Monitoring Ammonia Slip For Process Control And SCR Catalyst Management

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Unisearch Associates

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Topics

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

Why Measure Ammonia Slip – Gas Turbine

- 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.

Why Measure Ammonia Slip – Solid Fuel

- 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.

What Causes Ammonia Slip

- Poor NH3 distribution in front of SCR (RMS >5%)
- Failed or deteriorated side seals
- Failed or deteriorated catalyst seals
- Aging catalyst (K/Ko)
- Poorly sized/controlled/operating ammonia control valves
- Plugged ammonia distribution nozzles (carbon steel piping)
- Off spec SCR operation

Measuring Ammonia Slip

- Multiple Measuring Technologies
  - Differential NOx
  - FTIR, Fourier Transform Infrared Spectroscopy
  - DOAS, Differential Optical Absorption Spectroscopy
  - TDL, Tunable Diode Laser
    - Cavity Ringdown (Single Point)
    - Herriott Cell (Single Point)
    - Path

Measuring Ammonia Slip With TDLs

Reasons To Install TDL Analyzers

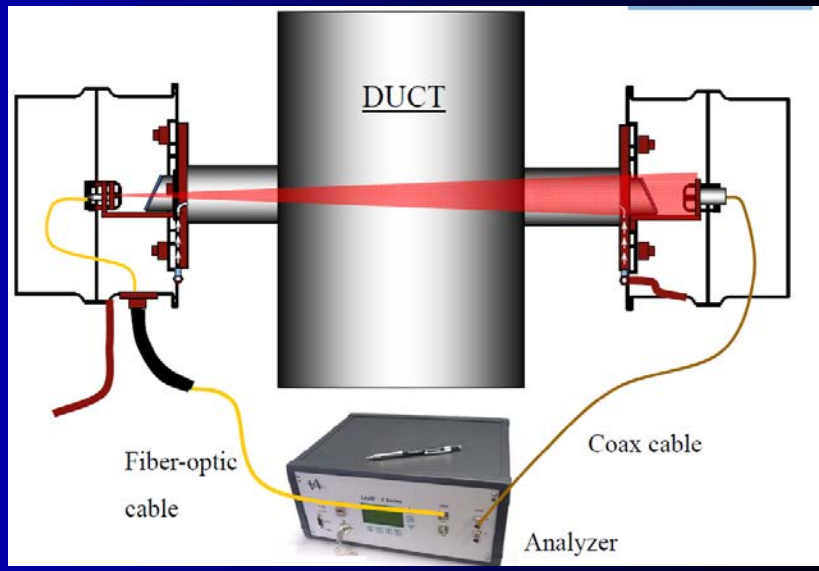
- Provides line average data instead of single point data.
- No gas sample transport.
- Inherent low operating costs.
- Low maintenance cost.
- Measures and outputs moisture (Unisearch only).
- Measures and outputs signal strength (Unisearch only).

Reasons Not To Install TDL Analyzers

- Installation requires a pair of well aligned nozzles on both sides of the duct/stack.
- Access required to both sides of 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 decreases level of detection (0.2 ppm goes to 0.1 ppm).*
- 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

Calculates using both Peak and Area method*

Can be dual ranged*

Easy port maintenance*

- Opacity monitor type purge housing
- Housing can be opened for cleaning port without losing alignment

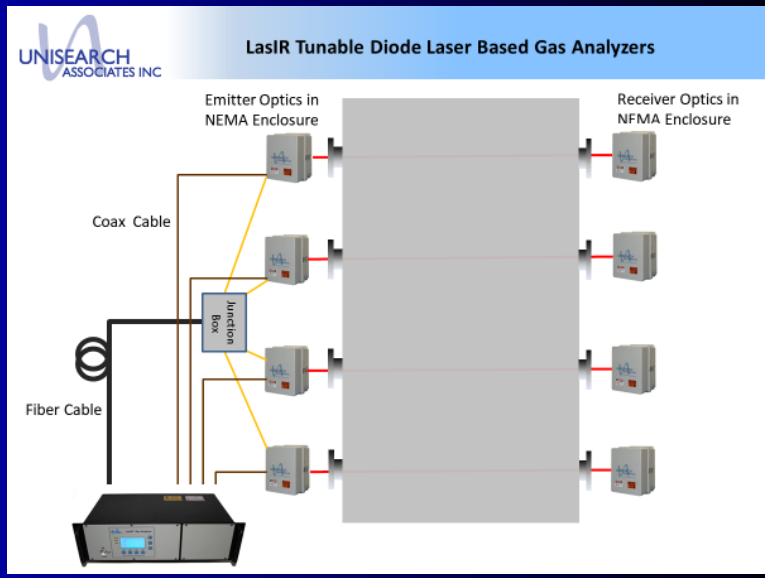
Excellent test/calibration tools*

- 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
    - Significant power loss
    - Maximum four splits
  - Multiplexed (coal fired boilers)*
    - Economical as number of paths increase
    - Minimal 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.

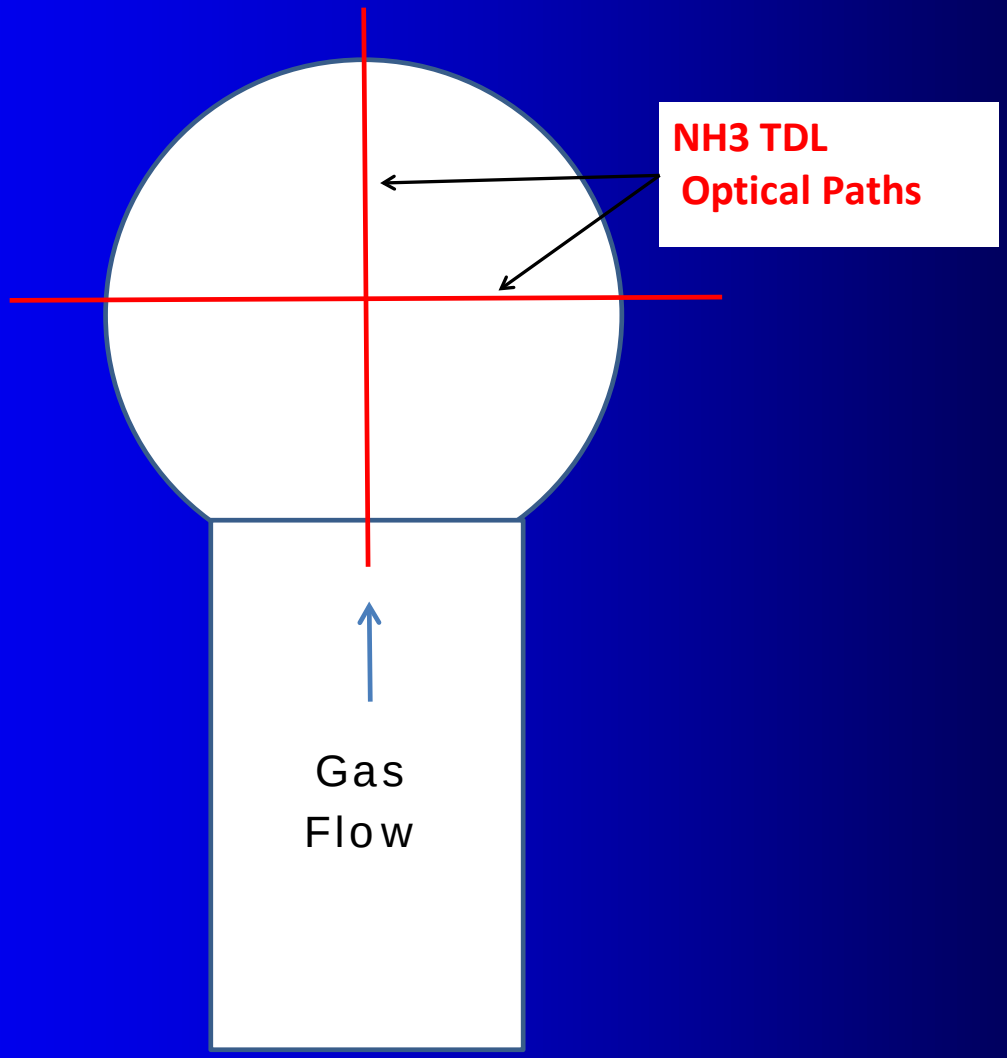
- Path length is important to get good level of detection/0.1 ppm.
  Single pass system if path length > 5 meters (17 feet).
  Double pass system if path length < 5 meters (17 feet).

- Particulate is the issue with measuring ammonia slip on coal fired boilers because it limits path length. We use what we get.

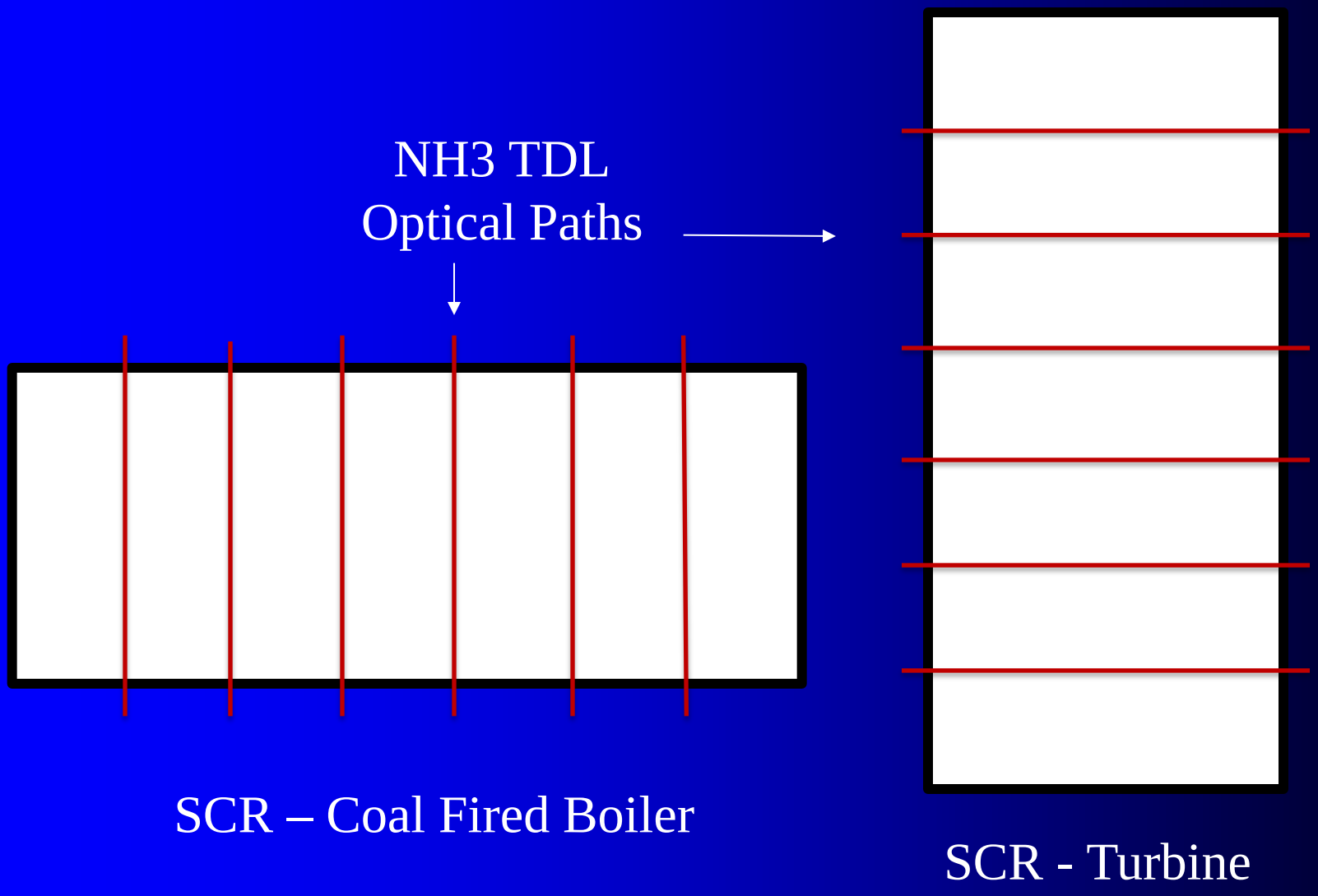
- Need purge system to keep optics clean and ports purged.
- Need pressure/temperature signals for accurate measurement.
- Need calibration system to verify analyzer operation.


UNIT 1 BYPASS
BACKUP HCL
RECEIVER
MSI HCLR1BYPB
1AE-BA5014
UNISEARCH
ASSOCIATES INC
DANGER
WARNING
DURAG
DURAG
DURAG

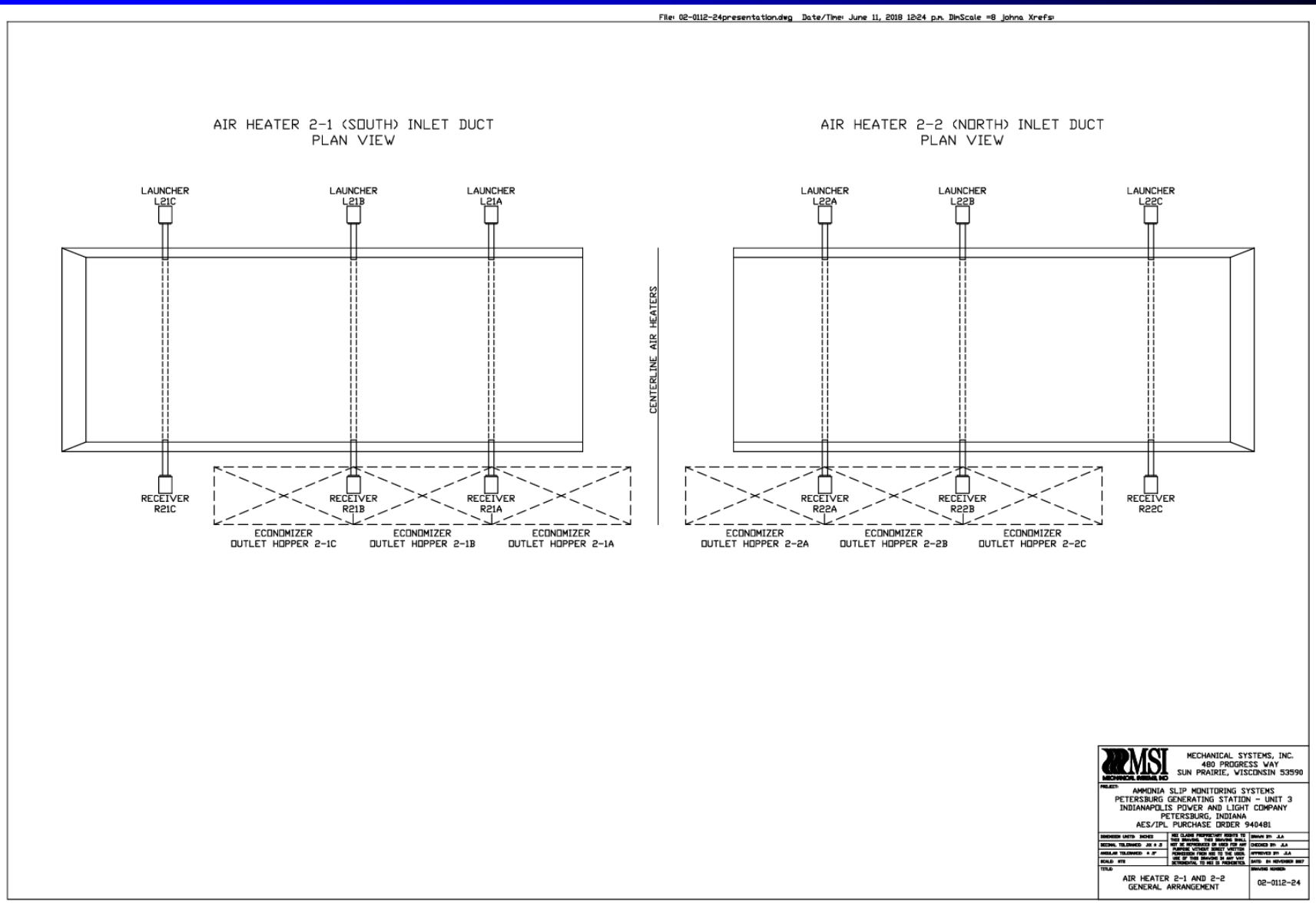
Measuring Ammonia Slip – Stack Installation



Measuring Ammonia Slip - Duct Installations



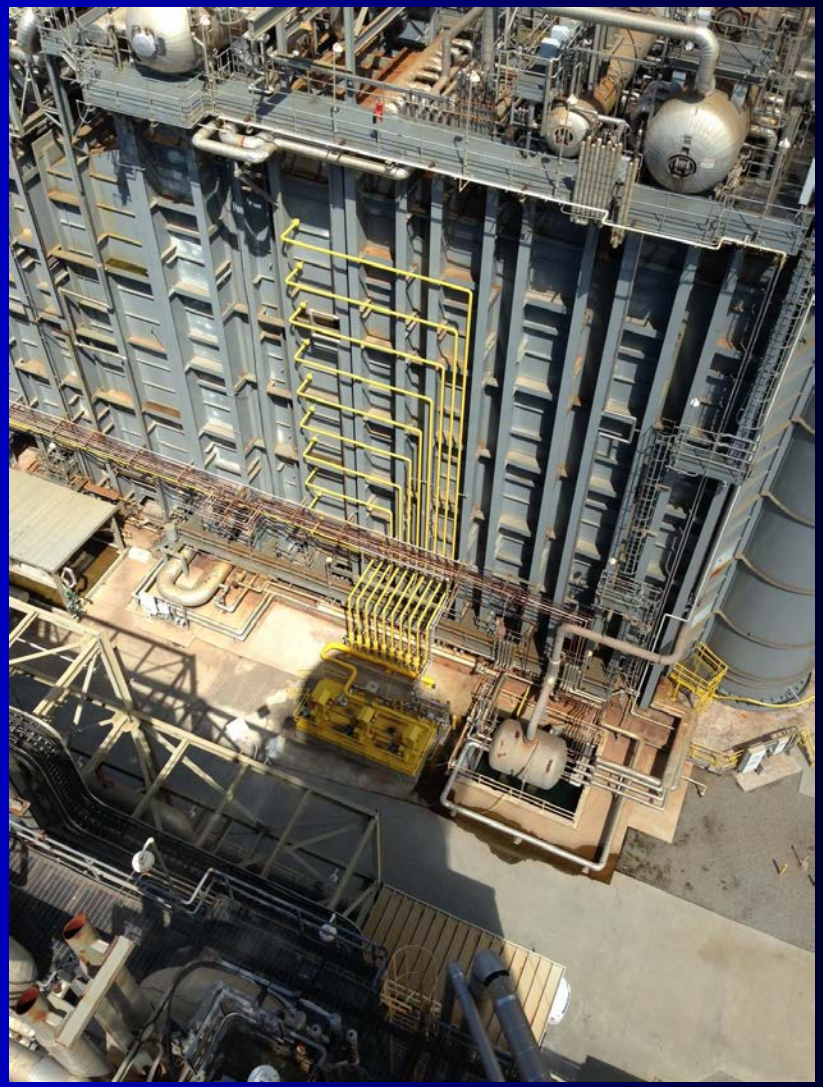
Measuring Ammonia Slip
Real World Considerations



Measuring Ammonia Slip
Real World Installations

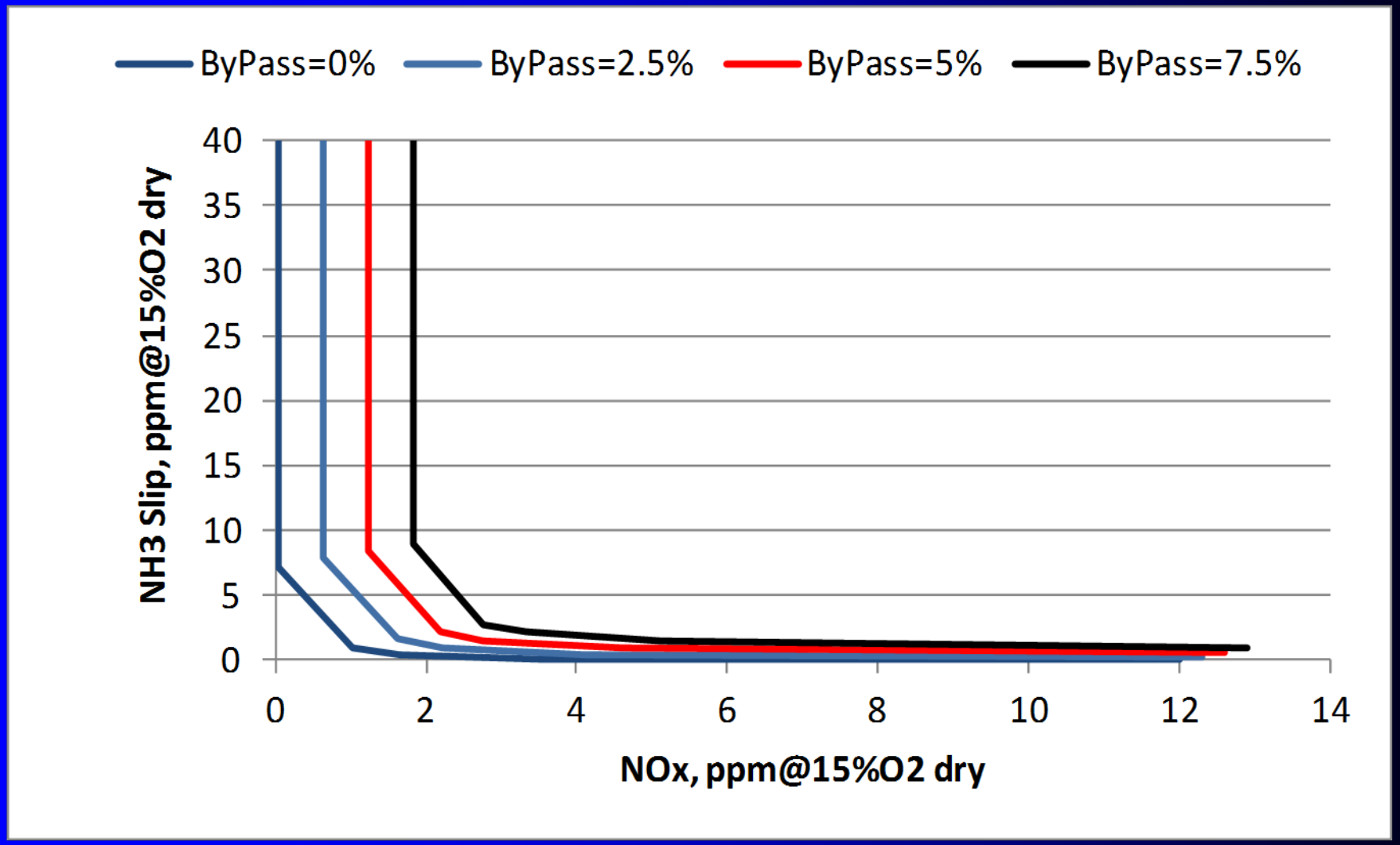
Measuring Ammonia Slip
Real World Installations

Measuring Ammonia Slip - Injection Grid



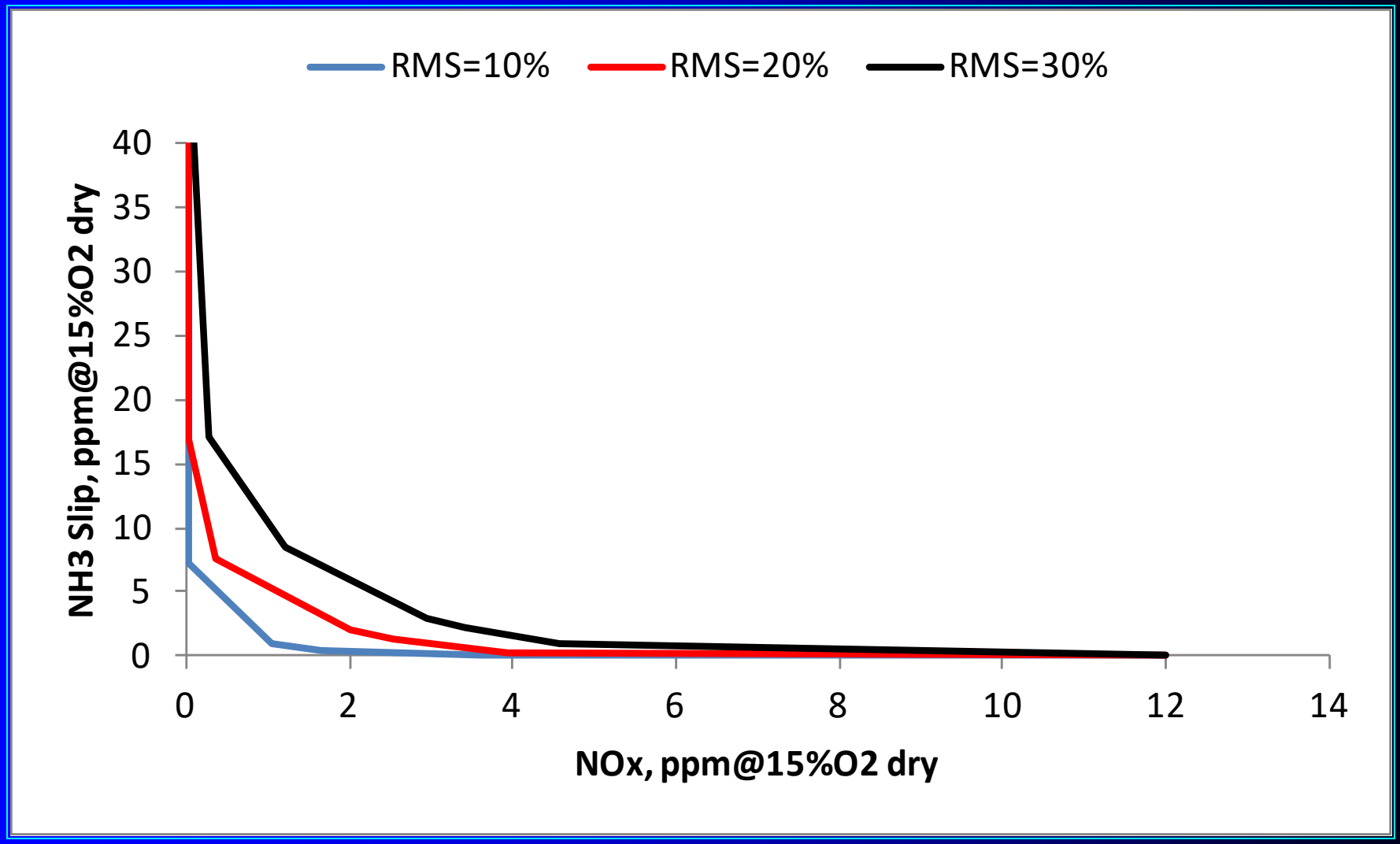
Analyzing The Data – Bypass Problem

Expected FERCo Results For SCR With Bypass Problems



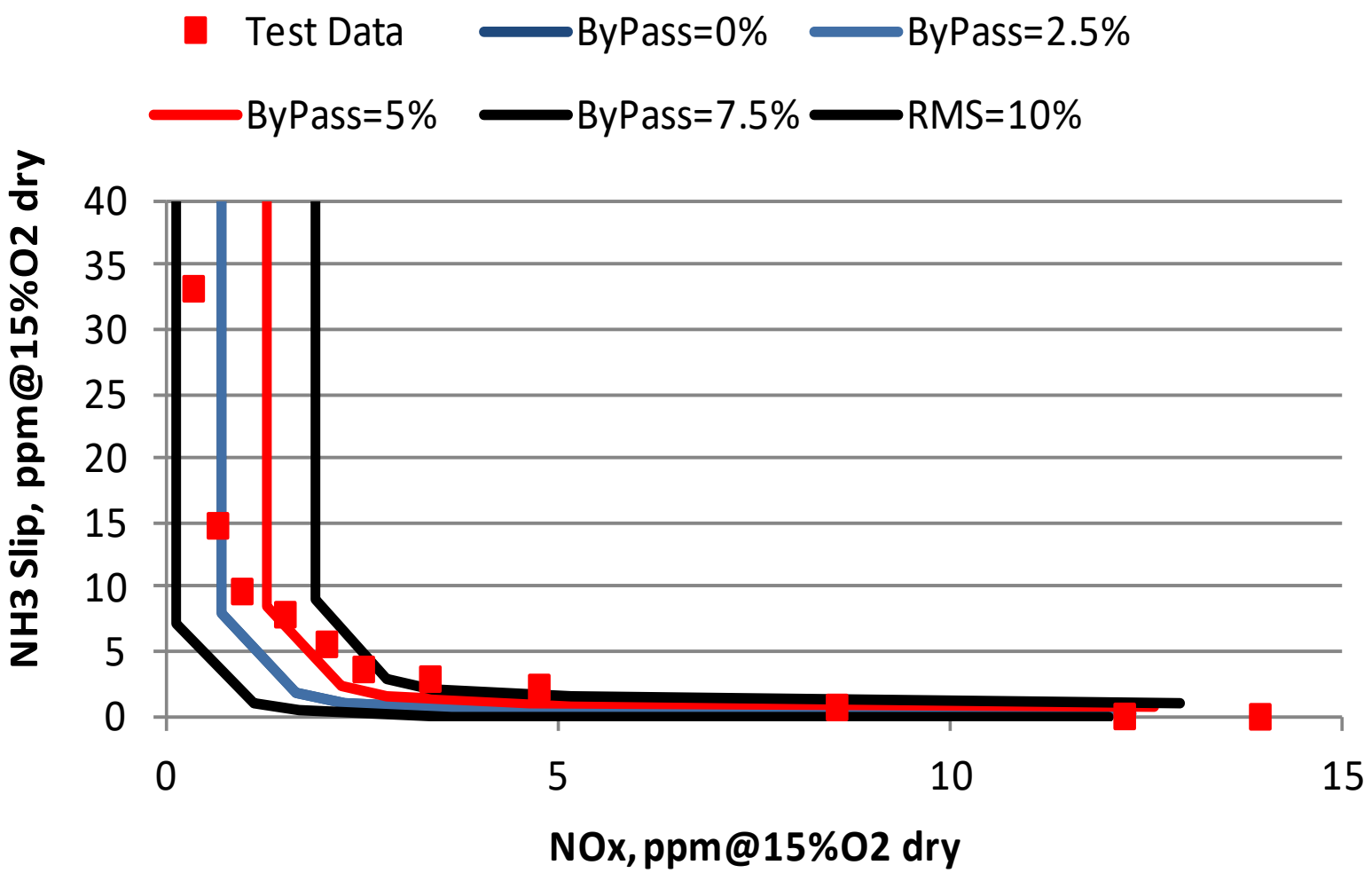
Analyzing The Data – NH3/NOX Distribution Problem

Expected FERCo Results For SCR With Distribution Problems



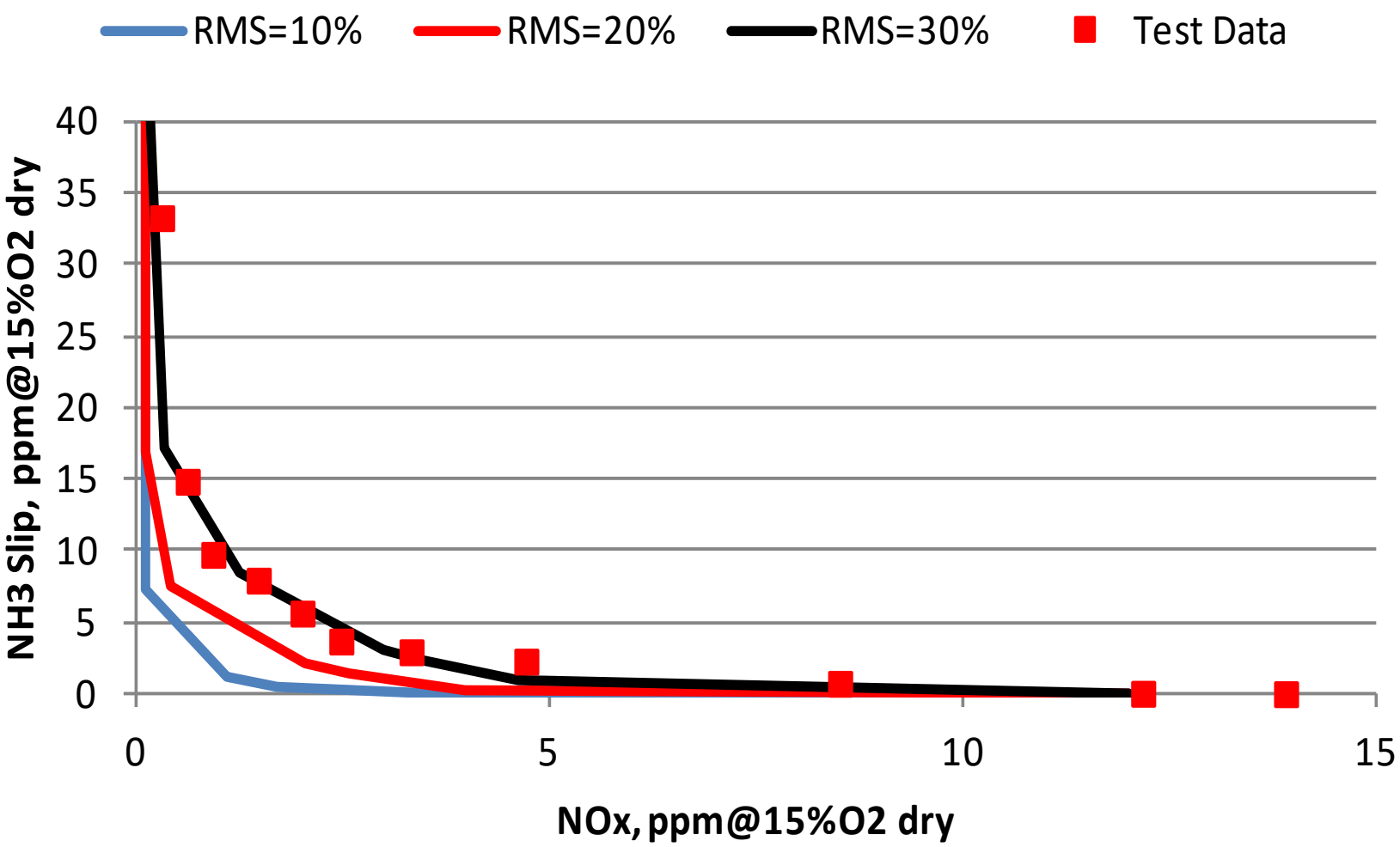
Analyzing The Data – Real Example

Actual FERCo Results Analyzed For SCR Bypass Problem



Analyzing The Date – Real Example

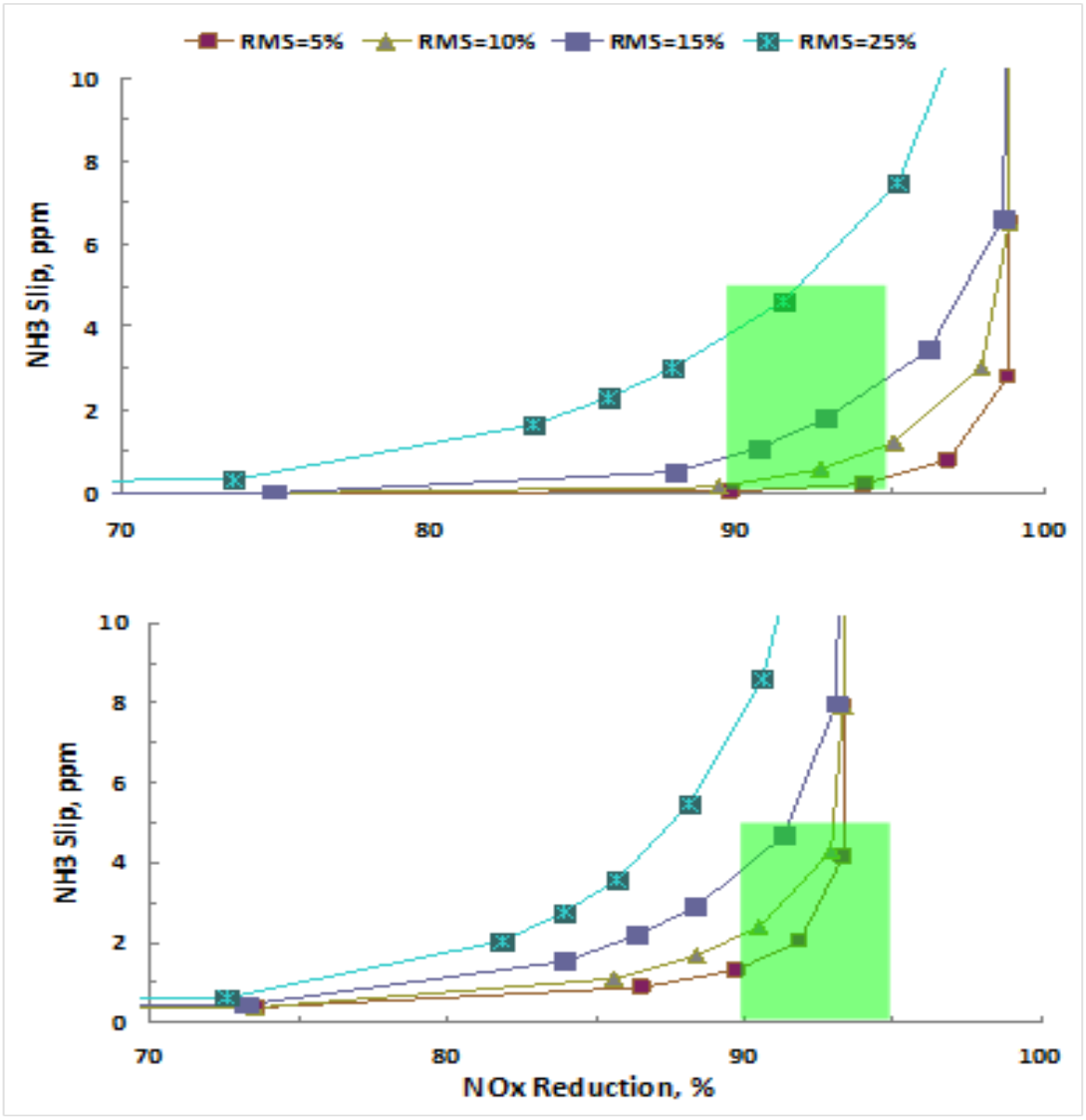
Actual FERCo Results Analyzed For SCR Distribution Problem



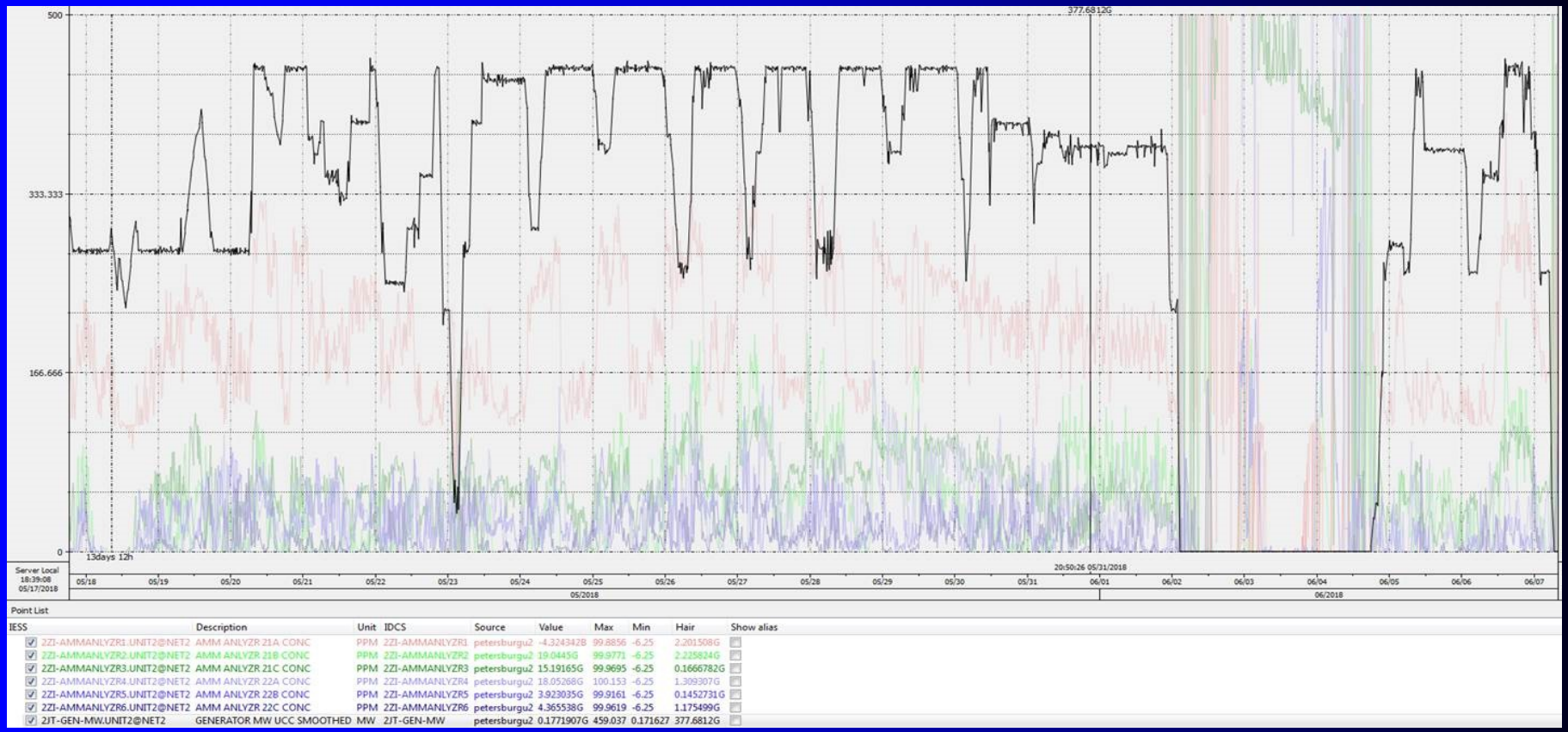
Analyzing The Data – Catalyst Management

New Catalyst

Catalyst Near End-of-Life



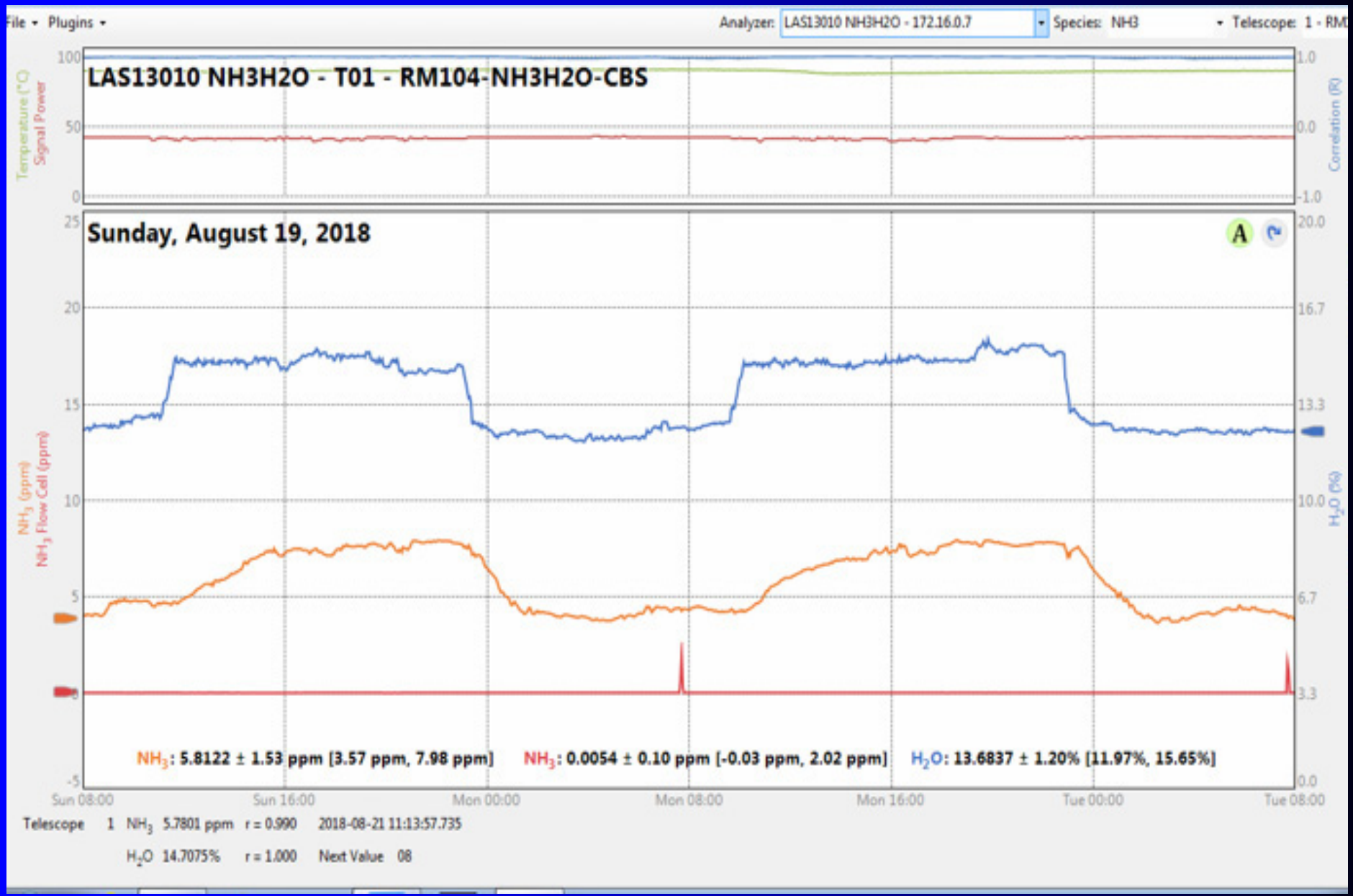
Real World Data – Coal Fired Boiler



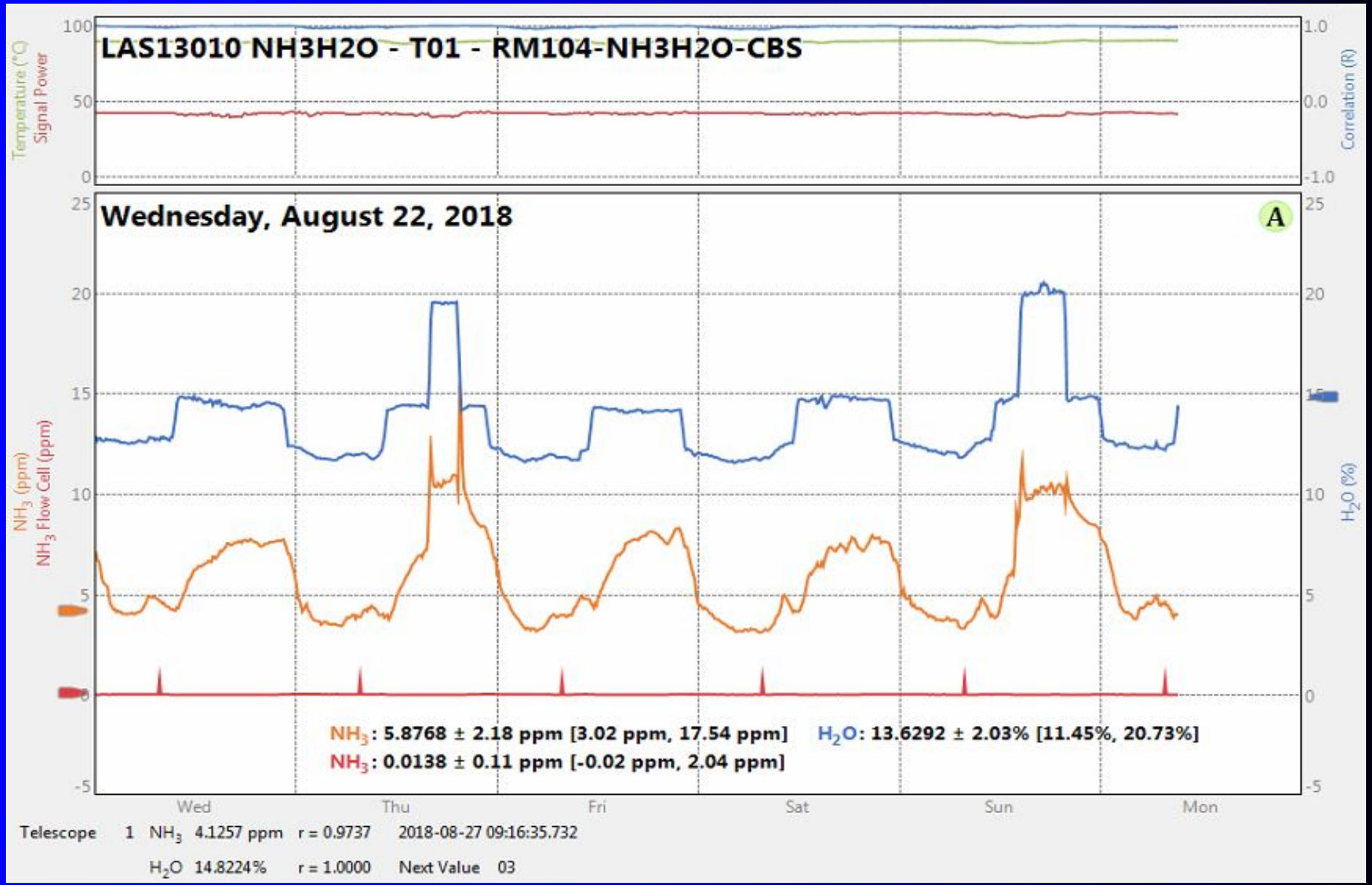
Point List

IESS	Description	Unit	IDCS	Source	Value	Max	Min	Hair	Show alias
2ZI-AMMANLYZR1.UNIT2@NET2	AMM ANLYZR 21A CONC	PPM	2ZI-AMMANLYZR1	petersburgu2	-4.324342B	99.8856	-6.25	2.201508G	
2ZI-AMMANLYZR2.UNIT2@NET2	AMM ANLYZR 21B CONC	PPM	2ZI-AMMANLYZR2	petersburgu2	19.0445G	99.9771	-6.25	2.225824G	
2ZI-AMMANLYZR3.UNIT2@NET2	AMM ANLYZR 21C CONC	PPM	2ZI-AMMANLYZR3	petersburgu2	15.19165G	99.9695	-6.25	0.1666782G	
2ZI-AMMANLYZR4.UNIT2@NET2	AMM ANLYZR 22A CONC	PPM	2ZI-AMMANLYZR4	petersburgu2	18.05268G	100.153	-6.25	1.309307G	
2ZI-AMMANLYZR5.UNIT2@NET2	AMM ANLYZR 22B CONC	PPM	2ZI-AMMANLYZR5	petersburgu2	3.923035G	99.9161	-6.25	0.1452731G	
2ZI-AMMANLYZR6.UNIT2@NET2	AMM ANLYZR 22C CONC	PPM	2ZI-AMMANLYZR6	petersburgu2	4.365538G	99.9619	-6.25	1.175499G	
2JT-GEN-MW.UNIT2@NET2	GENERATOR MW UCC SMOOTHED	MW	2JT-GEN-MW	petersburgu2	0.1771907G	459.037	0.171627	377.6812G	

Real World Data – Combined Cycle



Real World Data – Combined Cycle

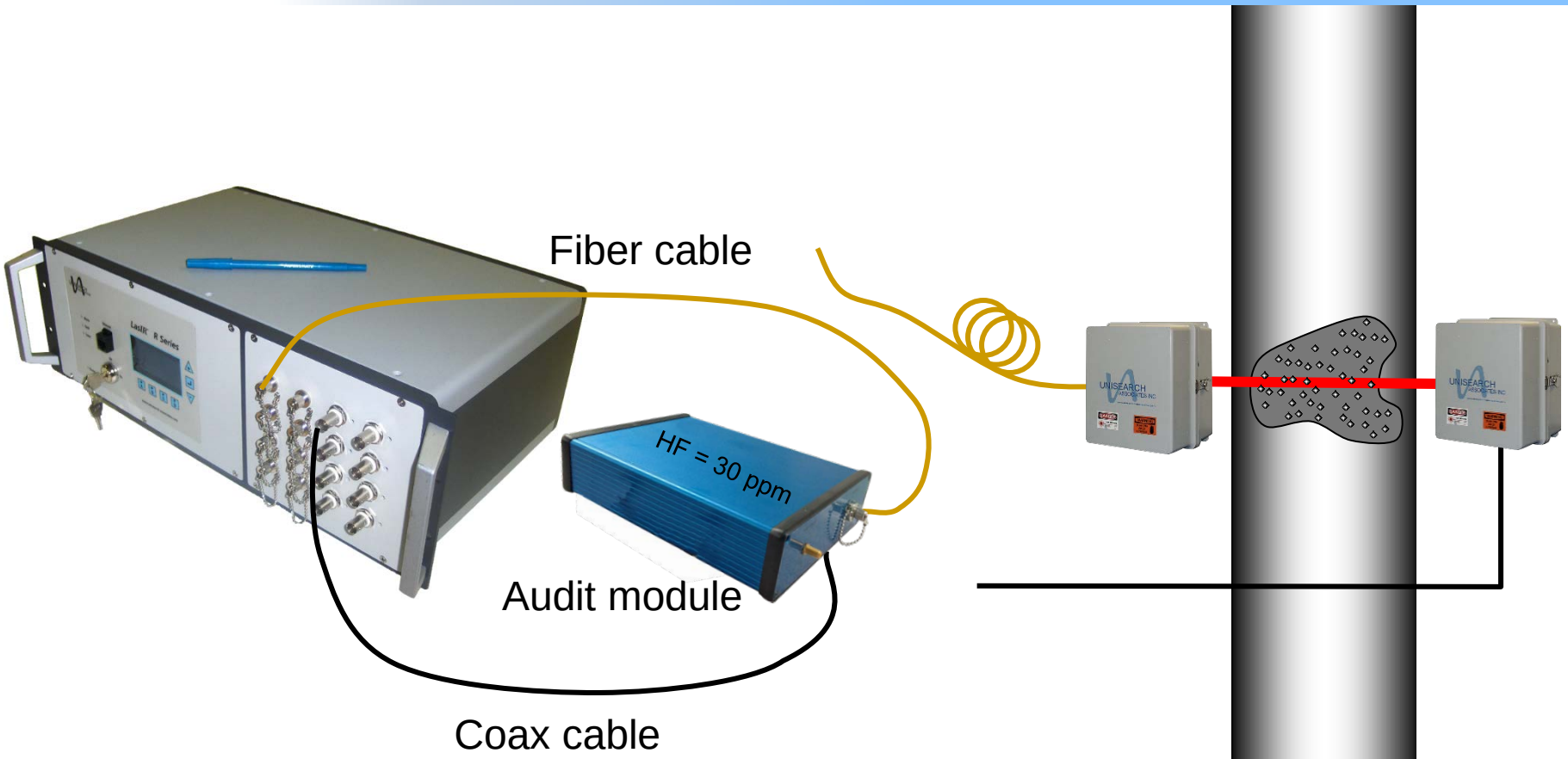


Summary

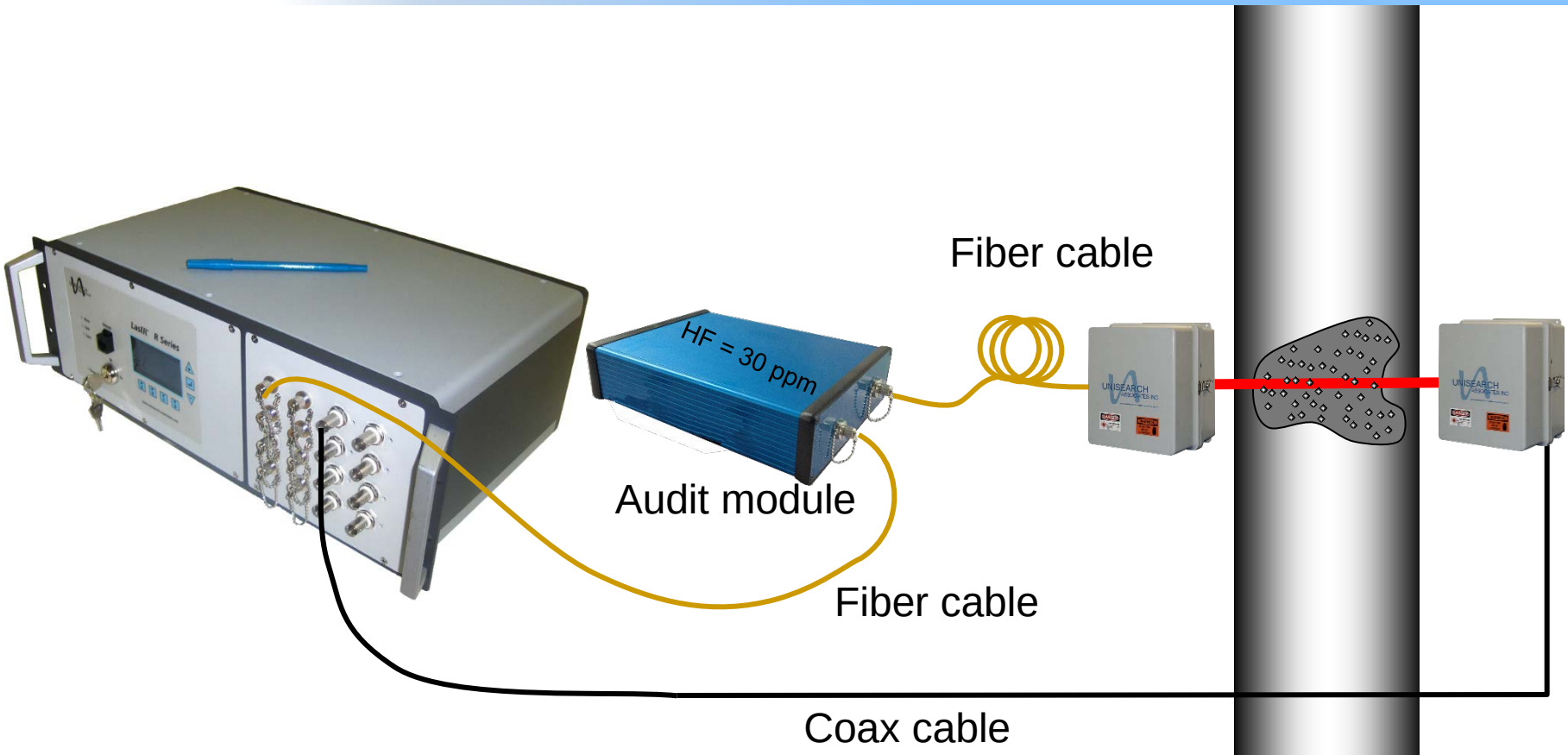
- Ammonia slip can be measured accurately with a tunable diode laser.
- An optical array of multiple lines of sight measured with a fiber coupled TDL analyzer can provide cost effective control of ammonia slip and document SCR operation.
- Moisture and line strength measurements when performed with ammonia 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.

Unisearch gas analyzer do not require field calibration.

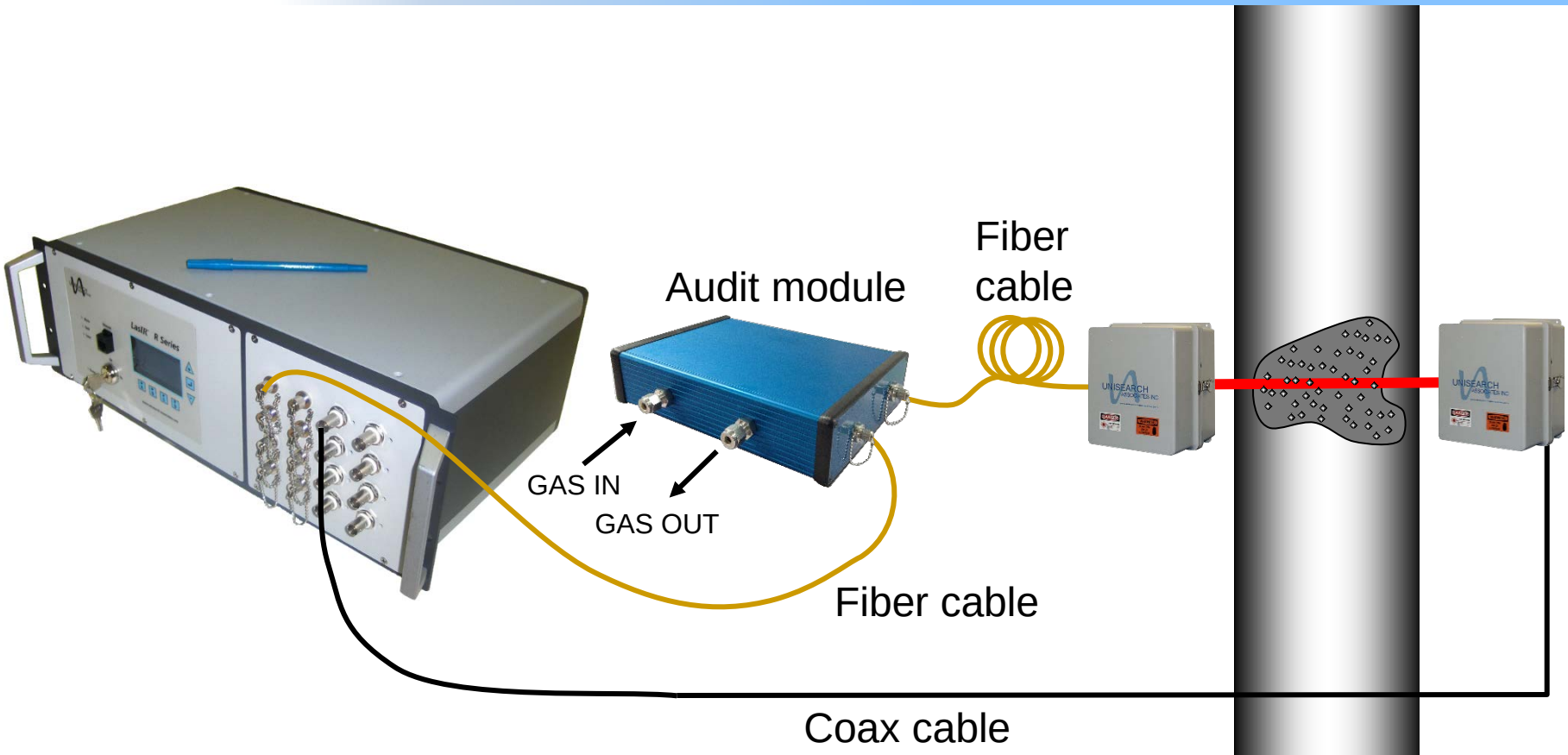
Audit Modules containing permanently sealed gas cells are available to check the validity of the measurements. Therefore, compressed gas cylinders are not required to check the performance or validity of the analyzer.



Analyzer Offline Audit

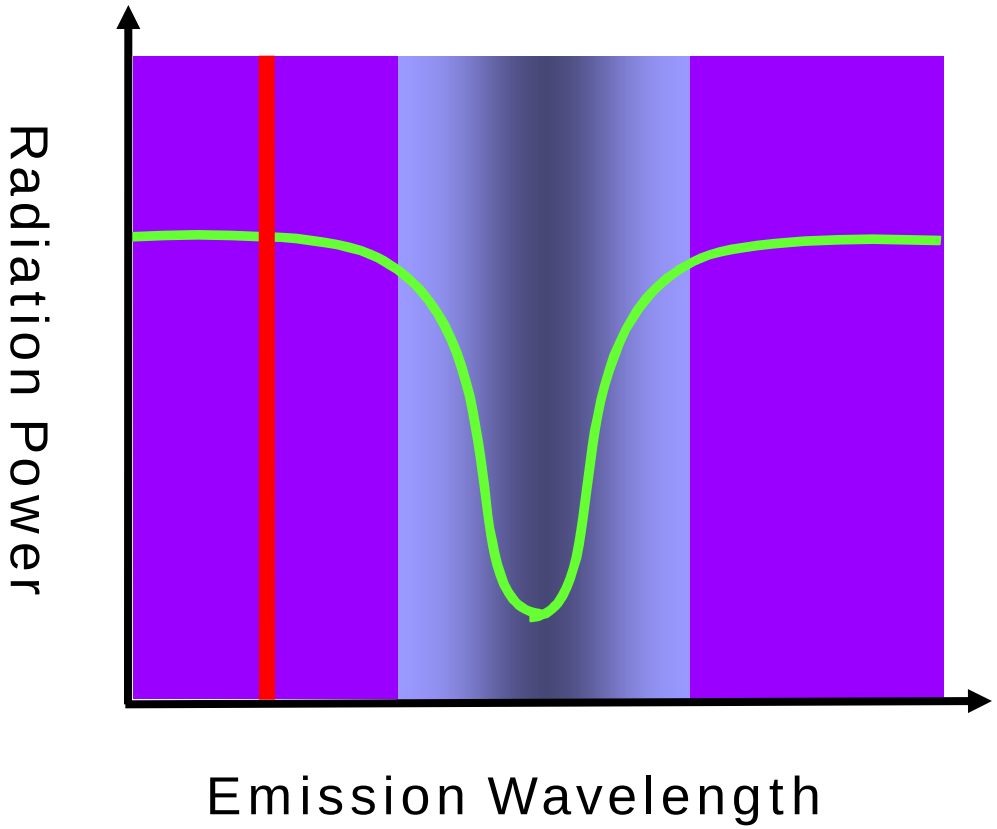


Analyzer Inline Audit



Analyzer Inline Audit with Cylinder Gas

Wavelength Scan (5 kHz)



Wavelength Scale