

It's Just Calibration...

How Hard Can it Be?

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Objectives

Proper instrument calibration and operation is essential to finding leaks, but its role and importance to a robust LDAR program can be overlooked. Even if you've calibrated hundreds of times before, there are a number of commonly misunderstood or misapplied requirements of Method 21. This presentation will review common calibration compliance issues and highlight some unique findings from compliance audits, including the requirements under NSPS Subpart VVa and Consent Decrees. Its objective is to capture lessons learned on daily calibration, performance tests, and Method 21 instrument specifications to improve compliance for LDAR professionals. In addition, empirical testing to show the impact of the sample flow rate on the calibration value and the instrument's ability to detect leaks is included.

EPA's Penalty Policy (September 2012)

Failure to follow Method 21 equals failure monitor

- Instrument not calibrated prior to monitoring (including using expired gases)
- Instrument does not pass a calibration check (e.g., “if the meter readout cannot be adjusted to the proper value”)
- Calibrated instrument not used in accordance with Method 21 (i.e., not converting from alternative gas/reference compound)

TABLE 4. MISSED MONITORING AND INSPECTION EVENTS

Per valve, flange, connector;	\$100
Per pump, agitator;	\$400
Per compressor, PRV, CVS.	\$2,000

Note: If equipment is not monitored because it is not identified as regulated equipment in the monitoring program then the penalty is assessed in accordance with Table 3, not Table 4.

EPA's Penalty Policy (Continued)

“A failure to calibrate the instrument before monitoring is equivalent to a failure to monitor because there is no information to validate the data collected.”

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Method 21 Instrument Requirements

Equipment Specifications

- Responsive to compounds being measured
- Capable of measuring the specified leak definition concentration
- Meter scale readable to $\pm 2.5\%$ of the specified leak definition concentration
- Constant sample pump flow rate from 0.1 to 3.0 L/min
- Probe/extension tip outside diameter ≤ 0.5 inches
- Intrinsically safe operation (Class 1 or 2, Division 1) and operated with an exhaust flame arrestor

Common Issues – Calibration

Equipment Specifications

- Not allowing sufficient warm-up time after lighting FID or changing the hydrogen exclusive of flameout
- Using outdated/incorrect Response Factor(s)
- Probe/extension outside diameter > 0.25"
- Extremely long extension probes with Response Time > 30 seconds
- Flame arrestor removed “to improve TVA operation”



LDARtools

Method 21 Calibration Gas Requirements

Method 21 Gas Specifications

- Zero gas (“air, less than 10 ppmv VOC”)
- Cylinder gases analyzed and certified within 2% accuracy
- Manufacturer-specified shelf life
- Prepared gases with 2% accuracy and daily replacement
- Non-reference compound gases with conversion factor

Specific Rule Gas Specifications

- Methane or other responsive compound (HON)
- Methane or n-hexane in air of about, but less than 10,000 ppm (VV/a)
- Calibration gas may exceed leak definition by $\leq 2,000$ ppm (HON)

Common Issues – Calibration Gases

Lack of certified accuracy or a shelf life

- Does zero gas require 2% accuracy or a shelf life?

Cylinder gas errors

- Using the wrong or expired gas cylinder
- Gas is outside of regulator parameters
- Records of certified gases cannot be located



Use Before: 08/12/2019			
ANALYTICAL RESULTS			
Component	Requested Concentration	Actual Concentration (Mole %)	Analytical Uncertainty
Methane	1.0% vol. (20% LEL)	0.95% vol.	+/- 2 %
Air	Balance		

Method 21 Calibration Requirements

Sample Collection, Preservation, Storage, and Transport

- Instrument Performance Evaluation

Determine Response Factor (< 10) for each compound to be measured, either by testing or from reference sources

- Calibration Precision ($\pm 10\%$)

Complete prior to placing analyzer into service and at subsequent 3-month intervals or next use, whichever is later

- Response Time (≤ 30 sec)

Conduct before placing the instrument into service or before use upon making a modification to the sample pumping system or flow configuration to change the response time

Common Issues – Calibration

Observations of Daily Calibration Techniques

- Not entering the correct span gas value prior to conducting daily calibration or quarterly calibration precision test
- Not calibrating at the “leak definition specified in the regulation”
- Calibrating with a different configuration than actually used
- Not documenting daily instrument calibrations (on days used) or instrument performance tests
- Re-zeroing the instrument without re-calibrating at each leak definition
- *What about re-starting the instrument after flameout or hydrogen changeout?*

Common Issues – Calibration Performance

Observations of Calibration Performance Testing

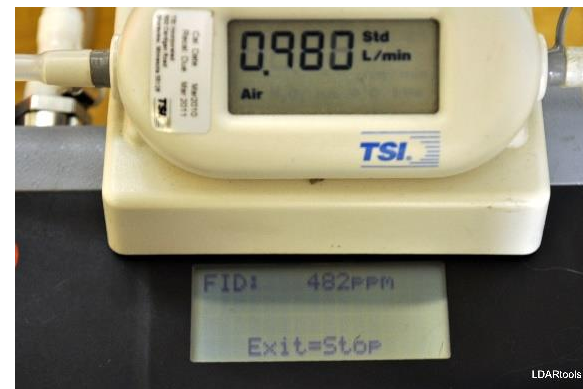
- “Precisely calibrating” rather than precision testing at each leak definition
- Not performance testing at all leak definitions (whether FID or PID)
- Not conducting a response time test after modification to the sample pumping system or flow configuration is made that would change the response time
 - Use of an extension probe
 - Different probe or cable length
 - External water trap



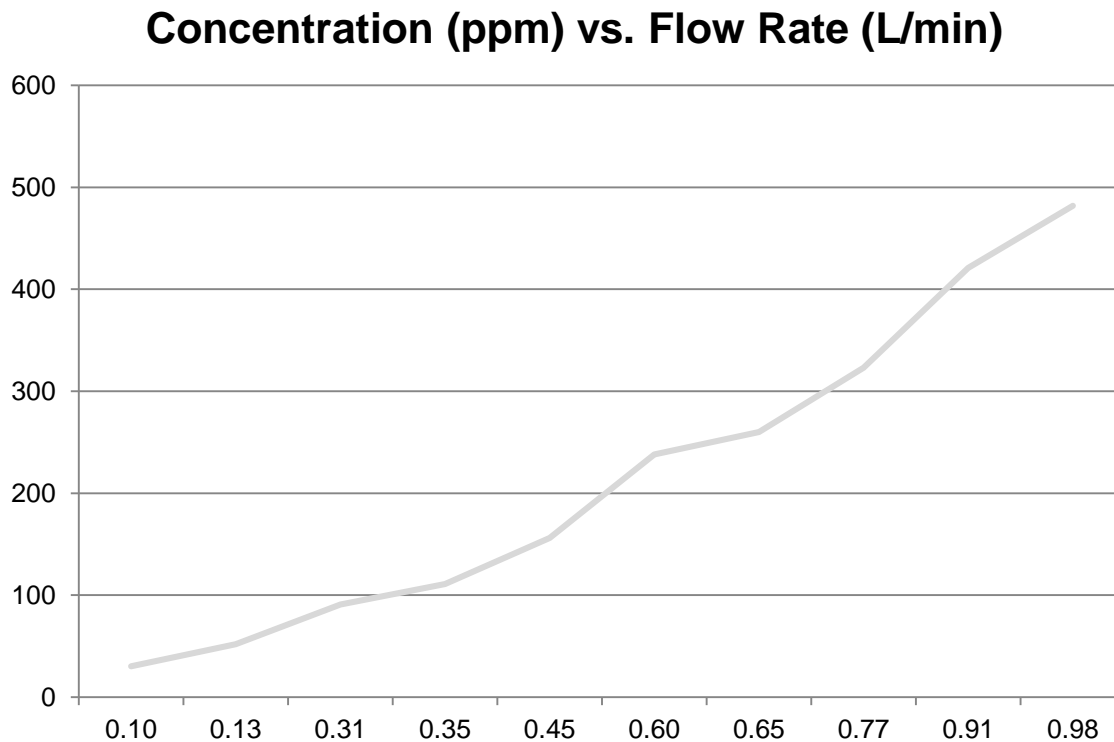
Calibration Experiment #1

Effect of Sample Flow Rate Reduction on Concentration

- Background: Concentration measured under various sample flow rates
- Question: How does a plugged filter affect the instrument's ability to detect leaks?
- Objective: Investigate the correlation between sample flow rate and concentration
- Method: Induce progressively lower flow rates by restricting the sample flow rate of a TVA



Sample Flow Rate vs. Concentration

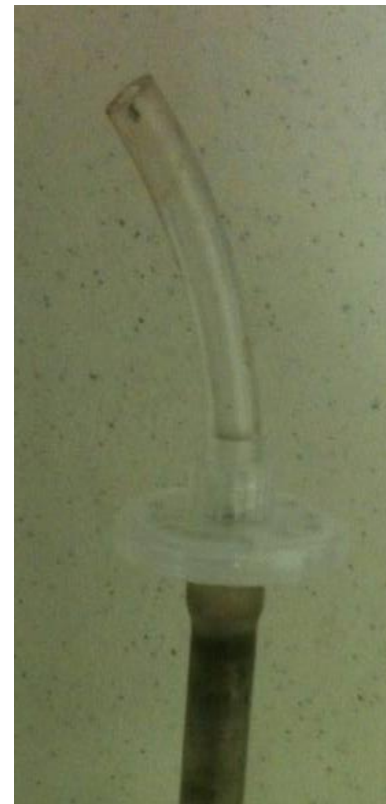


Data provided by **LDARtools**

Calibration Experiment #2

Effect of External Water Trap (EWT) on Concentration

- Background: Probes were calibrated with EWTs, which were then removed before monitoring
- Question: Was a bias introduced into leak detection?
- Objective: Investigate the effect of EWT on flow rate and concentration
- Method: Three trials with and without EWT with different calibration methods for the 500-ppm leak definition
 - 494 ppm calibration gas with LDARtools' Span Box
 - 494 ppm calibration gas with 1.5-L Tedlar Bag



External Water Trap vs. Concentration

- EWT affected flow rate by approximately 11-12%
- Removing the EWT after calibration could mean the difference between a leak and a non-leaker

494 ppm Span Gas	<i>Concentration (ppm) Using Span Box</i>		<i>Concentration (ppm) Using Tedlar Bag</i>	
Trial	With EWT	No EWT	With EWT	No EWT
1	479	540	448	519
2	486	531	465	513
3	482	533	464	512
Average	482.3 ppm	534.7 ppm	459.0 ppm	514.7 ppm
Increase	10.85%		12.13%	

Calibration Drift Assessment

LDAR Best Practices Guide

Elements:

- Conduct calibration drift assessments of LDAR monitoring equipment at the end of each monitoring shift, at a minimum.
- Conduct the calibration drift assessment using, at a minimum, approximately 500 ppm of calibration gas.
- If any calibration drift assessment after the initial calibration shows a negative drift of more than 10% from the previous calibration, re-monitor all valves that were monitored since the last calibration with a reading of greater than 100 ppm. Re-monitor all pumps that were monitored since the last calibration with a reading of greater than 500 ppm.

NSPS Subpart VVa

Requirements:

- Conduct calibration drift assessment of monitoring instrument at the end of each monitoring day, at a minimum.
- Check the instrument using the same calibration gas(es) that were used to calibrate the instrument before use.
- Calculate the average algebraic difference between the three meter readings and the most recent calibration value. Divide this algebraic difference by the initial calibration value and multiply by 100 to express the calibration drift as a percentage.
- If any calibration drift assessment shows a negative drift of more than 10 percent from the initial calibration value, then all equipment monitored since the last calibration with instrument readings below the appropriate leak definition and above the leak definition multiplied by (100 minus the percent of negative drift/divided by 100) must be re-monitored. If any calibration drift assessment shows a positive drift of more than 10 percent from the initial calibration value, then, at the owner/operator's discretion, all equipment since the last calibration with instrument readings above the appropriate leak definition and below the leak definition multiplied by (100 plus the percent of positive drift/divided by 100) may be re-monitored.

Calibration Drift Assessment

“...if any calibration drift assessment after the initial calibration shows a negative drift of more than 10% from the previous calibration...” (CD)

Drift based on average of three meter readings, compared to the initial calibration value. (VVa)

- Calibration Gas Standard: 490 ppm (500 ppm Leak Definition)
- Morning (Previous) Calibration: 510 ppm End of Shift Drift: 455, 450, 460 ppm

<u>Drift from Leak Definition</u>	<u>Drift from Gas Standard</u>	<u>Drift from Previous Calibration</u>	<u>Drift for Last Drift Check</u>
$\text{Drift} = \frac{(500-455)}{500}$	$\text{Drift} = \frac{(490-455)}{490}$	$\text{Drift} = \frac{(510-455)}{510}$	$\text{Drift} = \frac{(510-460)}{510}$
Drift = -9.0%	Drift = -7.1%	Drift = -10.8%	Drift = -9.8%

Common Issues – Drift Assessment

Procedural Errors or Not Performing Calibration Drift Assessment

- Morning or end-of-shift concentrations not recorded
- Conducted midday but not after monitoring shift
- Did not conduct drift after re-monitoring repaired components
- Failure to re-monitor valves/pumps after CDA failure
- Incorrect drift basis or math/conversion errors (e.g., 1.07% \neq 10,007 ppm)
- Re-starting/re-zeroing/re-calibrating instrument to pass the CDA
- *What if an instrument “dies” without a calibration drift?*

Conflicting Drift Assessment Requirements

Consent Decrees

Evaluate drift at 500-ppm leak definition (at minimum) per CD (stipulated penalty)

Older CDs do not specify “negative” drift, so positive drift requires re-monitoring

“Previous calibration value” commonly misconstrued as gas span concentration

Re-monitor valves > 100 ppm and pumps > 500 ppm, regardless of calculated negative drift percentage (despite repair action level)

Stipulated penalty for not conducting drift check, but only specifies 500 ppm “at a minimum”, so what about others?

NSPS Subpart VVa

Evaluate drift at each leak definition monitored

Negative 10% drift requires re-monitoring; positive drift is not an issue

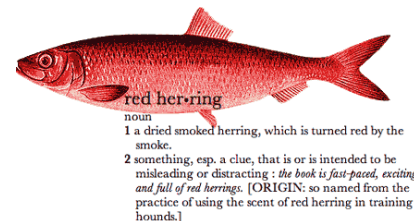
“Initial calibration value” is defined in the rule as previous reading

Re-monitor components with concentrations that are under the calculated negative drift percentage.

If subject to CD and VVa, which drift value do you use to evaluate against CD drift requirement if last value drifts -10%.

Calibration Practices That Are Not Findings

- Using a calibration gas that differs by more than 2% from the leak definition (e.g., 488 ppm gas vs. for 500 ppm)
- Daily calibration more than $\pm 10\%$ above or below the certified calibration gas concentration
- Not conducting a response time test every 3 months if instrument not used
- Not introducing zero gas from a cylinder/bag into the sample probe in between calibration precision test steps
- Using an instrument that was calibrated or performance tested at different gas concentrations for the same leak definition
- Instrument sample flow rates below the manufacturer's calibrated flow rate
- Cleaning (not replacing) probe filters prior to drift check



Questions?

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