in appendix D to this part over a period of 5 years after;

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme O_3 nonattainment.

(b) The quality assurance criteria of appendix A to this part must be implemented for all PAMS.

§ 58.45 PAMS data submittal.

(a) The requirements of this section apply only to those stations designated as PAMS by the network description required by § 58.40.

(b) All data shall be submitted to the Administrator in accordance with the format, reporting periods, reporting deadlines, and other requirements as specified for NAMS in § 58.35.

(c) The State shall report NO and NO_X data consistent with the requirements of § 58.35 for criteria pollutants.

(d) The State shall report VOC data and meteorological data within 6 months following the end of each quarterly reporting period.

§ 58.46 System modification.

(a) Any proposed changes to the PAMS network description will be evaluated during the annual SLAMS Network Review specified in § 58.20. Changes proposed by the State must be approved by the Administrator. The State will be allowed 1 year (until the next annual evaluation) to implement the appropriate changes to the PAMS network.

(b) PAMS network requirements are mandatory only for serious, severe, and extreme O_3 nonattainment areas. When any such area is redesignated to attainment, the State may revise its PAMS monitoring program subject to approval by the Administrator.

Subpart F—Air Quality Index Reporting

§ 58.50 Index reporting.

(a) The State shall report to the general public through prominent notice an air quality index in accordance with the requirements of appendix G to this part.

(b) Reporting is required by all Metropolitan Statistical Areas with a population exceeding 350,000.

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

[64 FR 42547, Aug. 4, 1999]

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 station if the State fails to locate, or schedule to be located, during the initial network design process or as a result of the annual review required by § 58.20(d):

(a) A SLAMS at a site which is necessary in the judgment of the Regional Administrator to meet the objectives defined in appendix D to this part, or

(b) A NAMS at a site which is necessary in the judgment of the Administrator for meeting EPA national data needs.

§ 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 a National Ambient Air Quality Standard 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.

APPENDIX A TO PART 58—QUALITY ASSURANCE REQUIREMENTS FOR STATE AND LOCAL AIR MONITORING STATIONS (SLAMS)

1. *General Information.*

1.1 This appendix specifies the minimum quality assurance/quality control (QA/QC) requirements applicable to SLAMS air monitoring data submitted to EPA. State and local agencies are encouraged to develop and maintain quality assurance programs more extensive than the required minimum.

1.2 To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad quality assurance activities, such as establishing policies and procedures, developing data quality objectives, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc. In general, the greater the control of a given monitoring system, the better will be the resulting quality of the monitoring data. The results of quality assurance reviews and assessments indicate whether the control efforts are adequate or need to be improved.

1.3 Documentation of all quality assurance and quality control efforts implemented during the data collection, analysis, and reporting phases is important to data users, who can then consider the impact of these control efforts on the data quality (see reference 1 of this appendix). Both qualitative and quantitative assessments of the effectiveness of these control efforts should identify those areas most likely to impact the data quality and to what extent.

1.4 Periodic assessments of SLAMS data quality are required to be reported to EPA. To provide national uniformity in this assessment and reporting of data quality for all SLAMS 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 QA and QC activities used by a monitoring agency depend on a number of local factors such as the field and laboratory conditions, the objectives for monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, pollutant concentration levels, etc. Therefore, the quality system requirements, in section 2 of this appendix, are specified in general terms to allow each State to develop a quality assurance program that is most efficient and effective for its own circumstances while achieving the Ambient Air Quality Programs data quality objectives.

2. *Quality System Requirements.*

2.1 Each State and local agency must develop a quality system (reference 2 of this appendix) to ensure that the monitoring results:

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

(b) Satisfy customers' expectations.

(c) Comply with applicable standards specifications.

(d) Comply with statutory (and other) requirements of society.

(e) Reflect consideration of cost and economics.

(f) Implement a quality assurance program consisting of policies, procedures, specifications, standards, and documentation necessary to:

(1) Provide data of adequate quality to meet monitoring objectives, and

(2) Minimize loss of air quality data due to malfunctions or out-of-control conditions. This quality assurance program must be described in detail, suitably documented in accordance with Agency requirements (reference 4 of this appendix), and approved by the appropriate Regional Administrator, or the Regional Administrator's designee. The Quality Assurance Program will be reviewed during the systems audits described in section 2.5 of this appendix.

2.2 Primary requirements and guidance documents for developing the quality assurance program are contained in references 2 through 7 of this appendix, which also contain many suggested and required procedures, checks, and control specifications. Reference 7 of this appendix describes specific guidance for the development of a QA Program 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 8 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. Quality assurance guidance for meteorological systems at PAMS is contained in reference 9 of this appendix. Quality assurance procedures for VOC, NO_X (including NO and NO_2), O_3, and carbonyl measurements at PAMS must be consistent with reference 15 of this appendix. Reference 4 of this appendix includes requirements for the development of quality assurance project plans, and quality assurance and control programs, and systems audits demonstrating attainment of the requirements.

2.3 Pollutant Concentration and Flow Rate Standards.

2.3.1 Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO_2, NO, and NO_2 must be traceable to either a National Institute of Standards and Technology (NIST) 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 10 of this appendix.

2.3.2 Test concentrations for O_3 must be obtained in accordance with the UV photometric calibration procedure specified in 40 CFR part 50, appendix D, or by means of a

certified ozone transfer standard. Consult references 11 and 12 of this appendix for guidance on primary and transfer standards for O_3.

2.3.3 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 7 of this appendix.

2.4 National Performance Audit Program (NPAP). Agencies operating SLAMS are required to participate in EPA's NPAP. These audits are described in reference 7 of this appendix. For further instructions, agencies should contact either the appropriate EPA Regional QA Coordinator at the appropriate EPA Regional Office location, or the NPAP Coordinator, Emissions Monitoring and Analysis Division (MD–14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

2.5 Systems Audit Programs. Systems audits of the ambient air monitoring programs of agencies operating SLAMS shall be conducted at least every 3 years by the appropriate EPA Regional Office. Systems audit programs are described in reference 7 of this appendix. For further instructions, agencies should contact either the appropriate EPA Regional QA Coordinator or the Systems Audit QA Coordinator, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division (MD-14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

3. *Data Quality Assessment Requirements.*

3.0.1 All ambient monitoring methods or analyzers used in SLAMS shall be tested periodically, as described in this section, to quantitatively assess the quality of the SLAMS data. Measurement uncertainty is estimated for both automated and manual methods. Terminology associated with measurement uncertainty are found within this appendix and includes:

(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) Accuracy. The degree of agreement between an observed value and an accepted reference value, accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations;

(c) Bias. The systematic or persistent distortion of a measurement process which causes errors in one direction. The individual results of these tests for each method or analyzer shall be reported to EPA as specified in section 4 of this appendix. EPA will then calculate quarterly assessments of measurement uncertainty applicable to the SLAMS data as described in section 5 of this appendix. Data assessment results should be reported to EPA only for methods and analyzers approved for use in SLAMS monitoring under appendix C of this part.

3.0.2 Estimates of the data quality will be calculated on the basis of single monitors and reporting organizations and may also be calculated for each region and for the entire Nation. A reporting organization is defined as a State, subordinate organization within a State, or other organization that is responsible for a set of stations that monitors the same pollutant and for which data quality assessments can be pooled. States must define one or more reporting organizations for each pollutant such that each monitoring station in the State SLAMS network is included in one, and only one, reporting organization.

3.0.3 Each reporting 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.

(a) Common factors that should be considered by States in defining reporting organizations include:

(1) Operation by a common team of field operators.

(2) Common calibration facilities.

(3) Oversight by a common quality assurance organization.

(4) Support by a common laboratory or headquarters.

(b) Where there is uncertainty in defining the reporting organizations or in assigning specific sites to reporting organizations, States shall consult with the appropriate EPA Regional Office. All definitions of reporting organizations shall be subject to final approval by the appropriate EPA Regional Office.

3.0.4 Assessment results shall be reported as specified in section 4 of this appendix. Table A–1 of this appendix provides a summary of the minimum data quality assessment requirements, which are described in more detail in the following sections.

3.1 Precision of Automated Methods Excluding $PM_{2.5}$.

3.1.1 Methods for SO_2, NO_2, O_3 and CO. A one- point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure SO_2, NO_2, O_3 and CO. The precision check is made by challenging the analyzer with a precision check gas of known concentration (effective concentration for open path analyzers) between 0.08 and 0.10 ppm for SO_2, NO_2, and O_3 analyzers, and between 8 and 10 ppm for CO analyzers. To check the precision of SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm SO_2, NO_2, and O_3, or 0 to 100 ppm for CO, use precision check gases of appropriately higher concentration as approved by the appropriate Regional Administrator or their designee. However, the results of precision checks at concentration levels other

than those specified above need not be reported to EPA. The standards from which precision check test concentrations are obtained must meet the specifications of section 2.3 of this appendix.

3.1.1.1 Except for certain CO analyzers described below, point analyzers must operate in their normal sampling mode during the precision 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 precision 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 precision check is made in conjunction with a zero or span adjustment, it must be made prior to such zero or span adjustments. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.1.1.2 Open path analyzers are tested by inserting a test cell containing a precision 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 precision check gas in the test cell must be selected to produce an effective concentration in the range specified in section 3.1.1. Generally, the precision test concentration measurement will be the sum of the atmospheric pollutant concentration and the precision 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 precision check test from the precision test 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.

3.1.1.3 Report the actual concentration (effective concentration for open path analyzers) of the precision check gas and the corresponding concentration measurement (corrected concentration, if applicable, for open path analyzers) indicated by the analyzer. The percent differences between these concentrations are used to assess the precision of the monitoring data as described in section 5.1. of this appendix.

3.1.2 Methods for Particulate Matter Excluding $PM_{2.5}$. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure PM_{10}. The precision check is made by checking the operational flow rate of the analyzer. If a precision flow rate check is made in conjunction with a flow rate adjustment, it must be made prior to such flow rate adjustment. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.1.2.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 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 actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.1.2.2 Alternative procedure:

3.1.2.2.1 It is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter without the use of an external flow rate transfer standard, provided that:

3.1.2.2.1.1 The flow meter is audited with an external flow rate transfer standard at least every 6 months.

3.1.2.2.1.2 Records of at least the three most recent flow audits of the instrument's internal flow meter over at least several weeks confirm that the flow meter is stable, verifiable and accurate to ±4%.

3.1.2.2.1.3 The instrument and flow meter give no indication of improper operation.

3.1.2.2.2 With suitable communication capability, the precision check may thus be carried out remotely. For this procedure, report the set-point flow rate as the actual flow rate along with the flow rate measured or indicated by the analyzer flow meter.

3.1.2.2.3 For either procedure, the percent differences between the actual and indicated flow rates are used to assess the precision of the monitoring data as described in section 5.1 of this appendix (using flow rates in lieu of concentrations). The percent differences between these concentrations are used to assess the precision of the monitoring data as described in section 5.1. of this appendix.

3.2 Accuracy of Automated Methods Excluding $PM_{2.5}$.

3.2.1 Methods for SO_2, NO_2, O_3, or CO.

3.2.1.1 Each calendar quarter (during which analyzers are operated), audit at least 25 percent of the SLAMS analyzers that monitor for SO_2, NO_2, O_3, or CO such that each analyzer is audited at least once per year. If there are fewer than four analyzers for a pollutant within a reporting organization, randomly reaudit one or more analyzers so that at least one analyzer for that pollutant is audited each calendar quarter. Where possible, EPA strongly encourages more frequent auditing, up to an audit frequency of once per quarter for each SLAMS analyzer.

3.2.1.2 (a) The audit is made by challenging the analyzer with at least one audit gas of known concentration (effective concentration for open path analyzers) from each of the following ranges applicable to the analyzer being audited:

Audit Level	Concentration Range, PPM		
	SO_2, O_3	NO_2	CO
1	0.03–0.08	0.03–0.08	3–8
2	0.15–0.20	0.15–0.20	15–20
3	0.35–0.45	0.35–0.45	35–45
4	0.80–0.90	.....	80–90

(b) NO_2 audit gas for chemiluminescence-type NO_2 analyzers must also contain at least 0.08 ppm NO.

3.2.1.3 NO concentrations substantially higher than 0.08 ppm, as may occur when using some gas phase titration (GPT) techniques, may lead to audit 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 NO_2 audit gas to levels closer to typical ambient NO concentrations at the site.

3.2.1.4 To audit SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm for SO_2, NO_2, and O_3 or 0 to 100 ppm for CO, use audit gases of appropriately higher concentration as approved by the appropriate Regional Administrator or the Administrators's designee. The results of audits at concentration levels other than those shown in the above table need not be reported to EPA.

3.2.1.5 The standards from which audit gas test concentrations are obtained must meet the specifications of section 2.3 of this appendix. The gas standards and equipment used for auditing must not be the same as the standards and equipment used for calibration or calibration span adjustments. The auditor should not be the operator or analyst who conducts the routine monitoring, calibration, and analysis.

3.2.1.6 For point analyzers, the audit shall be carried out by allowing the analyzer to analyze the audit 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 3.1 of this appendix for certain CO analyzers does not apply for audits.

3.2.1.7 Open path analyzers are audited 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 audit, and the normal monitoring configuration of the instrument should be modified as little as possible to accommodate the test cell for the audit. 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 ranges specified in this section 3.2 of this appendix. Generally, each audit concentration measurement result will be the sum of the atmospheric pollutant concentration and the audit 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 audit test (or preferably before and after each audit concentration level) from the audit 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 audited during periods when the atmospheric pollutant concentrations are relatively low and steady. Also, the monitoring path length must be reverified to within ±3 percent to validate the audit, since the monitoring path length is critical to the determination of the effective concentration.

3.2.1.8 Report both the actual concentrations (effective concentrations for open path analyzers) of the audit gases and the corresponding concentration measurements (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 accuracy of the monitoring data as described in section 5.2 of this appendix.

3.2.2 Methods for Particulate Matter Excluding $PM_{2.5}$.

3.2.2.1 Each calendar quarter, audit the flow rate of at least 25 percent of the SLAMS PM_{10} analyzers such that each PM_{10} analyzer is audited at least once per year. If there are fewer than four PM_{10} analyzers within a reporting organization, randomly re-audit one or more analyzers so that at least one analyzer is audited each calendar quarter. Where possible, EPA strongly encourages more frequent auditing, up to an audit frequency of once per quarter for each SLAMS analyzer.

3.2.2.2 The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 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 (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The percent differences between these flow rates are used to calculate accuracy (PM_{10}) as described in section 5.2 of this appendix.

3.3 Precision of Manual Methods Excluding $PM_{2.5}$.

3.3.1 For each network of manual methods other than for $PM_{2.5}$, select one or more monitoring sites within the reporting organization for duplicate, collocated sampling as follows: for 1 to 5 sites, select 1 site; for 6 to 20 sites, select 2 sites; and for over 20 sites, select 3 sites. Where possible, additional collocated sampling is encouraged. For purposes of precision assessment, networks for measuring TSP and PM_{10} shall be considered separately from one another. 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 Regional Administrator may be selected.

3.3.2 In determining the number of collocated sites required for PM_{10}, monitoring networks for lead should be treated independently from networks for particulate matter, even though the separate networks may share one or more common samplers. However, a single pair of samplers collocated at a common-sampler monitoring site that meets the requirements for both a collocated lead site and a collocated particulate matter site may serve as a collocated site for both networks.

3.3.3 The two collocated samplers must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart 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.

3.3.4 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 duplicate sampler. Each duplicate sampler must be operated concurrently with its associated routine sampler at least once per week. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the seven days of the week. A six-day sampling schedule is required. 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 5.3 of this appendix.

3.4 Accuracy of Manual Methods Excluding $PM_{2.5}$. The accuracy of manual sampling methods is assessed by auditing a portion of the measurement process.

3.4.1 Procedures for PM_{10} and TSP.

3.4.1.1 Procedures for flow rate audits for PM_{10}. Each calendar quarter, audit the flow rate of at least 25 percent of the PM_{10} samplers such that each PM_{10} sampler is audited at least once per year. If there are fewer than four PM_{10} samplers within a reporting organization, randomly reaudit one or more samplers so that one sampler is audited each calendar quarter. Audit each sampler at its normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the sampler. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate standard. The flow audit should be scheduled so as to avoid interference with a scheduled sampling period. Report the audit (actual) flow rate and the corresponding flow rate indicated by the sampler's normally used flow indicator. The percent differences between these flow rates are used to calculate accuracy and bias as described in section 5.4.1 of this appendix.

3.4.1.2 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.

3.4.2 SO_2 Methods.

3.4.2.1 Prepare audit solutions from a working sulfite-tetrachloromercurate (TCM) solution as described in section 10.2 of the SO_2 Reference Method (40 CFR part 50, appendix A). These audit samples must be prepared independently from the standardized sulfite solutions used in the routine calibration procedure. Sulfite-TCM audit samples must be stored between 0 and 5 °C and expire 30 days after preparation.

3.4.2.2 Prepare audit samples in each of the concentration ranges of 0.2-0.3, 0.5-0.6, and 0.8-0.9 µg SO_2/ml. Analyze an audit sample in each of the three ranges at least once each day that samples are analyzed and at least twice per calendar quarter. Report the audit concentrations (in µg SO_2/ml) and the corresponding indicated concentrations (in µg SO_2/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2 of this appendix.

3.4.3 NO_2 Methods. Prepare audit solutions from a working sodium nitrite solution as described in the appropriate equivalent method (see reference 8 of this appendix). These audit samples must be prepared independently from the standardized nitrite solutions used in the routine calibration procedure. Sodium nitrite audit samples expire in 3 months after preparation. Prepare audit samples in each of the concentration ranges of 0.2-0.3, 0.5-0.6, and 0.8-0.9 µg NO_2/ml. Analyze an audit sample in each of the three ranges at least once each day that samples are analyzed and at least twice per calendar quarter. Report the audit concentrations (in µg NO_2/ml) and the corresponding indicated concentrations (in µg NO_2/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2 of this appendix.

3.4.4 Pb Methods.

3.4.4.1 For the Pb Reference Method (40 CFR part 50, appendix G), the flow rates of the high-volume Pb samplers shall be audited as part of the TSP network using the same procedures described in section 3.4.1 of this appendix. For agencies operating both TSP and Pb networks, 25 percent of the total number of high-volume samplers are to be audited each quarter.

3.4.4.2 Each calendar quarter, audit the Pb Reference Method analytical procedure using glass fiber filter strips containing a known quantity of Pb. These audit sample strips are prepared by depositing a Pb solution on unexposed glass fiber filter strips of dimensions 1.9 cm by 20.3 cm (3/4 inch by 8 inch) 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	Pb Concentration, µg/Strip	Equivalent Ambient Pb Concentration, µg/m³ [1]
1	100–300	0.5–1.5
2	600–1000	3.0–5.0

[1] Equivalent ambient Pb concentration in µg/m³ is based on sampling at 1.7 m³/min for 24 hours on a 20.3 cm×25.4 cm (8 inch×10 inch) glass fiber filter.

3.4.4.3 Audit samples must be extracted using the same extraction procedure used for exposed filters.

3.4.4.4 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. Report the audit concentrations (in µg Pb/strip) and the corresponding measured concentrations (in µg Pb/strip) using unit code 77. The percent differences between the concentrations are used to calculate analytical accuracy as described in section 5.4.2 of this appendix.

3.4.4.5 The accuracy of an equivalent Pb method is 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.

3.5 Measurement Uncertainty for Automated and Manual $PM_{2.5}$ Methods. The goal for acceptable measurement uncertainty has been defined as 10 percent coefficient of variation (CV) for total precision and ± 10 percent for total bias (reference 14 of this appendix).

3.5.1 Flow Rate Audits.

3.5.1.1 Automated methods for $PM_{2.5}$. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure $PM_{2.5}$. The precision check is made by checking the operational flow rate of the analyzer. If a precision flow rate check is made in conjunction with a flow rate adjustment, it must be made prior to such flow rate adjustment. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.5.1.1.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 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 actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.5.1.1.2 Alternative procedure: It is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter

without the use of an external flow rate transfer standard, provided that the flow meter is audited with an external flow rate transfer standard at least every 6 months; records of at least the three most recent flow audits of the instrument's internal flow meter over at least several weeks confirm that the flow meter is stable, verifiable and accurate to ±4%; and the instrument and flow meter give no indication of improper operation. With suitable communication capability, the precision check may thus be carried out remotely. For this procedure, report the set-point flow rate as the actual flow rate along with the flow rate measured or indicated by the analyzer flow meter.

3.5.1.1.3 For either procedure, the differences between the actual and indicated flow rates are used to assess the precision of the monitoring data as described in section 5.5 of this appendix.

3.5.1.2 Manual methods for $PM_{2.5}$. Each calendar quarter, audit the flow rate of each SLAMS $PM_{2.5}$ analyzer. The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 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 (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The procedures used to calculate measurement uncertainty $PM_{2.5}$ are described in section 5.5 of this appendix.

3.5.2 Measurement of Precision using Collocated Procedures for Automated and Manual Methods of $PM_{2.5}$.

(a) For $PM_{2.5}$ sites within a reporting organization each EPA designated Federal reference method (FRM) or Federal equivalent method (FEM) must:

(1) Have 15 percent of the monitors collocated (values of .5 and greater round up).

(2) Have at least 1 collocated monitor (if the total number of monitors is less than 4). The first collocated monitor must be a designated FRM monitor.

(b) In addition, monitors selected must also meet the following requirements:

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

(2) For each monitor designated as an EPA FEM, 50 percent of the designated monitors shall be collocated with a monitor having the same method designation and 50 percent of the monitors shall be collocated with an FRM monitor. If there are an odd number of collocated monitors required, the additional monitor shall be an FRM. An example of this procedure is found in table A–2 of this appendix.

(c) For $PM_{2.5}$ sites during the initial deployment of the SLAMS network, special emphasis should be placed on those sites in areas likely to be in violation of the NAAQS. Once areas are initially determined to be in violation, the collocated monitors should be deployed according to the following protocol:

(1) Eighty percent of the collocated monitors should be deployed at sites with concentrations ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area); one hundred percent if all sites have concentrations above either NAAQS, and each area determined to be in violation should be represented by at least one collocated monitor.

(2) The remaining 20 percent of the collocated monitors should be deployed at sites with concentrations < ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area)

(3) If an organization has no sites at concentration ranges ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area), 60 percent of the collocated monitors should be deployed at those sites with the annual mean $PM_{2.5}$ concentrations (or 24-hour NAAQS if that is affecting the area) among the highest 25 percent for all $PM_{2.5}$ sites in the network.

3.5.2.1 In determining the number of collocated sites required for $PM_{2.5}$, monitoring networks for visibility 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 federal reference or equivalent method is not required to be included in the number of sites which are used to determine the number of collocated monitors.

3.5.2.2 The two collocated samples must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart (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.

3.5.2.3 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 duplicate sampler. Each duplicate sampler must be operated concurrently with its associated primary sampler. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the 7 days of the week and

therefore, a 6-day sampling schedule is required. 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 5.5 of this appendix.

3.5.3 Measurement of Bias using the FRM Audit Procedures for Automated and Manual Methods of $PM_{2.5}$.

3.5.3.1 The FRM audit is an independent assessment of the total measurement system bias. These audits will be performed under the National Performance Audit Program (section 2.4 of this appendix) or a comparable program. Twenty-five percent of the SLAMS monitors within each reporting organization will be assessed with an FRM audit each year. Additionally, every designated FRM or FEM within a reporting organization must:

(a) Have at least 25 percent of each method designation audited, including collocated sites (even those collocated with FRM instruments), (values of .5 and greater round up).

(b) Have at least one monitor audited.

(c) Be audited at a frequency of four audits per year.

(d) Have all FRM or FEM samplers subject to an FRM audit at least once every 4 years. Table A–2 illustrates the procedure mentioned above.

3.5.3.2 For $PM_{2.5}$ sites during the initial deployment of the SLAMS network, special emphasis should be placed on those sites in areas likely to be in violation of the NAAQS. Once areas are initially determined to be in violation, the FRM audit program should be implemented according to the following protocol:

(a) Eighty percent of the FRM audits should be deployed at sites with concentrations ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area); one hundred percent if all sites have concentrations above either NAAQS, and each area determined to be in violation should implement an FRM audit at a minimum of one monitor within that area.

(b) The remaining 20 percent of the FRM audits should be implemented at sites with concentrations < ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area).

(c) If an organization has no sites at concentration ranges ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24-hour NAAQS if that is affecting the area), 60 percent of the FRM audits should be implemented at those sites with the annual mean $PM_{2.5}$ concentrations (or 24-hour NAAQS if that is affecting the area) among the highest 25 percent for all $PM_{2.5}$ sites in the network. Additional information concerning the FRM audit program is contained in reference 7 of this appendix. The calculations for evaluating bias between the primary monitor and the FRM audit are described in section 5.5.

4. *Reporting Requirements.*

(a) For each pollutant, prepare a list of all monitoring sites and their AIRS site identification codes in each reporting organization and submit the list to the appropriate EPA Regional Office, with a copy to AIRS-AQS. Whenever there is a change in this list of monitoring sites in a reporting organization, report this change to the Regional Office and to AIRS-AQS.

4.1 Quarterly Reports. For each quarter, each reporting organization shall report to AIRS-AQS directly (or via the appropriate EPA Regional Office for organizations not direct users of AIRS) the results of all valid precision, bias and accuracy tests it has carried out during the quarter. The quarterly reports of precision, bias and accuracy data must be submitted consistent with the data reporting requirements specified for air quality data as set forth in §58.35(c). EPA strongly encourages early submittal of the QA data in order to assist the State and Local agencies in controlling and evaluating the quality of the ambient air SLAMS data. Each organization shall report all QA/QC measurements. Report results from invalid tests, from tests carried out during a time period for which ambient data immediately prior or subsequent to the tests were invalidated for appropriate reasons, and from tests of methods or analyzers not approved for use in SLAMS monitoring networks under appendix C of this part. Such data should be flagged so that it will not be utilized for quantitative assessment of precision, bias and accuracy.

4.2 Annual Reports.

4.2.1 When precision, bias and accuracy estimates for a reporting organization have been calculated for all four quarters of the calendar year, EPA will calculate and report the measurement uncertainty for the entire calendar year. These limits will then be associated with the data submitted in the annual SLAMS report required by §58.26.

4.2.2 Each reporting organization shall submit, along with its annual SLAMS report, a listing by pollutant of all monitoring sites in the reporting organization.

5. *Calculations for Data Quality Assessment.*

(a) Calculations of measurement uncertainty are carried out by EPA according to the following procedures. Reporting organizations should report the data for individual precision, bias and accuracy tests as specified in sections 3 and 4 of this appendix even though they may elect to perform some or all of the calculations in this section on their own.

5.1 Precision of Automated Methods Excluding $PM_{2.5}$. Estimates of the precision of automated methods are calculated from the results of biweekly precision checks as specified in section 3.1 of this appendix. At the end of each calendar quarter, an integrated precision probability interval for all SLAMS

analyzers in the organization is calculated for each pollutant.

5.1.1 Single Analyzer Precision.

5.1.1.1 The percent difference (d_i) for each precision check is calculated using equation 1, where Y_i is the concentration indicated by the analyzer for the I-th precision check and X_i is the known concentration for the I-th precision check, as follows:

EQUATION 1

$$d_i = \frac{Y_i - X_i}{X_i} \times 100$$

5.1.1.2 For each analyzer, the quarterly average (d_j) is calculated with equation 2, and the standard deviation (S_j) with equation 3, where n is the number of precision checks on the instrument made during the calendar quarter. For example, n should be 6 or 7 if precision checks are made biweekly during a quarter. Equation 2 and 3 follow:

EQUATION 2

$$d_j = \frac{1}{n} \sum_{i=1}^{n} d_i$$

EQUATION 3

$$S_j = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} d_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} d_i\right)^2\right]}$$

5.1.2 Precision for Reporting Organization.

5.1.2.1 For each pollutant, the average of averages (D) and the pooled standard deviation (S_a) are calculated for all analyzers audited for the pollutant during the quarter, using either equations 4 and 5 or 4a and 5a, where k is the number of analyzers audited within the reporting organization for a single pollutant, as follows:

EQUATION 4

$$D = \frac{1}{k} \sum_{j=1}^{k} d_j$$

EQUATION 4A

$$D = \frac{n_1 d_1 + n_2 d_2 + \ldots + n_j d_j + \ldots + n_k d_k}{n_1 + n_2 + \ldots + n_j + \ldots + n_k}$$

EQUATION 5

$$S_a = \sqrt{\frac{1}{k}\sum_{j=1}^{k} S_j^2}$$

EQUATION 5A

$$S_a = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2 + \ldots + (n_j - 1)S_j^2 + \ldots + (n_k - 1)S_k^2}{n_1 + n_2 + \ldots + n_j + \ldots + n_k - k}}$$

5.1.2.2 Equations 4 and 5 are used when the same number of precision checks are made for each analyzer. Equations 4a and 5a are used to obtain a weighted average and a weighted standard deviation when different numbers of precision checks are made for the analyzers.

5.1.2.3 For each pollutant, the 95 Percent Probability Limits for the precision of a reporting organization are calculated using equations 6 and 7, as follows:

EQUATION 6

Upper 95 Percent Probability Limit = $D + 1.96\ S_a$

EQUATION 7

Lower 95 Percent Probability Limit = $D - 1.96\ S_a$

5.2 Accuracy of Automated Methods Excluding $PM_{2.5}$. Estimates of the accuracy of automated methods are calculated from the results of independent audits as described in

section 3.2 of this appendix. At the end of each calendar quarter, an integrated accuracy probability interval for all SLAMS analyzers audited in the reporting organization is calculated for each pollutant. Separate probability limits are calculated for each audit concentration level in section 3.2 of this appendix.

5.2.1 Single Analyzer Accuracy. The percentage difference (d_i) for each audit concentration is calculated using equation 1, where Y_i is the analyzer's indicated concentration measurement from the I-th audit check and X_i is the actual concentration of the audit gas used for the I-th audit check.

5.2.2 Accuracy for Reporting Organization.

5.2.2.1 For each audit concentration level of a particular pollutant, the average (D) of the individual percentage differences (d_i) for all n analyzers audited during the quarter is calculated using equation 8, as follows:

EQUATION 8

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

5.2.2.2 For each concentration level of a particular pollutant, the standard deviation (S_a) of all the individual percentage differences for all n analyzers audited during the quarter is calculated, using equation 9, as follows:

EQUATION 9

$$S_a = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} d_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} d_i\right)^2\right]}$$

5.2.2.3 For reporting organizations having four or fewer analyzers for a particular pollutant, only one audit is required each quarter. For such reporting organizations, the audit results of two consecutive quarters are required to calculate an average and a standard deviation, using equations 8 and 9. Therefore, the reporting of probability limits shall be on a semiannual (instead of a quarterly) basis.

5.2.2.4 For each pollutant, the 95 Percent Probability Limits for the accuracy of a reporting organization are calculated at each audit concentration level using equations 6 and 7.

5.3 Precision of Manual Methods Excluding $PM_{2.5}$. Estimates of precision of manual methods are calculated from the results obtained from collocated samplers as described in section 3.3 of this appendix. At the end of each calendar quarter, an integrated precision probability interval for all collocated samplers operating in the reporting organization is calculated for each manual method network.

5.3.1 Single Sampler Precision.

5.3.1.1 At low concentrations, agreement between the measurements of collocated samplers, expressed as percent differences, may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits:

(a) TSP: 20 µg/m³.
(b) SO_2: 45 µg/m³.
(c) NO_2: 30 µg/m³.
(d) Pb: 0.15 µg/m³.
(e) PM_{10}: 20 µg/m³.

5.3.1.2 For each selected measurement pair, the percent difference (d_i) is calculated, using equation 10, as follows:

EQUATION 10

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

where:

Y_i is the pollutant concentration measurement obtained from the duplicate sampler; and

X_i is the concentration measurement obtained from the primary sampler designated for reporting air quality for the site.

(a) For each site, the quarterly average percent difference (d_j) is calculated from equation 2 and the standard deviation (S_j) is calculated from equation 3, where n= the number of selected measurement pairs at the site.

5.3.2 Precision for Reporting Organization.

5.3.2.1 For each pollutant, the average percentage difference (D) and the pooled standard deviation (S_a) are calculated, using equations 4 and 5, or using equations 4a and 5a if different numbers of paired measurements are obtained at the collocated sites. For these calculations, the k of equations 4, 4a, 5 and 5a is the number of collocated sites.

5.3.2.2 The 95 Percent Probability Limits for the integrated precision for a reporting organization are calculated using equations 11 and 12, as follows:

EQUATION 11

$$\text{Upper 95 Percent Probability Limit} = D + 1.96\, S_a$$

EQUATION 12

$$\text{Lower 95 Percent Probability Limit} = D - 1.96\, S_a$$

5.4 Accuracy of Manual Methods Excluding $PM_{2.5}$. Estimates of the accuracy of manual methods are calculated from the results of independent audits as described in section 3.4 of this appendix. At the end of each calendar quarter, an integrated accuracy probability interval is calculated for each manual method network operated by the reporting organization.

5.4.1 Particulate Matter Samplers other than $PM_{2.5}$ (including reference method Pb samplers).

5.4.1.1 Single Sampler Accuracy. For the flow rate audit described in section 3.4.1 of this appendix, the percentage difference (d_i) for each audit is calculated using equation 1, where X_i represents the known flow rate and Y_i represents the flow rate indicated by the sampler.

5.4.1.2 Accuracy for Reporting Organization. For each type of particulate matter measured (e.g., TSP/Pb), the average (D) of the individual percent differences for all similar particulate matter samplers audited during the calendar quarter is calculated using equation 8. The standard deviation (S_a) of the percentage differences for all of the similar particulate matter samplers audited during the calendar quarter is calculated using equation 9. The 95 Percent Probability Limits for the integrated accuracy for the reporting organization are calculated using equations 6 and 7. For reporting organizations having four or fewer particulate matter samplers of one type, only one audit is required each quarter, and the audit results of two consecutive quarters are required to calculate an average and a standard deviation. In that case, probability limits shall be reported semi-annually rather than quarterly.

5.4.2 Analytical Methods for SO_2, NO_2, and Pb.

5.4.2.1 Single Analysis-Day Accuracy. For each of the audits of the analytical methods for SO_2, NO_2, and Pb described in sections 3.4.2, 3.4.3, and 3.4.4 of this appendix, the percentage difference (d_j) at each concentration level is calculated using equation 1, where X_j represents the known value of the audit sample and Y_j represents the value of SO_2, NO_2, or Pb indicated by the analytical method.

5.4.2.2 Accuracy for Reporting Organization. For each analytical method, the average (D) of the individual percent differences at each concentration level for all audits during the calendar quarter is calculated using equation 8. The standard deviation (S_a) of the percentage differences at each concentration level for all audits during the calendar quarter is calculated using equation 9. The 95 Percent Probability Limits for the accuracy for the reporting organization are calculated using equations 6 and 7.

5.5 Precision, Accuracy and Bias for Automated and Manual $PM_{2.5}$ Methods.

(a) Reporting organizations are required to report the data that will allow assessments of the following individual quality control checks and audits:

(1) Flow rate audit.

(2) Collocated samplers, where the duplicate sampler is not an FRM device.

(3) Collocated samplers, where the duplicate sampler is an FRM device.

(4) FRM audits.

(b) EPA uses the reported results to derive precision, accuracy and bias estimates according to the following procedures.

5.5.1 Flow Rate Audits. The reporting organization shall report both the audit standard flow rate and the flow rate indicated by the sampling instrument. These results are used by EPA to calculate flow rate accuracy and bias estimates.

5.5.1.1 Accuracy of a Single Sampler - Single Check (Quarterly) Basis (d_i). The percentage difference (d_i) for a single flow rate audit d_i is calculated using equation 13, where X_i represents the audit standard flow rate (known) and Y_i represents the indicated flow rate, as follows:

EQUATION 13

$$d_i = \frac{Y_i - X_i}{X_i} \times 100$$

5.5.1.2 Bias of a Single Sampler - Annual Basis (D_j). For an individual particulate sampler j, the average (D_j) of the individual percentage differences (d_i) during the calendar year is calculated using equation 14, where n_j is the number of individual percentage differences produced for sampler j during the calendar year, as follows:

EQUATION 14

$$D_j = \frac{1}{n_j} \times \sum_{i=1}^{n_j} d_i$$

5.5.1.3 Bias for Each EPA Federal Reference and Equivalent Method Designation Employed by Each Reporting Organization - Quarterly Basis ($D_{k,q}$). For method designation k used by the reporting organization, quarter q's single sampler percentage differences (d_i) are averaged using equation 16, where $n_{k,q}$ is the number of individual percentage differences produced for method designation k in quarter q, as follows:

EQUATION 15

$$D_{k,q} = \frac{1}{n_{k,q}} \times \sum_{i=1}^{n_{k,q}} d_i$$

5.5.1.4 Bias for Each Reporting Organization - Quarterly Basis (D_q). For each reporting organization, quarter q's single sampler percentage differences (d_i) are averaged using equation 16, to produce a single average for each reporting organization, where n_q is the total number of single sampler percentage differences for all federal reference or equivalent methods of samplers in quarter q, as follows:

EQUATION 16

$$D_q = \frac{1}{n_q} \times \sum_{i=1}^{n_q} d_i$$

5.5.1.5 Bias for Each EPA Federal Reference and Equivalent Method Designation Employed by Each Reporting Organization - Annual Basis (D_k). For method designation k used by the reporting organization, the annual average percentage difference, D_k, is derived using equation 17, where $D_{k,q}$ is the average reported for method designation k during the qth quarter, and $n_{k,q}$ is the number of the method designation k's monitors that were deployed during the qth quarter, as follows:

EQUATION 17

$$D_k = \frac{\sum_{q=1}^{4} \left(n_{k,q} D_{k,q}\right)}{\sum_{q=1}^{4} n_{k,q}}$$

5.5.1.6 Bias for Each Reporting Organization - Annual Basis (D). For each reporting organization, the annual average percentage difference, D, is derived using equation 18, where D_q is the average reported for the reporting organization during the qth quarter, and n_q is the total number monitors that were deployed during the qth quarter. A single annual average is produced for each reporting organization. Equation 18 follows:

EQUATION 18

$$D = \frac{\sum_{q=1}^{4} \left(n_q D_q\right)}{\sum_{q=1}^{4} n_q}$$

5.5.2 Collocated Samplers, Where the Duplicate Sampler is not an FRM Device. (a) At low concentrations, agreement between the measurements of collocated samplers may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits:

$PM_{2.5}$: 6 μg/m³

(b) Collocated sampler results are used to assess measurement system precision. A collocated sampler pair consists of a primary sampler (used for routine monitoring) and a duplicate sampler (used as a quality control check). Quarterly precision estimates are calculated by EPA for each pair of collocated samplers and for each method designation employed by each reporting organization. Annual precision estimates are calculated by EPA for each primary sampler, for each EPA Federal reference method and equivalent method designation employed by each reporting organization, and nationally for each EPA Federal reference method and equivalent method designation.

5.5.2.1 Percent Difference for a Single Check (d_i). The percentage difference, d_i, for each check is calculated by EPA using equation 19, where X_i represents the concentration produced from the primary sampler and Y_i represents concentration reported for the duplicate sampler, as follows:

EQUATION 19

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

5.5.2.2 Coefficient of Variation (CV) for a Single Check (CV_i). The coefficient of variation, CV_i, for each check is calculated by EPA by dividing the absolute value of the percentage difference, d_i, by the square root of two as shown in equation 20, as follows:

EQUATION 20

$$CV_i = \frac{|d_i|}{\sqrt{2}}$$

5.5.2.3 Precision of a Single Sampler - Quarterly Basis ($CV_{j,q}$).

(a) For particulate sampler j, the individual coefficients of variation ($CV_{j,q}$) during the quarter are pooled using equation 21, where $n_{j,q}$ is the number of pairs of measurements from collocated samplers during the quarter, as follows:

EQUATION 21

$$CV_{j,q} = \sqrt{\frac{\sum_{i=1}^{n_j} CV_i^2}{n_{j,q}}}$$

(b) The 90 percent confidence limits for the single sampler's CV are calculated by EPA using equations 22 and 23, where $X^2_{0.05,df}$ and $X^2_{0.95,df}$ are the 0.05 and 0.95 quantiles of the chi-square (X^2) distribution with $n_{j,q}$ degrees of freedom, as follows:

EQUATION 22

$$\text{Lower Confidence Limit} = CV_{j,q}\sqrt{\frac{n_{j,q}}{\chi^2_{0.95,\ n_{j,q}}}}$$

EQUATION 23

$$\text{Upper Confidence Limit} = CV_{j,q}\sqrt{\frac{n_{j,q}}{\chi^2_{0.05,\ n_{j,q}}}}$$

5.5.2.4 Precision of a Single Sampler - Annual Basis. For particulate sampler j, the individual coefficients of variation, CV_i, produced during the calendar year are pooled using equation 21, where n_j is the number of checks made during the calendar year. The 90 percent confidence limits for the single sampler's CV are calculated by EPA using equations 22 and 23, where $X^2_{0.05,df}$ and $X^2_{0.95,df}$ are the 0.05 and 0.95 quantiles of the chi-square (X^2) distribution with n_j degrees of freedom.

5.5.2.5 Precision for Each EPA Federal Reference Method and Equivalent Method Designation Employed by Each Reporting Organization - Quarterly Basis ($CV_{k,q}$).

(a) For each method designation k used by the reporting organization, the quarter's single sampler coefficients of variation, $CV_{j,q}$s, obtained from equation 21, are pooled using equation 24, where $n_{k,q}$ is the number of collocated primary monitors for the designated method (but not collocated with FRM samplers) and $n_{j,q}$ is the number of degrees of freedom associated with $CV_{j,q}$, as follows:

EQUATION 24

$$CV_{k,q} = \sqrt{\frac{\sum_{j=1}^{n_{k,q}} \left(CV_{j,q}^2 n_{j,q}\right)}{\sum_{j=1}^{n_{k,q}} n_{j,q}}}$$

(b) The number of method CVs produced for a reporting organization will equal the number of different method designations having more than one primary monitor employed by the organization during the quarter. (When exactly one monitor of a specified designation is used by a reporting organization, it will be collocated with an FRM sampler.)

5.5.2.6 Precision for Each Method Designation Employed by Each Reporting Organization - Annual Basis (CV_k). For each method designation k used by the reporting organization, the quarterly estimated coefficients of variation, $CV_{k,q}$, are pooled using equation 25, where $n_{k,q}$ is the number of collocated primary monitors for the designated method during the qth quarter and also the number of degrees of freedom associated with the quarter's precision estimate for the method designation, $CV_{k,q}$, as follows:

EQUATION 25

$$CV_k = \sqrt{\frac{\sum_{q=1}^{4} \left(CV_{k,q}^2 n_{k,q}\right)}{\sum_{q=1}^{4} n_{k,q}}}$$

5.5.3 Collocated Samplers, Where the Duplicate Sampler is an FRM Device. At low concentrations, agreement between the measurements of collocated samplers may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits: $PM_{2.5}$: 6 μg/m³. These duplicate sampler results are used to assess measurement system bias. Quarterly bias estimates are calculated by EPA for each primary sampler and for each method designation employed by each reporting organization. Annual precision estimates are calculated by EPA for each primary monitor, for each method designation employed by each reporting organization, and nationally for each method designation.

5.5.3.1 Accuracy for a Single Check (d'_i). The percentage difference, d'_i, for each check is calculated by EPA using equation 26,

where X_i represents the concentration produced from the FRM sampler taken as the true value and Y_i represents concentration reported for the primary sampler, as follows:

EQUATION 26

$$d_i^{'} = \frac{Y_i - X_i}{X_i} \times 100\%$$

5.5.3.2 Bias of a Single Sampler - Quarterly Basis ($D'_{j,q}$).

(a) For particulate sampler j, the average of the individual percentage differences during the quarter q is calculated by EPA using equation 27, where $n_{j,q}$ is the number of checks made for sampler j during the calendar quarter, as follows:

EQUATION 27

$$D_{j,q}^{'} = \frac{1}{n_{j,q}} \times \sum_{i=1}^{n_{j,q}} d^{'}{}_i$$

(b) The standard error, $s'_{j,q}$, of sampler j's percentage differences for quarter q is calculated using equation 28, as follows:

EQUATION 28

$$s_{j,q}^{/} = \sqrt{\frac{1}{n_{j,q} - 1} \times \left[\left(\sum_{i=1}^{n_{j,q}} d_i^{/2}\right) - \left(n_{j,q} D_{j,q}^{/2}\right)\right] \times \frac{1}{n_{j,q}}}$$

(c) The 95 Percent Confidence Limits for the single sampler's bias are calculated using equations 29 and 30 where $t_{0.975,df}$ is the 0.975 quantile of Student's t distribution with df = $n_{j,q}$-1 degrees of freedom, as follows:

EQUATION 29

$$\text{Lower Confidence Limit} = D_{j,q}^{'} - t_{0.975,df} \times s_{j,q}^{'}$$

EQUATION 30

$$\text{Upper Confidence Limit} = D_{j,q}^{'} - t_{0.975,df} \times s_{j,q}^{'}$$

5.5.3.3 Bias of a Single Sampler - Annual Basis (D'_j).

(a) For particulate sampler j, the mean bias for the year is derived from the quarterly bias estimates, $D'_{j,q}$, using equation 31, where the variables are as defined for equations 27 and 28, as follows:

EQUATION 31

$$D_j^{'} = \frac{\sum_{q=1}^{4} \left(n_{j,q} D_{j,q}^{'}\right)}{\sum_{q=1}^{4} n_{j,q}}$$

(b) The standard error of the above estimate, se_j' is calculated using equation 32, as follows:

EQUATION 32

$$se_j^{'} = \sqrt{\frac{\sum_{q=1}^{4} \left[s_{j,q}^{'}\ 2 \times \left(n_{j,q} - 1\right)\right]}{\sum_{q=1}^{4} \left(n_{j,q} - 1\right) \sum_{q=1}^{4} \left(n_{j,q}\right)}}$$

(c) The 95 Percent Confidence Limits for the single sampler's bias are calculated using equations 33 and 34, where $t_{0.975,df}$ is the 0.975 quantile of Student's t distribution with df = ($n_{j,1}$ + $n_{j,2}$ + $n_{j,3}$ + $n_{j,4}$−4) degrees of freedom, as follows:

EQUATION 33

$$\text{Lower Confidence Limit} = D_j^{'} - t_{0.975,df} \times se_j^{'}$$

EQUATION 34

$$\text{Upper Confidence Limit} = D_j^{'} - t_{0.975,df} \times se_j^{'}$$

5.5.3.4 Bias for a Single Reporting Organization (D′) - Annual Basis. The reporting organizations mean bias is calculated using equation 35, where variables are as defined in equations 31 and 32, as follows:

EQUATION 35

$$D' = \frac{1}{n_j} \times \sum_{i=1}^{n_j} D'_j$$

5.5.4 FRM Audits. FRM Audits are performed once per quarter for selected samplers. The reporting organization reports concentration data from the primary sampler. Calculations for FRM Audits are similar to those for collocated samplers having FRM samplers as duplicates. The calculations differ because only one check is performed per quarter.

5.5.4.1 Accuracy for a Single Sampler, Quarterly Basis (d_i). The percentage difference, d_i, for each check is calculated using equation 26, where X_i represents the concentration produced from the FRM sampler and Y_i represents the concentration reported for the primary sampler. For quarter q, the bias estimate for sampler j is denoted $D_{j,q}$.

5.5.4.2 Bias of a Single Sampler - Annual Basis (D'_j). For particulate sampler j, the mean bias for the year is derived from the quarterly bias estimates, $D_{j,q}$, using equation 31, where $n_{j,q}$ equals 1 because one FRM audit is performed per quarter.

5.5.4.3. Bias for a Single Reporting Organization - Annual Basis (D′). The reporting organizations mean bias is calculated using equation 35, where variables are as defined in equations 31 and 32.

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TABLE A–1 TO APPENDIX A—MINIMUM DATA ASSESSMENT REQUIREMENTS

Method	Assessment Method	Coverage	Minimum Frequency	Parameters Reported
Precision:				
Automated Methods for SO_2, NO_2, O_3, and CO	Response check at concentration between .08 and .10 ppm (8 & 10 ppm for CO)[2]	Each analyzer	Once per 2 weeks	Actual concentration[2] and measured concentration[3]
Manual Methods: All methods except $PM_{2.5}$	Collocated samplers	1 site for 1–5 sites 2 sites for 6–20 sites 3 sites >20 sites (sites with highest conc.)	Once every six days	Particle mass concentration indicated by sampler and by collocated sampler
Accuracy:				
Automated Methods for SO_2, NO_2, O_3, and CO	Response check at .03–.08 ppm[1,2] .15–.20 ppm[1,2] .35–.45 ppm[1,2] 80–.90 ppm[1,2] (if applicable)	1. Each analyzer 2. 25% of analyzers (at least 1)	1. Once per year 2. Each calendar quarter	Actual concentration[2] and measured (indicated) concentration[3] for each level
Manual Methods for SO_2, and NO_2	Check of analytical procedure with audit standard solutions	Analytical system	Each day samples are analyzed, at least twice per quarter	Actual concentration and measured (indicated) concentration for each audit solution
TSP, PM_{10}	Check of sampler flow rate	1. Each sampler 2. 25% of samplers (at least 1)	1. Once per year 2. Each calendar quarter	Actual flow rate and flow rate indicated by the sampler
Lead	1. Check of sample flow rate as for TSP 2. Check of analytical system with Pb audit strips	1. Each sampler 2. Analytical system	1. Include with TSP 2. Each quarter	1. Same as for TSP 2. Actual concentration and measured (indicated) concentration of audit samples (μg Pb/strip)
$PM_{2.5}$				
Manual and Automated Methods-Precision	Collocated samplers	25% of SLAMS (monitors with Conc affecting NAAQS violation status)	Once every six days	1. Particle mass concentration indicated by sampler and by collocated sampler 2. 24-hour value for automated methods
Manual and Automated Methods-Accuracy and Bias	1. Check of sampler flow rate 2. Audit with reference method	Every SLAMS monitor	1. Automated—once every 2 weeks; Manual—each calendar quarter (4/year) 2. Minimum 4 measurements per year	1. Actual flow rate and flow rate indicated by sampler 2. Particle mass concentration indicated by sampler and by audit reference sampler

[1] Concentration times 100 for CO.
[2] Effective concentration for open path analyzers.
[3] Corrected concentration, if applicable, for open path analyzers.

TABLE A–2 TO APPENDIX A—SUMMARY OF $PM_{2.5}$ COLLOCATION AND AUDITS PROCEDURES AS AN EXAMPLE OF A TYPICAL REPORTING ORGANIZATION NEEDING 43 MONITORS, HAVING PROCURED FRMS AND THREE OTHER EQUIVALENT METHOD TYPES

Method Designation	Total # of Monitors	Total # Collocated	# of Collocated FRMs	# of Collocated Monitors of Same Type	# of Independent FRM Audits
FRM	25	6	6	n/a	6
Type A	10	3	2	1	3

TABLE A–2 TO APPENDIX A—SUMMARY OF $PM_{2.5}$ COLLOCATION AND AUDITS PROCEDURES AS AN EXAMPLE OF A TYPICAL REPORTING ORGANIZATION NEEDING 43 MONITORS, HAVING PROCURED FRMS AND THREE OTHER EQUIVALENT METHOD TYPES—Continued

Method Designation	Total # of Monitors	Total # Collocated	# of Collocated FRMs	# of Collocated Monitors of Same Type	# of Independent FRM Audits
Type C	2	1	1	0	1
Type D	6	2	1	1	2

[62 FR 38833, July 18, 1997; 63 FR 7714, 7715, Feb. 17, 1998; 68 FR 80328, Dec. 31, 2002]

APPENDIX B TO PART 58—QUALITY ASSURANCE REQUIREMENTS FOR PREVENTION OF SIGNIFICANT DETERIORATION (PSD) AIR MONITORING

1. *General Information*

This appendix specifies the minimum quality assurance requirements for the control and assessment of the quality of the PSD ambient air monitoring data submitted to EPA by an organization operating a network of PSD stations. Such organizations are encouraged to develop and maintain quality assurance programs more extensive than the required minimum.

Quality assurance of air monitoring systems includes two distinct and important interrelated functions. One function is the control of the measurement process through the implementation of policies, procedures, and corrective actions. The other function is the assessment of the quality of the monitoring data (the product of the measurement process). In general, the greater the effort and effectiveness of the control of a given monitoring system, the better will be the resulting quality of the monitoring data. The results of data quality assessments indicate whether the control efforts need to be increased.

Documentation of the quality assessments of the monitoring data is important to data users, who can then consider the impact of the data quality in specific applications (see Reference 1). Accordingly, assessments of PSD monitoring data quality are required to be made and reported periodically by the monitoring organization.

To provide national uniformity in the assessment and reporting of data quality among all PSD networks, specific assessment and reporting procedures are prescribed in detail in sections 3, 4, 5, and 6 of this appendix.

In contrast, the control function encompasses a variety of policies, procedures, specifications, standards, and corrective measures which affect the quality of the resulting data. The selection and extent of the quality control activities—as well as additional quality assessment activities—used by a monitoring organization depend on a number of local factors such as the field and laboratory conditions, the objectives of the monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, pollutant concentration levels, etc. Therefore, the quality assurance requirements, in section 2 of this appendix, are specified in general terms to allow each organization to develop a quality control system that is most efficient and effective for its own circumstances.

For purposes of this appendix, ''organization'' is defined as a source owner/operator, a government agency, or their contractor that operates an ambient air pollution monitoring network for PSD purposes.

2. *Quality Assurance Requirements*

2.1 Each organization must develop and implement a quality assurance program consisting of policies, procedures, specifications, standards and documentation necessary to:

(1) Provide data of adequate quality to meet monitoring objectives and quality assurance requirements of the permit-granting authority, and

(2) Minimize loss of air quality data due to malfunctions or out-of-control conditions.

This quality assurance program must be described in detail, suitably documented, and approved by the permit-granting authority. The Quality Assurance Program will be reviewed during the system audits described in section 2.4.

2.2 Primary guidance for developing the Quality Assurance Program is contained in References 2 and 3, which also contain many suggested procedures, checks, and control specifications. Section 2.0.9 of Reference 3 describes specific guidance for the development of a Quality Assurance Program for automated analyzers. Many specific quality control checks and specifications for manual 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 (see Reference 4). Similarly, quality control procedures related to specifically designated reference and equivalent analyzers are contained in their respective operation and instruction manuals. This guidance, and any

other pertinent information from appropriate sources, should be used by the organization in developing its quality assurance program.

As a minimum, each quality assurance program must include operational procedures for each of the following activities:

(1) Selection of methods, analyzers, or samplers;

(2) Training;

(3) Installation of equipment;

(4) Selection and control of calibration standards;

(5) Calibration;

(6) Zero/span checks and adjustments of automated analyzers;

(7) Control checks and their frequency;

(8) Control limits for zero, span and other control checks, and respective corrective actions when such limits are surpassed;

(9) Calibration and zero/span checks for multiple range analyzers (see section 2.6 of appendix C of this part);

(10) Preventive and remedial maintenance;

(11) Recording and validating data;

(12) Date quality assessment (precision and accuracy);

(13) Documentation of quality control information.

2.3 Pollutant Standards.

2.3.1 Gaseous standards (permeation tubes, permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO_2, and NO_2 must be traceable to either a National Institute of Standards and Technology (NIST) gaseous Standard Reference Material (SRM) or an NIST/EPA-approved commercially available Certified Reference Material (CRM). CRM's are described in Reference 5, and a list of CRM sources is available from Quality Assurance Division (MD–77), Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. A recommended protocol for certifying gaseous standards against an SRM or CRM is given in section 2.0.7 of Reference 3. Direct use of a CRM as a working standard is acceptable, but direct use of an NIST SRM as a working standard is discouraged because of the limited supply and expense of SRM's.

2.3.2 Test concentrations for ozone must be obtained in accordance with the UV photometric calibration procedure specified in appendix D of part 50 of this chapter, or by means of a certified ozone transfer standard. Consult References 6 and 7 for guidance on primary and transfer standards for ozone.

2.3.3. Flow measurement must be made by a flow measuring instrument that is traceable to an authoritative volume or other standard. Guidance for certifying various types of flowmeters is provided in Reference 3.

2.4 Performance and System Audit Programs. The organization operating a PSD monitoring network must participate in EPA's national performance audit program. The permit granting authority, or EPA, may conduct system audits of the ambient air monitoring programs of organizations operating PSD networks. See section 1.4.16 of reference 2 and section 2.0.11 of reference 3 for additional information about these programs. Organizations should contact either the appropriate EPA Regional Quality Control Coordinator or the Quality Assurance Branch, AREAL/RTP, at the address given in reference 3 for instructions for participation.

3. *Data Quality Assessment Requirements*

All ambient monitoring methods or analyzers used in PSD monitoring shall be tested periodically, as described in this section 3, to quantitatively assess the quality of the data being routinely collected. The results of these tests shall be reported as specified in section 6. Concentration standards used for the tests must be as specified in section 2.3. Additional information and guidance in the technical aspects of conducting these tests may be found in Reference 3 or in the operation or instruction manual associated with the analyzer or sampler. Concentration measurements reported from analyzers or analytical systems must be derived by means of the same calibration curve and data processing system used to obtain the routine air monitoring data. Table B–1 provides a summary of the minimum data quality assessment requirements, which are described in more detail in the following sections.

3.1 Precision of Automated Methods. A one-point precision check must be carried out at least once every two weeks on each automated analyzer used to measure SO_2, NO_2, O_2, and CO. The precision check is made by challenging the analyzer with a precision check gas of known concentration (effective concentration for open path analyzers) between 0.08 and 0.10 ppm for SO_2, NO_2, and O_3 analyzers, and between 8 and 10 ppm for CO analyzers. The standards from which precision check test concentrations are obtained must meet the specifications of section 2.3. Except for certain CO analyzers described below, point analyzers must operate in their normal sampling mode during the precision 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 precision 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.

Open path analyzers are tested by inserting a test cell containing a precision 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 precision check gas in the test cell must be selected to produce an ''effective concentration'' in the range specified above. Generally, the precision test concentration measurement will be the sum of the atmospheric pollutant concentration and the precision 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 precision check test from the precision test 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.

If a precision check is made in conjunction with a zero or span adjustment, it must be made prior to such zero or span adjustment. The difference between the actual concentration (effective concentration for open path analyzers) of the precision check gas and the corresponding concentration measurement (corrected concentration, if applicable, for open path analyzers) indicated by the analyzer is used to assess the precision of the monitoring data as described in section 4.1. Report data only from automated analyzers that are approved for use in the PSD network.

3.2 Accuracy of Automated Methods. Each sampling quarter, audit each analyzer that monitors for SO_2, NO_2, O_3, or CO at least once. The audit is made by challenging the analyzer with at least one audit gas of known concentration (effective concentration for open path analyzers) from each of the following ranges that fall within the measurement range of the analyzer being audited:

Audit level	Concentration range, ppm		CO
	SO_2, O_3,	NO_2,	
1	0.03–0.08	0.03–0.08	3–8
2	0.15–0.20	0.15–0.20	15–20
3	0.36–0.45	0.35–0.45	35–45
4	0.80–0.90	.....	80–90

NO_2 audit gas for chemiluminescence-type NO_2 analyzers must also contain at least 0.08 ppm NO.

NOTE: NO concentrations substantially higher than 0.08 ppm, as may occur when using some gas phase titration (GPT) techniques, may lead to audit 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. These errors may be minimized by modifying the GPT technique to lower the NO concentrations remaining in the NO_2 audit gas to levels closer to typical ambient NO concentrations at the site.

The standards from which audit gas test concentrations are obtained must meet the specifications of section 2.3. Working and transfer standards and equipment used for auditing must be different from the standards and equipment used for calibration and spanning. The auditing standards and calibration standards may be referenced to the same NIST, SRM, CRM, or primary UV photometer. The auditor must not be the operator/analyst who conducts the routine monitoring, calibration and analysis.

For point analyzers, the audit shall be carried out by allowing the analyzer to analyze the audit test atmosphere in the same manner as described for precision checks in section 3.1. The exception given in section 3.1 for certain CO analyzers does not apply for audits.

Open path analyzers are audited by inserting a test cell containing an audit 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 audit, and the normal monitoring configuration of the instrument should be modified as little as possible to accommodate the test cell for the audit. 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 range specified in this section 3.2. Generally, each audit concentration measurement result will be the sum of the atmospheric pollutant concentration and the audit 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 audit test (or preferably before and after each audit concentration level) from the audit concentration measurement. If the difference between these before and after measurements is greater than 20 percent of the effective concentration of the test gas standards, discard the test result for that concentration level and repeat the test for that level. If possible, open path analyzers should be audited during periods when the atmospheric pollutant concentrations are relatively low and steady. Also, the monitoring path length must be reverified to within ±3 percent to validate the audit, since the monitoring path length is critical to the determination of the effective concentration.

The differences between the actual concentrations (effective concentrations for open path analyzers) of the audit test gas and the corresponding concentration measurements (corrected concentrations, if applicable, for open path analyzers) indicated by the analyzer are used to assess the accuracy of the monitoring data as described in section 4.2. Report data only from automated analyzers that are approved for use in the PSD network.

3.3 Precision of Manual Methods.

3.3.1 TSP and PM_{10} Methods. For a given organization's monitoring network, one sampling site must have collocated samplers. A site with the highest expected 24-hour pollutant concentration must be selected. The two samplers must be within 4 meters of each other but at least 2 meters apart to preclude airflow interference. Calibration, sampling and analysis must be the same for both collocated samplers as well as for all other samplers in the network. The collocated samplers must be operated as a minimum every third day when continuous sampling is used. When a less frequent sample schedule is used, the collocated samplers must be operated at least once each week. For each pair of collocated samplers, designate one sampler as the sampler which will be used to report air quality for the site and designate the other as the duplicate sampler. The differences in measured concentration ($\mu g/m^3$) between the two collocated samplers are used to calculate precision as described in section 5.1.

3.3.2 Pb Method. The operation of collocated samplers at one sampling site must be used to assess the precision of the reference or an equivalent Pb method. The procedure to be followed for Pb methods is the same as described in 3.3.1 for the TSP method. If approved by the permit granting authority, the collocated TSP samplers may serve as the collocated lead samplers.

3.4 Accuracy of Manual Methods.

3.4.1 TSP and PM_{10} Methods. Each sampling quarter, audit the flow rate of each sampler at least once. Audit the flow at the normal flow rate, using a certified flow transfer standard (see reference 2). The flow transfer standard used for the audit must not be the same one used to calibrate the flow of the sampler being audited, although both transfer standards may be referenced to the same primary flow or volume standard. The difference between the audit flow measurement and the flow indicated by the sampler's flow indicator is used to calculate accuracy, as described in paragraph 5.2.

Great care must be used in auditing high-volume samplers having flow regulators because the introduction of resistance plates in the audit device can cause abnormal flow patterns at the point of flow sensing. For this reason, the orifice of the flow audit device should be used with a normal glass fiber 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.

3.4.2 Pb Method. For the reference method (appendix G of part 50 of this chapter) during each sampling quarter audit the flow rate of each high-volume Pb sampler at least once. The procedure to be followed for lead methods is the same as described in section 3.4.1 for the TSP method.

For each sampling quarter, audit the Pb analysis using glass fiber filter strips containing a known quantity of lead. Audit samples are prepared by depositing a Pb solution on 1.9 cm by 20.3 cm (¾ inch by 8 inch) unexposed glass fiber filter strips and allowing to dry thoroughly. The audit samples must be prepared using reagents different from those used to calibrate the Pb analytical equipment being audited. Prepare audit samples in the following concentration ranges:

Ranges	Pb concentration µg/strip	Equivalent ambient Pb concentration [1] µg/m³
1	100 to 300	0.5 to 1.5.
2	600 to 1,000	3.0 to 5.0.

[1] Equivalent ambient Pb concentration in $\mu g/m^3$ is based on sampling at 1.7 m^3/min for 24 hours on 20.3 cm × 25.4 cm (8 inch × 10 inch) glass fiber filter.

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

Analyze at least one audit sample in each of the two ranges each day that samples are anlayzed. The difference between the audit concentration (in mu;g Pb/strip) and the analyst's measured concentration (in mu;g Pb/strip is used to calculate accuracy as described in section 5.4.

The accuracy of an equivalent method is assessed in the same manner as the reference method. The flow auditing device and Pb analysis audit samples must be compatible with the specific requirements of the equivalent method.

4. *Calculations for Automated Methods*

4.1 Single Analyzer Precision. Each organization, at the end of each sampling quarter, shall calculate and report a precision probability interval for each analyzer. Directions for calculations are given below and directions for reporting are given in section 6. If monitoring data are invalidated during the period represented by a given precision check, the results of that precision check shall be excluded from the calculations. Calculate the percentage difference (d_i) for each precision check using equation 1.

$$d_i = \frac{Y_1 - X_1}{X_1} \times 100 \qquad (1)$$

where:

Y_i = analyzer's indicated concentration from the i-th precision check

X_i = known concentration of the test gas used for the i-th precision check.

For each instrument, calculate the quarterly average (d_j), equation 2, and the standard deviation (S_j), equation 3.

$$d_j = \frac{1}{n}\sum_{i=1}^{n} d_i \qquad (2)$$

$$S_j = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} d^2{}_i - \frac{1}{n}\left(\sum_{i=1}^{n} d_i\right)^2\right]} \qquad (3)$$

where n is the number of precision checks on the instrument made during ther sampling quarter. For example, n should be 6 or 7 if span checks are made biweekly during a quarter.

Calculate the 95 percent probability limits for precision using equation 4 and 5.

Upper 95 Percent Probability Limit = d_j+1.96 S_j (4)

Lower 95 Percent Probability Limit = d_j−1.96 S_j (5)

4.2 Single Analyzer Accuracy. Each organization, at the end of each sampling quarter, shall calculate and report the percentage difference for each audit concentration for each analyzer audited during the quarter. Directions for calculations are given below (directions for reporting are given in section 6).

Calculate and report the percentage difference (d_i) for each audit concentration using equation 1 where Y_i is the analyzer's indicated concentration from the i-th audit check and X_i is the known concentration of the audit gas used for the i-th audit check.

5. *Calculations for Manual Methods*

5.1 Single Instrument Precision for TSP, Pb and PM_{10}. Estimates of precision for ambient air quality particulate measurements are calculated from results obtained from collocated samplers as described in section 3.3. At the end of each sampling quarter, calculate and report a precision probability interval, using weekly result from the collecated samplers. Directions for calculations are given below, and directions for reporting are given in section 6.

For the paired measurements obtained as described in sections 3.3.1 and 3.3.2, calculate the percent difference (d_i) using equation 1a, where Y_i is the concentration of pollutant measured by the duplicate sampler, and X_i is the concentration measured by the sampler reporting air quality for the site. Calculate the quarterly average percent difference (d_j), equation 2; standard deviation (S_j), equation 3; and upper and lower 95 percent probability limits for precision, equations 6 and 7.

$$d_i = \frac{Y_i - X_i}{\left(Y_i + X_i\right)/2} \times 100 \qquad (1a)$$

Upper 95 percent probability limit = d_j+1.96 $S_j/\sqrt{2}$ (6)

Lower 95 percent probability limit = d_j−1.96 $S_j/\sqrt{2}$ (7)

5.2 Single Instrument Accuracy for TSP and PM_{10}. Each organization, at the end of each sampling quarter, shall calculate and report the percentage difference for each high-volume or PM_{10} sampler audited during the quarter. Directions for calculation are given below and directions for reporting are given in section 6.

For the flow rate audit described in section 3.4, let X_i represent the known flow rate and Y_i represent the indicated flow rate. Calculate the percentage difference (d_i) using equation 1.

5.3 Single Instrument Accuracy for Pb. Each organization, at the end of each sampling quarter, shall calculate and report the percentage difference for each high-volume lead sampler audited during the quarter. Directions for calculation are given in 5.2 and directions for reporting are given in section 6.

5.4 Single-Analysis-Day Accuracy for Pb. Each organization, at the end of each sampling quarter, shall calculate and report the percentage difference for each Pb analysis audit during the quarter. Directions for calculations are given below and directions for reporting are given in section 6.

For each analysis audit for Pb described in section 3.4.2, let X_i represent the known value of the audit sample and Y_i the indicated value of Pb. Calculate the percentage difference (d_i) for each audit at each concentration level using equation 1.

6. *Organization Reporting Requirements.*

At the end of each sampling quarter, the organization must report the following data assessment information:

(1) For automated analyzers—precision probability limits from section 4.1 and percentage differences from section 4.2, and

(2) For manual methods—precision probability limits from section 5.1 and percentage differences from sections 5.2 and 5.3. The precision and accuracy information for the entire sampling quarter must be submitted with the air monitoring data. All data used to calculate reported estimates of precision and accuracy including span checks, collocated sampler and audit results must be made available to the permit granting authority upon request.

TABLE B–1—MINIMUM PSD DATA ASSESSMENT REQUIREMENTS

Method	Assessment method	Coverage	Frequency	Parameters reported
Precision:				
Automated Methods for SO_2, NO_2, O_3, and CO.	Response check at concentration between .08 & .10 ppm (8 & 10 ppm for CO)[2].	Each analyzer	Once per 2 weeks	Actual concentration[2] & measured concentration.[3]
TSP, PM_{10}, Lead	Collocated samplers	Highest concentration site in monitoring network.	Once per week or every 3rd day for continuous sampling.	Two concentration measurements.
Accuracy:				
Automated Methods for SO_2, NO_2, O_3, and CO.	Response check at: .03–.08 ppm;[1,2] .15–.20 ppm;[1,2] .35–.45 ppm;[1,2] .80–.90 ppm;[1,2] (if applicable).	Each analyzer	Once per sampling quarter.	Actual concentration[2] & measured (indicated) concentration[3] for each level.
TSP, PM_{10}	Sampler flow check	Each sampler	Once per sampling quarter.	Actual flow rate and flow rate indicated by the sampler.
Lead	1. Sample flow rate check.. 2. Check analytical system with Pb audit strips.	1. Each sampler. 2. Analytical system	1. Once/quarter. 2. Each quarter Pb samples are analyzed.	1. Same as for TSP. 2. Actual concentration & measured concentration of audit samples (μg Pb/strip).

[1] Concentration shown times 100 for CO.
[2] Effective concentration for open path analyzers.
[3] Corrected concentration, if applicable, for open path analyzers.

References

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[44 FR 27571, May 10, 1979; 44 FR 65070, Nov. 9, 1979; 44 FR 72592, Dec. 14, 1979, as amended at 46 FR 44168, Sept. 3, 1981; 48 FR 2530, Jan. 20, 1983; 51 FR 9596, Mar. 19, 1986; 52 FR 24741, July 1, 1987; 59 FR 41628, 41629, Aug. 12, 1994; 60 FR 52321, Oct. 6, 1995]

APPENDIX C TO PART 58—AMBIENT AIR QUALITY MONITORING METHODOLOGY

1.0 *Purpose*

This appendix specifies the monitoring methods (manual methods or automated analyzers) which must be used in State ambient air quality monitoring stations.

2.0 *State and Local Air Monitoring Stations (SLAMS)*

2.1 Except as otherwise provided in this appendix, a monitoring method used in a SLAMS must be a reference or equivalent method as defined in §50.1 of this chapter.

2.2 *Substitute PM_{10} samplers.*

2.2.1 For purposes of showing compliance with the NAAQS for particulate matter, a high volume TSP sampler described in 40 CFR part 50, appendix B, may be used in a SLAMS in lieu of a PM_{10} monitor as long as the ambient concentrations of particles measured by the TSP sampler are below the PM_{10} NAAQS. If the TSP sampler measures a single value that is higher than the PM_{10} 24-hour standard, or if the annual average of its measurements is greater than the PM_{10} annual standard, the TSP sampler operating as a substitute PM_{10} sampler must be replaced with a PM_{10} monitor. For a TSP measurement above the 24-hour standard, the TSP sampler should be replaced with a PM_{10} monitor before the end of the calendar quarter following the quarter in which the high concentration occurred. For a TSP annual average above the annual standard, the PM_{10} monitor should be operating by June 30 of the year following the exceedance.

2.2.2 In order to maintain historical continuity of ambient particulate matter trends and patterns for PM_{10} NAMS that were previously TSP NAMS, the TSP high volume sampler must be operated concurrently with the PM_{10} monitor for a one-year period beginning with the PM_{10} NAMS start-up date. The operating schedule for the TSP sampler must be at least once every 6 days regardless of the PM_{10} sampling frequency.

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 in a SLAMS following cancellation for a reasonable period of time to be determined by the Administrator.

2.4 Approval of non-designated $PM_{2.5}$ methods operated at specific individual sites. A method for $PM_{2.5}$ that has not been designated as a reference or equivalent method as defined in §50.1 of this chapter may be approved for use for purposes of section 2.1 of this appendix at a particular SLAMS under the following stipulations.

2.4.1 The method must be demonstrated to meet the comparability requirements (except as provided in this section 2.4.1) set forth in §53.34 of this chapter in each of the four seasons at the site at which it is intended to be used. For purposes of this section 2.4.1, the requirements of §53.34 of this chapter shall apply except as follows:

2.4.1.1 The method shall be tested at the site at which it is intended to be used, and there shall be no requirement for tests at any other test site.

2.4.1.2 For purposes of this section 2.4, the seasons shall be defined as follows: Spring shall be the months of March, April, and May; summer shall be the months of June, July, and August; fall shall be the months of September, October, and November; and winter shall be the months of December, January, and February; when alternate seasons are approved by the Administrator.

2.4.1.3 No PM_{10} samplers shall be required for the test, as determination of the $PM_{2.5}$/PM_{10} ratio at the test site shall not be required.

2.4.1.4 The specifications given in table C–4 of part 53 of this chapter for Class I methods shall apply, except that there shall be no requirement for any minimum number of sample sets with Rj greater than 40 $\mu g/m^3$ for 24-hour samples or greater than 15 $\mu g/m_3$ average concentration collected over a 48-hour period.

2.4.2 The monitoring agency wishing to use the method must develop and implement appropriate quality assurance procedures for the method.

2.4.3 The monitoring agency wishing to use the method must develop and implement appropriate procedures for assessing and reporting the precision and accuracy of the method comparable to the procedures set forth in appendix A of this part for designated reference and equivalent methods.

2.4.4 The assessment of network operating precision using collocated measurements with reference method ''audit'' samplers required under section 3 of appendix A of this part shall be carried out semi-annually rather than annually (i.e., monthly audits with assessment determinations each 6 months).

2.4.5 Requests for approval under this section 2.4 must meet the general submittal requirements of sections 2.7.1 and 2.7.2.1 of this appendix and must include the requirements in sections 2.4.5.1 through 2.4.5.7 of this appendix.

2.4.5.1 A clear and unique description of the site at which the method or sampler will be

used and tested, and a description of the nature or character of the site and the particulate matter that is expected to occur there.

2.4.5.2 A detailed description of the method and the nature of the sampler or analyzer upon which it is based.

2.4.5.3 A brief statement of the reason or rationale for requesting the approval.

2.4.5.4 A detailed description of the quality assurance procedures that have been developed and that will be implemented for the method.

2.4.5.5 A detailed description of the procedures for assessing the precision and accuracy of the method that will be implemented for reporting to AIRS.

2.4.5.6 Test results from the comparability tests as required in section 2.4.1 through 2.4.1.4 of this appendix.

2.4.5.7 Such further supplemental information as may be necessary or helpful to support the required statements and test results.

2.4.6 Within 120 days after receiving a request for approval of the use of a method at a particular site under this section 2.4 and such further information as may be requested for purposes of the decision, the Administrator will approve or disapprove the method by letter to the person or agency requesting such approval.

2.5 Approval of non-designated methods under §58.13(f). An automated (continuous) method for $PM_{2.5}$ that is not designated as either a reference or equivalent method as defined in §50.1 of this chapter may be approved under §58.13(f) for use at a SLAMS for the limited purposes of §58.13(f). Such an analyzer that is approved for use at a SLAMS under §58.13(f), identified as correlated acceptable continuous (CAC) monitors, shall not be considered a reference or equivalent method as defined in §50.1 of this chapter by virtue of its approval for use under §58.13(f), and the $PM_{2.5}$ monitoring data obtained from such a monitor shall not be otherwise used for purposes of part 50 of this chapter.

2.6 Use of Methods With Higher, Nonconforming Ranges in Certain Geographical Areas.

2.6.1 [Reserved]

2.6.2 Nonconforming Ranges. An analyzer may be used (indefinitely) on a range which extends to concentrations higher than two times the upper limit specified in table B–1 of part 53 of this chapter if:

2.6.2.1 The analyzer has more than one selectable range and has been designated as a reference or equivalent method on at least one of its ranges, or has been approved for use under section 2.5 (which applies to analyzers purchased before February 18, 1975);

2.6.2.2 The pollutant intended to be measured with the analyzer is likely to occur in concentrations more than two times the upper range limit specified in table B–1 of part 53 of this chapter in the geographical area in which use of the analyzer is proposed; and

2.6.2.3 The Administrator determines that the resolution of the range or ranges for which approval is sought is adequate for its intended use. For purposes of this section (2.6), ''resolution'' means the ability of the analyzer to detect small changes in concentration.

2.6.3 Requests for approval under section 2.6.2 must meet the submittal requirements of section 2.7. Except as provided in subsection 2.7.3, each request must contain the information specified in subsection 2.7.2 in addition to the following:

2.6.3.1 The range or ranges proposed to be used;

2.6.3.2 Test data, records, calculations, and test results as specified in subsection 2.7.2.2 for each range proposed to be used;

2.6.3.3 An identification and description of the geographical area in which use of the analyzer is proposed;

2.6.3.4 Data or other information demonstrating that the pollutant intended to be measured with the analyzer is likely to occur in concentrations more than two times the upper range limit specified in table B–1 of part 53 of this chapter in the geographical area in which use of the analyzer is proposed; and

2.6.3.5 Test data or other information demonstrating the resolution of each proposed range that is broader than that permitted by section 2.5.

2.6.4 Any person who has obtained approval of a request under this section (2.6.2) shall assure that the analyzer for which approval was obtained is used only in the geographical area identified in the request and only while operated in the range or ranges specified in the request.

2.7 Requests for Approval; Withdrawal of Approval.

2.7.1 Requests for approval under sections 2.4, 2.6.2, or 2.8 of this appendix must be submitted to: Director, National Exposure Assessment Laboratory, Department E, (MD-77B), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

2.7.2 Except as provided in section 2.7.3, each request must contain:

2.7.2.1 A statement identifying the analyzer (e.g., by serial number) and the method of which the analyzer is representative (e.g., by manufacturer and model number); and

2.7.2.2 Test data, records, calculations, and test results for the analyzer (or the method of which the analyzer is representative) as specified in subpart B, subpart C, or both (as applicable) of part 53 of this chapter.

2.7.3 A request may concern more than one analyzer or geographical area and may incorporate by reference any data or other information known to EPA from one or more of the following:

2.7.3.1 An application for a reference or equivalent method determination submitted to EPA for the method of which the analyzer is representative, or testing conducted by the applicant or by EPA in connection with such an application;

2.7.3.2 Testing of the method of which the analyzer is representative at the initiative of the Administrator under §53.7 of this chapter; or

2.7.3.3 A previous or concurrent request for approval submitted to EPA under this section (2.7).

2.7.4 To the extent that such incorporation by reference provides data or information required by this section (2.7) or by sections 2.4, 2.5, or 2.6, independent data or duplicative information need not be submitted.

2.7.5 After receiving a request under this section (2.7), the Administrator may request such additional testing or information or conduct such tests as may be necessary in his judgment for a decision on the request.

2.7.6 If the Administrator determines, on the basis of any information available to him, that any of the determinations or statements on which approval of a request under this section (2.7) was based are invalid or no longer valid, or that the requirements of section 2.4, 2.5, or 2.6, as applicable, have not been met, he may withdraw the approval after affording the person who obtained the approval an opportunity to submit information and arguments opposing such action.

2.8 Modifications of Methods by Users.

2.8.1 Except as otherwise provided in this section (2.8), no reference method, equivalent method, or alternative method may be used in a SLAMS if it has been modified in a manner that will, or might, significantly alter the performance characteristics of the method without prior approval by the Administrator. For purposes of this section (2.8), ''alternative method'' means an analyzer the use of which has been approved under section 2.4, 2.5, or 2.6 of this appendix or some combination thereof.

2.8.2 Requests for approval under this section (2.8) must meet the submittal requirements of sections 2.7.1 and 2.7.2.1 of this appendix.

2.8.3 Each request submitted under this section (2.8) must include:

2.8.3.1 A description, in such detail as may be appropriate, of the desired modification;

2.8.3.2 A brief statement of the purpose(s) of the modification, including any reasons for considering it necessary or advantageous;

2.8.3.3 A brief statement of belief concerning the extent to which the modification will or may affect the performance characteristics of the method; and

2.8.3.4 Such further information as may be necessary to explain and support the statements required by sections 2.8.3.2 and 2.8.3.3.

2.8.4 Within 75 days after receiving a request for approval under this section (2.8) and such further information as he may request for purposes of his decision, the Administrator will approve or disapprove the modification in question by letter to the person or agency requesting such approval.

2.8.5 A temporary modification that will or might alter the performance characteristics of a reference, equivalent, or alternative method may be made without prior approval under this section (2.8) if the method is not functioning or is malfunctioning, provided that parts necessary for repair in accordance with the applicable operation manual cannot be obtained within 45 days. Unless such temporary modification is later approved under section 2.8.4, the temporarily modified method shall be repaired in accordance with the applicable operation manual as quickly as practicable but in no event later than 4 months after the temporary modification was made, unless an extension of time is granted by the Administrator. Unless and until the temporary modification is approved, air quality data obtained with the method as temporarily modified must be clearly identified as such when submitted in accordance with §58.28 or §58.35 of this chapter and must be accompanied by a report containing the information specified in section 2.8.3. A request that the Administrator approve a temporary modification may be submitted in accordance with sections 2.8.1 through 2.8.4. In such cases the request will be considered as if a request for prior approval had been made.

2.9 Use of IMPROVE Samplers at a SLAMS. ''IMPROVE'' samplers may be used in SLAMS for monitoring of regional background and regional transport concentrations of fine particulate matter. The IMPROVE samplers were developed for use in the Interagency Monitoring of Protected Visual Environments (IMPROVE) network to characterize all of the major components and many trace constituents of the particulate matter that impair visibility in Federal Class I Areas. These samplers are routinely operated at about 70 locations in the United States. IMPROVE samplers consist of four sampling modules that are used to collect twice weekly 24-hour duration simultaneous samples. Modules A, B, and C collect $PM_{2.5}$ on three different filter substrates that are compatible with a variety of analytical techniques, and module D collects a PM_{10} sample. $PM_{2.5}$ mass and elemental concentrations are determined by analysis of the 25mm diameter stretched Teflon filters from module A. More complete descriptions of the IMPROVE samplers and the data they collect are available elsewhere (references 4, 5, and 6 of this appendix).

3.0 *National Air Monitoring Stations (NAMS)*

3.1 Methods used in those SLAMS which are also designated as NAMS to measure

SO_2, CO, NO_2, or O_3 must be automated reference or equivalent methods (continuous analyzers).

4.0 *Photochemical Assessment Monitoring Stations (PAMS)*

4.1 Methods used for O_3 monitoring at PAMS must be automated reference or equivalent methods as defined in §50.1 of this chapter.

4.2 Methods used for NO, NO_2 and NO_X monitoring at PAMS should be automated reference or equivalent methods as defined for NO_2 in §50.1 of this chapter. If alternative NO, NO_2 or NO_X monitoring methodologies are proposed, such techniques must be detailed in the network description required by §58.40 and subsequently approved by the Administrator.

4.3 Methods for meteorological measurements and speciated VOC monitoring are included in the guidance provided in references 2 and 3. If alternative VOC monitoring methodology (including the use of new or innovative technologies), which is not included in the guidance, is proposed, it must be detailed in the network description required by §58.40 and subsequently approved by the Administrator.

5.0 *Particulate Matter Episode Monitoring*

5.1 For short-term measurements of PM_{10} during air pollution episodes (see §51.152 of this chapter) the measurement method must be:

5.1.1 Either the ''Staggered PM_{10}'' method or the ''PM_{10} Sampling Over Short Sampling Times'' method, both of which are based on the reference method for PM_{10} and are described in reference 1: or

5.1.2 Any other method for measuring PM_{10}:

5.1.2.1 Which has a measurement range or ranges appropriate to accurately measure air pollution episode concentration of PM_{10},

5.1.2.2 Which has a sample period appropriate for short-term PM_{10} measurements, and

5.1.2.3 For which a quantitative relationship to a reference or equivalent method for PM_{10} has been established at the use site. Procedures for establishing a quantitative site-specific relationship are contained in reference 1.

5.2 Quality Assurance. PM_{10} methods other than the reference method are not covered under the quality assessment requirements of appendix A. Therefore, States must develop and implement their own quality assessment procedures for those methods allowed under this section 4. These quality assessment procedures should be similar or analogous to those described in section 3 of appendix A for the PM_{10} reference method.

6.0 *References*

1. Pelton, D. J. Guideline for Particulate Episode Monitoring Methods, GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68–02–3584. EPA 450/4–83–005. February 1983.

2. Technical Assistance Document For Sampling and Analysis of Ozone Precursors. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8–91–215. October 1991.

3. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4–90–0003. August 1989.

(4) Eldred, R.A., Cahill, T.A., Wilkenson, L.K., et al., Measurements of fine particles and their chemical components in the IMPROVE/NPS networks, in Transactions of the International Specialty Conference on Visibility and Fine Particles, Air and Waste Management Association: Pittsburgh, PA, 1990; pp 187-196.

(5) Sisler, J.F., Huffman, D., and Latimer, D.A.; Spatial and temporal patterns and the chemical composition of the haze in the United States: An analysis of data from the IMPROVE network, 1988-1991, ISSN No. 0737-5253-26, National Park Service, Ft. Collins, CO, 1993.

(6) Eldred, R.A., Cahill, T.A., Pitchford, M., and Malm, W.C.; IMPROVE—a new remote area particulate monitoring system for visibility studies, Proceedings of the 81st Annual Meeting of the Air Pollution Control Association, Dallas, Paper 88-54.3, 1988.

[44 FR 27571, May 10, 1979, as amended at 44 FR 37918, June 29, 1979; 44 FR 65070, Nov. 9, 1979; 51 FR 9597, Mar. 19, 1986; 52 FR 24741, 24742, July 1, 1987; 58 FR 8469, Feb. 12, 1993; 59 FR 41628, Aug. 12, 1994; 62 FR 38843, July 18, 1997]

APPENDIX D TO PART 58—NETWORK DESIGN FOR STATE AND LOCAL AIR MONITORING STATIONS (SLAMS), NATIONAL AIR MONITORING STATIONS (NAMS), AND PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

1. SLAMS Monitoring Objectives and Spatial Scales

2. SLAMS Network Design Procedures

2.1 Background Information for Establishing SLAMS

2.2 Substantive Changes in SLAMS/NAMS Network Design Elements

2.3 Sulfur Dioxide (SO_2) Design Criteria for SLAMS

2.4 Carbon Monoxide (CO) Design Criteria for SLAMS

2.5 Ozone (O_3) Design Criteria for SLAMS

2.6 Nitrogen Dioxide (NO_2) Design Criteria for SLAMS
2.7 Lead (Pb) Design Criteria for SLAMS
2.8 Particluate Matter Design Criteria for SLAMS
3. Network Design for National Air Monitoring Stations (NAMS)
3.1 [Reserved]
3.2 Sulfur Dioxide (SO_2) Design Criteria for NAMS
3.3 Carbon Monoxide (CO) Design Criteria for NAMS
3.4 Ozone (O_3) Design Criteria for NAMS
3.5 Nitrogen Dioxide (NO_2) Design Criteria for NAMS
3.6 Lead (Pb) Design Criteria for NAMS
3.7 Particulate Matter Design Criteria for NAMS
4. Network Design for Photochemical Assessment Monitoring Stations (PAMS)
5. Summary
6. References

1. *SLAMS Monitoring Objectives and Spatial Scales*

The purpose of this appendix is to describe monitoring objectives and general criteria to be applied in establishing the State and Local Air Monitoring Stations (SLAMS) networks and for choosing general locations for new monitoring stations. It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS), Photochemical Assessment Monitoring Stations (PAMS), and core Stations for $PM_{2.5}$. These criteria will also be used by EPA in evaluating the adequacy of the SLAMS/NAMS/PAMS and core $PM_{2.5}$ networks.

The network of stations that comprise SLAMS should be designed to meet a minimum of six basic monitoring objectives. These basic monitoring objectives are:

(1) To determine highest concentrations expected to occur in the area covered by the network.

(2) To determine representative concentrations in areas of high population density.

(3) To determine the impact on ambient pollution levels of significant sources or source categories.

(4) To determine general background concentration levels.

(5) To determine the extent of Regional pollutant transport among populated areas; and in support of secondary standards.

(6) To determine the welfare-related impacts in more rural and remote areas (such as visibility impairment and effects on vegetation).

It should be noted that this appendix contains no criteria for determining the total number of stations in SLAMS networks, except in areas where Pb concentrations currently exceed or have exceeded the Pb NAAQS during any one quarter of the most recent eight quarters. The optimum size of a particular SLAMS network involves trade offs among data needs and available resources that EPA believes can best be resolved during the network design process.

This appendix focuses on the relationship between monitoring objectives and the geographical location of monitoring stations. Included are a rationale and set of general criteria for identifying candidate station locations in terms of physical characteristics which most closely match a specific monitoring objective. The criteria for more specifically siting the monitoring station, including spacing from roadways and vertical and horizontal probe and path placement, are described in appendix E of this part.

To clarify the nature of the link between general monitoring objectives and the physical location of a particular monitoring station, the concept of spatial scale of representativeness of a monitoring station is defined. The goal in siting stations is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring objective of the station.

Thus, spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station throughout which actual pollutant concentrations are reasonably similar. The scale of representativeness of most interest for the monitoring objectives defined above are as follows:

Microscale—defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.

Middle Scale—defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.

Neighborhood Scale—defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.

Urban Scale—defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.

Regional Scale—defines usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.

National and Global Scales—these measurement scales represent concentrations characterizing the nation and the globe as a whole.

Proper siting of a monitoring station requires precise specification of the monitoring objective which usually includes a desired spatial scale of representativeness. For example, consider the case where the objective is to determine maximum CO concentrations in areas where pedestrians may reasonably be exposed. Such areas would most likely be located within major street canyons of large urban areas and near traffic corridors.

Stations located in these areas are most likely to have a microscale of representativeness since CO concentrations typically peak nearest roadways and decrease rapidly as the monitor is moved from the roadway. In this example, physical location was determined by consideration of CO emission patterns, pedestrian activity, and physical characteristics affecting pollutant dispersion. Thus, spatial scale of representativeness was not used in the selection process but was a *result* of station location.

In some cases, the physical location of a station is determined from joint consideration of both the basic monitoring objective, and a desired spatial scale of representativeness. For example, to determine CO concentrations which are typical over a reasonably broad geographic area having relatively high CO concentrations, a neighborhood scale station is more appropriate. Such a station would likely be located in a residential or commercial area having a high overall CO emission density but not in the immediate vicinity of any single roadway. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the monitoring station.

In either case, classification of the station by its intended objective and spatial scale of representativeness is necessary and will aid in interpretation of the monitoring data.

Table 1 illustrates the relationship between the four basic monitoring objectives and the scales of representativeness that are generally most appropriate for that objective.

TABLE 1—RELATIONSHIP AMONG MONITORING OBJECTIVES AND SCALE OF REPRESENTATIVENESS

Monitoring Objective	Appropriate Siting Scales
Highest concentration	Micro, Middle, neighborhood (sometimes urban [1])
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
General/background	Neighborhood, urban, regional
Regional transport	Urban/regional
Welfare-related impacts	Urban/regional

[1] Urban denotes a geographic scale applicable to both cities and rural areas

Open path analyzers can often be used effectively and advantageously to provide better monitoring representation for population exposure monitoring and general or background monitoring in urban and neighborhood scales of representation. Such analyzers may also be able to provide better area coverage or operational advantages in high concentration and source-impact monitoring in middle scale and possibly microscale areas. However, siting of open path analyzers for the latter applications must be carried out with proper regard for the specific monitoring objectives and for the path-averaging nature of these analyzers. Monitoring path lengths need to be commensurate with the intended scale of representativeness and located carefully with respect to local sources or potential obstructions. For short-term/high-concentration or source-oriented monitoring, the monitoring path may need to be further restricted in length and be oriented approximately radially with respect to the source in the downwind direction, to provide adequate peak concentration sensitivity. Alternatively, multiple (e.g., orthogonal) paths may be used advantageously to obtain both wider area coverage and peak concentration sensitivity. Further discussion on this topic is included in section 2.2 of this appendix.

Subsequent sections of this appendix describe in greater detail the most appropriate scales of representativeness and general monitoring locations for each pollutant.

2. *SLAMS Network Design Procedures*

The preceding section of this appendix has stressed the importance of defining the objectives for monitoring a particular pollutant. Since monitoring data are collected to ''represent'' the conditions in a section or subregion of a geographical area, the previous section included a discussion of the scale of representativeness of a monitoring station. The use of this physical basis for locating stations allows for an objective approach to network design.

The discussion of scales in sections 2.3 through 2.8 of this appendix does not include all of the possible scales for each pollutant. The scales that are discussed are those that are felt to be most pertinent for SLAMS network design.

In order to evaluate a monitoring network and to determine the adequacy of particular monitoring stations, it is necessary to examine each pollutant monitoring station individually by stating its monitoring objective and determining its spatial scale of representativeness. This will do more than insure compatibility among stations of the same type. It will also provide a physical basis for the interpretation and application of the data. This will help to prevent mismatches between what the data actually represent and what the data are interpreted to represent. It is important to note that SLAMS are not necessarily sufficient for completely describing air quality. In many situations, diffusion models must be applied to complement ambient monitoring, e.g., determining the impact of point sources or defining boundaries of nonattainment areas.

Information such as emissions density, housing density, climatological data, geographic information, traffic counts, and the

results of modeling will be useful in designing regulatory networks. Air pollution control agencies have shown the value of screening studies, such as intensive studies conducted with portable samplers, in designing networks. In many cases, in selecting sites for core $PM_{2.5}$ or carbon monoxide SLAMS, and for defining the boundaries of $PM_{2.5}$ optional community monitoring zones, air pollution control agencies will benefit from using such studies to evaluate the spatial distribution of pollutants.

2.1 Background Information for Establishing SLAMS. Background information that must be considered in the process of selecting SLAMS from the existing network and in establishing new SLAMS includes emission inventories, climatological summaries, and local geographical characteristics. Such information is to be used as a basis for the judgmental decisions that are required during the station selection process. For new stations, the background information should be used to decide on the actual location considering the monitoring objective and spatial scale while following the detailed procedures in References 1 through 4.

Emission inventories are generally the most important type of background information needed to design the SLAMS network. The emission data provide valuable information concerning the size and distribution of large point sources. Area source emissions are usually available for counties but should be subdivided into smaller areas or grids where possible, especially if diffusion modeling is to be used as a basis for determining where stations should be located. Sometimes this must be done rather crudely, for example, on the basis of population or housing units. In general, the grids should be smaller in areas of dense population than in less densely populated regions.

Emission inventory information for point sources should be generally available for any area of the country for annual and seasonal averaging times. Specific information characterizing the emissions from large point sources for the shorter averaging times (diurnal variations, load curves, etc.) can often be obtained from the source. Area source emission data by season, although not available from the EPA, can be generated by apportioning annual totals according to degree days.

Detailed area source data are also valuable in evaluating the adequacy of an existing station in terms of whether the station has been located in the desired spatial scale of representativeness. For example, it may be the desire of an agency to have an existing CO station measuring in the neighborhood scale.

By examining the traffic data for the area and examining the physical location of the station with respect to the roadways, a determination can be made as to whether or not the station is indeed measuring the air quality on the desired scale.

The climatological summaries of greatest use are the frequency distributions of wind speed and direction. The wind rose is an easily interpreted graphical presentation of the directional frequencies. Other types of useful climatological data are also available, but generally are not as directly applicable to the site selection process as are the wind statistics.

In many cases, the meteorological data originating from the most appropriate (not necessarily the nearest) national weather service (NWS) airport station in the vicinity of the prospective siting area will adequately reflect conditions over the area of interest, at least for annual and seasonal averaging times. In developing data in complex meteorological and terrain situations, diffusion meteorologists should be consulted. NWS stations can usually provide most of the relevant weather information in support of network design activities anywhere in the country. Such information includes joint frequency distributions of winds and atmospheric stability (stability-wind roses).

The geographical material is used to determine the distribution of natural features, such as forests, rivers, lakes, and manmade features. Useful sources of such information may include road and topographical maps, aerial photographs, and even satellite photographs. This information may include the terrain and land-use setting of the prospective monitor siting area, the proximity of larger water bodies, the distribution of pollutant sources in the area, the location of NWS airport stations from which weather data may be obtained, etc. Land use and topographical characteristics of specific areas of interest can be determined from U.S. Geological Survey (USGS) maps and land use maps. Detailed information on urban physiography (building/street dimensions, etc.) can be obtained by visual observations, aerial photography, and also surveys to supplement the information available from those sources. Such information could be used in determining the location of local pollutant sources in and around the prospective station locations.

2.2 Substantive Changes in SLAMS/NAMS Network Design Elements. Two important purposes of the SLAMS monitoring data are to examine and evaluate overall air quality within a certain region, and to assess the trends in air pollutant levels over several years. The EPA believes that one of the primary tools for providing these characterizations is an ambient air monitoring program which implements technically representative networks. The design of these networks must be carefully evaluated not only at their outset, but at relatively frequent intervals thereafter, using an appropriate combination

of other important technical tools, including: dispersion and receptor modeling, saturation studies, point and area source emissions analyses, and meteorological assessments. The impetus for these subsequent reexaminations of monitoring network adequacy stems not only from the need to evaluate the effect that changes in the environment may pose, but also from the recognition that new and/or refined tools and techniques for use in impact assessments are continually emerging and available for application.

Substantiative changes to an ambient air monitoring network are both inevitable and necessary; however, any changes in any substantive aspect of an existing SLAMS network or monitoring site that might affect the continuity or comparability of pollutant measurements over time must be carefully and thoroughly considered. Such substantive changes would include cessation of monitoring at an existing site, relocation of an existing site, a change in the type of monitoring method used, any change in the probe or path height or orientation that might affect pollutant measurements, any significant changes in calibration procedures or standards, any significant change in operational or quality assurance procedures, any significant change in the sources or the character of the area in the vicinity of a monitoring site, or any other change that could potentially affect the continuity or comparability of monitoring data obtained before and after the change.

In general, these types of changes should be made cautiously with due consideration given to the impact of such changes on the network/site's ability to meet its intended goals. Some of these changes will be inevitable (such as when a monitoring site will no longer be available and the monitor must be relocated, for example). Other changes may be deemed necessary and advantageous, after due consideration of their impact, even though they may have a deleterious effect on the long-term comparability of the monitoring data. In these cases, an effort should be made to quantify, if possible, or at least characterize, the nature or extent of the effects of the change on the monitoring data. In all cases, the changes and all information pertinent to the effect of the change should be properly and completely documented for evaluation by trends analysts.

The introduction of open path methods to the SLAMS monitoring network may seem relatively straightforward, given the kinds of technical analyses required in this appendix. However, given the uncertainties attendant to these analyses and the critical nature and far-reaching regulatory implications of some sites in the current SLAMS network composed of point monitors, there is a need to 'bridge' between databases generated by these different candidate methods to evaluate and promote continuity in understanding of the historical representativeness of the database.

Concurrent, nominally collocated monitoring must be conducted in all instances where an open path analyzer is effectively intended to replace a criteria pollutant point monitor which meets either of the following:

1. Data collected at the site represents the maximum concentration for a particular nonattainment area; or

2. Data collected at the site is currently used to characterize the development of a nonattainment area State implementation plan.

The Regional Administrator, the Administrator, or their appropriate designee may also require collocated monitoring at other sites which are, based on historical technical data, significant in assessing air quality in a particular area. The term of this requirement is determined by the Regional Administrator (for SLAMS), Administrator (for NAMS), or their appropriate designee. The recommended minimum term consists of one year (or one season of maximum pollutant concentration) with a maximum term indexed to the subject pollutant NAAQS compliance interval (e.g., three calendar years for ozone). The requirement involves concurrent monitoring with both the open path analyzer and the existing point monitor during this term. Concurrent monitoring with more than one point analyzer with an open path analyzer using one or more measurement paths may also be advantageous to confirm adequate peak concentration sensitivity or to optimize the location and length of the monitoring path or paths.

All or some portion of the above requirement may be waived by the Regional Administrator (for SLAMS), the Administrator (for NAMS), or their designee in response to a request, based on accompanying technical information and analyses, or in certain unavoidable instances caused by logistical circumstances.

These requirements for concurrent monitoring also generally apply to situations where the relocation of any SLAMS site, using either a point monitor or an open path analyzer, within an area is being contemplated.

2.3 Sulfur Dioxide (SO_2) Design Criteria for SLAMS. The spatial scales for SO_2 SLAMS monitoring are the middle, neighborhood, urban, and regional scales. Because of the nature of SO_2 distributions over urban areas, the middle scale is the most likely scale to be represented by a single measurement in an urban area, but only if the undue effects from local sources (minor or major point sources) can be eliminated. Neighborhood scales would be those most likely to be represented by single measurements in suburban areas where the concentration gradients are less steep. Urban scales would represent

areas where the concentrations are uniform over a larger geographical area. Regional scale measurements would be associated with rural areas.

Middle Scale—Some data uses associated with middle scale measurements for SO_2 include assessing the effects of control strategies to reduce urban concentrations (especially for the 3-hour and 24-hour averaging times) and monitoring air pollution episodes.

Neighborhood Scale—This scale applies in areas where the SO_2 concentration gradient is relatively flat (mainly suburban areas surrounding the urban center) or in large sections of small cities and towns. In general, these areas are quite homogeneous in terms of SO_2 emission rates and population density. Thus, neighborhood scale measurements may be associated with baseline concentrations in areas of projected growth and in studies of population responses to exposure to SO_2. Also concentration maxima associated with air pollution episodes may be uniformly distributed over areas of neighborhood scale, and measurements taken within such an area would represent neighborhood, and to a limited extent, middle scale concentrations.

Urban Scale—Data from this scale could be used for the assessment of air quality trends and the effect of control strategies on urban scale air quality.

Regional Scale—These measurements would be applicable to large homogeneous areas, particularly those which are sparsely populated. Such measurements could provide information on background air quality and interregional pollutant transport.

After the spatial scale has been selected to meet the monitoring objectives for each station location, the procedures found in reference 2 should be used to evaluate the adequacy of each existing SO_2 station and must be used to relocate an existing station or to locate any new SLAMS stations. The background material for these procedures should consist of emission inventories, meteorological data, wind roses, and maps for population and topographical characteristics of specific areas of interest. Isopleth maps of SO_2 air quality as generated by diffusion models[5] are useful for the general determination of a prospective area within which the station is eventually placed.

2.4 Carbon Monoxide (CO) Design Criteria for SLAMS. Micro, middle, and neighborhood scale measurements are necessary station classifications for SLAMS since most people are exposed to CO concentrations in these scales. Carbon monoxide maxima occur primarily in areas near major roadways and intersections with high traffic density and poor atmospheric ventilation. As these maxima can be predicted by ambient air quality modeling, a large fixed network of CO monitors is not required. Long-term CO monitoring should be confined to a limited number of micro and neighborhood scale stations in large metropolitan areas to measure maximum pollution levels and to determine the effectiveness of control strategies.

Microscale—Measurements on this scale would represent distributions within street canyons, over sidewalks, and near major roadways. The measurements at a particular location in a street canyon would be typical of one high concentration area which can be shown to be a representation of many more areas throughout the street canyon or other similar locations in a city. This is a scale of measurement that would provide valuable information for devising and evaluating ''hot spot'' control measures.

Middle Scale—This category covers dimensions from 100 meters to 0.5 kilometer. In certain cases discussed below, it may apply to regions that have a total length of several kilometers. In many cases of interest, sources and land use may be reasonably homogeneous for long distances along a street, but very inhomogeneous normal to the street. This is the case with strip development and freeway corridors. Included in this category are measurements to characterize the CO concentrations along the urban features just enumerated. When a location is chosen to represent conditions in a block of street development, then the characteristic dimensions of this scale are tens of meters by hundreds of meters. If an attempt is made to characterize street-side conditions throughout the downtown area or along an extended stretch of freeway, the dimensions may be tens of meters by kilometer.

The middle scale would also include the parking lots and feeder streets associated with indirect sources which attract significant numbers of pollutant emitters, particularly autos. Shopping centers, stadia, and office buildings are examples of indirect sources.

Neighborhood Scale—Measurements in this category would represent conditions throughout some reasonably homogeneous urban subregions, with dimensions of a few kilometers and generally more regularly shaped than the middle scale. Homogeneity refers to CO concentration, but it probably also applies to land use. In some cases, a location carefully chosen to provide neighborhood scale data, might represent not only the immediate neighborhood, but also neighborhoods of the same type in other parts of the city. These kinds of stations would provide information relating to health effects because they would represent conditions in areas where people live and work. Neighborhood scale data would provide valuable information for developing, testing, and revising concepts and models that describe the larger scale concentration patterns, especially those models relying on spatially smoothed emission fields for inputs. These types of

measurements could also be used for interneighborhood comparisons within or between cities.

After the spatial scale has been determined to meet the monitoring objectives for each location, the location selection procedures, as shown in reference 3 should be used to evaluate the adequacy of each existing CO station and must be used to relocate an existing station or to locate any new SLAMS stations. The background material necessary for these procedures may include the average daily traffic on all streets in the area, wind roses for different hours of the day, and maps showing one-way streets, street widths, and building heights. If the station is to typify the area with the highest concentrations, the streets with the greatest daily traffic should be identified. If some streets are one-way, those streets that have the greatest traffic during the afternoon and evening hours should be selected as tentative locations, because the periods of high traffic volume are usually of greatest duration through the evening hours. However, the strength of the morning inversion has to be considered along with the traffic volume and pattern when seeking areas with the highest concentrations. Traffic counters near the stations will provide valuable data for interpreting the observed CO Concentrations.

Monitors should not be placed in the vicinity of possible anomalous source areas. Examples of such areas include toll gates on turnpikes, metered freeway ramps, and drawbridge approaches. Additional information on network design may be found in reference 3.

2.5 Ozone (O_3) Design Criteria for SLAMS. Ozone is not directly emitted into the atmosphere but results from complex photochemical reactions involving organic compounds, oxides of nitrogen, and solar radiation.

The relationships between primary emissions (precursors) and secondary pollutants (O_3) tend to produce large separations spatially and temporally between the major sources and the areas of high oxidant pollution. This suggests that the meteorological transport process and the relationships between sources and sinks need to be considered in the development of the network design criteria and placement of monitoring stations, especially in measuring peak concentration levels.

The principal spatial scales for SLAMS purposes based on the monitoring objectives are neighborhood, urban, regional, and to a lesser extent, middle scale. Since ozone requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small scale spatial variability.

Middle Scale—Measurement in this scale would represent conditions close to sources of NO_X such as roads where it would be expected that suppression of O_3 concentrations would occur. Trees also may have a strong scavenging effect on O_3 and may tend to suppress O_3 concentrations in their immediate vicinity. Measurements at these stations would represent conditions over relatively small portions of the urban area.

Neighborhood Scale—Measurements in this category represent conditions throughout some reasonably homogeneous urban subregion, with dimensions of a few kilometers. Homogeneity refers to pollutant concentrations. Neighborhood scale data will provide valuable information for developing, testing, and revising concepts and models that describe urban/regional concentration patterns. They will be useful to the understanding and definition of processes that take periods of hours to occur and hence involve considerable mixing and transport. Under stagnation conditions, a station located in the neighborhood scale may also experience peak concentration levels within the urban areas.

Urban Scale—Measurement in this scale will be used to estimate concentrations over large portions of an urban area with dimensions of several kilometers to 50 or more kilometers. Such measurements will be used for determining trends, and designing area-wide control strategies. The urban scale stations would also be used to measure high concentrations downwind of the area having the highest precursor emissions.

Regional Scale—This scale of measurement will be used to typify concentrations over large portions of a metropolitan area and even larger areas with dimensions of as much as hundreds of kilometers. Such measurements will be useful for assessing the ozone that is transported into an urban area. Data from such stations may be useful in accounting for the ozone that cannot be reduced by control strategies in that urban area.

The location selection procedure continues after the spatial scale is selected based on the monitoring objectives. The appropriate network design procedures as found in reference 4, should be used to evaluate the adequacy of each existing O_3 monitor and must be used to relocate an existing station or to locate any new O_3 SLAMS stations. The first step in the siting procedure would be to collect the necessary background material, which may consist of maps, emission inventories for nonmethane hydrocarbons and oxides of nitrogen (NO_X), climatological data, and existing air quality data for ozone, nonmethane hydrocarbons, and NO_2/NO.

For locating a neighborhood scale station to measure typical city concentrations, a reasonably homogeneous geographical area near the center of the region should be selected which is also removed from the influence of major NO_X sources. For an urban

scale station to measure the high concentration areas, the emission inventories should be used to define the extent of the area of important nonmethane hydrocarbons and NO_X emissions. The most frequent wind speed and direction for periods of important photochemical activity should be determined. Then the prospective monitoring area should be selected in a direction from the city that is most frequently downwind during periods of photochemical activity. The distance from the station to the upwind edge of the city should be about equal to the distance traveled by air moving for 5 to 7 hours at wind speeds prevailing during periods of photochemical activity. Prospective areas for locating O_3 monitors should always be outside the area of major NO_X.

In locating a neighborhood scale station which is to measure high concentrations, the same procedures used for the urban scale are followed except that the station should be located closer to the areas bordering on the center city or slightly further downwind in an area of high density population.

For regional scale background monitoring stations, the most frequent wind associated with important photochemical activity should be determined. The prospective monitoring area should be upwind for the most frequent direction and outside the area of city influence.

Since ozone levels decrease significantly in the colder parts of the year in many areas, ozone is required to be monitored at NAMS and SLAMS monitoring sites only during the ''ozone season'' as designated in the AIRS files on a State by State basis and described below:

OZONE MONITORING SEASON BY STATE

State	Begin month	End month
Alabama	March	October.
Alaska	April	October.
Arizona	January	December.
Arkansas	March	November.
California	January	December.
Colorado	March	September.
Connecticut	April	September.
Delaware	April	October.
District of Columbia	April	October.
Florida	March	October.
Georgia	March	October.
Hawaii	January	December.
Idaho	May	September.
Illinois	April	October.
Indiana	April	September.
Iowa	April	October.
Kansas	April	October.
Kentucky	March	October.
Louisiana AQCRs 019, 022.	March	October.
Louisiana AQCR 106	January	December.
Maine	April	September.
Maryland	April	October.
Massachusetts	April	September.
Michigan	April	September.
Minnesota	April	October.
Mississippi	March	October.

OZONE MONITORING SEASON BY STATE—Continued

State	Begin month	End month
Missouri	April	October.
Montana	June	September.
Nebraska	April	October.
Nevada	January	December.
New Hampshire	April	September.
New Jersey	April	October.
New Mexico	January	December.
New York	April	October.
North Carolina	April	October.
North Dakota	May	September.
Ohio	April	October.
Oklahoma	March	November.
Oregon	May	September.
Pennsylvania	April	October.
Puerto Rico	January	December.
Rhode Island	April	September.
South Carolina	April	October.
South Dakota	June	September.
Tennessee	March	October.
Texas AQCR 4,5,7,10,11	January	December
Texas AQCR 1, 2, 3, 6, 8, 9, 12.	March	October
Utah	May	September.
Vermont	April	September.
Virginia	April	October.
Washington	May	September.
West Virginia	April	October.
Wisconsin	April 15	October 15.
Wyoming	April	October.
American Samoa	January	December.
Guam	January	December.
Virgin Islands	January	December.

Additional discussion on the procedures for siting ozone stations may be found in reference 4.

2.6 Nitrogen Dioxide (NO_2) Design Criteria for SLAMS. The typical spatial scales of representativeness associated with nitrogen dioxide monitoring based on monitoring objectives are middle, neighborhood, and urban. Since nitrogen dioxide is primarily formed in the atmosphere from the oxidation of NO, large volumes of air and mixing times usually reduce the importance of monitoring on small scale spatial variability especially for long averaging times. However, there may be some situations where NO_2 measurements would be made on the middle scale for both long- and short-term averages.

Middle Scale—Measurements on this scale would cover dimensions from about 100 meters to 0.5 kilometer. These measurements would characterize the public exposure to NO_2 in populated areas. Also monitors that are located closer to roadways than the minimum distances specified in table 3 of appendix E of this part, would be represented by measurements on this scale.

Neighborhood and Urban Scales—The same considerations as discussed in section 2.5 for O_3 would also apply to NO_2.

After the spatial scale is selected based on the monitoring objectives, then the siting procedures as found in reference 4 should be

used to evaluate the adequacy of each existing NO_2 station and must be used to relocate an existing station or to locate any new NO_2 SLAMS stations. The siting procedures begin with collecting the background material. This background information may include the characteristics of the area and its sources under study, climatological data to determine where concentration maxima are most likely to be found, and any existing monitoring data for NO_2.

For neighborhood or urban scales, the emphasis in site selection will be in finding those areas where long-term averages are expected to be the highest. Nevertheless, it should be expected that the maximum NO_2 concentrations will occur in approximately the same locations as the maximum total oxides of nitrogen concentrations. The best course would be to locate the station somewhat further downwind beyond the expected point of maximum total oxides of nitrogen to allow more time for the formation of NO_2. The dilution of the emissions further downwind from the source should be considered along with the need for reaction time for NO_2 formation in locating stations to measure peak concentration. If dispersion is favorable, maximum concentrations may occur closer to the emission sources than the locations predicted from oxidation of NO to NO_2 alone. This will occur downwind of sources based on winter wind direction or in areas where there are high ozone concentrations and high density NO_2 emissions such as on the fringe of the central business district or further downwind. The distance and direction downwind would be based on ozone season wind patterns.

Once the major emissions areas and wind patterns are known, areas of potential maximum NO_2 levels can be determined. Nitrogen dioxide concentrations are likely to decline rather rapidly outside the urban area. Therefore, the best location for measuring NO_2 concentrations will be in neighborhoods near the edge of the city.

2.7 *Lead (Pb) Design Criteria for SLAMS.* Presently, less than 1 percent of the Nation's Pb air pollution emissions originate from on-road mobile source exhaust. The majority of Pb emissions come from point sources, such as metals processing facilities, waste disposal and recycling, and fuel combustion (reference 19 of this appendix). The SLAMS networks are used to assess the air quality impacts of Pb point sources, and to determine the broad population exposure from any Pb source. The most important spatial scales to effectively characterize the emissions from point sources are the micro, middle, and neighborhood scales. For purposes of establishing monitoring stations to represent large homogeneous areas other than the above scales of representativeness, urban or regional scale stations may also be needed.

Microscale—This scale would typify areas in close proximity to lead point sources. Emissions from point sources such as primary and secondary lead smelters, and primary copper smelters may under fumigation conditions likewise result in high ground level concentrations at the microscale. In the latter case, the microscale would represent an area impacted by the plume with dimensions extending up to approximately 100 meters. Data collected at microscale stations provide information for evaluating and developing ''hot-spot'' control measures.

Middle Scale—This scale generally represents Pb air quality levels in areas up to several city blocks in size with dimensions on the order of approximately 100 meters to 500 meters. The middle scale may for example, include schools and playgrounds in center city areas which are close to major Pb point sources. Pb monitors in such areas are desirable because of the higher sensitivity of children to exposures of elevated Pb concentrations (reference 7 of this appendix). Emissions from point sources frequently impact on areas at which single sites may be located to measure concentrations representing middle spatial scales.

Neighborhood Scale—The neighborhood scale would characterize air quality conditions throughout some relatively uniform land use areas with dimensions in the 0.5 to 4.0 kilometer range. Stations of this scale would provide monitoring data in areas representing conditions where children live and play. Monitoring in such areas is important since this segment of the population is more susceptible to the effects of Pb. Where a neighborhood site is located away from immediate Pb sources, the site may be very useful in representing typical air quality values for a larger residential area, and therefore suitable for population exposure and trends analyses.

Urban Scale—Such stations would be used to present ambient Pb concentrations over an entire metropolitan area with dimensions in the 4 to 50 kilometer range. An urban scale station would be useful for assessing trends in citywide air quality and the effectiveness of larger scale air pollution control strategies.

Regional Scale—Measurements from these stations would characterize air quality levels over areas having dimensions of 50 to hundreds of kilometers. This large scale of representativeness, rarely used in Pb monitoring, would be most applicable to sparsely populated areas and could provide information on background air quality and inter-regional pollutant transport.

Monitoring for ambient Pb levels is required for all major urbanized areas where Pb levels have been shown or are expected to be of concern due to the proximity of Pb point source emissions. Sources emitting five tons per year or more of actual point

and fugitive Pb emissions would generally be candidates for lead ambient air monitoring. Modeling may be needed to determine if a source has the potential to exceed the quarterly lead National Ambient Air Quality Standards (NAAQS). The total number and type of stations for SLAMS are not prescribed but must be determined on a case-by-case basis. As a minimum, there must be two stations in any area where Pb concentrations currently exceed or have exceeded the Pb NAAQS during any one quarter of the most recent eight quarters. Where the Pb air quality violations are widespread or the emissions density, topography, or population locations are complex and varied, there may be a need to establish more than two Pb ambient air monitoring stations. The EPA Regional Administrator may specify more than two monitoring stations if it is found that two stations are insufficient to adequately determine if the Pb standard is being attained and maintained. The Regional Administrator may also specify that stations be located in areas outside the boundaries of the urbanized areas.

Concerning the previously discussed required minimum of two stations, at least one of the stations must be a category (a) type station and the second may be either category (a) or (b) depending upon the extent of the point source's impact and the existence of residential neighborhoods surrounding the source. When the source is located in an area that is subject to NAMS requirements as in Section 3 of this Appendix, it is preferred that the NAMS site be used to describe the population's exposure and the second SLAMS site be used as a category (a) site. Both of these categories of stations are defined in section 3.

To locate monitoring stations, it will be necessary to obtain background information such as point source emissions inventories, climatological summaries, and local geographical characteristics. Such information should be used to identify areas that are most suitable to the particular monitoring objective and spatial scale of representativeness desired. References 9 & 10 of this appendix provide additional guidance on locating sites to meet specific urban area monitoring objectives and should be used in locating new stations or evaluating the adequacy of existing stations.

After locating each Pb station and, to the extent practicable, taking into consideration the collective impact of all Pb sources and surrounding physical characteristics of the siting area, a spatial scale of representativeness must be assigned to each station.

2.8 *Particulate Matter Design Criteria for SLAMS.*

As with other pollutants measured in the SLAMS network, the first step in designing the particulate matter network is to collect the necessary background information. Various studies in references 11, 12, 13, 14, 15, and 16 of section 6 of this appendix have documented the major source categories of particulate matter and their contribution to ambient levels in various locations throughout the country.

2.8.0.1 Sources of background information would be regional and traffic maps, and aerial photographs showing topography, settlements, major industries and highways. These maps and photographs would be used to identify areas of the type that are of concern to the particular monitoring objective. After potentially suitable monitoring areas for particulate matter have been identified on a map, modeling may be used to provide an estimate of particulate matter concentrations throughout the area of interest. After completing the first step, existing particulate matter stations should be evaluated to determine their potential as candidates for SLAMS designation. Stations meeting one or more of the six basic monitoring objectives described in section 1 of this appendix must be classified into one of the five scales of representativeness (micro, middle, neighborhood, urban and regional) if the stations are to become SLAMS. In siting and classifying particulate matter stations, the procedures in references 17 and 18 of section 6 of this appendix should be used.

2.8.0.2 The most important spatial scales to effectively characterize the emissions of particulate matter from both mobile and stationary sources are the middle scales for PM_{10} and neighborhood scales for both PM_{10} and $PM_{2.5}$. For purposes of establishing monitoring stations to represent large homogenous areas other than the above scales of representativeness and to characterize regional transport, urban or regional scale stations would also be needed. Most $PM_{2.5}$ monitoring in urban areas should be representative of a neighborhood scale.

2.8.0.3 Microscale—This scale would typify areas such as downtown street canyons and traffic corridors where the general public would be exposed to maximum concentrations from mobile sources. In some circumstances, the microscale is appropriate for particulate stations; core SLAMS on the microscale should, however, be limited to urban sites that are representative of long-term human exposure and of many such microenvironments in the area. In general, microscale particulate matter sites should be located near inhabited buildings or locations where the general public can be expected to be exposed to the concentration measured. Emissions from stationary sources such as primary and secondary smelters, power plants, and other large industrial processes may, under certain plume conditions, likewise result in high ground level concentrations at the microscale. In the latter case, the microscale would represent an area impacted by the plume with

dimensions extending up to approximately 100 meters. Data collected at microscale stations provide information for evaluating and developing hot spot control measures. Unless these sites are indicative of population-oriented monitoring, they may be more appropriately classified as SPMs.

2.8.0.4 Middle Scale—Much of the measurement of short-term public exposure to coarse fraction particles (PM_{10}) is on this scale and on the neighborhood scale; for fine particulate, much of the measurement is on the neighborhood scale. People moving through downtown areas, or living near major roadways, encounter particles that would be adequately characterized by measurements of this spatial scale. Thus, measurements of this type would be appropriate for the evaluation of possible short-term exposure public health effects of particulate matter pollution. In many situations, monitoring sites that are representative of micro-scale or middle-scale impacts are not unique and are representative of many similar situations. This can occur along traffic corridors or other locations in a residential district. In this case, one location is representative of a neighborhood of small scale sites and is appropriate for evaluation of long-term or chronic effects. This scale also includes the characteristic concentrations for other areas with dimensions of a few hundred meters such as the parking lot and feeder streets associated with shopping centers, stadia, and office buildings. In the case of PM_{10}, unpaved or seldom swept parking lots associated with these sources could be an important source in addition to the vehicular emissions themselves.

2.8.0.5 Neighborhood Scale—Measurements in this category would represent conditions throughout some reasonably homogeneous urban subregion with dimensions of a few kilometers and of generally more regular shape than the middle scale. Homogeneity refers to the particulate matter concentrations, as well as the land use and land surface characteristics. Much of the $PM_{2.5}$ exposures are expected to be associated with this scale of measurement. In some cases, a location carefully chosen to provide neighborhood scale data would represent not only the immediate neighborhood but also neighborhoods of the same type in other parts of the city. Stations of this kind provide good information about trends and compliance with standards because they often represent conditions in areas where people commonly live and work for periods comparable to those specified in the NAAQS. In general, most $PM_{2.5}$ monitoring in urban areas should have this scale. A $PM_{2.5}$ monitoring location is assumed to be representative of a neighborhood scale unless the monitor is adjacent to a recognized $PM_{2.5}$ emissions source or is otherwise demonstrated to be representative of a smaller spatial scale by an intensive monitoring study. This category also may include industrial and commercial neighborhoods especially in districts of diverse land use where residences are interspersed.

2.8.0.6 Neighborhood scale data could provide valuable information for developing, testing, and revising models that describe the larger-scale concentration patterns, especially those models relying on spatially smoothed emission fields for inputs. The neighborhood scale measurements could also be used for neighborhood comparisons within or between cities. This is the most likely scale of measurements to meet the needs of planners.

2.8.0.7 Urban Scale—This class of measurement would be made to characterize the particulate matter concentration over an entire metropolitan or rural area ranging in size from 4 to 50 km. Such measurements would be useful for assessing trends in area-wide air quality, and hence, the effectiveness of large scale air pollution control strategies. Core $PM_{2.5}$ SLAMS may have this scale.

2.8.0.8 Regional Scale—These measurements would characterize conditions over areas with dimensions of as much as hundreds of kilometers. As noted earlier, using representative conditions for an area implies some degree of homogeneity in that area. For this reason, regional scale measurements would be most applicable to sparsely populated areas with reasonably uniform ground cover. Data characteristics of this scale would provide information about larger scale processes of particulate matter emissions, losses and transport. Especially in the case of $PM_{2.5}$, transport contributes to particulate concentrations and may affect multiple urban and State entities with large populations such as in the Eastern United States. Development of effective pollution control strategies requires an understanding at regional geographical scales of the emission sources and atmospheric processes that are responsible for elevated $PM_{2.5}$ levels and may also be associated with elevated ozone and regional haze.

2.8.1 *Specific Design Criteria for $PM_{2.5}$.*

2.8.1.1 Monitoring Planning Areas.

Monitoring planning areas (MPAs) shall be used to conform to the community-oriented monitoring approach used for the $PM_{2.5}$ NAAQS given in part 50 of this chapter. MPAs are required to correspond to all metropolitan statistical areas (MSAs) with population greater than 200,000, and all other areas determined to be in violation of the $PM_{2.5}$ NAAQS.[1] MPAs for other designated parts of the State are optional. All MPAs

[1]The boundaries of MPAs do not have to necessarily correspond to those of MSAs and existing intra or interstate air pollution planning districts may be utilized.

shall be defined on the basis of existing, delineated mapping data such as State boundaries, county boundaries, zip codes, census blocks, or census block groups.

2.8.1.2 $PM_{2.5}$ Monitoring Sites within the State's PM Monitoring Network Description.

2.8.1.2.1 The minimum required number, type of monitoring sites, and sampling requirements for $PM_{2.5}$ are based on monitoring planning areas described in the PM monitoring network description and proposed by the State in accordance with §58.20.

2.8.1.2.2 Comparisons to the $PM_{2.5}$ NAAQS may be based on data from SPMs in addition to SLAMS (including NAMS, core SLAMS and collocated $PM_{2.5}$ sites at PAMS), that meet the requirements of §58.13 and Appendices A, C and E of this part, that are included in the PM monitoring network description. For comparison to the annual NAAQS, the monitors should be neighborhood scale community-oriented locations. Special purpose monitors that meet part 58 requirements will be exempt from NAAQS comparisons with the $PM_{2.5}$ NAAQS for the first 2 calendar years of their operation to encourage $PM_{2.5}$ monitoring initially. After this time, however, any SPM that records a violation of the $PM_{2.5}$ NAAQS must be seriously considered as a potential SLAMS site during the annual SLAMS network review in accordance with §58.25. If such SPMs are not established as a SLAMS, the agency must document in its annual report the technical basis for excluding it as a SLAMS.

2.8.1.2.3 The health-effects data base that served as the basis for selecting the new $PM_{2.5}$ standards relied on a spatial average approach that reflects average community-oriented area-wide PM exposure levels. Under this approach, the most effective way to reduce total population risk is by lowering the annual distributions of ambient 24-hour $PM_{2.5}$ concentrations, as opposed to controlling peak 24-hour concentrations on individual days. The annual standard selected by EPA will generally be the controlling standard for lowering both short- and long-term $PM_{2.5}$ concentrations on an area-wide basis and will achieve this result. In order to be consistent with this rationale, therefore, $PM_{2.5}$ data collected from SLAMS and special purpose monitors that are representative, not of area-wide but rather, of relatively unique population-oriented microscale, or localized hot spot, or unique population-oriented middle-scale impact sites are only eligible for comparison only to the 24-hour $PM_{2.5}$ NAAQS. However, in instances where certain population-oriented micro- or middle-scale $PM_{2.5}$ monitoring sites are determined by the EPA Regional Administrator to collectively identify a larger region of localized high ambient $PM_{2.5}$ concentrations, data from these population-oriented sites would be eligible for comparison to the annual NAAQS.

2.8.1.2.4 Within each MPA, the responsible air pollution control agency shall install core SLAMS, other required SLAMS and as many $PM_{2.5}$ stations judged necessary to satisfy the SLAMS requirements and monitoring objectives of this appendix.

2.8.1.3 Core Monitoring Stations for $PM_{2.5}$.

Core monitoring stations or sites are a subset of the SLAMS network for $PM_{2.5}$ that are sited to represent community-wide air quality. These core sites include sites to be collocated at PAMS.

2.8.1.3.1 Within each monitoring planning area, the responsible air pollution control agency shall install the following core $PM_{2.5}$ SLAMS:

(a) At least two core $PM_{2.5}$ SLAMS per MSA with population greater than 500,000 sampling everyday, unless exempted by the Regional Administrator, including at least one station in a population-oriented area of expected maximum concentration and at least one station in an area of poor air quality and at least one additional core monitor collocated at a PAMS site in each PAMS area[2].

(b) At least one core $PM_{2.5}$ SLAMS per MSA with population greater than 200,000 and less than or equal to 500,000 sampling every third day.

(c) Additional core $PM_{2.5}$ SLAMS per MSA with population greater than 1 million, sampling every third day, as specified in the following table:

TABLE 1—REQUIRED NUMBER OF CORE SLAMS ACCORDING TO MSA POPULATION

MSA Population	Minimum Required No. of Core Sites[1]
>1 M	3
>2 M	4
>4 M	6
>6 M	8
>8 M	10

[1]Core SLAMS at PAMS are in addition to these numbers.

2.8.1.3.2 The site situated in the area of expected maximum concentration is analogous to NAMS ''category a.'' [3] This will henceforth be termed a category a core SLAMS

[2]The core monitor to be collocated at a PAMS site shall not be considered a part of the PAMS as described in section 4 of this appendix, but shall instead be considered to be a component of the particular MPA $PM_{2.5}$ network.

[3]The measured maximum concentrations at core population-oriented sites should be consistent with the averaging time of the NAAQS. Therefore, sites only with high concentrations for shorter averaging times (say

site. The site located in the area of poor air quality with high population density or representative of maximum population impact is analogous to NAMS, ''category b.'' This second site will be called a category b core SLAMS site.

2.8.1.3.3 Those MPAs that are substantially impacted by several different and geographically disjoint local sources of fine particulate should have separate core sites to monitor each influencing source region.

2.8.1.3.4 Within each monitoring planning area, one or more required core SLAMS may be exempted by the Regional Administrator. This may be appropriate in areas where the highest concentration is expected to occur at the same location as the area of maximum or sensitive population impact, or areas with low concentrations (e.g., highest concentrations are less than 80 percent of the NAAQS). When only one core monitor for $PM_{2.5}$ is included in a MPA or optional CMZ, however, a ''category a'' core site is strongly preferred to determine community-oriented $PM_{2.5}$ concentrations in areas of high average $PM_{2.5}$ concentration.

2.8.1.3.5 More than the minimum number of core SLAMS should be deployed as necessary in all MPAs. Except for the core SLAMS described in section 2.8.1.3.1 of this appendix, the additional core SLAMS must only comply with the minimum sampling frequency for SLAMS specified in §58.13(e).

2.8.1.3.6 A subset of the core $PM_{2.5}$ SLAMS shall be designated NAMS as discussed in section 3.7 of this appendix. The selection of core monitoring sites in relation to MPAs and CMZs is discussed further in section 2.8.3 of this appendix.

2.8.1.3.7 Core monitoring sites shall represent neighborhood or larger spatial scales. A monitor that is established in the ambient air that is in or near a populated area, and meets appropriate 40 CFR part 58 criteria (i.e., meets the requirements of §58.13 and §58.14, Appendices A, C, and E of this part) can be presumed to be representative of at least a neighborhood scale, is eligible to be called a core site and shall produce data that are eligible for comparison to both the 24-hour and annual $PM_{2.5}$ NAAQS. If the site is adjacent to a dominating local source or can be shown to have average 24-hour concentrations representative of a smaller spatial scale, then the site would only be compared to the 24-hour $PM_{2.5}$ NAAQS.

2.8.1.3.8 Continuous fine particulate monitoring at core SLAMS. At least one continuous fine particulate analyzer (e.g., beta attenuation analyzer; tapered-element, oscillating microbalance (TEOM); transmissometer; nephelometer; or other acceptable continuous fine particulate monitor) shall be located at a core monitoring $PM_{2.5}$ site in each metropolitan area with a population greater than 1 million. These analyzers shall be used to provide improved temporal resolution to better understand the processes and causes of elevated $PM_{2.5}$ concentrations and to facilitate public reporting of $PM_{2.5}$ air quality and will be in accordance with appropriate methodologies and QA/QC procedures approved by the Regional Administrator.

2.8.1.4 Other $PM_{2.5}$ SLAMS Locations.

In addition to the required core sites described in section 2.8.1.3 of this appendix, the State shall also install and operate on an every third day sampling schedule at least one SLAMS to monitor for regional background and at least one SLAMS to monitor regional transport. These monitoring stations may be at a community-oriented site and their requirement may be satisfied by a corresponding SLAMS monitor in an area having similar air quality in another State. The State shall also be required to establish additional SLAMS sites based on the total population outside the MSA(s) associated with monitoring planning areas that contain required core SLAMS. There shall be one such additional SLAMS for each 200,000 people. The minimum number of SLAMS may be deployed anywhere in the State to satisfy the SLAMS monitoring objectives including monitoring of small scale impacts which may not be community-oriented or for regional transport as described in section 1 of this appendix. Other SLAMS may also be established and are encouraged in a State $PM_{2.5}$ network.

2.8.1.5 Additional $PM_{2.5}$ Analysis Requirements.

(a) Within 1 year after September 16, 1997, chemical speciation will be required at approximately 25 $PM_{2.5}$ core sites collocated at PAMS sites (1 type 2 site per PAMS area) and at approximately 25 other core sites for a total of approximately 50 sites. The selection of these sites will be performed by the Administrator in consultation with the Regional Administrator and the States. Chemical speciation is encouraged at additional sites. At a minimum, chemical speciation to be conducted will include analysis for elements, selected anions and cations, and carbon. Samples for required speciation will be collected using appropriate monitoring methods and sampling schedule in accordance with procedures approved by the Administrator.

(b) Air pollution control agencies shall archive $PM_{2.5}$ filters from all other SLAMS sites for a minimum of one year after collection. These filters shall be made available for supplemental analyses at the request of EPA or to provide information to State and local agencies on the composition for $PM_{2.5}$. The filters shall be archived in accordance with procedures approved by the Administrator.

1-hour) should not be category ''a'' core SLAMS monitors.

2.8.1.6 Community Monitoring Zones.

2.8.1.6.1 The CMZs describe areas within which two or more core monitors may be averaged for comparison with the annual $PM_{2.5}$ NAAQS. This averaging approach as specified in 40 CFR part 50, appendix N, is directly related to epidemiological studies used as the basis for the $PM_{2.5}$ NAAQS. A CMZ should characterize an area of relatively similar annual average air quality (i.e., the average concentrations at individual sites shall not exceed the spatial average by more than 20 percent) and exhibit similar day to day variability (e.g., the monitoring sites should not have low correlations, say less than 0.6). Moreover, the entire CMZ should principally be affected by the same major emission sources of $PM_{2.5}$.

2.8.1.6.2 Each monitoring planning area may have at least one CMZ, that may or may not cover the entire MPA. In metropolitan statistical areas (MSAs) for which MPAs are required, the CMZs may completely cover the entire MSA. When more than one CMZ is described within an MPA, CMZs shall not overlap in their geographical coverage. All areas in the ambient air may become a CMZ.

2.8.1.6.3. As $PM_{2.5}$ networks are first established, core sites would be used individually for making comparisons to the annual $PM_{2.5}$ NAAQS. As these networks evolve, individual monitors may not be adequate by themselves to characterize the annual average community wide air quality. This is especially true for areas with sharp gradients in annual average air quality. Therefore, CMZs with multiple core SLAMS or other eligible sites as described in accordance with section 2.8.1.2 to this appendix, may be established for the purposes of providing improved estimates of community wide air quality and for making comparisons to the annual NAAQS. This CMZ approach is subject to the constraints of section 2.8.1.6.1 to this appendix.

2.8.1.6.4 The spatial representativeness of individual monitoring sites should be considered in the design of the network and in establishing the boundaries of CMZs. Communities within the MPA with the highest $PM_{2.5}$ concentrations must have a high priority for $PM_{2.5}$ monitoring. Until a sufficient number of monitoring stations or CMZs are established, however, the monitored air quality in all parts of the MPA may not be precisely known. It would be desirable, however, to design the placement of monitors so that those portions of the MPAs without monitors could be characterized as having average concentrations less than the monitored portions of the network.

2.8.1.7 Selection of Monitoring Locations Within MPAs or CMZs.

2.8.1.7.1 Figure 1 of this appendix illustrates a hypothetical monitoring planning area and shows the location of monitors in relation to population and areas of poor air quality. Figure 2 of this appendix shows the same hypothetical MPA as Figure 1 of this appendix and illustrates potential community monitoring zones and the location of core monitoring sites within them.

2.8.1.7.2 In Figure 1 of this appendix, a hypothetical monitoring planning area is shown representing a typical Eastern US urban areas. The ellipses represent zones with relatively high population and poor air quality, respectively. Concentration isopleths are also depicted. The highest population density is indicated by the urban icons, while the area of worst air quality is presumed to be near the industrial symbols. The monitoring area should have at least one core monitor to represent community wide air quality in each sub-area affected by different emission sources. Each monitoring planning area with population greater than 500,000 is required to have at least two core population-oriented monitors that will sample everyday (with PAMS areas requiring three) and may have as many other core SLAMS, other SLAMS, and SPMs as necessary. All SLAMS should generally be population-oriented, while the SPMs can focus more on other monitoring objectives, e.g., identifying source impacts and the area boundaries with maximum concentration. C_a denotes ''category a'' core SLAMS site (community-oriented site in area of expected maximum concentration); it is shown within the populated area and closest to the area with highest concentration. C_b denotes a ''category b'' core SLAMS site (area of poor air quality with high population density or representative of maximum population impact); it is shown in the area of poor air quality, closest to highest population density. All other core SLAMS in this MPA are denoted by ''C.'' S denotes other SLAMS sites (monitoring for any objective: Max concentration, population exposure, source-oriented, background, or regional transport or in support of secondary NAAQS). P denotes a Special Purpose Monitor (a specialized monitor that, for example, may use a non-reference sampler). Finally, note that all SPMs would be subject to the 2-year moratorium against data comparison to the NAAQS for the first 2 complete calendar years of its operation.

2.8.1.7.3 A Monitoring Planning Area may have one or more community monitoring zones (CMZ) for aggregation of data from eligible SLAMS and SPM sites for comparison to the annual NAAQS. The planning area has large gradients of average air quality and, as shown in Figure 2 may be assigned three CMZs: An industrial zone, a downtown central business district (CBD), and a residential area. (If there is not a large difference between downtown concentrations and other residential areas, a separate CBD zone would not be appropriate).

Figure 1. Hypothetical Monitoring Planning Area

Eastern Urban Model - showing location of monitors in relation to population and area of poor air quality

C=Core site S=other SLAMS site p=Special Purpose Monitor

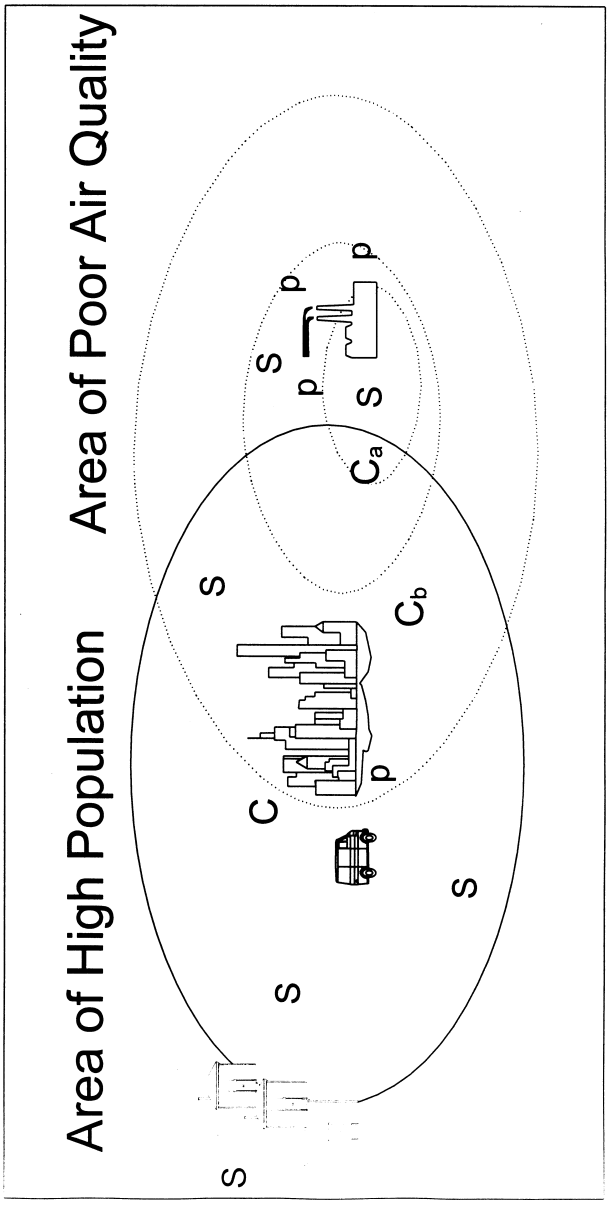
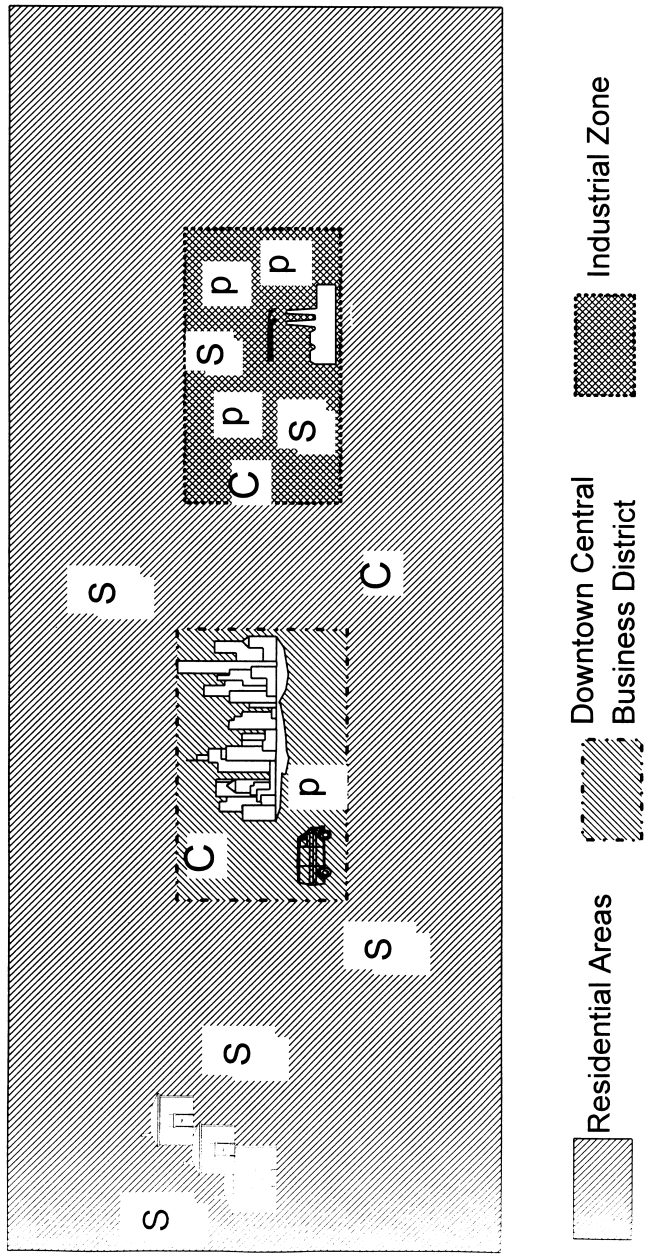


Figure 2. Hypothetical Monitoring Planning Area

Potential Community Monitoring Zones

C=Core site S=other SLAMS site p=Special Purpose Monitor

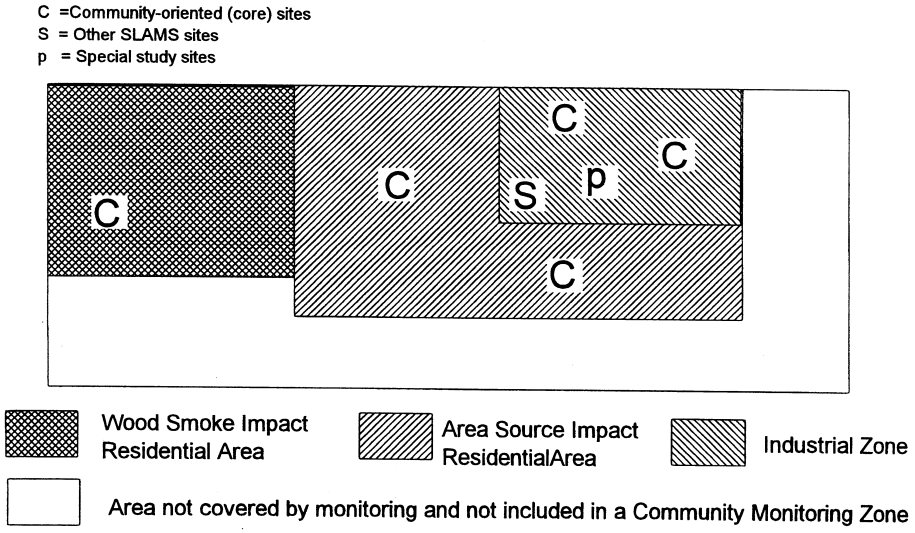


2.8.1.7.4 Figure 3 of this appendix illustrates how CMZs and $PM_{2.5}$ monitors might be located in a hypothetical MPA typical of a Western State. Western States with more localized sources of PM and larger geographic area could require a different mix of SLAMS and SPM monitors and may need

more total monitors. As the networks are deployed, the available monitors may not be sufficient to completely represent all geographic portions of the Monitoring Planning Area. Due to the distribution of pollution and population and because of the number and spatial representativeness of monitors, the MPAs and CMZs may not cover the entire State.

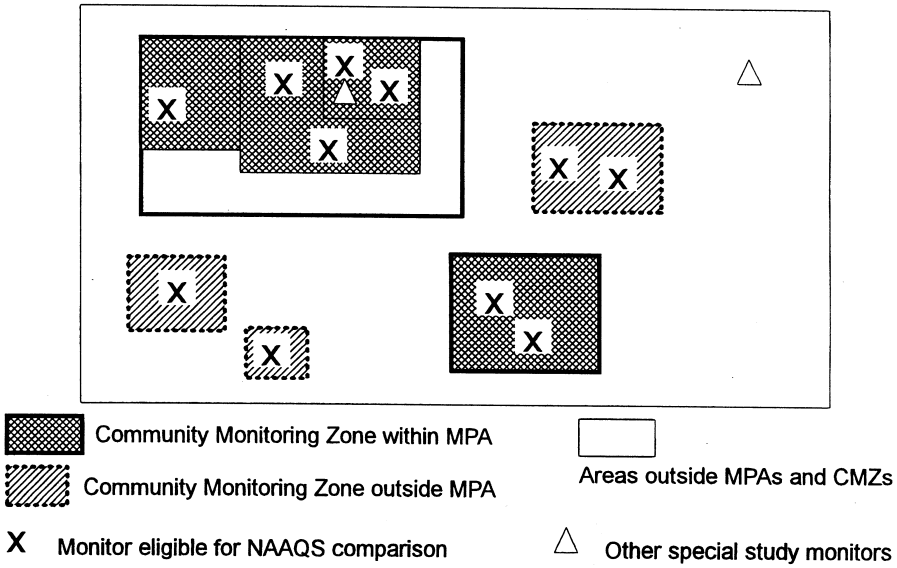
Figure 3. Hypothetical Monitoring Planning Area

Potential Community Monitoring Zones in Western MPA



2.8.1.7.5 Figure 4 of this appendix shows how the MPAs, CMZs, and $PM_{2.5}$ monitors might be distributed within a hypothetical State. Areas of the State included within MPAs are shown within heavy solid lines. Two MPAs are illustrated. Areas in the State outside the MPAs will also include monitors, but this monitoring coverage may be limited. This portion of the State may also be represented by CMZs (shown by areas enclosed within dotted lines). The monitors that are intended for comparison to the NAAQS are indicated by X. Furthermore, eligible monitors within a CMZ could be averaged for comparison to the annual NAAQS or examined individually for comparison to both NAAQS. Both within the MPAs and in the remainder of the State, some special study monitors might not satisfy applicable 40 CFR part 58 requirements and will not be eligible for comparison to the NAAQS.

Figure 4. MPAs and CMZs in Hypothetical State



2.8.2 *Substitute PM Monitoring Sites.*

2.8.2.1 Section 2.2 of appendix C of this part describes conditions under which TSP samplers can be used as substitutes for PM_{10}. This provision is intended to be used when PM_{10} concentrations are expected to be very low and substitute TSP samplers can be used to satisfy the minimum number of PM_{10} samplers needed for an adequate PM_{10} network.

2.8.2.2 If data produced by substitute PM samplers exceed the concentration levels described in appendix C of this part, then the need for this sampler to be converted to a PM_{10} or $PM_{2.5}$ sampler, shall be considered in the PM monitoring network review. If the State does not believe that a PM_{10} or $PM_{2.5}$ sampler should be sited, the State shall submit documentation to EPA as part of its annual PM report to justify this decision. If a PM site is not designated as a substitute site in the PM monitoring network description, then high concentrations at this site would not necessarily cause this site to become a $PM_{2.5}$ or PM_{10} site, whichever is indicated.

2.8.2.3 Consistent with §58.1, combinations of SLAMS PM_{10} or $PM_{2.5}$ monitors and other monitors may occupy the same structure without any mutual effect on the regulatory definition of the monitors.

3. *Network Design for National Air Monitoring Stations (NAMS)*

The NAMS must be stations selected from the SLAMS network with emphasis given to urban and multisource areas. Areas to be monitored must be selected based on urbanized population and pollutant concentration levels. Generally, a larger number of NAMS are needed in more polluted urban and multisource areas. The network design criteria discussed below reflect these concepts. However, it should be emphasized that deviations from the NAMS network design criteria may be necessary in a few cases. Thus, these design criteria are not a set of rigid rules but rather a guide for achieving a proper distribution of monitoring sites on a national scale.

The primary objective for NAMS is to monitor in the areas where the pollutant concentration and the population exposure are expected to be the highest consistent with the averaging time of the NAAQS. Accordingly, the NAMS fall into two categories:

Category (a): Stations located in area(s) of expected maximum concentrations, generally microscale for CO, microscale or middle scale for Pb, middle scale or neighborhood scale for population-oriented particulate matter, urban or regional scale for Regional transport $PM_{2.5}$, neighborhood scale for SO2, and NO2, and urban scale for O_3.

Category (b): Stations which combine poor air quality with a high population density but not necessarily located in an area of expected maximum concentrations (neighborhood scale, except urban scale for NO_2). Category (b) monitors would generally be representative of larger spatial scales than category (a) monitors.

For each urban area where NAMS are required, both categories of monitoring stations must be established. In the case of Pb and SO_2 if only one NAMS is needed, then category (a) must be used. The analysis and interpretation of data from NAMS should consider the distinction between these types of stations as appropriate.

For each MSA where NAMS are required, both categories of monitoring stations must be established. In the case of SO_2 if only one NAMS is needed, then category (a) must be used. The analysis and interpretation of data from NAMS should consider the distinction between these types of stations as appropriate.

The concept of NAMS is designed to provide data for national policy analyses/trends and for reporting to the public on major metropolitan areas. It is not the intent to monitor in every area where the NAAQS are violated. On the other hand, the data from SLAMS should be used primarily for nonattainment decisions/ analyses in specific geographical areas. Since the NAMS are stations from the SLAMS network, station locating procedures for NAMS are part of the SLAMS network design process.

3.1 [Reserved]

3.2 Sulfur Dioxide (SO_2) Design Criteria for NAMS. It is desirable to have a greater number of NAMS in the more polluted and densely populated urban and multisource areas. The data in table 3 show the approximate number of permanent stations needed in urban areas to characterize the national and regional SO_2 air quality trends and geographical patterns. These criteria require that the number of NAMS in areas where urban populations exceed 1,000,000 and concentrations also exceed the primary NAAQS may range from 6 to 10 and that in areas where the SO_2 problem is minor, only one or two (or no) monitors are required. For those cases where more than one station is required for an urban area, there should be at least one station for category (a) and category (b) objectives as discussed in section 3. Where three or more stations are required, the mix of category (a) and (b) stations is determined on a case-by-case basis. The actual number and location of the NAMS must be determined by EPA Regional Offices and the State Agency, subject to the approval of EPA Headquarters, Office of Air Quality Planning and Standards (OAQPS).

TABLE 3—SO_2 NATIONAL AIR MONITORING STATION CRITERIA

[Approximate number of stations per area] [a]

Population category	High concentration [b]	Medium concentration [c]	Low concentration [d]
>1,000,000	6–10	4–8	2–4
500,000 to 1,000,000	4–8	2–4	1–2
250,000 to 500,000	3–4	1–2	0–1
100,000 to 250,000	1–2	0–1	0

[a] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.
[b] High concentration—exceeding level of the primary NAAQS.
[c] Medium concentration—exceeding 60 percent of the level of the primary or 100% of the secondary NAAQS.
[d] Low concentration—less than 60 percent of the level of the primary or 100% of the secondary NAAQS.

The estimated number of SO_2 NAMS which would be required nationwide ranges from approximately 200 to 300. This number of NAMS SO_2 monitors is sufficient for national trend purposes due to the low background SO_2 levels, and the fact that air quality is very sensitive to SO_2 emission changes. The actual number of stations in any specific area depends on local factors such as meteorology, topography, urban and regional air quality gradients, and the potential for significant air quality improvements or degradation. The greatest density of stations should be where urban populations are large and where pollution levels are high. Fewer NAMS are necessary in the western States since concentrations are seldom above the NAAQS in their urban areas. Exceptions to this are in the areas where an expected shortage of clean fuels indicates that ambient air quality may be degraded by increased SO_2 emissions. In such cases, a minimum number of NAMS is required to provide EPA with a proper national perspective on significant changes in air quality.

Like TSP, the worst air quality in an urban area is to be used as the basis for determining the required number of SO_2 NAMS (see table 3). This includes SO_2 air quality levels within populated parts of urbanized areas, that are affected by one or two point sources of SO_2 if the impact of the source(s) extends over a reasonably broad geographic scale (neighborhood or larger). Maximum SO_2 air quality levels in remote unpopulated areas should be excluded as a basis for selecting NAMS regardless of the sources affecting the concentration levels. Such remote areas are more appropriately monitored by SLAMS or SPM networks and/or characterized by diffusion model calculations as necessary.

3.3 Carbon Monoxide (CO) Design Criteria for NAMS. Information is needed on ambient CO levels in major urbanized areas where CO levels have been shown or inferred to be a

significant concern. At the national level, EPA will not routinely require data from as many stations as are required for PM–10, and perhaps SO_2, since CO trend stations are principally needed to assess the overall air quality progress resulting from the emission controls required by the Federal motor vehicle control program (FMVCP) and other local controls.

Although State and local air programs may require extensive monitoring to document and measure the local impacts of CO emissions and emission controls, an adequate national perspective is possible with as few as two stations per major urban area. The two categories for which CO NAMS would be required are: (a) Peak concentration areas such as are found around major traffic arteries and near heavily traveled streets in downtown areas (micro scale); and (b) neighborhoods where concentration exposures are significant (middle scale, neighborhood scale).

The peak concentration station (micro scale) is usually found near heavily traveled downtown streets (street canyons), but could be found along major arterials (corridors), either near intersections or at low elevations which are influenced by downslope drainage patterns under low inversion conditions. The peak concentration station should be located so that it is representative of several similar source configurations in the urban area, where the general population has access. Thus, it should reflect one of many potential peak situations which occur throughout the urban area. It is recognized that this does not measure air quality which represents large geographical areas. Thus, a second type of station on the neighborhood scale is necessary to provide data representative of the high concentration levels which exist over large geographical areas.

The category (b) (middle scale or neighborhood scale) should be located in areas with a stable, high population density, projected continuity of neighborhood character, and high traffic density. The stations should be located where no major zoning changes, new highways, or new shopping centers are being considered. The station should be where a significant CO pollution problem exists, but not be unduly influenced by any one line source. Rather, it should be more representative of the overall effect of the sources in a significant portion of the urban area.

Because CO is generally associated with heavy traffic and population clusters, an urbanized area with a population greater than 500,000 is the principal criterion for identifying the urban areas for which pairs of NAMS for this pollutant will be required. The criterion is based on judgment that stations in urban areas with greater than 500,000 population would provide sufficient data for national analysis and national reporting to Congress and the public. Also, it has generally been shown that major CO problems are found in areas greater than 500,000 population.

3.4 Ozone (O_3) Design Criteria for NAMS. The criterion for selecting locations for ozone NAMS is any urbanized area having a population of more than 200,000. This population cut off is used since the sources of hydrocarbons are both mobile and stationary and are more diverse. Also, because of local and national control strategies and the complex chemical process of ozone formation and transport, more sampling stations than for CO are needed on a national scale to better understand the ozone problem. This selection criterion is based entirely on population and will include those relatively highly populated areas where most of the oxidant precursors originate.

Each urban area will generally require only two ozone NAMS, One station would be representative of maximum ozone concentrations (category (a), urban scale) under the wind transport conditions as discussed in section 2.5. The exact location should balance local factors affecting transport and buildup of peak O_3 levels with the need to represent population exposure. The second station (category (b), neighborhood scale), should be representative of high density population areas on the fringes of the central business district along the predominant summer/fall daytime wind direction. This latter station should measure peak O_3 levels under light and variable or stagnant wind conditions. Two ozone NAMS stations will be sufficient in most urban areas since spatial gradients for ozone generally are not as sharp as for other criteria pollutants.

3.5 Nitrogen Dioxide (NO_2) Criteria for NAMS. Nitrogen dioxide NAMS will be required in those areas of the country which have a population greater than 1,000,000. These areas will have two NO_2 NAMS. It is felt that stations in these major metropolitan areas would provide sufficient data for a national analysis of the data, and also because NO_2 problems occur in areas of greater than 1,000,000 population.

Within urban areas requiring NAMS, two permanent monitors are sufficient. The first station (category (a), middle scale or neighborhood scale) would be to measure the photochemical production of NO_2 and would best be located in that part of the urban area where the emission density of NO_X is the highest. The second station (category (b) urban scale), would be to measure the NO_2 produced from the reaction of NO with O_3 and should be downwind of the area of peak NO_X emission areas.

3.6 *Lead (Pb) Design Criteria for NAMS.* In order to achieve the national monitoring objective, one NAMS site must be located in one of the two cities with the greatest population in the following ten regions of the

country (the choice of which of the two metropolitan areas should have the lead NAMS requirement is made by the Administrator or the Administrator's designee using the recommendation of the Regional Administrators or the Regional Administrators' designee):

TABLE 1—EPA REGIONS & TWO CURRENT LARGEST MSA/CMSAS (USING 1995 CENSUS DATA)

Region (States)	Two Largest MSA/CMSAs
I (Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont).	Boston-Worcester-Lawrence CMSA, Hartford, CT MSA.
II (New Jersey, New York, Puerto Rico, U.S. Virgin Islands)	New York-Northern New Jersey-Long Island, CMSA, San Juan-Caguas-Arecibo, PR CMSA.
III (Delaware, Maryland, Pennsylvania, Virginia, West Virginia, Washington, DC).	Washington-Baltimore CMSA, Philadelphia-Wilmington-Atlantic City CMSA.
IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee).	Miami-Fort Lauderdale CMSA, Atlanta, GA MSA.
V (Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin)	Chicago-Gary-Kenosha CMSA, Detroit-Ann Arbor-Flint CMSA.
VI (Arkansas, Louisiana, New Mexico, Oklahoma, Texas)	Dallas-Fort Worth CMSA, Houston-Galveston-Brazoria CMSA.
VII (Iowa, Kansas, Missouri, Nebraska)	St. Louis MSA, Kansas City MSA.
VIII (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming).	Denver-Boulder-Greeley CMSA, Salt Lake City-Ogden MSA.
IX (American Samoa, Arizona, California, Guam, Hawaii, Nevada).	Los Angeles-Riverside-Orange County CMSA, San Francisco-Oakland-San Jose CMSA.
X (Alaska, Idaho, Oregon, Washington)	Seattle-Tacoma-Bremerton CMSA, Portland-Salem CMSA.

In addition, one NAMS site must be located in each of the MSA/CMSAs where one or more violations of the quarterly Pb NAAQS have been recorded over the previous eight quarters. If a violation of the quarterly Pb NAAQS is measured at a monitoring site outside of a MSA/CMSA, one NAMS site must be located within the county in a populated area, apart from the Pb source, to assess area wide Pb air pollution levels. These NAMS sites should represent the maximum Pb concentrations measured within the MSA/CMSA, city, or county that is not directly affected from a single Pb point source. Further, in order that on-road mobile source emissions may continue to be verified as not contributing to lead NAAQS violations, roadside ambient lead monitors should be considered as viable NAMS site candidates. A NAMS site may be a microscale or middle scale category (a) station, located adjacent to a major roadway (e.g., >30,000 ADT), or a neighborhood scale category (b) station that is located in a highly populated residential section of the MSA/CMSA or county where the traffic density is high. Data from these sites will be used to assess general conditions for large MSA/CMSAs and other populated areas as a marker for national trends, and to confirm continued attainment of the Pb NAAQS. In some cases, the MSA/CMSA subject to the latter lead NAMS requirement due to a violating point source will be the same MSA/CMSA subject to the lead NAMS requirement based upon its population. For these situations, the total minimum number of required lead NAMS is one.

3.7 *Particulate Matter Design Criteria for NAMS.*

3.7.1 Table 4 indicates the approximate number of permanent stations required in MSAs to characterize national and regional PM_{10} air quality trends and geographical patterns. The number of PM_{10} stations in areas where MSA populations exceed 1,000,000 must be in the range from 2 to 10 stations, while in low population urban areas, no more than two stations are required. A range of monitoring stations is specified in table 4 because sources of pollutants and local control efforts can vary from one part of the country to another and therefore, some flexibility is allowed in selecting the actual number of stations in any one locale.

3.7.2 Through promulgation of the NAAQS for $PM_{2.5}$, the number of PM_{10} SLAMS is expected to decrease, but requirements to maintain PM_{10} NAMS remain in effect. The PM_{10} NAMS are retained to provide trends data, to support national assessments and decisions, and in some cases to continue demonstration that a NAAQS for PM_{10} is maintained as a requirement under a State Implementation Plan.

3.7.3 The $PM_{2.5}$ NAMS shall be a subset of the core $PM_{2.5}$ SLAMS and other SLAMS intended to monitor for regional transport. The $PM_{2.5}$ NAMS are planned as long-term monitoring stations concentrated in metropolitan areas. A target range of 200 to 300 stations shall be designated nationwide. The largest metropolitan areas (those with a population greater than approximately one million) shall have at least one $PM_{2.5}$ NAMS stations.

3.7.4 The number of total $PM_{2.5}$ NAMS per Region will be based on recommendations of the EPA Regional Offices, in concert with their State and local agencies, in accordance with the network design goals described in sections 3.7.5 through 3.7.7 of this appendix. The selected stations should represent the

range of conditions occurring in the Regions and will consider factors such as total number or type of sources, ambient concentrations of particulate matter, and regional transport.

3.7.5 The approach for $PM_{2.5}$ NAMS is intended to give State and local agencies maximum flexibility while apportioning a limited national network. By advancing a range of monitors per Region, EPA intends to balance the national network with respect to geographic area and population. Table 5 presents the target number of $PM_{2.5}$ NAMS per Region to meet the national goal of 200 to 300 stations. These numbers consider a variety of factors such as Regional differences in metropolitan population, population density, land area, sources of particulate emissions, and the numbers of PM_{10} NAMS.

3.7.6 States will be required to establish approximately 50 NAMS sites for routine chemical speciation of $PM_{2.5}$. These sites will include those collocated at approximately 25 PAMS sites and approximately 25 other core SLAMS sites to be selected by the Administrator. After 5 years of data collection, the Administrator may exempt some sites from collecting speciated data. The number of NAMS sites at which speciation will be performed each year and the number of samples per year will be determined by the Administrator.

3.7.7 Since emissions associated with the operation of motor vehicles contribute to urban area particulate matter levels, consideration of the impact of these sources must be included in the design of the NAMS network, particularly in MSAs greater than 500,000 population. In certain urban areas particulate emissions from motor vehicle diesel exhaust currently is or is expected to be a significant source of particulate matter ambient levels. The actual number of NAMS and their locations must be determined by EPA Regional Offices and the State agencies, subject to the approval of the Administrator as required by §58.32. The Administrator's approval is necessary to ensure that individual stations conform to the NAMS selection criteria and that the network as a whole is sufficient in terms of number and location for purposes of national analyses.

TABLE 4—PM_{10} NATIONAL AIR MONITORING STATION CRITERIA

[Approximate Number of Stations per MSA] [1]

Population Category	High Concentration [2]	Medium Concentration [3]	Low Concentration [4]
>1,000,000	6-10	4-8	2-4
500,000-1,000,000	4-8	2-4	1-2
250,000-500,000	3-4	1-2	0-1

TABLE 4—PM_{10} NATIONAL AIR MONITORING STATION CRITERIA—Continued

[Approximate Number of Stations per MSA] [1]

Population Category	High Concentration [2]	Medium Concentration [3]	Low Concentration [4]
100,000-250,000	1-2	0-1	0

[1] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.

[2] High concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding either PM_{10} NAAQS by 20 percent or more.

[3] Medium concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding 80 percent of the PM_{10} NAAQS.

[4] Low concentration areas are those for which ambient PM_{10} data show ambient concentrations less than 80 percent of the PM_{10} NAAQS.

3.7.7.1 Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.

3.7.7.2 High concentration areas are those for which: Ambient PM_{10} data show ambient concentrations exceeding either PM_{10} NAAQS by 20 percent or more.

3.7.7.3 Medium concentration areas are those for which: Ambient PM_{10} data show ambient concentrations exceeding either 80 percent of the PM_{10} NAAQS.

3.7.7.4 Low concentration areas are those for which: Ambient PM_{10} data show ambient concentrations less than 80 percent of the PM_{10} NAAQS.

TABLE 5—GOALS FOR NUMBER OF $PM_{2.5}$ NAMS BY REGION

EPA Region	Number of NAMS [1]	Percent of National Total
1	15 to 20	6 to 8
2	20 to 30	8 to 12
3	20 to 25	8 to 10
4	35 to 50	14 to 20
5	35 to 50	14 to 20
6	25 to 35	10 to 14
7	10 to 15	4 to 6
8	10 to 15	4 to 6
9	25 to 40	10 to 16
10	10 to 15	4 to 6
Total	205–295	100

[1] Each region will have one to three NAMS having the monitoring of regional transport as a primary objective.

4. *Network Design for Photochemical Assessment Monitoring Stations (PAMS)*

In order to obtain more comprehensive and representative data on O_3 air pollution, the 1990 Clean Air Act Amendments require enhanced monitoring for ozone (O_3), oxides of nitrogen (NO, NO_2, and NO_X), and monitoring for VOC in O_3 nonattainment areas classified as serious, severe, or extreme. This will be accomplished through the establishment of a network of Photochemical Assessment Monitoring Stations (PAMS).

4.1 PAMS Data Uses. Data from the PAMS are intended to satisfy several coincident needs related to attainment of the National Ambient Air Quality Standards (NAAQS), SIP control strategy development and evaluation, corroboration of emissions tracking, preparation of trends appraisals, and exposure assessment.

(a) *NAAQS attainment and control strategy development.* Like SLAMS and NAMS data, PAMS data will be used for monitoring O_3 exceedances and providing input for attainment/nonattainment decisions. In addition, PAMS data will help resolve the roles of transported and locally emitted O_3 precursors in producing an observed exceedance and may be utilized to identify specific sources emitting excessive concentrations of O_3 precursors and potentially contributing to observed exceedances of the O_3 NAAQS. The PAMS data will enhance the characterization of O_3 concentrations and provide critical information on the precursors which cause O_3, therefore extending the database available for future attainment demonstrations. These demonstrations will be based on photochemical grid modeling and other approved analytical methods and will provide a basis for prospective mid-course control strategy corrections. PAMS data will provide information concerning (1) which areas and episodes to model to develop appropriate control strategies; (2) boundary conditions required by the models to produce quantifiable estimates of needed emissions reductions; and (3) the evaluation of the predictive capability of the models used.

(b) *SIP control strategy evaluation.* The PAMS will provide data for SIP control strategy evaluation. Long-term PAMS data will be used to evaluate the effectiveness of these control strategies. Data may be used to evaluate the impact of VOC and NO_X emission reductions on air quality levels for O_3 if data is reviewed following the time period during which control measures were implemented. Speciation of measured VOC data will allow determination of which organic species are most affected by the emissions reductions and assist in developing cost-effective, selective VOC reductions and control strategies. A State or local air pollution control agency can therefore ensure that strategies which are implemented in their particular nonattainment area are those which are best suited for that area and achieve the most effective emissions reductions (and therefore largest impact) at the least cost.

(c) *Emissions tracking.* PAMS data will be used to corroborate the quality of VOC and NO_X emission inventories. Although a perfect mathematical relationship between emission inventories and ambient measurements does not yet exist, a qualitative assessment of the relative contributions of various compounds to the ambient air can be roughly compared to current emission inventory estimates to evaluate the accuracy of the emission inventories. In addition, PAMS data which are gathered year round will allow tracking of VOC and NO_X emission reductions, provide additional information necessary to support Reasonable Further Progress (RFP) calculations, and corroborate emissions trends analyses. While the regulatory assessments of progress will be made in terms of emission inventory estimates, the ambient data can provide independent trends analyses and corroboration of these assessments which either verify or highlight possible errors in emissions trends indicated by inventories. The ambient assessments, using speciated data, can gauge the accuracy of estimated changes in emissions. The speciated data can also be used to assess the quality of the VOC speciated and NO_X emission inventories for input during photochemical grid modeling exercises and identify potential urban air toxic pollutant problems which deserve closer scrutiny.

The speciated VOC data will be used to determine changes in the species profile, resulting from the emission control program, particularly those resulting from the reformulation of fuels.

(d) *Trends.* Long-term PAMS data will be used to establish speciated VOC, NO_X, and limited toxic air pollutant trends, and supplement the O_3 trends database. Multiple statistical indicators will be tracked, including O_3 and its precursors during the events encompassing the days during each year with the highest O_3 concentrations, the seasonal means for these pollutants, and the annual means at representative locations.

The more PAMS that are established in and near nonattainment areas, the more effective the trends data will become. As the spatial distribution and number of O_3 and O_3 precursor monitors improves, trends analyses will be less influenced by instrument or site location anomalies. The requirement that surface meteorological monitoring be established at each PAMS will help maximize the utility of these trends analyses by comparisons with meteorological trends, and transport influences. The meteorological data can also help interpret the ambient air pollution trends by taking meteorological factors into account.

(e) *Exposure assessment.* PAMS data will be used to better characterize O_3 and toxic air pollutant exposure to populations living in serious, severe, or extreme areas. Annual mean toxic air pollutant concentrations will be calculated to help estimate the average risk to the population associated with individual VOC species, which are considered toxic, in urban environments.

4.2 PAMS Monitoring Objectives. Unlike the SLAMS and NAMS design criteria which are pollutant specific, PAMS design criteria are site specific. Concurrent measurements of O_3, NO_X, speciated VOC, and meteorology

are obtained at PAMS. Design criteria for the PAMS network are based on selection of an array of site locations relative to O_3 precursor source areas and predominant wind directions associated with high O_3 events. Specific monitoring objectives are associated with each location. The overall design should enable characterization of precursor emission sources within the area, transport of O_3 and its precursors into and out of the area, and the photochemical processes related to O_3 nonattainment, as well as developing an initial, though limited, urban air toxic pollutant database. Specific objectives that must be addressed include assessing ambient trends in O_3, NO, NO_2, NO_X, VOC (including carbonyls), and VOC species, determining spatial and diurnal variability of O_3, NO, NO_2, NO_X, and VOC species and assessing changes in the VOC species profiles that occur over time, particularly those occurring due to the reformulation of fuels. A maximum of five PAMS sites are required in an affected nonattainment area depending on the population of the Metropolitan Statistical Area/Consolidated Metropolitan Statistical Area (MSA/CMSA) or nonattainment area, whichever is larger. Specific monitoring objectives associated with each of these sites result in four distinct site types. Note that detailed guidance for the locating of these sites may be found in reference 19.

Type (1) sites are established to characterize upwind background and transported O_3 and its precursor concentrations entering the area and will identify those areas which are subjected to overwhelming transport. Type (1) sites are located in the predominant morning upwind direction from the local area of maximum precursor emissions during the O_3 season and at a distance sufficient to obtain urban scale measurements as defined in section 1 of this appendix. Typically, type (1) sites will be located near the edge of the photochemical grid model domain in the predominant morning upwind direction from the city limits or fringe of the urbanized area. Depending on the boundaries and size of the nonattainment area and the orientation of the grid, this site may be located outside of the nonattainment area. The appropriate predominant morning wind direction should be determined from historical wind data occurring during the period 7 a.m. to 10 a.m. on high O_3 days or on those days which exhibit the potential for producing high O_3 levels, i.e., O_3-conducive days as described in reference 25. Alternate schemes for specifying this morning wind direction may be submitted as a part of the network description required by §§58.40 and 58.41. Data measured at type (1) sites will be used principally for the following purposes:

- Future development and evaluation of control strategies,
- Identification of incoming pollutants,
- Corroboration of NO_X and VOC emission inventories,
- Establishment of boundary conditions for future photochemical grid modeling and mid-course control strategy changes, and
- Development of incoming pollutant trends.

Type (2) sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants. Type (2) sites are located immediately downwind of the area of maximum precursor emissions and are typically placed near the downwind boundary of the central business district to obtain neighborhood scale measurements. The appropriate downwind direction should be obtained similarly to that for type (1) sites. Additionally, a second type (2) site may be required depending on the size of the area, and should be placed in the second-most predominant morning wind direction as noted previously. Data measured at type (2) sites will be used principally for the following purposes:

- Development and evaluation of imminent and future control strategies,
- Corroboration of NO_X and VOC emission inventories,
- Augmentation of RFP tracking,
- Verification of photochemical grid model performance,
- Characterization of O_3 and toxic air pollutant exposures (appropriate site for measuring toxic emissions impact),
- Development of pollutant trends, particularly toxic air pollutants and annual ambient speciated VOC trends to compare with trends in annual VOC emission estimates, and
- Determination of attainment with the NAAQS for NO_2 and O_3.

Type (3) sites are intended to monitor maximum O_3 concentrations occurring downwind from the area of maximum precursor emissions. Locations for type (3) sites should be chosen so that urban scale measurements are obtained. Typically, type (3) sites will be located 10 to 30 miles downwind from the fringe of the urban area. The downwind direction should also be determined from historical wind data, but should be identified as those afternoon winds occurring during the period 1 p.m. to 4 p.m. on high O_3 days or on those days which exhibit the potential for producing high O_3 levels. Alternate schemes for specifying this afternoon wind direction may also be submitted as a part of the network description required by §§58.40 and 58.41. Data measured at type (3) sites will be used principally for the following purposes:

- Determination of attainment with the NAAQS for O_3 (this site may coincide with an existing maximum concentration O_3 monitoring site),

• Evaluation of future photochemical grid modeling applications,

• Future development and evaluation of control strategies,

• Development of pollutant trends, and

• Characterization of O_3 pollutant exposures.

Type (4) sites are established to characterize the extreme downwind transported O_3 and its precursor concentrations exiting the area and will identify those areas which are potentially contributing to overwhelming transport in other areas. Type (4) sites are located in the predominant afternoon downwind direction, as determined for the type (3) site, from the local area of maximum precursor emissions during the O_3 season and at a distance sufficient to obtain urban scale measurements as defined elsewhere in this appendix. Typically, type (4) sites will be located near the downwind edge of the photochemical grid model domain. Alternate schemes for specifying the location of this site may be submitted as a part of the network description required by §§58.40 and 58.41. Data measured at type (4) sites will be used principally for the following purposes:

• Development and evaluation of O_3 control strategies,

• Identification of emissions and photochemical products leaving the area,

• Establishment of boundary conditions for photochemical grid modeling,

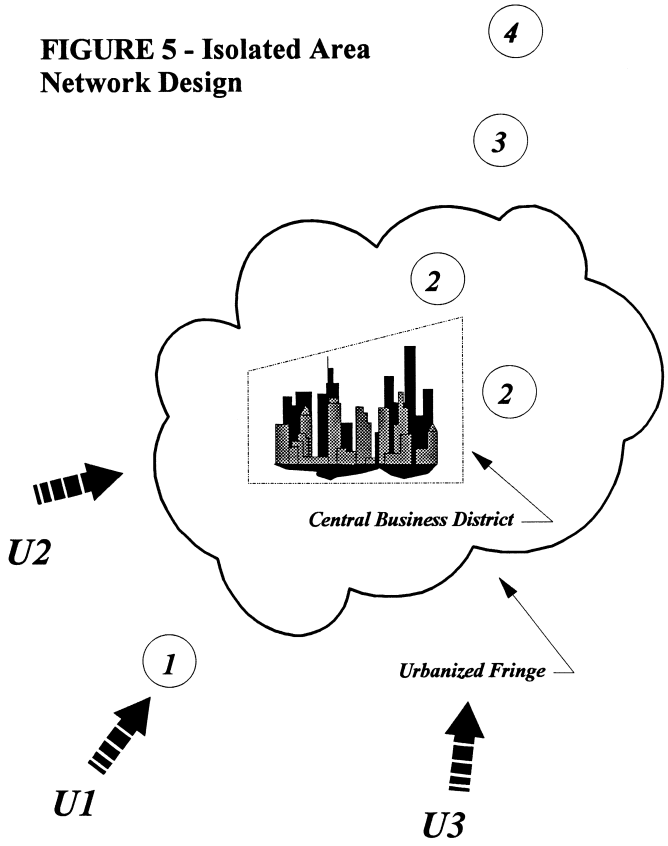
• Development of pollutant trends,

• Background and upwind information for other downwind areas, and

• Evaluation of photochemical grid model performance.

States choosing to submit an individual network description for each affected nonattainment area, irrespective of its proximity to other affected areas, must fulfill the requirements for isolated areas as described in section 4 of this appendix, as an example, and illustrated by Figure 5. States containing areas which experience significant impact from long-range transport or are proximate to other nonattainment areas (even in other States) should collectively submit a network description which contains alternative sites to those that would be required for an isolated area. Such a submittal should, as a guide, be based on the example provided in Figure 6, but must include a demonstration that the design satisfies the monitoring data uses and fulfills the PAMS monitoring objectives described in sections 4.1 and 4.2 of this appendix.

FIGURE 5 - Isolated Area Network Design



LEGEND:

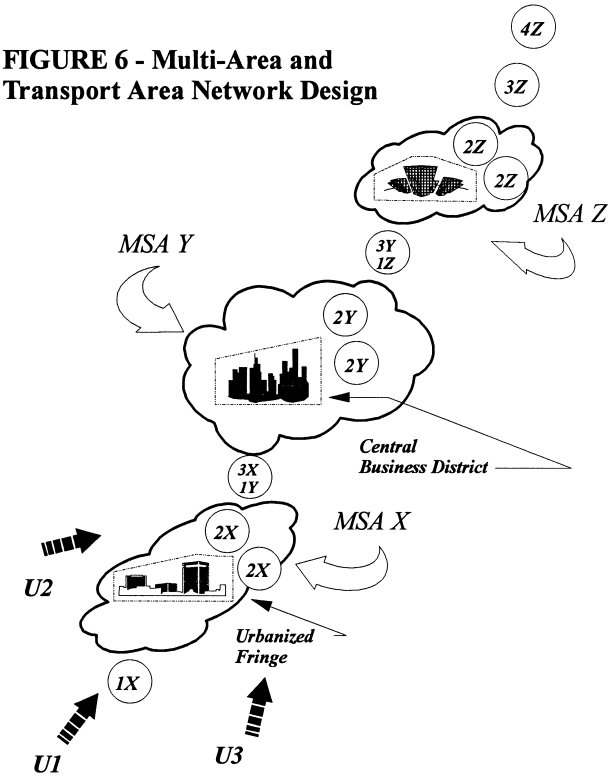
(1) - A circle denotes a PAMS Site. The number inside describes the Site number.

U1 - High ozone day predominant morning wind direction

U2 - Second most predominant high ozone day morning wind direction

U3 - High ozone day predominant afternoon wind direction

FIGURE 6 - Multi-Area and Transport Area Network Design



LEGEND:

(1X) - A circle denotes a PAMS Site. The number inside describes the Site number and the letter indicates the associated MSA/CMSA, e.g., a circle with 1X indicates a Site #1 for MSA X. Since PAMS can serve multiple purposes for more than one MSA/CMSA, Sites with mutiple associations are identified with multiple number and letter identifiers.

U1 - High ozone day predominant morning wind direction

U2 - Second most predominant high ozone day morning wind direction

U3 - High ozone day predominant afternoon wind direction

Alternative PAMS network designs should, on a site-by-site basis, provide those data necessary to enhance the attainment/non-attainment database for criteria pollutants and explain the origins of overwhelming O_3 transport. The alternative PAMS data should be usable for the corroboration and verification of O_3 precursor emissions inventories and should comprise a qualitative (if not quantitative) measure of the accuracy of RFP calculations. The data should be sufficient to evaluate the effectiveness of the implemented O_3 control strategies and should provide data necessary to establish photochemical grid modeling boundary conditions and necessary inputs including appropriate meteorological parameters, and provide measurements which can serve as model evaluation tools. Further, utilizing its PAMS database (alternative or not), a State should be able to draw conclusions regarding population exposure and conduct trends analyses for both criteria and non-criteria pollutants. Overall, the PAMS network should serve as one of several complementary means, together with modeling and analysis of other data bases (e.g., inventories) and availability of control technology, etc., for States to justify the modification of existing control programs, design

new programs, and evaluate future courses of actions for O_3 control.

4.3 Monitoring Period. PAMS precursor monitoring will be conducted annually throughout the months of June, July and August (as a minimum) when peak O_3 values are expected in each area; however, precursor monitoring during the entire O_3 season for the area is preferred. Alternate precursor monitoring periods may be submitted for approval as a part of the PAMS network description required by §58.40. Changes to the PAMS monitoring period must be identified during the annual SLAMS Network Review specified in §58.20. PAMS O_3 monitors must adhere to the O_3 monitoring season specified in section 2.5 of appendix D. To ensure a degree of national consistency, monitoring for the 1993 season should commence as follows:

One in 3-day sampling—June 3, 1993.

One in 6-day sampling—June 6, 1993.

These monitoring dates will thereby be coincident with the previously-established, intermittent schedule for particulate matter. States initiating sampling earlier (or later) than June 3, 1993 should adjust their schedules to coincide with this national schedule.

4.4 Minimum Monitoring Network Requirements. The minimum required number and type of monitoring sites and sampling requirements are based on the population of the affected MSA/CMSA or nonattainment area (whichever is larger). The MSA/CMSA basis for monitoring network requirements was chosen because it typically is the most representative of the area which encompasses the emissions sources contributing to nonattainment. The MSA/CMSA emissions density can also be effectively and conveniently portrayed by the surrogate of population. Additionally, a network which is adequate to characterize the ambient air of an MSA/CMSA often must extend beyond the boundaries of such an area (especially for O_3 and its precursors); therefore, the use of smaller geographical units (such as counties or nonattainment areas which are smaller than the MSA/CMSA) for monitoring network design purposes is inappropriate. Various sampling requirements are imposed according to the size of the area to accommodate the impact of transport on the smaller MSAs/CMSAs, to account for the spatial variations inherent in large areas, to satisfy the differing data needs of large versus small areas due to the intractability of the O_3 nonattainment problem, and to recognize the potential economic impact of implementation on State and local government. Population figures must reflect the most recent decennial U.S. census population report. Specific guidance on determining network requirements is provided in reference 19. Minimum network requirements are outlined in table 2.

TABLE 2—PAMS MINIMUM MONITORING NETWORK REQUIREMENTS [1]

Population of MSA/CMSA or nonattainment area [2]	Required site type [3]	Minimum speciated VOC sampling frequency [4]	Minimum carbonyl sampling frequency [4]
Less than 500,000	(1)	A or C	
	(2)	A or C	D or F [5]
500,000 to 1,000,000	(1)	A or C	
	(2)	B	E
	(3)	A or C	
1,000,000 to 2,000,000 ..	(1)	A or C	
	(2)	B	E
	(2)	B	E
	(3)	A or C	
More than 2,000,000	(1)	A or C	
	(2)	B	E
	(2)	B	E
	(3)	A or C	
	(4)	A or C	

[1] O_3 and NO_X (including NO and NO_2) monitoring should be continuous measurements.

[2] Whichever area is larger.

[3] See Figure 5.

[4] Frequency Requirements are as follows: A—Eight 3-hour samples every third day and one additional 24-hour sample every sixth day during the monitoring period; B—Eight 3-hour samples, every day during the monitoring period and one additional 24-hour sample every sixth day year-round; C—Eight 3-hour samples on the 5 peak O_3 days plus each previous day, eight 3-hour samples every sixth day, and one additional 24-hour sample every sixth day, during the monitoring period; D—Eight 3-hour samples every third day during the monitoring period; E—Eight 3-hour samples every day during the monitoring period; F—Eight 3-hour samples on the 5 peak O_3 days plus each previous day and eight 3-hour samples every sixth day during the monitoring period. (NOTE: multiple samples taken on a daily basis must begin at midnight and consist of sequential, non-overlapping sampling periods.)

[5] Carbonyl sampling frequency must match the chosen speciated VOC frequency.

Note that the use of Frequencies C or F requires the submittal of an ozone event forecasting scheme.

For purposes of network implementation and transition, EPA recommends the following priority order for the establishment of sites:

- The type (2) site which provides the most comprehensive data concerning O_3 precursor emissions and toxic air pollutants,
- The type (3) site which provides a maximum O_3 measurement and total conversion of O_3 precursors,
- The type (1) site which delineates the effect of incoming precursor emissions and concentrations of O_3 and provides upwind boundary conditions,
- The type (4) site which provides extreme downwind boundary conditions, and
- The second type (2) site which provides comprehensive data concerning O_3 precursor emissions and toxic air pollutants in the second-most predominant morning wind direction on high O_3 days.

Note also that O_3 event (peak day) monitoring will require the development of a scheme for forecasting such high O_3 days or will necessitate the stipulation of what meteorological conditions constitute a potential high O_3 day; monitoring could then be

triggered only via meteorological projections. The O_3 event forecasting and monitoring scheme should be submitted as a part of the network description required by §§58.40 and 58.41 and should be reviewed during each annual SLAMS Network Review specified in §58.20.

4.5 Transition Period. A variable period of time is proposed for phasing in the operation of all required PAMS. Within 1 year after (1) February 12, 1993, (2) or date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme, or (3) the designation of a new area and classification to serious, severe, or extreme O_3 nonattainment, a minimum of one type (2) site must be operating. Operation of the remaining sites must, at a minimum, be phased in at the rate of one site per year during subsequent years as outlined in the approved PAMS network description provided by the State.

4.6 Meteorological Monitoring. In order to support monitoring objectives associated with the need for various air quality analyses, model inputs and performance evaluations, meteorological monitoring including wind measurements at 10 meters above ground is required at each PAMS site. Monitoring should begin with site establishment. In addition, upper air meteorological monitoring is required for each PAMS area. Upper air monitoring should be initiated as soon as possible, but no later than 2 years after (1) February 12, 1993, (2) or date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme, or (3) the designation of a new area and classification to serious, severe, or extreme O_3 nonattainment. The upper air monitoring site may be located separately from the type (1) through (4) sites, but the location should be representative of the upper air data in the nonattainment area. Upper air meteorological data must be collected during those days specified for monitoring by the sampling frequencies in table 2. of section 4.4 of this appendix D in accordance with current EPA guidance.

5. *Summary.*

Table 6 of this appendix shows by pollutant, all of the spatial scales that are applicable for SLAMS and the required spatial scales for NAMS. There may also be some situations, as discussed later in appendix E of this part, where additional scales may be allowed for NAMS purposes.

TABLE 6—SUMMARY OF SPATIAL SCALES FOR SLAMS AND REQUIRED SCALES FOR NAMS

Spatial Scale	Scales Applicable for SLAMS						
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$
Micro		✔			✔	✔	✔
Middle	✔	✔	✔	✔	✔	✔	✔
Neighborhood	✔	✔	✔	✔	✔	✔	✔
Urban	✔		✔	✔	✔	✔	✔
Regional	✔		✔		✔	✔	✔
	Scales Required for NAMS						
Micro		✔			✔	✔	✔[1]
Middle					✔	✔	✔[1]
Neighborhood	✔	✔	✔	✔	✔	✔	✔
Urban			✔	✔			✔[2]
Regional							✔[2]

[1] Only permitted if representative of many such micro-scale environments in a residential district (for middle scale, at least two).
[2] Either urban or regional scale for regional transport sites.

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[44 FR 27571, May 10, 1979]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix D to part 58, see the List of CFR Sections Affected, which appears in the Finding Aids section of the printed volume and on GPO Access.

EFFECTIVE DATE NOTE: At 60 FR 52323, October 6, 1995, appendix D to part 58 was amended in part by adding Section 2.2. This section contains information collection and recordkeeping requirements and will not become effective until approval has been given by the Office of Management and Budget.

APPENDIX E TO PART 58—PROBE AND MONITORING PATH SITING CRITERIA FOR AMBIENT AIR QUALITY MONITORING

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1. *Introduction*

This appendix contains specific location criteria applicable to ambient air quality monitoring probes and monitoring paths after the general station siting has been selected based on the monitoring objectives and spatial scale of representation discussed in appendix D of this part. Adherence to these siting criteria is necessary to ensure the uniform collection of compatible and comparable air quality data.

The probe and monitoring path siting criteria discussed below must be followed to the maximum extent possible. It is recognized that there may be situations where some deviation from the siting criteria may be necessary. In any such case, the reasons must be thoroughly documented in a written request for a waiver that describes how and why the proposed siting deviates from the criteria. This documentation should help to avoid later questions about the validity of the resulting monitoring data. Conditions under which the EPA would consider an application for waiver from these siting criteria are discussed in section 11 of this appendix.

The spatial scales of representation used in this appendix, i.e., micro, middle, neighborhood, urban, and regional, are defined and discussed in appendix D of this part. The pollutant-specific probe and monitoring path siting criteria generally apply to all spatial scales except where noted otherwise. Specific siting criteria that are phrased with a ''must'' are defined as requirements and exceptions must be approved through the waiver provisions. However, siting criteria that are phrased with a ''should'' are defined as goals to meet for consistency but are not requirements.

2. *Sulfur Dioxide (SO_2), Ozone (O_3), and Nitrogen Dioxide (NO_2)*

Open path analyzers may be used to measure SO_2, O_3, and NO_2 at SLAMS/NAMS sites for middle, neighborhood, urban, and regional scale measurement applications. Additional information on SO_2, NO_2, and O_3 monitor siting criteria may be found in references 11 and 13.

2.1 Horizontal and Vertical Placement. The probe or at least 80 percent of the monitoring path must be located between 3 and 15 meters above ground level. The probe or at least 90 percent of the monitoring path must be at least 1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, etc., and away from dusty or dirty areas. If the probe or a significant portion of the monitoring path is located near the side of a building, then it should be located on the windward side of the building relative to the prevailing wind direction during the season of highest concentration potential for the pollutant being measured.

2.2 Spacing from Minor Sources (Applicable to SO_2 and O_3 Monitoring Only). Local minor sources of SO_2 can cause inappropriately high concentrations of SO_2 in the vicinity of probes and monitoring paths for SO_2. Similarly, local sources of nitric oxide (NO) and ozone-reactive hydrocarbons can have a scavenging effect causing unrepresentatively low concentrations of O_3 in the vicinity of probes and monitoring paths for O_3. To minimize these potential interferences, the probe or at least 90 percent of the monitoring path must be away from furnace or incineration flues or other minor sources of SO_2 or NO, particularly for open path analyzers because of their potential for greater exposure over the area covered by the monitoring path. The separation distance should take into account the heights of the flues, type of waste or fuel burned, and the sulfur content of the fuel. It is acceptable, however, to monitor for SO_2 near a point source of SO_2 when the objective is to assess the effect of this source on the represented population.

2.3 Spacing From Obstructions. Buildings and other obstacles may possibly scavenge SO_2, O_3, or NO_2. To avoid this interference, the probe or at least 90 percent of the monitoring path must have unrestricted airflow and be located away from obstacles so that the distance from the probe or monitoring path is at least twice the height that the obstacle protrudes above the probe or monitoring path. Generally, a probe or monitoring path located near or along a vertical wall is undesirable because air moving along the wall may be subject to possible removal mechanisms. A probe must have unrestricted airflow in an arc of at least 270 degrees around the inlet probe, or 180 degrees if the probe is on the side of a building. This arc must include the predominant wind direction for the season of greatest pollutant concentration potential. A sampling station having a probe located closer to an obstacle than this criterion allows should be classified as middle scale rather than neighborhood or urban scale, since the measurements from such a station would more closely represent the middle scale. A monitoring path must be clear of all trees, brush, buildings, plumes, dust, or other optical obstructions,

including potential obstructions that may move due to wind, human activity, growth of vegetation, etc. Temporary optical obstructions, such as rain, particles, fog, or snow, should be considered when siting an open path analyzer. Any of these temporary obstructions that are of sufficient density to obscure the light beam will affect the ability of the open path analyzer to continuously measure pollutant concentrations.

Special consideration must be devoted to the use of open path analyzers due to their inherent potential sensitivity to certain types of interferences, or optical obstructions. While some of these potential interferences are comparable to those to which point monitors are subject, there are additional sources of potential interferences which are altogether different in character. Transient, but significant obscuration of especially longer measurement paths could be expected to occur as a result of certain prevailing meteorological conditions (e.g., heavy fog, rain, snow) and/or aerosol levels that are of a sufficient density to prevent the open path analyzer's light transmission. If certain compensating measures are not otherwise implemented at the onset of monitoring (e.g., shorter path lengths, higher light source intensity), data recovery during periods of greatest primary pollutant potential could be compromised. For instance, if heavy fog or high particulate levels are coincident with periods of projected NAAQS-threatening pollutant potential, the representativeness of the resulting data record in reflecting maximum pollutant concentrations may be substantially impaired despite the fact that the site may otherwise exhibit an acceptable, even exceedingly high overall valid data capture rate.

In seeking EPA approval for inclusion of a site using an open path analyzer into the formal SLAMS/NAMS or PSD network, monitoring agencies must submit an analysis which evaluates both obscuration potential for a proposed path length for the subject area and the effect this potential is projected to have on the representativeness of the data record. This analysis should include one or more of the following elements, as appropriate for the specific circumstance: climatological information, historical pollutant and aerosol information, modeling analysis results, and any related special study results.

2.4 Spacing From Trees. Trees can provide surfaces for SO_2, O_3, or NO_2 adsorption or reactions and obstruct wind flow. To reduce this possible interference, the probe or at least 90 percent of the monitoring path should be 20 meters or more from the drip line of trees. If a tree or trees could be considered an obstacle, the probe or 90 percent of the monitoring path must meet the distance requirements of section 2.3 and be at least 10 meters from the drip line of the tree or trees. Since the scavenging effect of trees is greater for O_3 than for other criteria pollutants, strong consideration of this effect must be given to locating an O_3 probe or monitoring path to avoid this problem.

2.5 Spacing From Roadways (Applicable to O_3 and NO_2 Only). In siting an O_3 analyzer, it is important to minimize destructive interferences from sources of NO, since NO readily reacts with O_3. In siting NO_2 analyzers for neighborhood and urban scale monitoring, it is important to minimize interferences from automotive sources. Table 1 provides the required minimum separation distances between a roadway and a probe and between a roadway and at least 90 percent of a monitoring path for various ranges of daily roadway traffic. A sampling station having a point analyzer probe located closer to a roadway than allowed by the table 1 requirements should be classified as middle scale rather than neighborhood or urban scale, since the measurements from such a station would more closely represent the middle scale. If an open path analyzer is used at a site, the monitoring path(s) must not cross over a roadway with an average daily traffic count of 10,000 vehicles per day or more. For those situations where a monitoring path crosses a roadway with fewer than 10,000 vehicles per day, one must consider the entire segment of the monitoring path in the area of potential atmospheric interference from automobile emissions. Therefore, this calculation must include the length of the monitoring path over the roadway plus any segments of the monitoring path that lie in the area between the roadway and the minimum separation distance, as determined from table 1. The sum of these distances must not be greater than 10 percent of the total monitoring path length.

TABLE 1—MINIMUM SEPARATION DISTANCE BETWEEN ROADWAYS AND PROBES OR MONITORING PATHS FOR MONITORING NEIGHBORHOOD—AND URBAN—SCALE OZONE AND NITROGEN DIOXIDE

Roadway average daily traffic, vehicles per day	Minimum separation distance,[1] meters
≤10,000	10
15,000	20
20,000	30
40,000	50
70,000	100
≥110,000	250

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

2.6 Cumulative Interferences on a Monitoring Path. The cumulative length or portion of a monitoring path that is affected by minor sources, obstructions, trees, or roadways must not exceed 10 percent of the total monitoring path length.

2.7 Maximum Monitoring Path Length. The monitoring path length must not exceed 1 kilometer for analyzers in neighborhood, urban, or regional scale. For middle scale monitoring sites, the monitoring path length must not exceed 300 meters. In areas subject to frequent periods of dust, fog, rain, or snow, consideration should be given to a shortened monitoring path length to minimize loss of monitoring data due to these temporary optical obstructions. For certain ambient air monitoring scenarios using open path analyzers, shorter path lengths may be needed in order to ensure that the monitoring station meets the objectives and spatial scales defined for SLAMS in appendix D. Therefore, the Regional Administrator or the Regional Administrator's designee may require shorter path lengths, as needed on an individual basis, to ensure that the SLAMS meet the appendix D requirements. Likewise, the Administrator or the Administrator's designee may specify the maximum path length used at monitoring stations designated as NAMS or PAMS as needed on an individual basis.

3. [Reserved]

4. *Carbon Monoxide (CO)*

Open path analyzers may be used to measure CO at SLAMS/NAMS sites for middle or neighborhood scale measurement applications. Additional information on CO monitor siting criteria may be found in reference 12.

4.1 Horizontal and Vertical Placement. Because of the importance of measuring population exposure to CO concentrations, air should be sampled at average breathing heights. However, practical factors require that the inlet probe be higher. The required height of the inlet probe for CO monitoring is therefore 3±½ meters for a microscale site, which is a compromise between representative breathing height and prevention of vandalism. The recommended 1 meter range of heights is also a compromise to some extent. For consistency and comparability, it would be desirable to have all inlets at exactly the same height, but practical considerations often prevent this. Some reasonable range must be specified and 1 meter provides adequate leeway to meet most requirements.

For the middle and neighborhood scale stations, the vertical concentration gradients are not as great as for the microscale station. This is because the diffusion from roads is greater and the concentrations would represent larger areas than for the microscale. Therefore, the probe or at least 80 percent of the monitoring path must be located between 3 and 15 meters above ground level for middle and neighborhood scale stations. The probe or at least 90 percent of the monitoring path must be at least 1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, etc., and away from dusty or dirty areas. If the probe or a significant portion of the monitoring path is located near the side of a building, then it should be located on the windward side of the building relative to both the prevailing wind direction during the season of highest concentration potential and the location of sources of interest, i.e., roadways.

4.2 Spacing From Obstructions. Buildings and other obstacles may restrict airflow around a probe or monitoring path. To avoid this interference, the probe or at least 90 percent of the monitoring path must have unrestricted airflow and be located away from obstacles so that the distance from the probe or monitoring path is at least twice the height that the obstacle protrudes above the probe or monitoring path. A probe or monitoring path located near or along a vertical wall is undesirable because air moving along the wall may be subject to possible removal mechanisms. A probe must have unrestricted airflow in an arc of at least 270 degrees around the inlet probe, or 180 degrees if the probe is on the side of a building. This arc must include the predominant wind direction for the season of greatest pollutant concentration potential. A monitoring path must be clear of all trees, brush, buildings, plumes, dust, or other optical obstructions, including potential obstructions that may move due to wind, human activity, growth of vegetation, etc. Temporary optical obstructions, such as rain, particles, fog, or snow, should be considered when siting an open path analyzer. Any of these temporary obstructions that are of sufficient density to obscure the light beam will affect the ability of the open path analyzer to continuously measure pollutant concentrations.

Special consideration must be devoted to the use of open path analyzers due to their inherent potential sensitivity to certain types of interferences, or optical obstructions. While some of these potential interferences are comparable to those to which point monitors are subject, there are additional sources of potential interferences which are altogether different in character. Transient, but significant obscuration of especially longer measurement paths could be expected to occur as a result of certain prevailing meteorological conditions (e.g., heavy fog, rain, snow) and/or aerosol levels that are of a sufficient density to prevent the open path analyzer's light transmission. If certain compensating measures are not otherwise implemented at the onset of monitoring (e.g., shorter path lengths, higher light source intensity), data recovery during periods of greatest primary pollutant potential could be compromised. For instance, if heavy fog or high particulate levels are coincident with periods of projected NAAQS-threatening pollutant potential, the representativeness of the resulting data record in reflecting maximum pollutant concentrations may be substantially impaired despite

the fact that the site may otherwise exhibit an acceptable, even exceedingly high overall valid data capture rate.

In seeking EPA approval for inclusion of a site using an open path analyzer into the formal SLAMS/NAMS or PSD network, monitoring agencies must submit an analysis which evaluates both obscuration potential for a proposed path length for the subject area and the effect this potential is projected to have on the representativeness of the data record. This analysis should include one or more of the following elements, as appropriate for the specific circumstance: climatological information, historical pollutant and aerosol information, modeling analysis results, and any related special study results.

4.3 Spacing From Roadways. Street canyon and traffic corridor stations (microscale) are intended to provide a measurement of the influence of the immediate source on the pollution exposure of the population. In order to provide some reasonable consistency and comparability in the air quality data from microscale stations, a minimum distance of 2 meters and a maximum distance of 10 meters from the edge of the nearest traffic lane must be maintained for these CO monitoring inlet probes. This should give consistency to the data, yet still allow flexibility of finding suitable locations.

Street canyon/corridor (microscale) inlet probes must be located at least 10 meters from an intersection and preferably at a midblock location. Midblock locations are preferable to intersection locations because intersections represent a much smaller portion of downtown space than do the streets between them. Pedestrian exposure is probably also greater in street canyon/corridors than at intersections. Also, the practical difficulty of positioning sampling inlets is less at midblock locations than at the intersection. However, the final siting of the monitor must meet the objectives and intent of appendix D, sections 2.4, 3, 3.3, and appendix E, section 4.

In determining the minimum separation between a neighborhood scale monitoring station and a specific line source, the presumption is made that measurements should not be substantially influenced by any one roadway. Computations were made to determine the separation distance, and table 2 provides the required minimum separation distance between roadways and a probe or 90 percent of a monitoring path. Probes or monitoring paths that are located closer to roads than this criterion allows should not be classified as a neighborhood scale, since the measurements from such a station would closely represent the middle scale. Therefore, stations not meeting this criterion should be classified as middle scale.

TABLE 2—MINIMUM SEPARATION DISTANCE BETWEEN ROADWAYS AND PROBES OR MONITORING PATHS FOR MONITORING NEIGHBORHOOD SCALE CARBON MONOXIDE

Roadway average daily traffic, vehicles per day	Minimum separation distance [1] for probes or 90% of a monitoring path (meters)
≤10,000	10
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
≤60,000	150

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

4.4 Spacing From Trees and Other Considerations. Since CO is relatively nonreactive, the major factor concerning trees is as obstructions to normal wind flow patterns. For middle and neighborhood scale stations, trees should not be located between the major sources of CO, usually vehicles on a heavily traveled road, and the monitor. The probe or at least 90 percent of the monitoring path must be 10 meters or more from the drip line of trees which are between the probe or the monitoring path and the road and which extend at least 5 meters above the probe or monitoring path. For microscale stations, no trees or shrubs should be located between the probe and the roadway.

4.5 Cumulative Interferences on a Monitoring Path. The cumulative length or portion of a monitoring path that is affected by obstructions, trees, or roadways must not exceed 10 percent of the total monitoring path length.

4.6 Maximum Monitoring Path Length. The monitoring path length must not exceed 1 kilometer for analyzers used for neighborhood scale monitoring applications, or 300 meters for middle scale monitoring applications. In areas subject to frequent periods of dust, fog, rain, or snow, consideration should be given to a shortened monitoring path length to minimize loss of monitoring data due to these temporary optical obstructions. For certain ambient air monitoring scenarios using open path analyzers, shorter path lengths may be needed in order to ensure that the monitoring station meets the objectives and spatial scales defined for SLAMS in appendix D. Therefore, the Regional Administrator or the Regional Administrator's designee may require shorter path lengths, as needed on an individual basis, to ensure that the SLAMS meet the appendix D requirements. Likewise, the Administrator or the Administrator's designee may specify the maximum path length used

at monitoring stations designated as NAMS or PAMS as needed on an individual basis.

5.–6. [Reserved]

7. *Lead (Pb)*

7.1 *Vertical Placement.* Optimal placement of the sampler inlet for Pb monitoring should be at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered when siting a Pb monitor. Given these considerations, the sampler inlet for microscale Pb monitors must be 2–7 meters above ground level. The lower limit was based on a compromise between ease of servicing the sampler and the desire to avoid unrepresentative conditions due to re-entrainment from dusty surfaces. The upper limit represents a compromise between the desire to have measurements which are most representative of population exposures and a consideration of the practical factors noted above.

For middle or larger spatial scales, increased diffusion results in vertical concentration gradients which are not as great as for the small scales. Thus, the required height of the air intake for middle or larger scales is 2–15 meters.

7.2 Spacing From Obstructions. The sampler must be located away from obstacles such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler.

A minimum of 2 meters of separation from walls, parapets, and penthouses is required for rooftop samplers. No furnace or incinerator flues should be nearby. The height and type of flues and the type, quality, and quantity of waste or fuel burned determine the separation distances. For example, if the emissions from the chimney have high lead content and there is a high probability that the plume would impact on the sampler during most of the sampling period, then other buildings/locations in the area that are free from the described sources should be chosen for the monitoring site.

There must be unrestricted airflow in an arc of at least 270° around the sampler.

Since the intent of the category (a) site is to measure the maximum concentrations from a road or point source, there must be no significant obstruction between a road or point source and the monitor, even though other spacing from obstruction criteria are met. The predominant direction for the season with the greatest pollutant concentration potential must be included in the 270° arc.

7.3. *Spacing from Roadways.* This criteria applies only to those Pb sites designed to assess lead concentrations from mobile sources. Numerous studies have shown that ambient Pb levels near mobile sources are a function of the traffic volume and are most pronounced at ADT >30,000 within the first 15 meters on the downwind side of the roadways. Numberous studies have shown that ambient lead levels near mobile source are a function of the traffic volume and are most pronounced at ADT ≥30,000 within the first 15 meters, on the downwind side of the roadways. (1, 16–19) Therefore, stations to measure the peak concentration from mobile sources should be located at the distance most likely to produce the highest concentrations. For the microscale station, the location must be between 5 and 15 meters from the major roadway. For the middle scale station, a range of acceptable distances from the major roadway is shown in table 4. This table also includes separation distances between a roadway and neighborhood or larger scale stations. These distances are based upon the data of reference 16 which illustrates that lead levels remain fairly constant after certain horizontal distances from the roadway. As depicted in the above reference, this distance is a function of the traffic volume.

TABLE 3—SEPARATION DISTANCE BETWEEN PB STATIONS AND ROADWAYS (EDGE OF NEAREST TRAFFIC LANE)

Roadway average daily traffic vehicles per day	Separation distance between roadways and stations, meters		
	Micro-scale	Middle scale	Neighborhood urban regional scale
≤10,000	5–15	[1]>15–50	[1]>50
20,000	5–15	>15–75	>75
≥40,000	5–15	>15–100	>100

[1] Distances should be interpolated based on traffic flow.

7.4. *Spacing from trees and other considerations.* Trees can provide surfaces for deposition or adsorption of Pb particles and obstruct normal wind flow patterns. For microscale and middle scale category (a) sites there must not be any tree(s) between the source of the Pb and the sampler. For neighborhood scale category (b) sites, the sampler should be at least 20 meters from the drip line of trees. The sampler must, however, be placed at least 10 meters from the drip line of trees which could be classified as an obstruction, i.e., the distance between the tree(s) and the sampler is less than the height that the tree protrudes above the sampler.

8. *Particulate Matter (PM_{10} and $PM_{2.5}$)*

8.1 Vertical Placement. Although there are limited studies on the PM_{10} concentration gradients around roadways or other ground level sources, References 1, 2, 4, 18 and 19 of this appendix show a distinct variation in the distribution of TSP and Pb levels near roadways, TSP, which is greatly affected by gravity, has large concentration gradients, both horizontal and vertical, immediately adjacent to roads. Lead, being predominately

sub-micron in size, behaves more like a gas and exhibits smaller vertical and horizontal gradients than TSP. PM_{10}, being intermediate in size between these two extremes exhibits dispersion properties of both gas and settleable particulates and does show vertical and horizontal gradients.[30] Similar to monitoring for other pollutants, optimal placement of the sampler inlet for PM_{10} monitoring should be at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered when siting a PM_{10} monitor. Given these considerations, the sampler inlet for microscale PM_{10} monitors must be 2–7 meters above ground level. The lower limit was based on a compromise between ease of servicing the sampler and the desire to avoid re-entrainment from dusty surfaces. The upper limit represents a compromise between the desire to have measurements which are most representative of population exposures and a consideration of the practical factors noted above. Although microscale or middle scale stations are not the preferred spatial scale for $PM_{2.5}$ sites, there are situations where such sites are representative of several locations within an area where large segments of the population may live or work (e.g., central business district of Metropolitan area). In these cases, the sampler inlet for such microscale $PM_{2.5}$ stations must also be 2-7 meters above ground level.

For middle or larger spatial scales, increased diffusion results in vertical concentration gradients that are not as great as for the microscale. Thus, the required height of the air intake for middle or larger scales is 2–15 meters.

8.2 Spacing From Obstructions. If the sampler is located on a roof or other structure, then there must be a minimum of 2 meters separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. This separation distance from flues is dependent on the height of the flues, type of waste or fuel burned, and quality of the fuel (ash content). In the case of emissions from a chimney resulting from natural gas combustion, as a precautionary measure, the sampler should be placed at least 5 meters from the chimney.

On the other hand, if fuel oil, coal, or solid waste is burned and the stack is sufficiently short so that the plume could reasonably be expected to impact on the sampler intake a significant part of the time, other buildings/locations in the area that are free from these types of sources should be considered for sampling. Trees provide surfaces for particulate desposition and also restrict airflow. Therefore, the sampler should be placed at least 20 meters from the dripline and must be 10 meters from the dripline when the tree(s) acts as an obstruction.

The sampler must also be located away from obstacles such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler except for street canyon sites. Sampling stations that are located closer to obstacles than this criterion allows should not be classified as neighborhood, urban, or regional scale, since the measurements from such a station would closely represent middle scale stations. Therefore, stations not meeting the criterion should be classified as middle scale.

There must be unrestricted airflow in an arc of at least 270° around the sampler except for street canyon sites. Since the intent of the category (a) site is to measure the maximum concentrations from a road or point source, there must be no significant obstruction between a road or point source and the monitor, even though other spacing from obstruction criteria are met. The predominant direction for the season with the greatest pollutant concentration potential must be included in the 270° arc.

8.3 Spacing From Roads. Since emissions associated with the operation of motor vehicles contribute to urban area particulate matter ambient levels, spacing from roadway criteria are necessary for ensuring national consistency in PM sampler siting.

The intent is to locate category (a) NAMS sites in areas of highest concentrations whether it be from mobile or multiple stationary sources. If the area is primarily affected by mobile sources and the maximum concentration area(s) is judged to be a traffic corridor or street canyon location, then the monitors should be located near roadways with the highest traffic volume and at separation distances most likely to produce the highest concentrations. For the microscale traffic corridor station, the location must be between 5 and 15 meters from the major roadway. For the microscale street canyon site the location must be between 2 and 10 meters from the roadway. For the middle scale station, a range of acceptable distances from the roadway is shown in Figure 2. This figure also includes separation distances between a roadway and neighborhood or larger scale stations by default. Any station, 2 to 15 meters high, and further back than the middle scale requirements will generally be neighborhood, urban or regional scale. For example, according to Figure 2, if a PM sampler is primarily influenced by roadway emissions and that sampler is set back 10 meters from a 30,000 ADT road, the station should be classified as a micro scale, if the sampler height is between 2 and 7 meters. If the sampler height is between 7 and 15 meters, the station should be classified as middle scale. If the sample is 20 meters from the same road, it will be classified as middle scale; if 40 meters, neighborhood scale; and if 110 meters, an urban scale.

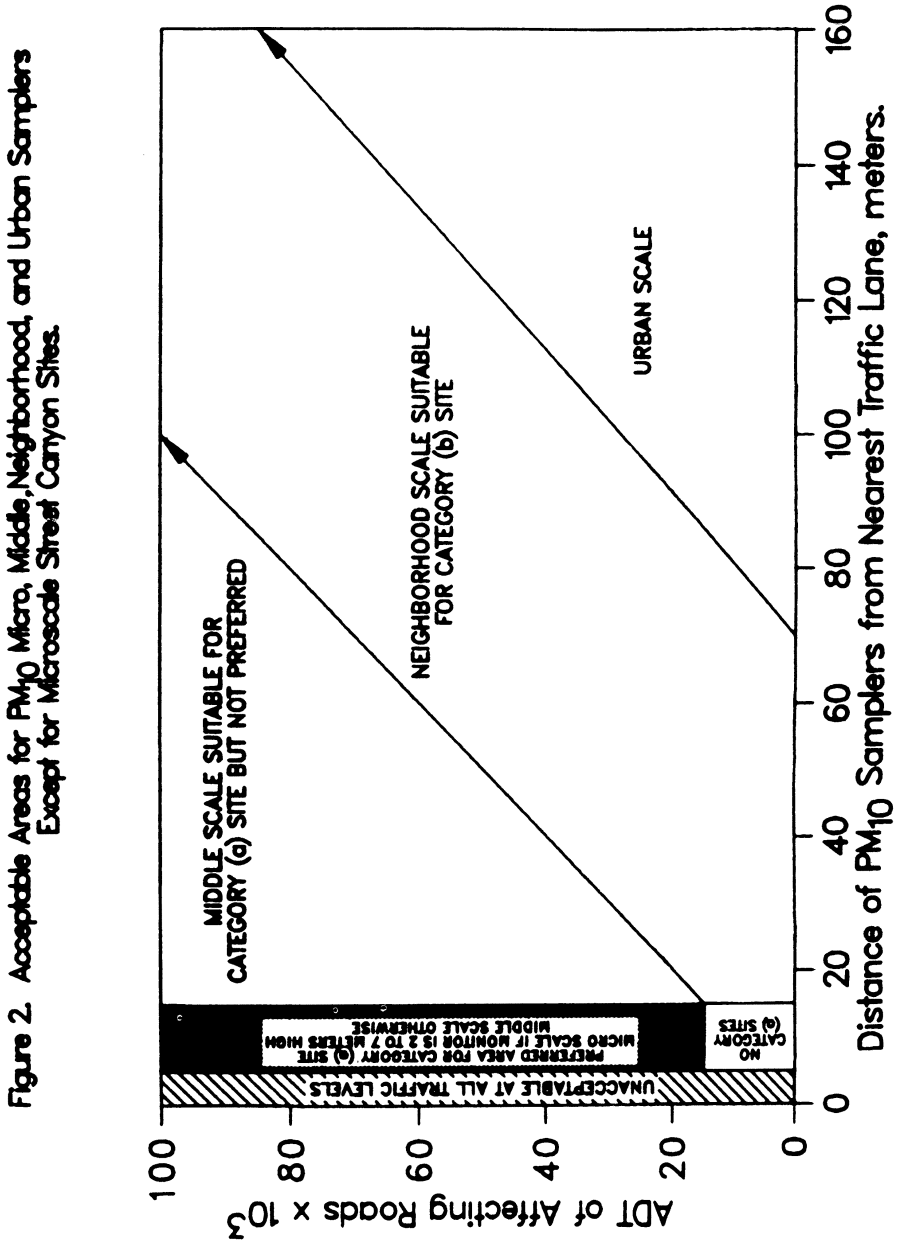

Figure 2. Acceptable Areas for PM_{10} Micro, Middle, Neighborhood, and Urban Samplers Except for Microscale Street Canyon Sites.

It is important to note that the separation distances shown in Figure 2 are measured from the edge of the nearest traffic lane of the roadway presumed to have the most influence on the site. In general, this presumption is an oversimplification of the usual urban settings which normally have several streets that impact a given site. The effects

of surrounding streets, wind speed, wind direction and topography should be considered along with Figure 2 before a final decision is made on the most appropriate spatial scale assigned to the sampling station.

8.4 Other Considerations. For those areas that are primarily influenced by stationary source emissions as opposed to roadway emissions, guidance in locating these areas may be found in the guideline document Optimum Network Design and Site Exposure Criteria for Particulate Matter.[29]

Stations should not be located in an unpaved area unless there is vegetative ground cover year round, so that the impact of wind blown dusts will be kept to a minimum.

9. *Probe Material and Pollutant Sample Residence Time*

For the reactive gases, SO_2, NO_2, and O_3, special probe material must be used for point analyzers. Studies[20-24] have been conducted to determine the suitability of materials such as polypropylene, polyethylene, polyvinyl chloride, Tygon, aluminum, brass, stainless steel, copper, Pyrex glass and Teflon for use as intake sampling lines. Of the above materials, only Pyrex glass and Teflon have been found to be acceptable for use as intake sampling lines for all the reactive gaseous pollutants. Furthermore, the EPA[25] has specified borosilicate glass or FEP Teflon as the only acceptable probe materials for delivering test atmospheres in the determination of reference or equivalent methods. Therefore, borosilicate glass, FEP Teflon, or their equivalent must be used for existing and new NAMS or SLAMS.

For VOC monitoring at those SLAMS designated as PAMS, FEP teflon is unacceptable as the probe material because of VOC adsorption and desorption reactions on the FEP teflon. Borosilicate glass, stainless steel, or its equivalent are the acceptable probe materials for VOC and carbonyl sampling. Care must be taken to ensure that the sample residence time is 20 seconds or less.

No matter how nonreactive the sampling probe material is initially, after a period of use reactive particulate matter is deposited on the probe walls. Therefore, the time it takes the gas to transfer from the probe inlet to the sampling device is also critical. Ozone in the presence of NO will show significant losses even in the most inert probe material when the residence time exceeds 20 seconds.[26] Other studies[27M28] indicate that a 10-second or less residence time is easily achievable. Therefore, sampling probes for reactive gas monitors at SLAMS or NAMS must have a sample residence time less than 20 seconds.

10. *Photochemical Assessment Monitoring Stations (PAMS)*

10.1 Horizontal and Vertical Placement. The probe or at least 80 percent of the monitoring path must be located 3 to 15 meters above ground level. This range provides a practical compromise for finding suitable sites for the multipollutant PAMS. The probe or at least 90 percent of the monitoring path must be at least 1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, etc., and away from dusty or dirty areas.

10.2 Spacing From Obstructions. The probe or at least 90 percent of the monitoring path must be located away from obstacles and buildings such that the distance between the obstacles and the probe or the monitoring path is at least twice the height that the obstacle protrudes above the probe or monitoring path. There must be unrestricted airflow in an arc of at least 270° around the probe inlet. Additionally, the predominant wind direction for the period of greatest pollutant concentration (as described for each site in section 4.2 of appendix D) must be included in the 270° arc. If the probe is located on the side of the building, 180° clearance is required. A monitoring path must be clear of all trees, brush, buildings, plumes, dust, or other optical obstructions, including potential obstructions that may move due to wind, human activity, growth of vegetation, etc. Temporary optical obstructions, such as rain, particles, fog, or snow, should be considered when siting an open path analyzer. Any of these temporary obstructions that are of sufficient density to obscure the light beam will affect the ability of the open path analyzer to continuously measure pollutant concentrations.

Special consideration must be devoted to the use of open path analyzers due to their inherent potential sensitivity to certain types of interferences, or optical obstructions. While some of these potential interferences are comparable to those to which point monitors are subject, there are additional sources of potential interferences which are altogether different in character. Transient, but significant obscuration of especially longer measurement paths could be expected to occur as a result of certain prevailing meteorological conditions (e.g., heavy fog, rain, snow) and/or aerosol levels that are of a sufficient density to prevent the open path analyzer's light transmission. If certain compensating measures are not otherwise implemented at the onset of monitoring (e.g., shorter path lengths, higher light source intensity), data recovery during periods of greatest primary pollutant potential could be compromised. For instance, if heavy fog or high particulate levels are coincident with periods of projected NAAQS-threatening pollutant potential, the representativeness of the resulting data record

[20-29] See References at end of this appendix.

in reflecting maximum pollutant concentrations may be substantially impaired despite the fact that the site may otherwise exhibit an acceptable, even exceedingly high overall valid data capture rate.

In seeking EPA approval for inclusion of a site using an open path analyzer into the formal SLAMS/NAMS or PSD network, monitoring agencies must submit an analysis which evaluates both obscuration potential for a proposed path length for the subject area and the effect this potential is projected to have on the representativeness of the data record. This analysis should include one or more of the following elements, as appropriate for the specific circumstance: climatological information, historical pollutant and aerosol information, modeling analysis results, and any related special study results.

10.3 Spacing From Roadways. It is important in the probe and monitoring path siting process to minimize destructive interferences from sources of NO since NO readily reacts with O_3. Table 4 below provides the required minimum separation distances between roadways and PAMS (excluding upper air measuring stations):

TABLE 4—SEPARATION DISTANCE BETWEEN PAMS AND ROADWAYS

[Edge of Nearest Traffic Lane]

Roadway average daily traffic, vehicles per day	Minimum separation distance between roadways and stations in meters [1]
<10,000	>10
15,000	20
20,000	30
40,000	50
70,000	100
>110,000	250

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table based on the actual traffic flow.

10.4 Spacing From Trees. Trees can provide surfaces for adsorption and/or reactions to occur and can obstruct normal wind flow patterns. To minimize these effects at PAMS, the probe or at least 90 percent of the monitoring path should be placed at least 20 meters from the drip line of trees. Since the scavenging effect of trees is greater for O_3 than for the other criteria pollutants, strong consideration of this effect must be given in locating the PAMS probe or monitoring path to avoid this problem. Therefore, the probe or at least 90 percent of the monitoring path must be at least 10 meters from the drip line of trees.

11. *Waiver Provisions*

It is believed that most sampling probes or monitors can be located so that they meet the requirements of this appendix. New stations with rare exceptions, can be located within the limits of this appendix. However, some existing stations may not meet these requirements and yet still produce useful data for some purposes. EPA will consider a written request from the State Agency to waive one or more siting criteria for some monitoring stations providing that the State can adequately demonstrate the need (purpose) for monitoring or establishing a monitoring station at that location. For establishing a new station. a waiver may be granted only if both of the following criteria are met:

The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.

The monitor or probe cannot reasonably be located so as to meet the siting criteria because of physical constraints (e.g., inability to locate the required type of station the necessary distance from roadways or obstructions).

However, for an existing station, a waiver may be granted if either of the above criteria are met.

Cost benefits, historical trends, and other factors may be used to add support to the above, however, they in themselves, will not be acceptable reasons for granting a waiver. Written requests for waivers must be submitted to the Regional Administrator. For those SLAMS also designated as NAMS, the request will be forwarded to the Administrator. For those SLAMS also designated as NAMS or PAMS, the request will be forwarded to the Administrator.

12. *Summary*

Table 5 presents a summary of the general requirements for probe and monitoring path siting criteria with respect to distances and heights. It is apparent from table 5 that different elevation distances above the ground are shown for the various pollutants. The discussion in the text for each of the pollutants described reasons for elevating the monitor, probe, or monitoring path. The differences in the specified range of heights are based on the vertical concentration gradients. For CO, the gradients in the vertical direction are very large for the microscale, so a small range of heights has been used. The upper limit of 15 meters was specified for consistency between pollutants and to allow the use of a single manifold or monitoring path for monitoring more than one pollutant.

TABLE 5—SUMMARY OF PROBE AND MONITORING PATH SITING CRITERIA

Pollutant	Scale [maximum monitoring path length, meters]	Height from ground to probe or 80% of monitoring path [A] (meters)	Horizontal and vertical distance from supporting structures [B] to probe or 90% of monitoring path [A] (meters)	Distance from trees to probe or 90% of monitoring path [A] (meters)	Distance from roadways to probe or monitoring path [A] (meters)
SO_2 [C,D,E,F]	Middle [300m] Neighborhood, Urban, and Regional [1km].	3–15	>1	>10	N/A.
CO [D,E,G]	Micro Middle [300m] Neighborhood [1km].	3±0.5; 3–15	>1	>10	2–10; See table 2 for middle and neighborhood scales.
O_3 [C,D,E]	Middle [300m] Neighborhood, Urban, and Regional [1km].	3–15	>1	>10	See table 1 for all scales.
Ozone precursors (for PAMS) [C,D,E].	Neighborhood and Urban. [1 km]	3–15	>1	>10	See table 4 for all scales.
NO_2 [C,D,E]	Middle [300m] Neighborhood and Urban [1km].	3–15	>1	>10	See table 1 for all scales.
Pb [C,D,E,F,H]	Micro; Middle, Neighborhood, Urban and Regional.	2–7 (Micro); 2–15 (All other scales).	>2 (All scales, horizontal distance only).	>10 (All scales)	5–15 (Micro); See table 3 for all other scales.
PM–10 [C,D,E,F,H]	Micro; Middle, Neighborhood, Urban and Regional.	2–7 (Micro); 2–15 (All other scales).	>2 (All scales, horizontal distance only).	>10 (All scales)	2–10 (Micro); See Figure 2 for all other scales.

N/A—Not applicable.

[A] Monitoring path for open path analyzers is applicable only to middle or neighborhood scale CO monitoring and all applicable scales for monitoring SO_2, O_3, O_3 precursors, and NO_2.

[B] When probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouses located on roof.

[C] Should be >20 meters from the dripline of tree(s) and must be 10 meters from the dripline when the tree(s) act as an obstruction.

[D] Distance from sampler, probe, or 90% of monitoring path to obstacle, such as a building, must be at least twice the height the obstacle protrudes above the sampler, probe, or monitoring path. Sites not meeting this criterion may be classified as middle scale (see text).

[E] Must have unrestricted airflow 270° around the probe or sampler; 180° if the probe is on the side of a building.

[F] The probe, sampler, or monitoring path should be away from minor sources, such as furnace or incineration flues. The separation distance is dependent on the height of the minor source's emission point (such as a flue), the type of fuel or waste burned, and the quality of the fuel (sulfur, ash, or lead content). This criterion is designed to avoid undue influences from minor sources.

[G] For microscale CO monitoring sites, the probe must be >10 meters from a street intersection and preferably at a midblock location.

[H] For collocated Pb and PM–10 samplers, a 2–4 meter separation distance between collocated samplers must be met.

13. *References*

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[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979, as amended at 46 FR 44170, Sept. 3, 1981; 51 FR 9598, Mar. 19, 1986; 52 FR 24744—24748, July 1, 1987; 52 FR 27286, July 20, 1987; 58 FR 8474, 8475, Feb. 12, 1993; 60 FR 52324, Oct. 6, 1995; 62 FR 38854, July 18, 1997; 64 FR 3036, Jan. 20, 1999]

APPENDIX F TO PART 58—ANNUAL SLAMS AIR QUALITY INFORMATION

1. General
2. Required Information
2.1 Sulfur Dioxide (SO_2)
2.1.1 Site and Monitoring Information
2.1.2 Annual Summary Statistics
2.2 Total Suspended Particulates (TSP)
2.2.1 Site and Monitoring Information
2.2.2 Annual Summary Statistics
2.2.3 Episode and Other Unscheduled Sampling Data
2.3 Carbon Monoxide (CO)
2.3.1 Site and Monitoring Information
2.3.2 Annual Summary Statistics
2.4 Nitrogen Dioxide (NO_2)
2.4.1 Site and Monitoring Information
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2.5 Ozone(O_3)
2.5.1 Site and Monitoring Information
2.5.2 Annual Summary Statistics
2.6 Lead (Pb)
2.6.1 Site and Monitoring Information
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2.7 Particulate Matter (PM_{10})
2.7.1 Site and Monitoring Information
2.7.2 Annual Summary Statistics
2.7.3 Annual Summary Statistics
2.7.4 Episode and Other Unscheduled Sampling Data

1. *General*

This appendix describes information to be compiled and submitted annually to EPA for each ambient monitoring station in the SLAMS Network in accordance with §58.26. The annual summary statistics that are described in section 2 below shall be construed as only the minimum necessary statistics needed by EPA to overview national air quality status. They will be used by EPA to convey information to a variety of interested parties including environmental groups, Federal agencies, the Congress, and private citizens upon request. As the need arises, EPA may issue modifications to these minimum requirements to reflect changes in EPA policy concerning the National Ambient Air Quality Standards (NAAQS).

As indicated in §58.26(c), the contents of the SLAMS annual report shall be certified by the senior air pollution control officer in the State to be accurate to the best of his knowledge. In addition, the manner in which the data were collected must be certified to have conformed to the applicable quality assurance, air monitoring methodology, and probe siting criteria given in appendices A, C, and E to this part. A certified statement to this effect must be included with the annual report. As required by §58.26(a), the report must be submitted by July 1 of each year for data collected during the period January 1 to December 31 of the previous year.

EPA recognizes that most air pollution control agencies routinely publish air quality statistical summaries and interpretive reports. EPA encourages State and local agencies to continue publication of such reports and recommends that they be expanded, where appropriate, to include analysis of air quality trends, population exposure, and pollutant distributions. At their discretion, State and local agencies may wish to integrate the SLAMS report into routine agency publications.

2. *Required Information*

This paragraph describes air quality monitoring information and summary statistics which must be included in the SLAMS annual report. The required information is itemized below by pollutant. Throughout this appendix, the time of occurrence refers to the ending hour. For example, the ending hour of an 8-hour CO average from 12:01 a.m. to 8:00 a.m. would be 8:00 a.m.

For the purposes of range assignments the following rounding convention will be used. The air quality concentration should be rounded to the number of significant digits used in specifying the concentration intervals. The digit to the right of the last significant digit determines the rounding process. If this digit is greater than or equal to 5, the last significant digit is rounded up. The insignificant digits are truncated. For example, 100.5 ug/m^3 rounds to 101 ug/m^3 and 0.1245 ppm rounds to 0.12 ppm.

2.1 Sulfur Dioxide (SO_2)

2.1.1 Site and Monitoring Information. City name (when applicable), county name and street address of site location. AIRS-AQS site code. AIRS-AQS monitoring method code. Number of hourly observations. (*1*) Number of daily observations. (*2*)

2.1.2 Annual Summary Statistics. Annual arithmetic mean (ppm). Highest and second highest 24-hour averages (*3*) (ppm) and dates of occurrence. Highest and second highest 3-hour averages (*1, 3*) (ppm) and dates and times (*1*) (ending hour) of occurrence. Number of exceedances of the 24-hour primary

NAAQS. (*3*) Number of exceedances of the 3-hour secondary NAAQS. (*3*) Number of 24-hour average concentrations (*4*) in ranges:

Range	Number of values
0.00 to 0.04 (ppm)	
0.05 to 0.08	
0.09 to 0.12	
0.13 to 0.16	
0.17 to 0.20	
0.21 to 0.24	
0.25 to 0.28	
Greater than .28	

2.2 Total Suspended Particulates (TSP)

2.2.1 Site and Monitoring Information. City name (when applicable), county name and street address of site location. AIRS-AQS site code. Number of daily observations.

2.2.2 Annual Summary Statistics. Annual arithmetic mean ($\mu g/m^3$) as specified in appendix K of part 50. Daily TSP values exceeding the level of the 24-hour PM_{10} NAAQS and dates of occurrence. If more than 10 occurrences, list only the 10 highest daily values. Sampling schedule used such as once every six days, once every three days, etc. Number of additional sampling days beyond sampling schedule used. Number of 24-hour average concentrations in ranges:

Range	Number of values
0 to 50 ($\mu g/m^3$)	
51 to 100	
101 to 150	
151 to 200	
201 to 250	
251 to 300	
301 to 400	
Greater than 400	

2.2.3 Episode and Other Unscheduled Sampling Data. List episode measurements, other unscheduled sampling data, and dates of occurrence. List the regularly scheduled sample measurements and date of occurrence that preceded the episode or unscheduled measurement.

2.3 Carbon Monoxide (CO)

2.3.1 Site and Monitoring Information. City name (when applicable), county name and street address of site location. AIRS-AQS site code. AIRS-AQS monitoring method code. Number of hourly observations.

2.3.2 Annual Summary Statistics. Highest and second highest 1-hour values (ppm) and date and time of occurrence. Highest and second highest 8-hour averages (*3*) (ppm) and date and time of occurrence (ending hour). Number of exceedances of the 1-hour primary NAAQS. Number of exceedances of the 8-hour average primary NAAQS. (*3*) Number of 8-hour average concentrations (*4*) in ranges:

Range	Number of values
0 to 4 (ppm)	
5 to 8 (ppm)	
9 to 12	
13 to 16	
17 to 20	
21 to 24	
25 to 28	
Greater than 28	

2.4 Nitrogen Dioxide (NO_2)

2.4.1 Site and Monitoring Information. City name (when applicable), county name, and street address of site location. AIRS-AQS site code. AIRS-AQS monitoring method code. Number of hourly observations. (*1*) Number of daily observations. (*2*)

2.4.2 Annual Summary Statistics. Annual arithmetic mean (ppm). Highest and second highest hourly averages (*3*) (ppm) and their dates and time of occurrence. Highest and second highest 24-hour averages (*2*) and their date of occurrence (ppm). Number of hourly average concentrations in ranges. (*1*)

Range	Number of values
.0 to .04 (ppm)	
.05 to .08	
.09 to .12	
.13 to .16	
.17 to .20	
.21 to .24	
.25 to .28	
Greater than 0.28	

2.5 Ozone (O_3)

2.5.1 Site and Monitoring Information. City name (when applicable), county name and street address of site location. AIRS-AQS site code. AIRS-AQS monitoring method code. Number of hourly observations.

2.5.2 Annual Summary Statistics. Four highest daily maximum hour values (ppm) and their dates and time of occurrence. Number of exceedances of the daily maximum 1-hour primary NAAQS. Number of daily maximum hour concentrations in ranges:

Range	Number of values
0 to .04 (ppm)	
.05 to .08	
.09 to .12	
.13 to .16	
.17 to .20	
.21 to .24	
.25 to .28	
Greater than .28	

2.6 Lead (Pb).

2.6.1 Site and Monitoring Information. City name (when applicable), county name, and street address of site location, AIRS-AQS site code. AIRS-AQS monitoring method code. Sampling interval of submitted data, e.g., twenty-four hour or quarterly composites.

2.6.2 Annual Summary Statistics. The four quarterly arithmetic averages given to two decimal places for the year together with the

number of twenty-four hour samples included in the average, as in the following format:

Quarter	Number of 24-hour samples	Quarterly arithmetic average (μg/m^3)
Jan.-March		
April-June		
July-Sept.		
Oct.-Dec.		

2.7 Particulate Matter (PM_{10})

2.7.1 Site and Monitoring Information. City name (when applicable), county name, and street address of site location. AIRS-AQS site code. Number of daily observations.

2.7.2 Annual Summary Statistics. Annual arithmetic mean (μg/m^3) as specified in appendix K of part 50. All daily PM_{10} values above the level of the 24-hour PM_{10} NAAQS and dates of occurrence. Sampling schedule used such as once every six days, once every three days, etc. Number of additional sampling days beyond sampling schedule used. Number of 24-hour average concentrations in ranges:

Range	Number of values
0 to 25 (μg/m^3)	
26 to 50	
51 to 75	
76 to 100	
101 to 125	
126 to 150	
151 to 175	
176 to 200	
Greater than 200	

2.7.3 Annual Summary Statistics. Annual arithmetic mean (μg/m^3) as specified in 40 CFR part 50, appendix N. All daily PM-fine values above the level of the 24-hour PM-fine NAAQS and dates of occurrence. Sampling schedule used such as once every 6 days, everyday, etc. Number of 24-hour average concentrations in ranges:

Range	Number of Values
0 to 15 (μg/m^3).	
16 to 30	
31 to 50	
51 to 70	
71 to 90	
91 to 110	
Greater than 110	

2.7.4 Episode and Other Unscheduled Sampling Data. List episode measurements, other unscheduled sampling data, and dates of occurrence. List the regularly scheduled sample measurements and date of occurrence that preceded the episode or unscheduled measurement.

Footnotes

1. Continuous methods only.
2. Manual or intermittent methods only.
3. Based on nonoverlapping values computed according to procedures described in reference (1) or on individual intermittent measurements.
4. Based on overlapping running averages for continuous measurements as described in reference (1) or on individual measurement for intermittent methods.

Reference

1. ''Guidelines for the Interpretation of Air Quality Standards'' U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. OAQPS No. 1.2–008, February, 1977.

[44 FR 27571, May 10, 1979, as amended at 46 FR 44171, Sept. 3, 1981; 51 FR 9600, Mar. 19, 1986; 52 FR 24748, 24749, July 1, 1987; 59 FR 41628, Aug. 12, 1994; 62 FR 38854, July 18, 1997]

APPENDIX G TO PART 58—UNIFORM AIR QUALITY INDEX (AQI) AND DAILY REPORTING

GENERAL REQUIREMENTS

1. What is the AQI?
2. Why report the AQI?
3. Must I report the AQI?
4. What goes into my AQI report?
5. Is my AQI report for my MSA only?
6. How do I get my AQI report to the public?
7. How often must I report the AQI?
8. May I make exceptions to these reporting requirements?

CALCULATION

9. How does the AQI relate to air pollution levels?
10. Where do I get the pollutant concentrations to calculate the AQI?
11. Do I have to forecast the AQI?
12. How do I calculate the AQI?

BACKGROUND AND REFERENCE MATERIALS

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GENERAL REQUIREMENTS

1. What Is the AQI?

The AQI is a tool that simplifies reporting air quality to the general public. The AQI incorporates into a single index concentrations of 5 criteria pollutants: ozone (O_3), particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). The scale of the index is divided into general categories that are associated with health messages.

2. Why Report the AQI?

The AQI offers various advantages:

a. It is simple to create and understand.

b. It conveys the health implications of air quality.

c. It promotes uniform use throughout the country.

3. Must I Report the AQI?

You must report the AQI daily if yours is a metropolitan statistical area (MSA) with a population over 350,000.

4. What Goes Into My AQI Report?

i. Your AQI report must contain the following:

a. The reporting area(s) (the MSA or subdivision of the MSA).

b. The reporting period (the day for which the AQI is reported).

c. The critical pollutant (the pollutant with the highest index value).

d. The AQI (the highest index value).

e. The category descriptor and index value associated with the AQI and, if you choose to report in a color format, the associated color. Use only the following descriptors and colors for the six AQI categories:

TABLE 1—AQI CATEGORIES

For this AQI	Use this descriptor	And this color [1]
0 to 50	"Good"	Green.
51 to 100	"Moderate"	Yellow.
101 to 150	"Unhealthy for Sensitive Groups".	Orange.
151 to 200	"Unhealthy"	Red.
201 to 300	"Very Unhealthy"	Purple.
301 and above	"Hazardous"	Maroon.[1]

[1] Specific colors can be found in the most recent reporting guidance (Guideline for Public Reporting of Daily Air Quality—Air Quality Index (AQI)).

f. The pollutant specific sensitive groups for any reported index value greater than 100. Use the following sensitive groups for each pollutant:

When this pollutant has an index value above 100 * * *	Report these sensitive groups * * *
Ozone	Children and people with asthma are the groups most at risk.
$PM_{2.5}$	People with respiratory or heart disease, the elderly and children are the groups most at risk.
PM_{10}	People with respiratory disease are the group most at risk.
CO	People with heart disease are the group most at risk.
SO_2	People with asthma are the group most at risk.
NO_2	Children and people with respiratory disease are the groups most at risk.

ii. When appropriate, your AQI report may also contain the following:

a. Appropriate health and cautionary statements.

b. The name and index value for other pollutants, particularly those with an index value greater than 100.

c. The index values for sub-areas of your MSA.

d. Causes for unusual AQI values.

e. Actual pollutant concentrations.

5. Is My AQI Report for My MSA Only?

Generally, your AQI report applies to your MSA only. However, if a significant air quality problem exists (AQI greater than 100) in areas significantly impacted by your MSA but not in it (for example, O_3 concentrations are often highest downwind and outside an urban area), you should identify these areas and report the AQI for these areas as well.

6. How Do I Get My AQI Report to the Public?

You must furnish the daily report to the appropriate news media (radio, television, and newspapers). You must make the daily report publicly available at one or more places of public access, or by any other means, including a recorded phone message, a public Internet site, or facsimile transmission. When the AQI value is greater than 100, it is particularly critical that the reporting to the various news media be as extensive as possible. At a minimum, it should include notification to the media with the largest market coverages for the area in question.

7. How Often Must I Report the AQI?

You must report the AQI at least 5 days per week. Exceptions to this requirement are in section 8 of this appendix.

8. May I Make Exceptions to These Reporting Requirements?

i. If the index value for a particular pollutant remains below 50 for a season or year, then you may exclude the pollutant from your calculation of the AQI in section 12.

ii. If all index values remain below 50 for a year, then you may report the AQI at your discretion. In subsequent years, if pollutant levels rise to where the AQI would be above 50, then the AQI must be reported as required in sections 3, 4, 6, and 7 of this appendix.

CALCULATION

9. How Does the AQI Relate to Air Pollution Levels?

For each pollutant, the AQI transforms ambient concentrations to a scale from 0 to 500. The AQI is keyed as appropriate to the national ambient air quality standards (NAAQS) for each pollutant. In most cases, the index value of 100 is associated with the numerical level of the short-term standard (i.e., averaging time of 24-hours or less) for each pollutant. Different approaches are taken for NO_2, for which no short-term standard has been established, and for $PM_{2.5}$, for which the annual standard is the principal vehicle for protecting against short-term concentrations. The index value of 50 is associated with the numerical level of the annual standard for a pollutant, if there is one, at one-half the level of the short-term standard for the pollutant, or at the level at which it is appropriate to begin to provide guidance on cautionary language. Higher categories of the index are based on increasingly serious health effects and increasing proportions of the population that are likely to be affected. The index is related to other air pollution concentrations through linear interpolation based on these levels. The AQI is equal to the highest of the numbers corresponding to each pollutant. For the purposes of reporting the AQI, the sub-indexes for PM_{10} and $PM_{2.5}$ are to be considered separately. The pollutant responsible for the highest index value (the reported AQI) is called the ''critical'' pollutant.

10. Where Do I Get the Pollutant Concentrations To Calculate the AQI?

You must use concentration data from population-oriented State/Local Air Monitoring Station (SLAMS) or parts of the SLAMS required under 40 CFR 58.20 for each pollutant except PM. For PM, you need only calculate and report the AQI on days for which you have measured air quality data (e.g., particulate monitors often report values only every sixth day). You may use particulate measurements from monitors that are not reference or equivalent methods (for example, continuous PM_{10} or $PM_{2.5}$ monitors) if you can relate these measurements by statistical linear regression to reference or equivalent method measurements.

11. Do I Have to Forecast the AQI?

You should forecast the AQI to provide timely air quality information to the public, but this is not required. If you choose to forecast the AQI, then you may consider both long-term and short-term forecasts. You can forecast the AQI at least 24-hours in advance using the most accurate and reasonable procedures considering meteorology, topography, availability of data, and forecasting expertise. The document ''Guideline for Developing an Ozone Forecasting Program'' (the Forecasting Guidance) will help you start a forecasting program. You can also issue short-term forecasts by predicting 8-hour ozone values from 1-hour ozone values using methods suggested in the Reporting Guidance, ''Guideline for Public Reporting of Daily Air Quality.''

12. How Do I Calculate the AQI?

i. The AQI is the highest value calculated for each pollutant as follows:

a. Identify the highest concentration among all of the monitors within each reporting area and truncate the pollutant concentration to one more than the significant digits used to express the level of the NAAQS for that pollutant. This is equivalent to the rounding conventions used in the NAAQS.

b. Using Table 2, find the two breakpoints that contain the concentration.

c. Using Equation 1, calculate the index.

d. Round the index to the nearest integer.

TABLE 2—BREAKPOINTS FOR THE AQI

These breakpoints						Equal these AQIs * * *		Category
O_3 (ppm) 8-hour	O_3 (ppm) 1-hour [1]	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI	
0.000–0.064	.....	0.0–15.4	0–54	0.0–4.4	0.000–0.034	([2])	0–50	Good.
0.065–0.084	.....	15.5–40.4	55–154	4.5–9.4	0.035–0.144	([2])	51–100	Moderate.
0.085–0.104	0.125–0.164	40.5–65.4	155–254	9.5–12.4	0.145–0.224	([2])	101–150	Unhealthy for sensitive groups.
0.105–0.124	0.165–0.204	[4] 65.5–150.4	255–354	12.5–15.4	0.225–0.304	([2])	151–200	Unhealthy.
0.125–0.374	0.205–0.404	[4] 150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24	201–300	Very unhealthy.
([3])	0.405–0.504	[4] 250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64	301–400	
([3])	0.505–0.604	[4] 350.5–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04	401–500	Hazardous.

[1] Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be more precautionary. In these cases, in addition to calculating the 8-hour ozone index value, the 1-hour ozone index value may be calculated, and the maximum of the two values reported.

[2] NO_2 has no short-term NAAQS and can generate an AQI only above an AQI value of 200.

[3] 8-hour O_3 values do not define higher AQI values (≥ 301). AQI values of 301 or higher are calculated with 1-hour O_3 concentrations.

[4] If a different SHL for $PM_{2.5}$ is promulgated, these numbers will change accordingly.

ii. If the concentration is equal to a breakpoint, then the index is equal to the corresponding index value in Table 2. However, Equation 1 can still be used. The results will be equal. If the concentration is between two breakpoints, then calculate the index of that pollutant with Equation 1. You must also note that in some areas, the AQI based on 1-hour O_3 will be more precautionary than using 8-hour values (see footnote 1 to Table 2). In these cases, you may use 1-hour values as well as 8-hour values to calculate index values and then use the maximum index value as the AQI for O_3.

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{HI} - BP_{Lo}}\left(C_p - BP_{Lo}\right) + I_{Lo} \qquad \text{(Equation 1)}$$

Where:

I_p = the index value for pollutant$_p$
C_p = the truncated concentration of pollutant$_p$
BP_{Hi} = the breakpoint that is greater than or equal to C_p
BP_{Lo} = the breakpoint that is less than or equal to C_p
I_{Hi} = the AQI value corresponding to BP_{Hi}
I_{lo} = the AQI value corresponding to BP_{Lo}.

iii. If the concentration is larger than the highest breakpoint in Table 2 then you may use the last two breakpoints in Table 2 when you apply Equation 1.

EXAMPLE

iv. Using Table 2 and Equation 1, calculate the index value for each of the pollutants measured and select the one that produces the highest index value for the AQI. For example, if you observe a PM_{10} value of 210 µg/m^3, a 1-hour O_3 value of 0.156 ppm, and an 8-hour O_3 value of 0.130 ppm, then do this:

a. Find the breakpoints for PM_{10} at 210 µg/m^3 as 155 µg/m^3 and 254 µg/m^3, corresponding to index values 101 and 150;

b. Find the breakpoints for 1-hour O_3 at 0.156 ppm as 0.125 ppm and 0.164 ppm, corresponding to index values 101 and 150;

c. Find the breakpoints for 8-hour O_3 at 0.130 ppm as 0.125 ppm and 0.374 ppm, corresponding to index values 201 and 300;

d. Apply Equation 1 for 210 µg/m^3, PM_{10}:

$$\frac{150-101}{254-155}(210-155)+101=128.$$

e. Apply Equation 1 for 0.156 ppm, 1-hour O_3:

$$\frac{150-101}{0.164-0.125}(0.156-0.125)+101=140$$

f. Apply Equation 1 for 0.130 ppm, 8-hour O_3:

$$\frac{300-201}{0.374-0.125}(0.130-0.125)+201=203$$

g. Find the maximum, 203. This is the AQI. The minimal AQI report would read:

v. Today, the AQI for my city is 203 which is very unhealthy, due to ozone. Children and people with asthma are the groups most at risk.

BACKGROUND AND REFERENCE MATERIALS

13. What Additional Information Should I Know?

The EPA has developed a computer program to calculate the AQI for you. The program works with Windows 95, it prompts for inputs, and it displays all the pertinent information for the AQI (the index value, color, category, sensitive group, health effects, and cautionary language). The EPA has also prepared a brochure on the AQI that explains the index in detail (The Air Quality Index), Reporting Guidance (Guideline for Public Reporting of Daily Air Quality) that provides associated health effects and cautionary statements, and Forecasting Guidance (Guideline for Developing an Ozone Forecasting Program) that explains the steps necessary to start an air pollution forecasting program. You can download the program and the guidance documents at *www.epa.gov/airnow*.

[64 FR 42547, Aug. 4, 1999]

PART 59—NATIONAL VOLATILE ORGANIC COMPOUND EMISSION STANDARDS FOR CONSUMER AND COMMERCIAL PRODUCTS

Sec.

Subpart A [Reserved]

Subpart B—National Volatile Organic Compound Emission Standards for Automobile Refinish Coatings

59.100 Applicability and designation of regulated entity.
59.101 Definitions.
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