

## **Chapter 15**

### **Quality Systems Audit Criteria and Procedures for Evaluating Ambient Air Monitoring Networks**



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## 1.0 Introduction

This chapter serves as a guideline for ambient air monitoring network evaluations performed by the Indiana Department of Environmental Management (IDEM), Office of Air Quality, Quality Assurance Section (QAS). These evaluations are performed on all organizations (state, local, and industrial/consultant) that report data to the Air Quality System (AQS) database for the state of Indiana. The data is used for statistical analysis and to determine compliance with federal and state air pollution regulations. These network evaluations assist the State in determining the quality of the air monitoring programs in general and the accuracy and reliability of the data being collected. The evaluations are performed in accordance with 40 CFR Parts 50 and 58. Topics covered in this chapter include:

- Ambient air monitoring and quality assurance project plan (QAPP) ambient monitoring contents
- QAPP review
- Quality systems audit procedures

The criteria and guidelines used for the evaluations will depend partly on the reason for the monitoring (e.g., Prevention of Significant Deterioration, SO<sub>2</sub> Rules (326 IAC 7-3-2), Agreed Order, Special Purpose Monitoring, or the State Implementation Plan).

This chapter covers general information on the evaluation process. Additional reference information is provided for select sections. For detailed information on monitoring of specific parameters, refer to the appropriate chapters of this manual.

## 2.0 Ambient Monitoring and Quality Assurance Project Plan

An organization or industry that secures an air quality permit often is required to operate an air-monitoring network to collect evidence of degradation to the ambient air. The requirements for ambient air monitoring are identified in the air quality permit, which can be reviewed using the IDEM Air Quality Permit Status Search ([www.in.gov/ai/appfiles/idem-caats/](http://www.in.gov/ai/appfiles/idem-caats/)) and searching the permit for “ambient monitoring requirements.”

The guidelines for operating the air-monitoring network are collected in a document called the Air Monitoring QAPP. This document provides information on the operation of the network including, but not limited to, monitoring equipment standard operating procedures (SOPs), quality assurance (QA) procedures, and data management. The Air Monitoring QAPP may be written as stand-alone document or may be separated into two plans: a site monitoring plan and a QA plan.

Quality assurance project plan (QAPP) specifications are detailed in “EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA/240/B-01/003, March 2001)” and additional guidance is provided in “Guidance for Quality Assurance Project Plans, EPA QA/G-5, (EPA/240/R-02/009, December 2002)”. These documents divide the plan into four element groups covering:

- Project management
- Data generation/acquisition
- Assessment and oversight
- Data validation/usability

Each element group is further divided into elements covering different topics, for a total of 24 elements. **Not all elements will pertain to every monitoring project**; in addition, the amount of detail for each element will depend on the type of project, the data obtained, the decisions made, and the consequences of potential errors. More in-depth information on each of the elements can be found in “[Guidance for Quality Assurance Project Plans, EPA QA/G-5,](#)” (EPA/240/R-02/009, December 2002)”.

## 2.1 Group A - Project Management Elements

The project management elements address administrative functions, project goals and approaches, and should provide the information in the following sections.

- A1. Title and Approval Sheet – This element identifies the project, key officials, and documents the approval of the project plan. It may contain the following information:
  - Title
  - Submitting organization’s name
  - Consultant name, if applicable
  - Location (city, state)
  - Date
  - Document number, if applicable
  - Provisional page for approval signatures of all parties involved
- A2. Table of Contents Page – This element lists the different information sections of the plan.
- A3. Distribution List – This element contains a listing of all individuals and organizations receiving a copy of the plan.
- A4. Project Organization – A section that identifies the key individuals involved with the project and their respective roles and responsibilities. It should include the principal data users, the decision makers, the project QA officer, and all those responsible for project implementation. It also should include other data users outside of the organization generating data (e.g., for whom the data is intended), and should identify any subcontractor relevant to environmental data operations, including laboratories providing analytical services. A concise organization chart should be included showing lines of authority and lines of reporting responsibility.

- A5. Problem Definition/Background and Project Objective(s) – A narrative stating the specific problem to be solved, decision to be made, or outcome to be achieved. There should be sufficient background information to provide a historical, scientific, and regulatory perspective. It should state the reason for the monitoring (e.g., Prevention of Significant Deterioration, SO<sub>2</sub> Rule (326 IAC 7-3), Agreed Order, Special Purpose Monitoring, or State Implementation Plan) and the applicable National Ambient Air Quality Standards (NAAQS). The current NAAQS values can be found on the USEPA website <https://www.epa.gov/criteria-air-pollutants>. The data quality objectives (DQOs) should be defined in this section. DQOs are qualitative and quantitative statements that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. (Ref: “[Guidance on Systematic Planning using the DQO Process, EPA QA/G-4](#), (EPA/240/B-06/001, February 2006)”).
- A6. Project/Task Description – This section provides a management summary of all work to be performed, measurements to be taken, and the schedule for implementation of the project. It may include an introductory map showing the geographic locations of field tasks.
- A7. Quality Objectives and Criteria for Measurement of Data – This section describes data quality indicators of the project (e.g., the measurement quality objectives (MQOs) for each parameter to be collected). MQOs are designed to evaluate and control various phases (sampling and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the data quality objectives. MQOs for each of the ambient air criteria pollutants can be found in USEPA’s “Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, (EPA-454/B-17-001, January 2017)”. MQOs can be defined in terms of the following data quality indicators:
- Precision
  - Bias
  - Representativeness
  - Detection limit
  - Completeness
  - Comparability
- A8. Special Training/Certifications – This section describes any specialized training or certifications needed by personnel in order to complete the project or task. It should discuss how such training is to be provided and how the necessary skills are assured and documented.

- A9. Documents and Records – This section itemizes all the documents and records that will be produced, such as final reports, performance evaluation (audits), and QAPP revisions. It also lists field logs, sample preparation and analysis logs, laboratory analysis, instrument printouts, model inputs and outputs, data from other sources such as databases or literature, and the results of calibration and QC checks. Copies of example data sheets should be included in an appendix of the plan.

## 2.2 Group B - Measurement and Data Acquisition Elements

The elements in this section address data generation, data acquisition, and data management activities.

- B1. Sampling Process Design – This section is a description of the data collection design and needs to define the key parameters, the types and numbers of samples, the design assumptions, the mechanics of data collection (the where, when and how samples are to be taken), and the rationale for the design. It should include the following activities:
- Developing and understanding the monitoring objective(s) and appropriate data quality objectives. It should review the permit status and the length of time that is mandatory for monitoring (including the expected start date of the project). The description needs enough detail so that the reviewer can determine compliance with the conditions stated in the permit. The reviewer is encouraged to use the on-line IDEM Air Quality Permit Status Search ([www.in.gov/ai/appfiles/idem-caats/](http://www.in.gov/ai/appfiles/idem-caats/)) to locate the reporting organization's operating permit for further information.
  - Identifying the appropriate NAAQS requirements for the project.
  - Identifying the spatial scale most appropriate for the site(s) monitoring objective.
  - Identifying the general site location(s) where monitoring site(s) should be placed. The monitoring network needs to be designed to meet the project's objectives. In most cases, a computer model and other pertinent information (e.g., historical meteorological conditions) were used to locate the high impact area in which the sites are to be located. The name of the model, the model input parameters, and the modeling results should be included. For IDEM, the Technical Support and Modeling Section of the Air Programs Branch provides useful information on where to locate a site. The dispersion model used is the U.S. EPA preferred model - AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model). Model inputs include the pollutant emission rates, stack parameters (stack heights and stack diameters, stack gas temperature and flow rates), width/length/height of nearby buildings, hourly meteorological data (temperature, wind speed/ direction, humidity and solar radiation) from a nearby weather station, terrain elevations and several other parameters. Model outputs are calculated based on the health-based time-averaged period of each pollutant's National Ambient Air Quality Standard and are expressed in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ).
  - Identification of specific monitoring sites. This section should provide general information regarding the site (address, AQS identification number) and how the site conforms to siting criteria. This section will include type of ground cover, topography

of the site, land usage surrounding the site, and general meteorological conditions of the area. Photographs of the site, photographs of the cardinal and ordinal directions surrounding the site, and topographic maps or aerial photographs, should be included, if possible. The site description also must include Universal Transverse Mercator (UTM) coordinates, longitude, and latitude coordinates; elevation of the site; and any other references useful in locating the air-monitoring site via geographical information systems (GIS).

B2. Sampling Methods – This section should describe the procedures for collecting the samples; identify the sampling methods (including the names, models, and manufacturers of all equipment); equipment calibration and maintenance; and specific performance requirements. In addition, it should describe the support equipment (e.g., audit/calibration equipment, meteorological equipment) used to verify and validate the air data. To establish the basic validity of such air monitoring data, it must be shown that:

- The proposed sampling method complies with the appropriate testing regulations (e.g., the USEPA equivalency numbers for the analyzers used in the network).
- The equipment is accurately sited, including descriptions of shelters and environmental controls for heating and cooling necessary to maintain the shelter's environment; and information on the sampling train (e.g., material type, length, and residence time of the sampling train; probe inlet height).
- The equipment is accurately calibrated using correct and established calibration methods (e.g., all calibration and auditing equipment necessary for the monitoring project must be listed).
- The organization implementing the data collection operation is qualified and competent. This section describes the methods for operating the equipment and the collection of data. It should include all SOPs for the operation of the monitoring and meteorological equipment and site visit procedures by the station operator. Included in this section is information on corrective actions to be taken, when problems occur; and documentation of the problem and corrective actions undertaken.

Some of this information may be provided in the appendices by specific reference to existing equipment, equipment specifications, methods, field/laboratory SOPs, and (QA/QC) manuals.

B3. Sample Handling and Custody – This section describes the requirements for sample handling and custody. This section is important when the project plan requires filter based sampling.

- Sample handling – The various phases of sample handling are sample labeling, sample collection, and sample transportation.
- Chain of Custody – If the results of a sampling program are to be used as evidence, a written record must be available tracking location and possession of the sample/data at all times.

Sample handling forms, sample custody forms, and the associated SOPs can be included in the appendices.

- B4. Analytical Methods – This section identifies the analytical methods and equipment required for the analysis of ambient air samples. Generally, these are manual sample collection methods for lead and particulates, with subsequent laboratory analyses (including filter-weighing analysis).
- B5. Quality Control – QC is the overall system of technical activities that measures the attributes and performance of a process, equipment, or service against defined standards to verify that they meet the stated requirements defined in this plan. This section describes the QC activities and the frequency of the activities that will be used to control the monitoring process to validate sample data. These activities include internally performed QC checks (e.g., span, precision, zero checks, flow checks); and the use of filter and field blanks for a particulate network.

In addition, this section must state the control limits, standards traceability, and describe the corrective action to be taken when control limits are exceeded. Data QA/QC requirements should be summarized in table format (e.g., Data Validation Tables) for each parameter to be measured. These validation tables define criteria for accepting or rejecting pollutant and meteorological data.

- B6. Instrument/Equipment Testing, Inspection and Maintenance – This section discusses the procedures used to verify that all instruments and equipment are maintained in sound operating condition and are capable of operating at acceptable performance levels. Elements to include in Instrument/Equipment Testing, Inspection and Maintenance documents are the following:
- Equipment lists – by monitoring group or station.
  - Spare equipment/parts lists – by equipment, including suppliers.
  - Inspection/maintenance frequency – by equipment.
  - Equipment replacement schedules.
  - Sources of repair – by equipment.
  - Monthly check sheets and entry forms for documenting testing, inspection, and maintenance performed.
  - SOPs for equipment testing, inspections, and maintenance (this documentation can be included in the Appendices).
- B7. Instrument/Equipment Calibration and Frequency – This section identifies all instruments and other sampling, measuring, or test equipment used for data collection activities that must be calibrated to maintain performance within specified limits and be representative of the ambient environment to be measured. It identifies certified equipment and the procedures used for calibration. It identifies the standards (e.g., primary, secondary); their traceability to known master standards; and their certification/verification and expiration

dates. For standards where certification extends over a measurement range (e.g., thermometers, flow meters), this section also specifies the range over which these respective standards are traceable. This section also specifies how records of calibration are to be maintained. Documentation should be readily available for review and should include calibration data, calibration equations, analyzer identification, calibration date, analyzer location, shelter temperature at the time of the calibration, calibration standards used and their traceability, and the person conducting the calibration.

- B8. Inspection/Acceptance of Supplies and Consumables –Describes how and by whom supplies and consumables (e.g., standard materials and solutions, filters, tubing, volumetric glassware, gas manifolds, sample bottles, water purity, calibration gases, reagents, electronic data storage media) are inspected and accepted for use in the project. The acceptance criteria should be stated.
- B9. Non-direct Measurements – This section identifies the type of data needed for project implementation or decision-making that is obtained from non-measurement sources such as maps, charts, GPS latitude/longitude measurements, computer databases, programs, literature files, and historical databases (e.g., climatology). It describes the acceptance criteria for the use of such data and specifies any limitations to the use of the data.
- B10. Data Management – This section describes the project data management process, tracing the path of the data from generation to final use or storage. It discusses the control mechanism for detecting and correcting errors as well as performance evaluation of the data management system.

### **2.3 Group C - Assessments and Oversight Elements**

This section of the report details what assessments or evaluations will occur during and after the project and is designed to assess whether the plan is being implemented as approved. It should include, as a minimum, the following sections.

- C1. Assessments and Response Actions – This section describes the evaluation processes and criteria used to measure the performance or effectiveness of the QA/QC system, the monitoring network, and various data quality indicators. These assessments include, but are not limited to:
- Management systems reviews
  - Network reviews
  - Technical systems audits
  - Performance audits (accuracy) by an independent external party
  - Data quality audits
  - Corrective action reports and corrective action responses

This section will specify the frequency, acceptance criteria, and type of project assessments to be undertaken. It describes how and to whom the results of the assessment

are reported; and discusses how response actions to assessment findings, including corrective actions for deficiencies and non-conforming conditions, are to be addressed and by whom. It discusses the process for revising an approved AMQAPP, if necessary.

- C2. Reports to Management – This section describes the frequency, content, responsible individual, and distribution of assessment reports to management and other recipients. These reports include the following:
- QA annual report: submitted to the U.S. EPA R5 quality manager each January by the IDEM QA Section.
  - Network reviews: submitted to the U.S. EPA R5 air monitoring Section Chief annually by the Ambient Monitoring Section.
  - Quarterly reports and the submission of AQS compatible parameter data and precision/accuracy reports. Data submission formats for AQS can be found on the USEPA website <https://www.epa.gov/aqs>. Parameter data is submitted by the Ambient Monitoring Section within 90 days from the end of the quarter. QA data is submitted by the QA Section within 120 days from the end of the quarter.
  - Performance audit reports: submitted to the PQAQO by the IDEM QA Section once the audit is completed.
  - Corrective action reports and corrective action responses: This is submitted by the QA Section Chief to the U.S.EPA R5 quality manager within a specific time following the occurrence.
  - NAAQS exceedance reporting: The NAAQS exceedance is evaluated by the QA Section and then a report is submitted to the IDEM Ambient Monitoring Section Chiefs. This includes the investigation into the cause of the high values and any corrective actions undertaken to prevent a recurrence.

#### **2.4 Group D. Data Validation and Usability Elements**

The elements in this group address the final project check to determine if the data obtained will conform to the project's objectives, and to estimate the effect of any deviations.

- D1. Data Review, Verification, and Validation Requirements – The purpose of this section is to state the criteria used to review and validate (that is, accept, reject or qualify) data in an objective and consistent manner. It is a way to decide the degree to which each data item has met its quality specifications as described in the Measurement and Data Acquisition Elements.
- Data verification is the process for evaluating the completeness, correctness, and conformance of a data set against method, procedural, or contractual specifications.
  - Data validation focuses on the quality of the data relative to the project's specifications and needs.
- D2. Validation and Verification Methods – This section describes the process for validating

and verifying data. It discusses how issues are resolved and identifies the authorities for resolving such issues. It describes how the results are to be conveyed to the data users. Any project-specific calculations are identified in this section.

- D3. Reconciliation with User Requirements – The purpose of this section is to outline and specify the acceptable methods for evaluating the results obtained from the project. It includes scientific and statistical evaluations to determine if the data are of the right type, quantity, and quality to support the intended use.

## **2.5 Group E. Appendices**

This portion of the plan should include illustrations necessary to clarify information in the plan, references used to document requirements, any forms used for audits and calibrations, and other documentation that provide additional details for the plan. SOPs may be found in this section as well.

## **3.0 Ambient Monitoring and Quality Assurance Project Plan Review and Approval**

Prior to initiating any monitoring, the QAPP must be submitted to the IDEM Air Monitoring Branch for review and approval. The submitted plan does not have to contain all the QAPP elements or have to follow the sequence of elements listed in Section 2.0, but must contain all the necessary information to perform the project. The Ambient Monitoring Branch reviews the QAPP to ensure the proposed network meets all applicable regulations and guidelines concerning operation of an ambient air network. For those monitoring networks that are their own primary quality assurance organization (PQAO), their QAPP will be sent to USEPA for review once IDEM QA Section completes their review.

Upon receipt of the QAPP from the submitting organization, it is given to a reviewer, normally the QA staff member responsible for the industrial evaluations. The reviewer may contact any branch staff member, who has been designated as a plan reviewer, to assist with the review. A time frame must be developed so all applicable participants in the review process have adequate time to review and comment on the plan, but short enough so that the plan can be returned to the submitting organization within a reasonable time.

To assist the reviewer, QAPP check sheets are available in Appendix C of the “Guidance for Quality Assurance Project Plans (QA/G-5) (EPA/240/R-02/009, December 2002)”. After reviewing the plan, the reviewer(s) shall prepare a list of requirements or recommendations that need to be added, deleted, edited, or corrected to make the plan a better and more complete document. Requirements are procedures that must be met, while recommendations are made to ensure procedures are consistent for similar plans throughout the state.

After the list of requirements and recommendations, if any, has been compiled, an approval/recommendation letter is written by the QAS with comments stating those requirements and recommendations needed to make the plan complete. The comments are then sent back to the reporting organization and any involved parties, pending any required changes in operation

or documentation. Reviewing the QAPP prior to the project start date is an effective way to catch procedural errors early.

Revisions and updates to the plan also must be reviewed as changes occur to the network.

#### **4.0 Ambient Air Monitoring Quality Systems Audit**

The QAS attempts to perform an annual ambient air monitoring systems assessment of all industries that submit ambient air monitoring data to USEPA's AQS. An ambient air monitoring quality systems audit is an evaluation process used to evaluate the performance or effectiveness of a system and its elements, and consists of the following:

- A data quality assessment – a scientific and statistical evaluation of validated data to determine if the data are of the right type, quality, and quantity to support their intended use.
- A technical assessment – a qualitative examination of a monitoring network to determine whether environmental data collection activities and its related results comply with the network's QAPP.
- A performance evaluation – a type of audit in which the quantitative data generated in a measurement system are independently obtained and compared with routinely obtained data to verify the performance of the equipment.

Additional information on the various types of audits and assessments can be found in "Guidance on Technical Audits and Related Assessments for Environmental Data Operations (EPA QA/G7) (EPA/600/R-99/080, January 2000)". Each PQAQO also has a technical systems audit conducted by USEPA on a three year cycle.

#### **5.0 Quality Systems Audit Procedures**

The evaluation process begins by contacting the site operators approximately 30 days prior to the evaluation, to schedule a site visit date. Once a date for a site visit is finalized, documentation on the site operator is reviewed to ensure the information is up-to-date. Information to review includes pictures, maps, a site evaluation form (Form 1), and specific information on the air monitoring networks. If all sites in a network cannot be visited, the sites with the most problems during the last evaluation and the sites which have not been evaluated in the previous year will have priority. The evaluation process generally involves reviewing all documentation, reviewing certification information, checking siting criteria, conducting performance evaluations, and evaluating operator technique. A record of all of this information should be on file with State QA. This process is followed with a detailed correspondence describing program deficiencies with recommendations that may improve the monitoring network performance. A follow-up letter is sent to State QA stating how the deficiencies were addressed.

## 5.1 Data Quality Assessment

Prior to the site visit, a review should be performed of the monitoring network's previous year MQOs and operating data. The MQOs include the following:

- Precision
- Accuracy
- Bias
- Representativeness
- Detectability
- Completeness
- Comparability

Four MQOs (precision, accuracy, bias, and completeness) can be assessed quantitatively and the procedures for calculating the appropriate statistics of precision and bias are found in Appendix A of 40 CFR Part 58 and in Chapter 13 of the QA Manual. The data and statistics also have been compiled by USEPA's AQS and can be accessed via the following reports:

- Air Monitoring Program (AMP) 256, QA Data Quality Indicator Report (precision, bias, accuracy)
- AMP 430, Data Completeness Report (completeness)

The Quality Indicator Summary Data Report (AMP 256) provides statistical estimates of the precision, bias, and accuracy of criteria air pollutant monitor outputs, and summarizes the completeness of monitor checks (precision and accuracy data) from which the statistical estimates are derived. The Data Completeness Report (AMP 430) is a raw data report that generates a monthly count of the number of observations conducted by a monitor across a given time frame. It also calculates the percentage of valid observations that are collected within the month.

The data used in calculating the precision, bias, and accuracy statistics are found in the QA Raw Assessment Report (AMP 251). The QA Raw Assessment Report lists the precision value data pairs, raw accuracy value pairs, and calculates the percent difference between the reported values for a monitoring site(s). USEPA provides a stand-alone EXCEL application, the Data Assessment Statistical Calculator (DASC), for those inclined to calculate precision and bias statistics, at <https://www3.epa.gov/ttn/amtic/qareport.html>.

An annual statistical summary of the parameter data reported by air quality monitors can be accessed via the Maximum Values Report (AMP 440), and the Frequency Distribution Report (AMP 230). The Maximum Values Report (AMP440) presents site and monitor descriptive information as well as selected summary statistics including the number of observations, number of observations above the standard, maximum value, and the ten highest concentrations for the monitor during the given year. The Frequency Distribution Report (AMP230) presents site and monitor descriptive information as well as selected summary statistics including the number of

observations, number of observations above the standard, maximum value, and the defined percentiles for the system.

Additional information on the data collected by the network can be found in the Quick Look Report (AMP 450) and the Daily Summary Report (AMP 435). The Quick Look Report displays a unique format, for each of the criteria pollutants, designed to highlight special calculations that are derived for the given pollutant in order to determine compliance with the NAAQS. The Daily Summary Report (AMP 435) provides basic statistics for all reported sample data with durations of less than 24 hours. In addition to sample data, the daily summaries will include any criteria pollutant data (regardless of the sample duration) as well as summarized NAAQS averages, when applicable. The report will provide a tabular listing of the following daily statistics: average, number of samples, data capture rate for the day, maximum sample value, hour of the maximum sample value, and daily ranking.

## **5.2 Technical Assessment**

A technical assessment of the network is performed by reviewing calibrations, audits, and other documentation to ensure timelines are met and information is accurate. In addition, site operator procedures and documentation are compared to the procedures outlined in the monitoring site's QAPP. Other aspects of the assessment are to review the site logbook for information about analyzer drift, calibrations, specific problems with the instruments, and what actions were taken by the site operators. Furthermore, the site logbook should reveal if any data was invalidated and why. The filter logbook is checked to ensure QA limits and procedures are consistent with the AMQAPP.

### **5.2.1 Documentation**

The reporting organization's documentation is checked to ensure that all work performed is consistent with the 40 CFR Part 58, the "USEPA Quality Assurance Handbook for Air Pollution Measurement Systems", and the IDEM, Office of Air Quality, QA manual. The site logbook, quarterly reports, and other pertinent paperwork are reviewed to verify documentation is organized and useful. The following areas are examined by the QAS to verify that adequate documentation is maintained:

- Bi-weekly QC checks (precision) and quarterly accuracy audits
- Quarterly precision and accuracy reports for USEPA's AQS
- Certifications and calibrations

The documentation of the areas above are checked to ensure that calculations are performed correctly, audits are run in the correct concentration ranges, certifications, audits, and calibrations are performed in a timely manner. Documentation is also checked to answer the following questions:

- Was the indoor temperature sensor certified by the site operator? If so, was the certification documented?

- Are the accuracy audits performed with different equipment than that used to calibrate the analyzer?
- Are there periods of invalid data? If so, was the reason for the invalid data documented?

Prior to the evaluation, AQS precision and accuracy submittals are checked to ensure timely submittal, audit results are within limits, and audits are run in the appropriate concentration ranges.

Furthermore, if particulate monitoring is being performed, a well-organized logbook must be kept to ensure proper QA procedures are followed. If the company or agency performs particulate filter weighing, the QAS will check the following items:

- QA checks of initial and final weights, to ensure they are being performed and meet the limits for weight and minimum number of filters reweighed.
- The equipment used in the filter preparation area is certified (e.g., thermometers, relative humidity sensors, ANSI Class weights), and copies of certifications performed by the company or agency are being sent to the QAS.
- The balance checks are performed in the correct ranges.
- The filter cards are checked for chain-of-custody, pre and post sampling flow meter drift checks, and elapsed time 1440 minutes  $\pm$ 60 minutes.
- Filter handling and weighing procedures meet requirements (see Chapter 7, Measurement of Particulates).

If the company or agency performing the filter weighing is located out of state, a filter handling questionnaire is sent to the laboratory weighing the filters or performing any analysis (Form 2).

### **5.2.2 Certifications**

The reporting organization's certification information is reviewed to ensure that the transfer standards used for calibrations and performance evaluations (audits) are within the specified certification period, and whether the standards are certified through the QAS certification facility or other approved certified entity. This ensures that all transfer standards throughout the state are referenced back to primary standards used by the state of Indiana for uniformity and accuracy. The certifications must meet the time frames and criteria established in Chapter 6, Certification Methods of Transfer Standards of the QA Manual. If the agency or company performs its own certifications, then copies of these certifications must be sent to the QAS. All companies hired to perform calibrations, QC checks, or performance evaluation (audit) checks must also certify their transfer standards with the QA Section, if the air monitoring data is to be submitted to the AQS for the state of Indiana. Equipment certifications may be reviewed prior to the site visit by the QAS. Calibrations, QC checks, and performance evaluation (audit) checks records are reviewed to ensure a designated, certified piece of equipment is used for each procedure.

### 5.2.3 Site Description

The site description is a physical description of the monitoring site relative to its surroundings. Most of this information should be collected during the initial site visit. It involves:

- Obtaining cardinal and ordinal directional photographs surrounding the site.
- Collecting longitude, latitude, and elevation GPS coordinates.
- Obtaining a satellite map of the monitoring site and the surrounding area.
- Determining residence time, if applicable.
- Measuring distances to roadways and nearby obstructions.
- Measuring or estimating the heights of sample probes and nearby obstructions.

A site evaluation form provides specific site information on continuous and intermittent parameters (see Form 1). The form is completed upon the initial visit and checked during each audit. The meteorological parameters have additional site evaluation forms to ensure that the siting is adequate (see Chapter 9, Meteorological Systems). These forms, along with the photographs and maps of the site, are collected and saved electronically.

In addition to the cardinal and ordinal directional photographs around the site, photographs are taken of instruments at the sites. Additional photographs will be taken, if questionable siting criteria exist. A GPS unit may be used to evaluate the site geographic position (longitude, latitude, and elevation).

A detailed satellite map of the monitoring site can be downloaded from the Internet (Google, Bing) and relevant information (distances, directions, and heights of obstructions; ground cover; distances to the parameter source; etc.) can be superimposed on the satellite map.

Several items need to be considered when measuring distances to potential obstructions:

- The direction of the source
- Topography (e.g., influence of hills and valleys)
- Parameter siting requirements
- The type of monitoring
- The type of obstruction (trees or building).

The general rule to follow, when measuring for obstructions, is the 2 times rule. This rule states the distance to an obstruction must be at least twice the distance that the height of the obstruction extends above the inlet or probe. The siting is checked on every evaluation to ensure that changes have not occurred, such as new tree growth interfering with siting criteria.

### 5.3 Performance Evaluation

The performance evaluation is a quantitative assessment of the performance of continuous monitors, intermittent samplers, and/or meteorological parameters. The assessment follows the

guidelines of the “Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, (EPA-454/B-17-001, January 2017)” and pertinent parameter chapters of this manual. When auditing a continuous air monitoring analyzer, three or more audit levels from Table 1 are introduced into the analyzer and compared to the values observed from the analyzer. The results are compared against the MQOs of the monitoring network AMQAPP or the USEPA QA Handbook, and are a measure of analyzer performance.

**Table 1**  
**Audit Levels for Performing Performance Evaluations**

Audit Level	O <sub>3</sub> , ppb	SO <sub>2</sub> , ppb	NO <sub>2</sub> , ppb	CO, ppm
1	0.004 – 0.0059	0.0003 – 0.0029	0.0003 – 0.0029	0.020 – 0.059
2	0.006 – 0.019	0.0030 – 0.0049	0.0030 – 0.0049	0.600 – 0.199
3	0.020 – 0.039	0.0050 – 0.0079	0.0050 – 0.0079	0.200 – 0.899
4	0.040 – 0.069	0.0080 – 0.0199	0.0080 – 0.0199	0.900 – 2.999
5	0.070 – 0.089	0.0200 – 0.0499	0.0200 – 0.0499	3.000 – 7.999
6	0.090 – 0.119	0.0500 – 0.0999	0.0500 – 0.0999	8.000 – 15.999
7	0.120 – 0.139	0.1000 – 0.1499	0.1000 – 0.1499	16.000 – 30.999
8	0.140 – 0.169	0.1500 – 0.2599	0.1500 – 0.2599	31.000 – 39.999
9	0.170 – 0.189	0.2600 – 0.7999	0.2600 – 0.7999	40.000 – 49.999
10	0.190 – 0.259	0.8000 – 1.000	0.8000 – 1.000	50.000 – 60.000

Ref: *Office of Air Quality Planning and Standards technical memorandum, Subject: Use of Expanded List of Audit Levels for Annual Performance Evaluation for SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, and CO as described in 40 CFR Part 58 Appendix A Section 3.2.2, dated November 10, 2010.*

Intermittent audits consist of a one-point flow comparison with a QA calibrated orifice or certified flow transfer standard. The results should fall within the requirements outlined in the monitoring network’s QAPP or the MQOs outlined in the USEPA QA Handbook.

The meteorological audit procedures will vary with the parameter and follow the guidelines in “Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Version 2.0 (EPA-454/B-08-002, March 2008)”.

### **5.3.1 Site Safety Conditions and Site Cleanliness**

During the performance evaluation, information is collected on the safety conditions and the cleanliness of the site. The following items are checked for safety:

- Exterior electrical connections should not be exposed to the weather.
- Extension cords should not be cracked or brittle.
- Ladders and railings should be secure.
- Cylinders should be secured with a chain or tie down strap.
- Access to the site should be safe in general.

The following items are checked for cleanliness:

- A particulate sampler should be free of dust and dirt in the filter collection area and overall.
- The manifold used in continuous sampling should be free of dust and dirt.
- The candy cane used in continuous sampling should be free of dust and dirt.
- The sample lines going from the manifold to the continuous analyzers should be free of dust, dirt, and condensation.
- The continuous analyzers should be free of dust, dirt, and clutter.
- The overall condition of the site should be free of extra equipment, bent or rusty fencing, broken skirting, etc.

### **5.3.2 Intermittent Particulate Sampler Operations**

A lot of information can be collected by discussing the site procedures with the site operators. The following items are examples of information gathered when conducting an intermittent particulate sampling network evaluation and include, but are not limited to:

- Are the manometers leak checked prior to use?
- Is the thermometer placed out of direct sunlight?
- How is the barometric pressure taken?
- If the barometric pressure is taken from weather station information, is it corrected to station pressure?
- Who performs the flow audits and calibrations?
- Are elapsed time meters (ETMs) certified and if not, are the audits performed using uncertified ETMs?

### **5.3.3 Continuous Analyzer Operations**

The information collected when conducting a continuous analyzer network performance audit includes, but is not limited to:

- Is there a 5% offset on the strip chart?
- Do the values of the strip chart recorder match the data logger?
- Have the strip chart recorder and the data logger been calibrated?
- Is the analyzer within its calibration period?
- Are the calibrator and span tanks certified?
- Does the daily span/zero meet the drift limits for 24-hour periods?
- Is the sample train composed of nonreactive material? (e.g., Teflon, borosilicate glass)
- When the site operator performs audits, do they go through the sample inlet?
- If meteorological audits are being performed, is the audit equipment certified?

## **6.0 Ambient Air Quality Systems Audit Report**

A report of the quality systems audit will be forwarded to the monitoring site contact. The report will provide the results of the performance evaluation (instrument response to a known value or standard), summary of the data quality assessment, and any deficiencies noted in the technical assessment. In addition, recommendations for improving the air-monitoring program may be included.

## **7.0 References**

“EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA/240/B-01/003, March 2001)”

“Guidance for Quality Assurance Project Plans, EPA QA/G-5, (EPA/240/R-02/009, December 2002)”

“Guidance on Systematic Planning using the Data Quality Objective Process, EPA QA/G-4, (EPA/240/B-06/001, February 2006)”

“Guidance on Technical Audits and Related Assessments for Environmental Data Operations, (EPA QA/G7) (EPA/600/R-99/080, January 2000)”

“Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, (EPA-454/B-17-001, January 2017)”

“Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Version 2.0, (EPA-454/B-08-002, March 2008)”

## Form 1 Continuous and Intermittent Site Evaluation

Site Names: \_\_\_\_\_

Date: \_\_\_\_\_

**GPS**

Coordinates:     **N** \_\_\_\_\_

AQS #: \_\_\_\_\_

**W** \_\_\_\_\_

Auditors \_\_\_\_\_

**I.     Scale of Representativeness**

Parameter	Micro	Middle	Neighborhood	Urban	Regional	N/A
SO <sub>2</sub>						
CO						
CO <sub>2</sub>						
O <sub>3</sub>						
NO <sub>2</sub>						
NO <sub>y</sub>						
Pb						
Pb Collocated						
Metals						
Metals Collocated						
PM <sub>2.5</sub> - Int						
PM <sub>2.5</sub> - Int Collocated						
PM <sub>2.5</sub> - Cont						
PM <sub>2.5</sub> - Cont Collocated						
PM <sub>10</sub> - Int						
PM <sub>10</sub> - Int Collocated						
PM <sub>10</sub> - Cont						
Speciation - Met One /URG						
Black Carbon / UVC (Aeth)						

Met						
Toxics VOC						
Toxics Carbonyl						
Toxics Ozone Precursor						

Is this station category (a) Highest Concentration, (b) Population Exposure, (c) Background, (d) Upwind Background, (e) General Background, (f) Quality Assurance, (g) Regional Transport, (h) Source Oriented, (i) Max Prec. Em. Impact?

Parameter	Int PM <sub>2.5</sub>	Int Colo PM <sub>2.5</sub>	Int PM <sub>10</sub>	Int Colo PM <sub>10</sub>	Cont PM <sub>2.5</sub>	Cont Colo PM <sub>2.5</sub>	Cont PM <sub>10</sub>	Met One Spec	URG Spec	Aeth BC/UV
Category										
Parameter	O <sub>3</sub>	CO	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>2</sub>	Pb	Pb Colo	Toxics VOC	Toxics Carb	Toxics O <sub>3</sub> Prec.
Category										

**II. Probe Siting**

1. Height (2 meters min for gases/particulates)

Int PM <sub>2.5</sub>	Int PM <sub>10</sub>	Int Colo PM <sub>2.5</sub>	Int Colo PM <sub>10</sub>	Cont PM <sub>2.5</sub>	Cont Colo PM <sub>10</sub>	Cont Colo PM <sub>2.5</sub>	SO <sub>2</sub>	CO	CO <sub>2</sub>	O <sub>3</sub>	NO <sub>2</sub>
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
NO <sub>y</sub>	TSP Pb/metals	TSP Pb/metals	TSP Colo Pb/metals	Met One Spec	URG Spec	Aeth BC/UVC	Wind	OT	RH		
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
SR	UV	BP	Precip	Toxics VOC	Toxics Carbonyl	Toxics O <sub>3</sub> Pre					
_____	_____	_____	_____	_____	_____	_____					

2. Gas/particulate obstructions - Distance must be greater than two times the height of the obstruction, which extends above the probe. Are there any obstructions? (Yes / No) If yes, list parameter, distance to obstruction, direction of obstruction, and height above the probe.

3. The probe/inlet must be at least 10 meters or further from the drip line of trees. Is the gas/particulate probe greater than 10 meters from the drip line of trees? (Yes / No)

If less than 10 meters, list distance to tree, direction, and which parameter(s).

4. Is the PM sampler greater than two meters from walls, parapets, etc.? (Yes / No / NA) If not, how far?
5. Is the continuous monitoring probe greater than one meter from any walls or supporting structure? (Yes / No / NA) If not, how far?
6. Is the probe located away from dirty, dusty areas? (Yes / No)
7. 270° Rule - At least 270° (180° if located on the side of a building) around the sampler inlet must be unobstructed.

The 270° arc must include the predominant wind direction for the season of expected highest concentration. Does the sampler meet this rule? (Yes / No)

8. Is the PM sampler located in an area that is paved or has vegetative ground cover year round? (Yes / No / NA)
9. Are any furnace or incineration flues nearby? (Yes / No)

If yes, list the distance between the sampler or probe (which parameter) and the flue.

10. Distance to nearest traffic lane Street Name

Parameter	Int PM <sub>2.5</sub>	Int Colo PM <sub>2.5</sub>	Int PM <sub>10</sub>	Int Colo PM <sub>10</sub>	Cont PM <sub>2.5</sub>	Cont Colo PM <sub>2.5</sub>	Cont PM <sub>10</sub>	Met One Spec	URG Spec	Aeth BC/UV
Distance										
Parameter	O <sub>3</sub>	CO	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>2</sub>	Pb	Pb Colo	Toxics VOC	Toxics Carb	Toxics O <sub>3</sub> Prec.
Distance										

11. Are all probes, manifolds, candy canes, etc., constructed of FEP Teflon or borosilicate glass for gases except for toxics, which must have stainless steel for the sample line? (Yes / No / NA) If no, list parameter and material used.
12. If the samplers are collocated, do they meet distance requirements (horizontal distance within 1 – 4 meters and vertical distance is within 1 meter)? (Yes / No / NA)
13. For samplers/inlets not collocated, is there a minimum distance of 1 meter for low flow samplers/inlets and 2 meters if one or both of these is a high flow sampler/inlet? (Yes / No / NA) If no, list distance and specific parameters.
14. Residence Time:                      SO<sub>2</sub>    O<sub>3</sub>    NO<sub>2</sub>    CO  

\_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_

Residence Time must be less than 20 seconds. Less than 10 seconds is optimal.

15. Wind Obstructions – Distance must be greater than ten times the height of the obstruction which extends above the wind unit. Are there any obstructions? (Yes / No / NA) If yes, list the distance to the obstruction, direction

of obstruction, and height above the wind unit.

16. OT/RH Obstructions – Distance must be greater than four times the height of the obstruction which extends above the OT/RH unit. Are there any obstructions? (Yes / No / NA) If yes, list the distance to the obstruction, direction of obstruction, and height above the OT/RH unit.
17. Radiation Sensors – No obstruction that can cast a shadow on the unit. Are there any obstructions? (Yes / No / NA) If yes, list the distance and direction of the obstruction.
18. Precipitation – Distance must be greater than two times the height of the obstruction which extends above the unit. Also, nothing should interfere with precipitation getting into the unit or cause any splashing. Are there any obstructions? (Yes / No / NA) If yes, list the distance to the obstruction, direction of obstruction, and height above the precipitation unit.
19. Photos taken of the cardinal/ordinal directions, obstructions, and overall site? (Yes/No)

COMMENTS:

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### **Residence Time Information**

**If the site has a manifold and blower (list each pollutant where needed):**

Inner diameter of sample line from analyzer to manifold = \_\_\_\_\_

Inner diameter of manifold = \_\_\_\_\_

Inner diameter of sample line from manifold to inlet = \_\_\_\_\_

Length of sample line from analyzer to manifold = \_\_\_\_\_

Distance of sample line inside manifold to top of manifold = \_\_\_\_\_

Length of sample line from manifold to inlet = \_\_\_\_\_

Total flow at inlet = \_\_\_\_\_

Analyzer flow = \_\_\_\_\_

**If the site does not have a manifold and blower:**

Inner diameter of sample line = \_\_\_\_\_

Length of sample line = \_\_\_\_\_

Analyzer flow = \_\_\_\_\_

**Form 2**  
**Filter Handling Questionnaire**

Please answer the following questions. If any questions are answered no, please explain.

**Reporting Agency:** \_\_\_\_\_ **Date:** \_\_\_\_\_

	<u>Yes</u>	<u>No</u>
1. Is the temperature in the weighing facility kept between 15 °C to 30 °C?	_____	_____
2. Is the temperature in this room controlled within ±3 °C?	_____	_____
3. Is the humidity in the weighing facility kept below 50%?	_____	_____
4. Is the humidity controlled within ±5%?	_____	_____
5. Is your filter conditioning area free from all acidic or basic gases that might react with the filter media or the collected particulate matter during filter conditioning?	_____	_____
6. Is your analytical balance checked with Class 1 weights prior to weighing filters?	_____	_____
7. Does your company desiccate filters for approximately 24 hours prior to weighing filters before and after runs?	_____	_____
8. Does your company reweigh initial filter weights?	_____	_____
9. Does your company initially inspect filters for irregularities or inconsistencies in the filters?	_____	_____
10. Does your company reweigh exposed filters?	_____	_____
11. Does your company maintain bound filter logbooks?	_____	_____
12. Does your company send all pertinent filter information along with the monitoring report?	_____	_____
13. Does your company transport and store filters separately?	_____	_____
14. Does your company maintain filter information for at least three years?	_____	_____
15. How long after an intermittent sample is collected before the filter is received by the lab?	_____	
16. How long after the filter is received by the lab before the analysis is done?	_____	