Gas Turbine SCR Performance Optimization and Management

T. D. Martz, L. J. Muzio

Fossil Energy Research Corp.

Laguna Hills, CA

McIlvaine Hot Topic Hour

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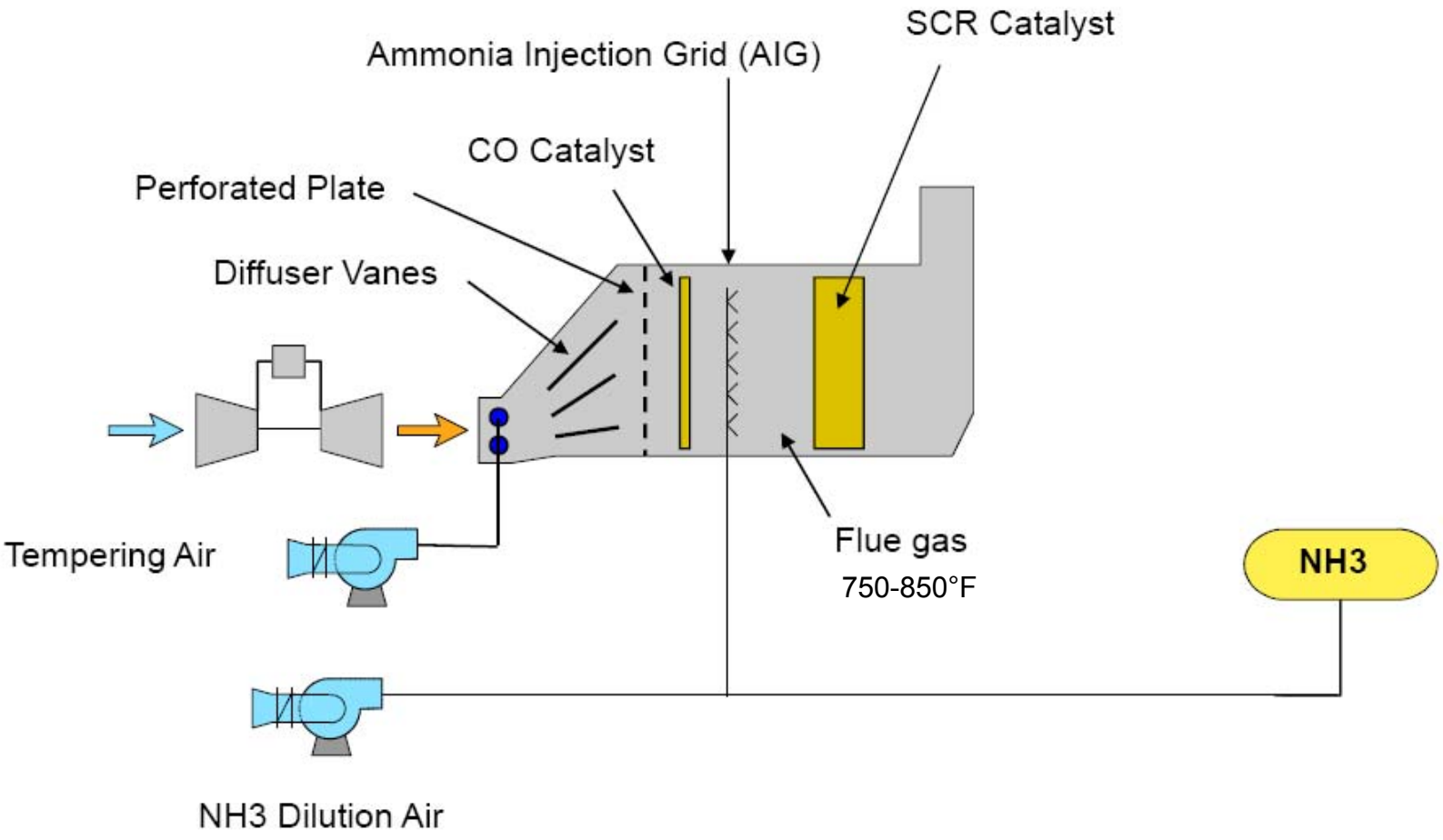
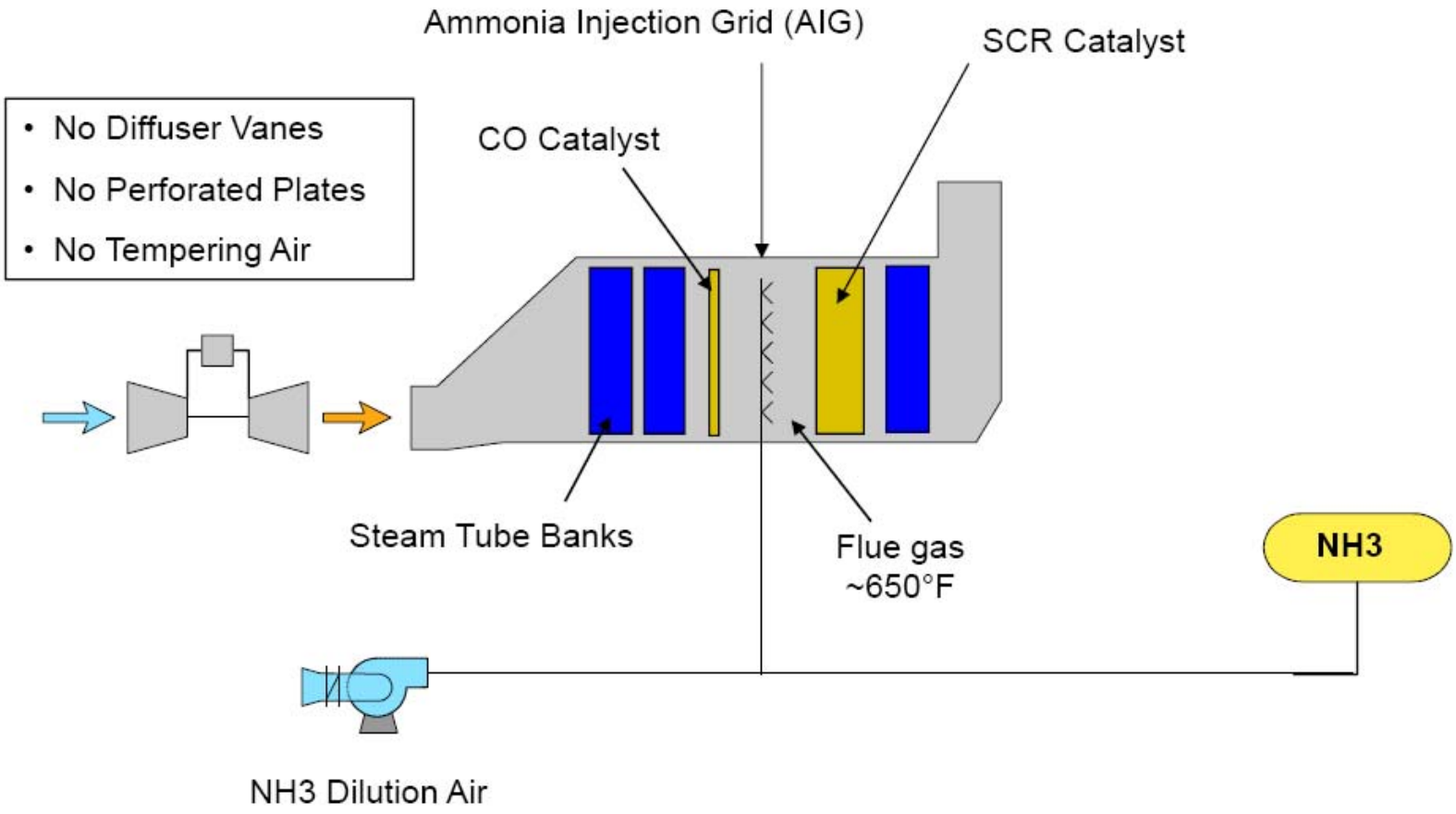
Gas Turbine SCR Systems

Simple Cycle GT SCR



Gas Turbine SCR Systems

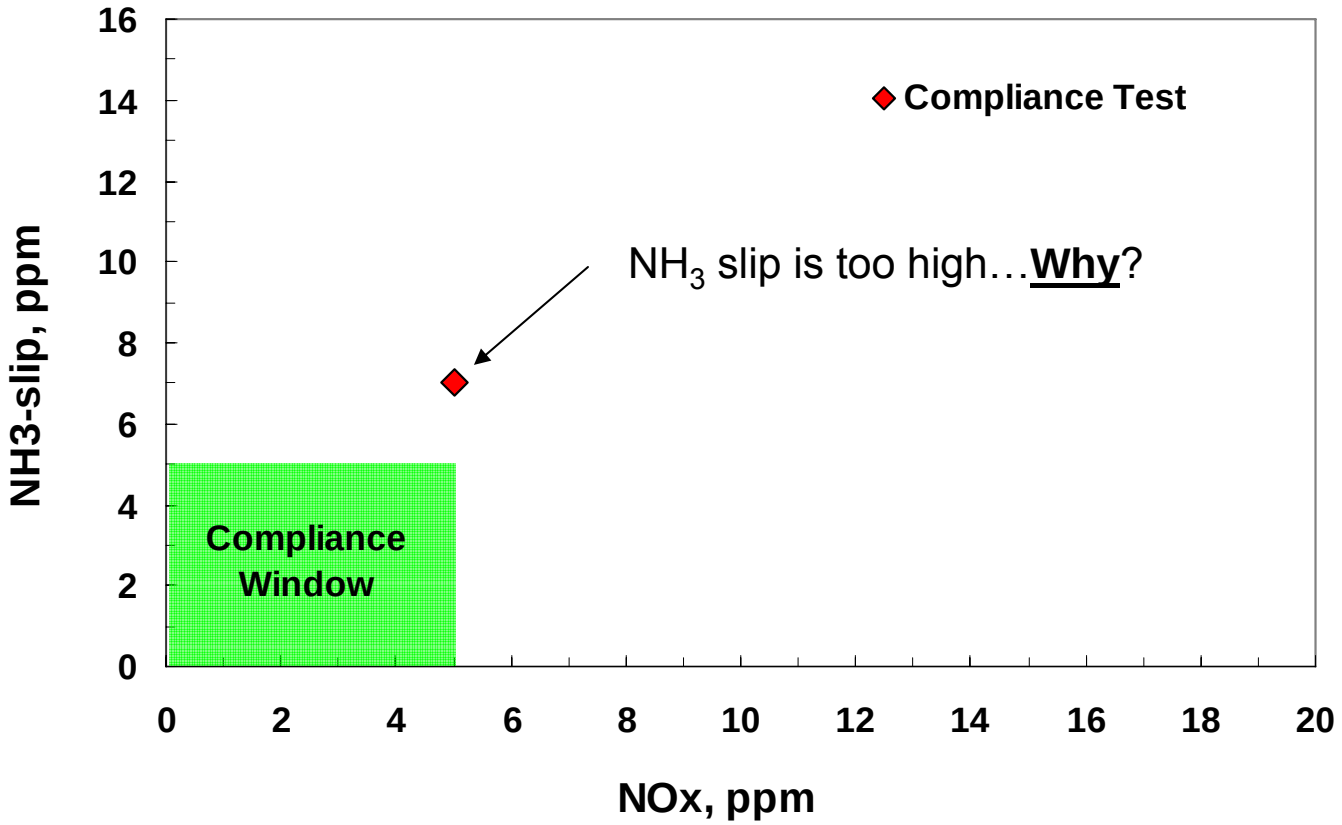
Combined Cycle GT SCR



Today's Gas Turbine SCR Topics

- **Troubleshooting**
  - FERCo is a trusted 3rd party engineering services company
  - Extensive background with SCR (design, modeling, full scale testing)
  - Developed a process model for SCR design and troubleshooting
- **Catalyst Inlet NH_3/NO_x Distribution and AIG Tuning**
  - Why NH_3/NO_x distribution is important
  - How AIG tuning can extend catalyst life
  - FERCo's approach to AIG tuning
- **SCR Catalyst Management**
  - What is it?
  - How is it done?
  - Why is it done?

Troubleshooting



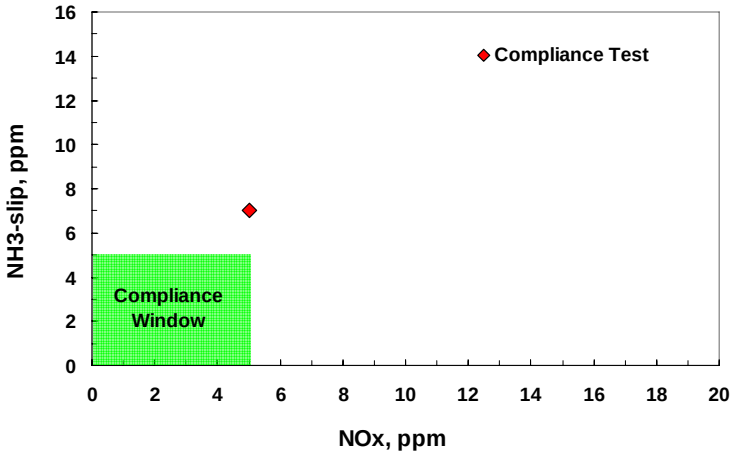
Why?

Catalyst Activity (K)?

- F(material, geometry)
- Condition of active sites

Reactor Potential?

- Ability of the catalyst bed to reduce NO_x
- RP= K * A_{sp}* V_{cat}/ Q_{fg}



Poor NH3/NOx Distribution?

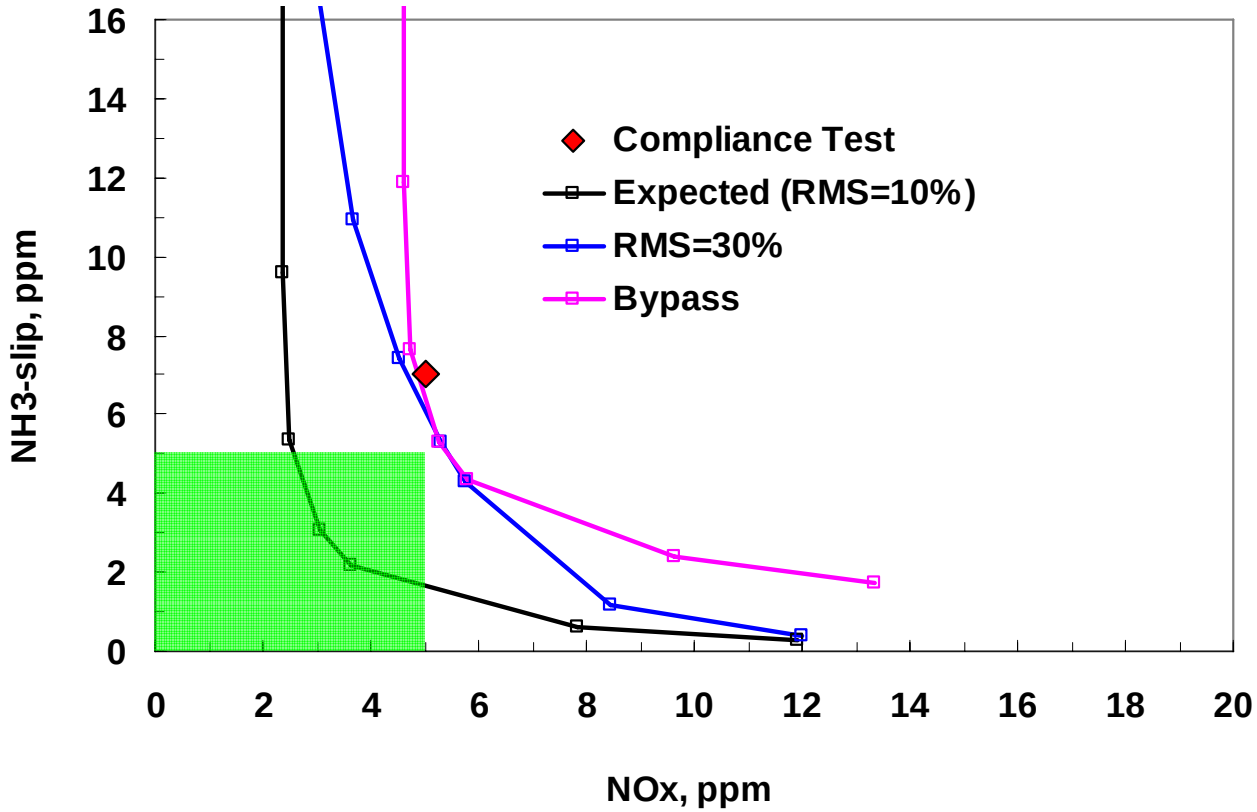
- Uniform NH_3/NO_x profile is critical
- Local NH_3/NO_x >1 creates NH_3 slip

Flue Gas Bypass?

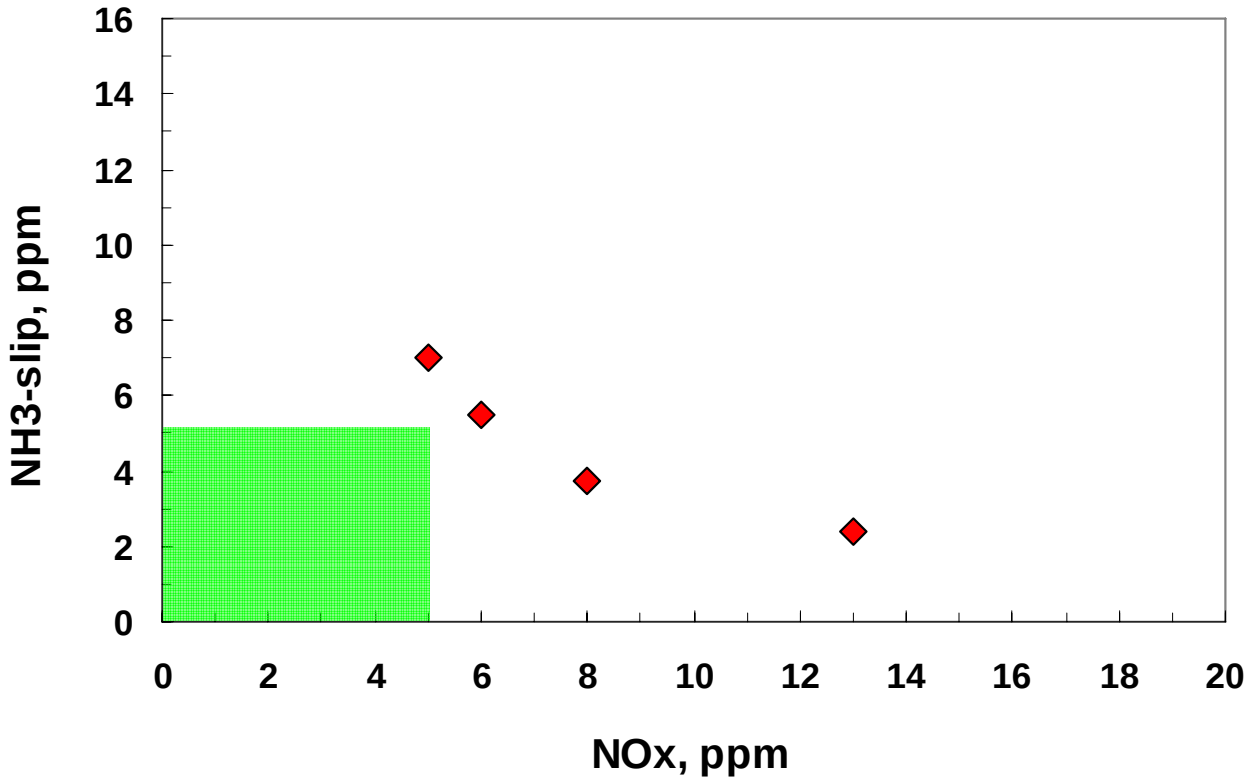
- Any leakage around the catalyst increases stack NO_x & NH_3

Activity, NH3 Distribution, or Bypass?

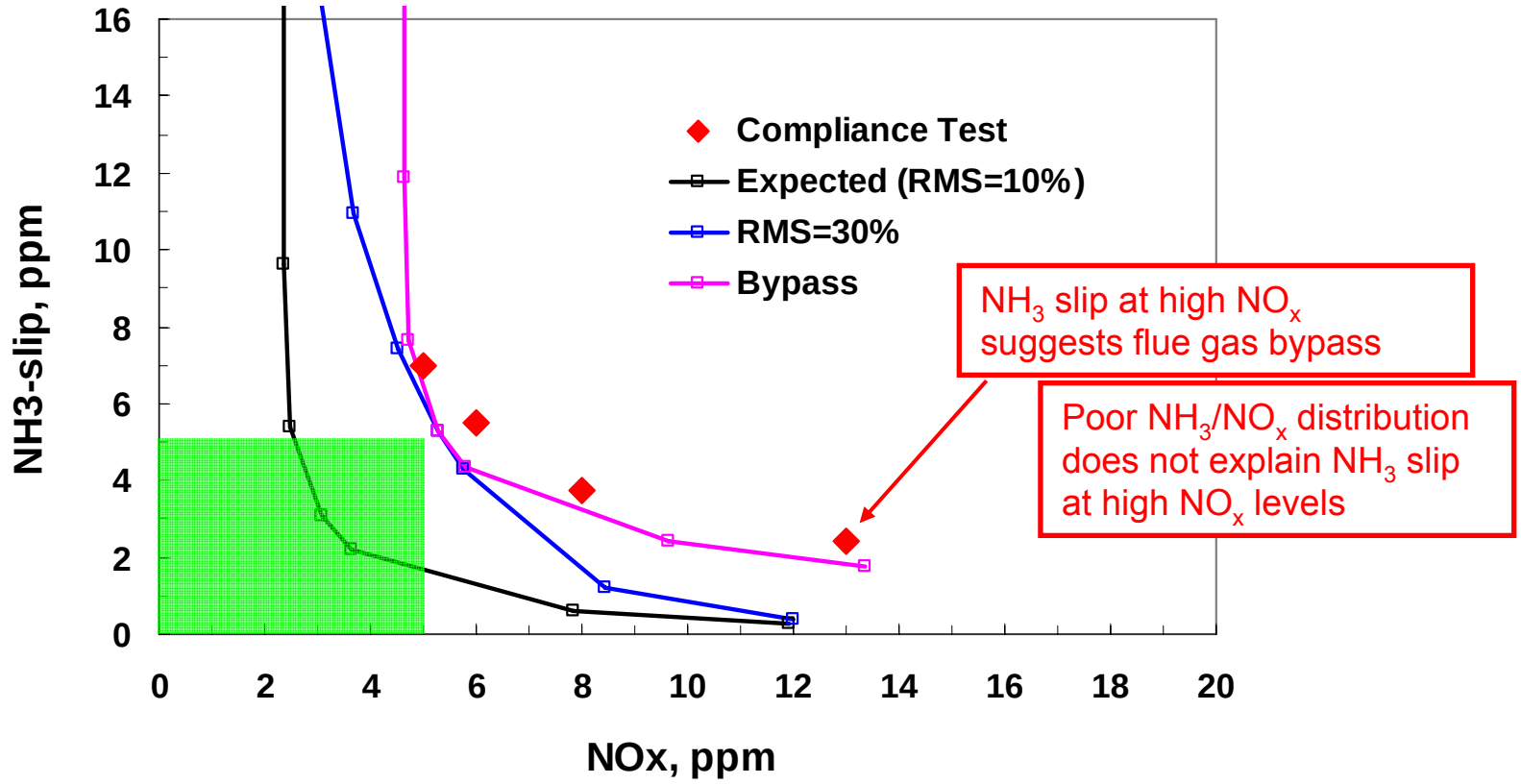
- FERCo utilizes a process model to compare expected SCR performance to actual performance (see curves below)
- A single data point is not sufficient for identifying the problem



Perform Additional Tests



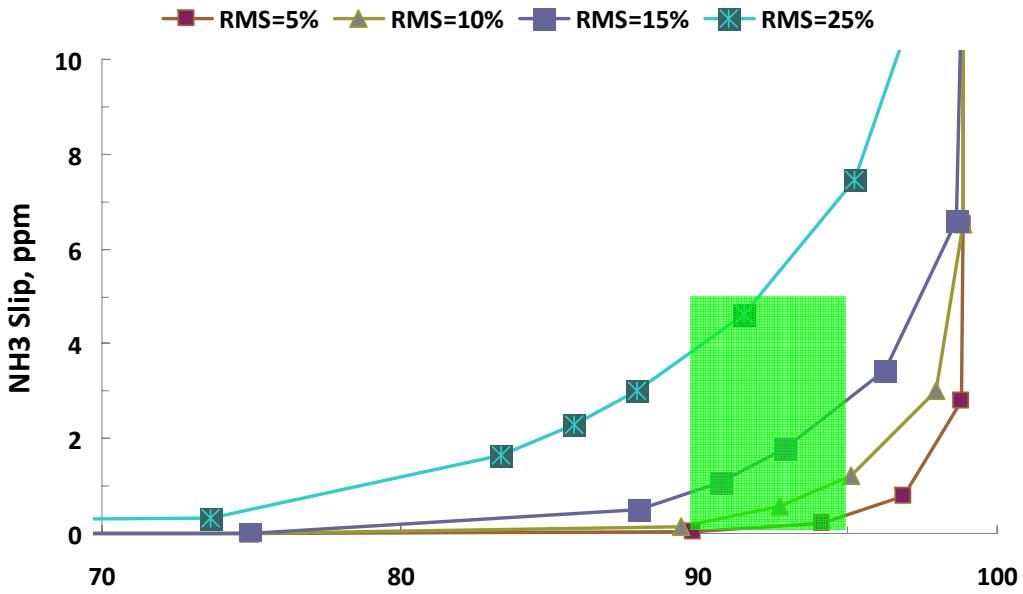
Flue Gas Bypass?



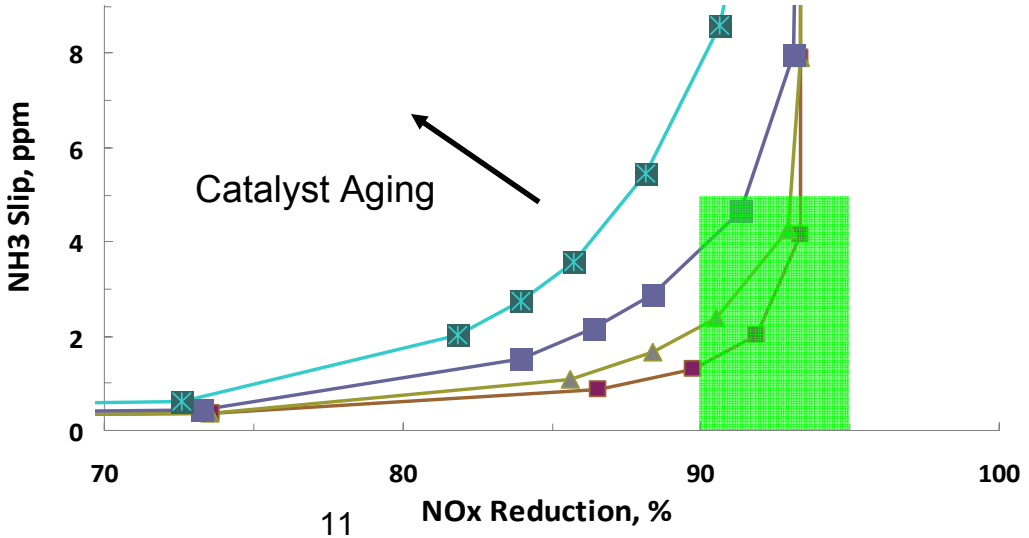
Catalyst Inlet NH3/NOx Distribution and AIG Tuning

NH_3/NO_x Distribution and AIG Tuning

New Catalyst



Near Catalyst End-of-Life



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Sample Probe Grid Expedites Tuning

- AIG tuning is difficult without a probe grid at the catalyst exit

- The costs for installing a probe grid will be recovered in the long run:
  - No scaffolding or manlift required for testing ($, safety issues)
  - Reduced test times (no manual probe)
  - Reduced testing contractor costs
  - More data

50MW simple cycle SCR
With a grid of 50 sample probes (5 x 10)

Sample Probe Grid Expedites Tuning

Sample Probe Grid Expedites Tuning

A sample grid is especially important for larger units (e.g., more than 30’ wide)

325MW combined cycle SCR with a 36-point sample grid (6 x 6)

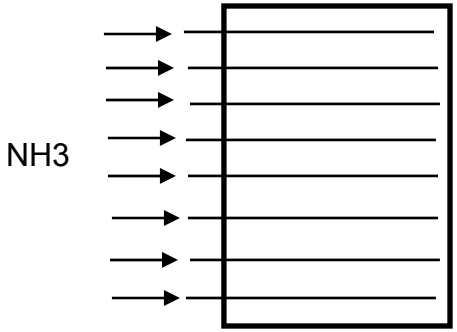
FERCo's Multipoint Instrumentation

- Samples 48 points in 15 minutes
- NOx and O2

AIG Design Influences Tuning

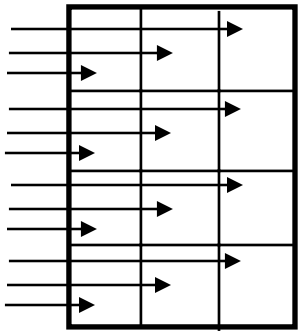
- **Some systems have no AIG adjustment valves – *bad idea!* No flexibility to account for 1) duct velocity gradients, 2) duct NOx gradients, or 3) lance-to-lance ammonia flow gradients**

- **Most systems have one-dimensional adjustability**



Vertical adjustability can handle only vertical velocity or inlet NOx gradients

- **Ideal design: multiple zone adjustability**



Multiple zones allow treatment of localized gradients

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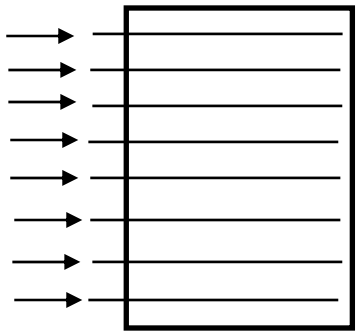
AIG Tuning, 10 MW Gas Turbine SCR

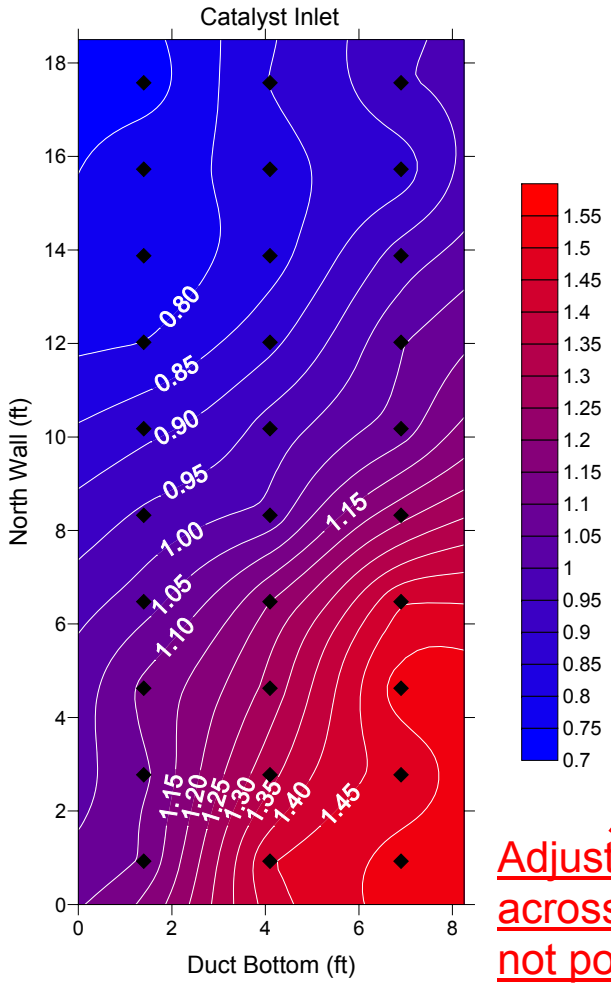
One-Dimensional, Vertical AIG

NH3



As-Found

NH3/NOx Distribution

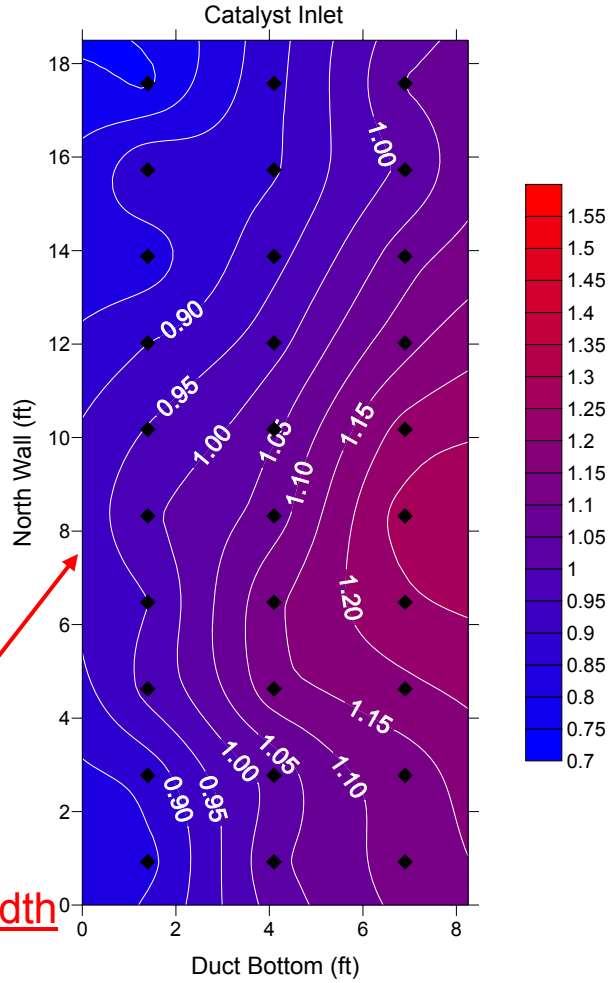


RMS = 22%

Adjustments across the width not possible

Adjusted

NH3/NOx Distribution



RMS = 13%

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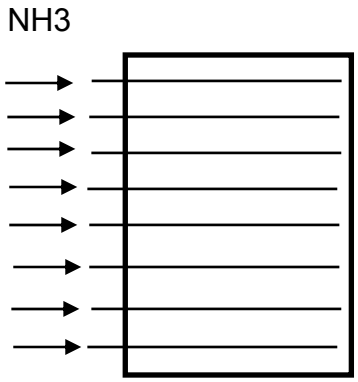
AIG Tuning, 350MW Combined Cycle SCR

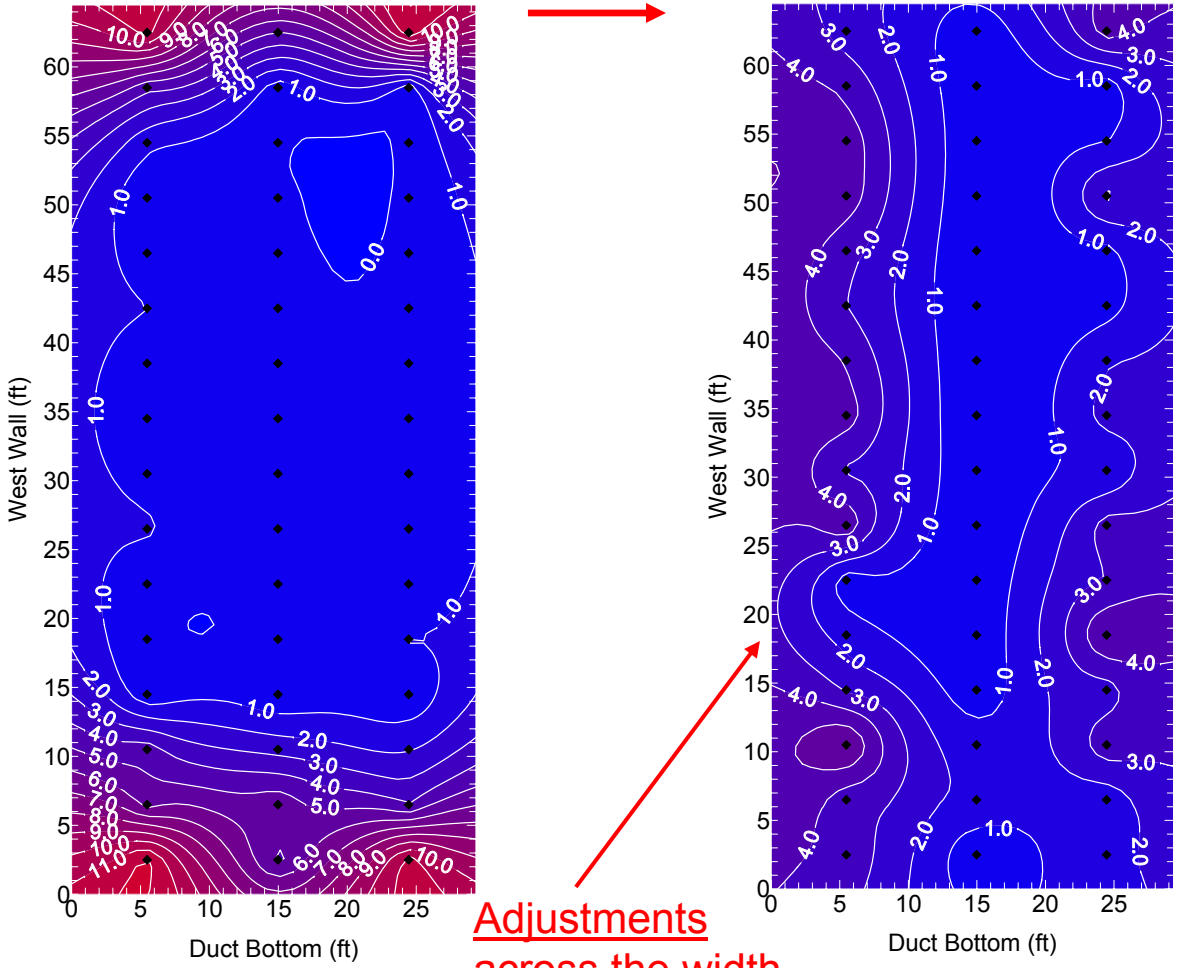
One-Dimensional, Vertical AIG



As-Found Outlet NOx (ppm)

NH_3 consumption reduced by 5%

Optimized Outlet NOx (ppm)



Adjustments across the width not possible

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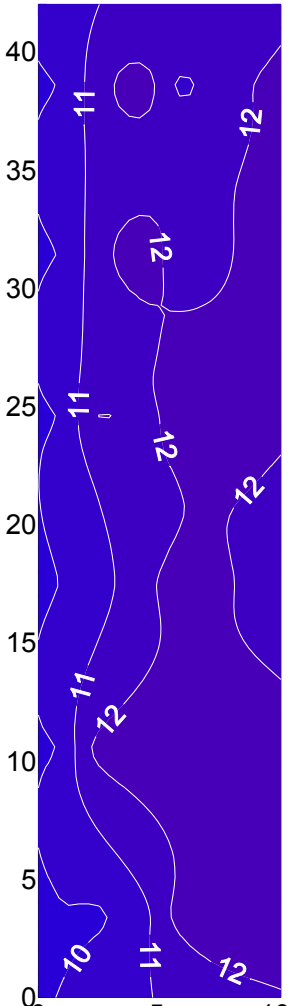
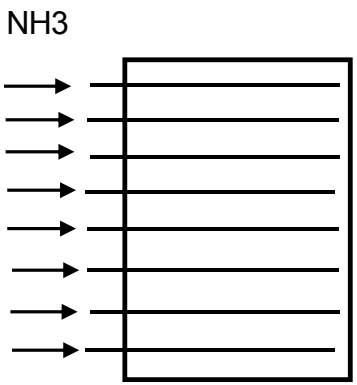
Duct Burners Impact AIG Tuning

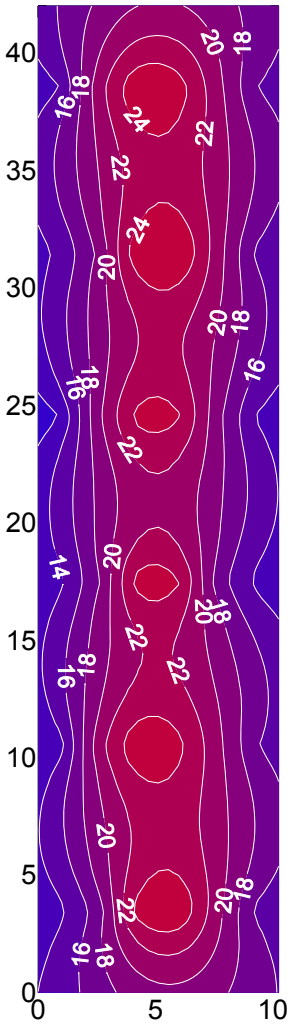
Duct Burners Off (Inlet NO_x ppm)



AIG Tough to Tune



Duct Burners On (Inlet NO_x ppm)



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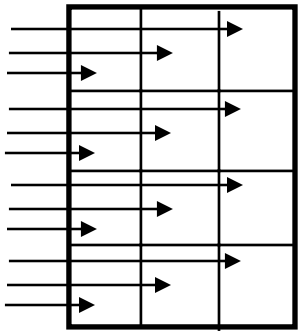
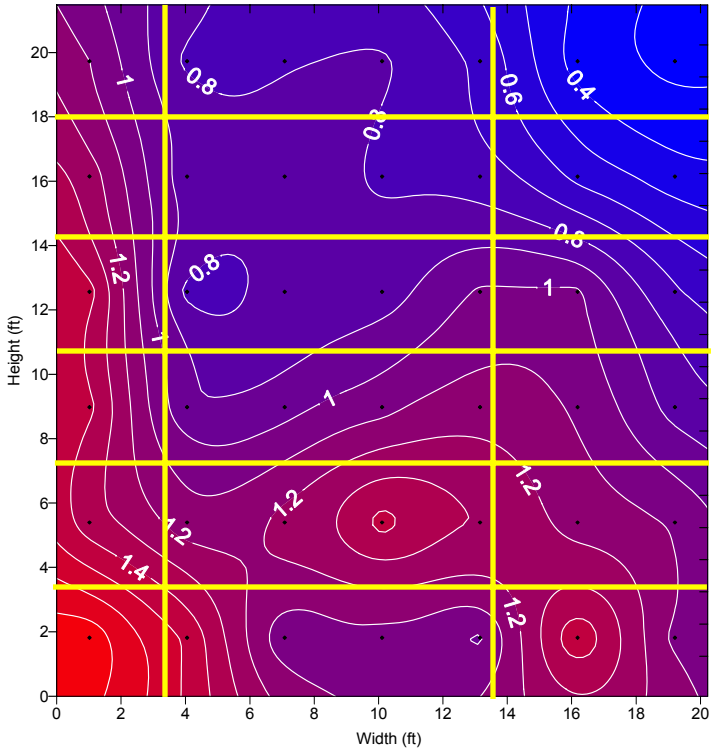
AIG Tuning, 10 MW Gas Turbine SCR, 90° Turn



Multiple zones, skewed based on flow modeling

As-Found

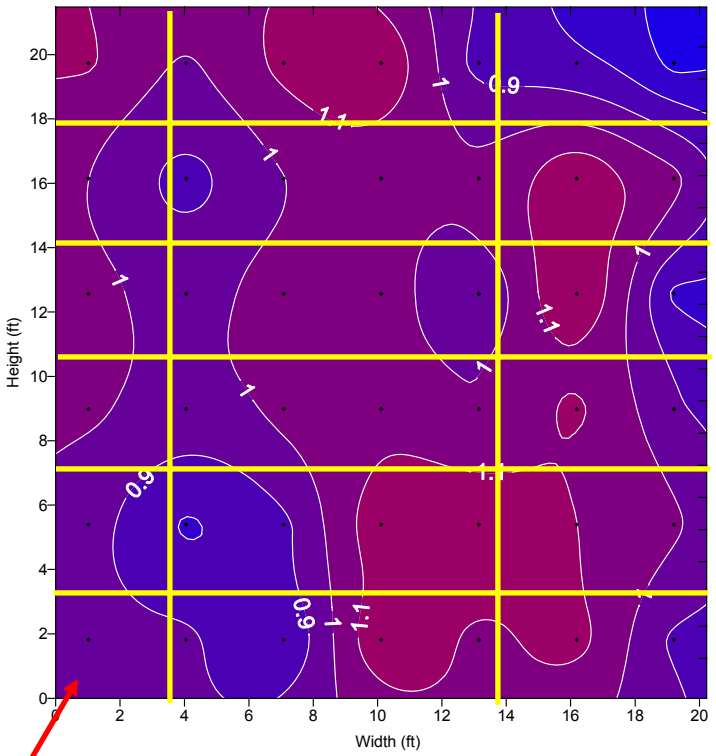
Normalized NH3/NOx Distribution



RMS = 32%

Adjusted

Normalized NH3/NOx Distribution



Corners adjusted

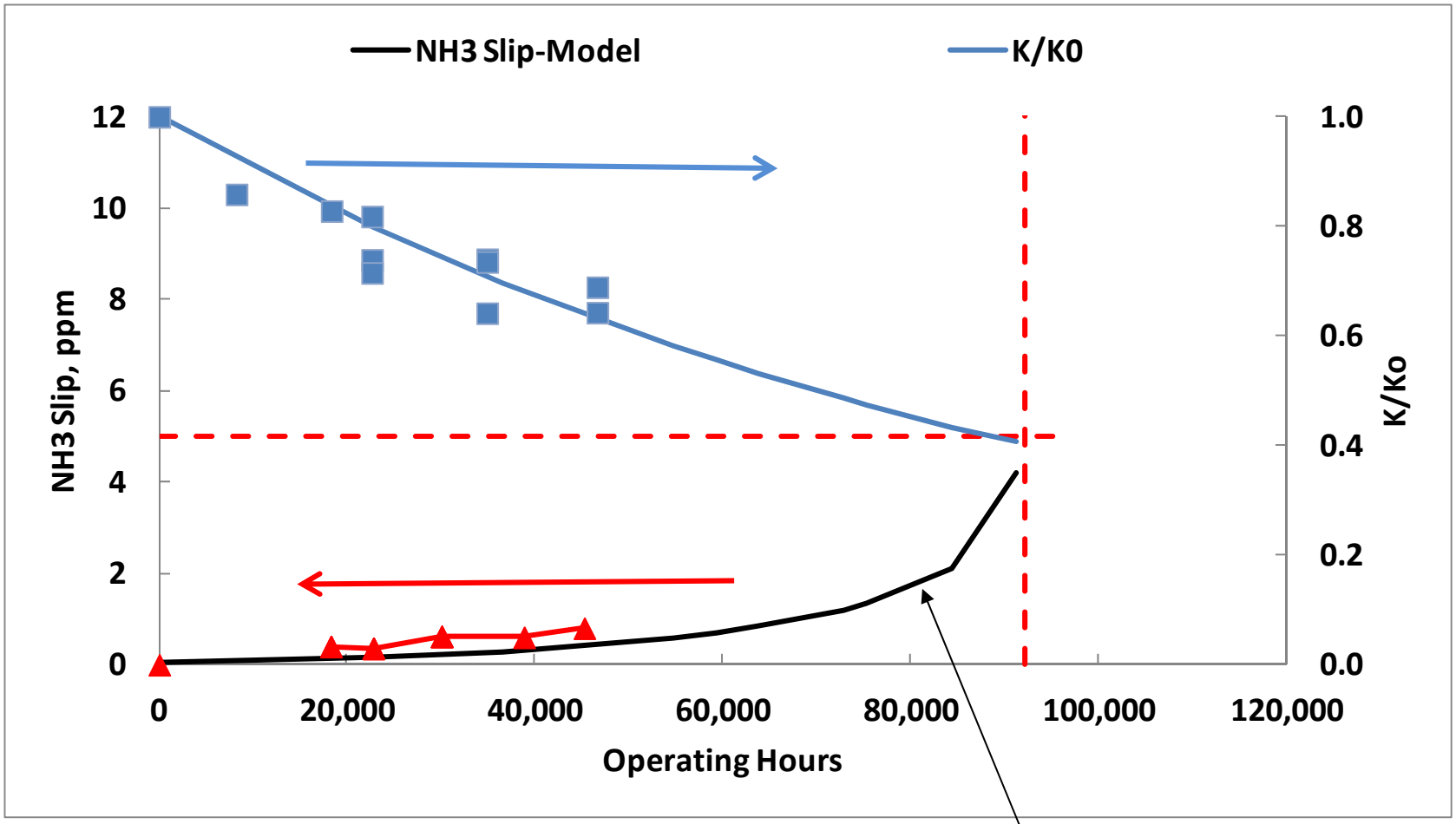
RMS = 13%

SCR Catalyst Management

SCR Catalyst Management

- **What is catalyst management?**
  - **Keeping track of catalyst activity to ensure continued compliance**
- **How is catalyst management done?**
  - **Periodically determining the activity of the catalyst in the reactor**
  - **Laboratory analysis (if a sample can be obtained)**
  - **In situ analysis (later discussion topic)**
  - **Utilize catalyst management software for planning**
- **Why is it done?**
  - **Forecast when catalyst additions or replacements are necessary**
  - **Provide sufficient lead time to procure catalyst (6-9 months)**

Catalyst Activity Degrades With Time



Monitoring ammonia slip is also critical

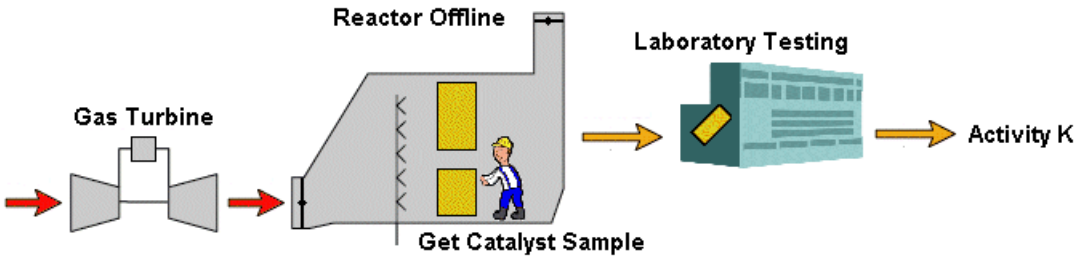
In Situ Catalyst Activity Measurement*

Traditional Lab Measurement

- Typically one per year
- Currently no test protocol

$K_{Lab} = -A_{Vdesign} \ln(1-\Delta NO_x)_{Lab}$

@NH3/NOx=1-1.5

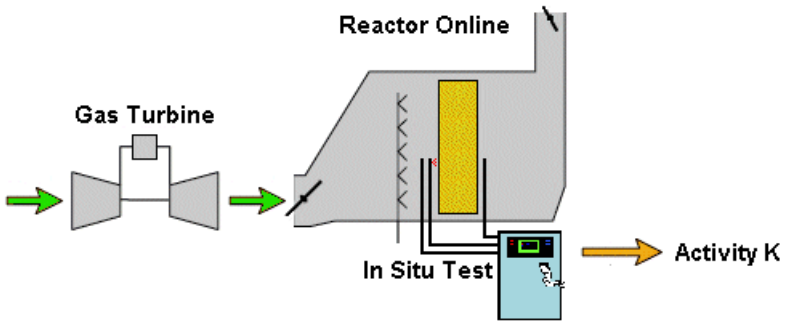


FERCo's **CatalysTrak®***

- *in situ* measurement
- No outage required

$K_{In\text{-}situ} = -A_{Vactual} \ln(1-\Delta NO_x)_{full\ scale}$

@NH3/NOx>1 locally



*** Patented Process**


Questions?
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