مجلس أبـوظبي للـجـودة والـمـطابـقـة
ABU DHABI QUALITY & CONFORMITY COUNCIL

Abu Dhabi Guideline

دليل أبوظبي الإرشادي

ADG 1 / 2014

د أ ر ١ / ٢٠١٤

First Edition

الإصدار الأول

HANDBOOK ON

HOW TO DEVELOP A QUALITY SYSTEM FOR AN

AMBIENT AIR QUALITY MONITORING NETWORK

كتيب عن

تطوير نظام الجودة في إدارة وتشغيل

شبكات رصد نوعية الهواء

هاتف ٦٦٦٦ ٤٠٦ ٢ ٩٧١+ | فاكس ٦٦٧٧ ٤٠٦ ٢ ٩٧١+ | ص.ب. ٨٥٣ أبوظبي، الإمارات العربية المتحدة
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Amendment Page

To ensure that each copy of this ADG contains a complete record of amendments, the Amendment Page is updated and issued with each set of revised/new pages of the document. This Guideline is a live document which can be amended when necessary. QCC operates an Environmental Monitoring – Air Quality and Noise Working Group which prepared this document and can review stakeholder comments in order to review and amend this document, issuing an updated version when necessary.

Amendment			Discarded		Insert	
No	**Date**	***Sections Changed**	**Page(s)**	**Issue no**	**Page(s)**	**Issue no**
1	10/06/2014	Document launched	-	-	12	1.0

About the Abu Dhabi Quality and Conformity Council

The Abu Dhabi Quality and Conformity Council (QCC) was established by law No. 3 of 2009, issued by His Highness Sheikh Khalifa Bin Zayed Al Nahyan, President of the UAE.

QCC is responsible for the development of Abu Dhabi Emirate's Quality Infrastructure, which enables industry and regulators to ensure that products, systems and personnel can be tested and certified to UAE and International Standards.

Products certified by QCC receive the Abu Dhabi Trustmark. The Trustmark is designed to communicate that a product or system conforms to various safety and performance standards that are set by Abu Dhabi regulators.

Acknowledgements

QCC would like to thank the members of the Working Group listed below:

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Contents:

1. Introduction

This document describes the minimum requirements for the implementation of a quality system (management system) for an ambient air quality monitoring network. It also gives examples on how the quality system documentation can be organised. The document is based on the international standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. This handbook focuses on practical work at the stations, data validation and traceability in calibrations. Many aspects such as review of tenders, subcontracting, purchases, complaints and corrective actions are important parts of the standard but not covered here because it is usually already part of the company's existing administrative system. The examples given in this handbook are only illustrative and should be adapted to the organisation's needs and requirements.

This handbook is intended for people involved in the planning and development of a quality system for an ambient air quality monitoring network. Quality work is a top management responsibility and continuous active involvement by the management is necessary to assure good quality work in an organisation.

Any part of this document can be copied, changed and used as fit with the following reference:

> *Documentation based in part on Handbook on how to develop a quality system for an ambient air quality monitoring network, EAD Standardisation unit.*

In this handbook the term Quality System equals the term Management System used in ISO/IEC 17025.

2. Background for establishing a quality system

The main objective of an ambient air quality monitoring network is to provide reliable information about the air quality. Good data quality and high data capture are essential if the monitoring network is to achieve its objectives.

To ensure that data are sufficiently accurate, reliable and comparable a quality system has to be established. The quality system describes how the organisation manages its activities. The two important parts of the quality system are quality assurance and quality control (QA/QC). Quality assurance is all planned and systematic activities which are needed to assure that the predefined quality requirements are met. Quality control is the operational techniques and activities that are undertaken to make sure the quality requirements are met. The quality

system documentation is compiled in a Quality Manual. Necessary copies of e.g. standard operating procedures (SOPs) and forms for a station will be made from the quality manual.

Good QA/QC practices cover most aspects of network operation, including equipment evaluation, site operation, maintenance and calibration, data review and ratification. The successful implementation of each component of QA/QC is essential for the success of the measurement programme.

The fundamental aims of the quality system are:

- The data obtained from measurement systems should be representative of ambient concentrations existing in each area
- Measurements must be accurate, precise and traceable
- Data must be comparable and reproducible. Results from a geographically extended network must be internally consistent and comparable with international and other accepted standards
- Results must be consistent over time
- In order for seasonally or annually averaged measurements to be meaningful, an appropriate level of data capture is required throughout the year

Essential requirements of the quality system are:

- Measurement methods used must be of known performance and defined scope of application
- All calibrations must be traceable through an unbroken chain to international standards (the SI system)
- All operations that may influence the quality of the final data must be described in written procedures and the results compiled during the operations must be filed systematically for later reference

The quality system shall be based on the principles laid down in the international standard ISO/IEC17025:2005 General requirements for the competence of testing and calibration laboratories.

3. Quality manual overview

The quality system shall be described in a quality manual. The quality manual will contain templates of all documents used in the network. Copies of e.g. SOPs and forms will be made from the quality manual as necessary. To make copying easy a ring binder is suitable for hosting the quality manual.

A suggested layout of the quality manual is shown below:

1 Introduction
2 Monitoring network objectives and overview
3 Organisation and responsibilities
4 Network traceability
5 Measurement methods
6 Action criteria
7 Standard Operating Procedures
8 Training
9 Internal audits
10 Document management system
11 Log books

Each of the sections listed above are described in more detail in the following chapters. The quality system must be adapted to the organisation where it is established and more sections may be necessary.

4. Quality manual formats

The quality manual will typically contain three types of documents, procedures, descriptive documents and forms. Usually an organisation has a defined layout for such documents. Procedures and descriptive documents shall have a fixed format and on every page be identified by:

- Name of institution
- Document name
- Page number
- Date of issue
- Issue number

Figure 1 shows an example of a document heading.

	EAD Standardisation unit
Document: Handbook on how to develop a quality system for an ambient air quality monitoring network	Page : 1 of 47 Date : 2010.10.20 Issue No : 001

Figure 1. Document heading

A large part of the quality system documentation will be the Standard Operating Procedures (SOPs) which describe how to perform various tasks. SOPs shall as a minimum describe the following:

- Purpose of document (what does the SOP cover)
- Applicability and description of equipment
- Responsibilities (what is the responsibilities of personnel performing the works)
- Instrumentation (list of equipment necessary to perform the SOP)
- Documentation and forms (list of forms used, how to store and distribute them)
- The procedure (detailed description on how to perform the SOP)
- Forms (blank forms used to document the work)

There is no specific layout for forms except that they shall on every page be identified by:

- Date of issue
- Issue number

5. Quality manual details

The chapters of the quality manual are described below.

5.1 Monitoring network objectives and overview

The chapter shall include:

- A description of the purpose of doing measurements
- A list of station classifications
- A table of stations, their locations and the parameters measured at each station
- For each station a description of location and type of station, e.g. road side, urban.

Station classification is a method of grouping stations according to their location. The stations are classified according to the area they cover and their relation to dominant emission sources.

Types of area are:

Urban: Continuously built-up area

Suburban: Largely built-up area: continuous settlement of detached buildings mixed with non-urbanised areas (small lakes, woods, agricultural)

Rural: All areas that not fulfil the criteria for urban/suburban areas

Dominant emission sources are:

Traffic: Stations located such that their pollution level is influenced mainly by emissions from a nearby road/street

Industrial: Stations located such that their pollution level is influenced mainly by nearby single industrial sources or industrial areas

Background: Stations that are neither traffic nor industrial

Subcategories of Rural Background (if necessary):
— Near-city
— Regional
— Remote

A station is classified by a combination of type of area and dominant emission source. The table below shows all possible classifications.

Station classification

Urban Traffic	Urban Industrial	Urban Background
Suburban Traffic	Suburban Industrial	Suburban Background
Rural Traffic	Rural Industrial	Rural Background

Subcategories of Rural Background stations

Rural Background Near-city
Rural Background Regional
Rural Background Remote

An example is shown in Appendix A.

5.2 Organisation and responsibility

An ambient air quality monitoring network will include several participants having different responsibilities. Typical functions may be instrument operation, instrument calibration, data validation, network supervision and data reporting. It shall be described how work is organised and who in the organisation is allowed to perform which function.

An example is shown in Appendix B.

5.3 Network traceability

All instruments need performance checks, calibrations and adjustments from time to time. This is valid for the equipment used to do performance checks and calibrations too. This creates a chain of calibrations where the instrument at a station is calibrated using a certain calibration standard. The calibration standard is again calibrated periodically using a higher quality standard. This chain of calibrations makes the measurement done by an instrument traceable back to a reference.

Figure 2 shows a possible traceability chain for a NOx analyser. The analyser is checked biweekly at the station using a working standard gas cylinder. Every six months the analyser and working standard is calibrated at the station using a travelling standard. The travelling standard is also a gas cylinder. The travelling standard itself is calibrated every six months using a high quality gas as reference. The reference gas should be bought from well reputed manufacturers and be compared to the national reference gas standard at the Standardisation unit before use. This scheme makes the calibration of all analysers in a monitoring network traceable back to one common calibration standard. A similar traceability chain can be established for dust analysers where the calibration standards will be flow and mass references.

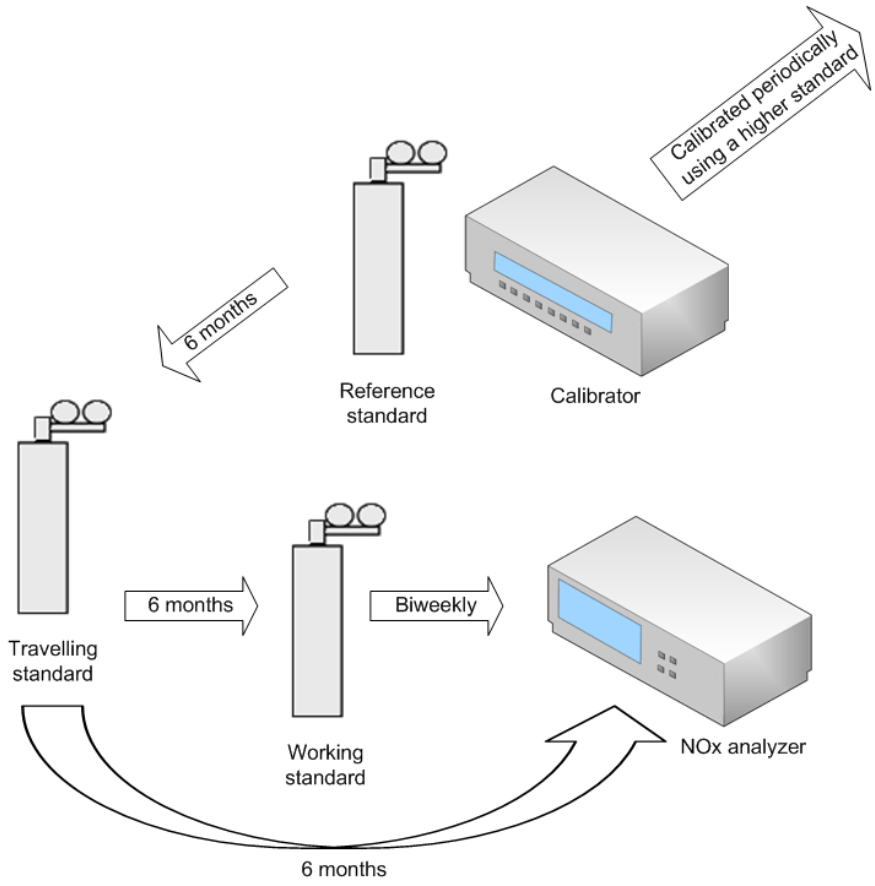


Figure 2. Traceability in gas monitoring

The traceability chain shall be described including schedules for calibration of instruments and calibration standards.

5.4 Measurement methods

The measurement methods, e.g. measurement of nitrogen dioxides by chemiluminescence, used in the network shall be listed with reference to USEPA or The European Air Quality Directive (2008/50/EC) where applicable.

An example is shown in Appendix C.

5.5 Action criteria

Action criteria shall be established for all instruments to assure unified evaluation of results from performance testing. Action criteria may be that if an analyser's response to span gas is

more than ±5% off the span gas concentration some action shall be taken. The actions shall be described.

An example is shown in Appendix D.

5.6 Standard Operating Procedures

All operations that may affect the quality of results shall be described in Standard Operating Procedures (SOPs) and the work shall be documented in forms for later reference. Typical work that should be covered by SOPs is:

- Periodic inspections to stations
- Preventive maintenance of instruments
- Calibration of instruments
- Data evaluation
- Data reporting

An example of an inspection procedure is shown in Appendix E. An example of a data validation procedure is shown in Appendix F.

5.7 Training

A system for training of employees shall be described including how it is documented. Usually an organisation has already established a system for training of its employees that can be used.

An example of a training form is shown in Appendix G.

5.8 Internal audits

Internal audits must be performed to validate the operation of the air quality monitoring network. A system for performing audits shall be described including how it is documented. A performance audit which tests the performance of analysers can usually be documented in the same forms as e.g. calibration of analysers.

5.9 External audits

An external audit is performed by an institution external to the network operator, the external audit institution can typically be:

- An accreditation body if the network operator is accredited
- A client or a third party on behalf of the client if the network operation is outsourced
- The EAD Standardisation unit

Note: External audits performed by the EAD Standardisation unit are described here

An audit is a qualitative evaluation of an entire measurement system. It can look at everything including facilities, equipment, record keeping, data validation, maintenance and calibration procedures. Due to limited time usually only parts of the organisation's activities are audited. Irregularities found during the audit are reported in a Non-compliance form. It is the responsibility of the network operator to take necessary actions to close the non-compliance. The purpose of the audit is to verify that the network operator's quality system is sufficient for its purpose, that the network operator follows the requirements of the quality system and that the measurement instruments give data of required quality.

There are two types of audits, the system audit and the performance audit. The system audit concentrates on procedures, documentation and records. The performance audit focuses on instrument performance. During the performance audit instruments at the measurement station will be tested using independent calibration reference materials, e.g. gas cylinders for gas analysers and flow meters and reference filters for particulate

Below are some areas that may be audited:

- Responsibilities within the AQM network
- Are personnel authorized for their tasks
- Training and training assessment
- Sufficient SOPs and forms to cover activities and QC requirements
- SOPs and forms of latest version
- Type of reference material and its use, traceability
- Filter handling
- Log books and data storage, record keeping
- Vertical revision

The procedure in Appendix K shall be included in the quality manual.

5.10 Document version control system

A document version control system shall be established to track the document versions in the quality system. The document version control system can be a table listing all documents in the quality manual and their version number and date of issue. Usually an organisation has already established a document version control system that can be used.

An example is shown in Appendix H.

5.11 Log books

Log books shall be established for all equipment in the ambient air quality monitoring network. The log book layout and content shall be described.

Figure 3 shows an example of how log books can be distributed in the air quality monitoring network. Copies are made from the quality manual. A station manual is established for each station including documents necessary for each particular station. The station manual is located at the station. In the home office history log books are established for all equipment and for each station. The equipment log book will contain notes on instrument maintenance and forms documenting operations such as maintenance and calibrations. The station history log book will contain notes on shelter maintenance and station specific forms, e.g. check lists covering more than one specific analyser.

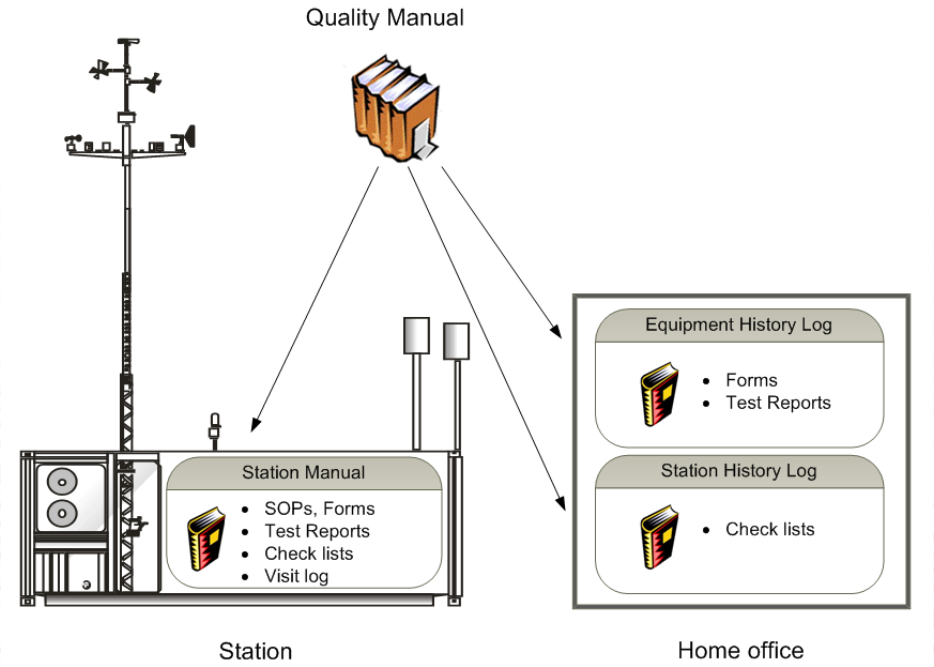


Figure 3. Distribution of log books and manuals in the air quality monitoring network.

Examples of log books are shown in Appendix I and I.

6. Contact information

Assistance or guidance on QA/QC issues and development of a quality manual can be addressed to:

The Environmental Agency – Abu Dhabi (EAD)
Environmental Quality Sector (EQS)
Environmental Monitoring and Analysis Division (EM&AD)
Air Quality, Noise and Climate Change Section (AQN&CCS)
PO Box:45553
Al Mamoura Building
Murour Road
Abu Dhabi, United Arab Emirates

References

EU directive 2008/50/EC on ambient air quality and cleaner air for Europe,
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

Amending Annexes 2001/752/EC to Council Decision 97/101/EC describing station classifications,
http://air-climate.eionet.europa.eu/databases/airbase/country_tools/aq/aq-dem/docs/2001_752_EC_AmAnnex_EoI.pdf

EN ISO 17025:2005 General requirements for the competence of testing and calibration laboratories,
http://www.iso.org

CEN European standardisation organisation,
http://www.cen.eu/

Appendix A. Monitoring network objectives and overview

Monitoring network objectives and overview

The main objective of the EAD air quality monitoring network is to provide reliable information to the authorities and to the public about the air quality in Abu Dhabi.

As a part of the air quality monitoring strategy, several objectives can be achieved, including:

- Establish source/receptor relationships;
- Identify which pollutants are of greatest concern and their current status;
- Show how widespread air pollution problems are and indicate the general extent of the public exposure;
- Provide benchmarks against which trends in overall air quality can be compared and devise performance indicators for assessing the impact of an air quality management plan or strategy;
- Provide a data base for evaluation of effects; of urban, land use, and transportation planning; of development and evaluation of abatement strategies; and of development and validation of atmospheric processes and models.

Stations are classified according to the area they cover and their relation to dominant emission sources.

Types of area are:

Urban:	Continuously built-up area
Suburban:	Largely built-up area: continuous settlement of detached buildings mixed with non-urbanised areas (small lakes, woods, agricultural)
Rural:	All areas that not fulfil the criteria for urban/suburban areas

Dominant emission sources are:

Traffic:	Stations located such that their pollution level is influenced mainly by emissions from a nearby road/street
Industrial:	Stations located such that their pollution level is influenced mainly by nearby single industrial sources or industrial areas
Background:	Stations that are neither traffic nor industrial
	Subcategories of Rural Background (if necessary): — Near-city — Regional — Remote

Overview of the EAD monitoring network

In the following the EAD air quality monitoring network in Abu Dhabi is described. A map showing the locations of the stations is presented below.


Sir Abu Nuer
Das
Diyenah
Arzanah
Ras Ghanadah
Al Qaffay
Muhayyimat
Dalma
Mubarraz
Sir Bani Yas
Abu Dhabi Island
Baniyas School
Gayathi School
Bida Zayed
Western Region
Eastern Region
Al Ain
Liwa Oasis
Oman
Saudi Arabia

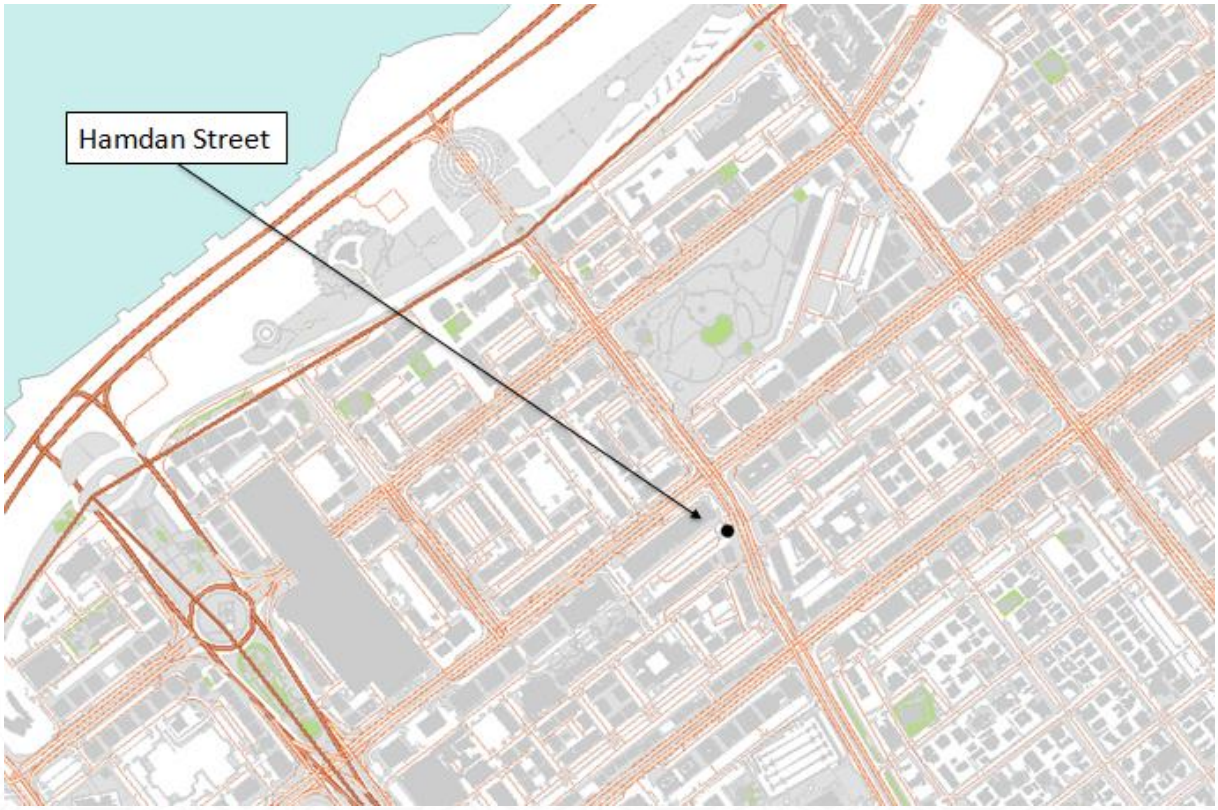
The table below shows all stations.

Station Name	Site Type	Components										Coordinates
		SO_2	NO_x	CO	O_3	PM_{10}	H_2S	CH_4	BETX	Met.	Noise	
Hamdan Street	Urban Traffic	X	X	X		X		X	X	X	X	24° 29\' 20.14\'\' N 54° 21\' 49.38\'\' E
Khadejah School	Urban Background	X	X		X	X	X	X		X	X	24° 28\' 53.61\'\' N 54° 22\' 09.59\'\' E
Khalifa School	Suburban Background	X	X		X	X	X	X		X	X	24° 25\' 48.33\'\' N 54° 24\' 30.35\'\' E
Mussafah	Suburban Industrial	X	X			X	X	X		X	X	24° 20\' 49.92\'\' N 54° 30\' 10.38\'\' E
Baniyas School	Suburban Background	X	X		X	X	X	X		X	X	24° 19\' 16.82\'\' N 54° 38\' 09.34\'\' E
Al Ain Islamic Institute	Suburban Background	X	X		X	X	X	X		X	X	24° 13\' 08.61\'\' N 55° 44\' 05.51\'\' E
Al Ain Street	Urban Traffic	X	X	X		X		X	X	X	X	24° 13\' 33.09\'\' N 55° 45\' 56.99\'\' E
Bida Zayed	Suburban Background	X	X		X	X	X	X		X	X	23° 39\' 08.15\'\' N 53° 42\' 14.01\'\' E
Gayathi School	Suburban Background	X	X		X	X	X	X		X	X	23° 50\' 07.84\'\' N 52° 48\' 37.18\'\' E
Liwa Oasis	Rural Background Regional	X	X		X	X		X		X	X	23° 50\' 07.84\'\' N 52° 48\' 37.18\'\' E
Mobile 1		X	X	X	X	X	X	X	X	X	X	
Mobile 2		X	X	X	X	X	X	X	X	X	X	

Monitoring station details

Details about site locations are listed below.

Site	Hamdan street
ID	1
Site type	Urban Traffic
Area/Location	The area along the roads in Abu Dhabi city centre is mainly occupied with parking lots. The location selected is south of the crossing of Hamdan and Al Moroor streets, one of the most congested crossings in the city.



Appendix B. Organisation and responsibilities

Organisation and responsibilities

This section describes the air quality monitoring and management organisation. The team appointed for the operations of instruments, for maintenance, repair and calibrations as well as for quality control and reporting is presented below.

Function and name	Responsibility
Project manager NN	• Overall network management • Daily air quality monitoring network management • Air quality management and planning • Site selection • Equipment procurement • Appointment and management of site operators
Quality manager NN	• Maintain, review and update QA plan and quality documentation • Initiate and participate in network audits • Coordinate training • Final data validation • Report QA/QC findings to Project Manager
Network supervisor NN	• Supervise all operations • Inspect status reports, checklists and data reports • Audit operations
Workshop operator NN	• Maintain workshop equipment • Repair, service and calibrate field equipment in workshop
Field operator NN	• Management of measurement site • Periodic site visit: QC at stations, filter change, cleaning of manifold, manual zero/span check, e.t.c. • Responsible for keeping of logbooks at station • Emergency call-outs to diagnose and rectify problems • Reporting to air quality monitoring network Manager in case of problem or instrument failure • Instrument testing, maintenance, calibration and repairs • Assist with site installation
Data Expert NN	• Data acquisition from sites • Daily and weekly QC of data • Data presentation for monthly and yearly reports • Contact Site Operator when data indicates need for trouble-shooting

Authorized personnel

The following personnel are authorized to operate the air quality monitoring network.

Below are examples of authorization areas. Change the list to suit your needs

Table 1. Authorized personnel

Name	**Area of authorization**
NN	Calibration and operation of: • NOx analyser • SO2 analyser • H2S analyser • O3 analyser • CO analyser • NMHC analyser • CH4 analyser • BTX analyser • PM analyser • Noise • Meteorology sensors Operation of: • Data acquisition system • Data evaluation system • Data logger
NN	QA/QC aspects: • Perform internal audits • Update quality system documentation
NN	Operation of: • Data acquisition system • Data evaluation system

E.t.c.

Appendix C. Measurement methods

Measurement methods

This section lists the measurement methods

Component	Measurement method	Reference to standard
NO, NOx, NO2	Automatic Chemiluninecsence	CEN/EN142111, Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence
SO2	Automatic Ultraviolet fluorescence	CEN/EN14212, Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence
H2S	Automatic Ultraviolet fluorescence	NA
CO	Automatic Nondispersive infrared spectroscopy	CEN/EN14626, Standard method for the measurement of the concentration of carbon monoxide by nondispersive infrared spectroscopy
O3	Automatic Ultraviolet photometry	CEN/EN14625, Standard method for the measurement of the concentration of ozone by ultraviolet photometry
TNMHC	FID	NA
CH4	Automatic Non-dispersive infrared spectroscopy	NA
BTX	Automatic, GC w/PID	CEN/EN14662, Ambient air quality - Reference method for measurement of benzene concentrations
PM10	Automatic Beta gauge	CEN/EN12341, Determination of the PM 10 fraction of suspended particulate matter. Reference method and field test procedure to demonstrate reference equivalence of measurement methods Adapted to CEN/EN12341 for automatic methods

Appendix D. Action criteria

Action criteria

1. Introduction

To assure proper data quality the instruments must be tested regularly using a suitable calibration material. If the response of the instrument to the calibration material is outside certain (action) limits you have to act, e.g. service, calibrate and adjust the analyser.

2. Action criteria gas analysers

This method assumes that the analyser is always measuring correct. However all analysers will drift. When the analyser response at zero or span drifts past the action limit during a routine zero/span check the analyser is adjusted using a proper span gas cylinder as reference material. There will be a “jump” in the results when an adjustment is made. To avoid big jumps the action limits or window should be tight. Acceptable instrument responses are given in Table 1.

Table 1. Action criteria for gas monitors at the monitoring stations.

Monitor	Recalibrate and adjust	
	Zero level	Span level
SO_2	-3 > Z > 3 [ppb]	± 5 %
H2S	3 > Z > 3 [ppb]	± 5 %
NO_x	-3 > Z > 3 [ppb]	± 5 %
CO	-0.2 > Z > 0.2 [ppm]	± 5 %
O_3	-3 > Z > 3 [ppb]	± 5 %
HC	-0.1 > Z > 0.1 [ppm]	± 5 %
CH4	-0.4 > Z > 0.4 [ppm]	± 5 %

- **Zero level**: If a stabile zero reading is outside the action limits when the analyser is measuring zero air the zero test should be repeated the day after. If the reading continues to stay outside the limits the analyser should be adjusted.
- **Span level**: If a stabile reading is outside the action limits when the analyser is measuring span gas the span test should be repeated the day after. If the reading continues to stay outside the limits the analyser should be adjusted. The deviation is calculated as the difference between a stable reading and the certified span gas concentration divided by the span gas concentration and multiplied by 100. Usually the span result has a downward trend.

Appendix E. Standard operating procedures – Inspection

SOP Six-monthly inspections

1 Purpose of SOP

To maintain and calibrate instruments at measurement sites.

2 Applicability and description of equipment

This SOP applies to preventive maintenance and calibration of instruments at the stations. The analyser calibration (before adjustment) is already covered by the biweekly inspection and under normal circumstances the results can be copied from the biweekly inspection checklist to the calibration reports.

Any adjustments in offset or instrument gain must be recorded in the calibration report.

If an analyser requires maintenance, service or repairs one calibration report must be completed before these activities commence and another report must be completed after. The purpose is to document instrument status before and after maintenance, service or repairs.

3 Instrumentation

This SOP assumes the following instrumentation:

- Gas analysers
- PM10 or PM2.5 analysers
- Meteorology sensors
- Ambient air inlet manifold

4 Documentation and forms

This SOP requires the following forms:

Form: Six-monthly inspection checklist
File: Six-monthly inspection checklist-AA-yyyy-mm-dd.xls

Form: B analyser calibration report
File: B analyser calibration report-n-yyyy-mm-dd.xls

AA denotes the station name, yyyy the year, mm the month and dd the date of the station visit. B denotes the analyser type, e.g. NOx and n its serial number. Use these formats if you choose to save an electronic copy of the completed checklist. The inspection checklist covers all

instruments and the shelter itself. There is one calibration report for each instrument at the station.

Copies of the Six-monthly inspection checklist and analyser calibration reports shall be submitted to the Network Supervisor no later than one week after the end of the month.

The paper copy of the Six-monthly inspection checklist is stored in the history log book of the station. The paper copy of the Analyser calibration report is stored in the history log book of the respective analyser.

The operator is required to perform the biweekly and three-monthly inspections prior to the six-monthly inspection.

5 Six-monthly inspection procedure overview

The Six-monthly inspection checklist is used to tick off yes or no for routine checks at the station. The calibration report is used to register status parameters from the analysers as well as results from the calibration of gas analysers.

The Six-monthly inspection procedure includes:

1. Registration of general information in Six-monthly inspection checklist
2. Biweekly inspection
3. Three-monthly inspection including two point calibration before maintenance
4. Maintenance on analyser systems
5. Two point calibration after maintenance as necessary

There is one calibration report for each analyser at the station. You will use the same report as the one used in the three-monthly inspection.

It is assumed that the following tasks were completed during the three-monthly inspection:

- Registration of general information in calibration report
- Registration of calibration equipment
- Registration of displayed instrument status
- Two point calibration before maintenance

Do not perform the two point post calibration during the three-monthly inspection.

6 Registration of general information in Six-monthly inspection checklist

Registration of general information:

- In the Six-monthly inspection checklist enter station name, station ID, date of visit, time of start of visit and your name in the Station, ID, Date, Start time and Engineer fields respectively.

7 Pre six-monthly inspections

It is assumed that the six-monthly inspection coincides in time with the biweekly and three monthly inspections and that these inspections are performed prior to the six-monthly inspection.

7.1 Biweekly inspection

Perform biweekly inspection:

1. Perform SOP Biweekly inspections and complete all relevant forms.
2. Tick off Y in Biweekly inspection performed in the Six-monthly inspection checklist.

7.2 Three-monthly inspection

There is one calibration report for each analyser at the station. Do not perform a two point calibration after adjustment. It will be done after six-monthly maintenance is finished.

Perform three-monthly inspection:

1. Perform SOP three-monthly inspections and complete all relevant forms.
2. Tick off Y in Three-monthly inspection performed in the Six-monthly inspection checklist.

8 Maintenance on analysers

8.1 Maintenance on NOx analysers

It is assumed that three-monthly maintenance was performed as described in SOP Three-monthly inspection.

Cleaning of ozone generator electrodes:

1. Follow the procedure in Operation sheet 4.3.4 of the analyser instruction manual.
2. If the electrodes were cleaned tick off Y in the Cleaning of ozone generator electrodes field of the Six-monthly inspection sheet. Otherwise tick off N.

Flow rate and air tightness checking:

1. Follow the procedure in Operation sheet 4.3.5 of the analyser instruction manual.
2. If the check was done tick off Y in the Flow rate and air tightness checking field. Otherwise tick off N.

Inspection of pump valves and diaphragms:

1. Follow the procedure in Operation sheet 4.3.6, scope Pumping assembly checking, of the analyser instruction manual.
2. If the check was done tick off Y in the Insp. of pump valves and diaphragms field. Otherwise tick off N.

8.2 Maintenance on SO2, H2S and CH4 analysers

It is assumed that three-monthly maintenance was performed as described in SOP Three-monthly inspection.

Inspection of pump valves and diaphragms:

1. Follow the procedure in Operation sheet 4.3.5 of the analyser instruction manual.
2. If the check was done tick off Y in the Insp. of pump valves and diaphragms field. Otherwise tick off N.

8.3 Maintenance on O3 analysers

It is assumed that three-monthly maintenance was performed as described in SOP Three-monthly inspection.

Inspection of pump valves and diaphragms:

1. Follow the procedure in Operation sheet 4.3.3 of the analyser instruction manual.
2. If the check was done tick off Y in the Insp. of pump valves and diaphragms field. Otherwise tick off N.

Realignment of measurement and reference signals:

1. Follow the procedure in Operation sheet 4.3.7 of the analyser instruction manual.
2. If the check was done tick off Y in the Realignment of meas. and ref. signals field. Otherwise tick off N.

8.4 Maintenance on CO analysers

It is assumed that three-monthly maintenance was performed as described in SOP Three-monthly inspection.

Replacement of internal zero filter:

1. Follow the procedure in Operation sheet 4.3.3 of the analyser instruction manual.
2. If cleaning was done tick off Y in the Replacement of internal zero filter field. Otherwise tick off N.

8.5 Maintenance on PM analysers

It is assumed that three-monthly maintenance was performed as described in SOP Three-monthly inspection.

Inspection of pump valves and diaphragms:

1. Follow the procedure in Operation sheet 4.3.9 of the analyser instruction manual.
2. If the check was done tick off Y in the Insp. of pump valves and diaphragms field. Otherwise tick off N.

Check of filter ribbon tension:

1. Follow the procedure in Operation sheet 4.3.4 of the analyser instruction manual.
2. If the check was done tick off Y in the Check of filter ribbon tension field. Otherwise tick off N.

Dust measurement calibration:

1. Follow the procedure in Operation sheet 4.3.5 of the analyser instruction manual.
2. If the check was done tick off Y in the Dust measurement calibration field. Otherwise tick off N.

Suction flow test:

1. Follow the procedure in Operation sheet 4.3.6 of the analyser instruction manual.
2. If the check was done tick off Y in the Suction flow test field. Otherwise tick off N.

9 Post calibration of gas analysers

After maintenance, the gas analysers must be calibrated and if necessary adjusted to give correct measurements.

Two point post calibration of gas analysers:

1. Perform a zero/span check and if necessary adjust the zero and span factors, see analyser instruction manual on details. Let the analyser measure zero and span gas for 20 minutes respectively and until you have a stable reading.
2. Enter the analyser zero reading in the After adjustment - Zero Meas. field of the calibration report sheet.
3. Enter the span gas reference value in the NN Ref. field.
4. Enter the analyser span reading in the NN Meas. field.
5. Enter the new span factor and zero offset value in the After adjustment - Instr. Gain and Instr. Offset fields respectively.
6. If the zero or span factors were adjusted enter Y in Zero or span adjusted in the Six-monthly inspection checklist.
7. If the analyser does not pass the post calibration test it may need more service.

10 Finalising the visit

1. Write the time of end of inspection in the Time Begin/End field in the analyser report.
2. Before leaving the station record the visit in the station visit log and tick off in Update visitors log book in the Six-monthly inspection sheet.
3. After returning to the lab record information in the instrument history log books as required. Remember to update the Daily status report.
4. Any observed faults should be reported to the project manager.
5. If you are using a paper based system store the checklist and calibration reports in the history log book of the station and analysers respectively.

Six-monthly inspection checklist

Station:..... Date:_____ Start time:_____ End time:_____

Engineer.....

Tick off Y (yes) or N (no) for action performed or not	NOx	SO2	H2S	O3	CO	HC	CH4	BTEX	PM	Noise	Met	Other
Three-monthly inspection performed?												
Ozone generator electrodes checked?												
Flow rate and air tightness checked?												
Pump valves and diaphragms insp?												
Internal zero filter replaced?												
Meas. and ref. signals realigned?												
Filter ribbon tension checked?												
Dust measurement calibration perf.?												
Suction flow test performed?												
Zero or span adjusted?												
Update visitors log book												

Comments/Events:

Appendix F. Standard operating procedures – Data validation

1 Purpose of SOP

To validate and report status on instruments in the measurement network.

2 Applicability and description of equipment

This SOP applies to data validation and daily status reporting from measurement stations. The contents of the status report is very limited and its purpose is to give a quick overview of the status of the measurement network.

A simple coding system is used to describe the status of the analysers at each station.

The Daily report

Status codes in the Daily report:

Status	Code	Status	Code	Status	Code
OK	Blank	Damaged	D	Not Working	N
Suspicious	S	Attention	A	In Calibration	C
In Repair	R	Switched Off	O	Data Logger	L
Communication	T	Zero Level	Z	Drifting	F

3 Responsibilities

Personnel reporting status from stations will be thoroughly knowledgeable of the contents of this SOP and will comply with its requirements when performing status reporting.

4 Instrumentation

This SOP assumes no particular instrumentation.

5 Documentation and forms

This SOP requires one form:

Form: Daily report

File: Daily report-yyyy-mm-dd.xls

where yyyy the year, mm the month and dd the date. Use this format if you choose to save an electronic copy of the completed daily report.

Paper copies of the Daily report forms are stored in the Daily report log book.

The daily report shall be distributed to administration, operation and maintenance teams.

6 Daily report procedure

The Daily report is based on remote inspection of status parameters and data from the instruments. By inspecting measurement data errors can be detected. The Daily report shall be submitted to the network manager before 11:00.

6.1 Detection of sudden errors and disturbances

Measurement data, zero/span checks and status parameters must be checked daily, preferably in charts, to detect and fix disturbances as soon as possible. This is particularly important when data is shown to the public in near real time.

Normally sudden errors would be detected from day to day. Typical errors can be:

- Breakthrough in filters
- Clogging of filters
- Power failures
- Telecommunication failures
- Lamp failures
- O3 generator failure (NOx analyser)
- Valve failure
- Electronic breakdown
- Software hangs
- Sudden leaks
- Water condensation in tubes

The errors are often detected because the data stops varying; typically the values will be close to zero. An O3 generator failure in the NOx analyser will give zero readings while a valve failure in the same analyser can cause the analyser to continue to measure NO and NOx but NO2 will be zero. At stations where normal values are close to zero, e.g. at background stations, such errors can be hard to detect. Software hangs, e.g. due to short power breaks, can cause the analyser to output constant values at any level.

Spikes in PM analyser readings can be caused by particles which has accumulated on the inlet pipe wall fall off the wall and onto the filter. Negative readings can be caused by water evaporating from the filter.

Shelter surroundings, e.g. cars running on idle next to the shelter, can cause high readings.

Data is checked by looking at them in charts. Last 24 hours of measurement data and zero/span checks should be compared with at least 7 previous days of data. If in doubt nearby stations should be compared. If the zero/span checks during the last seven days are comparable the instrument is probably OK and possible errors may be due to surroundings (inside or outside the shelter).

6.2 Detection of long term errors

Over a longer period of time the response of gas analysers may change. Normally the sensitivity decreases while the zero offset increases due to dust build-ups in tubes and valves. Build-up of dust in tubes of the SO2 analyser can affect the sensitivity dramatically because Calcium reacts with SO2. This can go unnoticed if the span gas flow line is different from the sample flow line. The concentration of low concentration gas cylinders may decrease due to reactions between the gas and the blending gas or the walls of the cylinder. This may cause what looks like a decrease in analyser sensitivity. The gas flow rate through the analyser may decrease due to clogging of filters and critical orifices or because the pump becomes worn. Lower efficiency of the TEOM pump will cause the flow rate to go down but larger particles to be collected. The two effects may cancel each other and make the error not visible in the measurement data. Lamps that are part of the measurement principle will deteriorate by time and cause a slow drop in sensitivity. Magnetic valves may start to leak causing slow changes in the sensitivity. The O3 scrubber of the O3 monitor can deteriorate slowly causing a slow decrease in response.

Slow changes in response can easily go on without notice until the monitor suddenly breaks down, e.g. complete breakthrough in a valve. At this time it is not easy to estimate when the error condition started making it difficult to decide how far back data has to be invalidated. To detect slow changes in sensitivity data should be compared over longer time periods of time or same period last year. The daily zero/span check are a valuable tool for checking long term changes. Always look for trends!

Date: dd/mm/yyyy	DAILY REPORT AD AIR QUALITY MONITORING NETWORK												Prepared by: NN
ANALYZER	Hamdan St	Kadejah Schl	Khalifa Schl	Musaffah Ind	Baniyas Schl	Al Ain Schl	Al Ain St	Bida Zayed	Gyathi Schl	Lina Schl	New Mobile	Old Mobile	REMARK
PM10													
SO2													
NO2													
CO													
O3													
H2S													
CH4													
HC													
B- benzene													
T- toluene													
E- ethyle benzene													
O- xylene													
mp-xylene													
NOISE													
WS													
WD													
TEMP 2 Meters													
TEMP 10 Meters													
HUMIDITY													
NET RADIATION													
ATMOS- PRESSURE													
SHELTER TEMP													
WIND ELEVATION ANGLE													
ANALYZERS SITUATION:	Z = Zero Level			C = Calibration			S = Suspected Performance			R = Repairs			N = Not Working
T= Communication	D = Damaged			L= Data logger			O= Switched off			A=Attention			F = Drifting

مجلس أبوظبي للجودة والمطابقة
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Appendix G. Training form

Training report

1. General information

Name of person being trained:..... ..... Date:.....

Teacher/assessor: .....

☐ Training ☐ Assessment

Background for training/assessment: .....

2. Area covered by training/assessment

4. Training/Assessment results: Actions to be taken

☐ OK ☐ More training necessary

Comments:

Appendix H. Document version control table

The document version control table

Table 1. The version history of all documents.

	Document	Version
1.	Contents	001-2006.09.01 002-2009.01.12
2.	Introduction	001-2006.09.01
3.	Quality manual quick reference	001-2006.09.01
4.	Monitoring network objectives and overview	001-2006.09.01
5.	Organisation and responsibilities	001-2006.09.01
6.	Network traceability	001-2006.09.01
7.	Measurement methods	001-2006.09.01
8.	Task schedules	001-2006.09.01 002-2009.01.12
9.	Form Task schedule	001-2006.09.01 002-2009.01.12
10.	Contents – SOPs	001-2006.09.01
11.	SOP Status reporting	001-2006.09.01 002-2009.01.12
12.	Form Daily status report	001-2006.09.01
13.	Form Biweekly status report	001-2006.09.01

Appendix I. Log books – Station manual

STATION MANUAL

Station: NN	Station Id: II

Enter station name and Id within brackets.
Entries will be repeated on all pages next time document is opened

CONTENTS: Section

The station manual is located at the station

STATION VISIT LOG

STATION: NN	STATION ID: II	
Date	Remarks on site visits	Initials

Notes on visits to the station.

TRAVEL REPORT

(Use as necessary as notepad)

STATION / DESTINATION:	STATION ID:
Date of travel:	Archive ref:
Participants:	Distribution:
Observations, results and actions:	

Notes for the history log-book (if any)

Instrument		
Type / model	Serial number	Observations, results, actions etc.

Date _____ Signature _____

Notes made at the station to be reported home.

STATION DATA SHEET

SHELTER:	
PRODUCT MAKER (name, addr., tel., fax):	MODEL:
SALES REPRESENTATIVE (name, addr., tel., fax):	
SERIAL NUMBER:	
DATE RECEIVED:	NEW ☐ USED ☐ OK ☐ DAMAGED ☐
REMARKS ON MALFUNCTIONS AND WARRANTY CLAIMS ON RECEIVAL:	

Date:_____ Signature:_____

Information about the shelter maker and sales representative. Recorded once.

TECHNICAL INFORMATION SHEET

STATION: NN	STATION ID: II

ADDRESS:	UTM COORDINATES (X / Y):
OWNER OF PREMISSES (name, addr., tel., fax):	LOCAL CONTACT PERSON (name, addr., tel., fax):

PERSON RESPONSIBLE FOR STATION (name, institution, addr., tel., fax):

TECHNICAL SPECIFICATIONS:		TECHNICAL SPECIFICATIONS (cont.):	
	Yes No	Electrical power circuits (no. of):	_____
Stand-alone shelter:	☐☐	Electrical power sockets (no. of):	_____
Air Condition:	☐☐	Intake holes in walls/ roof (no. of):	_____
Windows:	☐☐	Benches (meter):	_____
Floor number:	Ground	Size (L x W x H, meter):	_____
Access: From ground_____		Instrument racks (no. of):	_____
		Telephone number:	_____

REMARKS:

Technical information about the shelter. Recorded once.

Appendix J. Log books – Equipment history log book

EQUIPMENT HISTORY LOG - BOOK

Instrument: NN	Serial no: SS

Enter instrument name and serial number within brackets.
Entries will be repeated on all pages next time document is opened

CONTENTS: Section

Equipment history log book is kept in the office.

EQUIPMENT DATA SHEET

INSTRUMENT: NN		
PRODUCT MAKER (name, addr., tel., fax):		
SALES REPRESENTATIVE (name, addr., tel., fax):		
SERIAL NUMBER: SS		
DATE RECEIVED:	NEW ☐ OK ☐	USED ☐ DAMAGED ☐
REMARKS ON MALFUNCTIONS AND WARRANTY CLAIMS ON RECEIVAL:		

Date:_____ Signature:_____

Information about equipment maker and sales representative. Recorded once.

EQUIPMENT HISTORY LOG

INSTRUMENT: NN		SERIAL NUMBER: SS
Date	Remarks on maintenance, repairs, adjustments, calibration, etc.	Initials

Notes on maintenance, repairs, calibration, e.t.c.

Appendix K. External audits

The EAD Standardisation unit will perform an audit at 10% of the stations, minimum 2 stations, in the measurement network once a year. The audit will be a combined system audit and performance audit. The system audit will concentrate on procedures, documentation and records. The performance audit will focus on instrument performance. Both audits will take place at the measurement stations. The system audit can also take place “at home” when auditing data validation, history logs and other records.

The EAD Standardisation unit will initiate the audit by submitting an information letter to the network operator 1 month prior to the audit. The network operator will receive the audit agenda 1 week before the audit.

Irregularities found during the audit are reported in the Non-compliance form, see attachment. The Non-compliance form includes a description of the irregularity. The network operator will propose a corrective action and a time limit for performing the corrective action. It is the responsibility of the network operator to take necessary actions to close the non-compliance. The corrective actions shall be recorded in the Non-compliance form and a copy of the completed form shall be submitted to the Standardisation unit. The Standardisation unit will report non-compliances that are not closed in due time to EAD.

Filling in the Non-compliance report at the site:

1. The auditor enters the report number in the **Non-compliance report no** field. There is one form for each Non-compliance.
2. **Place/area** and **Station Id** is the name and station identity of the station respectively.
3. **Reference document(s)** are the document(s) which the non-compliance is in conflict with.
4. The auditor writes his/her name in the **Name of auditor** field and todays date in the **Date** field.
5. The auditor enters a short text describing the non-compliance in the **Non-compliance** field.
6. The auditor and network representative signs the observed non-compliance in the **Non-compliance - Auditor** and **For the institution** fields respectively.
7. The network representative and the auditor agree upon a possible action which will correct the non-compliance. A short text describing the corrective action should be entered in the **Corrective action(s)** field.

The Non-compliance report is now as complete at the station.

Filling in the Non-compliance report during the summary meeting after the audit:

1. The network manager suggests a time limit necessary to correct the non-compliance. This time limit is entered in the **Corrective action(s) - Date when corrective action will be completed** field.
2. The lab manager signs the **Signature** field below.
3. The monitoring institution keeps the original non-compliance report. The Standardisation unit keeps a copy.

The monitoring institution will now carry out the work necessary to correct the non-compliance.

Closing a non-compliance:

1. When the monitoring institution has implemented the corrective action the lab manager signs in the **Corrective action implemented - Name**, **Signature** and **Date** field and submits a copy of the non-compliance form to the Standardisation unit.
2. The Standardisation unit assesses the corrective action. If the implemented action is sufficient to close the non-compliance the auditor signs in the **Corrective action confirmed by auditor - Signature** and **date** fields.

The non-compliance is now closed.

Non-compliance report no .....

Place/area: ..... **Station id:** .....

Reference document(s): .....

Name of auditor: .....

Date: .....

Non-compliance:		
Signatures:	**Auditor :**	**For the institution :**

Corrective action(s) :
Date when corrective action will be completed:
Signature of manager responsible for place/area where the non-compliance is identified:

Corrective action implemented:	**Name**	**Signature**	**Date**

Corrective action confirmed by auditor:	**Signature**	**Date**

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