

REINHOLD ENVIRONMENTAL Ltd.



2019 NO_x-Combustion-CCR Round Table Presentation

February 11 & 12, 2019, in Salt Lake City, Utah / Hosted by PacifiCorp

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Monitoring Ammonia Slip For Process Control And SCR Catalyst Management



Reinhold NO_x-Combustion-CCR Conference 2019

February 11, 2019

Mechanical Systems Inc./Fossil Energy Research Corp.

Topics

- Why Measure Ammonia Slip
- What Causes Ammonia Slip
- Measuring Ammonia Slip (MSI)
- Analyzing The Data (FERCo)
- Real World Data

Why Measure Ammonia Slip

Solid Fuel Fired Boilers

- Minimize the use of ammonia.
- Prevent damage to downstream equipment.
- Prevent major maintenance issues.
- Avoid operational issues with air heaters.
- Avoid operational issues with ESP, fabric filter, ID fans.
- Avoid operational issues with mercury removal system.
- Avoid operational issues with FGD wet chemistry.
- Preserve value of flyash if flyash is sold for beneficial use.
- Preserve option to landfill flyash if flyash is presently buried.
- Document status of SCR catalyst independent of lab testing.
- Develop program to estimate and prolong catalyst life.

Why Measure Ammonia Slip

Combustion Turbines

- Minimize the use of ammonia.
- Minimize HRSG damage.
- Minimize HRSG operational issues.
- Avoid air compliance issues.
- Document status of SCR catalyst independent of lab testing.
- Develop program to estimate and prolong catalyst life.

What Causes Ammonia Slip

Coal Fired Boilers/Combustion Turbines

- Poor NH₃/NO_x flue gas distribution (RMS >5%)
- Failed or deteriorated side seals
- Failed or deteriorated catalyst seals
- Aging catalyst (K/K₀)
- Poorly sized ammonia control valves
- Poorly controlled ammonia control valves
- Poorly operating ammonia control valves
- Off spec SCR operation

Measuring Ammonia Slip

- Multiple Measuring Technologies
 - Differential NO_x
 - FTIR, Fourier Transform Infrared Spectroscopy
 - DOAS, Differential Optical Absorption Spectroscopy
 - TDL, Tunable Diode Laser
 - Cavity Ringdown
 - Herriott Cell
 - Path
- Different Approaches
 - Manual
 - Single point measurement
 - Multiple point measurement with sampling grid (gas turbines only)
 - Integrated path, line of sight

Measuring Ammonia Slip With TDLs

Reasons To Install TDL Analyzers

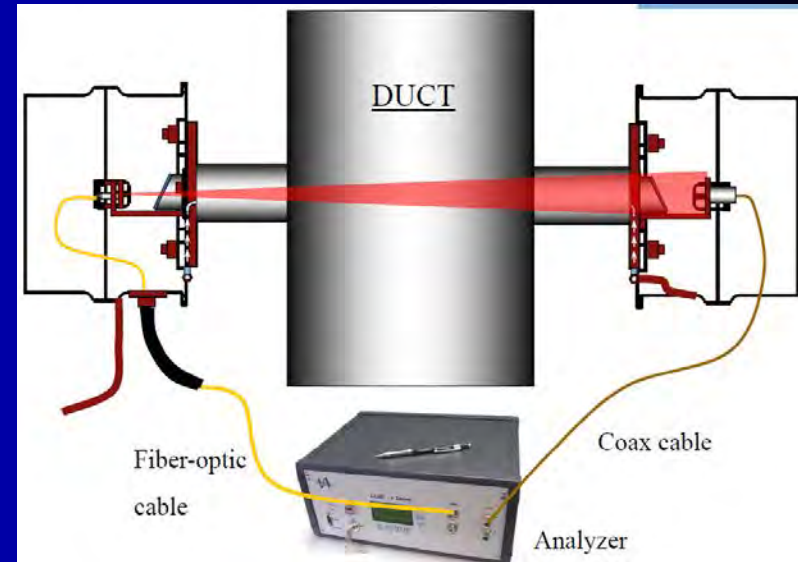
- Provides enough data to figure out what is going on.
- Most cost effective.
- Inherent low operating costs.
- Low maintenance cost.
- Measures and outputs moisture (Unisearch only).
- Measures and outputs signal strength (Unisearch only).

Disadvantages Of TDL Analyzers

- Not always easy to find an acceptable location for the technology to work well in solid fuel fired boilers.
- Generally not an easy installation. May requires unit shutdown to install optic mounting nozzles across duct/stack.
-

Measuring Ammonia Slip With Unisearch TDL

- Analyzer is on ground not on duct/stack.
- Little or no electronics on the duct/stack.
- Single or double pass design. Double pass doubles path length and level of detection.*
- Receivers with 2" or 3" optics*
- Gimbal alignment device on both launcher and receiver.*
- Inline calibration cell in analyzer on ground*



Measuring Ammonia Slip With Unisearch TDL

Easy port maintenance*

- Opacity monitor type purge housing

- Housing can be opened for cleaning port without losing alignment

Calculates using both Peak and Area method*

Can be dual ranged*

Excellent test/calibration tools*

- Red laser alignment tool

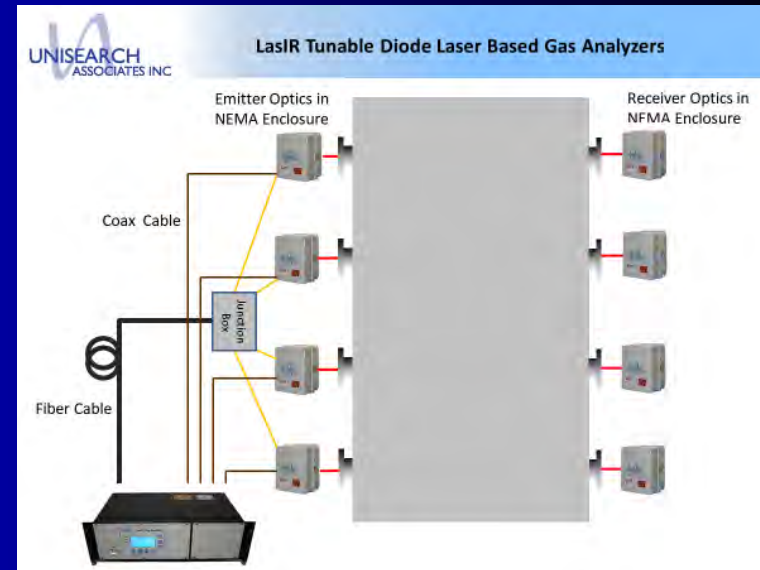
- Power meter

- Permeation audit module test cell

Optional high powered lasers

Measuring Ammonia Slip With Unisearch TDL

- Fiber coupled for multiple measurement paths
 - Beam split (clean stacks/gas turbines)
 - Inexpensive
 - Loses power
 - Maximum four splits
 - Multiplexed (coal fired boilers)*
 - Economical as number of paths increase
 - Little or no power loss
 - Maximum 16 paths
- Temperature and pressure compensation on each measurement path
- Three outputs on each measurement path
 - Ammonia, water vapor, signal strength



Measuring Ammonia Slip - TDL Installation

- Alignment is critical.
- Vibration cannot be ignored.
- Path length is important to get good level of detection/0.1 ppm.
 - Single pass system if path length > 5 meters (17 feet).
 - Double pass system if path length < 5 meters (17 feet).
- Particulate is the issue with measuring ammonia slip on coal fired boilers because it limits path length. We use what we get.
- Need purge system to keep optics clean and ports purged.
- Need pressure/temperature signals for accurate measurement.
- Need calibration system to verify analyzer operation.



UNIT 1 BYPASS
BACKUP HCL
RECEIVER
MSI HCLR1BYPB
1AE-BA5014

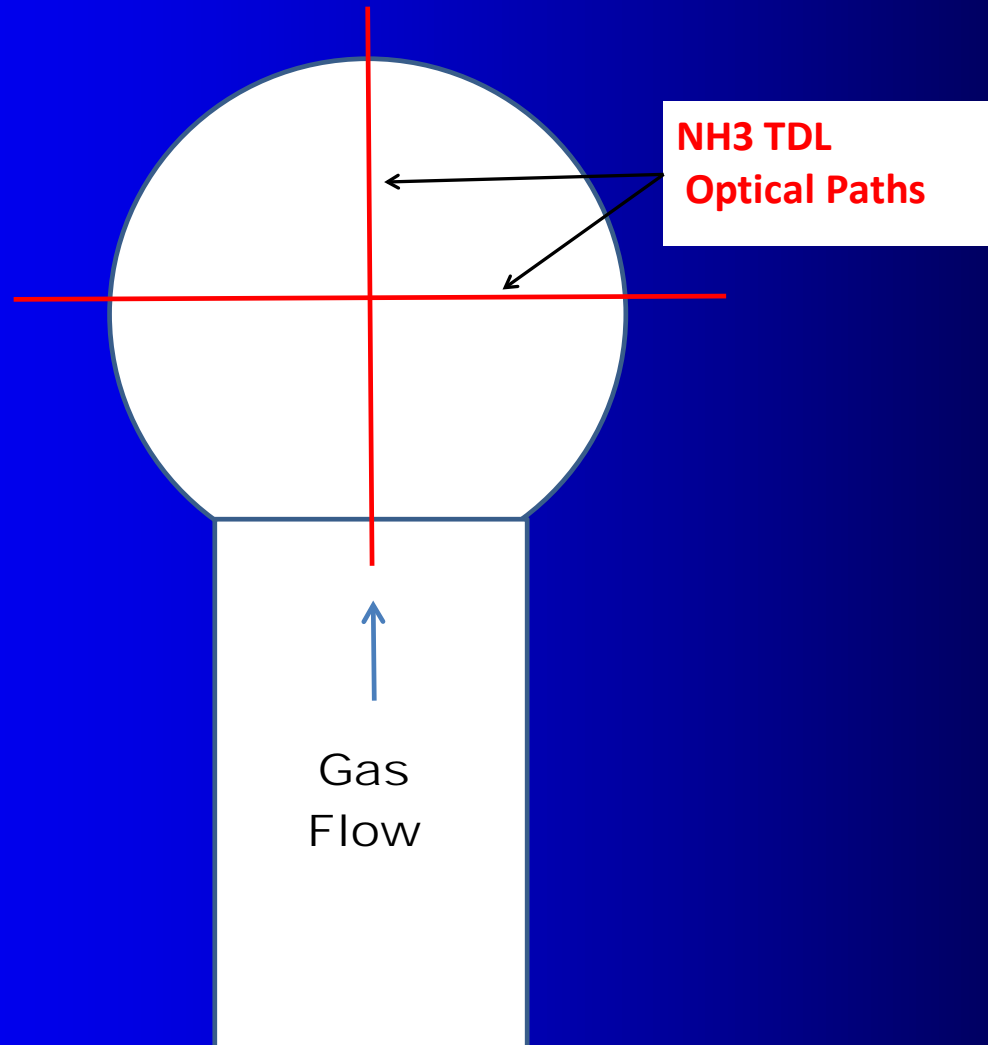
UNISEARCH
ASSOCIATES INC
www.unisearch.com

DANGER
Hazardous
Material
Do Not Open
Unless Authorized

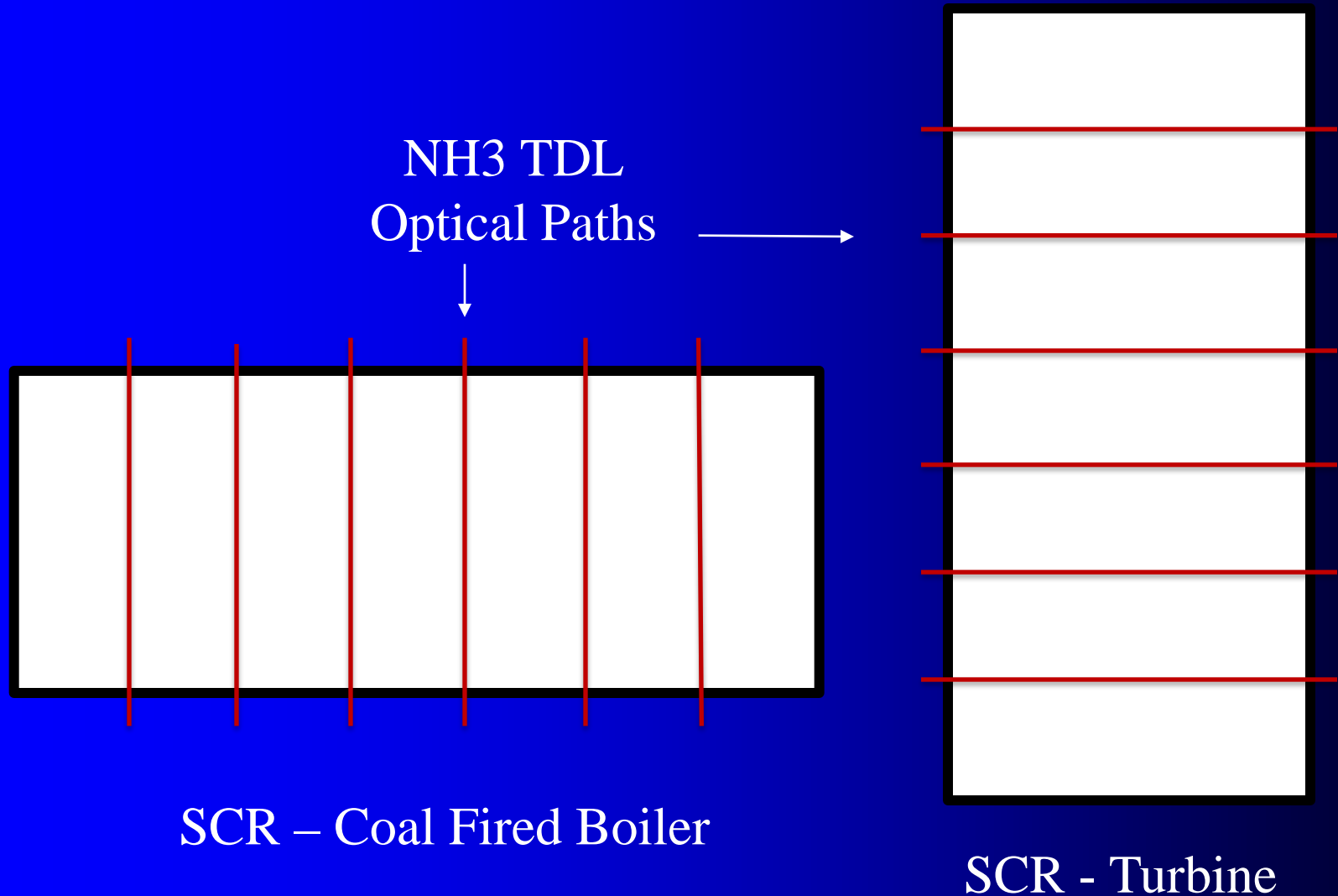
WARNING
Do Not Open
Unless Authorized

DURAG
MSI HCLR1BYPB
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DURAG
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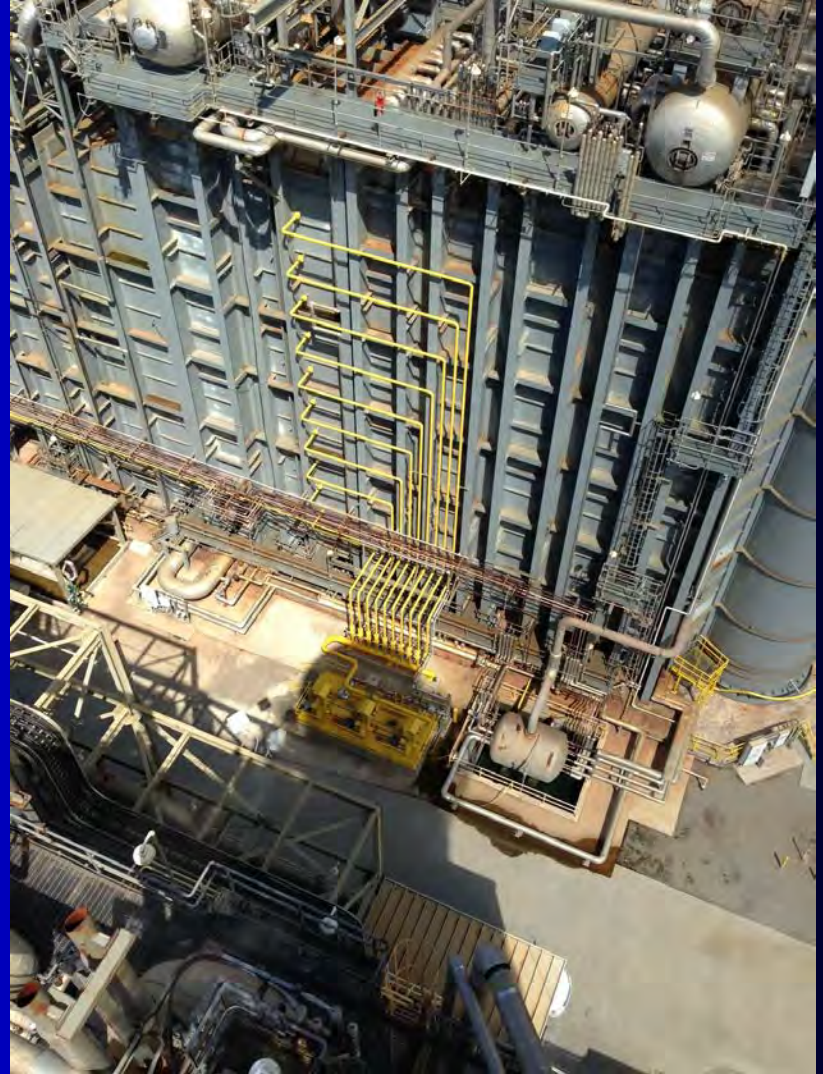
Measuring Ammonia Slip – Stack Installation



Measuring Ammonia Slip - Duct Installations



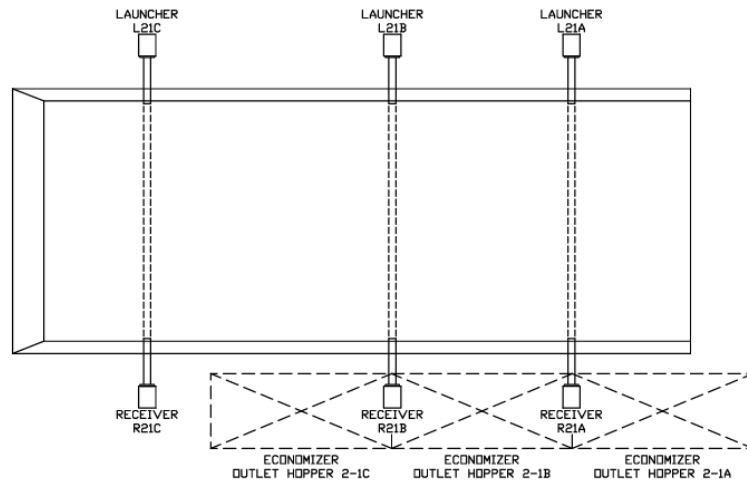
Measuring Ammonia Slip - Injection Grid



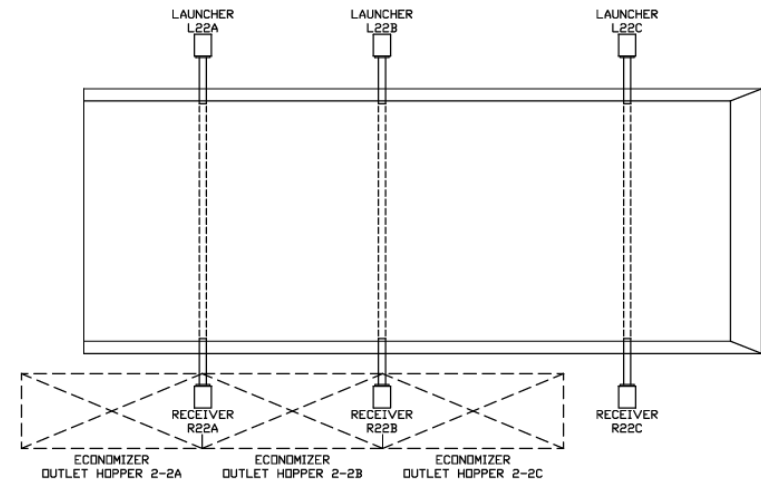
Measuring Ammonia Slip Real World Considerations

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AIR HEATER 2-1 (SOUTH) INLET DUCT
PLAN VIEW



AIR HEATER 2-2 (NORTH) INLET DUCT
PLAN VIEW



CENTERLINE AIR HEATERS

MSI MECHANICAL SYSTEMS, INC.		MECHANICAL SYSTEMS, INC. 480 PROGRESS WAY SUN PRAIRIE, WISCONSIN 53590
PROJECT: AMMONIA SLIP MONITORING SYSTEMS PETERSBURG GENERATING STATION - UNIT 3 INDIANAPOLIS POWER AND LIGHT COMPANY PETERSBURG, INDIANA AES/IPL PURCHASE ORDER 940481		
DESIGNED BY: JJA	CHECKED BY: JJA	DATE: 06/11/18
DRAWN BY: JJA	DATE: 06/11/18	SCALE: AS SHOWN
TITLE: AIR HEATER 2-1 AND 2-2 GENERAL ARRANGEMENT	REVISED BY: JJA	DATE: 06/11/18
PROJECT NUMBER: 02-0112-24		

Measuring Ammonia Slip Real World Installations

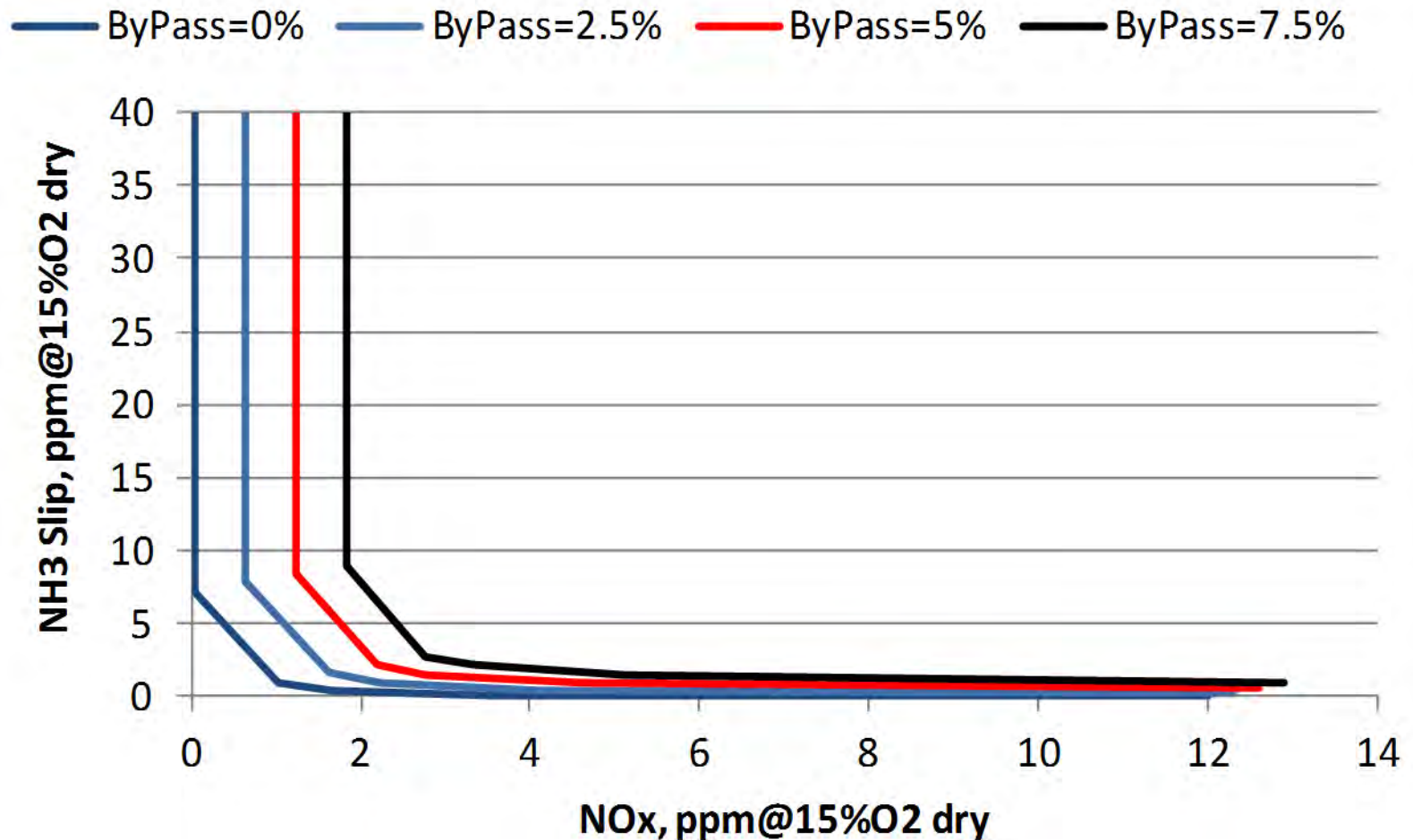


Measuring Ammonia Slip Real World Installations



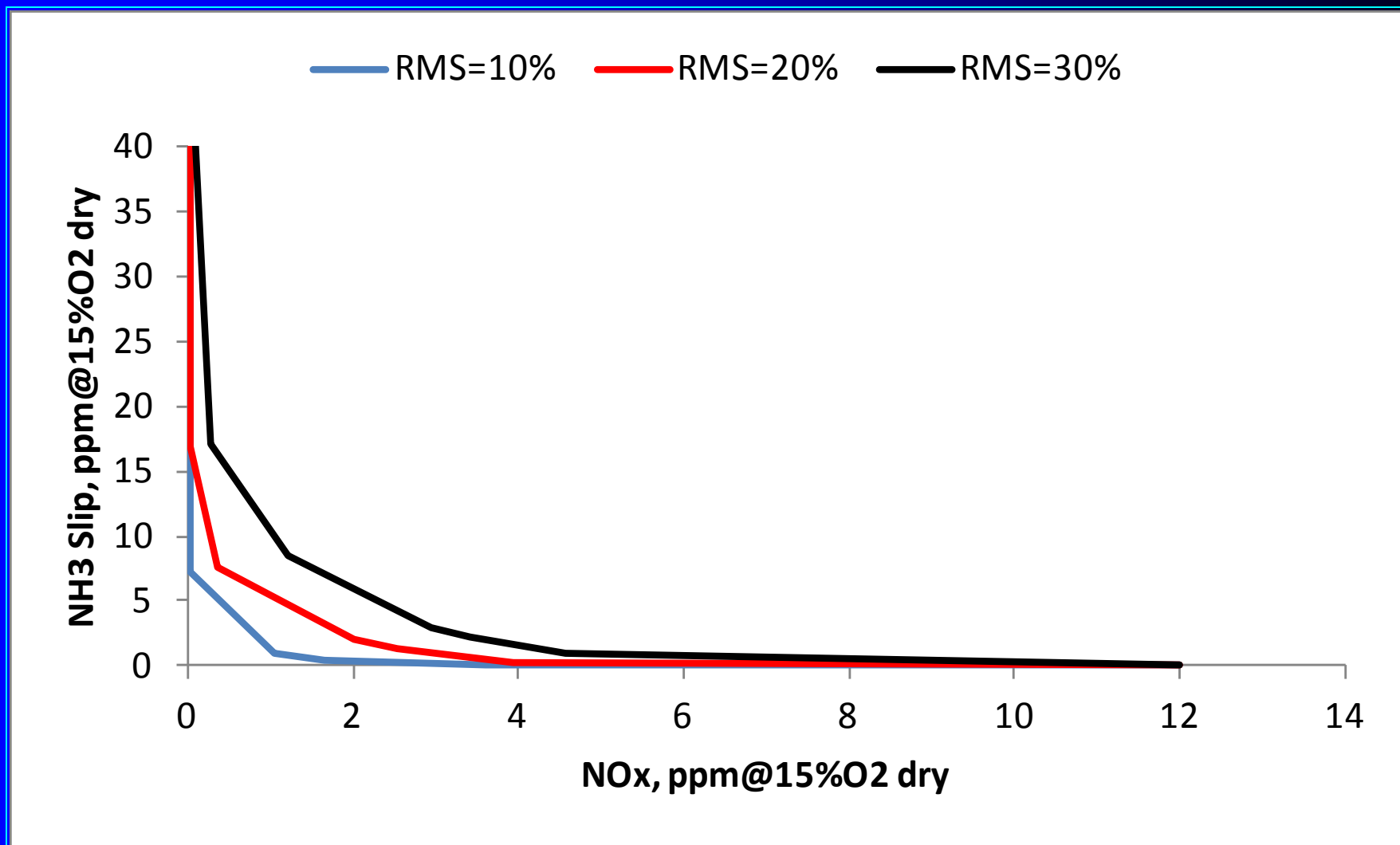
Analyzing The Data – Bypass Problem

Expected FERCo Results For SCR With Bypass Problems



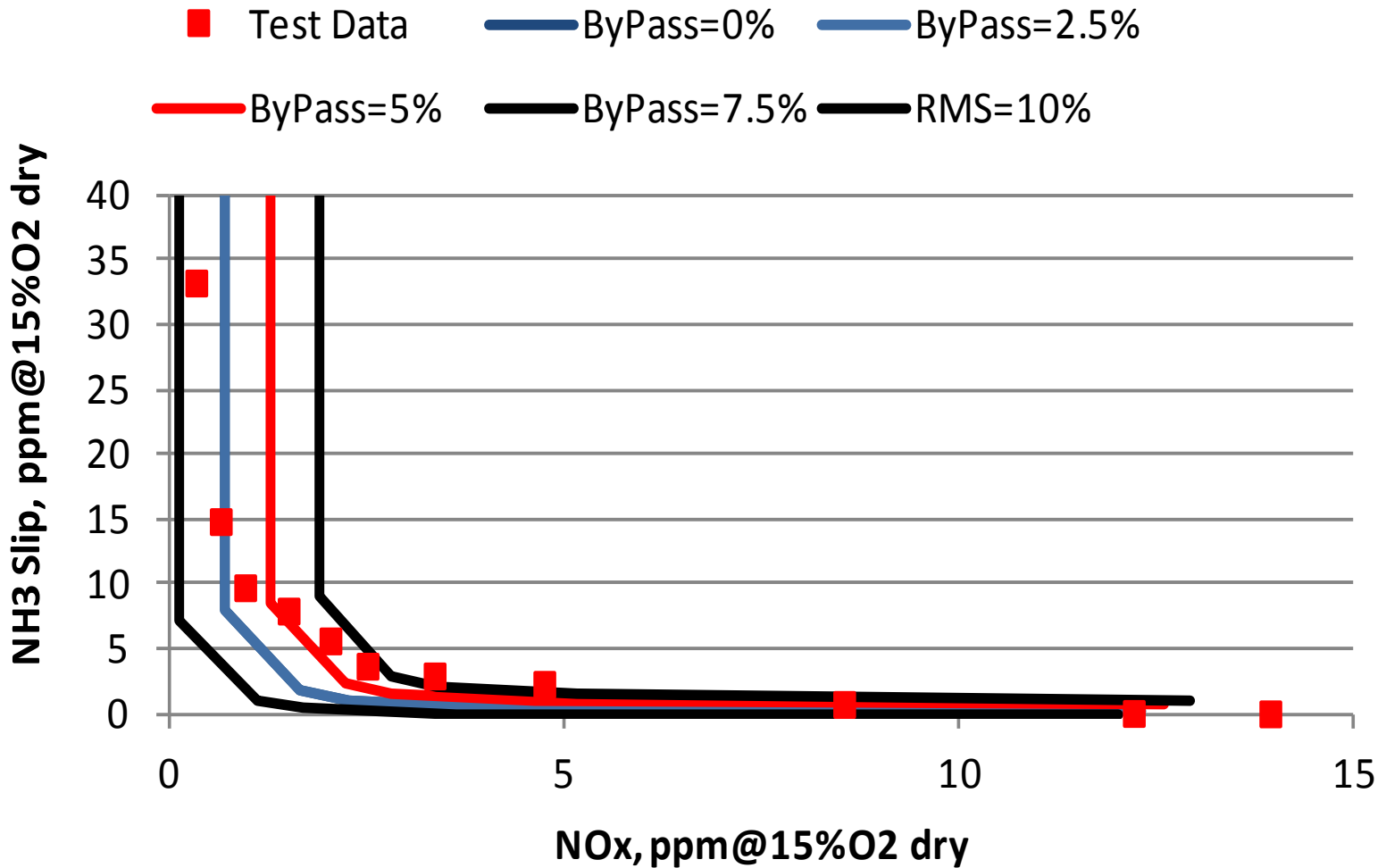
Analyzing The Data – NH3/NOX Distribution Problem

Expected FERCo Results For SCR With Distribution Problems



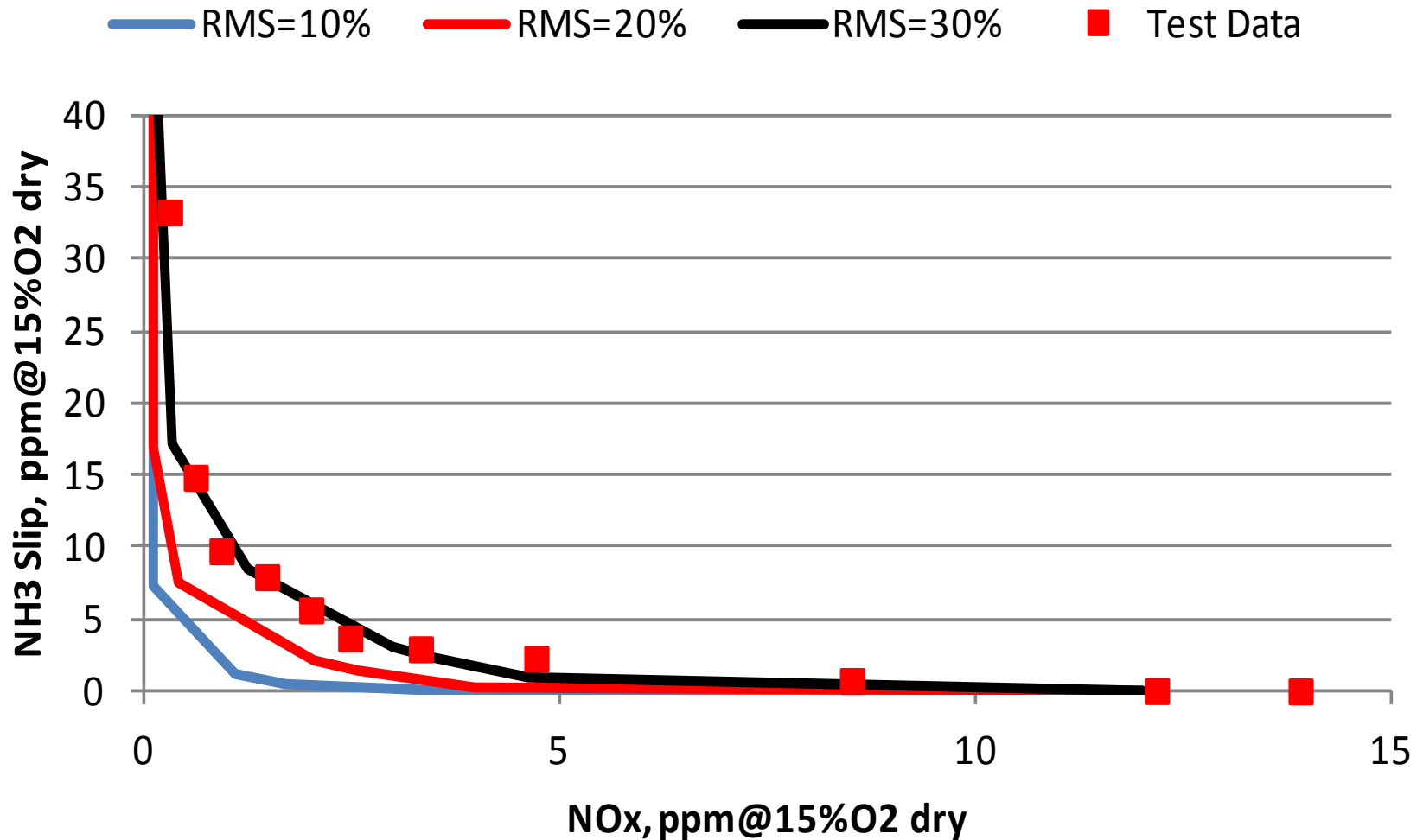
Analyzing The Data – Real Example

Actual FERCo Results Analyzed For SCR Bypass Problem



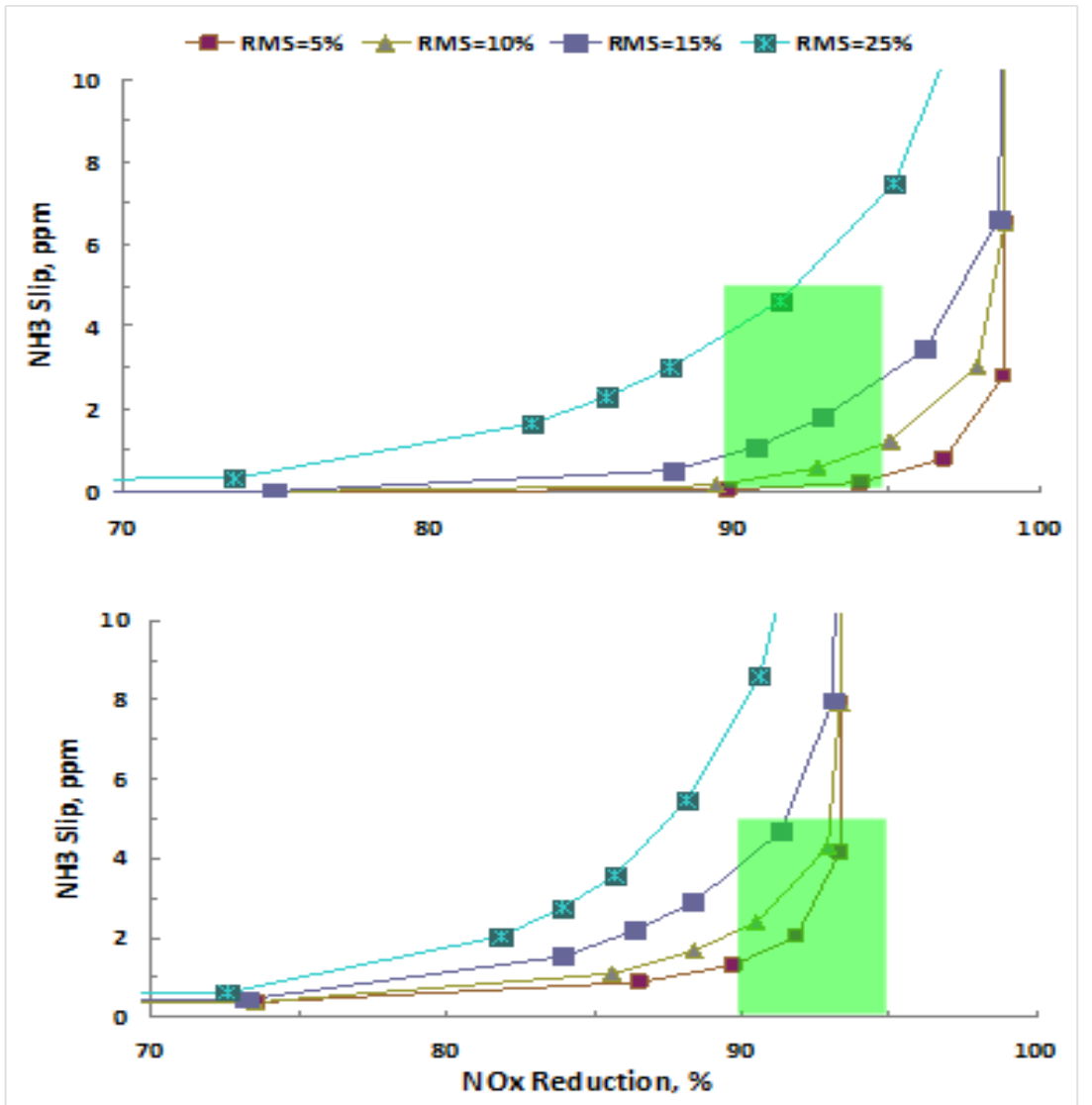
Analyzing The Date – Real Example

Actual FERCo Results Analyzed For SCR Distribution Problem



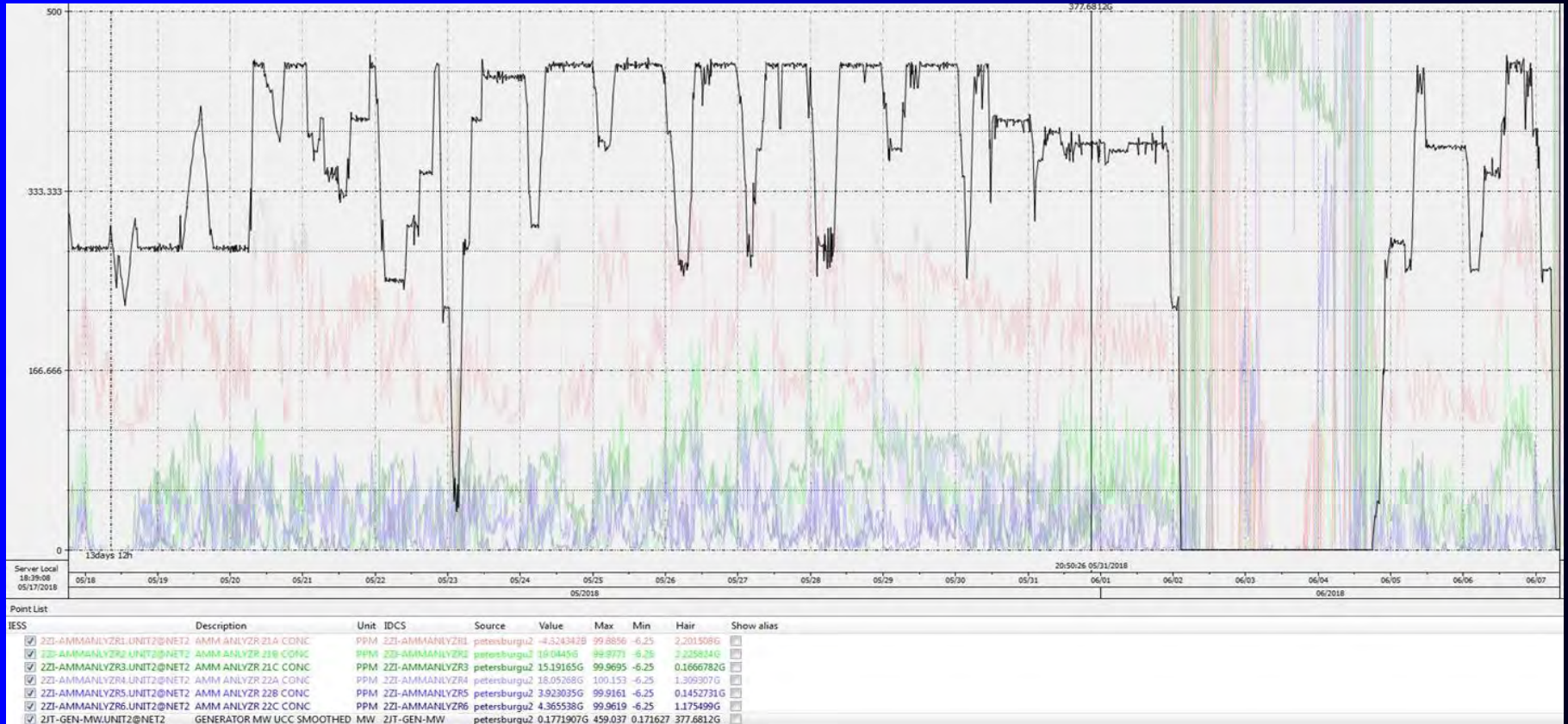
Analyzing The Data – Catalyst Management

New Catalyst



Catalyst Near End-of-Life

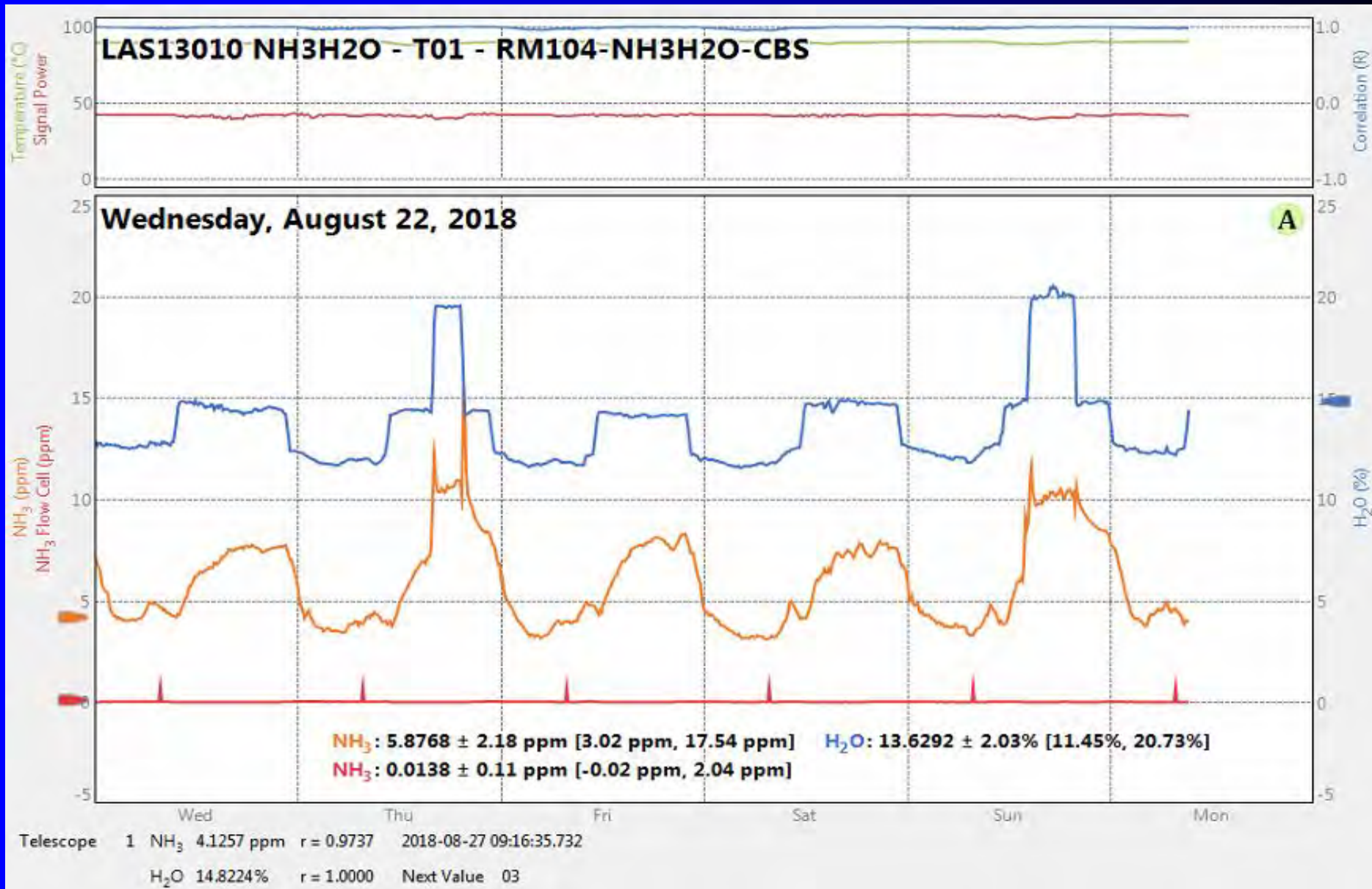
Real World Data – Coal Fired Boiler



Real World Data – Combined Cycle



Real World Data – Combined Cycle



Summary

- Ammonia slip can be measured accurately with a tunable diode laser.
- An optical array of multiple lines of sight measured with a fiber coupled TDL analyzer can provide cost effective control of ammonia slip and document SCR operation.
- Moisture and line strength measurements when performed with ammonia slip measurements provide important feedback on SCR operation and performance.
- If testing is performed regularly, it is possible to characterize catalyst health and predict when replacement will be required.