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Technical support for Air Quality Management Plans in Uttar Pradesh and Bihar

Task 5: Evaluation of Indian guidelines for air quality monitoring

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ABSTRACT

NILU has, on contract with the World Bank (WB), assessed the Indian ambient air quality monitoring guidelines and suggested some updates to the guidelines. The assessment was based on interviews with representatives of UPPCB and BSPCB and inspection of guidelines and other documentation received.

NORWEGIAN TITLE

Teknisk støtte til plan for luftkvalitetsforvaltning i Uttar Pradesh og Bihar – Oppgave 5: Evaluering av indiske veiledninger for overvåking av luftkvalitet

KEYWORDS

Evaluation | Guidelines | Air Quality Management Plan

ABSTRACT (in Norwegian)

NILU har, på oppdrag fra Verdensbanken, vurdert Indias nasjonale veiledninger for måling av luftkvalitet. Vurderingen er basert på intervjuer med representanter for myndighetene samt inspeksjon av veiledninger og annen dokumentasjon mottatt fra dem.

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Summary

NILU has, on contract with the World Bank (WB), assessed the Indian ambient air quality monitoring guidelines and suggested some updates to the guidelines. The assessment was based on interviews with representatives of UPPCB and BSPCB and inspection of guidelines and other documentation received.

The guidelines for manual sampling and analysis are comprehensive, but the detailing of the procedures varies. The chapters should be reviewed and procedures harmonised where possible. One should consider introducing general forms or guidance for recording status parameters as well as results from calibrations. A separate guideline/ chapter covering the topic of filter weighing and weighing room conditions should be added.

The guidelines for real time sampling and analysis need to be updated regarding calibration methods, maintenance of sampling manifolds, leak checks and new measurement methods. A data validation procedure should be included in the guideline and the network operator should be required to periodically resend finally quality controlled data to the CPCB data base. Due to the lack of manual data validation, one has assume that the CPCB data base includes invalid 15 minute averages.

Technical support for Air Quality Management Plans in Uttar Pradesh and Bihar

Task 5: Evaluation of Indian guidelines for air quality monitoring

1 Introduction

This note gives recommendations for possible improvements in Indian ambient air quality monitoring guidelines. CPCB guidelines were inspected and managers at UPPCB and BSPCB interviewed. The observations are not necessarily exhaustive and recommendations in one document or procedure may apply to other similar documents and procedures as well.

Air quality monitoring in Uttar Pradesh and Bihar is assessed by two types of stations, National Manual Air Monitoring Program (NMAP) using manual samplers and Continuous Automatic Air Monitoring Stations (CAAMS) using automatic analysers.

CAAMS stations are usually installed and operated by private companies. The company will provide all required instrumentation and accessories, together with a custom-made quality system. This quality system covers all activities and documentation intended to ensure the data quality objectives set by the authorities. It is supposed to be compliant with Indian guidelines generated by CPCB.

2 Indian air quality guidelines

Three guidelines were identified

- Guidelines for Ambient Air Quality Monitoring
  (National Ambient Air Quality Monitoring Series: NAAQMS/ ... /2003-04)
- Guidelines for the Measurement of Ambient Air Pollutants Volume-I, Guidelines for Manual Sampling & Analyses (National Ambient Air Quality Series: NAAQMS/36/2012-13)
- Guidelines for the Measurement of Ambient Air Pollutants Volume II, Guidelines for Real Time Sampling & Analyses (National Ambient Air Quality Series: NAAQMS/37/2012-13)

The Guidelines for Ambient Air Quality Monitoring and Vol I and II partly overlap. Not all methods described in Volume I and II are described in the Guidelines for Ambient Air Quality Monitoring. Usually the Guideline is more detailed than Volume I and II. All guidelines should be consulted to get the whole picture of a measurement method.

The Guidelines for Ambient Air Quality Monitoring covers measured parameters and air quality standards (limit values), site selection and classification, calibration methods, calibration facilities at CPCB, calibrations standards (gasses, thermometer, flow measure, etc) and description of measurement methods. The guideline does not include any forms for registration of observations.

The guidelines for measurements (Vol 1 and 2) focus more on the operation of instruments and analysis of samples.

3 Guidelines for Manual Sampling & Analyses, Volume-I

The guidelines include procedures for operating manual samplers. The detailing of the procedures varies. The Guidelines for determination of $PM_{2.5}$ in ambient air (Gravimetric Method) cover 16 pages and includes description of interferences and artefacts, precision and accuracy, siting requirements, apparatus and materials, leak checking, temperature and pressure sensors checking and calibration,

etc. On the other hand, the Guidelines for sampling and analysis of Particulate Matter (PM_{10}) in ambient air (Gravimetric Method) cover only 4 pages. Some of the sections in the first guideline will probably apply to the second guideline as well, such as the more stringent environmental requirements during filter conditioning, blank filters and conditions for weighing.

The Guidelines for determination of $PM_{2.5}$ in ambient air also provides recommendations for filter weighing and introduces requirements regarding equipment and infrastructure. This topic is broad and concerns other types of filters as well. One should consider putting it in a separate stand-alone chapter. The topic of quality control is mentioned in each chapter. However, it includes neither instrument-specific checks nor schedules for these checks.

Several forms for reporting data are included at the end of the guidelines. There are no forms or guidance for recording status parameters and results from calibrations.

Guidance on on-going quality control and maintenance can be found in various international CEN standards, |R1|, search for committee CEN/TC 264. More specific guidance on PM_{10}/ $PM_{2.5}$ sampling can be found in CEN standard "Ambient air - Standard gravimetric measurement method for the determination of the PM_{10} or $PM_{2,5}$ mass concentration of suspended particulate matter", chapter 7, |R2|.

4 Guidelines for Real Time Sampling & Analyses, Volume-II

The guideline includes procedures for operating automatic analysers. The Guidelines for Automatic Measurement of Sulphur Dioxide in ambient air was inspected. The procedure states that the zero/span check system at the station is suitable for quality control only and shall not be used for calibration. The span source should regularly be compared to a laboratory-based calibration system. Alternatively, it may be compared to a transfer standard, e.g. low concentration gas cylinder, at the station. Calibration frequency is left to the operator to decide based on the drift performance of the analyser. Zero/Span checks and recording of operational parameters shall be made at least once a week, and the analyser serviced once or twice a year based on the performance of the analyser. Span gas generation using high concentration gas cylinders and a dilution unit is only mentioned, but not described. There is no requirement for recording analyser response to zero and span gas before adjusting zero and gain. Multipoint calibration is required, but no period is specified. The frequency of routine periodic calibration is left the operator to decide based on experience.

The guideline includes a check of the sample flow rate. If it is too low, one should change the inlet filter. There is no suggested action if the flow rate remains too low after filter change. There is no requirement for leak checks although leaks are the most common fault in analysers.

Specific quality control operations should be introduced in all chapters i.e. for each instrument type. Typical quality control activities include leak checks, flow checks, pressure sensor checks, temperature sensor checks, linearity checks and converter checks The required frequency of these activities shall not be left to the appreciation of the operators. Performance criteria and required schedule should be clearly presented in the guidelines by using table formats.

There is no requirements for checking and cleaning the inlet manifold, tubes and filter holder. It is recommended that the analyser be fully serviced every 6 month or annually.

High temperatures and high relative humidity conditions are commonly found in India. All Indian CAAMS are therefore equipped with a sampling manifold upstream all gas analyser inlets. The latter typically consists of a heated tube made of inert material (e.g. borosilicate glass) connected to an extraction fan. The design shall be adequate in order to ensure short sample residence time of the

sampled air inside the manifold. It is supposed to avoid analysers to be flooded with condensation water and shall provide all gas analysers with chemically unaffected outdoor air. A guideline covering this topic should be included. A stringent quality control should be introduced given that this CAAMS component may influence all gas measurements. Short sample residence time, airtightness and cleanliness of the sampling manifold should be ensured at all times when gas analysers are measuring.

The guideline refers to the document ISO 10498.2. 1999 Ambient Air - Determination of Sulphur Dioxide - Ultraviolet Fluorescence method. The document is outdated. The latest version is from 2004.

The Guidelines for Automatic Measurement of Particulate Matter ($PM_{2.5}$ and PM_{10}) was inspected. The guideline seems to refer to a specific analyser brand and model, the BAM 1020 beta gauge particulate monitor. There is no description of the TEOM analyser although it is included in several forms.

Since the publishing of the guidelines, several new measurement methods have emerged. The classical TEOM 1400 fails to measure volatile organic compounds (VOCs) because they evaporate in the heated inlet of the analyser. Its successor, the TEOM 1405F PM analyser, is able to measure the VOCs by measuring the evaporation. Measurement of particulates based on the principle of light scattering is offered by several producers, such as Grimm, Pallas and Envea. The classical NO_2 measurement method is based on converting NO_2 to NO and letting NO react with O_3 back to NO_2 while measuring the emitted light from the reaction. An alternative method is based on spectroscopy (CAPS) where NO_2 is measured directly without chemical reactions. The measurement principle is offered by several producers, such as Envea, Teledyne API and ACOEM.

Averaged data from automatic analysers are transferred directly to the CPCB data base every 15 minutes in a prescribed format (see “Protocol for Data Transmission from CAAQM Stations Existing as on Date”). The format includes 2 status flags, one indicating calibration activity and one indicating maintenance activity. Flagged values will not be considered for averaging purposes. In addition, there is an option for adding a remark, presumably predefined. Faults not captured by the flagging may cause invalid data to be averaged and transferred to the CPCB data base. This is adequate for online display of data to the public, but not for air quality assessment, because decisions may be based on invalid data. Typical errors that may cause transfer of invalid data are leaks, failing pumps, falling converters in NO_x analysers, failing scrubbers in O_3 analysers, ruptured inlet filters, etc. Even if the error is discovered at the next daily visit, the last 24 hours of data may be invalid and already transferred to CPCB. There is no procedure or requirement in the guidelines for updating the flagging or the averaged values after the online transfer to CPCB. In addition, there is no requirement or procedure for validating data from automatic analysers. It must be expected that CPCB data base includes invalid 15 minute averages.

The network operator is the only institution having detailed knowledge about the condition of the instruments. They should perform a post validation of the data and flag invalid data manually. The operator should resend the finally quality controlled data to the CPCB data base. A suitable data validation period is 1 month. It is sufficient to detect slow changes in the zero level, periods of constant levels, values below zero, noise close to zero, spikes, sudden drops, etc. The data series may also be compared to similar or neighbouring stations to see if trends are reasonable. Data may also be validated based on observations from the daily/ weekly station visits.

Several forms for reporting data are included at the end of the guidelines. There are no forms for recording status parameters (e.g. zero response, span response, gain, flow rate, vacuum, lamp intensity, voltage, etc.), and no forms for recording results from calibrations.

Guidance on on-going quality control and maintenance can be found in various international CEN standards, |R1|, search for committee CEN/TC 264. More specific guidance on e.g. NO_x monitoring can be found in CEN standard "EN 14211:2005, Ambient air quality - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence", chapter 9, |R3|.

5 Documents on CPCB web site

The following documents are available for download from the CPCB web site:

- Field Data sheet cum receipt of Source Samples
- Field Data sheet for Ambient Particulate Matter Sampling (SPM/PM10)
- Field Data sheet for Ambient Gaseous Sampling (SO2/NO2)
- Field Data sheet for Ambient Particulate Matter (PM2.5) Sampling
- Field Data sheet for Source Emission Monitoring
- Protocol for Data Transmission from CAAQM Stations Existing as on Date

They are all dated 25.09.2020 and are of course newer than the forms in the guidelines. The last document is dated 30.04.2015.

6 Recommendations

For both guidelines, quality control operations should be better defined, together with performance criteria and schedules.

Guidelines for Ambient Air Quality Monitoring Vol I:

- It should be reviewed and the procedures harmonised where possible
- General forms for recording status parameters should be included
- General forms for recording results from calibrations should be included
- A separate guideline covering the topic of filter weighing and weighing room should be added

Guidelines for Ambient Air Quality Monitoring Vol II:

- Span gas generation using high concentration gas cylinders and a dilution unit should be described
- A guideline for design and maintenance of sampling manifolds should be introduced.
- Analyser response to zero and span gas should be recorded before adjusting zero and gain
- Requirement for leak checks should be included
- References to outdated documents should be updated
- If the TEOM analyser is in use it should be described. If not, references to TEOM should be deleted
- New measurement methods should be included in the guidelines
- A data validation procedure should be included in the guideline, and the network operator should be required to periodically resend finally quality controlled data to the CPCB data base
- General forms with performance criteria for recording status parameters, Z/S check results and leak check results should be included
- General forms with performance criteria for recording results from calibrations should be included

An alternative to including forms for recording status parameters and results from Z/S checks and calibrations, is to include a requirement for the contractor to establish such documents. This is probably better because the forms are often instrument specific.

7 References

|R1| CEN standards on air quality
https://standards.cencenelec.eu/dyn/www/f?p=205:105:0:::::

|R2| EN 12341:2014, Ambient air - Standard gravimetric measurement method for the determination of the PM10 or PM2,5 mass concentration of suspended particulate matter, CENELEC

|R3| EN 14211:2005, Ambient air quality - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence, CENELEC

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