QA/QC Systems
Air Quality Measurements

Visit from

India, October 2002

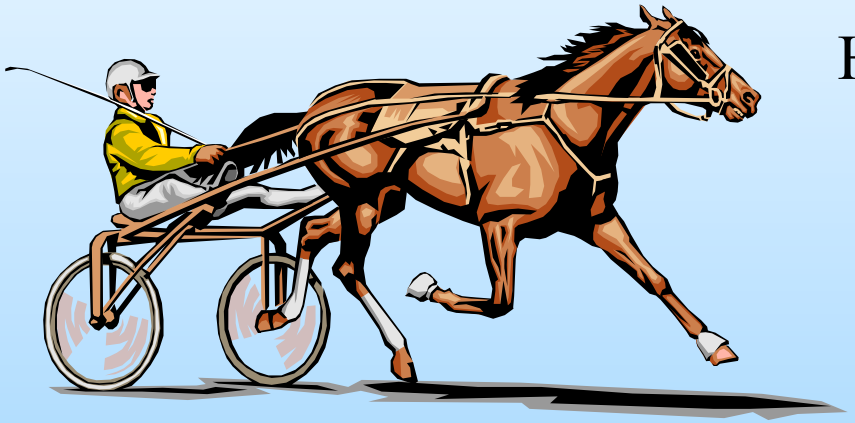
by

Leif Marsteen

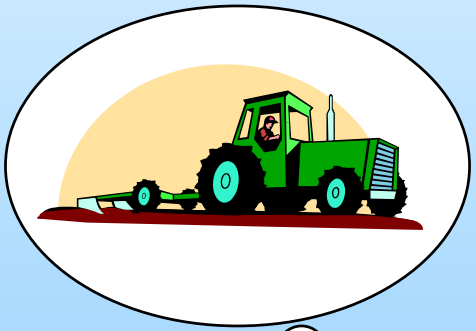
NILU

What is quality?

Depends on your needs



Horse racing - Speed



Farming
- Strength

Why QA/QC systems?

CONTRA

- Increased costs
- Conservative
  - Resisits changes
  - Too much to update
- Extra paper work
  - No time to do the job!
- Too many documents
  - Impossible to learn

Myths or reality?

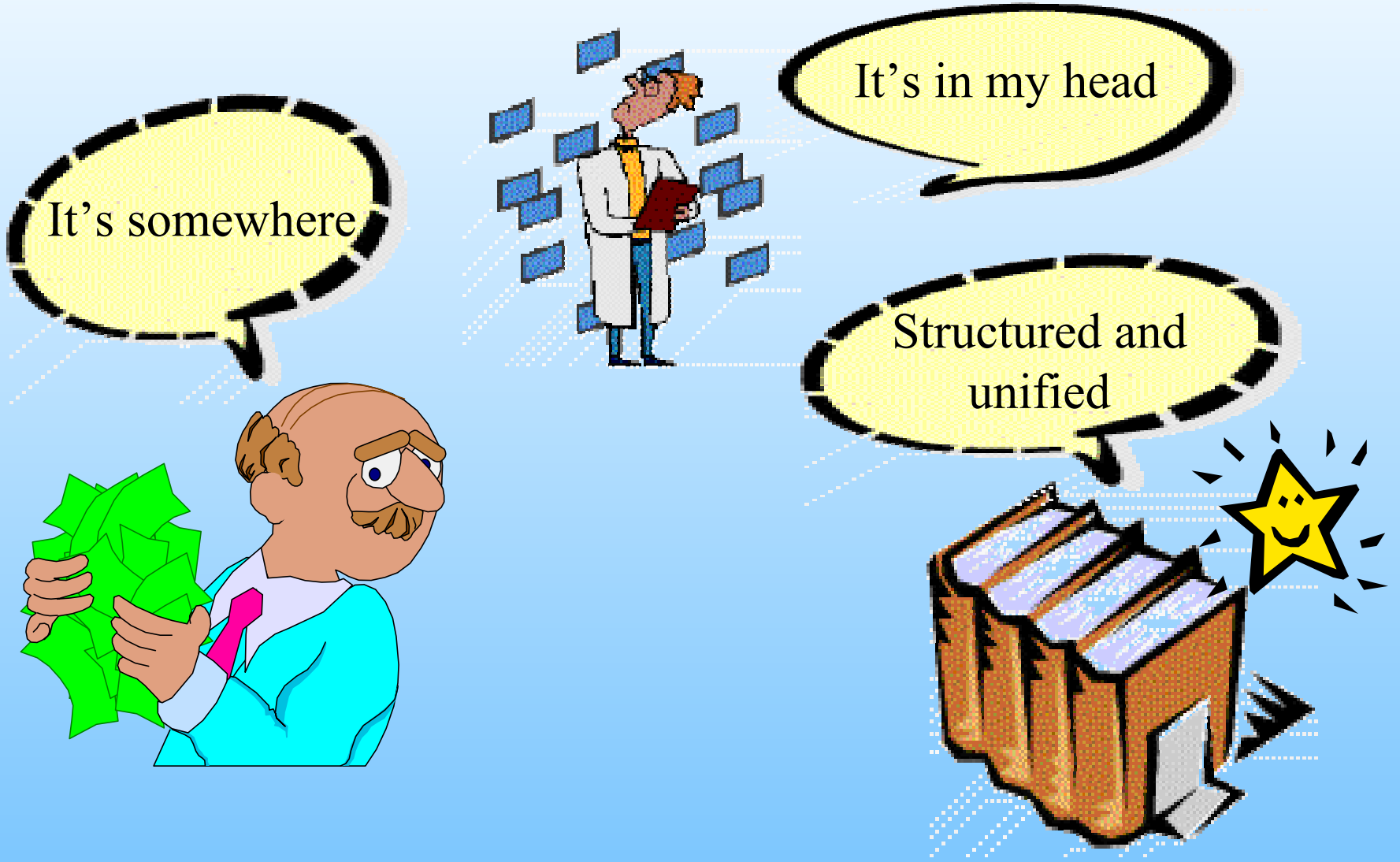
PRO

- Competitive edge
- Operations documented
- Results documented
- Easy training
  - Documentation exists

Reliable results with known quality

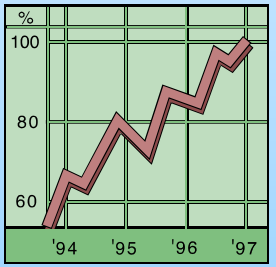
We want information not only numbers

Different levels of QA/QC

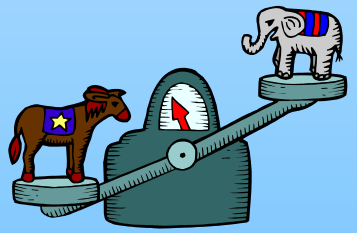


Elements of the quality system

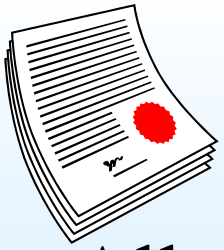
Quality Assurance



Quality Control



Quality Assessment



Quality Assurance

All planned and systematic activities which are needed to assure and demonstrate the predefined quality of data

1) Monitoring Objectives

Determine use of data, e.g. monitoring of trends

2) Data Quality Objectives

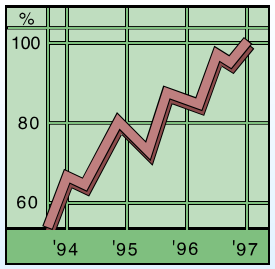
Determine necessary data quality to fulfil the Monitoring Objectives

3) Equipment selection

Results must fulfil the DQO. Select best measuring practice (surrogate DQOs)

4) Site selection

Must be representative for the Monitoring Objectives



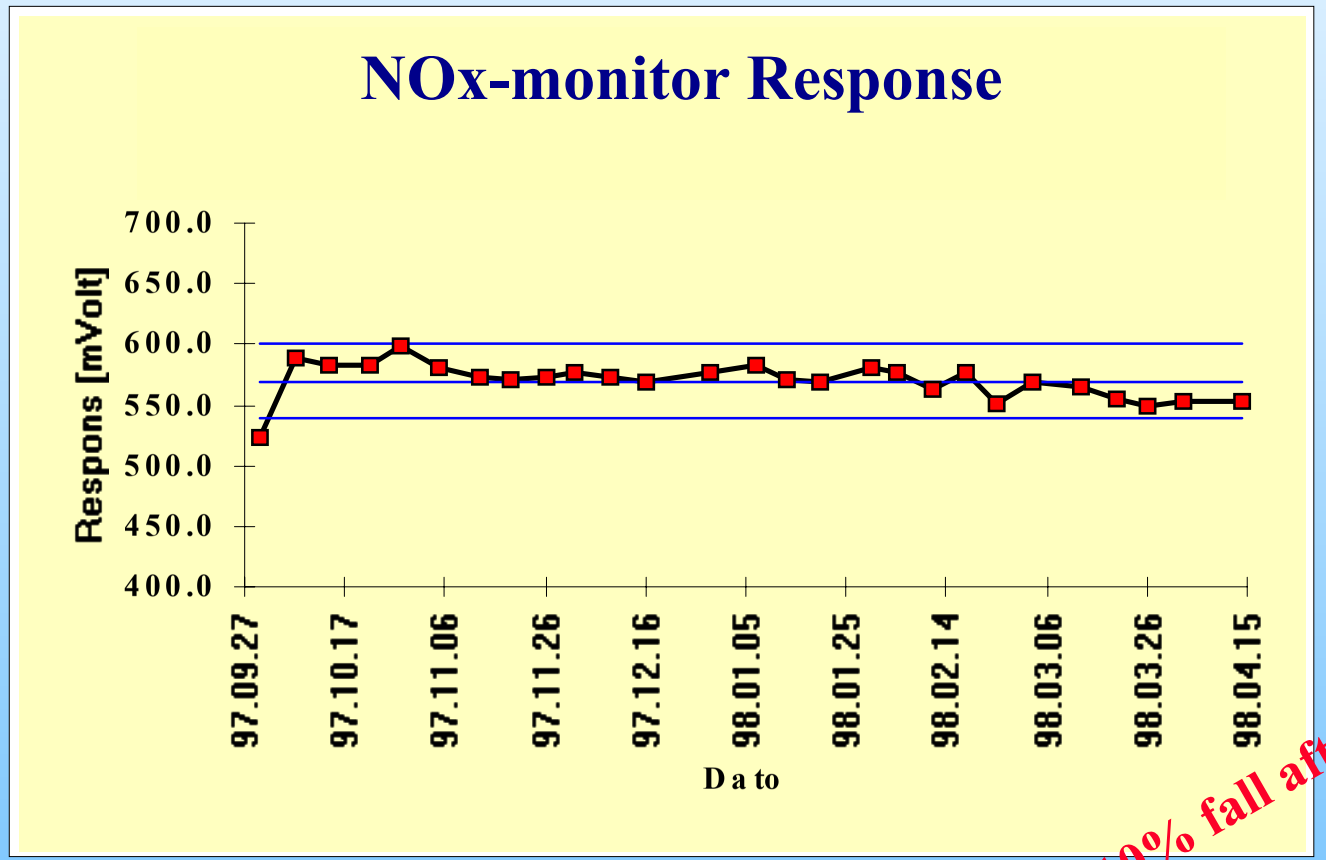
Quality Control

Operational techniques and activities that are undertaken to fulfil the quality requirements

- Calibration and maintenance plan
- Standard Operations Procedures (SOPs)
  - Describe how to perform and document all operations
  - Maintenance, calibration, repairs, data validation, e.t.c.
- All operations are documented in forms
- All forms are stored in files for later reference

The Necessity of Quality Control 1

Site : 1099 Kirkeveien Comp: NO



Øvre gr: 599.7

Middel: 569.4

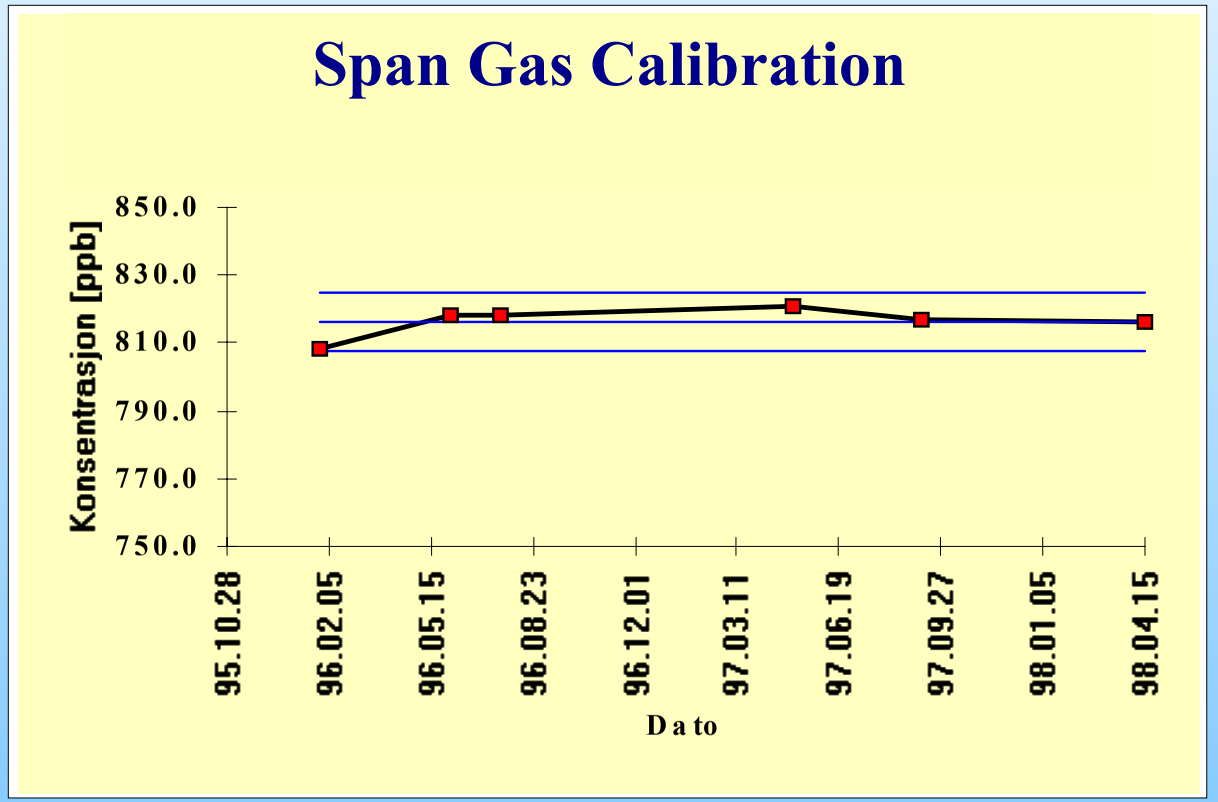
Nedre gr: 539.2

Gr. %: + - 5.3

10% fall after 7 months!

The Necessity of Quality Control 2

Bestemmelse av span gass **Comp: NO**



Øvre gr: 825.2

Middel: 816.3

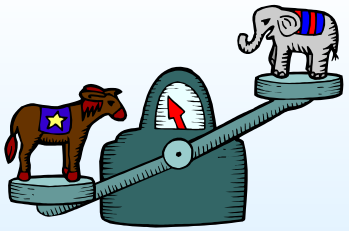
Nedre gr: 807.5

Gr. %: + - 1.1

Min: 808.0

Max: 821.0

Good stability after 2 years



Quality Assessment

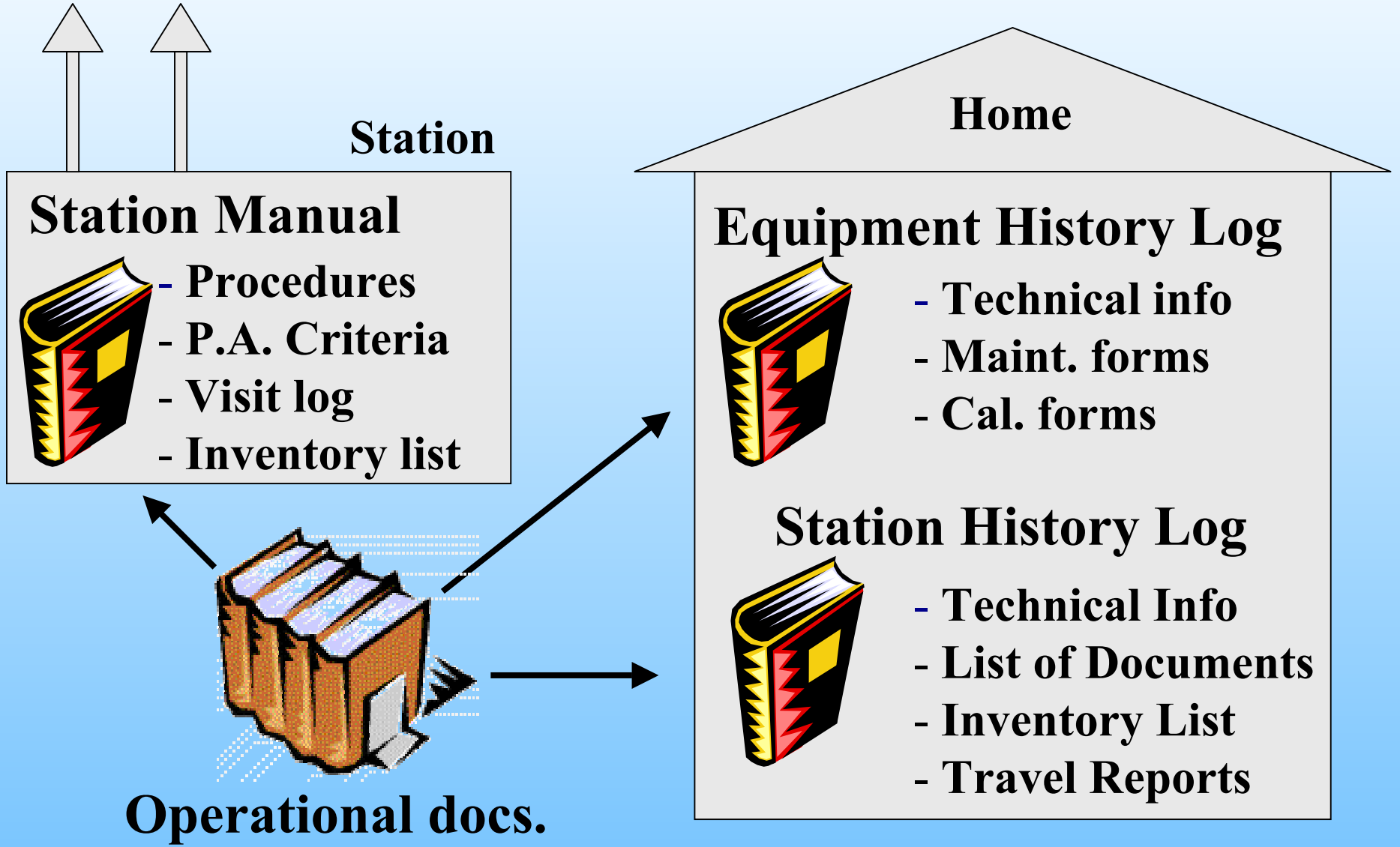
Determining the actual quality of the data and if the data fulfils the Data Quality Objectives

- Audits
  - **System Audit**: Inspection of QA/QC plan and documents
  - **Performance Audit**: Instrument response is checked at the station using a test standard
- International intercomparisons
  - Instruments measure a test standard in parallel
- Round robin tests
  - A test standard is measured at each laboratory

Quality Manual – Operational Part
Overview

1. Operator manuals used in the networks
2. Standard Operations Procedures (SOPs)
3. Performance Acceptance Criteria
4. Description of traceability and calibrations
5. Document handling

1. Manuals used in the networks



2. Standard Operations Procedures

- Operating instruments
- Quality Assessment
- Document Handling
- Method Validation
- Selecting a Site
- Data transmition and data validation

Calibration in the lab.
Calibration at the Site
Routine Maintenance
- 3 SOPs/instrument type

System Audit
Performance Audit
- 1 SOP/instrumenttype

Assemble documentation for a new instrument / site
Update quality docs.

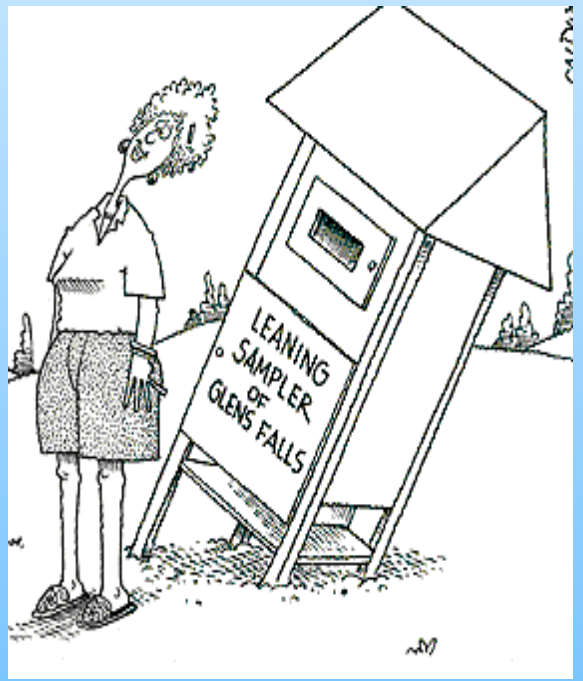
2.1. SOP - Operating instruments

Zero calibration of monitors

1. On the monitor press the **MENU** pushbutton to enter the monitor menu and select **CALIBRATION** using the arrow buttons. Press **ENTER** to enter the **CALIBRATION** menu.
2. Select **CALIBRATE ZERO** using the arrow buttons. Press **ENTER** to enter the **CALIBRATE ZERO** menu.
3. Press **ENTER** to calibrate the zero level. Wait 10 seconds then press **RUN** to return to the Run screen. The monitor is now zero level calibrated.

2.2. SOP - Method Validation

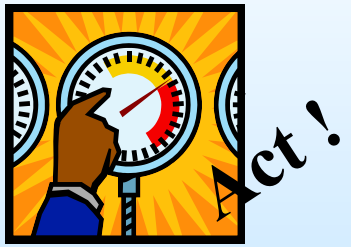
- Reference methods are defined in
  - EU's daughter directive, USEPA, other national EPAs
- European standards describe the measurement methods and procedures for testing alternative methods



?

Test procedure:
- EN12341

3. Performance acceptance criteria



Criteria for gas monitors

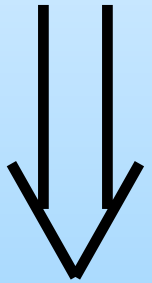
Monitor		Zero level		Span level	
Type	Range	Stability	Recalibrate	Stability	Recalibrate
SO2	1000 ppb	0 ± 2.0 ppb	-3 > Z > 5	± 2.0 %	± 15.0 %
NOx	1000 ppb	0 ± 2.0 ppb	-3 > Z > 5	± 2.0 %	± 15.0 %
CO	100 ppm	0 ± 0.2 ppm	-0.2 > Z > 1	± 2.0 %	± 15.0 %
HC	20 ppm	0 ± 0.1 ppm	-0.1>Z >0.5	± 2.0 %	± 15.0 %
O3	500 ppb	0 ± 2.0 ppb	-3 > Z > 5	± 2.0 %	± 15.0 %

- All operators assess the instruments using common criteria
- Criteria specific for each measurement method

4. Traceability and Calibrations

Not practical to carry advanced calibration equipment to all sites

Solution !

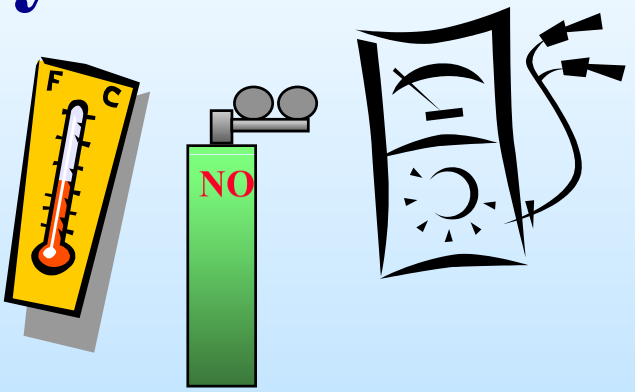


System of calibrations og documentation makes it possible for an instrument to have a reference to a calibration standard of high quality without being in direct contact with it

4.1. Traceability

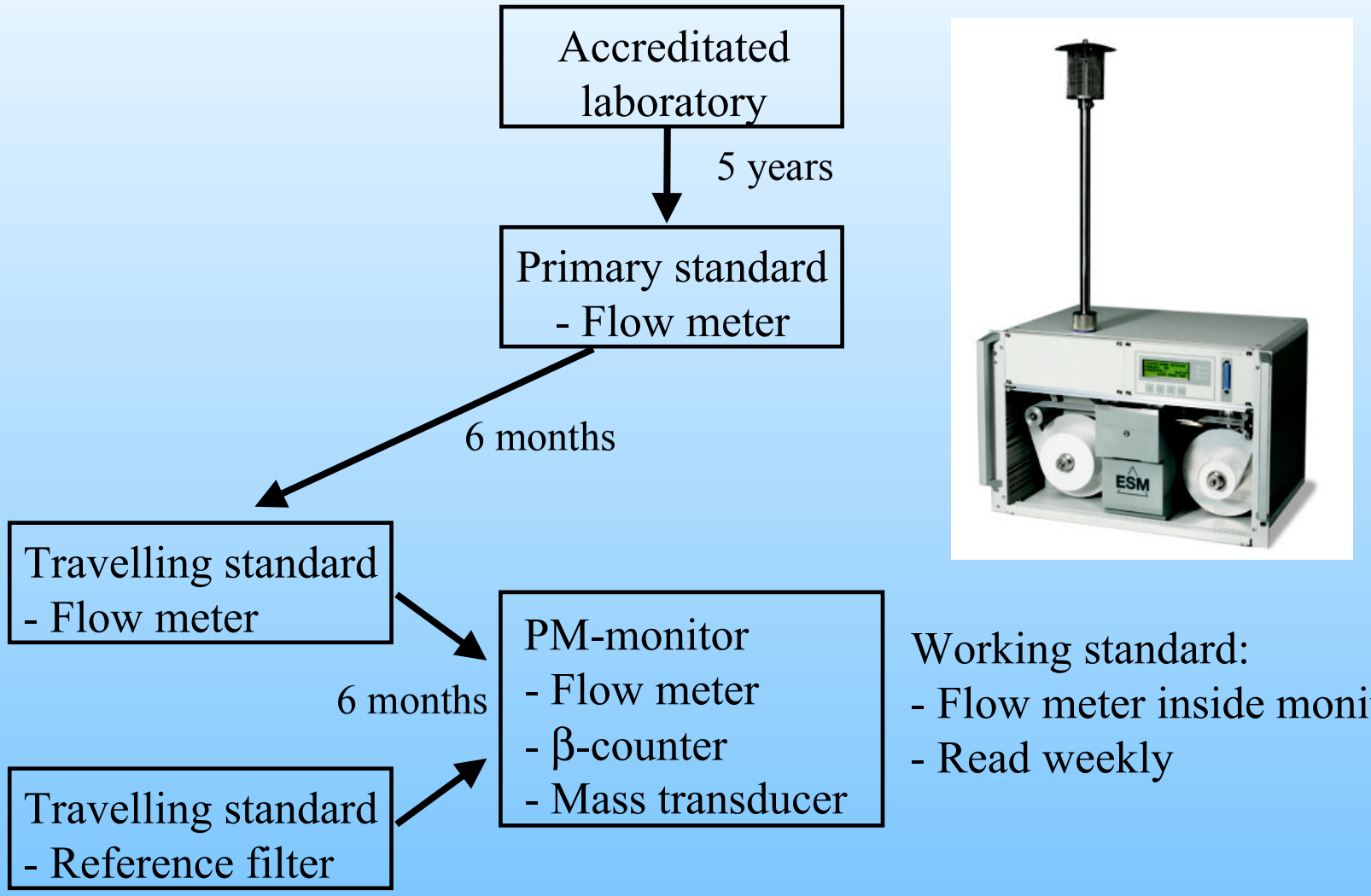
For each measurement method:

- Calibration methods
- Suggested calibraiton standards
- Time between calibration - Instruments and Standards



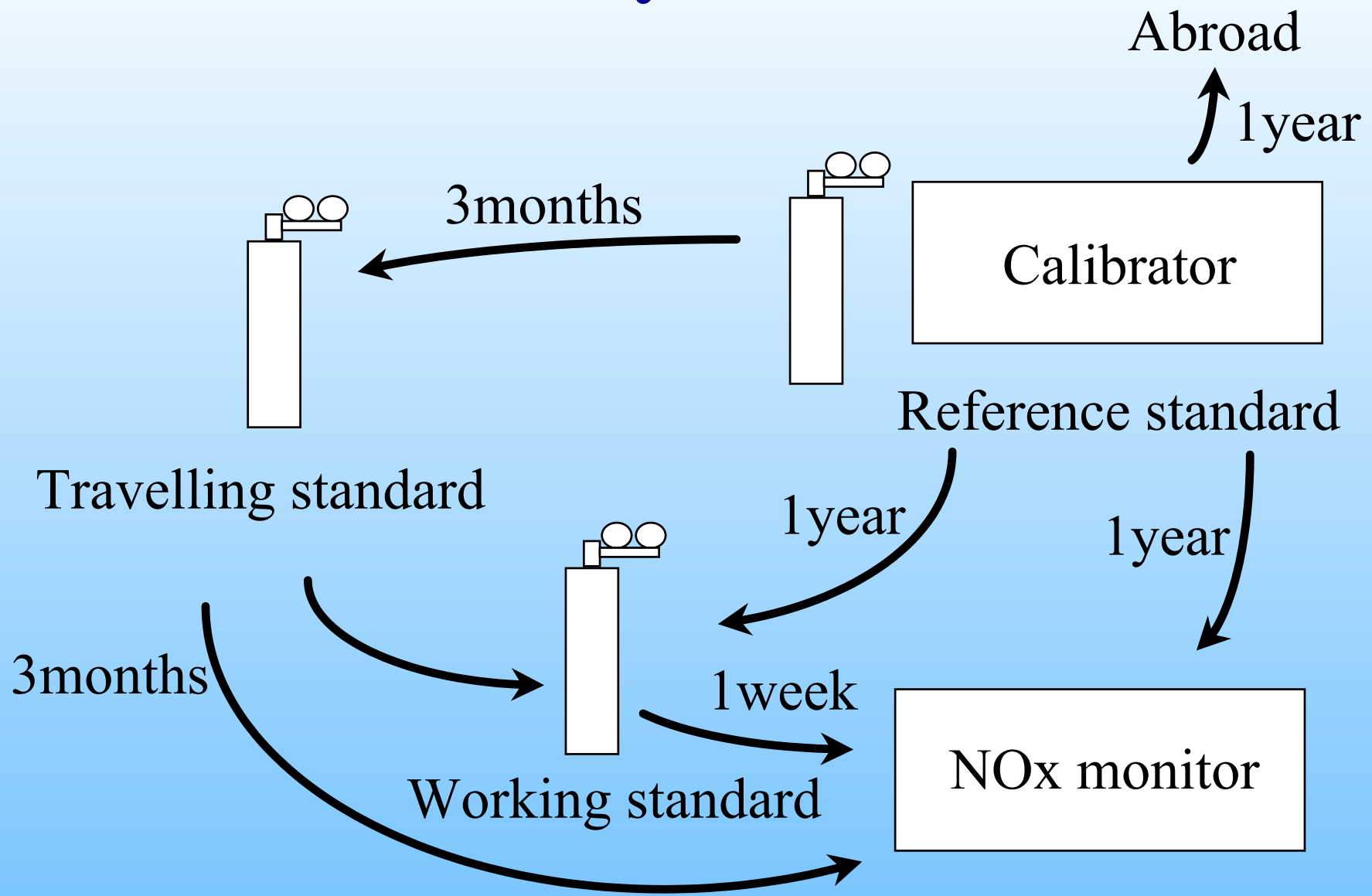
Calibration of PM-monitors	Suggested period	Reference std.
Flow-controllers (software)	6 months	Flow meter
Analog inputs and outputs	1-2 years	Multi meter
Flow-controllers (hardware)	1 years	Flow meter
Mass-transducer	1 years	Filter
Ambient temperature sensor	1 years	Thermometer
Barometric pressure sensor	1 years	Barometer

4.2. Traceability – PM-monitors

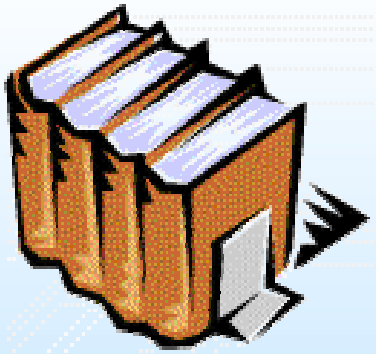


Working standard:
- Flow meter inside monitor
- Read weekly

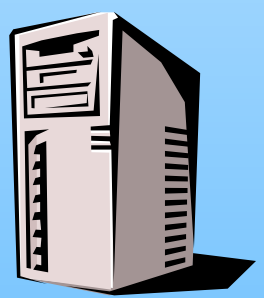
4.3. Traceability - Gas monitors



5. Document handling



- Version control
  - Assures all operators use the same document version
- List of all documents in the quality manual
  - Documents are copied from the manual as needed
- List of electronically stored documents
  - Excel sheets for calculating calibration results e.t.c.



Standard Operations Procedures
SOPs

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NILU

The Operational Level

The practical work

All what we do ⇒

- Daily tasks
  - Maintenance
  - Calibrations
  - Installations
- Laboratory work
- Field work

Documentation

All tasks:

- Described in Standard Operations Procedures - SOPs

Results:

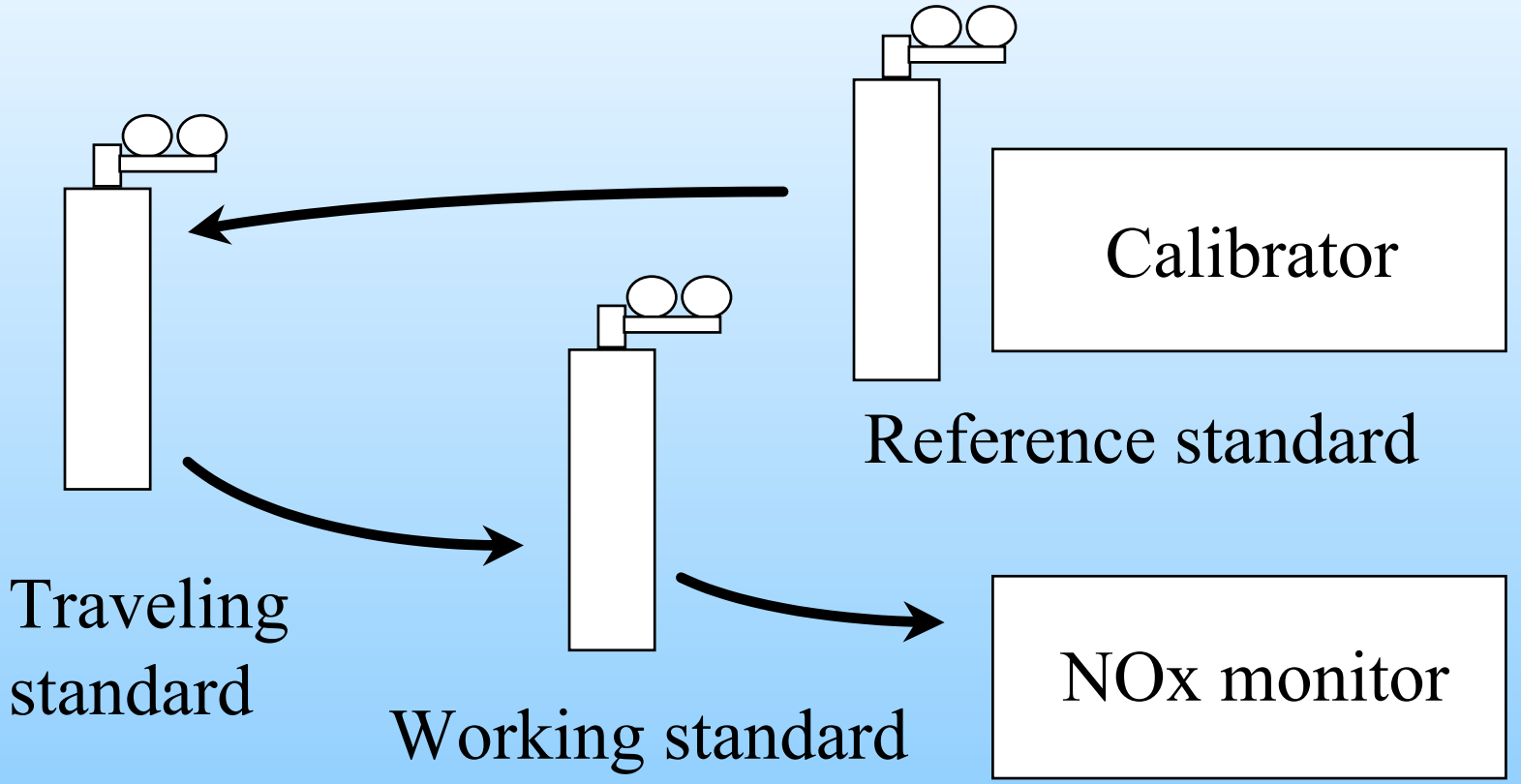
- Everybody performs tasks in the same way
- Repeatable
- Can compare results

- Documented in forms

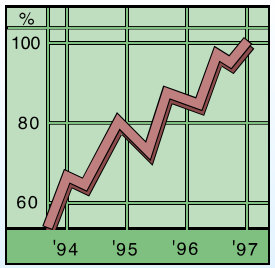
- Information is stored
- Can be reviewed later

Task example

Traceable chain of calibrations



→ Complicated - Procedure necessary and all steps must be documented



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Update quality docs.

SOP formats

- Purpose of SOP
- Applicability and description of equipment
- Responsibilities
- Instrumentation
- Documentation
- Procedure

Standard Operations Procedures

Example - Routine maintenance SO_2 monitor

- **Purpose of SOP**
  - To maintain the gas monitor in good working order.
- **Applicability and description of equipment**
  - This SOP applies to the maintenance of SO_2 gas monitors
- **Responsibilities**
  - Personnel performing routine maintenance on gas monitors shall use this procedure when performing the above mentioned task

Standard Operations Procedures

Example cont. - Routine maintenance SO_2 monitor

- **Instrumentation**
  - TEI 145 zero/ span check calibrator
  - TEI model 42C SO2 monitor
- **Documentation**
  - Form: Routine maintenance, TEI model 43C SO2 monitor
- **Instructions on performing the task**
  - The practical work

Standard Operations Procedures

Example cont. - Instructions

1. On the monitor press the **MENU** pushbutton to enter the monitor menu and select **CALIBRATION** using the arrow buttons. Press **ENTER** to enter the **CALIBRATION** menu.
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Form - Maintenance

Routine maintenance. TEI model 43C SO2 monitor

Station name		Station Id.	Instr. ser.no.		
	Date				
	Start time/ Stop time				
Ambient	Monitor	SO2			
Diagnostics	Volt	PMT			
		Lamp			
		+5 Supply			
		+15 Supply			
		-15 Supply			
		Battery			
	Temp	Internal			
		Chamber			
	Sample	Pressure			
		Flow			
	Lamp	Intensity			

Alarms	Temp	Internal		
		Chamber		
	Sample	Pressure		
		Flow		
	Lamp	Intensity		
		Volt		
	Conc.	SO2		
Filter		Changed		
Silica PT	Blue fract. / Changed			
Z/S check monitor	Z/S unit	Serial no.		
		Cert. conc.		
	Wrk. std.	Serial no.		
		Pressure		
	Response	Range		
		Zero		
		Span		

Form - Dynamic calibration

Guest			Reference		
Owner: Cairo U.	SO2		Cal. lab: Mon.lab.	Gas std: Scott, SO2, 1%	
Monitor: TEI 43C	Range:	ppb	Calibrator: TEI 146	Ser. no: ALM043897	
Ser. no:	Cal. bkg:	ppb	Ser. no: 57545-317	SO2: 101.06 ppm	
Date:	Cal. Cof:		Purpose:		

Parameter SO2

Zero air [LPM]	Gas [SCCM]	Ref. [ppb]	Guest [ppb]	G - R [ppb]	Statistics, y=ax+b	a	b
8.00	0.0	0.0	0.0	0.0	Scale f:	1.001	0.000
8.00	21.0	264.6	260.0	-4.6	Regression		
8.00	42.0	527.8	530.0	2.2	Scale f:	1.002	1.482
8.00	50.0	627.7	620.0	-7.7	St. error:	0.007	3.792
8.00	63.0	789.6	789.0	-0.6	St. error y estimate:		4.539
					r2:	0.99984