Quality System Training
Module 3
Implementation

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2008 Conference on Managing Environmental Quality Systems

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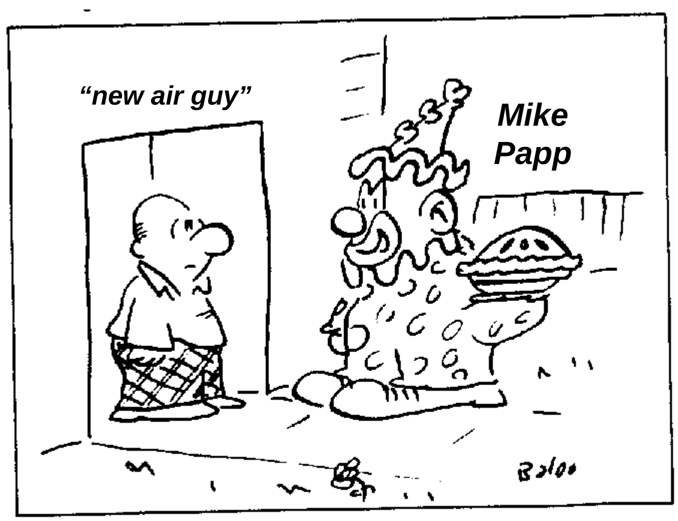

"Hi! I'm from the government, and I'm here to help you!"

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Why and What Do You Want To Monitor??

What is my monitoring objective?

- *National Ambient Air Quality Standard Attainment (NAAQS)*
- *Objectives in addition to or outside of NAAQS*
  - *Health studies (air toxics)*
  - *Fence line monitoring*
  - *Monitoring representativeness (saturation)*

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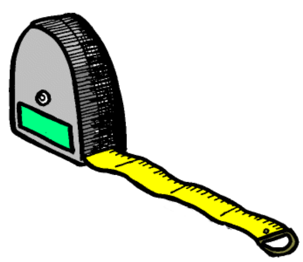
Why and What Do You Want To Monitor??

No matter what your objectives are, you want your data to stand up to scrutiny and meet quality standards

Quality Assurance helps to do this, by:

Measuring and monitoring your error, so that you can

- *Keep data within MQO limits, and*
- *prove to others and yourself that your data are reliable*



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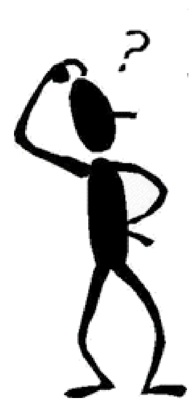
Equipment Selection, Testing and Maintenance

- *Do I have appropriate site locations?*
- *Am I using the appropriate equipment? Do I need FRM or FEM or other?*
- *What are the sampling system material requirements? Teflon and glass only.*
- *Is the instrument functioning properly initially? Test and document!*
- *What are the general maintenance requirements?*
- *What training might be needed?*



References

- *40 CFR Part 58 Appendix A includes specific quality assurance requirements (MQO tables)*
- *40 CFR Part 50 includes NAAQS monitoring standards and requirements*

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Types of Sampling Systems

Why discuss monitoring systems during a QA conference? If you don't begin correctly...

you WILL NOT collect accurate and representative data

Important Notes to Think About with Sampling Systems

Cleanliness is a key!

- *If your lines or manifolds are dirty, you will scrub pollutants you are trying to measure.*

Maintenance is another key

- *ROUTINELY check your manifold or lines inside and outside the shelter. Different sites may require different cleaning frequencies.*

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Types of Sampling Systems

Conventional Manifold Information

- Low volume flow
- Can handle multiple analyzers
- Calibrations may be done through the probe
- Condensation is possible, heating might be required

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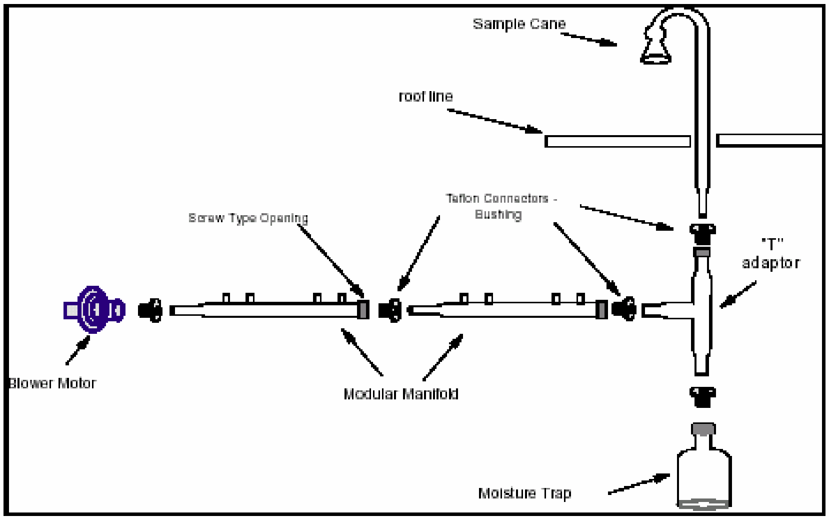
T-Style Manifold



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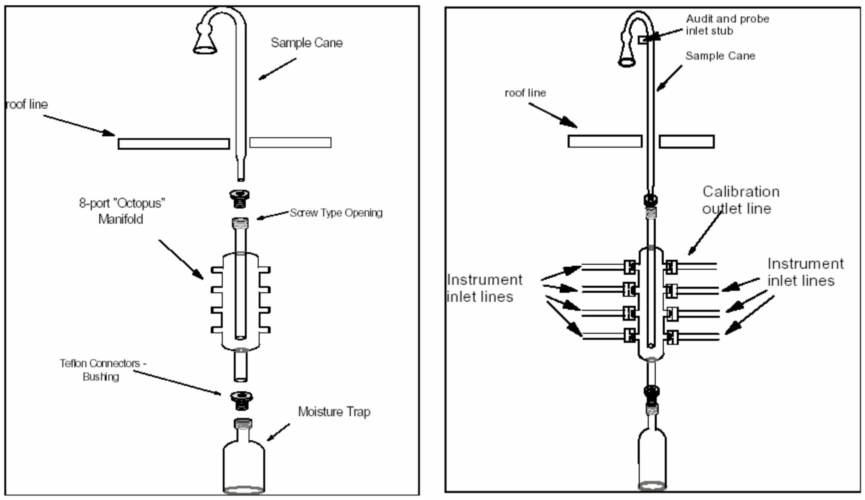
CARB Octopus Manifold



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Single Line System

- *Single teflon line and probe for each analyzer*
- *Short residence time*
- *No blower*
- *Analyzers are isolated, if blower fails all data is not lost*
- *Must ensure clean probe lines*

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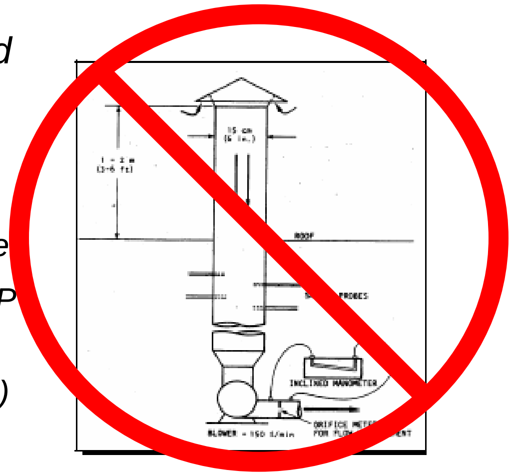
Types of Sampling Systems

Laminar Flow Manifold

- *High Flows*
- *Difficult to Clean*
- *Temperature Difference*
- *Can't be audited by TTP*
- *Not Allowed in New Regulation (40 CFR 58)*



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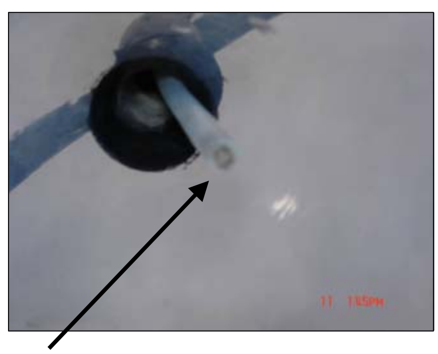
Probe Issues - Examples

Dirty Lines



Mold/tarry contamination

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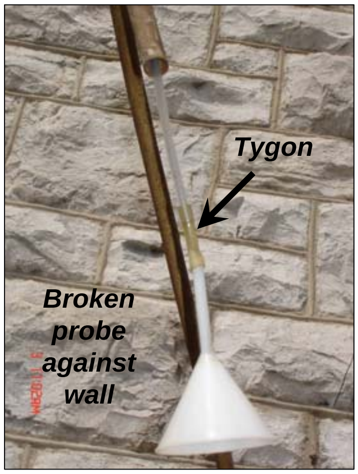
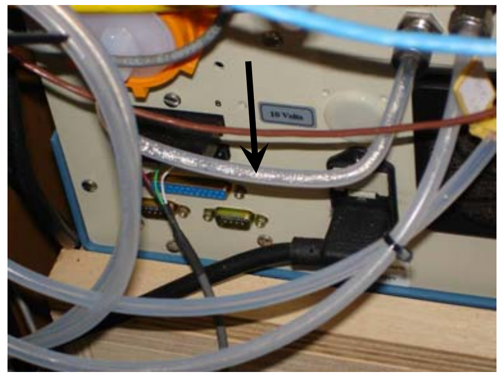
Probe Issues - Examples

Improper probe placement and material



Condensation in lines



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Siting Requirements

Different Monitors Have Different Siting Criteria

A few common questions to consider...

- *Does the site represent the scale I want to monitor?*
- *Does it have 270 degrees unobstructed air flow or 180 degrees if on the side of a building?*
- *Does anything obstruct air flow, i.e. trees, buildings, backstops?*
- *How far away from trees is my site?*
- *Are there any sources nearby that may impact your sampler or analyzer?*
- *How far am I from roads? What is the traffic count?*
- *How high is my probe?*

All specific regulations for siting all pollutant monitors can be found in ***40 CFR, Part 58, Appendix E***

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Siting Issues

Example: Probes located too close to trees

Shout out to everyone...

Review your sites annually! Conditions around the site are always changing.

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Effects of Improper Siting

If your monitor is...

- *Too close to trees*
- *Too close to buildings*
- *Next to a source*
- *Too close to the road*
- *Down in a depression*

Your data could be biased

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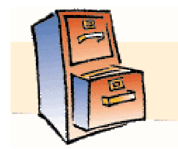
Acceptance of Supplies and Consumables

- *Create an inventory and track usage*
- *Record and file QC standards/equipment certification activity*
- *Do multi-point verifications or recalibrate if necessary before gathering any data*
- *Test analyzers, samplers, standards against each other*
- *Test and examine consumables (contamination, acceptable materials, design specs, etc)*
- *Document EVERYTHING!*



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You Have a Plan,

The Site is Chosen,

The Equipment Checks out,

Instruments are Operating,

How do you know you are collecting quality data and meeting your MQOs?

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Before We Look at Data... Concepts

QC checks measure and help us limit uncertainty

Uncertainty = Error

…the difference between your answer and the "truth," as a proportion of the "truth"

$$d_i(PercentDiff) = \frac{meas - truth}{truth} \cdot 100$$

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Precision

Precision =“wiggle” (variability within many measurements of the same thing, either one check over and over again [gas] or several at the same time [PM])

- *You are trying to <u>estimate</u> the variability within the population of "all" your measurements of the same thing*
- *You don't need to know the true value to measure precision*
- *Every step of your meas system has inherent imprecision, and each step adds up*
- *Imprecision in some steps can be measured separately from whole (e.g., flow rate)*

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Components of imprecision:

- *Some components of the process have their own QC checks to limit their contribution to imprecision*
  - *Flow rate*
  - *Operator doing things slightly differently*
  - *Electronic variations*
- *Overall imprecision measured by QC checks of end data (ppb, μg/m3)*

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Estimating imprecision:

- *Two ways to estimate precision:*
  - *side-by-side, two or more devices measuring the same concentration at the same time (PM)*
  - *If you have only one continuous instrument, you must estimate precision by how much the measurement fluctuates over time when it is measuring the <u>same</u> concentration (over a period of time)*

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Using Precision Estimates

- ***We*** ***need to estimate and limit precision EARLY to***
  - *stop drift,*
  - *operator error,*
  - *creeping changes in components,*
  - *Know what auditors will find*
- ***EPA*** ***needs precision estimates to calculate whether DQOs are met, and plan***

Accuracy

Accuracy = Total error

- ***Includes both bias and precision***
- ***Measured by true audits, over time***
- ***If MQOs are met, total error is bounded by an upper limit***

This term has been used throughout the CFR and in some documents. Whenever possible, it is recommended that an attempt be made to distinguish measurement uncertainties into precision and bias components. In cases where such a distinction is not possible, the term accuracy can be used.

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Bias

A systematic or persistent distortion of a measurement process which causes errors in one direction

- *Bias can be assessed by using standards of known concentration or authority*
- *Internal program standards (your own)*
- *External (NPAP, another PQAO's stnds), and if you use external it can be used to estimate accuracy (total error)*

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Components of Bias:

- *Like precision, each step of system can have bias*
- *Your routine checks help you track and limit bias*
- *Small factors that "push" parameters high or low affect bias*
- *Your routine QC checks may show you bias as well as imprecision—YOU must analyze your own data*

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Two components of error:

- *Different components of error*
  - *Random component (sometimes high, sometimes low) = PRECISION ERROR*
  - *Systematic component (mostly high, or mostly low) = BIAS ERROR*

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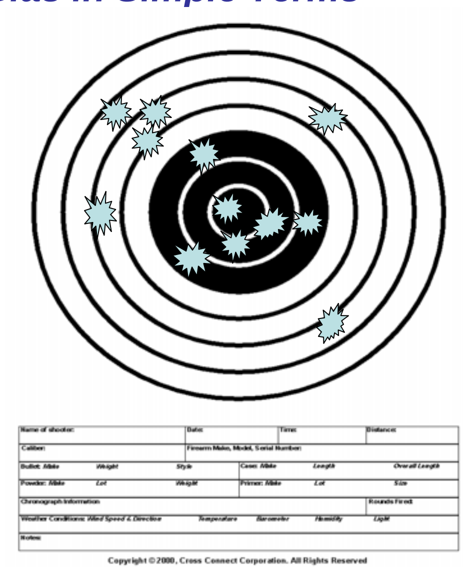
Precision and Bias in Simple Terms

Lets define precision and bias, pilgrim…

DUKE STYLE!



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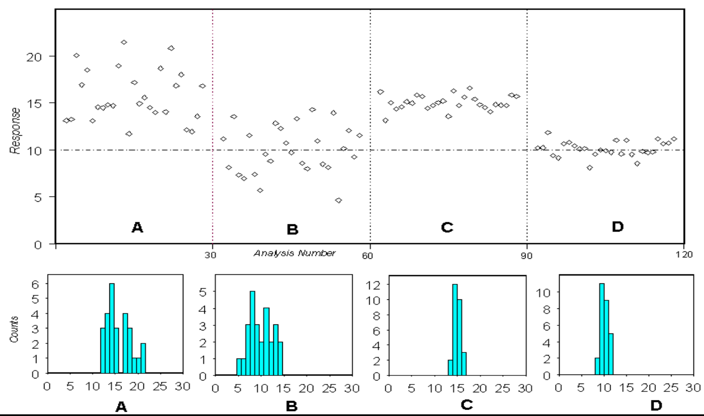
Precision and Bias

Air Monitoring Style… What might I see??

Imprecise and biased	Imprecise and unbiased	Precise and biased	Precise and unbiased



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Summary:

- ***Precision***
  - *Variability within many measurements of the same thing*
- ***Bias***
  - *Systematic or persistent distortion of a measurement process which causes errors in one direction, a shift*
- ***Accuracy***
  - *How close to "truth" are your measurements*

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Blue Collar Quality Assurance Elements

These are the QA tools that are used routinely in the field during the processes and help you confirm you have quality data

- ***Calibrations***
- ***QC Checks***
- ***Instrument Audits***
- ***System Checks***
- ***Internal Audits***
- ***External Audits***
- ***Blanks, Duplicates, Balance Checks***
- ***Collocations***
- ***Certifications***
- ***Instrument Maintenance***

Routine stuff for field grunts.

These ain't "Ivory Tower" assessments

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Calibrations

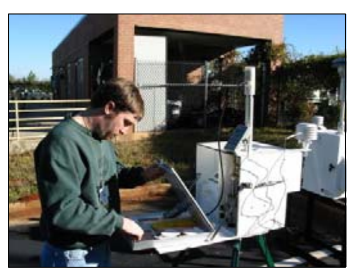
Needed when verifications show measurements out of limits, or when required by QAPP

Verification = Done without making adjustments to instrument response and prove system is operating within MQOs; therefore, DQOs should be met

Calibration = Instrument response is changed, and are made when No Adjustment

We calibrate:

- *Monitors/Samplers*
- *Through probe*
- *Calibrators*
- *Data loggers*
- *Voltage outputs*



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Calibrations: Common Issues

Garbage in, garbage out…

- *If you calibrate flow on a sampler and "tell it" 16.67 LPM is 15 LPM, the sampler will read 16.67 LPM on the display*
- *If you don't let a point stabilize (10 minutes) on a continuous analyzer like ozone, your calibration will be biased*

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Flow Calibrations

Flow Calibrations

REMEMBER

"Indicated versus Actual"

- *Indicated is what your* ***monitor*** *tells you.*
- *Actual is what your* ***flow standard*** *tells you.*
- *Your sampler only knows what you tell it.*
- *If you calibrate it poorly, it will lie to you!!!!*

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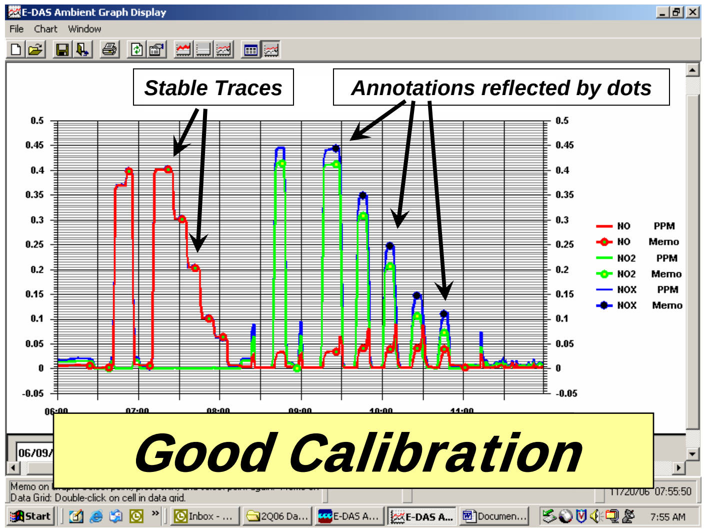
Gaseous Analyzer Calibrations



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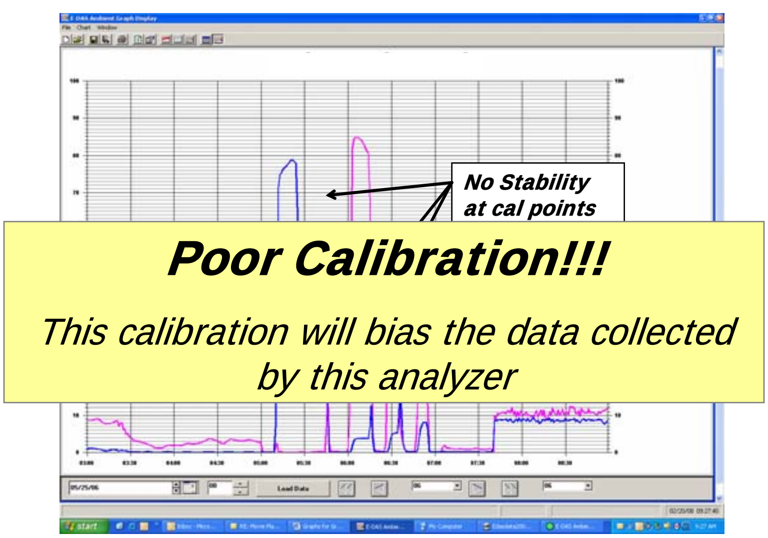
Gaseous Analyzer Calibrations



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QC Checks (previously Precision Checks)

A QC Check is essentially an audit on yourself…

QC Checks have a variety of purposes

- *To **estimate our errors** and keep **within limits** (internal program use, stay ahead of auditors)*
- *To **troubleshoot performance** of equipment (lamp intensity, pump efficiency)*
- *To **identify drift** over time*
- *To keep system **stable** (instrument checks, shelter conditions)*
- *To **report** to EPA for their use*

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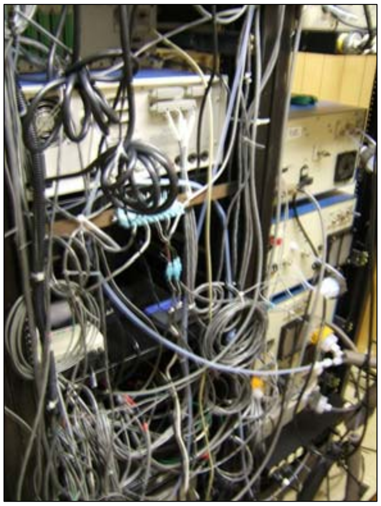
QC Checks

QC checks done with your own equipment

- *Auto biweeklies*
- *Manual biweeklies can be reported to EPA as a QC check (used to be called precision check)*
- *Zero/span checks done automatically are usually INTERNAL checks for program's purposes*



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Zero/Span/One-Point QC Checks

Why do we do these checks?

- *Provide data on monitor performance*
- *Helps to validate or invalidate data*
- *Helps troubleshooting problems*
- *Gives credibility and defensibility to your dataset—you estimate your precision error*

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Instrument Audits

Sometimes called a performance audit

Performance Audits use an independent standard to verify a device's calibration. ***This standard may not be the same device used for the calibration****.*

All standards for performance checks MUST be NIST traceable and certified annually, unless they are a primary standard

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Instrument Audits

Performance Audits may be conducted to assess:

- *Flow rate (PM samplers, analyzers, mass flow controllers, etc..)*
- *Temperature (ambient and filter if PM sampler)*
- *Barometric Pressure*

Important! Ambient temp and BP help a monitor calculate flow. If one is incorrect, the flow will reflect it.

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Flow Rate Audit Criteria Examples

Low Volume Manual and Automated

All PM2.5, All PM10-2.5, PM10 } → *4% PD from Standard; 5% PD from 16.67 L/min Design*

PM10 High Volume, PM10-Dichotomous } → *7% from Standard; 10% from Design*

PM2.5 Continuous Frequency and Criteria

Flow rate verification	*Monthly, with your standard*	*< 4% of standard and 5% of design value*

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Instrument Audits, Why Do Them?

Why are they so important?

Flow checks for example

- *PM2.5 cut point will change*
- *To calculate accurate concentrations*
- *Assessing pump efficiency; will it fail soon? Should I replace it?*

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Criteria for Calibrations, QC Checks, and Instrument Audits

Ranges for Calibrations, QC Checks, and Instrument Audits are found in Various Places

•40 CFR Part 58 Appendix A (gaseous pollutants)

•40 CFR Part 50 Appendix L (PM)

•Quality Assurance Guidance Document 2.12 (PM2.5)

•EPA's QA Handbook (Redbook)
http://www.epa.gov/ttn/amtic/qabook.html

•Quality Assurance Project Plan (QAPP)

•Instrument Manuals

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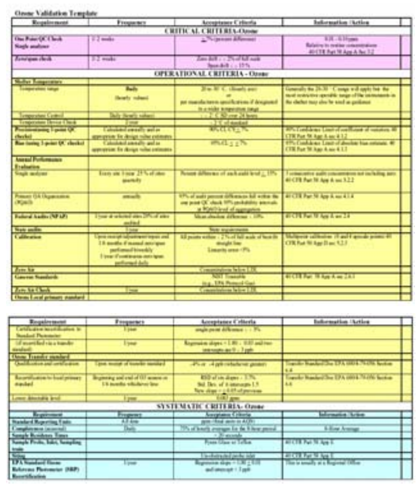
Criteria for Calibrations, QC Checks, and Instrument Audits

Look for these tables



All the ranges and parameters you will need are neatly laid out here

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Excellent Air Monitoring Resource

REDBOOK!

Light reading for the air monitoring newbies and grizzled veterans

EPA Quality Assurance Handbook for Air Pollution Measurement Systems

Volume II

Ambient Air Quality Monitoring Program

DRAFT

http://www.epa.gov/ttn/amtic/qabook.html

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Monitoring System Checks



- *Sample line integrity checks (line loss)*
  - *Indicates contamination*
  - *Reduces bias*
- *Residence time*
- *Shelter conditions/temperature*
  - *Affects monitor performance*
- *Maintenance, cleaning*
- *SITE SAFETY*

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Annual Performance Audits

Two types of Audits:

Internal:

Conducted by your own agency QA group. This group is independent of the monitoring group

External:

Conducted by your Regional EPA staff or another agency. This group is independent of your agency completely

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Internal Audits

This is the role of agency QA staff, generally a quarterly Audit

Might Include...

- *Performance Audits*
- *Data Audits*
- *Standards*

Your QA staff follows EPA regulations and guidance. They ensure the quality of your work according to our policies.

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External Audits

EPA Audits or Audits Outside the Organization, Frequency varies

Might Include...

- *Technical systems audits*
- *Performance Audits*
- *PM2.5 Performance Evaluation Program (PEP)*
- *National Performance Audit Program (NPAP)*

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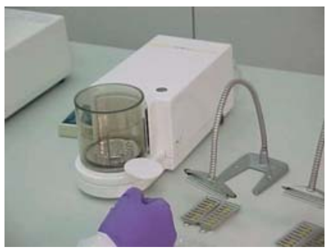
Blanks, Duplicates, Balance Checks

Blanks, replicates, and duplicates are tools used to discover bias in field samples from the lab, field, or method procedure.



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Lab Blanks

Used to determine if contamination is occurring in the laboratory

A blank is weighed during the pre-weighing of a batch of filters, then again during post-weighing and a difference is determined.

Problems that may be seen are:

- *Filter handling*
- *Lab cleanliness*
- *Procedural Issues*

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Replicate Weighings

Used to evaluate the repeatability of the microbalance during weighings and equilibration of filters

One filter is weighed twice during a weighing session (at the beginning and end) or in a following weighing session

Problems that may be seen are:

- *Filter handling*
- *Filter Conditioning*
- *Balance Drift*

Balance Checks

Used to evaluate the precision of the microbalance throughout a weighing session

Standard weights are weighed at the beginning and the end of a weighing session and a difference is determined

Problems that may be seen are:

- *Improper handling*
- *Balance stability*
- *Effects of static or temperature on the microbalance*

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Collocations

Placing a second monitor at a percentage of sites of a PQAO can estimate PM precision and in some cases bias.

- *Applies to:*
  - *Automated $PM_{2.5}$ and $PM_{10\text{-}2.5}$ (not automated PM_{10})*
  - *All manual PM methods*
- *15% of each designated method (at least one) in a Primary Quality Assurance Organization*

More information can be found in the Redbook

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Collocations

- *Multiple measures of the same thing (packet of air) at the same location*
- *Every 12 days*
- *Provides estimates of precision when both routine and collocated are compared*

Relative Percent Difference
$$d_i = \frac{meas - colloc}{(meas + colloc)/2} \cdot 100$$

As a proportion of the best estimate of "truth"

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Certifications

Testifies to the accuracy of an instrument/standard/gas as it compares to a NIST traceable standard.

The Following May Require Certification…

•Electronic flow meters

•Electronic temperature device

•Electronic BP devices

•Tank gases

•Balance weights

•Follow guidance for your MQOs in QAPP

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Instrument Maintenance:

- ***Own freq***
- ***Crea***
  - *D*
  - *C ... d for re*
  - *T ... n da ... s (not ju*
- ***Keep ... mps, tubi***

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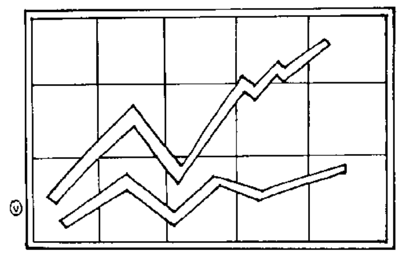
What to do with QC results?

- PLOT PLOT PLOT!
  - Review after every QC event, and review data over longer periods of time.
  - Check data against MQOs?
  - Check that response is not drifting
  - Calibrate if needed



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Evaluate your result as a proportion of the "truth"

When the audit standard is "truth"
(flow, temp, pressure, PEP etc.)

Percent Difference $d_i = \frac{meas - audit}{audit} \cdot 100$

When the best estimate of the truth is the average of two meas's:

Relative Percent Difference $d_i = \frac{meas - colloc}{(meas + colloc)/2} \cdot 100$

For routine day to day QC this may be all you need

Beyond this it gets more complicated

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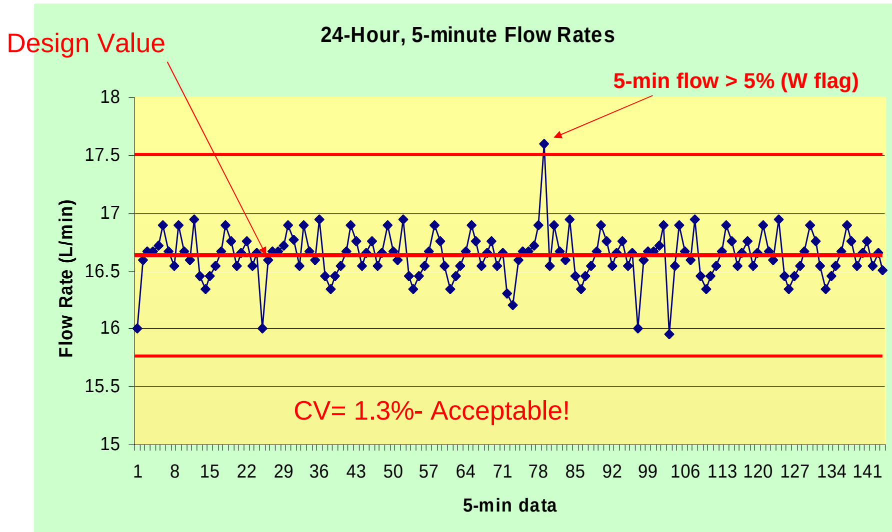
Automated Flow Rate Variability



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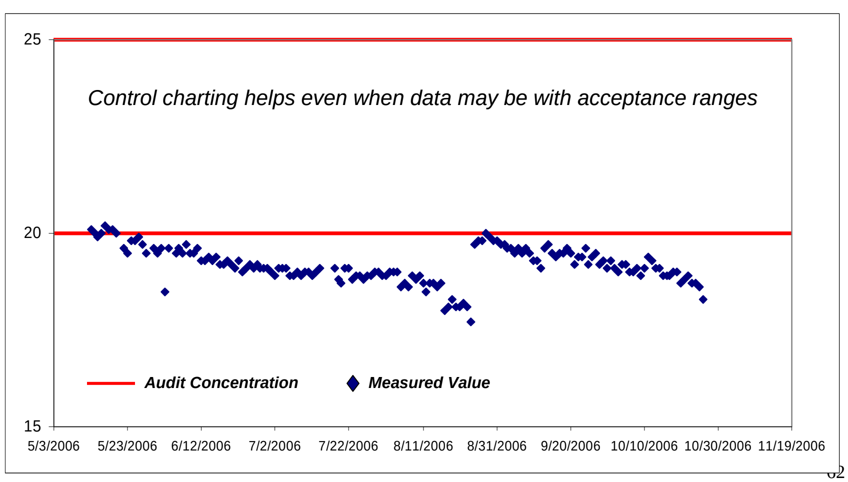
NO-API
One-Point QC Check



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More Control Charts

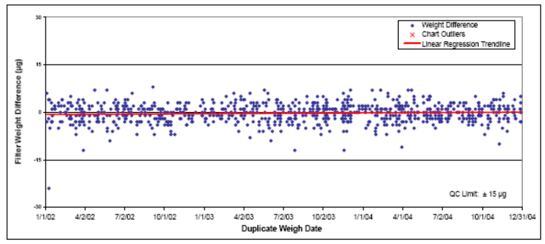
Control Charts can show:

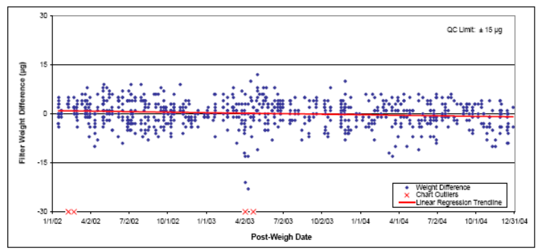
You are meeting your MQOs

Show you trends

Identify problem areas

Monitor completeness





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Parting Words...

There are many Quality Assurance tools to assess your networks precision, accuracy, and bias.

Many references are available for specific monitoring objectives.

You can collect QA data all day long, but if you don't use it, the most likely result will be poor biased data that is unusable.

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Don’t be “that guy”

(Its not ok even though the sampler is upwind)

Questions?

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