

Field Calibrations

PQAO Training 2017

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Calibrations

- ▶ Right now: Introduction, Big Picture
- ▶ This afternoon:
 - Demo: Ozone Analyzer Calibration
 - Some additional slides (nitty gritty)
 - More time for Q&A

Session: Station Operations & Documentation “B”

Room: Mountain Vista 2

Times: 2:35 to 3:15 and again 4:20 to 5:00

Some Definitions

- ▶ “Calibration” is defined as:

*The comparison of a measurement standard or item with a standard or instrument of high accuracy to detect and quantify inaccuracies and to report those inaccuracies by **adjustment**.*

(EPA QA Handbook Vol II)

- ▶ “Verification”: comparison but no adjustment made

“AS IS”

- ▶ We’ll focus on gas instruments, but concepts apply to PM and meteorology, too.

How

- ▶ Calibrations should be carried out
 - at the field monitoring site
 - by allowing the analyzer to sample test atmospheres containing known pollutant concentrations
- ▶ The analyzer should be warmed up:
 - at least several hours but preferable overnight
 - Warm-up periods (per API) :
 - 2 hours (O₃)
 - 24 – 48 hours (NO_x)
 - 4 – 7 days (TCO)

How

- ▶ During the calibration, the analyzer should be operating in its normal sampling mode, including:
 - Filters / scrubbers / conditioners
 - Through as much of the ambient air inlet system as is practicable. → Ideally, through the probe.

- ▶ Keep this in mind when:
 - Designing new station
 - Purchasing calibration equipment

When

- ▶ EPA QA Vol II, Section 12.3:
 - Installation
 - Relocation
 - Repairs or Service
 - Interruption
 - Upon any indication of potential malfunction
 - At least every 6 or 12 months (see below)
 - Station shutdown

- ▶ Minimum frequency of calibration (EPA QA Vol II, App D)
 - Every 6 months
 - Or annually, **IF** zero/span check is done daily

- ▶ Keep track of when calibrations are happening!

When Continued

Audits:

- No calibrations within 30 days before an audit (CARB QA)

Ambient Conditions:

- Pollution: not during pollutant episodes, (i.e., O_3 not in afternoon)
- O_3 : Not during O_3 season
- Met / Particulates: not during high wind conditions or adverse weather conditions due to safety



How Many Points?

- ▶ EPA requirements (EPA QA Vol II. App D):
 - Ozone, SO₂, Carbon Monoxide:
 - Zero
 - 4 Upscale Points
 - NO, NO₂, NO_x:
 - Zero
 - 4 Upscale Points for NO & NO_x
 - 3 NO₂ Titration Points

What Levels (Concentrations)?

- ▶ No EPA/ARB requirements, but:
 - Highest point should be 80% of full scale and >NAAQS (EPA QA Vol II)
 - Keep limits of calibrator (i.e. MFC ranges) in mind
 - Good idea to bracket audit levels
 - ARB proposed 2017 audit levels (ppm):

Full Scale

Audit Point	O3	CO	NO2	SO2
1	0.130	17.0	0.147	0.120
2	0.080	12.0	0.075	0.080
3	0.055	6.0	0.035	0.040
4	0.030	2.0		0.014
5	0.015			

Trace-Level

Audit Point	O3	CO	NO2	SO2
1	N/A	2.00	N/A	0.035
2		0.70		0.015
3		0.11		0.004
4		0.04		0.002

What Levels (Concentrations)?

- EPA audit levels:

Audit Level	O ₃ (ppm)	SO ₂ (ppm)	NO ₂ (ppm)	CO (ppm)
1	0.004-0.0059	0.0003-0.0029	0.0003-0.0029	0.020-0.059
2	0.006-0.019	0.0030-0.0049	0.0030-0.0049	0.060-0.199
3	0.020-0.039	0.0050-0.0079	0.0050-0.0079	0.200-0.899
4	0.040-0.069	0.0080-0.0199	0.0080-0.0199	0.900-2.999
5	0.070-0.089	0.0200-0.0499	0.0200-0.0499	3.000-7.999
6	0.090-0.119	0.0500-0.0999	0.0500-0.0999	8.000-15.999
7	0.120-0.139	0.1000-0.1499	0.1000-0.2999	16.000-30.999
8	0.140-0.169	0.1500-0.2599	0.3000-0.4999	31.000-39.999
9	0.170-0.189	0.2600-0.7999	0.5000-0.7999	40.000-49.999
10	0.190-0.259	0.8000-1.000	0.8000-1.000	50.000-60.000

- Regular analyzers: 3 yellow levels
- Trace analyzers: 2 pink & 2 yellow

Standards

- ▶ Must be certified and traceable
 - EPA QA Vol II, Section 12.1.2
 - CARB Standards Lab:
 - <http://www.arb.ca.gov/aaqm/qa/stdslab/stdslab.htm>
- ▶ Check expiration dates:
 - Cal Gas Tanks
 - Mass Flow Controllers
 - Ozone transfer standard (6 months)
 - Flow Standards (1 year)
 - etc
- ▶ Properly warm-up/equilibrate:
 - Flow Standards
 - Ozone transfer standard
 - etc

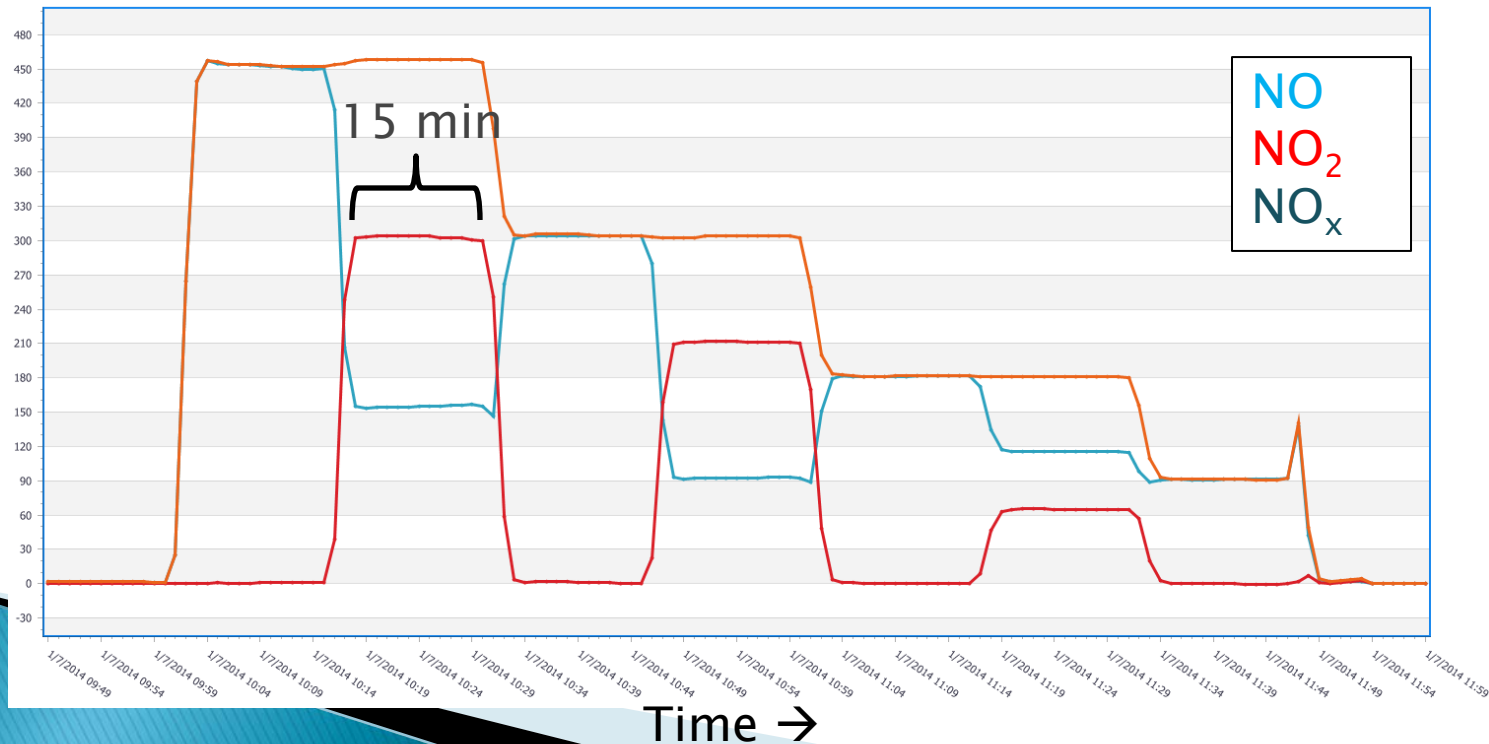


Zero Air

- ▶ Zero Air Generator is part of calibration system
- ▶ Per EPA's TSA of ARB, we should:
 - Verify that our zero is clean
 - Document ZAG maintenance
- ▶ In depth presentations on this topic:
 - Wednesday, 10:35 – 11:00
Yousef Hameed
Zero Air Guidance: Introduction.
 - Wednesday, 1:45 & 3:30, Mountain Vista 2
David Roque
Zero Air Generator Certification.

Response Plateauing

- ▶ General practice is to allow concentrations to stabilize (plateau) for at least 10–15 minutes
- ▶ Teledyne API Analyzers:
Stability should be <0.5 ppb (non-trace level)



Documentation

- ▶ Usual stuff: name, data, initials/signature
- ▶ Information for standard(s):
 - Serial number(s)
 - Calibration/certification date(s)
 - Concentrations, correction factors, etc.
- ▶ Information for instrument:
 - Serial number
 - As-Is and Final slope/intercept/correction factor
- ▶ Calibration info:
 - Calibration points
 - Instrument response

Criteria for PASS/FAIL

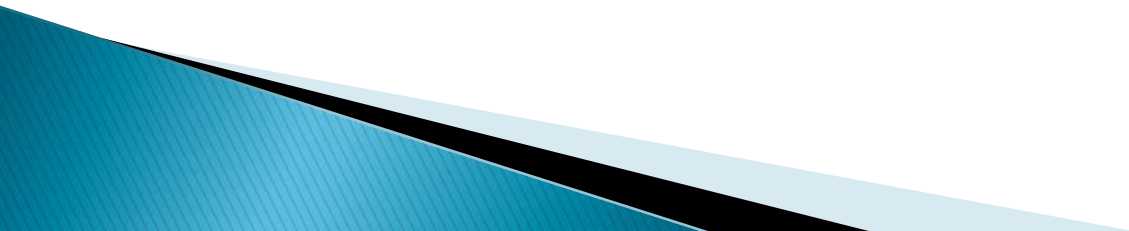
- ▶ **EPA** says (QA Vol II sec 12.2 & App D; 40 CFR 50 Apps A, C, D or F):
 - All points within 2% of calibration scale
 - For NO₂: NO_x convertor efficiency > 96%
- ▶ **ARB** says (SOPs):
 - “Overall % Accuracy”: $100\% * (\sum \text{true}_i - \sum \text{resp}_i) / \sum \text{true}_i$
 - Ozone: <2%
 - NO/NO₂/No_x: <5%, convertor efficiency > 96%
- ▶ Check your SOPs and QAPPs!!

Failed Calibration?

- ▶ Whatever happens: Document Document Document!!
- ▶ Double check calibration equipment, data logger, and calculations
- ▶ Corrective Action:
 - Rezero and/or Respan
 - Fix or replace instrument
 - Perform calibration/verification prior to placing monitor back online.
- ▶ Inform upstream data users
- ▶ Effect on Data: Depends
 - Note: “post-processing” of data no longer accepted

Questions?



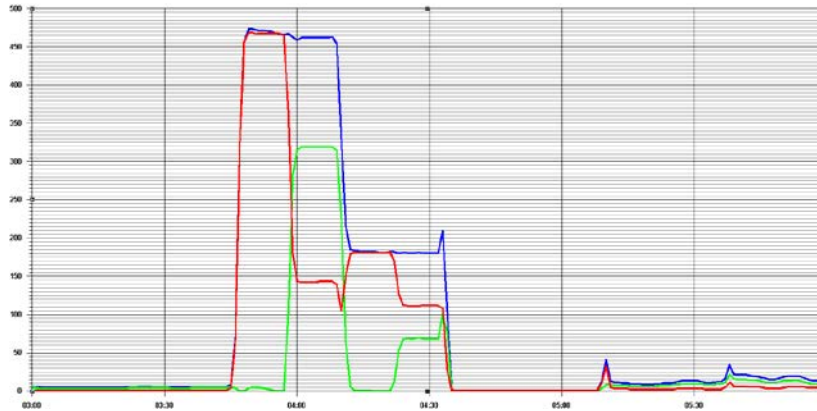


Field Calibration Demo

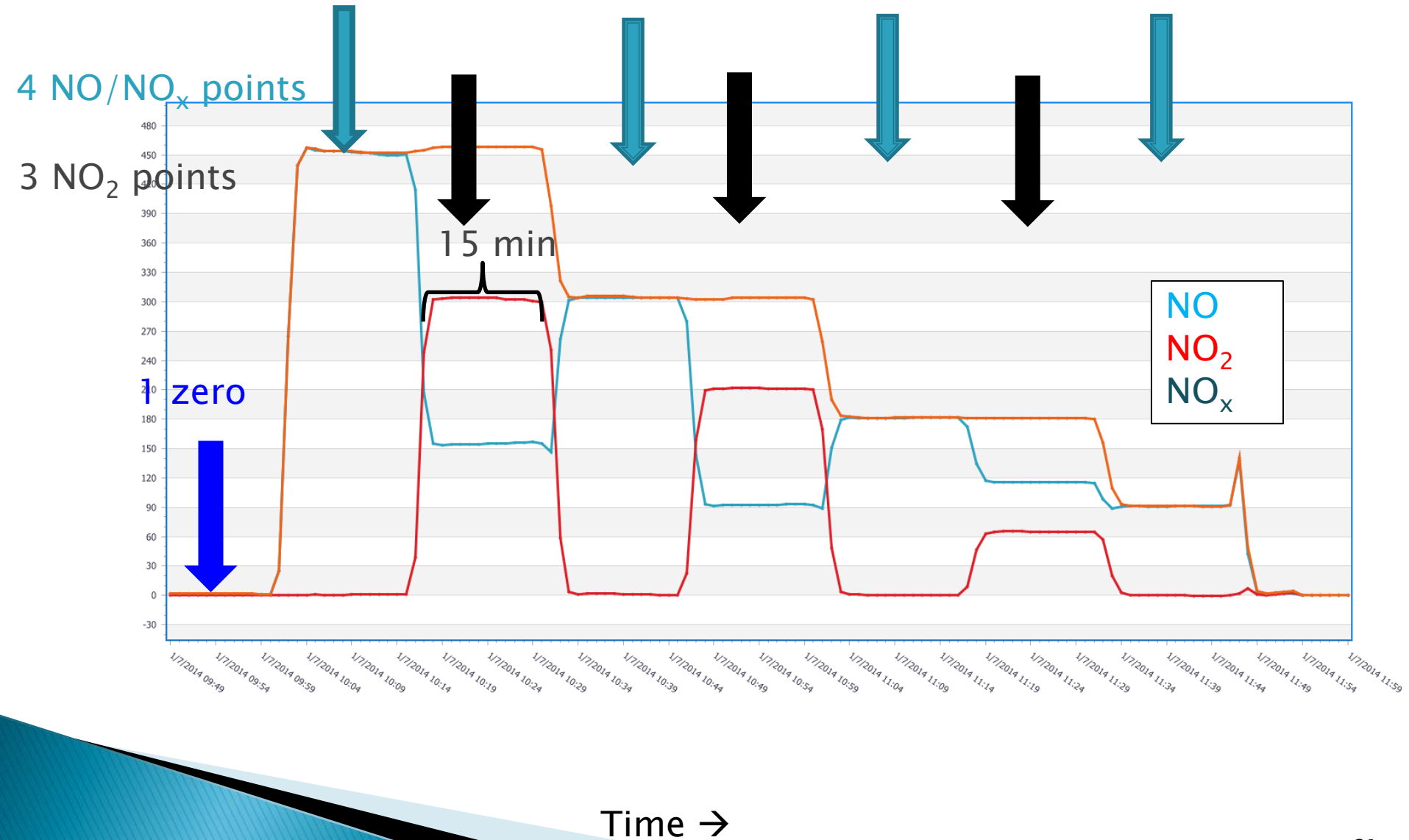
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Proper use of Standards

- ▶ Response plateauing
- ▶ Purging regulators
- ▶ Warm-up period

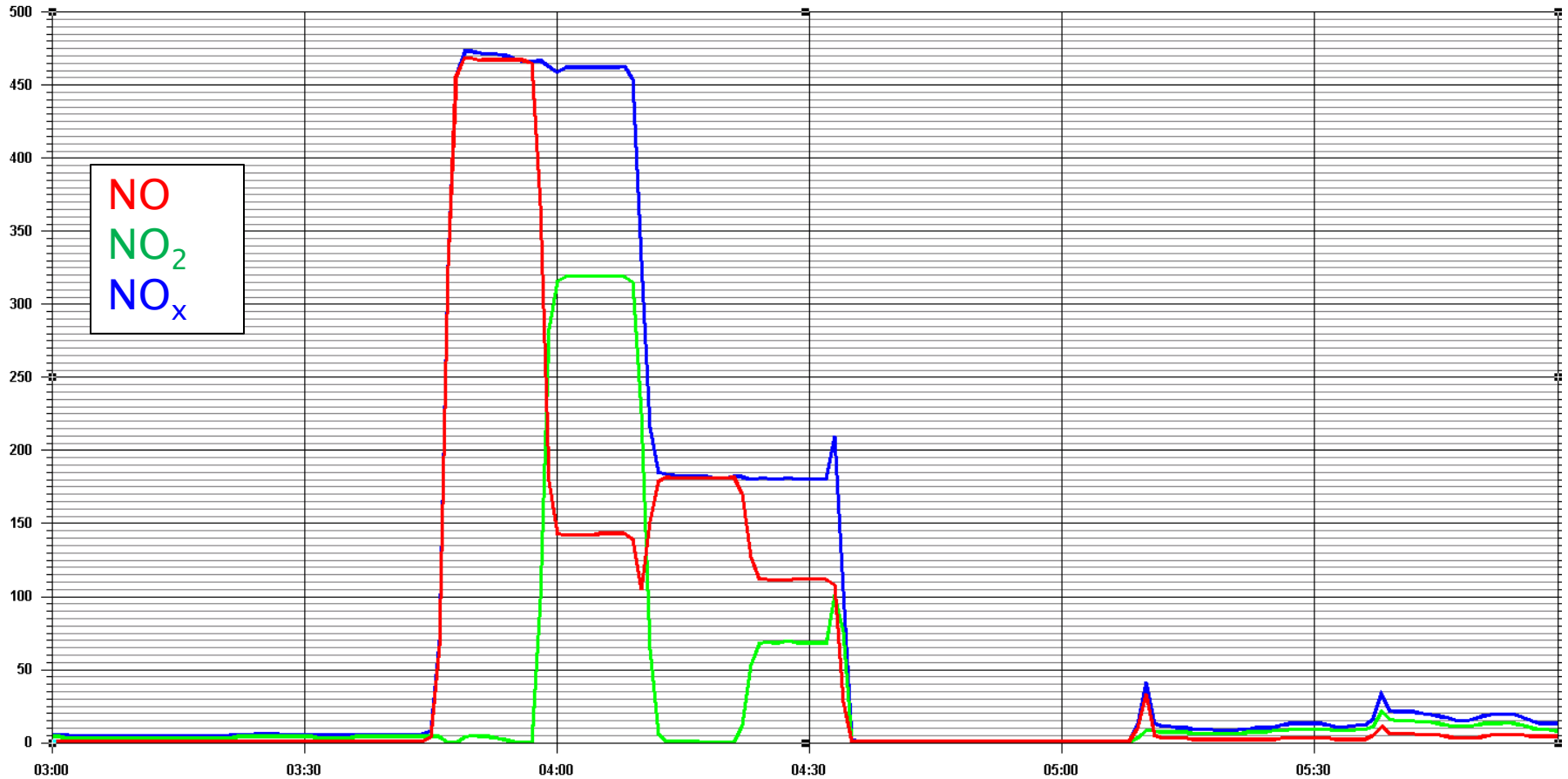


NO₂ Example



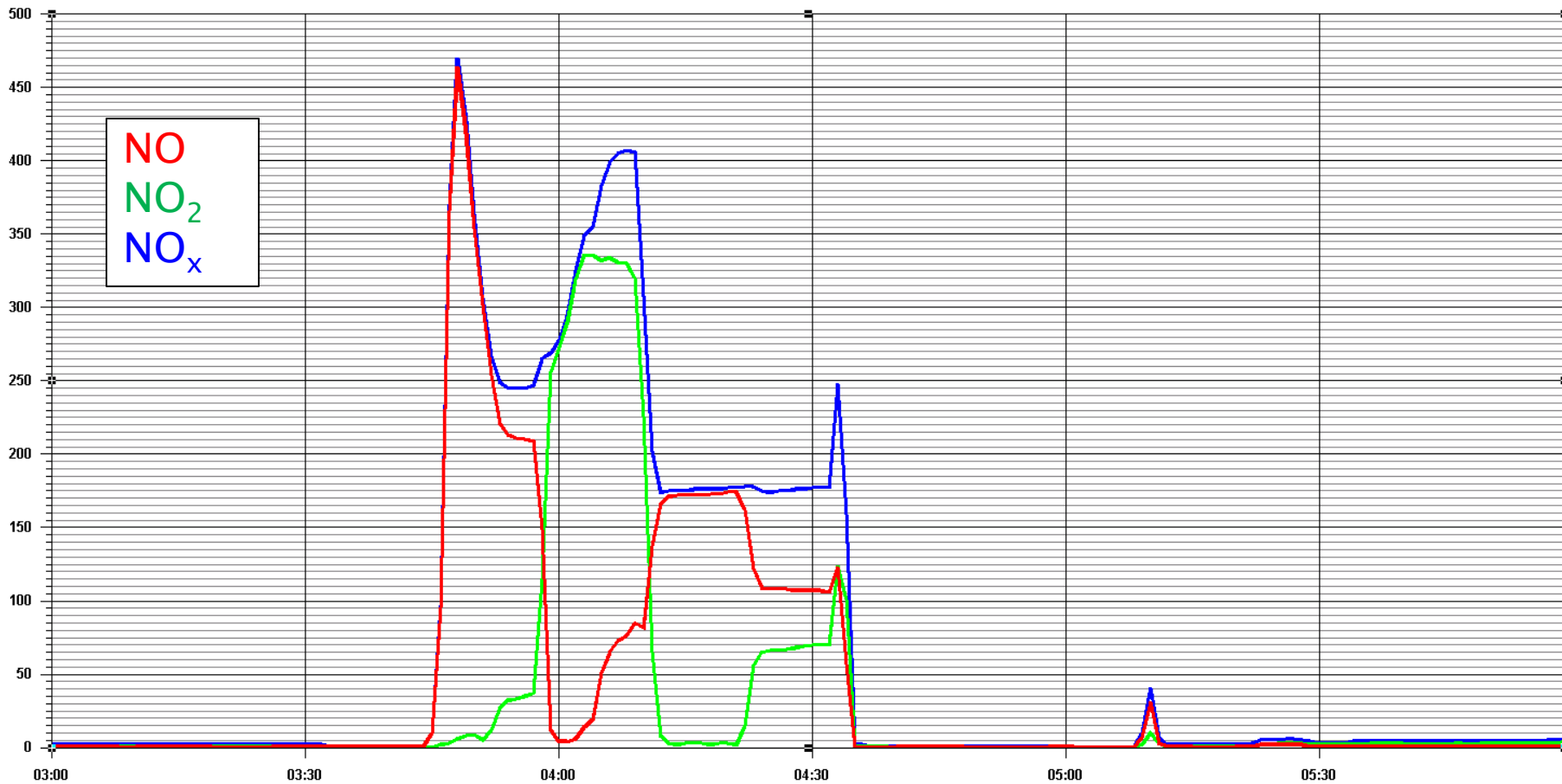
Purging a Regulator

Z/S/P with Properly Purged Reg



Purging a Regulator

Autocal with Improperly Purged Reg



Calibration: Purging a Regulator Demo



Purging a Regulator

1. Attach the regulator to the cylinder valve.
 2. Open the cylinder valve to flow gas into the regulator, then immediately close the cylinder valve.
 3. Increase the regulator outlet pressure several PSI.
 4. Then open the regulator outlet valve to vent the gas trapped in the regulator.
 5. Close the regulator outlet valve.
 6. Repeat steps 2 through 5 (4–5 times).
- **CAUTION:** Many gas mixtures contain harmful or toxic substances. Suitable vents must be used to avoid breathing these substances.