

Subpart E [Reserved]

Subpart F—Air Quality Index Reporting

§ 58.50 Index reporting.

(a) The State or where applicable, local agency shall report to the general public on a daily basis through prominent notice an air quality index that complies with the requirements of appendix G to this part.

(b) Reporting is required for all individual MSA with a population exceeding 350,000.

(c) The population of a MSA for purposes of index reporting is the most recent decennial U.S. census population.

[71 FR 61302, Oct. 17, 2006]

Subpart G—Federal Monitoring

SOURCE: 44 FR 27571, May 10, 1979, unless otherwise noted. Redesignated at 58 FR 8467, Feb. 12, 1993.

§ 58.60 Federal monitoring.

The Administrator may locate and operate an ambient air monitoring site if the State or local agency fails to locate, or schedule to be located, during the initial network design process, or as a result of the 5-year network assessments required in § 58.10, a SLAMS station at a site which is necessary in the judgment of the Regional Administrator to meet the objectives defined in appendix D to this part.

[71 FR 61303, Oct. 17, 2006]

§ 58.61 Monitoring other pollutants.

The Administrator may promulgate criteria similar to that referenced in subpart B of this part for monitoring a pollutant for which an NAAQS does not exist. Such an action would be taken whenever the Administrator determines that a nationwide monitoring program is necessary to monitor such a pollutant.

[71 FR 61303, Oct. 17, 2006]

APPENDIX A TO PART 58—QUALITY ASSURANCE REQUIREMENTS FOR SLAMS, SPMs AND PSD AIR MONITORING

- 1. General Information
- 2. Quality System Requirements
- 3. Measurement Quality Check Requirements
- 4. Calculations for Data Quality Assessments
- 5. Reporting Requirements
- 6. References

1. General Information.

This appendix specifies the minimum quality system requirements applicable to SLAMS air monitoring data and PSD data for the pollutants SO₂, NO₂, O₃, CO, Pb, PM_{2.5}, PM₁₀ and PM_{10-2.5} submitted to EPA. This appendix also applies to all SPM stations using FRM, FEM, or ARM methods which also meet the requirements of Appendix E of this part. Monitoring organizations are encouraged to develop and maintain quality systems more extensive than the required minimums. The permit-granting authority for PSD may require more frequent or more stringent requirements. Monitoring organizations may, based on their quality objectives, develop and maintain quality systems beyond the required minimum. Additional guidance for the requirements reflected in this appendix can be found in the "Quality Assurance Handbook for Air Pollution Measurement Systems", volume II, part 1 (see reference 10 of this appendix) and at a national level in references 1, 2, and 3 of this appendix.

1.1 Similarities and Differences Between SLAMS and PSD Monitoring. In most cases, the quality assurance requirements for SLAMS, SPMs if applicable, and PSD are the same. Affected SPMs are subject to all the SLAMS requirements, even where not specifically stated in each section. Table A-1 of this appendix summarizes the major similarities and differences of the requirements for SLAMS and PSD. Both programs require:

- (a) The development, documentation, and implementation of an approved quality system;
- (b) The assessment of data quality;
- (c) The use of reference, equivalent, or approved methods. The requirements of this appendix do not apply to a SPM that does not use a FRM, FEM, or ARM;
- (d) The use of calibration standards traceable to NIST or other primary standard;
- (e) Performance evaluations and systems.

1.1.1 The monitoring and quality assurance responsibilities for SLAMS are with the State or local agency, hereafter called the monitoring organization, whereas for PSD they are with the owner/operator seeking the permit. The monitoring duration for SLAMS is indefinite, whereas for PSD the duration is usually 12 months. Whereas the reporting period for precision and accuracy data is on an annual or calendar quarter basis for SLAMS,

it is on a continuing sampler quarter basis for PSD, since the monitoring may not commence at the beginning of a calendar quarter.

1.1.2 The annual performance evaluations (described in section 3.2.2 of this appendix) for PSD must be conducted by personnel different from those who perform routine span checks and calibrations, whereas for SLAMS, it is the preferred but not the required condition. For PSD, the evaluation rate is 100 percent of the sites per reporting quarter whereas for SLAMS it is 25 percent of the sites or instruments quarterly. Monitoring for sulfur dioxide (SO₂) and nitrogen dioxide (NO₂) for PSD must be done with automated analyzers—the manual bubbler methods are not permitted.

1.1.3 The requirements for precision assessment for the automated methods are the same for both SLAMS and PSD. However, for manual methods, only one collocated site is required for PSD.

1.1.4 The precision, accuracy and bias data for PSD are reported separately for each sampler (site), whereas for SLAMS, the report may be by sampler (site), by primary quality assurance organization, or nationally, depending on the pollutant. SLAMS data are required to be reported to the AQS, PSD data are required to be reported to the permit-granting authority. Requirements in this appendix, with the exception of the differences discussed in this section, and in Table A-1 of this appendix will be expected to be followed by both SLAMS and PSD networks unless directly specified in a particular section.

1.2 Measurement Uncertainty. Measurement uncertainty is a term used to describe deviations from a true concentration or estimate that are related to the measurement process and not to spatial or temporal population attributes of the air being measured. Monitoring organizations must develop quality assurance project plans (QAPP) which describe how the organization intends to control measurement uncertainty to an appropriate level in order to achieve the objectives for which the data are collected. The process by which one determines the quality of data needed to meet the monitoring objective is sometimes referred to the Data Quality Objectives Process. Data quality indicators associated with measurement uncertainty include:

(a) Precision. A measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation.

(b) Bias. The systematic or persistent distortion of a measurement process which causes errors in one direction.

(c) Accuracy. The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combina-

tion of random error (imprecision) and systematic error (bias) components which are due to sampling and analytical operations.

(d) Completeness. A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.

(e) Detectability. The low critical range value of a characteristic that a method specific procedure can reliably discern.

1.3 Measurement Quality Checks. The SLAMS measurement quality checks described in sections 3.2 and 3.3 of this appendix shall be reported to AQS and are included in the data required for certification. The PSD network is required to implement the measurement quality checks and submit this information quarterly along with assessment information to the permit-granting authority.

1.4 Assessments and Reports. Periodic assessments and documentation of data quality are required to be reported to EPA or to the permit granting authority (PSD). To provide national uniformity in this assessment and reporting of data quality for all networks, specific assessment and reporting procedures are prescribed in detail in sections 3, 4, and 5 of this appendix. On the other hand, the selection and extent of the quality assurance and quality control activities used by a monitoring organization depend on a number of local factors such as field and laboratory conditions, the objectives for monitoring, the level of data quality needed, the expertise of assigned personnel, the cost of control procedures, pollutant concentration levels, etc. Therefore, quality system requirements in section 2 of this appendix are specified in general terms to allow each monitoring organization to develop a quality system that is most efficient and effective for its own circumstances while achieving the data quality objectives required for the SLAMS sites.

2. QUALITY SYSTEM REQUIREMENTS

A quality system is the means by which an organization manages the quality of the monitoring information it produces in a systematic, organized manner. It provides a framework for planning, implementing, assessing and reporting work performed by an organization and for carrying out required quality assurance and quality control activities.

2.1 Quality Management Plans and Quality Assurance Project Plans. All monitoring organizations must develop a quality system that is described and approved in quality management plans (QMP) and quality assurance project plans (QAPP) to ensure that the monitoring results:

(a) Meet a well-defined need, use, or purpose;

(b) Provide data of adequate quality for the intended monitoring objectives;

(c) Satisfy stakeholder expectations;

(d) Comply with applicable standards specifications;

(e) Comply with statutory (and other) requirements of society; and

(f) Reflect consideration of cost and economics.

2.1.1 The QMP describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, assessing and reporting activities involving environmental data operations (EDO). The QMP must be suitably documented in accordance with EPA requirements (reference 2 of this appendix), and approved by the appropriate Regional Administrator, or his or her representative. The quality system will be reviewed during the systems audits described in section 2.5 of this appendix. Organizations that implement long-term monitoring programs with EPA funds should have a separate QMP document. Smaller organizations or organizations that do infrequent work with EPA funds may combine the QMP with the QAPP based on negotiations with the funding agency. Additional guidance on this process can be found in reference 10 of this appendix. Approval of the recipient's QMP by the appropriate Regional Administrator or his or her representative, may allow delegation of the authority to review and approve the QAPP to the recipient, based on adequacy of quality assurance procedures described and documented in the QMP. The QAPP will be reviewed by EPA during systems audits or circumstances related to data quality.

2.1.2 The QAPP is a formal document describing, in sufficient detail, the quality system that must be implemented to ensure that the results of work performed will satisfy the stated objectives. The quality assurance policy of the EPA requires every environmental data operation (EDO) to have a written and approved QAPP prior to the start of the EDO. It is the responsibility of the monitoring organization to adhere to this policy. The QAPP must be suitably documented in accordance with EPA requirements (reference 3 of this appendix).

2.1.3 The monitoring organization's quality system must have adequate resources both in personnel and funding to plan, implement, assess and report on the achievement of the requirements of this appendix and its approved QAPP.

2.2 Independence of Quality Assurance. The monitoring organization must provide for a quality assurance management function- that aspect of the overall management system of the organization that determines and implements the quality policy defined in a monitoring organization's QMP.

Quality management includes strategic planning, allocation of resources and other systematic planning activities (e.g., planning, implementation, assessing and reporting) pertaining to the quality system. The quality assurance management function must have sufficient technical expertise and management authority to conduct independent oversight and assure the implementation of the organization's quality system relative to the ambient air quality monitoring program and should be organizationally independent of environmental data generation activities.

2.3. Data Quality Performance Requirements.

2.3.1 Data Quality Objectives. Data quality objectives (DQO) or the results of other systematic planning processes are statements that define the appropriate type of data to collect and specify the tolerable levels of potential decision errors that will be used as a basis for establishing the quality and quantity of data needed to support the objectives of the SLAMS stations. DQO will be developed by EPA to support the primary SLAMS objectives for each criteria pollutant. As they are developed they will be added to the regulation. DQO or the results of other systematic planning processes for PSD or other monitoring will be the responsibility of the monitoring organizations. The quality of the conclusions made from data interpretation can be affected by population uncertainty (spatial or temporal uncertainty) and measurement uncertainty (uncertainty associated with collecting, analyzing, reducing and reporting concentration data). This appendix focuses on assessing and controlling measurement uncertainty.

2.3.1.1 Measurement Uncertainty for Automated and Manual PM_{2.5} Methods. The goal for acceptable measurement uncertainty is defined as 10 percent coefficient of variation (CV) for total precision and plus or minus 10 percent for total bias.

2.3.1.2 Measurement Uncertainty for Automated Ozone Methods. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the coefficient variation (CV) of 7 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 7 percent.

2.3.1.3 Measurement Uncertainty for PM_{10-2.5} Methods. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the coefficient variation (CV) of 15 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 15 percent.

2.3.1.4 *Measurement Uncertainty for Pb Methods.* The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the coefficient variation (CV) of 20 percent and

for bias as an upper 95 percent confidence limit for the absolute bias of 15 percent.

2.3.1.5 Measurement Uncertainty for NO₂. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the coefficient of variation (CV) of 15 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 15 percent.

2.4 National Performance Evaluation Programs. Monitoring plans or the QAPP shall provide for the implementation of a program of independent and adequate audits of all monitors providing data for SLAMS and PSD including the provision of adequate resources for such audit programs. A monitoring plan (or QAPP) which provides for monitoring organization participation in EPA's National Performance Audit Program (NPAP) and the PM Performance Evaluation Program (PEP) program and which indicates the consent of the monitoring organization for EPA to apply an appropriate portion of the grant funds, which EPA would otherwise award to the monitoring organization for monitoring activities, will be deemed by EPA to meet this requirement. For clarification and to participate, monitoring organizations should contact either the appropriate EPA Regional Quality Assurance (QA) Coordinator at the appropriate EPA Regional Office location, or the NPAP Coordinator at the Air Quality Assessment Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency in Research Triangle Park, North Carolina.

2.5 Technical Systems Audit Program. Technical systems audits of each ambient air monitoring organization shall be conducted at least every 3 years by the appropriate EPA Regional Office and reported to the AQS. Systems audit programs are described in reference 10 of this appendix. For further instructions, monitoring organizations should contact the appropriate EPA Regional QA Coordinator.

2.6 Gaseous and Flow Rate Audit Standards.

2.6.1 Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen oxide (NO), and nitrogen dioxide (NO₂) must be traceable to either a National Institute of Standards and Technology (NIST) Traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS), certified in accordance with one of the procedures given in reference 4 of this appendix. Vendors advertising certification with the procedures provided in reference 4 of this appendix and distributing gasses as "EPA Protocol Gas" must participate in the EPA Protocol Gas Verification Program or not use "EPA" in any form of advertising.

2.6.2 Test concentrations for ozone (O₃) must be obtained in accordance with the ultra violet photometric calibration procedure specified in appendix D to part 50 of this chapter, or by means of a certified O₃ transfer standard. Consult references 7 and 8 of this appendix for guidance on primary and transfer standards for O₃.

2.6.3 Flow rate measurements must be made by a flow measuring instrument that is traceable to an authoritative volume or other applicable standard. Guidance for certifying some types of flowmeters is provided in reference 10 of this appendix.

2.7 Primary Requirements and Guidance. Requirements and guidance documents for developing the quality system are contained in references 1 through 10 of this appendix, which also contain many suggested procedures, checks, and control specifications. Reference 10 of this appendix describes specific guidance for the development of a quality system for SLAMS. Many specific quality control checks and specifications for methods are included in the respective reference methods described in part 50 of this chapter or in the respective equivalent method descriptions available from EPA (reference 6 of this appendix). Similarly, quality control procedures related to specifically designated reference and equivalent method analyzers are contained in the respective operation or instruction manuals associated with those analyzers.

3. MEASUREMENT QUALITY CHECK REQUIREMENTS

This section provides the requirements for primary quality assurance organizations (PQAOs) to perform the measurement quality checks that can be used to assess data quality. With the exception of the flow rate verifications (sections 3.2.3 and 3.3.2 of this appendix), data from these checks are required to be submitted to the AQS within the same time frame as routine ambient concentration data. Section 3.2 of this appendix describes checks of automated or continuous instruments while section 3.3 describe checks associated with manual sampling instruments. Other quality control samples are identified in the various references described earlier and can be used to control certain aspects of the measurement system.

3.1 Primary Quality Assurance Organization. A primary quality assurance organization is defined as a monitoring organization or a coordinated aggregation of such organizations that is responsible for a set of stations that monitors the same pollutant and for which data quality assessments can logically be pooled. Each criteria pollutant sampler/monitor at a monitoring station in the SLAMS network must be associated with one, and only one, primary quality assurance organization.

3.1.1 Each primary quality assurance organization shall be defined such that measurement uncertainty among all stations in the organization can be expected to be reasonably homogeneous, as a result of common factors. Common factors that should be considered by monitoring organizations in defining primary quality assurance organizations include:

- (a) Operation by a common team of field operators according to a common set of procedures;
- (b) Use of a common QAPP or standard operating procedures;
- (c) Common calibration facilities and standards;
- (d) Oversight by a common quality assurance organization; and
- (e) Support by a common management, laboratory or headquarters.

3.1.2 Primary quality assurance organizations are not necessarily related to the organization reporting data to the AQS. Monitoring organizations having difficulty in defining the primary quality assurance organizations or in assigning specific sites to primary quality assurance organizations should consult with the appropriate EPA Regional Office. All definitions of primary quality assurance organizations shall be subject to final approval by the appropriate EPA Regional Office during scheduled network reviews or systems audits.

3.1.3 Data quality assessment results shall be reported as specified in section 5 of this appendix.

3.2 Measurement Quality Checks of Automated Methods. Table A-2 of this appendix provides a summary of the types and frequency of the measurement quality checks that will be described in this section.

3.2.1 One-Point Quality Control Check for SO₂, NO₂, O₃, and CO. A one-point quality control (QC) check must be performed at least once every 2 weeks on each automated analyzer used to measure SO₂, NO₂, O₃ and CO. The frequency of QC checks may be reduced based upon review, assessment and approval of the EPA Regional Administrator. However, with the advent of automated calibration systems more frequent checking is encouraged. See Reference 10 of this appendix for guidance on the review procedure. The QC check is made by challenging the analyzer with a QC check gas of known concentration (effective concentration for open path analyzers) between 0.01 and 0.10 parts per million (ppm) for SO₂, NO₂, and O₃, and between 1 and 10 ppm for CO analyzers. The ranges allow for appropriate check gas selection for SLAMS sites that may be sampling for different objectives, i.e., trace gas monitoring vs. comparison to National Ambient Air Quality Standards (NAAQS). The QC check gas concentration selected should be related to the routine concentrations normally measured at sites within the moni-

toring network in order to appropriately reflect the precision and bias at these routine concentration ranges. To check the precision and bias of SLAMS analyzers operating at ranges either above or below the levels identified, use check gases of appropriate concentrations as approved by the appropriate EPA Regional Administrator or their designee. The standards from which check concentrations are obtained must meet the specifications of section 2.6 of this appendix.

3.2.1.1 Except for certain CO analyzers described below, point analyzers must operate in their normal sampling mode during the QC check, and the test atmosphere must pass through all filters, scrubbers, conditioners and other components used during normal ambient sampling and as much of the ambient air inlet system as is practicable. If permitted by the associated operation or instruction manual, a CO point analyzer may be temporarily modified during the QC check to reduce vent or purge flows, or the test atmosphere may enter the analyzer at a point other than the normal sample inlet, provided that the analyzer's response is not likely to be altered by these deviations from the normal operational mode. If a QC check is made in conjunction with a zero or span adjustment, it must be made prior to such zero or span adjustments.

3.2.1.2 Open path analyzers are tested by inserting a test cell containing a QC check gas concentration into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and as appropriate, reflecting devices should be used during the test and the normal monitoring configuration of the instrument should be altered as little as possible to accommodate the test cell for the test. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentration of the QC check gas in the test cell must be selected to produce an effective concentration in the range specified earlier in this section. Generally, the QC test concentration measurement will be the sum of the atmospheric pollutant concentration and the QC test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the QC test from the QC check gas concentration measurement. If the difference between these before and after measurements is greater than 20 percent of the effective concentration of the test gas, discard the test result and repeat the test. If

possible, open path analyzers should be tested during periods when the atmospheric pollutant concentrations are relatively low and steady.

3.2.1.3 Report the audit concentration (effective concentration for open path analyzers) of the QC gas and the corresponding measured concentration (corrected concentration, if applicable, for open path analyzers) indicated by the analyzer. The percent differences between these concentrations are used to assess the precision and bias of the monitoring data as described in sections 4.1.2 (precision) and 4.1.3 (bias) of this appendix.

3.2.2 Annual performance evaluation for SO₂, NO₂, O₃, or CO. Each calendar quarter (during which analyzers are operated), evaluate at least 25 percent of the SLAMS ana-

lyzers that monitor for SO₂, NO₂, O₃, or CO such that each analyzer is evaluated at least once per year. If there are fewer than four analyzers for a pollutant within a primary quality assurance organization, it is suggested to randomly evaluate one or more analyzers so that at least one analyzer for that pollutant is evaluated each calendar quarter. The evaluation should be conducted by a trained experienced technician other than the routine site operator.

3.2.2.1 (a) The evaluation is made by challenging the analyzer with audit gas standard of known concentration (effective concentration for open path analyzers) from at least three consecutive audit levels. The audit levels selected should represent or bracket 80 percent of ambient concentrations measured by the analyzer being evaluated:

Audit level	Concentration range, ppm			
	O ₃	SO ₂	NO ₂	CO
1	0.02-0.05	0.0003-0.005	0.0002-0.002	0.08-0.10
2	0.06-0.10	0.006-0.01	0.003-0.005	0.50-1.00
3	0.11-0.20	0.02-0.10	0.006-0.10	1.50-4.00
4	0.21-0.30	0.11-0.40	0.11-0.30	5-15
5	0.31-0.90	0.41-0.90	0.31-0.60	20-50

(b) An additional 4th level is encouraged for those monitors that have the potential for exceeding the concentration ranges described by the initial three selected.

3.2.2.2 (a) NO₂ audit gas for chemiluminescence-type NO₂ analyzers must also contain at least 0.08 ppm NO. NO concentrations substantially higher than 0.08 ppm, as may occur when using some gas phase titration (GPT) techniques, may lead to evaluation errors in chemiluminescence analyzers due to inevitable minor NO-NO_x channel imbalance. Such errors may be atypical of routine monitoring errors to the extent that such NO concentrations exceed typical ambient NO concentrations at the site. These errors may be minimized by modifying the GPT technique to lower the NO concentrations remaining in the NO₂ audit gas to levels closer to typical ambient NO concentrations at the site.

(b) To evaluate SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm for SO₂, NO₂, and O₃ or 0 to 50 ppm for CO, use audit gases of appropriately higher concentration as approved by the appropriate EPA Regional Administrator or the Administrator's designee.

3.2.2.3 The standards from which audit gas test concentrations are obtained must meet the specifications of section 2.6 of this appendix. The gas standards and equipment used for evaluations must not be the same as the standards and equipment used for calibration or calibration span adjustments. For SLAMS sites, the auditor should not be the operator

or analyst who conducts the routine monitoring, calibration, and analysis. For PSD sites the auditor must not be the operator or analyst who conducts the routine monitoring, calibration, and analysis.

3.2.2.4 For point analyzers, the evaluation shall be carried out by allowing the analyzer to analyze the audit gas test atmosphere in its normal sampling mode such that the test atmosphere passes through all filters, scrubbers, conditioners, and other sample inlet components used during normal ambient sampling and as much of the ambient air inlet system as is practicable. The exception provided in section 3.2.1 of this appendix for certain CO analyzers does not apply for evaluations.

3.2.2.5 Open path analyzers are evaluated by inserting a test cell containing the various audit gas concentrations into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and, as appropriate, reflecting devices should be used during the evaluation, and the normal monitoring configuration of the instrument should be modified as little as possible to accommodate the test cell for the evaluation. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentrations of the audit gas in the test cell must be selected to produce effective concentrations in the evaluation level ranges specified in this section

of this appendix. Generally, each evaluation concentration measurement result will be the sum of the atmospheric pollutant concentration and the evaluation test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the evaluation test (or preferably before and after each evaluation concentration level) from the evaluation concentration measurement. If the difference between the before and after measurements is greater than 20 percent of the effective concentration of the test gas standard, discard the test result for that concentration level and repeat the test for that level. If possible, open path analyzers should be evaluated during periods when the atmospheric pollutant concentrations are relatively low and steady. Also, if the open path instrument is not installed in a permanent manner, the monitoring path length must be reverified to within plus or minus 3 percent to validate the evaluation, since the monitoring path length is critical to the determination of the effective concentration.

3.2.2.6 Report both the evaluation concentrations (effective concentrations for open path analyzers) of the audit gases and the corresponding measured concentration (corrected concentrations, if applicable, for open path analyzers) indicated or produced by the analyzer being tested. The percent differences between these concentrations are used to assess the quality of the monitoring data as described in section 4.1.4 of this appendix.

3.2.3 Flow Rate Verification for Particulate Matter. A one-point flow rate verification check must be performed at least once every month on each automated analyzer used to measure PM_{10} , $PM_{10-2.5}$ and $PM_{2.5}$. The verification is made by checking the operational flow rate of the analyzer. If the verification is made in conjunction with a flow rate adjustment, it must be made prior to such flow rate adjustment. Randomization of the flow rate verification with respect to time of day, day of week, and routine service and adjustments is encouraged where possible. For the standard procedure, use a flow rate transfer standard certified in accordance with section 2.6 of this appendix to check the analyzer's normal flow rate. Care should be used in selecting and using the flow rate measurement device such that it does not alter the normal operating flow rate of the analyzer. Report the flow rate of the transfer standard and the corresponding flow rate measured (indicated) by the analyzer. The percent differences between the audit and measured flow rates are used to assess the bias of the monitoring data as de-

scribed in section 4.2.2 of this appendix (using flow rates in lieu of concentrations).

3.2.4 Semi-Annual Flow Rate Audit for Particulate Matter. Every 6 months, audit the flow rate of the PM_{10} , $PM_{10-2.5}$ and $PM_{2.5}$ particulate analyzers. Where possible, EPA strongly encourages more frequent auditing. The audit should (preferably) be conducted by a trained experienced technician other than the routine site operator. The audit is made by measuring the analyzer's normal operating flow rate using a flow rate transfer standard certified in accordance with section 2.6 of this appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Great care must be used in auditing the flow rate to be certain that the flow measurement device does not alter the normal operating flow rate of the analyzer. Report the audit flow rate of the transfer standard and the corresponding flow rate measured (indicated) by the analyzer. The percent differences between these flow rates are used to validate the one-point flow rate verification checks used to estimate bias as described in section 4.2.3 of this appendix.

3.2.5 Collocated Sampling Procedures for $PM_{2.5}$. For each pair of collocated monitors, designate one sampler as the primary monitor whose concentrations will be used to report air quality for the site, and designate the other as the audit monitor.

3.2.5.1 Each EPA designated Federal reference method (FRM) or Federal equivalent method (FEM) within a primary quality assurance organization must:

(a) Have 15 percent of the monitors collocated (values of 0.5 and greater round up); and

(b) Have at least 1 collocated monitor (if the total number of monitors is less than 3). The first collocated monitor must be a designated FRM monitor.

3.2.5.2 In addition, monitors selected for collocation must also meet the following requirements:

(a) A primary monitor designated as an EPA FRM shall be collocated with an audit monitor having the same EPA FRM method designation.

(b) For each primary monitor model designated as an EPA FEM used by the PQAO, 50 percent of the monitors designated for collocation shall be collocated with an audit monitor having the same method designation and 50 percent of the monitors shall be collocated with an FRM audit monitor. If the primary quality assurance organization only has one FEM monitor it shall be collocated with an FRM audit monitor. If there are an odd number of collocated monitors required, the additional monitor shall be an

FRM audit monitor. An example of this procedure is found in Table A-3 of this appendix.

3.2.5.3 The collocated monitors should be deployed according to the following protocol:

(a) 80 percent of the collocated audit monitors should be deployed at sites with annual average or daily concentrations estimated to be within ± 20 percent of the applicable NAAQS and the remainder at what the monitoring organizations designate as high value sites;

(b) If an organization has no sites with annual average or daily concentrations within ± 20 percent of the annual NAAQS (or 24-hour NAAQS if that is affecting the area), 60 percent of the collocated audit monitors should be deployed at those sites with the annual mean concentrations (or 24-hour NAAQS if that is affecting the area) among the highest 25 percent for all sites in the network.

3.2.5.4 In determining the number of collocated sites required for $PM_{2.5}$ monitoring networks for visibility assessments should not be treated independently from networks for particulate matter, as the separate networks may share one or more common samplers. However, for Class I visibility areas, EPA will accept visibility aerosol mass measurement instead of a $PM_{2.5}$ measurement if the latter measurement is unavailable. Any $PM_{2.5}$ monitoring site which does not have a monitor which is an EPA FRM, FEM or ARM is not required to be included in the number of sites which are used to determine the number of collocated monitors.

3.2.5.5 For each PSD monitoring network, one site must be collocated. A site with the predicted highest 24-hour pollutant concentration must be selected.

3.2.5.6 The two collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.2.5.7 Sample the collocated audit monitor for SLAMS sites on a 12-day schedule; sample PSD sites on a 6-day schedule or every third day for PSD daily monitors. If a primary quality assurance organization has only one collocated monitor, higher sampling frequencies than the 12-day schedule may be needed in order to produce about 25 valid sample pairs a year. Report the measurements from both primary and collocated audit monitors at each collocated sampling site. The calculations for evaluating precision between the two collocated monitors are described in section 4.3.1 of this appendix.

3.2.6 Collocated Sampling Procedures for $PM_{10-2.5}$. For the $PM_{10-2.5}$ network, all automated methods must be designated as Fed-

eral equivalent methods (FEMs). For each pair of collocated monitors, designate one sampler as the primary monitor whose concentrations will be used to report air quality for the site, and designate the other as the audit monitor.

3.2.6.1 The EPA shall ensure that each EPA designated FEM within the national $PM_{10-2.5}$ monitoring network must:

(a) Have 15 percent of the monitors collocated (values of 0.5 and greater round up); and

(b) Have at least 2 collocated monitors (if the total number of monitors is less than 10). The first collocated monitor must be a designated FRM monitor and the second must be a monitor of the same method designation. Both collocated FRM and FEM monitors can be located at the same site.

3.2.6.2 The Regional Administrator for the EPA Regions where the FEMs are implemented will select the sites for collocated monitoring. The site selection process shall consider giving priority to sites at primary quality assurance organizations or States with more than one $PM_{10-2.5}$ site, sites considered important from a regional perspective, and sites needed for an appropriate distribution among rural and urban NCore sites. Depending on the speed at which the $PM_{10-2.5}$ network is deployed, the first sites implementing FEMs shall be required to perform collocation until there is a larger distribution of FEM monitors implemented in the network.

3.2.6.3 The two collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.2.6.4 Sample the collocated audit monitor for SLAMS sites on a 12-day schedule. Report the measurements from both primary and collocated audit monitors at each collocated sampling site. The calculations for evaluating precision between the two collocated monitors are described in section 4.3.1 of this appendix.

3.2.7 $PM_{2.5}$ Performance Evaluation Program (PEP) Procedures. The PEP is an independent assessment used to estimate total measurement system bias. These evaluations will be performed under the PM Performance Evaluation Program (PEP) (section 2.4 of this appendix) or a comparable program. Performance evaluations will be performed on the SLAMS monitors annually within each primary quality assurance organization. For primary quality assurance organizations with less than or equal to five monitoring sites, five valid performance evaluation audits must be collected and reported

each year. For primary quality assurance organizations with greater than five monitoring sites, eight valid performance evaluation audits must be collected and reported each year. A valid performance evaluation audit means that both the primary monitor and PEP audit concentrations are valid and above $3 \mu\text{g}/\text{m}^3$. Additionally, each year, every designated FRM or FEM within a primary quality assurance organization must:

(1) Have each method designation evaluated each year; and,

(2) Have all FRM or FEM samplers subject to a PEP audit at least once every six years; which equates to approximately 15 percent of the monitoring sites audited each year.

(b) Additional information concerning the Performance Evaluation Program is contained in reference 10 of this appendix. The calculations for evaluating bias between the primary monitor and the performance evaluation monitor for $\text{PM}_{2.5}$ are described in section 4.3.2 of this appendix.

3.2.8 $\text{PM}_{10-2.5}$ Performance Evaluation Program. For the $\text{PM}_{10-2.5}$ network, all automated methods will be designated as federal equivalent methods (FEMs). One performance evaluation audit, as described in section 3.2.7 must be performed at one $\text{PM}_{10-2.5}$ site in each primary quality assurance organization each year. The calculations for evaluating bias between the primary monitor(s) and the performance evaluation monitors for $\text{PM}_{10-2.5}$ are described in section 4.1.3 of this appendix.

3.3 Measurement Quality Checks of Manual Methods. Table A-2 of this appendix provides a summary of the types and frequency of the measurement quality checks that will be described in this section.

3.3.1 Collocated Sampling Procedures for PM_{10} . For each network of manual PM_{10} methods, select 15 percent (or at least one) of the monitoring sites within the primary quality assurance organization for collocated sampling. For purposes of precision assessment, networks for measuring total suspended particulate (TSP) and PM_{10} shall be considered separately from one another. However, PM_{10} samplers used in the $\text{PM}_{10-2.5}$ network, may be counted along with the PM_{10} samplers in the PM_{10} network as long as the PM_{10} samplers in both networks are the same method designation. PM_{10} and TSP sites having annual mean particulate matter concentrations among the highest 25 percent of the annual mean concentrations for all the sites in the network must be selected or, if such sites are impractical, alternative sites approved by the EPA Regional Administrator may be selected.

3.3.1.1 In determining the number of collocated sites required for PM_{10} , monitoring networks for lead (Pb) should be treated independently from networks for particulate matter (PM), even though the separate networks may share one or more common sam-

plers. However, a single pair of samplers collocated at a common-sampler monitoring site that meets the requirements for both a collocated Pb site and a collocated PM site may serve as a collocated site for both networks.

3.3.1.2 The two collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference. Calibration, sampling, analysis and verification/validation procedures must be the same for both collocated samplers and the same as for all other samplers in the network.

3.3.1.3 For each pair of collocated samplers, designate one sampler as the primary sampler whose samples will be used to report air quality for the site, and designate the other as the audit sampler. Sample SLAMS sites on a 12-day schedule; sample PSD sites on a 6-day schedule or every third day for PSD daily samplers. If a primary quality assurance organization has only one collocated monitor, higher sampling frequencies than the 12-day schedule may be needed in order to produce approximately 25 valid sample pairs a year. Report the measurements from both samplers at each collocated sampling site. The calculations for evaluating precision between the two collocated samplers are described in section 4.2.1 of this appendix.

3.3.2 Flow Rate Verification for Particulate Matter. Follow the same procedure as described in section 3.2.3 of this appendix for $\text{PM}_{2.5}$, PM_{10} (low-volume instruments), and $\text{PM}_{10-2.5}$. High-volume PM_{10} and TSP instruments can also follow the procedure in section 3.2.3 but the audits are required to be conducted quarterly. The percent differences between the audit and measured flow rates are used to assess the bias of the monitoring data as described in section 4.2.2 of this appendix.

3.3.3 Semi-Annual Flow Rate Audit for Particulate Matter. Follow the same procedure as described in section 3.2.4 of this appendix for $\text{PM}_{2.5}$, PM_{10} , $\text{PM}_{10-2.5}$ and TSP instruments. The percent differences between these flow rates are used to validate the one-point flow rate verification checks used to estimate bias as described in section 4.2.3 of this appendix. Great care must be used in auditing high-volume particulate matter samplers having flow regulators because the introduction of resistance plates in the audit flow standard device can cause abnormal flow patterns at the point of flow sensing. For this reason, the flow audit standard should be used with a normal filter in place and without resistance plates in auditing flow-regulated high-volume samplers, or other steps should be taken to assure that flow patterns are not perturbed at the point of flow sensing.

3.3.4 *Pb Methods.*

3.3.4.1 *Flow Rates.* For the Pb Reference Methods (40 CFR Part 50, appendix G and appendix Q) and associated FEMs, the flow rates of the Pb samplers shall be verified and audited using the same procedures described in sections 3.3.2 and 3.3.3 of this appendix.

3.3.4.2 *Pb Analysis Audits.* Each calendar quarter or sampling quarter (PSD), audit the Pb Reference Method analytical procedure using filters containing a known quantity of Pb. These audit filters are prepared by depositing a Pb solution on unexposed filters and allowing them to dry thoroughly. The audit samples must be prepared using batches of reagents different from those used to calibrate the Pb analytical equipment being audited. Prepare audit samples in the following concentration ranges:

Range	Equivalent ambient Pb concentration, $\mu\text{g}/\text{m}^3$
1	30–100% of Pb NAAQS.
2	200–300% of Pb NAAQS.

(a) Audit samples must be extracted using the same extraction procedure used for exposed filters.

(b) Analyze three audit samples in each of the two ranges each quarter samples are analyzed. The audit sample analyses shall be distributed as much as possible over the entire calendar quarter.

(c) Report the audit concentrations (in μg Pb/filter or strip) and the corresponding measured concentrations (in μg Pb/filter or strip) using AQS unit code 077. The percent differences between the concentrations are used to calculate analytical accuracy as described in section 4.1.3 of this appendix.

(d) The audits of an equivalent Pb method are conducted and assessed in the same manner as for the reference method. The flow auditing device and Pb analysis audit samples must be compatible with the specific requirements of the equivalent method.

3.3.4.3 *Collocated Sampling.* The collocated sampling requirements for Pb-TSP and Pb-PM₁₀ shall be determined using the same procedures described in sections 3.3.1 of this appendix with the exception that the first collocated Pb site selected must be the site measuring the highest Pb concentrations in the network. If the site is impractical, alternative sites, approved by the EPA Regional Administrator, may be selected. If additional collocated sites are necessary, collocated sites may be chosen that reflect average ambient air Pb concentrations in the network.

3.3.4.4 *Pb Performance Evaluation Program (PEP) Procedures.* Each year, one performance evaluation audit, as described in section 3.2.7 of this appendix, must be performed at one Pb site in each primary quality assurance organization that has less than or equal to 5 sites and two audits at primary quality assurance organizations with greater than 5 sites. In addition, each year, four collocated

samples from primary quality assurance organizations with less than or equal to 5 sites and six collocated samples at primary quality assurance organizations with greater than 5 sites must be sent to an independent laboratory, the same laboratory as the performance evaluation audit, for analysis.

3.3.5 *Collocated Sampling Procedures for PM_{2.5}.* Follow the same procedure as described in section 3.2.5 of this appendix. PM_{2.5} samplers used in the PM_{10-2.5} network, may be counted along with the PM_{2.5} samplers in the PM_{2.5} network as long as the PM_{2.5} samplers in both networks are the same method designation.

3.3.6 *Collocated Sampling Procedures for PM_{10-2.5}.* All designated FRMs within the PM_{10-2.5} monitoring network must have 15 percent of the monitors collocated (values of 0.5 and greater round up) at the PM_{10-2.5} sites. All FRM method designations can be aggregated.

3.3.6.1 The EPA shall ensure that each designated FEM within the PM_{10-2.5} monitoring network must:

(a) Have 15 percent of the monitors collocated (values of 0.5 and greater round up); and

(b) Have at least 2 collocated monitors (if the total number of monitors is less than 10). The first collocated monitor must be a designated FRM monitor and the second must be a monitor of the same method designation. Both collocated FRM and FEM monitors can be located at the same site.

3.3.6.2 The Regional Administrator for the EPA Region where the FRM or FEMs are implemented will select the sites for collocated monitoring. The collocation site selection process shall consider sites at primary quality assurance organizations or States with more than one PM_{10-2.5} site; primary quality assurance organizations already monitoring for PM₁₀ and PM_{2.5} using FRMs or FEMs; and an appropriate distribution among rural and urban NCore sites. Monitoring organizations implementing PM₁₀ samplers and PM_{2.5} FRM samplers of the same method designation as the PM_{10-2.5} FRM can include the PM_{10-2.5} monitors in their respective PM₁₀ and PM_{2.5} count. Follow the same procedures as described in sections 3.2.6.2 and 3.2.6.3 of this appendix.

3.3.7 *PM_{2.5} Performance Evaluation Program (PEP) Procedures.* Follow the same procedure as described in section 3.2.7 of this appendix.

3.3.8 *PM_{10-2.5} Performance Evaluation Program (PEP) Procedures.* One performance evaluation audit, as described in section 3.2.7 of this appendix must be performed at one PM_{10-2.5} site in each primary quality assurance organization each year. Monitoring organizations implementing PM_{2.5} FRM samplers of the same method designation in both the PM_{2.5} and the PM_{10-2.5} networks can include the PM_{10-2.5} performance evaluation

audit in their respective PM_{2.5} performance evaluation count as long as the performance evaluation is conducted at the PM_{10-2.5} site. The calculations for evaluating bias between the primary monitor(s) and the performance evaluation monitors for PM_{10-2.5} are described in section 4.1.3 of this appendix.

4. CALCULATIONS FOR DATA QUALITY ASSESSMENT

(a) Calculations of measurement uncertainty are carried out by EPA according to the following procedures. Primary quality assurance organizations should report the data for all appropriate measurement quality checks as specified in this appendix even though they may elect to perform some or all of the calculations in this section on their own.

(b) The EPA will provide annual assessments of data quality aggregated by site and primary quality assurance organization for SO₂, NO₂, O₃ and CO and by primary quality assurance organization for PM₁₀, PM_{2.5}, PM_{10-2.5} and Pb.

(c) At low concentrations, agreement between the measurements of collocated samplers, expressed as relative percent difference or percent difference, may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision and bias calculations only when both measurements are equal to or above the following limits:

- (1) TSP: 20 µg/m³.
- (2) Pb: 0.02 µg/m³.
- (3) PM₁₀ (Hi-Vol): 15 µg/m³.
- (4) PM₁₀ (Lo-Vol): 3 µg/m³.
- (5) PM_{10-2.5} and PM_{2.5}: 3 µg/m³.

4.1 Statistics for the Assessment of QC Checks for SO₂, NO₂, O₃ and CO.

4.1.1 Percent Difference. All measurement quality checks start with a comparison of an audit concentration or value (flowrate) to the concentration/value measured by the analyzer and use percent difference as the comparison statistic as described in equation 1 of this section. For each single point check, calculate the percent difference, d_i , as follows:

$$\text{Equation 1}$$

$$d_i = \frac{\text{meas} - \text{audit}}{\text{audit}} \times 100$$

where, *meas* is the concentration indicated by the monitoring organization's instrument and *audit* is the audit concentration of the standard used in the QC check being measured.

4.1.2 Precision Estimate. The precision estimate is used to assess the one-point QC checks for SO₂, NO₂, O₃, or CO described in section 3.2.1 of this appendix. The precision estimator is the coefficient of variation

upper bound and is calculated using equation 2 of this section:

$$\text{Equation 2}$$

$$CV = \sqrt{\frac{n \cdot \sum_{i=1}^n d_i^2 - \left(\sum_{i=1}^n d_i\right)^2}{n(n-1)}} \cdot \sqrt{\frac{n-1}{X_{0.1,n-1}^2}}$$

where, $X_{0.1,n-1}^2$ is the 10th percentile of a chi-squared distribution with $n-1$ degrees of freedom.

4.1.3 Bias Estimate. The bias estimate is calculated using the one-point QC checks for SO₂, NO₂, O₃, or CO described in section 3.2.1 of this appendix and the performance evaluation program for PM_{10-2.5} described in sections 3.2.8 and 3.3.8 of this appendix. The bias estimator is an upper bound on the mean absolute value of the percent differences as described in equation 3 of this section:

$$\text{Equation 3}$$

$$|AB| = AB + t_{0.95,n-1} \cdot \frac{AS}{\sqrt{n}}$$

where, n is the number of single point checks being aggregated; $t_{0.95,n-1}$ is the 95th quantile of a t-distribution with $n-1$ degrees of freedom; the quantity *AB* is the mean of the absolute values of the d_i 's and is calculated using equation 4 of this section:

$$\text{Equation 4}$$

$$AB = \frac{1}{n} \cdot \sum_{i=1}^n |d_i|$$

and the quantity *AS* is the standard deviation of the absolute value of the d_i 's and is calculated using equation 5 of this section:

$$\text{Equation 5}$$

$$AS = \sqrt{\frac{n \cdot \sum_{i=1}^n |d_i|^2 - \left(\sum_{i=1}^n |d_i|\right)^2}{n(n-1)}}$$

4.1.3.1 Assigning a sign (positive/negative) to the bias estimate. Since the bias statistic as calculated in equation 3 of this appendix uses absolute values, it does not have a tendency (negative or positive bias) associated with it. A sign will be designated by rank ordering the percent differences of the QC check samples from a given site for a particular assessment interval.

4.1.3.2 Calculate the 25th and 75th percentiles of the percent differences for each site. The absolute bias upper bound should be

flagged as positive if both percentiles are positive and negative if both percentiles are negative. The absolute bias upper bound would not be flagged if the 25th and 75th percentiles are of different signs.

4.1.4 Validation of Bias Using the one-point QC Checks. The annual performance evaluations for SO₂, NO₂, O₃, or CO described in section 3.2.2 of this appendix are used to verify the results obtained from the one-point QC checks and to validate those results across a range of concentration levels. To quantify this annually at the site level and at the 3-year primary quality assurance organization level, probability limits will be calculated from the one-point QC checks using equations 6 and 7 of this appendix:

Equation 6

$$\text{Upper Probability Limit} = m + 1.96 \cdot S$$

Equation 7

$$\text{Lower Probability Limit} = m - 1.96 \cdot S$$

where, *m* is the mean (equation 8 of this appendix):

Equation 8

$$m = \frac{1}{k} \cdot \sum_{i=1}^k d_i$$

where, *k* is the total number of one point QC checks for the interval being evaluated and *S* is the standard deviation of the percent differences (equation 9 of this appendix) as follows:

Equation 9

$$S = \sqrt{\frac{k \cdot \sum_{i=1}^k d_i^2 - \left(\sum_{i=1}^k d_i\right)^2}{k(k-1)}}$$

4.1.5 Percent Difference. Percent differences for the performance evaluations, calculated using equation 1 of this appendix can be compared to the probability intervals for the respective site or at the primary quality assurance organization level. Ninety-five percent of the individual percent differences (all audit concentration levels) for the performance evaluations should be captured within the probability intervals for the primary quality assurance organization.

4.2 Statistics for the Assessment of PM₁₀.

4.2.1 Precision Estimate from Collocated Samplers. Precision is estimated via dupli-

cate measurements from collocated samplers of the same type. It is recommended that the precision be aggregated at the primary quality assurance organization level quarterly, annually, and at the 3-year level. The data pair would only be considered valid if both concentrations are greater than the minimum values specified in section 4(c) of this appendix. For each collocated data pair, calculate the relative percent difference, *d_i*, using equation 10 of this appendix:

Equation 10

$$d_i = \frac{X_i - Y_i}{(X_i + Y_i)/2} \cdot 100$$

where, *X_i* is the concentration from the primary sampler and *Y_i* is the concentration value from the audit sampler. The coefficient of variation upper bound is calculated using the equation 11 of this appendix:

Equation 11

$$CV = \sqrt{\frac{n \cdot \sum_{i=1}^n d_i^2 - \left(\sum_{i=1}^n d_i\right)^2}{2n(n-1)}} \cdot \sqrt{\frac{n-1}{X_{0.1, n-1}^2}}$$

where, *n* is the number of valid data pairs being aggregated, and *X*²_{0.1, n-1} is the 10th percentile of a chi-squared distribution with *n-1* degrees of freedom. The factor of 2 in the denominator adjusts for the fact that each *d_i* is calculated from two values with error.

4.2.2 Bias Estimate Using One-Point Flow Rate Verifications.

For each one-point flow rate verification described in sections 3.2.3 and 3.3.2 of this appendix, calculate the percent difference in volume using equation 1 of this appendix where *meas* is the value indicated by the sampler's volume measurement and *audit* is the actual volume indicated by the auditing flow meter. The absolute volume bias upper bound is then calculated using equation 3, where *n* is the number of flow rate audits being aggregated; *t*_{0.95, n-1} is the 95th quantile of a t-distribution with *n-1* degrees of freedom, the quantity *AB* is the mean of the absolute values of the *d_i*'s and is calculated using equation 4 of this appendix, and the quantity *AS* in equation 3 of this appendix is the standard deviation of the absolute values if the *d_i*'s and is calculated using equation 5 of this

4.2.3 Assessment Semi-Annual Flow Rate Audits. The flow rate audits described in sections 3.2.4 and 3.3.3 of this appendix are used to assess the results obtained from the one-point flow rate verifications and to provide

an estimate of flow rate acceptability. For each flow rate audit, calculate the percent difference in volume using equation 1 of this appendix where *meas* is the value indicated by the sampler's volume measurement and *audit* is the actual volume indicated by the auditing flow meter. To quantify this annually and at the 3-year primary quality assurance organization level, probability limits are calculated from the percent differences using equations 6 and 7 of this appendix where *m* is the mean described in equation 8 of this appendix and *k* is the total number of one-point flow rate verifications for the year and *S* is the standard deviation of the percent differences as described in equation 9 of this appendix.

4.2.4 Percent Difference. Percent differences for the annual flow rate audit concentration, calculated using equation 1 of this appendix, can be compared to the probability intervals for the one-point flow rate verifications for the respective primary quality assurance organization. Ninety-five percent of the individual percent differences (all audit concentration levels) for the performance evaluations should be captured within the probability intervals for primary quality assurance organization.

4.3 Statistics for the Assessment of PM_{2.5} and PM_{10-2.5}.

4.3.1 Precision Estimate. Precision for collocated instruments for PM_{2.5} and PM_{10-2.5} may be estimated where both the primary and collocated instruments are the same method designation and when the method designations are not similar. Follow the procedure described in section 4.2.1 of this appendix. In addition, one may want to perform an estimate of bias when the primary monitor is an FEM and the collocated monitor is an FRM. Follow the procedure de-

scribed in section 4.1.3 of this appendix in order to provide an estimate of bias using the collocated data.

4.3.2 Bias Estimate. Follow the procedure described in section 4.1.3 of this appendix for the bias estimate of PM_{10-2.5}. The PM_{2.5} bias estimate is calculated using the paired routine and the PEP monitor data described in section 3.2.6 of this appendix. Calculate the percent difference, *d_i*, using equation 1 of this appendix, where *meas* is the measured concentration from agency's primary monitor and *audit* is the concentration from the PEP monitor. The data pair would only be considered valid if both concentrations are greater than the minimum values specified in section 4(c) of this appendix. Estimates of bias are presented for various levels of aggregation, sometimes aggregating over time, sometimes aggregating over samplers, and sometimes aggregating over both time and samplers. These various levels of aggregation are achieved using the same basic statistic.

4.3.2.1 This statistic averages the individual biases described in equation 1 of this appendix to the desired level of aggregation using equation 12 of this appendix:

Equation 12

$$D = \frac{1}{n_j} \cdot \sum_{i=1}^{n_j} d_i$$

where, *n_j* is the number of pairs and *d₁*, *d₂*, * * *, *d_{n_j}* are the biases for each of the pairs to be averaged.

4.3.2.2 Confidence intervals can be constructed for these average bias estimates in equation 12 of this appendix using equations 13 and 14 of this appendix:

Equation 13

$$\text{Upper 90\% Confidence Interval} = D + t_{0.95,df} \cdot \frac{s}{\sqrt{n_j}}$$

Equation 14

$$\text{Lower 90\% Confidence Interval} = D - t_{0.95,df} \cdot \frac{s}{\sqrt{n_j}}$$

Where, $t_{0.95,df}$ is the 95th quantile of a t-distribution with degrees of freedom $df = n_j - 1$ and s is an estimate of the variability of the average bias calculated using equation 15 of this appendix:

$$\text{Equation 15}$$

$$s = \sqrt{\frac{\sum_{i=1}^{n_j} (d_i - D)^2}{n_j - 1}}$$

4.4 Statistics for the Assessment of Pb.

4.4.1 *Precision Estimate.* Follow the same procedures as described for PM_{10} in section 4.2.1 of this appendix using the data from the collocated instruments. The data pair would only be considered valid if both concentrations are greater than the minimum values specified in section 4(c) of this appendix.

4.4.2 *Bias Estimate.* For the Pb analysis audits described in section 3.3.4.2 and the Pb Performance Evaluation Program described in section 3.3.4.4, follow the same procedure as described in section 4.1.3 for the bias estimate.

4.4.3 *Flow rate calculations.* For the one point flow rate verifications, follow the same procedures as described for PM_{10} in section 4.2.2; for the flow rate audits, follow the same procedures as described in section 4.2.3.

5. REPORTING REQUIREMENTS

5.1 SLAMS Reporting Requirements. For each pollutant, prepare a list of all monitoring sites and their AQS site identification codes in each primary quality assurance organization and submit the list to the appropriate EPA Regional Office, with a copy to AQS. Whenever there is a change in this list of monitoring sites in a primary quality assurance organization, report this change to the EPA Regional Office and to AQS.

5.1.1 Quarterly Reports. For each quarter, each primary quality assurance organization shall report to AQS directly (or via the appropriate EPA Regional Office for organizations not direct users of AQS) the results of all valid measurement quality checks it has carried out during the quarter. The quarterly reports must be submitted consistent with the data reporting requirements specified for air quality data as set forth in §58.16. The EPA strongly encourages early submission of the quality assurance data in order to assist the monitoring organizations control and evaluate the quality of the ambient air data.

5.1.2 Annual Reports.

5.1.2.1 When the monitoring organization has certified relevant data for the calendar year, EPA will calculate and report the measurement uncertainty for the entire calendar year.

5.2 PSD Reporting Requirements. At the end of each sampling quarter, the organization must report the appropriate statistical assessments in section 4 of this appendix for the pollutants measured. All data used to calculate reported estimates of precision and bias including span checks, collocated sampler and audit results must be made available to the permit granting authority upon request.

6.0 REFERENCES

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(5) Guidance for the Data Quality Objectives Process. EPA QA/G-4. EPA/240/B-06/001. February, 2006. Office of Environmental Information, Washington DC 20460. <http://www.epa.gov/quality/qs-docs/g4-final.pdf>.

(6) List of Designated Reference and Equivalent Methods. Available from U.S. Environmental Protection Agency, National Exposure Research Laboratory, Human Exposure and Atmospheric Sciences Division, MD-D205-03, Research Triangle Park, NC 27711. <http://www.epa.gov/ttn/amtic/criteria.html>.

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(9) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 1—

A Field Guide to Environmental Quality Assurance. EPA-600/R-94/038a. April 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268. <http://www.epa.gov/ttn/amtic/qabook.html>.

(10) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1—Ambient Air Quality Monitoring Program Quality System Development. EPA-454/R-98-004. <http://www.epa.gov/ttn/amtic/qabook.html>.

TABLE A-1 OF APPENDIX A TO PART 58—DIFFERENCE AND SIMILARITIES BETWEEN SLAMS AND PSD REQUIREMENTS

Topic	SLAMS	PSD
Requirements	1. The development, documentation, and implementation of an approved quality system. 2. The assessment of data quality	
Monitoring and QA Responsibility ..	3. The use of reference, equivalent, or approved methods. 4. The use of calibration standards traceable to NIST or other primary standard. 5. The participation in EPA performance evaluations and the permission for EPA to conduct system audits. State/local agency via the "primary quality assurance organization".	Source owner/operator.
Monitoring Duration	Indefinitely	Usually up to 12 months.
Annual Performance Evaluation (PE).	Standards and equipment different from those used for spanning, calibration, and verifications. Prefer different personnel.	Personnel, standards and equipment different from those used for spanning, calibration, and verifications.
PE audit rate:		
—Automated	100% per year	100% per quarter.
—Manual	Varies depending on pollutant. See Table A-2 of this appendix.	100% per quarter.
Precision Assessment:		
—Automated	One-point QC check biweekly but data quality dependent.	One point QC check biweekly.
—Manual	Varies depending on pollutant. See Table A-2 of this appendix.	One site: 1 every 6 days or every third day for daily monitoring (TSP and Pb).
Reporting		
—Automated	By site—EPA performs calculations annually	By site—source owner/operator performs calculations each sampling quarter.
—Manual	By reporting organization—EPA performs calculations annually.	By site—source owner/operator performs calculations each sampling quarter.

TABLE A-2 OF APPENDIX A TO PART 58—MINIMUM DATA ASSESSMENT REQUIREMENTS FOR SLAMS SITES

Method	Assessment method	Coverage	Minimum frequency	Parameters reported
Automated Methods				
1-Point QC for SO ₂ , NO ₂ , O ₃ , CO.	Response check at concentration 0.01–0.1 ppm SO ₂ , NO ₂ , O ₃ , and 1–10 ppm CO.	Each analyzer	Once per 2 weeks	Audit concentration ¹ and measured concentration ² .
Annual performance evaluation for SO ₂ , NO ₂ , O ₃ , CO.	See section 3.2.2 of this appendix.	Each analyzer	Once per year	Audit concentration ¹ and measured concentration ² for each level.
Flow rate verification PM ₁₀ , PM _{2.5} , PM _{10-2.5} .	Check of sampler flow rate.	Each sampler	Once every month	Audit flow rate and measured flow rate indicated by the sampler.
Semi-annual flow rate audit PM ₁₀ , PM _{2.5} , PM _{10-2.5} .	Check of sampler flow rate using independent standard.	Each sampler	Once every 6 months ..	Audit flow rate and measured flow rate indicated by the sampler.

TABLE A-2 OF APPENDIX A TO PART 58—MINIMUM DATA ASSESSMENT REQUIREMENTS FOR SLAMS SITES—Continued

Method	Assessment method	Coverage	Minimum frequency	Parameters reported
Collocated sampling PM _{2.5} , PM _{10-2.5} .	Collocated samplers	15%	Every 12 days	Primary sampler concentration and duplicate sampler concentration.
Performance evaluation program PM _{2.5} , PM _{10-2.5} .	Collocated samplers	1. 5 valid audits for primary QA orgs, with ≤5 sites. 2. 8 valid audits for primary QA orgs, with >5 sites. 3. All samplers in 6 years.	Over all 4 quarters	Primary sampler concentration and performance evaluation sampler concentration.
Manual Methods				
Collocated sampling PM ₁₀ , TSP, PM _{10-2.5} , PM _{2.5} , Pb-TSP, Pb-PM ₁₀ .	Collocated samplers	15%	Every 12 days PSD—every 6 days.	Primary sampler concentration and duplicate sampler concentration.
Flow rate verification PM ₁₀ (low Vol), PM _{10-2.5} , PM _{2.5} , Pb-PM ₁₀ .	Check of sampler flow rate.	Each sampler	Once every month	Audit flow rate and measured flow rate indicated by the sampler.
Flow rate verification PM ₁₀ (High-Vol), TSP, Pb-TSP.	Check of sampler flow rate.	Each sampler	Once every quarter	Audit flow rate and measured flow rate indicated by the sampler.
Semi-annual flow rate audit PM ₁₀ , TSP, PM _{10-2.5} , PM _{2.5} , Pb-TSP, Pb-PM ₁₀ .	Check of sampler flow rate using independent standard.	Each sampler, all locations.	Once every 6 months ..	Audit flow rate and measured flow rate indicated by the sampler.
Pb audit strips Pb-TSP, Pb-PM ₁₀ .	Check of analytical system with Pb audit strips.	Analytical	Each quarter	Actual concentration and audit concentration.
Performance evaluation program PM _{2.5} , PM _{10-2.5} .	Collocated samplers	1. 5 valid audits for primary QA orgs, with ≤5 sites. 2. 8 valid audits for primary QA orgs, with >5 sites. 3. All samplers in 6 years.	Over all 4 quarters	Primary sampler concentration and performance evaluation sampler concentration.
Performance evaluation program Pb-TSP, Pb-PM ₁₀ .	Collocated samplers	1. 1 valid audit and 4 collocated samples for primary QA orgs, with >5 sites. 2. 2 valid audits and 6 collocated samples for primary QA orgs, with >5 sites.	Over all 4 quarters	Primary sampler concentration and performance evaluation sampler concentration. Primary sampler concentration and duplicate sampler concentration.

¹ Effective concentration for open path analyzers.
² Corrected concentration, if applicable, for open path analyzers.

TABLE A-3 OF APPENDIX A TO PART 58—SUMMARY OF PM_{2.5} NUMBER AND TYPE OF COLLOCATION (15% COLLOCATION REQUIREMENT) NEEDED AS AN EXAMPLE OF A PRIMARY QUALITY ASSURANCE ORGANIZATION THAT HAS 54 MONITORS AND PROCURED FRMS AND THREE OTHER EQUIVALENT METHOD TYPES

Primary sampler method designation	Total no. of monitors	Total no. collocated	No. of collocated FRM	No. of collocated monitors of same method designation as primary
FRM	20	3	3	n/a
FEM (A)	20	3	1	1
FEM (C)	2	1	1	0
FEM (D)	12	2	1	1

[71 FR 61303, Oct. 17, 2006, as amended at 72 FR 32211, June 12, 2007; 73 FR 67060, Nov. 12, 2008; 75 FR 6534, Feb. 9, 2010]

EDITORIAL NOTE: At 72 FR 32211, June 13, 2007, the last sentence in section 4.2.2.2, was amended in Appendix A to Part 58; however, the amendment could not be incorporated due to inaccurate amendatory instruction.

EFFECTIVE DATE NOTE: At 75 FR 35602, June 22, 2010, appendix A to part 58 was amended by adding paragraph 2.3.1.6, effective Aug. 23, 2010. For the convenience of the user, the added text is set forth as follows:

APPENDIX A TO PART 58—QUALITY ASSURANCE REQUIREMENTS FOR SLAMS, SPMS AND PSD AIR MONITORING

* * * * *

2.3.1.6 *Measurement Uncertainty for SO₂*. The goal for acceptable measurement uncertainty for precision is defined as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 10 percent.

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APPENDIX B TO PART 58 [RESERVED]

APPENDIX C TO PART 58—AMBIENT AIR QUALITY MONITORING METHODOLOGY

- 1.0 Purpose
- 2.0 SLAMS Ambient Air Monitoring Stations
- 3.0 NCore Ambient Air Monitoring Stations
- 4.0 Photochemical Assessment Monitoring Stations (PAMS)
- 5.0 Particulate Matter Episode Monitoring
- 6.0 References

1.0 PURPOSE

This appendix specifies the criteria pollutant monitoring methods (manual methods or automated analyzers) which must be used in SLAMS and NCore stations that are a subset of SLAMS.

2.0 SLAMS AMBIENT AIR MONITORING NETWORK

2.1 Except as otherwise provided in this appendix, a criteria pollutant monitoring method used for making NAAQS decisions at a SLAMS site must be a reference or equivalent method as defined in §50.1 of this chapter.

2.1.1 Any NO₂ FRM or FEM used for making primary NAAQS decisions must be capable of providing hourly averaged concentration data.

2.2 Reserved

2.3 Any manual method or analyzer purchased prior to cancellation of its reference

or equivalent method designation under §53.11 or §53.16 of this chapter may be used at a SLAMS site following cancellation for a reasonable period of time to be determined by the Administrator.

2.4 Approval of Non-designated Continuous PM_{2.5} Methods as Approved Regional Methods (ARMs) Operated Within a Network of Sites. A method for PM_{2.5} that has not been designated as an FRM or FEM as defined in §50.1 of this chapter may be approved as an ARM for purposes of section 2.1 of this appendix at a particular site or network of sites under the following stipulations.

2.4.1 The candidate ARM must be demonstrated to meet the requirements for PM_{2.5} Class III equivalent methods as defined in subpart C of part 53 of this chapter. Specifically the requirements for precision, correlation, and additive and multiplicative bias apply. For purposes of this section 2.4, the following requirements shall apply:

2.4.1.1 The candidate ARM shall be tested at the site(s) in which it is intended to be used. For a network of sites operated by one reporting agency or primary quality assurance organization, the testing shall occur at a subset of sites to include one site in each MSA/CSA, up to the first 2 highest population MSA/CSA and at least one rural area or Micropolitan Statistical Area site. If the candidate ARM for a network is already approved for purposes of this section in another agency's network, subsequent testing shall minimally occur at one site in a MSA/CSA and one rural area or Micropolitan Statistical Area. There shall be no requirement for tests at any other sites.

2.4.1.2 For purposes of this section, a full year of testing may begin and end in any season, so long as all seasons are covered.

2.4.1.3 No PM₁₀ samplers shall be required for the test, as determination of the PM_{2.5}/PM₁₀ ratio at the test site shall not be required.

2.4.1.4 The test specification for PM_{2.5} Class III equivalent method precision defined in subpart C of part 53 of this chapter applies; however, there is no specific requirement that collocated continuous monitors be operated for purposes of generating a statistic for coefficient of variation (CV). To provide an estimate of precision that meets the requirement identified in subpart C of part 53 of this chapter, agencies may cite peer-reviewed published data or data in AQS that can be presented demonstrating the candidate ARM operated will produce data