Integrated Programme for Better Air Quality (IBAQ Programme)

CITY SOLUTIONS TOOLKIT:

QUALITY ASSURANCE AND QUALITY CONTROL

THE SITUATION

The presence of air quality monitors and instruments is one of the key indicators in assessing the capacity of air quality management (AQM) of a city. However, having an air quality monitoring in place does not equate to having accurate data. Sharing unsorted raw data publicly must be refrained as this can lead to confusion or panic or create a false sense of security. Proper quality assurance (QA) and quality control (QC) procedures are part of the requirements of an effective air quality monitoring system (ADB and Clean Air Asia, 2014).

In this module you will find:

- Summary explanation of the importance of QA/QC in AQM;
- Guide on how to ensure the quality of AQ data through QA/QC; and,
- Overview of considerations when preparing for the QA/QC process

GUIDANCE ON QUALITY ASSURANCE AND QUALITY CONTROL

Air quality data will be generated, transferred to a database, and analyzed to achieve objectives or inform policy. The data capture and management scheme will be based on the air quality monitoring objectives and the monitoring instruments used. It must be ensured that there is proper handling and processing of data before it is used for targeted activities and communications by stakeholders.

Data management involves the collection, transfer, and processing (i.e. QA/QC, data analyses) of information collected from air quality monitoring. In some cases, this process is overlooked due to lack of comprehensive monitoring planning and preparation which leads to poor work planning and resource utilization. This toolkit serves as a quick guide for air quality managers to ensure that they are producing, maintaining, and using quality data.

QA/QC is very important in AQ monitoring because:

Quality Assurance

- ✓ Provides independent oversight to ensure QC activities are being performed
- ✓ Involves data set review, validation, and verification before final presentation

Quality Control

- ✓ Provides data for validation of equipment and monitoring results (precision and accuracy)
- ✓ Provides records of instrument performance over time and detects drift

RESOURCE REQUIREMENTS AND STAKEHOLDER ENGAGEMENT

The required human resources for AQM data management are the following:

- Data providers – implements QA/QC processes; assists in maintaining process credibility and validity of data, use of software (can be outsourced or from internal capacity);
- Data managers – oversees and manages QA/QC processes;
- Station operators – ensures the instruments are working well/in best condition;
- Engineer – troubleshoot and manage data transfer and storage (can be outsourced or from internal capacity); and,
- Service engineer – for repairs

In some cases where the air quality monitoring system is outsourced, the service provider usually provides a cloud storage and support for analysis for the collected data. Otherwise, the data must be manually collected from the system through memory cards or automatically transmitted through data acquisition system (DAS) to receive the measurement values. DAS includes recorders and data loggers, computer software and the appropriate hardware (computer and operating system) fit for the need and expected volume of data.

The timeframe required to accomplish the QA/QC process depends on the amount of data generated, which is in turn defined by the sampling resolution (for real-time measurements) and the number of monitoring stations.

In performing the QA/QC in AQ monitoring process, it would be best to only engage the team/individuals specified above. While an inclusive approach is always the best and preferred strategy in AQM, it is not advised that raw data is shared to external groups as this can lead to miscommunication of results. At most, academic institutions can be involved for consultations. Other stakeholders, especially the public, can however always demand for information on the QA/QC process for transparency and can also provide checks and balance to the overall process.

THE QA/QC APPROACH

Quality assurance involves all aspects of quality operation in the ambient air while quality control, on the other hand, pertains more to the operations of the field site and the support laboratory. The key elements in QA/QC are summarized below. This can help in preparing accordingly for the process, by mapping the necessary requirements and planning prior to the actual QA/QC procedure.

Quality Assurance (QA)	Quality Control (QC)
• System audit - ensures that procedures are observed and followed or modified to reflect current practice • Performance audit - evaluates outputs for external standards • Inter-laboratory comparisons and co-located sampling • Interference evaluation with reference materials	• Standard Operating Procedures (SOPs) - as a guide and reference in the conduct of QC processes; revised periodically • Periodic instrument calibrations through comparison with a standard instrument of higher accuracy • Periodic adjustments to zero and setting the desired span (difference between the lowest and highest value of the calibration range) • Replicate analyses • Cross-instrument comparisons • Internal consistency tests

Source: Chow, et al. (2012)

The Quality Assurance/Quality Control Plan has three basic components. The first is focused on activities that develop specifications for operating a monitoring network. The second component is on activities that assess compliance to the guidance developed, while the third one is focused on activities that implement corrective actions to ensure compliance. The elements for each component are summarized in the table below.

Activities in a QA/QC process	**Elements covered**
1. Development of specifications for operating a monitoring network	Data quality objectives
	Measurement methodology (reference methods)
	Equipment selection and operation
	Site selection (site classification, distribution, location)
	Sampling System (shelter requirements and probe siting)
2. Assessment of compliance to the guidelines developed	Station and analyzer operation (station visits, ensuring that operation procedures are followed, and preventive maintenance)
	Calibration (calibration frequency, calibration procedures, and zero and span verifications)
3. Implementation of corrective actions to ensure compliance	System audits and station performance (independent verifications)
	Data validation
	Documentation (logbooks and operation manuals)
	Personnel training and technical support

Source: Clean Air Asia (2015)

Before communicating air quality data and using it to inform action, its quality needs to be examined. For each pollutant, the following main questions should be answered:

- Have suitable QA/QC procedures been set up for all stages and activities?
- Was a QA/QC plan followed?

- Was monitoring undertaken at suitable locations?
- Have appropriate arrangements for data handling and storage been implemented?

Data processing to ensure data quality involves data record notes, data quality flags, and process documentation. Metrics to ensure these are the following (Clean Air Asia, 2019):

(1) **Validity**. Supported by documentation, this is proof that all applicable standard scientific procedures have been followed. The document should contain the following: precise descriptions of collected and processed numeric data, including collection method; instrument type; instrument accuracy; instrument precision; data format; unit conventions; variable naming conventions; as well as QA/QC flags.

(2) ***Traceability***. A documented history of all processes performed on each raw data set transmitted to the database. Traceability is assured by maintaining tabulated, chronological listings, which summarize each step that is performed along with the method by which it is performed. It indicates the chain of steps and includes the verification and quality assurance procedures implemented and the corresponding results.

(3) ***Reproducibility***. This allows the duplication of results at any data validity level. Reproducibility requires traceability, since all processing steps performed in producing specific results must be duplicated. Reproducibility requires that all data management tools used be stored together with a chronological set of data validation records for all data sets (e.g. source codes for processing programs must be stored and available if needed).

Key to the QA/QC process is the documentation of the process to ensure credibility of the data collection, handling, analysis, and evaluation process. QA and QC information should thus be elaborately documented in clear data records (e.g., data sheets, laboratory notebooks, etc.). The steps taken must be clearly described that the process can be replicated or performed in a similar manner.

All the activities related to QA/QC must be in a QA/QC plan, and clearly recorded in manual and digital logbooks. Especially for QA documentation, records are kept in laboratory and field notebooks, data sheets, and chain-of-custody forms. Original records of sampling, monitoring, and laboratory analysis are kept. It must be emphasized as well that there must be a QA Auditor who must evaluate if proper procedures were followed, through checks of the documents. Aside from helping in the entire process, proper documentation can explain unusual data (e.g. spikes, zero readings, etc.) and help in troubleshooting should the need arise.

In any AQM Plan, it must be a requisite that apart from an Air Quality Monitoring Plan, there should be a clear QA/QC Plan with an identified team of implementors. This would ensure the best quality of data and can complement efforts done in the other components of AQM.

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