REINHOLD ENVIRONMENTAL ®

2026 Reinhold/PCUG Round Table Presentation

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2026 REINHOLD/PCUG CONFERENCE

Gas Catalyst Testing Protocol

Round-Robin Testing Update

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Acknowledgments

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ELECTRIC POWER RESEARCH INSTITUTE

Participating Laboratories (anonymous) - provided in-kind testing support

Overview

- Prior work (2024) developed updated testing protocol for SCR and CO catalysts (discussed at last year's conference)

Laboratory **Testing** Guidelines for **Combustion Turbine** Selective Catalytic Reduction (SCR) and Carbon Monoxide (CO) Oxidation **Catalysts**, 2nd Edition 12/16/2024

Turbine Selective Catalytic Reduction (SCR) and ... **Catalyst testing** also provides a near real-time assessment of the performance capabilities of the **catalyst**, such that impacts of changing ...

Product ID: 3002030252 Pages: 94
Program: SCR Performance Issues Type: Technical Results
Level: Membership

- Current effort (2025) reports results of round-robin testing comparison of SCR catalyst (available to EPRI members)

Multi-Laboratory Comparative **Testing** of Combustion Turbine SCR **Catalysts** 11/20/2025

The objective of this project is to develop a methodology and software tool for solving a variety of voltage control and reactive management issues in transmission systems, such as the assessment of reactive power reserve adequacy and optimal scheduling and siting of reactive power resources. EPRI ;s VCA Studio software developed in this project is a versatile tool for different volt/var control (VVC) and optimization applications, including 1) assessment of reactive power reserve, optimal scheduling, or...

Product ID: 3002032499 Pages: 33 Program: SCR Performance Issues
Type: Technical Results Level: Membership

Prior Work Summary

Developed a protocol based on laboratory input to arrive at a standard test approach for both SCR and CO catalysts.

DeNOx Activity Testing

Table 3-1 SCR Catalyst Activity (K) - Standard Test Conditions

Parameter [1]	**Target Level**	**Accuracy** [2]	**Maximum Drift** [3]
Temperature	Field value	± 4.5°F (±2.5°C)	4.5°F (2.5°C)
Area Velocity	Field value or alternate of 35 m/hr[5,10]	± 5% of target	± 2% of value
Linear Velocity	Field, or as needed to achieve alternate AV	± 5 % of target	± 2% of value
O_2	Field value (nominally 15% dry)	± 1% absolute of target	± 0.5% absolute of value
H_2O	As generated[4] or field value[8]	± 1% absolute of target	± 0.5% absolute of value
CO_2	As generated[4] or field value (nominally 3% dry)	± 1% absolute of target	± 0.5% absolute of value
NO_x	Field value or alternate[9,10]	± 1% of target	± 0.5% of value
NO_2/NO_x	Less than 5% or field[7]		
SO_2	None added		
NH_3/NO_x ratio	1.2 or alternate[6]	±2% of target	±2% of value
N_2	Balance	NA	NA

1. As measured at the reactor inlet.
2. Accuracy refers to the absolute deviation of the test condition from the target condition.
3. Drift refers to the maximum amount of drift that a parameter may have during the duration of a single test.
4. "As generated" assumes a natural gas-fired combustion source and does not need to be controlled unless a specific target is set.
5. Use field value if measured NOx reduction < 95%; otherwise increase AV to 35 m/hr. If NOx reduction is not <95% at AV of 35 m/hr, then inlet NOx may be increased as necessary.
6. If the required accuracy cannot be met for the NH_3/NOx ratio, then see discussion under alternate multi-point testing.
7. If the field NO_2/NOx ratio is known to be high (especially for values >50%), then field values should be used. See discussion in Chapter 6.
8. Note that field moisture levels vary widely according to the reference field condition as a function of assumed ambient relative humidity and temperature, as well as if water injection (such as steam augmentation) is included.

CO Oxidation Testing

Table 4-1 CO Oxidation Catalyst Performance Test Conditions

Parameter[1]	Target Level	Accuracy[2]	Maximum Drift[3]
Temperature	Field value or light-off curve from 200°F at low end up to 100°F above full-load field value	± 10° F (6°C)	5° F (3°C)
Space Velocity[4]	Field value	± 5 % of target	± 2% of value
Test Sample Length	Field value		
O_2	Field value (nominally 15% vol. dry)	± 1% absolute of target	± 0.5% absolute of value
H_2O	Field value[5]	± 1% absolute of target	± 0.5% absolute of value
CO	100 ppmvd @ 15% O2	± 1 % of target	± 0.5% of value
SO_2	None added		
CO_2	Field value (nominally 3% vol. dry)	± 1% absolute of target	± 0.5% absolute of value
NOx	None added		
N_2	Balance	NA	NA

1. As measured at the reactor inlet.
2. Accuracy refers to the absolute deviation of the test condition from the target condition.
3. Drift refers to the maximum amount of drift that a parameter may have during the duration of a single test.
4. The flow rate is set to match the field space velocity taking into account cell blockage, unless the laborator and end user agree to test a higher space velocity (i.e., higher flow or worst-case condition)
5. Note that field moisture levels vary widely according to the reference field condition as a function of assumed ambient relative humidity and temperature, as well as if water injection (such as steam augmentation) is included.

Current Effort
Round Robin Approach

Two honeycomb samples sent from lab-to-lab in traditional round-robin fashion with initial lab re-testing at end of sequence.

Each lab was asked to make their own geometry measurements, and then set the AV at 32 Nm/hr. Since labs used the same full length samples, matching the AV will also result in the same LV for each lab/sample. This constitutes a semi-bench test according to EPRI definitions. Other testing conditions were identical within the allowances of the testing protocol.

Sample Characteristics

Parmeter	Units	Sample 1	Sample 2
		EPRI-RR-2501	EPRI-RR-2502
Typical Application	mm	Combined Cycle	Simple Cycle
Catalyst pitch	mm	2.1	2.1
Wall thickness	mm	0.22	0.22
Length	mm	124	150
# Cells each direction	mm	16	16
Sample width and height	mm	33.82	33.82
Total # Cells		256	256
Internal Circumference of Cell	mm	7.52	7.52
SSA	m^2/m^3	1,700	1,700
Area Velocity (target)	Nm/hr (1 atm, 0°C)	32.0	32.0
Flow Rate	Nm/hr (1 atm, 0°C)	7.6	9.2

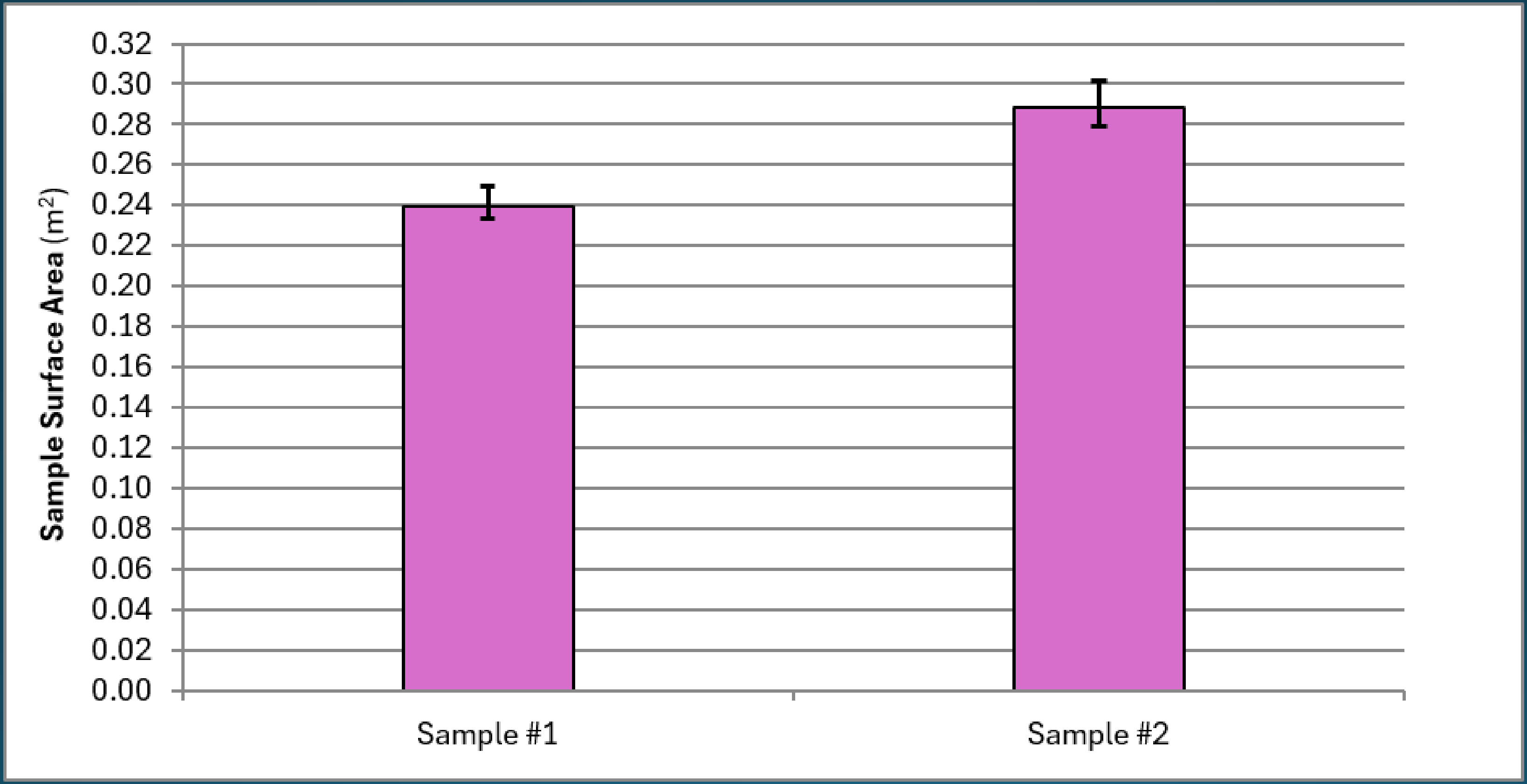
Samples In Foam Packing For Transport

Test Conditions

Parmeter	Units	Sample 1	Sample 2
Typical Application		EPRI-RR-2501	EPRI-RR-2502
Typical Application		Combined Cycle	Simple Cycle
Area Velocity (target)	Nm_3/hr (1 atm, 0 °C)	32.0	32.0
Temperature	°F	608	828
	°C	320	442
O_2	% volume, dry	14.00	14.50
H_2O	% volume	7.00	10.40
CO_2	% volume, dry	3.40	3.68
	% volume, dry	82.6	81.8
Inlet NOx (as NO)	ppmvd (15% O_2)	25.0	27.1
NH3/NOx Ratio		1.2	1.2

Test Results

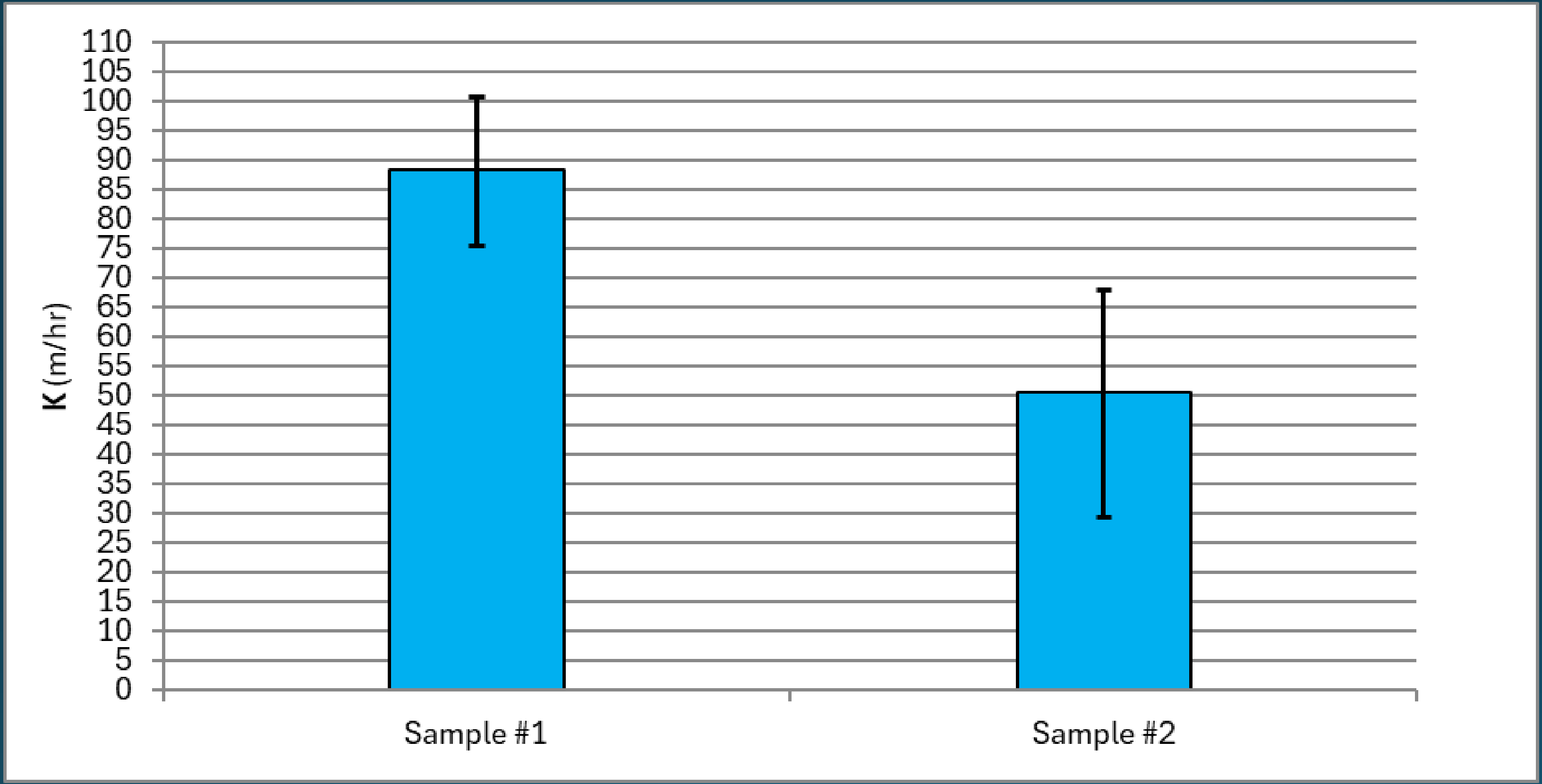
Measured Sample Surface Area



The measured sample surface area deviated as much as ~4% from the mean. This results in a deviation in calculated AV vs. actual AV, and consequently results in a roughly proportional deviation in measured K-value. Note: this is different from a known deviation in AV from the target.

Test Results

DeNOx Activity



A large deviation was present for the K-value (activity) results. Labs were consistent in the way that they deviated for both samples, i.e. they were high on both samples or low on both samples, possibly indicating systemic differences in measurements, versus random error. The deviation was ~ ± 38% in K-value, unacceptably large for catalyst management purposes.

Sources of Variability and Errors

1) Geometry Measurements

Activity error roughly proportional to SA measurement error for typical catalysts.

2) Setting the NH_3/NO_x Ratio

Fairly flat K vs. NH_3/NO_x ratio at 1.2 NH_3/NO_x, small errors will not have large effect

3) Flow Measurements

Activity error roughly proportional to flow measurement error, similar to the effect that geometry error. This only applies to errors. Known deviations in flow do not have the same effect.

4) NOx Measurement (both inlet and outlet)

5) Flue Gas Leak-By

NOx Measurement Sensitivity

Inlet NOx

Activity measurement not as sensitivity to inlet NOx measurements as outlet NOx measurement (see below). Error of ±1 ppm causes error of roughly ± 1% to 2% in activity at standard test conditions, depending on absolute catalyst activity (low activity catalyst more sensitive).

Critical to measurement accuracy

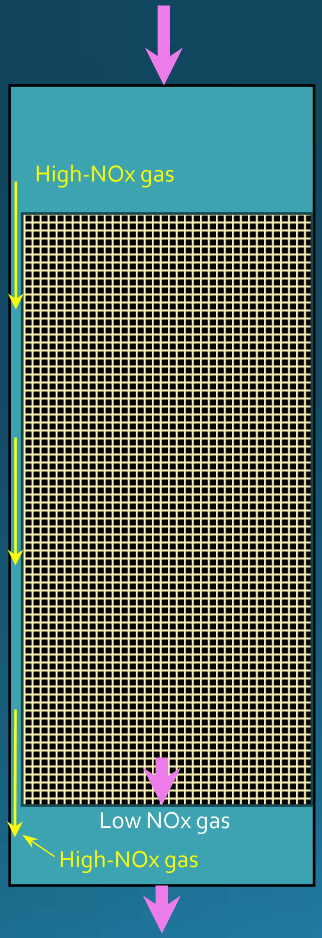
Outlet NOx

Activity very sensitive to outlet NOx measurements. Error of ± 0.1 ppm causes error of roughly ± 1.5% to 3% in activity at standard test conditions (at 95% deNOx). The higher the deNOx during the test, the more sensitive the activity measurement is to the outlet NOx. DeNOx needs to be <90% for reasonable accuracy requirement, maybe lower.

Leak-By Sensitivity

Critical to measurement accuracy

Activity <u>very</u> sensitive to leak-by. Error of ± 1% causes error of roughly ± 3% to 6% in activity at standard test conditions and depending on absolute activity of the catalyst. High activity catalyst will be more sensitive to leak-by.



Future Work

1) Determine the source of the lab-to-lab variability and develop approaches for improving agreement (QA/QC, instrument accuracy, testing guidelines, etc.). This work is currently underway.

2) Apply the same round-robin approach to oxidation (CO) catalyst testing.

3) Determine appropriate testing procedures for multi-function catalysts.

Work Currently Underway

(troubleshooting testing)

1) EPRI will provide participating laboratories with individual (identical) catalyst samples so that testing can be carried out simultaneously.

2) Perform troubleshooting testing using a standard test condition as a start. Compare results "on the fly" with free exchange of information between labs to troubleshoot sources of error and testing approach differences. Labs are free to test as much as needed.

3) Ultimately refine the QA/QC, measurement accuracy, and testing approaches needed to reduce the lab-to-lab variability in test results.

Conclusions

CT catalyst testing can be complicated compared to coal catalyst testing. Current round-robin results highlight testing difficulties.

Test results and associated accuracy are highly dependent on test conditions and the characteristics of the samples being tested - need to understand the reason for inter-lab variability.

Ultimately, the testing guidelines may be need to be updated to better ensure consistent data between labs.

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Questions?