Department of Environment
Dhaka, Bangladesh

Norwegian Institute for
Air Research

Air Quality Management Project,
Dhaka, Bangladesh, 2006

Seminar on
Network Operation and QA/QC

Leif Marsteen

NILU: F 5/2006

NILU: F 5/2006
REFERENCE: O-105154
DATE: May 2006

Air Quality Management Project

Dhaka, Bangladesh, 2006

Seminar on network operation and QA/QC

Leif Marsteen

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Summary

This report includes four presentations held at DOE, Bangladesh, on 12 March 2006 for the AQMP project. The presentations covered the following subjects:

- Introduction to Monitoring Equipment
- Network operations
- Introduction to QA/QC systems
- The AQMP QA/QC system

The aim of the presentations was to open up to a discussion on the status and needs in the AQMP project regarding network operation and quality systems and to transfer knowledge in these areas to the AQMP staff.

Dhaka, Bangladesh, 2006
Seminar on network operation and QA/QC

1 Presentation: Introduction to Monitoring Equipment

The presentation looks at monitoring equipment. There are two main types, manual samplers and automatic monitors. Choice of type depends on use of data.

1.1 Samplers

Samplers are often preferred in background areas where the concentration levels are low. Samplers are also suitable when diurnal variations are not interesting, e.g. when looking at variations from one year to the next (trends). Typical sampling time is 24 hours and is always followed by chemical analysis in the laboratory.

Samplers are relatively cheap to buy but are labour intensive due to daily filter changes. Sequential samplers exist which allows for typically 14 days of unattended operation. The sampler switches filter automatically. In hot/humid areas the first exposed filter may change its contents after staying in the sampler for 13 days. Some sequential samplers come with a cooling system to preserve the exposed filters.

The passive sampler is an inexpensive device used for sampling of either NO_2, SO_2, O_3 or BTEX. It is the size of a coin and has no pump. The component of interest is collected on an impregnated filter. Typical sampling time is for 1 to 4 weeks depending upon ambient concentrations. The sampler can be used for regular measurements, detection of hot spots and for evaluation of possible measurement sites. In the latter case a number of samplers can be deployed in an area to get an estimate of the concentration levels. Based on the results the measurement sites can be decided.

1.2 Automatic monitors

Automatic monitors are used when detection of diurnal variations is important, the public shall be informed about concentration levels or to pinpoint pollution sources. In the latter case the measurements are usually combined with meteorology measurements in order to detect the source.

Data usually stored in an external data logger and automatic transferred to a data centre. Usually only one parameter per instrument can be measured. The monitors are expensive to buy and maintain and they are not easy to repair.

Automatic monitors can be found for many components, e.g. NO, NO_2, NO_x, SO_2, CO, O_3, HC and BTEX. Meteorological measurements are also done automatically. Components measured can be wind speed (horisontal and vertical), wind direction, temperature, relative humidity, barometric pressure and net radiation.

Gas monitors need to be calibrated regularly. This is accomplished by using a gas calibrator. The calibration unit consists of a zero air generator, one or more gas cylinders and a dilution unit. The zero air generator takes ambient air and produces air free from the pollution component(s). The zero air is mixed with the high concentration calibration gas in the dilution unit. When the user specifies a desired output gas concentration the dilution unit will adjust the zero air and gas flows rates to get the correct mixture. Typical calibration gases are NO, SO_2, CO, CH_4, C_3H_8 and BTEX.

2 Presentation: Network operations

The presentation looks at typical tasks that have to be performed when operating a measurement network.

Due to heavy loads and none routine site visits the shelter should have easy access and car parking nearby. The shelter should be protected against theft and damage, e.g. by a fence and door lock. It has to be air conditioned. A telephone line must be available for data communication. Inlets should be at least 1.5 m above rooftop to prevent collection of resuspended dust from roof. It should not be higher due to necessary cleaning. The inlets should have free sight to the pollution source, e.g. road. Trees and constructions close to shelter/ met. tower should be avoided. Take care when mounting the air condition. It should not influence the inlets.

Regular and preventive maintenance is important. No instruments will run without problems but periodic maintenance will prevent some of them. One should do weekly zero/span checks on gas monitors, change inlet filters as necessary, check status parameters, warnings and alarms and compare status parameters with previous checks. One should look for trends in both data and status parameters.

Regarding samplers it is important to have control of pre and post conditioning and weighing of filters, filter storage as well as the balance which should be checked regularly with certified masses. The $PM_{2.5}$ and PM_{10} inlets should be cleaned and the sampler's flow rate should be calibrated regularly.

3 Presentation: Introduction to QA/QC systems

The presentation looks at quality systems in general.

A quality system is necessary to produce reliable results. When a measurement network is operated according to a quality system all activities that may influence the quality of the final results are documented. Typically all operations are described in Standard Operations Procedures (SOPs) and results from routine activities are compiled in forms and stored for later reference. This results in a transparent system in which all activities and results from doing the measurements to presenting the final results are documented. Because all operations are documented it is also easy to train new personnel. The purpose is to get reliable results with known quality.

Quality depends on your needs. Before acquiring any instrumentation it is important to specify:

1. Monitoring Objectives: Why measure? What is the purpose, e.g. trends or daily information to the public.
2. Data Quality Objectives: Determine necessary data quality to fulfil the Monitoring Objectives. Detection of trends requires sensitive analysis while a high concentration alarm to the public requires only a rough measurement.
3. Equipment selection. Results must fulfil the DQO. Detection of trends may require a filter sampler with a sensitive post analysis while a high concentration alarm to the public requires an automatic monitor.
4. Site selection: Must be representative for the Monitoring Objectives, e.g. detection of trends is best accomplished in a remote area.

The quality system consists of three elements:

1. Quality Assurance: All planned and systematic activities which are needed to assure and demonstrate the predefined quality of data.
2. Quality Control: Operational techniques and activities that are undertaken to fulfil the quality requirements.
3. Quality Assessment: Determining the actual quality of the data and if the data fulfils the Data Quality Objectives

Quality assessment in usually performed by an external institution, e.g. an accreditation body or a reference lab. The accreditation body will audit the institution according to the requirements of the ISO/IEC17025 standard.

The European Union requires that each member state appoints a National Reference Laboratory for air quality (NRL). NRL will maintain the nation wide quality system, help other institutions in measurement network design, approve new measurement techniques, maintain the national reference calibration standards, provide traceability in calibrations to the network operators, maintain the central data base for air quality data and perform audits in the measurement networks.

In order to be able to compare measurements from different sites one must be sure that the instruments at all sites measure correctly. Correctly means that if we put the instruments side by side they will give the same results. This can be achieved only if the instruments have been exposed to and adjusted according to the same calibration standard. Because it is not practical to carry a common calibration standard from site to site a calibration standard, called a working standard, is installed at each site. The working standards are calibrated in the lab using a common reference calibration standard. So instead of using the same calibration standard at all sites one reference calibration standard is used to calibrate the working calibration standards used at each site. We now have a chain of calibrations making the calibration of the instruments at the sites traceable back to one common reference standard.

4 Presentation: The AQMP QA/QC system

The presentation looks at a proposed quality system for AQMP.

The framework of a complete quality system was prepared for AQMP. The system consists of a loose-leaf binder from which copies are made as necessary. The following document types are used in the network:

1. The Quality manual: The complete quality system documentation from which copies are made as necessary.
2. The Station manual: Includes SOPs and forms necessary at a particular station. The station manual is located at the station.
3. Station history log book: Includes remarks and observations about the shelter itself and forms covering results and observations from weekly site visits. There is one log book for each station. The history log book is located “at home”.
4. Instrument history log books: Includes remarks and observations about the instrument itself and forms covering results from calibration, maintenance, service and repairs. There is one log book for each instrument. The history log book is located “at home”.

SOPs will typically cover:

- Quality control at station (weekly)
- Operating instruments
- Data transmission and data validation
- Reporting
- Calibration of gas cylinders and analysers
- Quality Assessment

Appendix A

Slides: Introduction to Monitoring Equipment

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Introduction to Monitoring Equipment

Presentation at Seminar
AQMP, Dhaka, Bangladesh
12 March 2006

Leif Marsteen
NILU

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Purpose of presentation

Look at:

- The measurement station
- Air quality instrumentation

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Measurement station

Stand alone instruments
- No shelter required

Delicate instruments
- Shelter required

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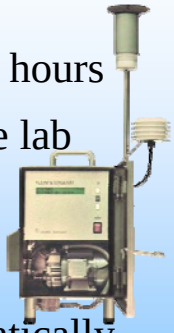
Air Quality Instrumentation

Two basic types:

- Manual samplers
- Automatic monitors

Air Quality Instrumentation
Manual samplers



- Samples air or particulates on a filter, 24 hours
- Multicomponent chemical analysis in the lab
- Relatively cheap to buy and maintain
- Labour intensive, daily filter change
- Sequential sampler changes filter automatically
  - 14 days maintenance period
- Passive sampler, 2 – 4 weeks exposure

Manual Samplers
When to use

- Detect several components
  - Chemical analysis
- Components can not be detected by monitors
  - No detection method
  - Low concentrations
- Trend analysis
  - Modest diurnal variation
  - Detect long term changes
  - Typical at background sites

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Air Quality Instrumentation

Automatic Monitors

- Continous analysis at the site
- Local or remote sensing techniques
- Data usually stored in an external data logger
- Automatic data transfer to center
- Usually only one parameter per instrument
- Expensive to buy
- Expensive to maintain
- Not easy to repair

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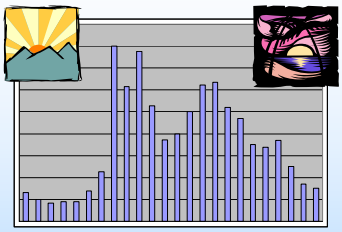
Automatic Monitors

When to use



- Document diurnal variations
  - Rush hours, human activity
- Pinpoint pollution sources
  - Together with wind speed/direction/stability
- Air pollution information/warning to the public
  - Radio, TV, Internet, SMS

Requires high time resolution
Usually 1 hour or 30 minutes

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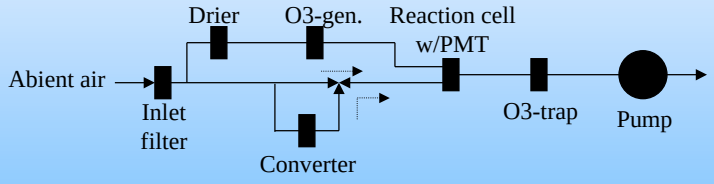
NOx-monitor – Measurement principle

- The monitor measures only NO
  - NO_2 is converted to NO i a hot molybden converter
- NO reacts with O_3 emitting light which is measured
  - A generator produces O_3 from dried ambient air



O3-gen.	: O_2 + UV –> O_3
Converter	: NO_2 –> NO
Reaction cell	: NO + O_3 –> NO_2 + light

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NOx-monitor – Error symptoms

- No response (always measuring zero):
  - Broken O_3-generator. Cold generator - Broken
- NO_2 always zero (NO_x equals NO > zero):
  - Broken converter. Cold converter - Broken
  - Leak in valve. No “click” every 5 sec. – Broken
- Low response:
  - Dirt buildup in reaction chamber, tubes, …
  - Worn pump

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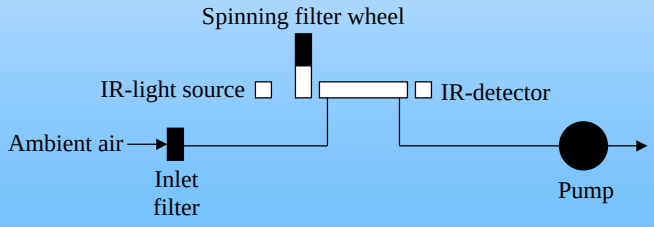
CO-monitor – Measurement principle

- Test sample is iluminated with infra red light
- An IR detector measures light not absorbed by CO
- A split filter wheel is filled with CO and N_2 respectively
  - CO-part absorbs all light. No light absorbed by ambient CO
  - N_2-part absorbs no light. Light absorbed by ambient CO
  - Difference in measured light is proportional to CO concentration



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CO-monitor – Error symptoms

- Unstable or noisy measurements:
  - Leak
  - Weak IR-source
- Elevated zero level, rising trend:
  - Leak in filter wheel, broken reference

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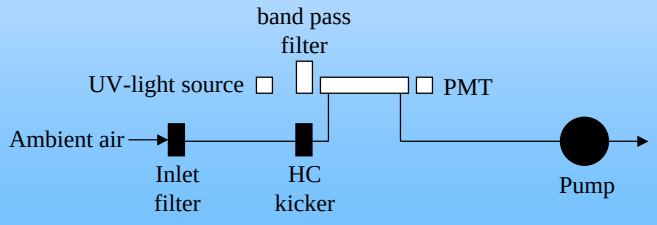
SO_2-monitor – Measurement principle

- Test sample is iluminated with UV light
- SO_2 molecules are excited and emits fluorescent light
- The fluorescent signal is measured by a photomultiplier tube (PMT)



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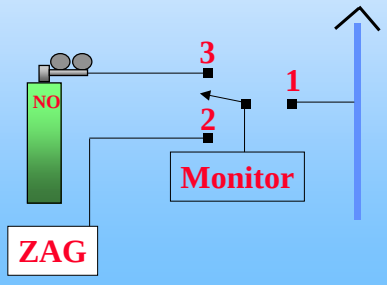
Zero/span check equipment - Simple

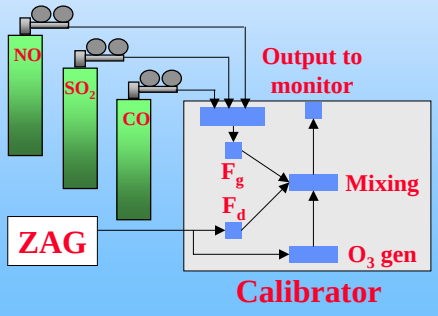
- Zero/span checks are performed to:
  - Verify instrument response
  - Calculate scale factors for adjustment of measurement data
- ”Normal” concentration gas cylinders
- Zero air generator



Monitor connected to:
1. **Inlet – normal operation**
2. **ZAG – Check zero level**
3. **Gas – Check span level**

Zero/span equipment - Calibrator

- High concentration reference gas cylinders
- Zero air generator
- Dynamic calibrator
- Gas monitors



$$OGC = C_{cyl} * \frac{F_g}{F_g + F_d}$$

OGC = Output Gas Concentration
C_{cyl} = Gas Cylinder Concentration
F_g = Gas flow rate
F_d = Dilution air flow rate

C_{cyl} is preprogrammed into the calibrator
We only have to ask for an OGC

THE END

Appendix B

Slides: Network operations

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Network operations

Presentation at Seminar
AQMP, Dhaka, Bangladesh
12 March 2006

Leif Marsteen
NILU

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Shelter requirements

- Easy access
  - Inspections, repairs - ’24 hours’
  - Heavy loads - Car parking nearby
- Protection against
  - Theft and damage
  - Sunshine - No windows
  - Outdoor environment - Air conditioned
- Data communication line
- Benches or racks for instruments, a chair
- No smoking, clean workplace

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Shelter Surroundings

- Inlets approx 1.5 m above rooftop
  - High: Prevents resuspension of dust from roof
  - Low: Easy access during cleaning
- Free sight to the pollution source, e.g. road
- Avoid:
  - Trees and constructions close to shelter/ met. tower
  - Dusty ground - resuspension (PM10)
  - Vent outlets, e.g. air cond. (gases)

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Conditions affecting instruments

- Indoor temperature and humidity
  - Never leave door open during site visits
- Dirt buildup in tubes, valves, inlets, manifold
- Saturation of scrubbers, converters, filters
- Clogged filters, valves, junctions, orifices
- Leaks in junctions, O-rings, valves
- Aging pump

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Maintenance

Valid data requires maintained instruments

- Change consumables regularly
- Clean air inlets and manifolds
- Clean outdoor sensors and inlets
- Check instrument status
- Maintain air condition
- Keep station tidy
- Look at data every day

No instruments will run without problems but periodic maintenance will prevent some of them

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Basic checks and maintenance

- Gas monitors:
  - Weekly zero/span checks
  - Change inlet filters as necessary
- PM monitors:
  - Change filter tape approx. 1 per year
- All:
  - Check status parameters, warnings, alarms
  - Compare paramteres with previous checks
  - Look for trends

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Checking instruments from home
Look at data every morning

- Constant levels, e.g. many hours of zeros?
- Spikes, sudden drops, values below zero?
- Rising zero level?
- Values never close to zero at night?
- Unstable or noisy values?
- Values not as expected for particular station?
- Compare neighbouring stations, same trend?

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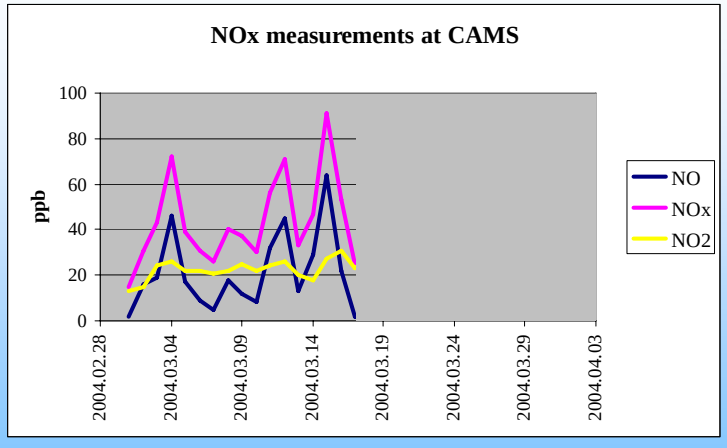
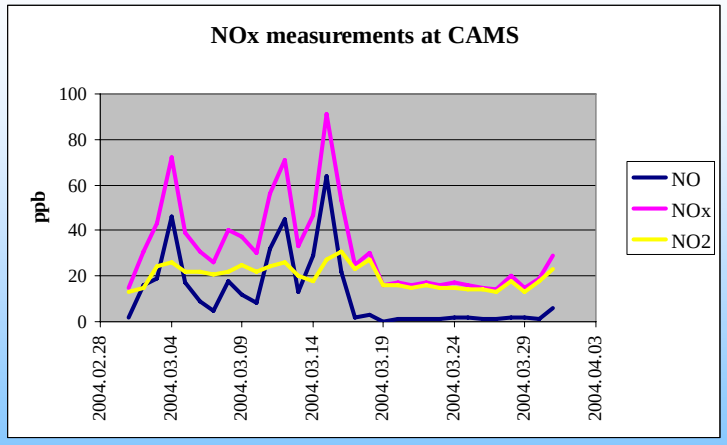
Inspection of trends 1



Normal sequence

NO2 should maby go down to zero at night?

Inspection of trends 2



What happens on March 17?

Was it investigated?

Data invalidation

- In analyser: $NO_2 = NO_x - NO$ (NO_2 is computed)
- If NO or NO_x is invalid, NO, NOx and NO_2 will be invalid

Site Name :

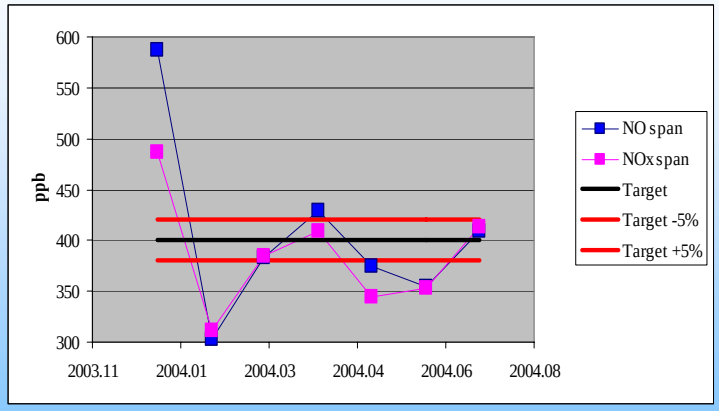
Continuous Air Monitoring Station
Sangsad Bhaban

Contact Tel. (+88) 02-9137304

Day	NO ppb	NO2 ppb	NOx ppb
01 (Mon)	-	37.4	155.0
02 (Tue)	-	40.8	134.6
03 (Wed)	-	46.8	279.2
04 (Thu)	-	53.4	222.7
05 (Fri)	-	48.2	134.9
06 (Sat)	-	59.7	235.5
07 (Sun)	-	67.1	160.8
08 (Mon)	-	53.2	287.8
09 (Tue)	-	46.1	230.5
10 (Wed)	143.4	52.5	188.3
11 (Thu)	80.4	51.6	132.0
12 (Fri)	177.8	44.8	229.3
13 (Sat)	143.6	49.4	185.5
14 (Sun)	224.6	61.1	273.6
15 (Mon)	-	70.1	149.4
16 (Tue)	-	53.3	90.1
17 (Wed)	33.4	63.7	111.5
18 (Thu)	28.4	50.8	79.2
19 (Fri)	15.3	33.4	46.9
20 (Sat)	41.6	44.8	86.5
21 (Sun)	23.7	31.7	55.3

Control charts and Zero/Span checks

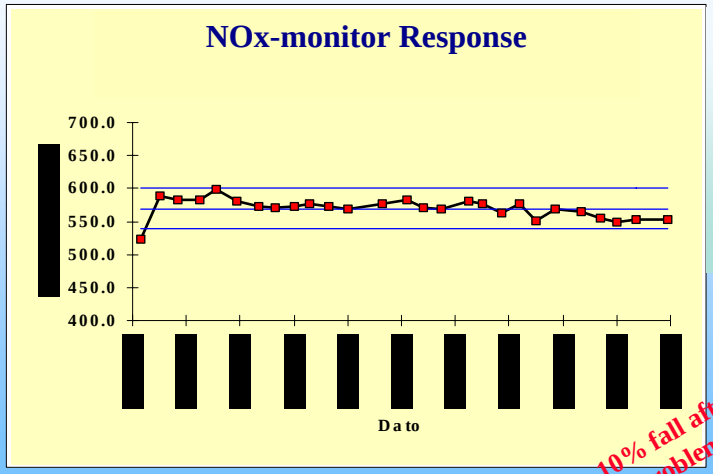
NOx analyser at CAMS



- Analyser not stable before reading?
- Wait at least 15 minutes to stabilise

Control chart – Normal response

Site : 1099 Kirkeveien Comp: NO



Reference: 569 ppb
Action limits: +- 5%

10% fall after 7 months!
No problem – We know it!

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QA/QC of samplers

- Proper filter handling
  - Preconditioning and weighing
  - At site
  - Postconditioning and weighing
  - Filter storage
- Control of balance
  - Check balance with certified masses
- Clean $PM_{2.5}$ and PM_{10} inlets regularely
- Calibrate flow rates regularely

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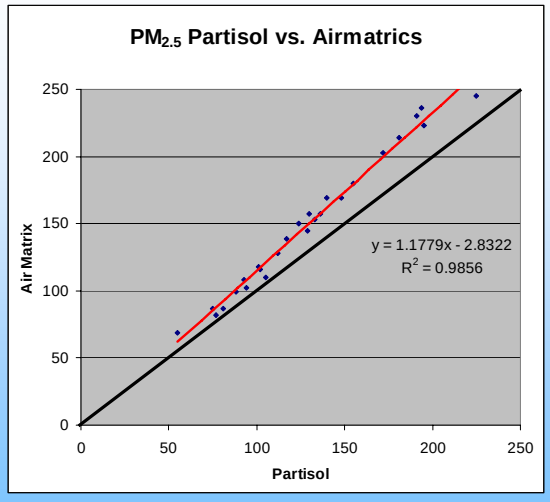
PM intercomparison



Results indicate good control in PM measurements

Appendix C

Slides: Introduction to QA/QC systems

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Introduction to QA/QC systems

Presentation at Seminar
AQMP, Dhaka, Bangladesh
12 March 2006

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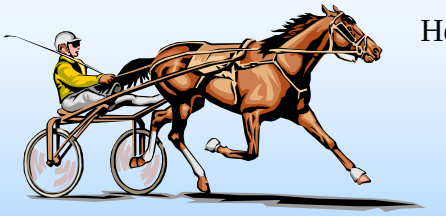
What is quality?

It 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?

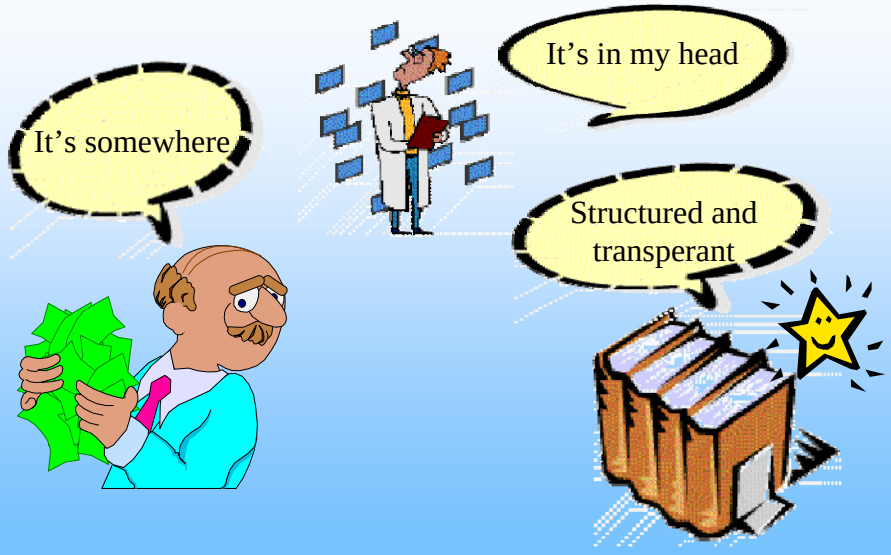
PRO

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

Reliable results with known quality

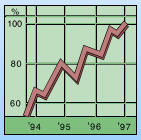
We want information not only numbers

Different levels of QA/QC

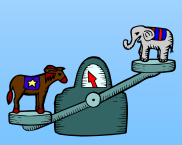


Elements of the quality system

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

Example: Designing a measurement program

1) Monitoring Objectives

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

2) Data Quality Objectives

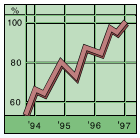
Determine necessary data quality to fulfil the Monitoring Objectives

3) Equipment selection

Results must fulfil the DQO. Select best measuring practice

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

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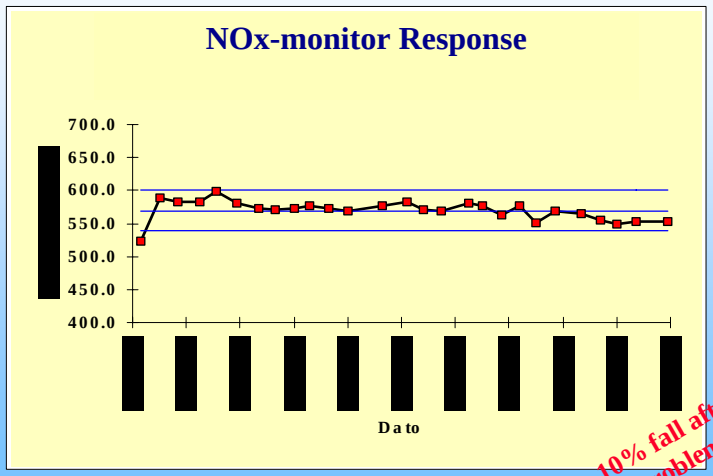
The Necessity for Quality Control

Site : 1099 Kirkeveien Comp: NO



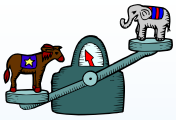
Øvre gr: 599.7

Middel: 569.4

Nedre gr: 539.2

Gr. %: + - 5.3

10% fall after 7 months!
No problem – We know it!



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

Accreditation

- According to ISO/IEC17025 (revised ISO 25)
- Describes Good Laboratory Practice in general
  - Documented QA/QC system
  - Measurement methods, reporting, complaints, audits, traceability, calibration, uncertainties, doc. control
- Controlled by an external auditer annually
  - E.g. The U.K. Accrediation body (UKAS)
  - According to international standards (ISO 17025)
  - Customer pays all expenses

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The Reference laboratory
Tasks and Responsibilities

- Maintaining the quality system
- Measurment network design
- Instrument approval
- Calibrating instruments
- Maintaining national reference standards
- Providing traceability
- Maintaining the central data base
- Audits, once a year

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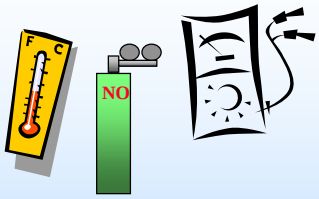
Traceability and Calibrations

Not practical to carry advanced calibration equipment to all sites

Solution ! ⇓

System of calibrations and 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

Traceability



For each measurement method:

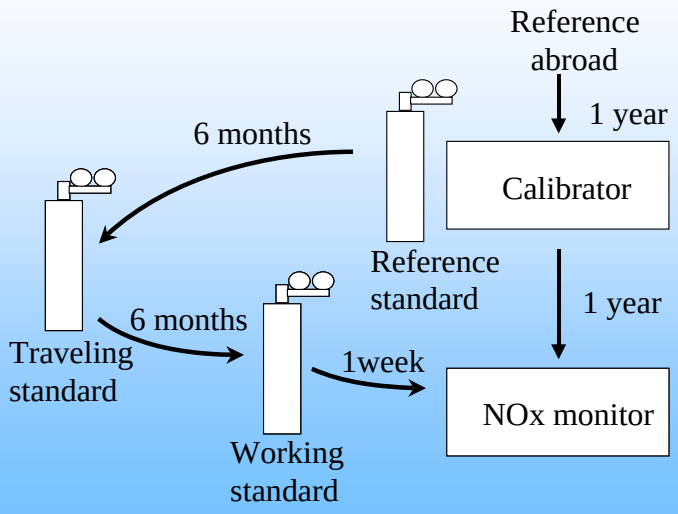
- Description of calibration methods
- Suggested calibration standards
- Time between calibration - Instruments and Standards

Example: Thermometer calibration

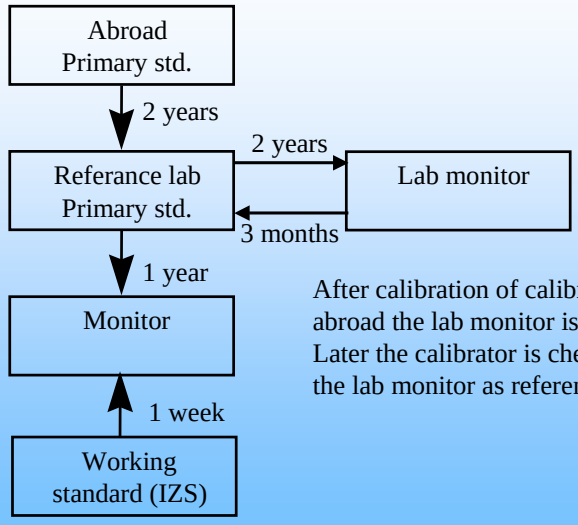
- Dip it into an ice/water solution
- Does it read zero?
- If not adjust the scale until it does

This is called an offset or zero level calibration

Traceability - Gas monitors



Traceability – O_3 monitors



After calibration of calibrator abroad the lab monitor is calibrated. Later the calibrator is checked using the lab monitor as reference

The End

Appendix D

Slides: The AQMP QA/QC system

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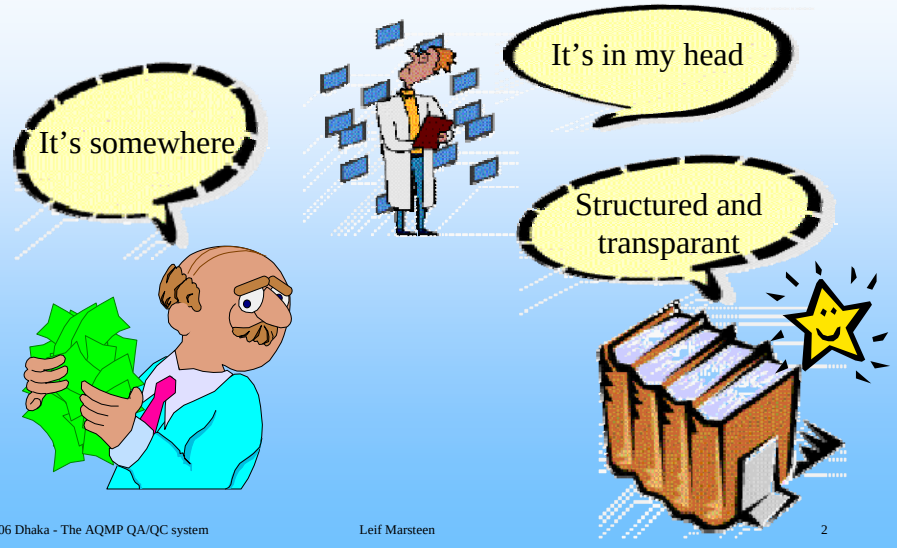
The AQMP QA/QC system

Presentation at Seminar
AQMP, Dhaka, Bangladesh
12 March 2006

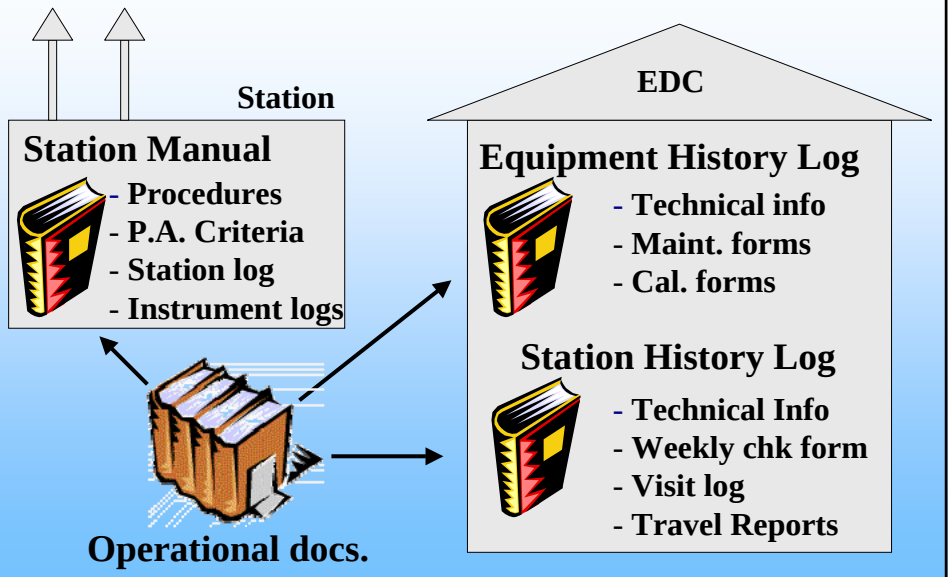
Leif Marsteen
NILU

Norwegian Institute for Air Research www.nilu.no

Remember the different levels of QA/QC systems?



Manuals used in the network



Contents of Quality Manual

Introduction
Quality Manual quick reference
Organisation and responsibilities
Routine work done checklist
Reference laboratory and traceability
Task schedules
SOPs on:
- QC at stations, QC at EDC, SO2, NOx, CO, O3, PM analysers
- Calibrations, Station audits

Log books
Titles

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Documentation at station

- Station manual
  - SOPs specific for station
    - Quality control procedures at monitoring station
    - Operation of NN analyzer
    - Installing a gas cylinder
  - Empty travel reports

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Standard Operations Procedures

SOPs on:

- Quality control at station (weekly)
- Operating instruments
- Data transmition and data validation
- Reporting
- Calibration of gas cylinders and analyzers
- Quality Assessment

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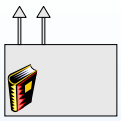
SOPs at monitoring station



1. Quality control procedures at monitoring station
   - One common procedure and form for all analyzers
   - Used during routine visits
   - Form: Weekly station check form
2. Operation of NN analyzer (for each analyzer)
   - Details about specific analyzers on troubleshooting and two point calibration
   - Form: Two point calibration - NN analyzer
3. Installing a gas cylinder
   - Instructions and safety mesaures on handling gas cylinders

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Documentation at station

Still missing

- SOPs for operation of samplers
- SOPs for flow rate calibration of samplers
- Fine tune SOPs to new station in Chittagong

AQMP should develop this

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What to do during routine site visits

1. Before visit consult Task schedule and To do-list
   - Time for preventive maintenance or calibrations?
   - Other things to remember, filters, scrubbers, e.t.c?
2. At site perform routine work according to SOP Quality control procedures at monitoring station
   - Fill in Weekly station check form
   - Fill in station and analyser log books
3. If necessesary troubleshoot analyser using SOP Operation of NN analyser
4. Bring back to DoE the Weekly station check form
5. Bring back to DoE exposed filters

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Task schedules

One schedule for each type of analyzer

MAINTENANCE SCHEDULE FOR PM MONITOR ESM EBERLINE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Maitenance interval
Filter tape													Every week. Change if necessary
PM impactor and inlet													Every 2 months. Clean
Mass sensor													Every 12 months
Pump													Every 12 months. Replace membrane

Actions done every 12 months are normally performed in the lab during yearly maintenance and calibration

The Weekly station check form

Weekly station check form

STATION name:	Date of visit to station:	Time of visit:	Person conducting check:

Station exterior	Checked?	**Air intake manifold**	Inspected?
	Damage found?		Cleaned?
Station interior	Checked?	**API zero air generator**	Pressure?
	Cleaned?		Air inlet particle filter inspected?
Air conditioner	Inspected?		Air inlet particle filter replaced?
	Cleaned?	**Air intake teflon lines for API analysers**	Inspected?
			Cleaned/replaced?

Instrument	API100 SO_2	API200 NO_x	API300 CO	API400 O_3	ESM PM10
RED fault light flashing?					
Warning message? (Recorded in logbook too)					
Observed test value for warning parameter?					
Warning message cleared?					
Zero check reading after stable signal (20 min.)					
Span check reading after stable signal (20 min.)					
Zero and span response witin action limits?					
Gas cylinder pressure					
Gas cylinder closed?					
Sample tube connected to sample inlet again?					
Analyser sample flow before filter change? (ml/min)					
Analyser particle filters changed?					
Analyser sample flow after filter change? (ml/min)					
Box temperature? (°C)					
Instrument surfaces cleaned?					
ESM Status LED warning?					
Status code					
Error code (messages in Comments box)					
PM10 sampling head cleaned?					

Comments-

What to do upon return to DoE after routine site visits

1. Copy from Weekly station check form to:
   - Weekly report form (one form for all stations)
     - Status on analyzers
   - Station visit and history log book
     - Reason for visit, maintenance on shelter, air cond. ..
   - Equipment history log books
     - Work done on analyzers, calibration, troubleshooting
2. Hand over exposed filters to filter analyst
3. Fill in To do-list for next visit
4. Hand over Weekly report form to manager
5. Enter zero/span results into Excel sheet and validate

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The Weekly report form

	DOSTE	TSH	TD	HB	ZOO	QT	D2	TN	BC
SO_2				X	X				X
NOx									
CO			X		X	X	X		
O_3			X					X	X
PM10			X	X					
Power									
Tel									
Trans Data									
Other devices									
Comment									

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STATION VISIT AND HISTORY LOG - BOOK

Station:	Station Id:

CONTENTS:

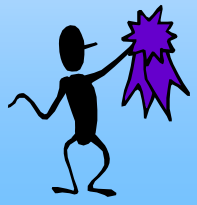
EQUIPMENT HISTORY LOG - BOOK

Instrument:	Serial no:

CONTENTS:	Section
EQUIPMENT DATA SHEET	1
EQUIPMENT HISTORY LOG	2
MAINTENANCE AND CALIBRATION SHEETS	3
CALIBRATION CERTIFICATES	4

Just to repeat

- Consult Task schedule and To do-list before site visit
- At site perform SOP and fill in Weekly station check form
- Bring Weekly station check form back to DoE
- Upon return to DoE copy information from form to
  - Weekly report form
  - Station visit and history log book
  - Equipment history log books
- Hand over exposed filters to filter analyst
- Fill in To do-list for next visit
- Hand over Weekly report form to manager



Scheduled operation of gas analyzers

- Every week: Routine maintenance
- Every 3 months: Calibration of HiVol at site
- Every 6 months: Calibration of gas analyzer and working standard and LoVol at site
- Every year: Service and calibration in lab

MAINTENANCE SCHEDULE FOR GAS ANALYZER M100A SO2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Maitenance interval
Inlet filter													Every 2 weeks. Change if necessary
Monitor sensitivity													Every 6 months. Adjust monitor at station using travelling std.
Linearity test													Every 12 months. Also two point calibration and adjustment

Yearly service and calibration in lab

Tasks

1. Perform linearity test to document instrument status after measurement period
2. Clean tubes, junctions, reaction cell, e.t.c.
3. Change spare parts
4. Perform two point calibration, adjust zero and span, perform linearity test
5. Calibrate working standard gas cylinder

Yearly service and calibration in lab

Analyzer calibration SOP

- SOP: Two point calibration and linearity test of a gas analyzer
- Form: Two point calibration and linearity test of NN analyzer
- Form: Dynamic calibration NN monitor
  - Excel sheet for calculation of linear regression
- Store forms in analyzer history log book

Weekly work follow up

Week:					Done				
Task	Dost e	Hong Bang	Thu duc	Tan Son Hoa	Thong Nhat	Binh Chanh	Zoo	Distr ict 2	Quang Trung
Site visit									
Update instrument history log books									
Update station history and visit log book									
Fill in weekly report									
Enter zero/span check results into AirQuis									
Evaluate zero/span check results									
Evaluate last week of data									

Quality assessment / System audit

- Inspection of QA/QC plan and documents
- Check to see if
  - The quality system is used as supposed
  - Procedures are followed
  - Results are documented and stored
  - Station and instruments are in working order

Quick reference guide to Quality system

Activity	Quality manual reference
Check of instrument performance during site visit	SOP on instrument operation, Section 7
Quality control at EDC	Section 8
Reporting	Section 9
Maintenance and calibrations	Section 6, 15
Service, calibration and linearity test	SOP on instrument operation, Section 15
Internal audit of standard operation procedures	Section 16
Calibration of gas cylinders in lab	Section 15
When to do what (task schedule)	Section 6
Troubleshooting	SOP on instrument operation, Section 7
Log books	Section 17
Routine work checklist - work done	Section 4

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Summary

- Follow procedures
- Do preventive maintenance
- Document work
- Store forms imediately
- Look for errors
- Report irregularities

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The End