Demonstration of SNCR Trim on a 185 MW Tangential Design Coal-Fired Utility Boiler

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Background

- Ozone Season NOx Regulations Based Upon System-Wide Tonnage Emission Caps
- Need for Low Capital - Variable Cost Oriented NOx Control Technology
  - Scenario 1 : Trim 20% - 30% NOx from high capacity or marginally economic units to avoid/minimize sites requiring capital intensive NOx controls, or purchase of NOx credits
  - Scenario 2 : Provide NOx tonnage reductions at low load while operating during off peak generation, offsetting potential NOx increases from increased excess oxygen levels for steam temperature control
  - Scenario 3 : Broad based deployment of low capital cost NOx control technology to accommodate delayed/phased installation of SCR systems

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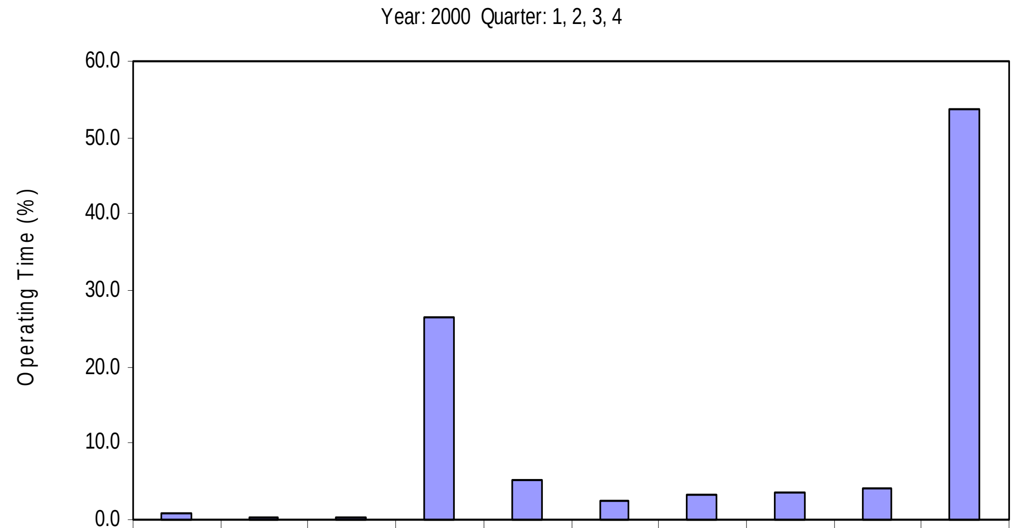
SNCR Trim Concept

- Low capital cost approach for achieving 20% - 30% NOx reductions
  - tailored to base loaded units with limited range of operation
  - single level of ‘low energy’ injectors
    - Reduces capital cost
    - Operation optimized for limited load range of interest
    - System off during ramping
  - urea reagent



	1	2	3	4	5	6	7	8	9	10
Operating Time	0.7	0.4	0.2	26.4	5.1	2.5	3.3	3.5	4.2	53.6

Load Range

Project Objectives

- Capital Cost of \$5/kW - \$7.5/kW
  - nominally one-half of conventional SNCR system
- Reagent Utilization ~ 30%
  - NO_x reductions of 20% - 30% at a NSR of 0.7 – 1.0
- Average Ammonia Slip < 5 ppmv
- NO_x Reduction Cost Effectiveness < \$2,500/ton
  - 2003 ozone season NO_x allowance credits are currently greater than \$4,000/ton

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Approach

- Three phase project to demonstrate SNCR Trim performance
  - Field measurements
    - furnace exit gas temperature
    - gaseous species at points of reagent injection
      - NOx, CO, and O_2
  - CFD model to assess system performance with most promising injection scenarios
  - Field demonstration

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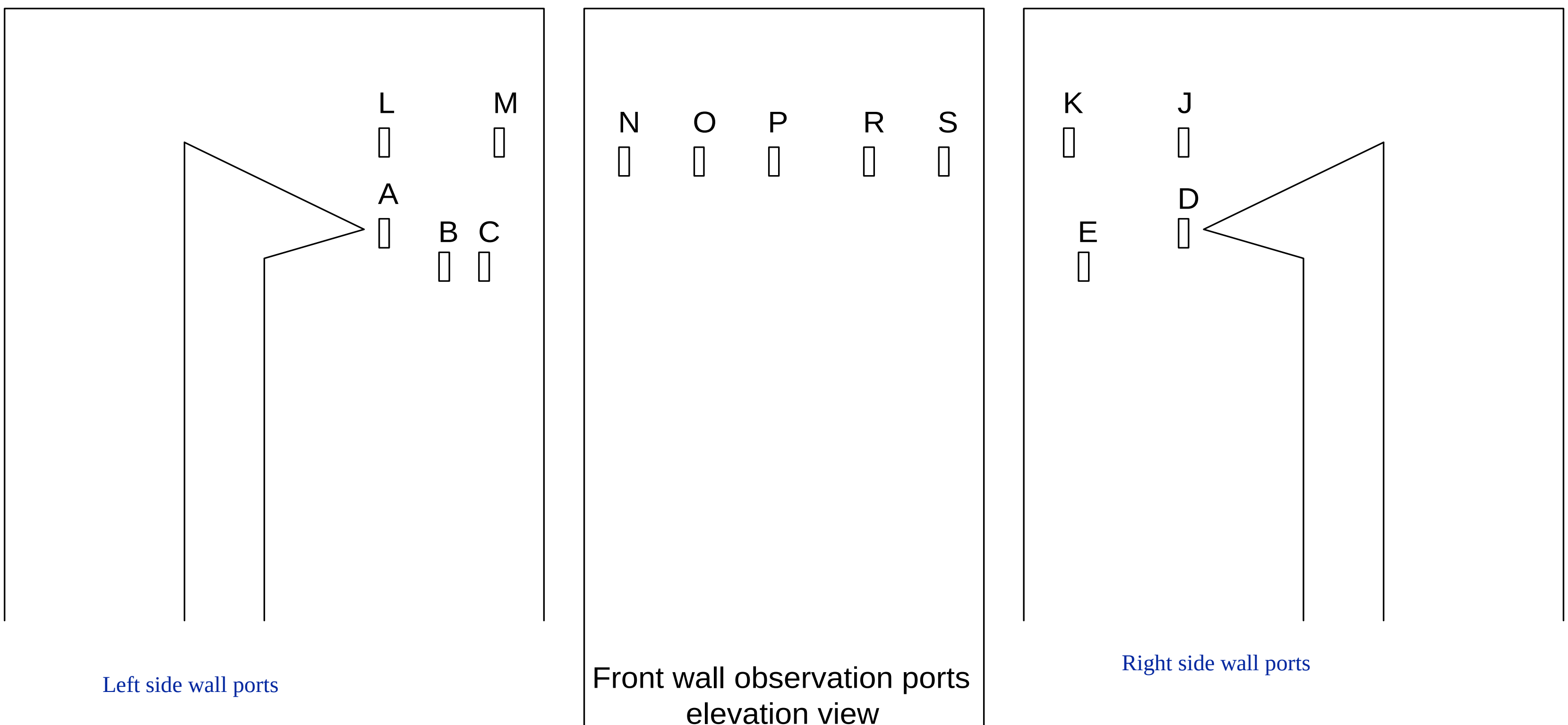
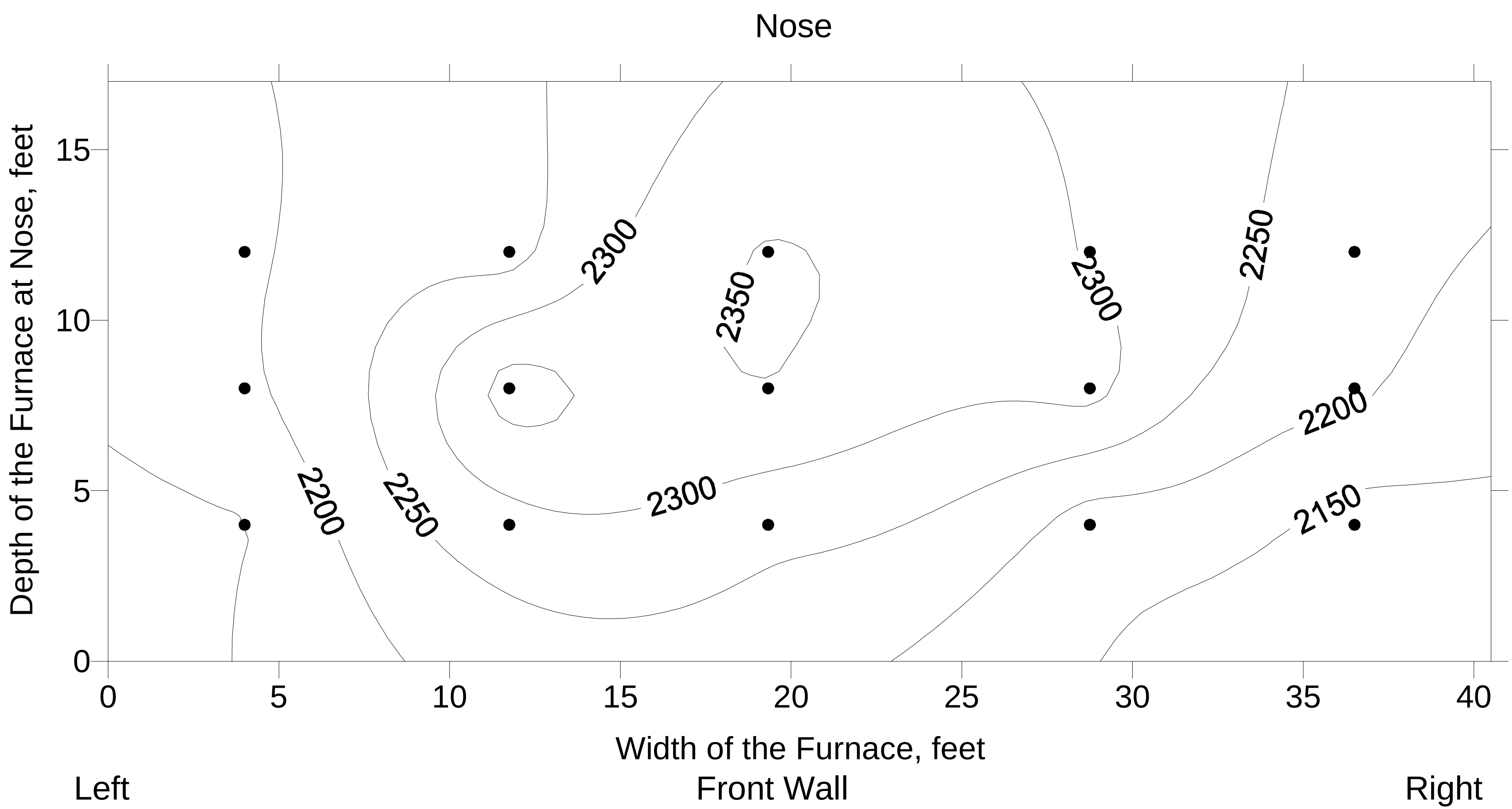
Temperature Measurement Locations

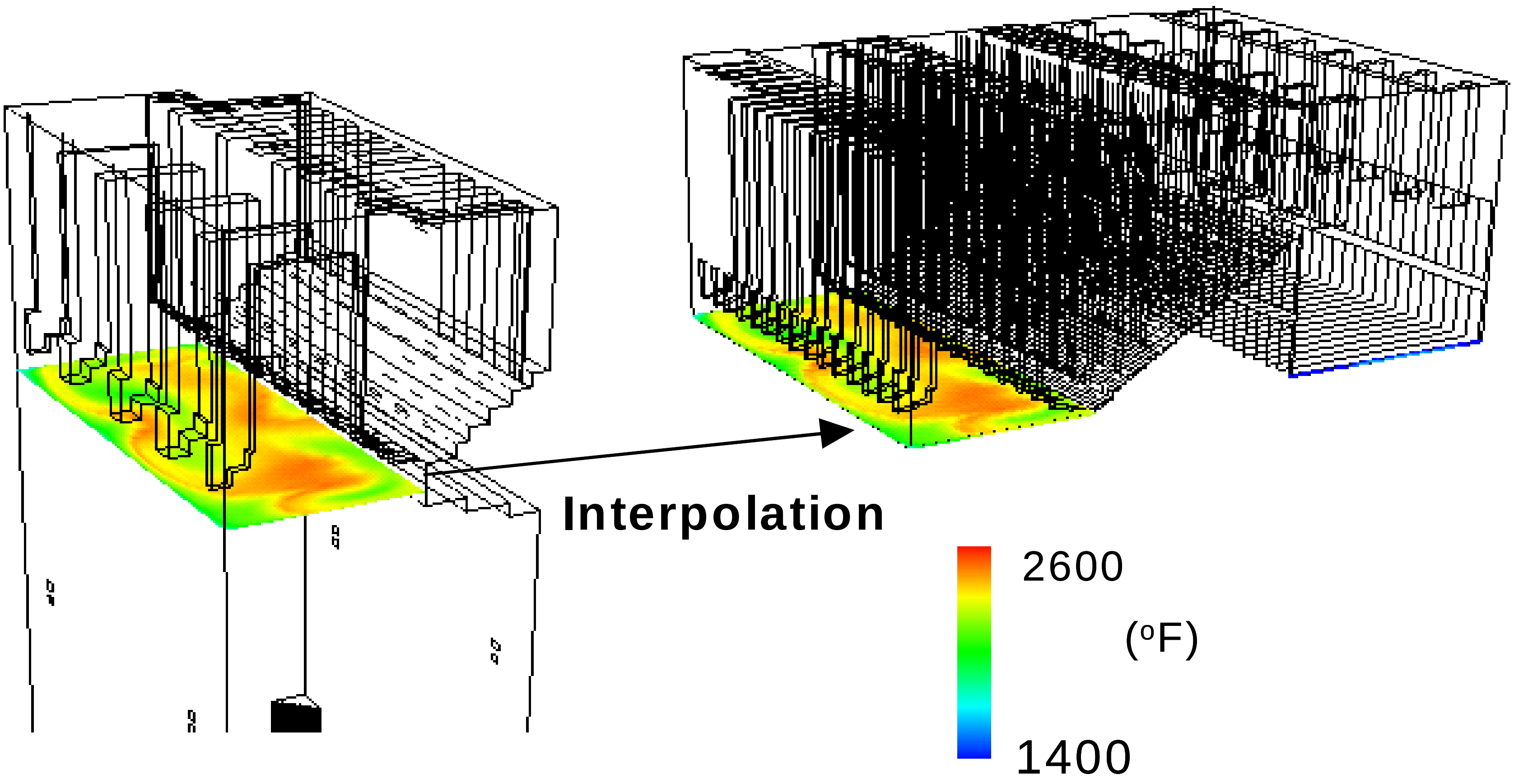


Front wall ports @ EL 672'
Upper sidewall ports (L, M, K, J) @ EL 674'
Lower sidewall ports (A, D) @ EL 665'
Lower sidewall ports (B, C, E) @ EL 661'

Temperature Measurements

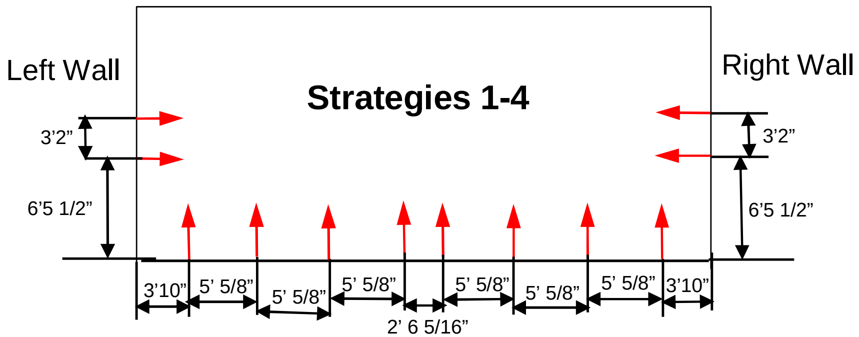


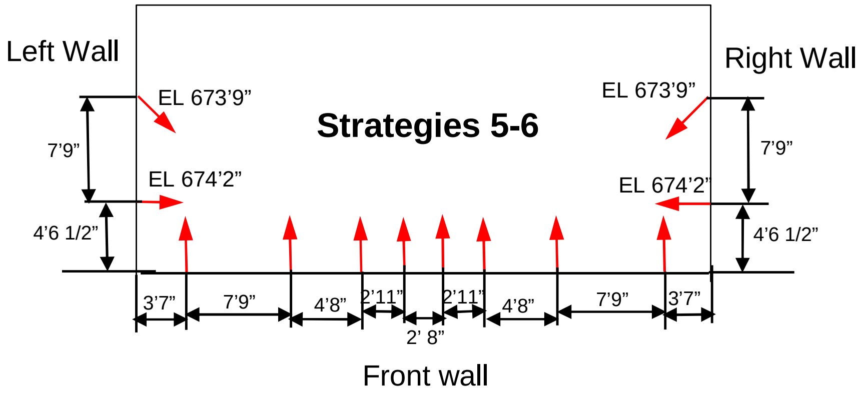
CFD Model Approach



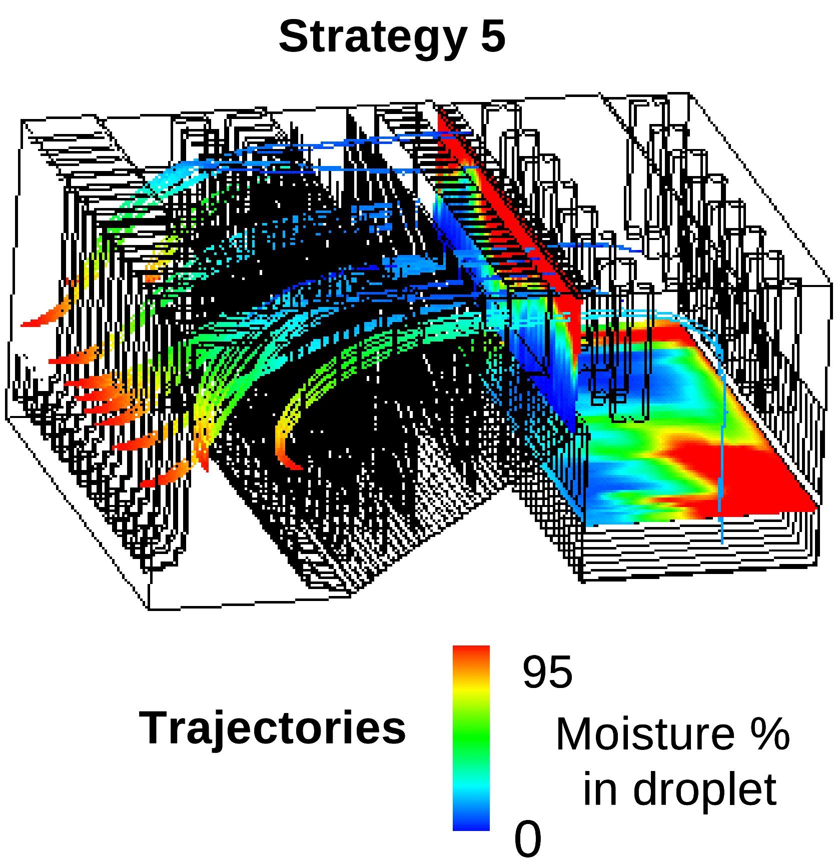
CFD Model
Injection Strategies Evaluated

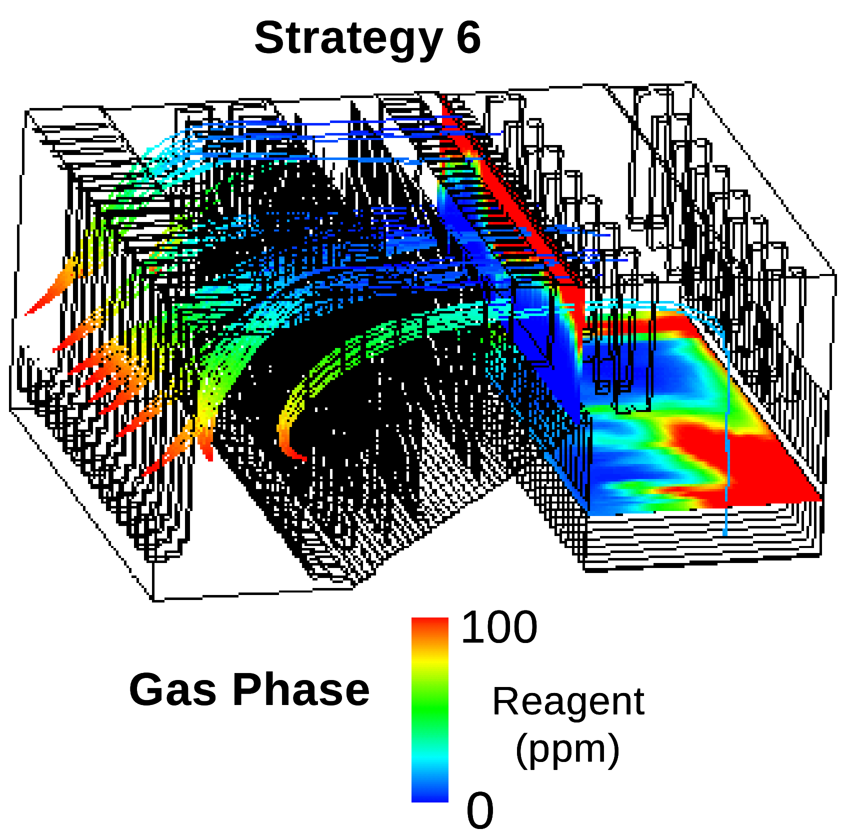
- 8 - 12 Injectors
  - nominal 1 gpm/injector
  - 5% - 10% urea solution
  - 300 – 500 micron droplets
  - 50 – 65 ft/s injector velocity



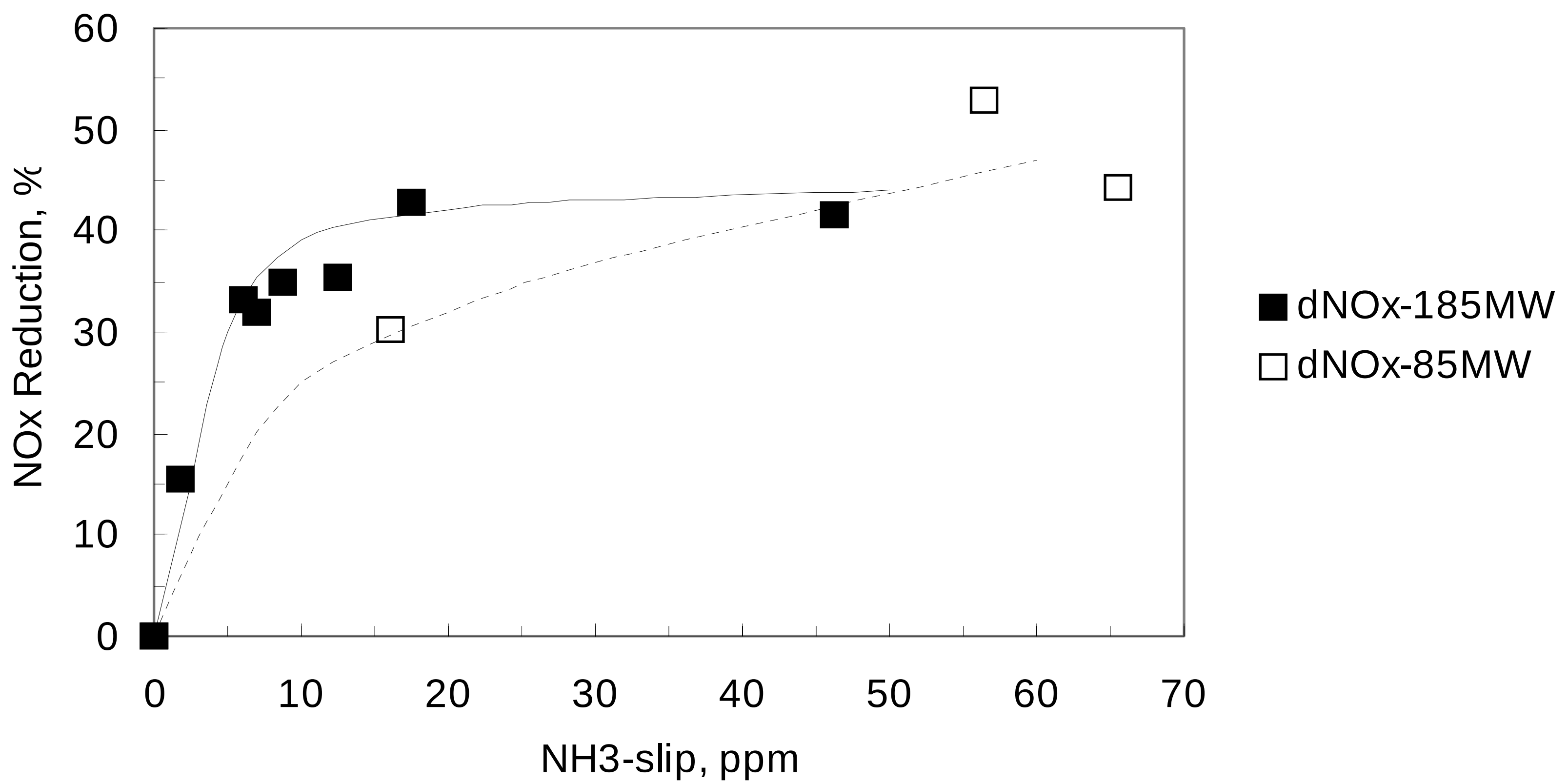


CFD Model Predictions



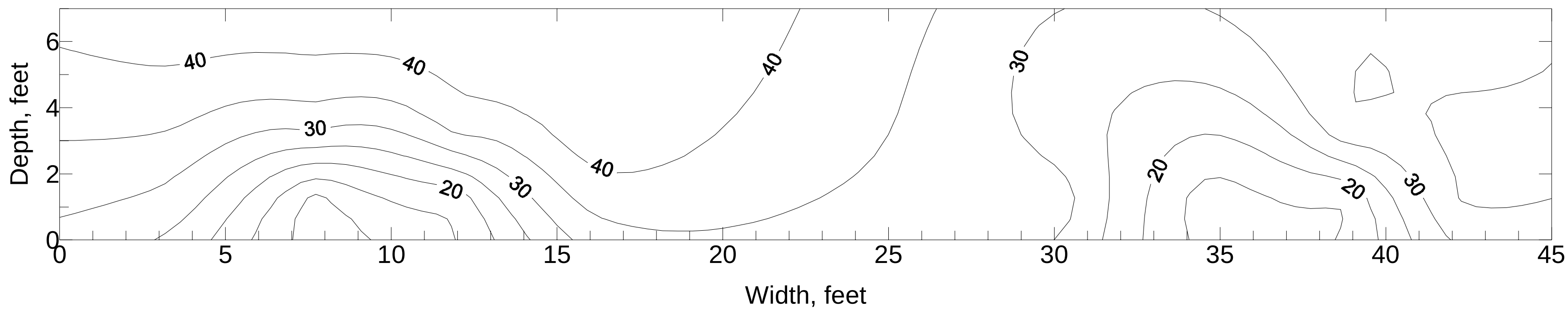


Field Results Summary

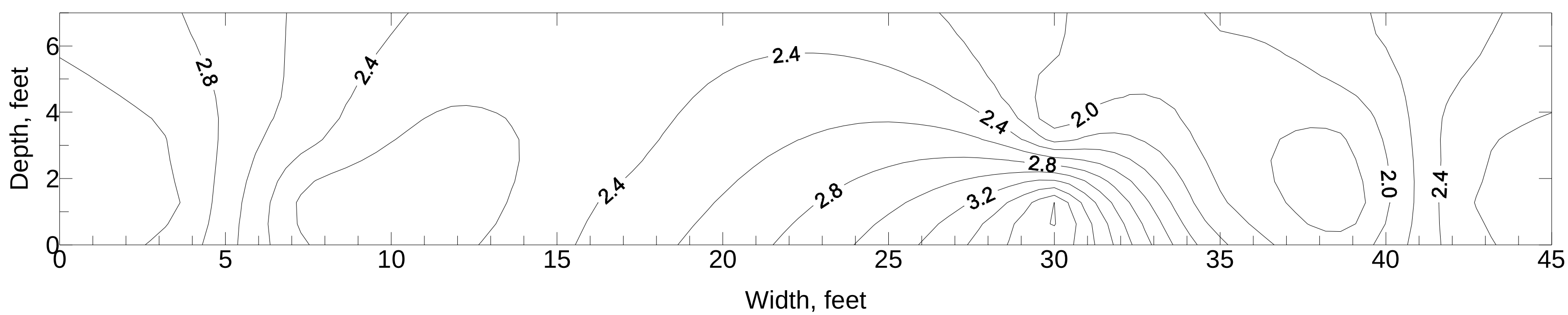


Field Results
Gaseous Emissions

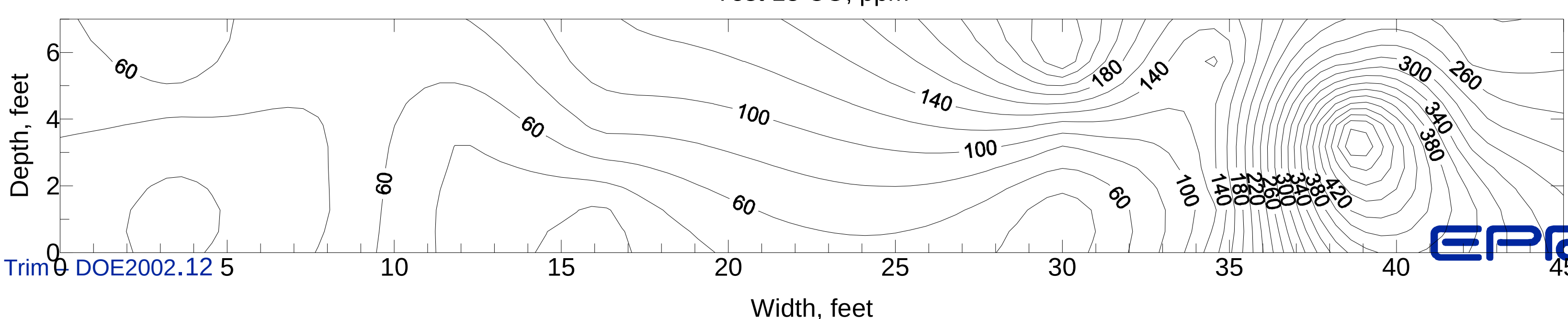
Test 13 dNOx, %



Test 13 O2, %



Test 13 CO, ppm



Economic Assessment

- Premise
  - $6.5/kW capital cost
  - 12.5% capital cost recovery factor
  - 0.22 lb/MBtu baseline NOx (~400 lb NOx/hr)
  - 60% ozone season capacity factor
  - $0.90/gallon delivered urea cost (50% solution)
  - 30% NOx reduction at NSR of 1.0

- Result
  - Annualized capital cost
    - $151,000
  - Ozone season O&M
    - $152,000
    - 94% reagent cost
  - Tons NOx removed
    - 131 tons
  - Cost effectiveness
    - $2,310/ton

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Conclusions

- Full load performance
  - 35% NOx reductions achieved with 6 – 12 ppm ammonia slip
  - 30% NOx reductions achievable with < 5 ppm ammonia slip
- Load and NSR exhibited primary effect on achievable NOx reduction
  - Load changes varied FEGT and CO levels
- Cost effectiveness estimates indicate $2,300/ton NOx removed achievable

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EPRI Future Research Plans

- Additional demonstrations to evaluate performance:
  - on larger scale furnace (> 500 MW)
  - furnace with FEGT ~2400 F
  - different furnace designs (e.g. wall-fired)
- Assess feasibility of multi-point continuous ammonia slip measurement
- EPRI's Post Combustion NOx Control Program