Furnace Model  
(SNCR)**



# Sioux 1 NOx vs Barrel SR



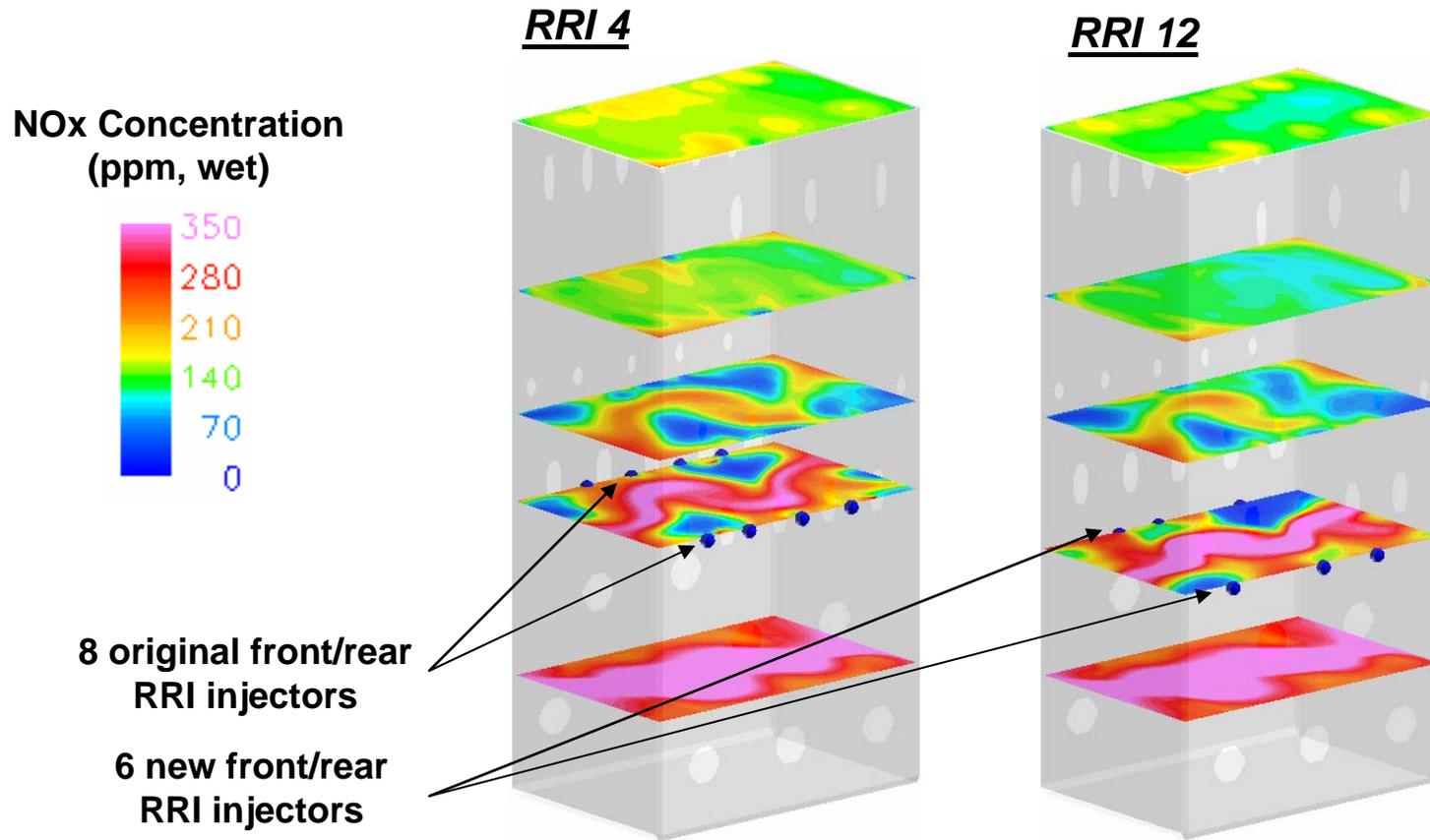
# Sioux Unit 1 OFA Modeling



**Interlaced OFA combined with GT provides good mixing and CO oxidation**



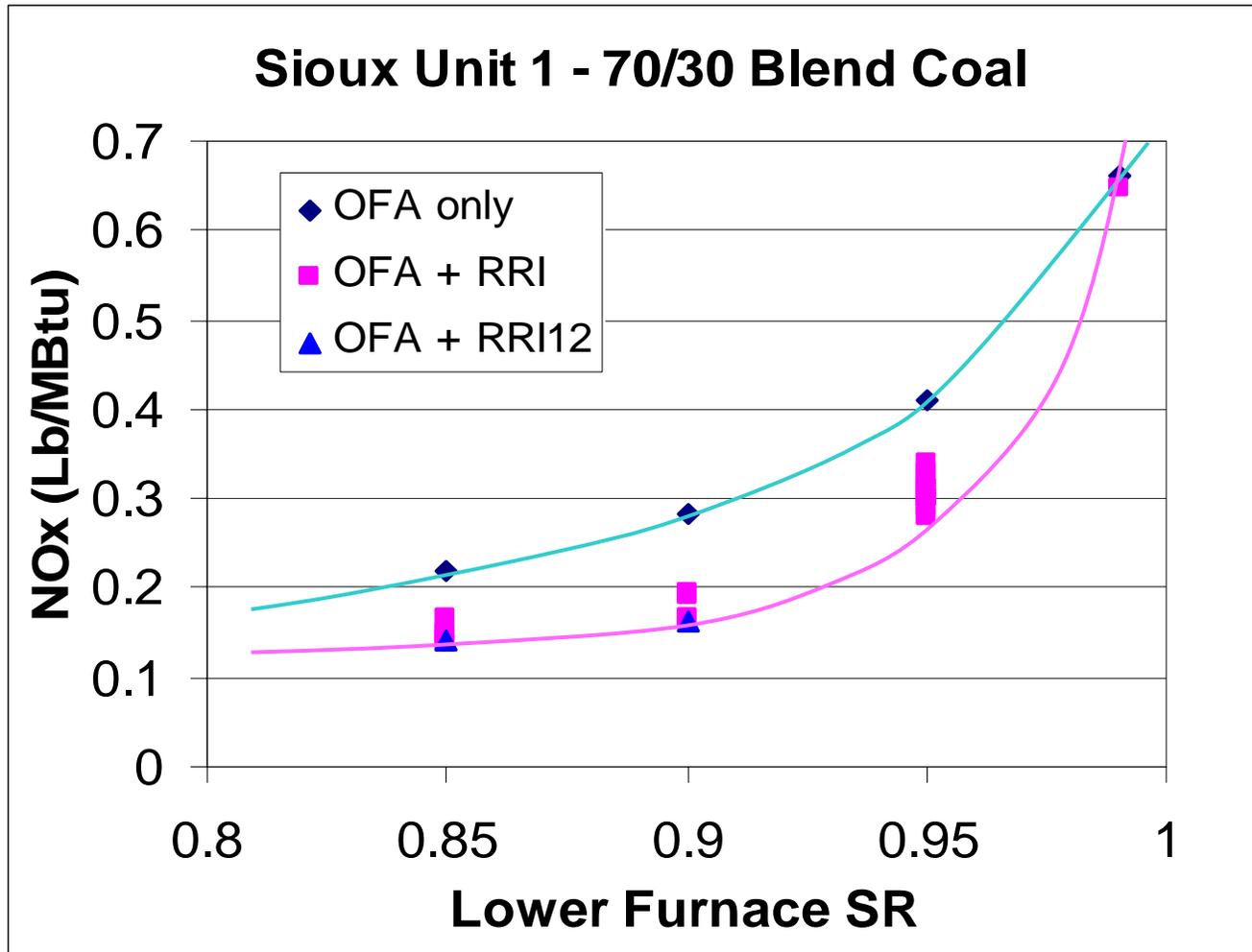
# Sioux Unit 1 RRI Modeling



**Significant improvement to NOx reduction predicted with addition of six new RRI ports 7' feet below original ports**



# Predicted RRI Performance



# Spring 2005 Outage

## *ALTA in Sioux Unit 1*

- **Installation of 8 new RRI ports**
  - 6 on front and rear walls
  - 2 on the side walls
- **Installation of 14 new SNCR ports**
  - 9 through existing GT ports
  - 5 through upper front wall
- **Installed maximum ports for testing flexibility**



# Overview of Tests

## *ALTA in Sioux Unit 1*

- **Test Plan**
  - RRI only tests
  - SNCR only tests
  - Combined RRI+SNCR tests
- **Parametric Testing Conditions**
  - 480 MW<sub>g</sub>, 80/20 blend (*10 days*)
  - 530-540 MW<sub>g</sub>, 100% Ill. #6 (*2.5 days*)
  - 530 MW<sub>g</sub>, 60/40 blend (*0.5 days*)
  - 425 MW<sub>g</sub>, 80/20 blend (*1 day*)
- **Continuous Tests – 3 days 24 hrs/day**



# Urea Supply Tank

## *ALTA in Sioux Unit 1*



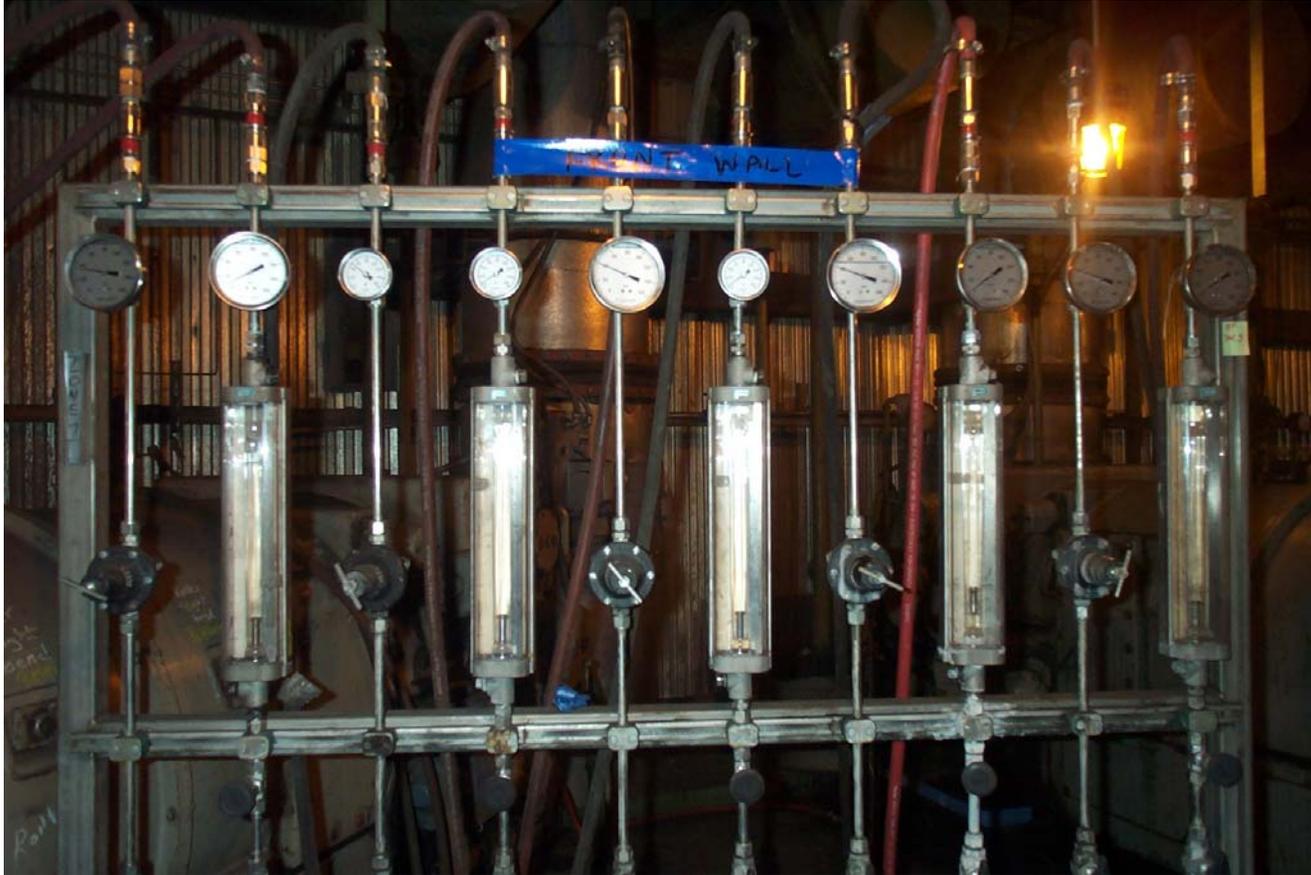
# FuelTech MTT

## *ALTA in Sioux Unit 1*



# Distribution Module

*ALTA in Sioux Unit 1*



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# RRI Injector

*ALTA in Sioux Unit 1*



# Extractive $\text{NH}_3$ Measurement

## *ALTA in Sioux Unit 1*



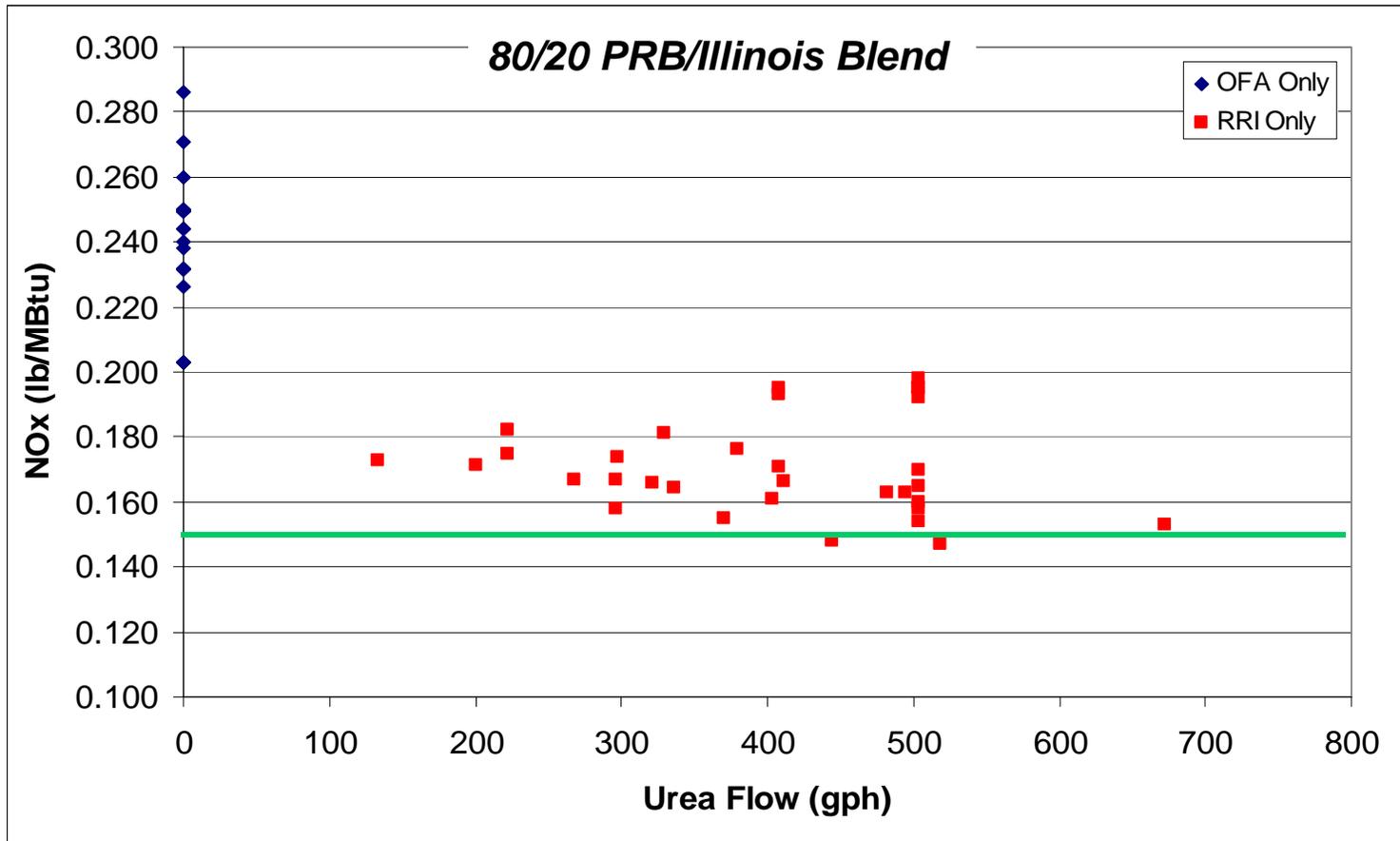
# Continuous NH<sub>3</sub> Measurement

## *ALTA in Sioux Unit 1*



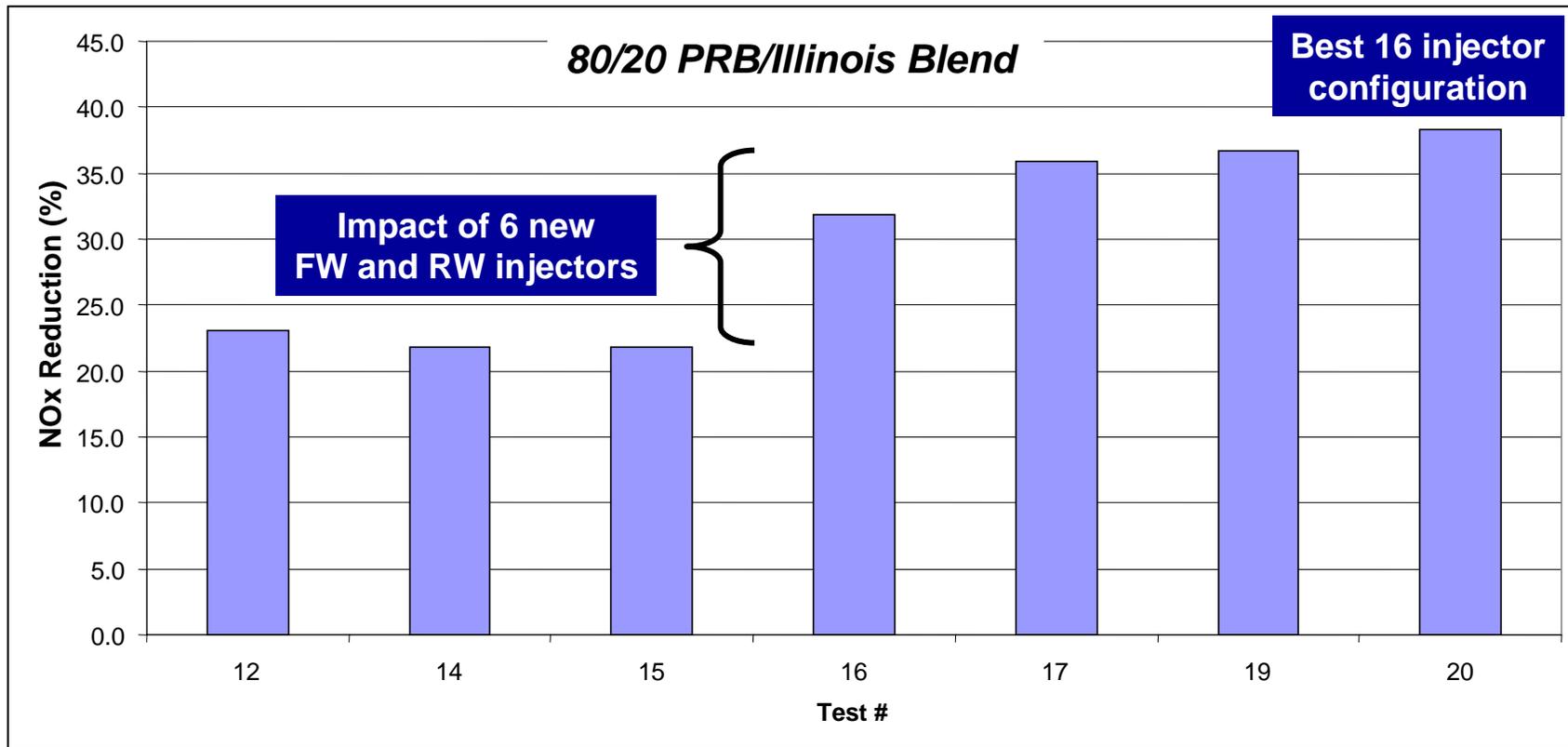
# RRI NOx Performance

## *RRI in Sioux Unit 1*



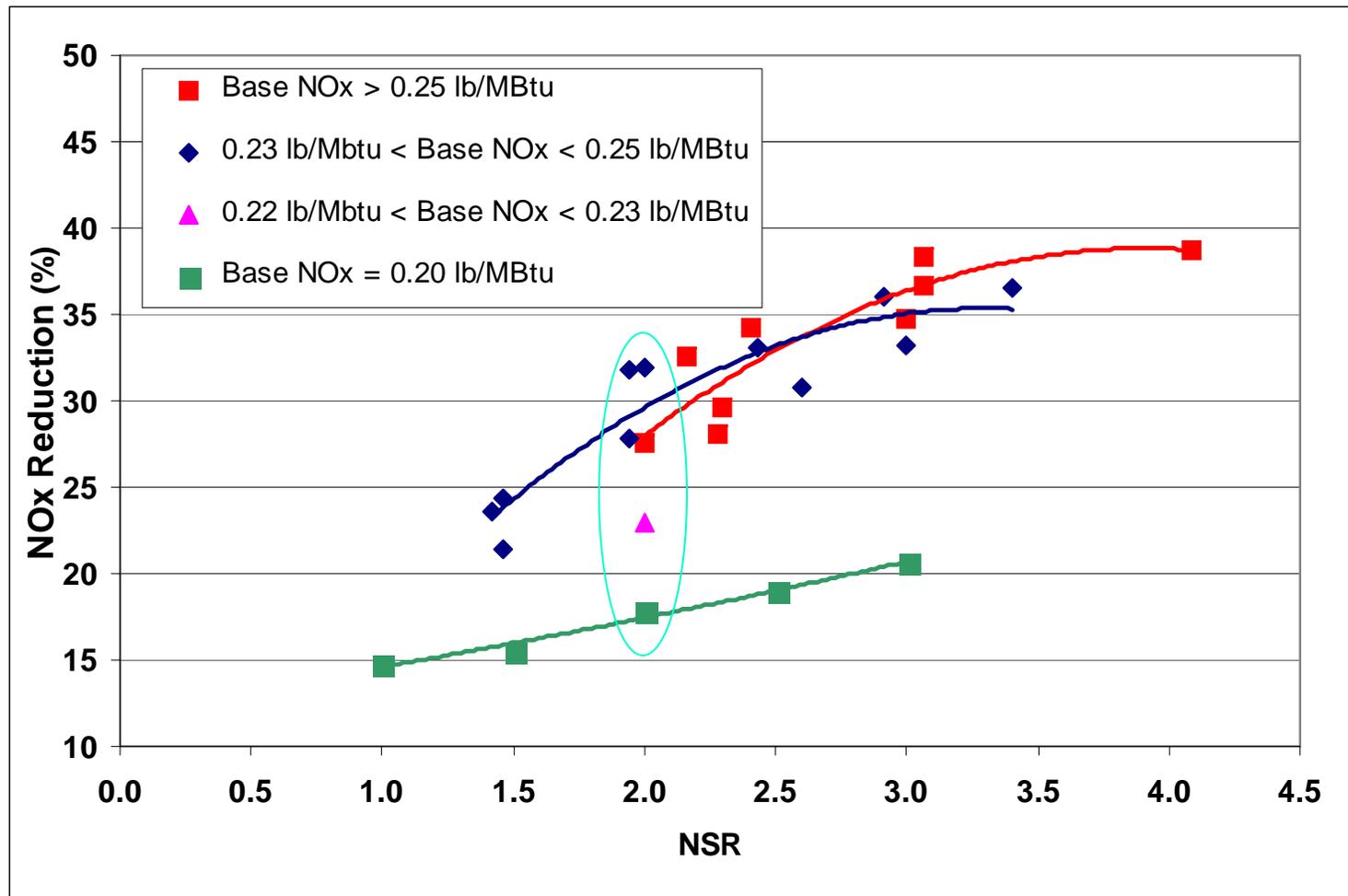
# Injector Location Impacts

## *RRI in Sioux Unit 1*



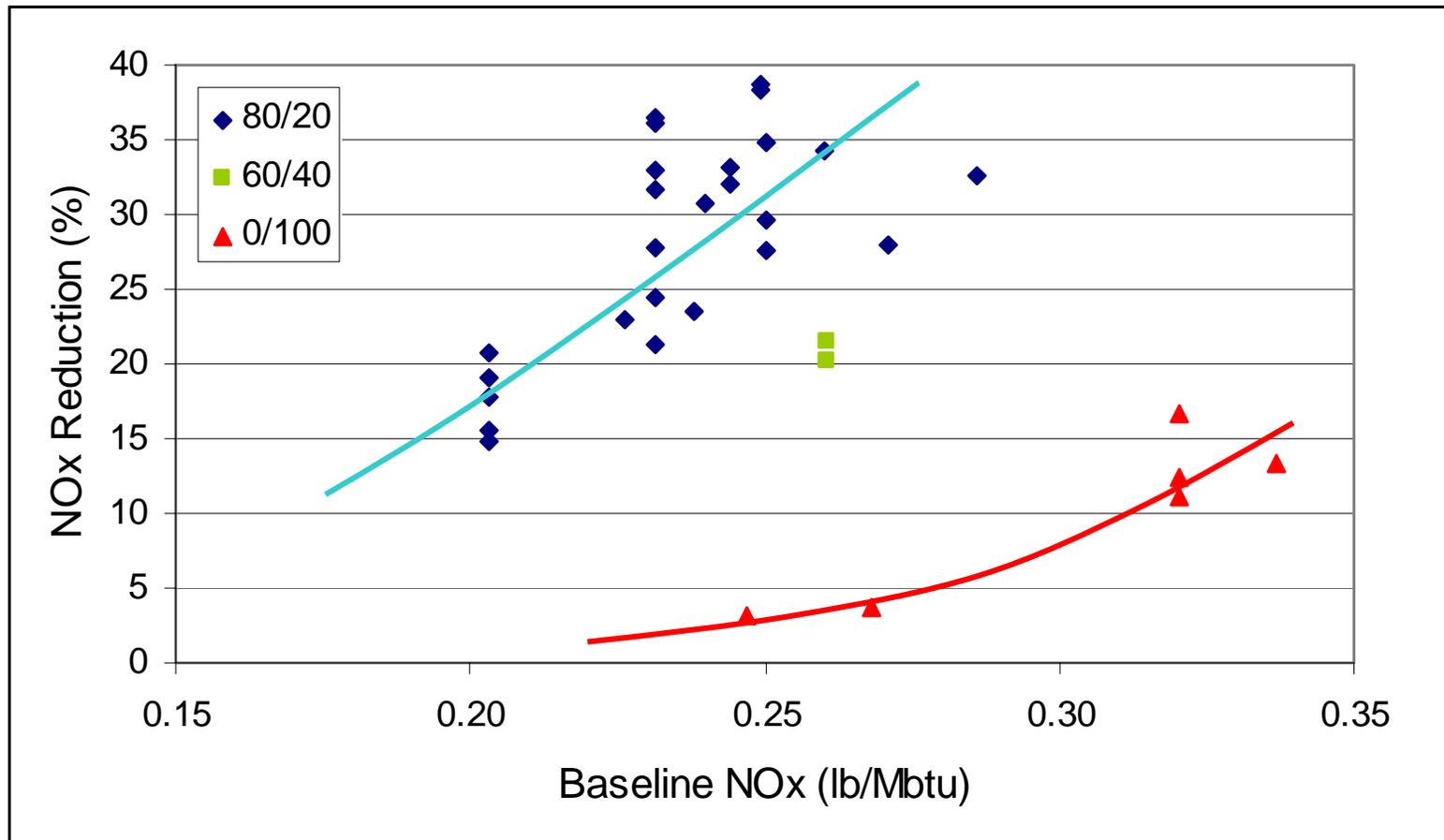
# Dependence on Staging Level

## *RRI in Sioux Unit 1*



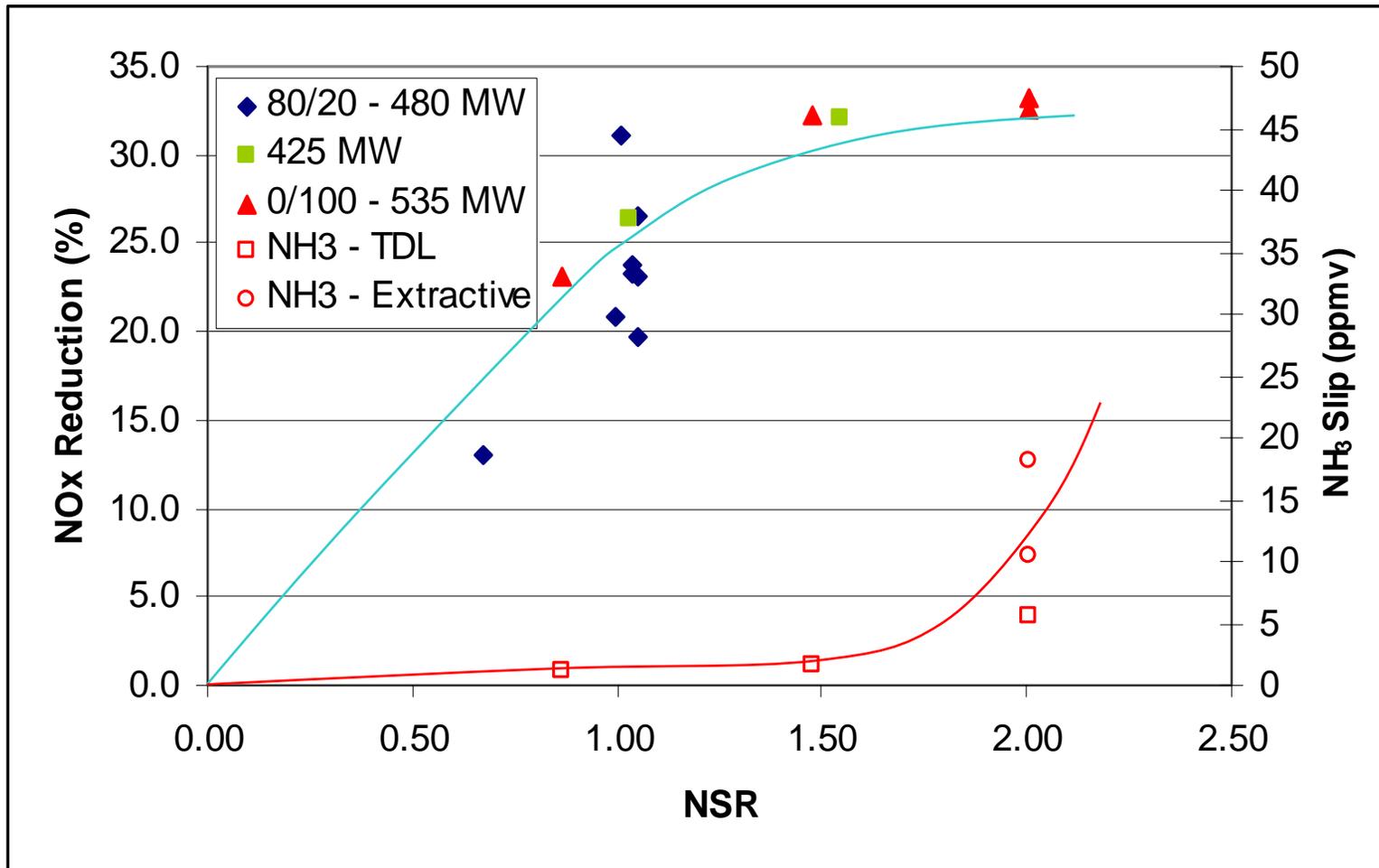
# Fuel Blend & NOx Conc. Impacts

## *RRI in Sioux Unit 1*



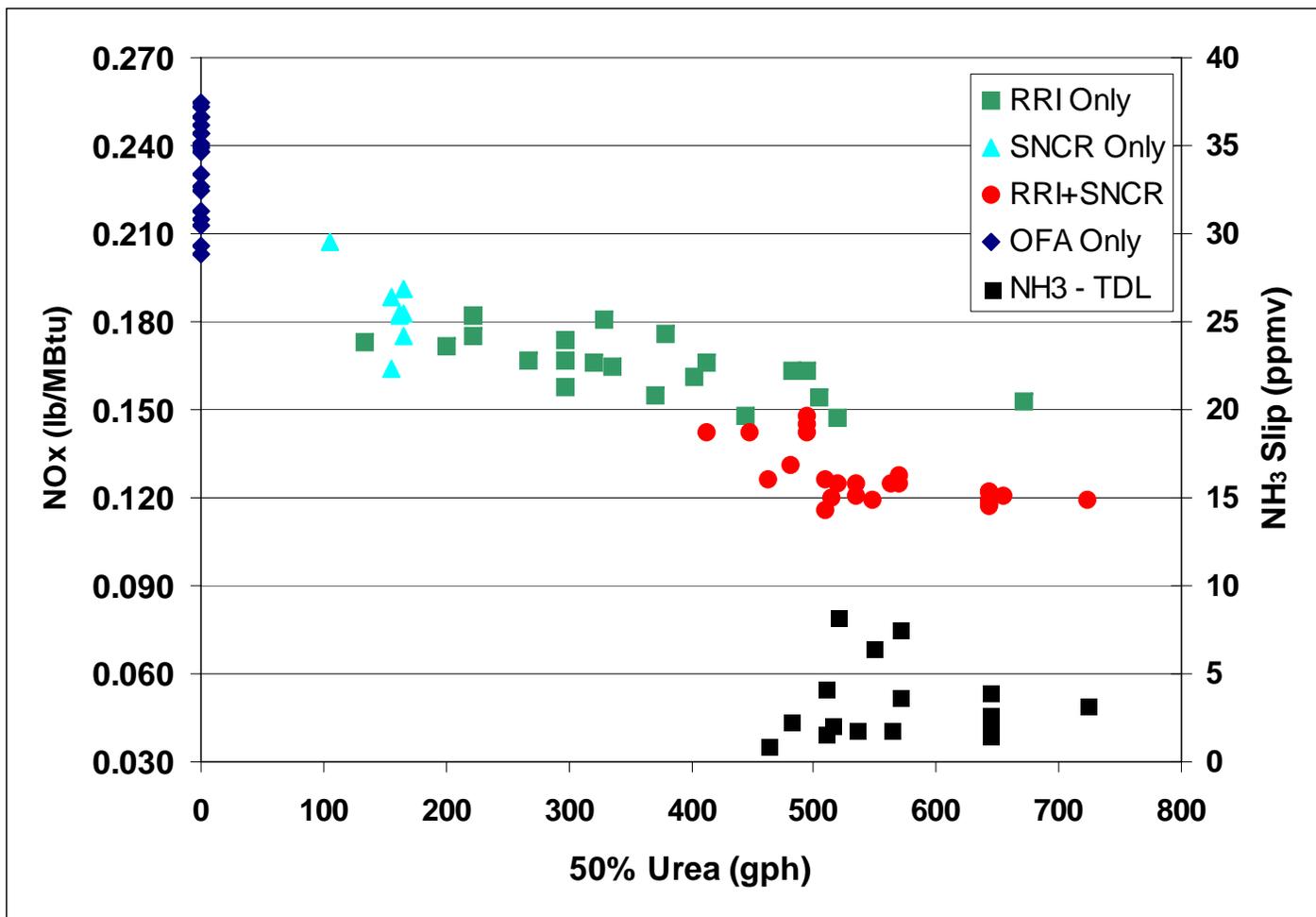
# NOxOut SNCR Results

## *ALTA in Sioux Unit 1*



# ALTA NOx Results

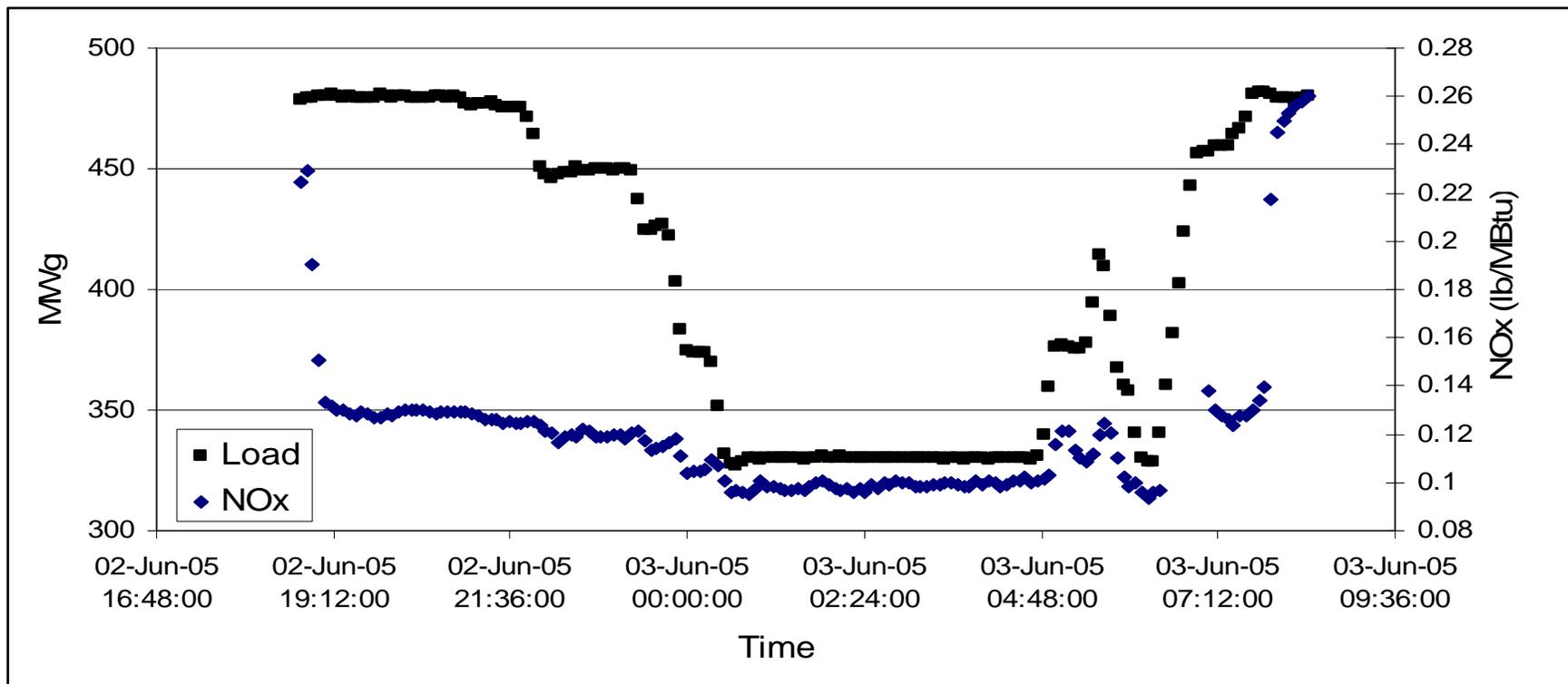
## *ALTA in Sioux Unit 1*



# Reduced Load Testing

## *ALTA in Sioux Unit 1*

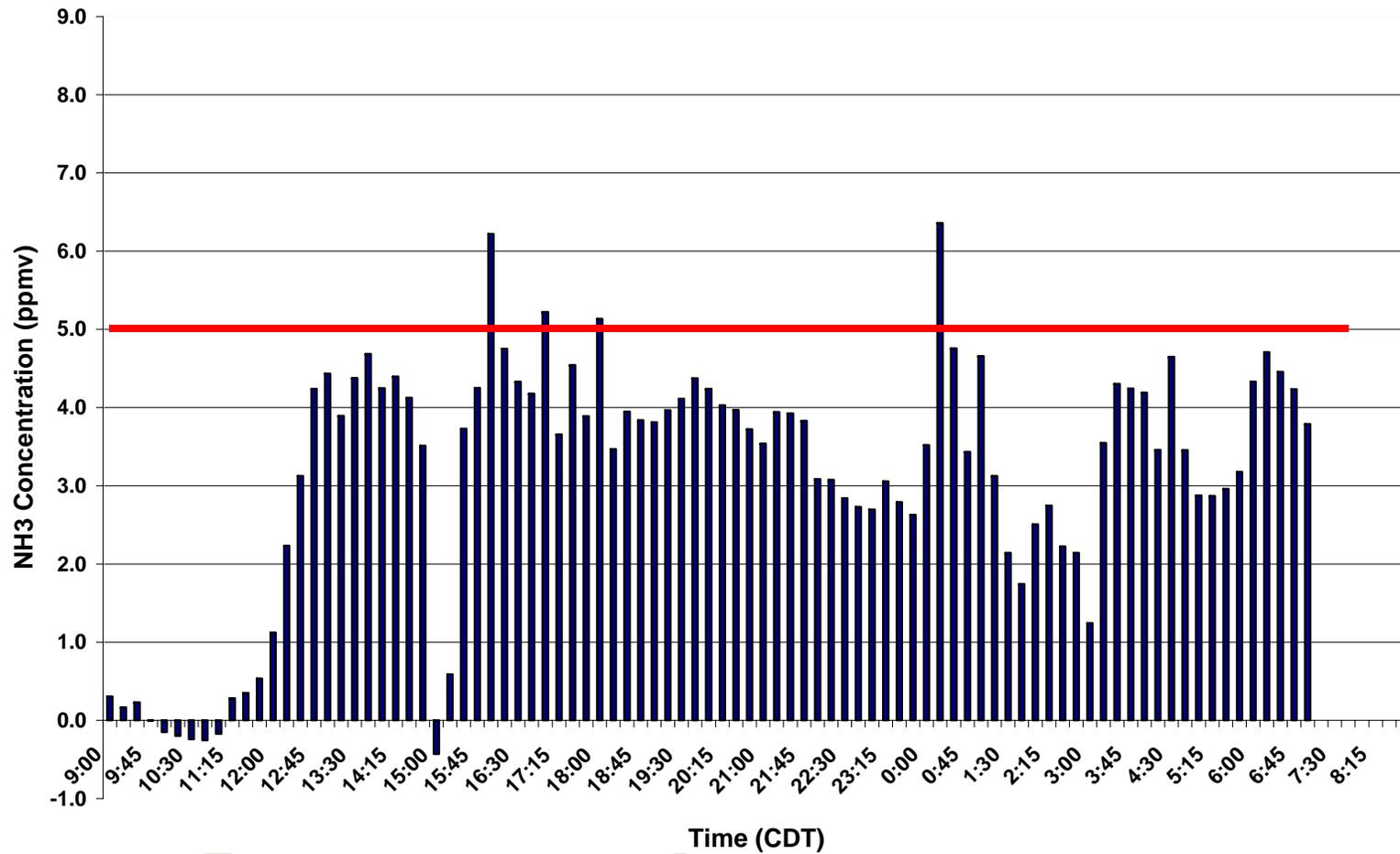
### ALTA run overnight in Automatic Mode



# Continuous Tests – NH<sub>3</sub> Slip

## *ALTA in Sioux Unit 1*

NH<sub>3</sub> Sioux Ameren Power Plant, June 6-7, 2005



Time (CDT)



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# Summary of Testing

## *ALTA in Sioux Unit 1*

- **0.12 lb/MBtu NO<sub>x</sub> with 80/20 PRB blend**
  - As low as 0.15 lb/MBtu with RRI alone
  - 90% NO<sub>x</sub> reduction from uncontrolled baseline
- **Decreased RRI performance with increased Illinois 6 blend (0.165 lb/MBtu w/ 100% Ill. 6)**
- **Minimal BOP impacts observed**
  - Typically less than 5 ppm NH<sub>3</sub> slip
  - No observed increase to LOI
  - No atypical slagging issues observed



# ALTA Summary

- **Sioux 1 test results met project objectives**
  - **NO<sub>x</sub> < 0.15 lb/MBtu**
  - **Minimal BOP impacts**
  - **ALTA levelized costs ~\$700/ton NO<sub>x</sub> removed (0.4 lb/MBtu baseline) vs ~\$2500/ton for SCR**
- **ALTA test results consistent with model predictions**
- **Ameren is proceeding with installation of commercial ALTA systems in both Sioux units**



# Thank You

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