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AUTHORITY: Sections 110, 301(a), and 319 of the Clean Air Act as amended (42 U.S.C. 7410, 7601(a), and 7619).

SOURCE: 44 FR 27571, May 10, 1979, As amended at 59 FR 41628, Aug. 12, 1994.

Subpart A—General Provisions

§ 58.1 Definitions.

As used in this part, all terms not defined herein have the meaning given them in the Act:

(a) *Act* means the Clean Air Act as amended (42 U.S.C. 7401, *et seq.*).

(b) *SLAMS* means State or Local Air Monitoring Station(s). The SLAMS make up the ambient air quality monitoring network which is required by § 58.20 to be provided for in the State's implementation plan. This definition places no restrictions on the use of the physical structure or facility housing the SLAMS. Any combination of SLAMS and any other monitors (Special Purpose, NAMS, PSD) may occupy the same facility or structure without affecting the respective definitions of those monitoring station.

(c) *NAMS* means National Air Monitoring Station(s). Collectively the NAMS are a subset of the SLAMS ambient air quality monitoring network.

(d) *PSD station* means any station operated for the purpose of establishing the effect on air quality of the emissions from a proposed source for purposes of prevention of significant deterioration as required by § 51.24(n) of part 51 of this chapter.

- (e) *SO₂* means sulfur dioxide.
- (f) *NO₂* means nitrogen dioxide. *NO* means nitrogen oxide. *NO_x* means oxides of nitrogen and is defined as the sum of the concentrations of *NO₂* and *NO*.
- (g) *CO* means carbon monoxide.
- (h) *O₃* means ozone.
- (i) *Plan* means an implementation plan, approved or promulgated pursuant to section 110 of the Clean Air Act.
- (j) *Administrator* means the Administrator of the Environmental Protection Agency (EPA) or his or her authorized representative.
- (k) *Regional Administrator* means the Administrator of one of the ten EPA Regional Offices or his or her authorized representative.
- (l) *State agency* means the air pollution control agency primarily responsible for development and implementation of a plan under the Act.
- (m) *Local agency* means any local government agency, other than the State agency, which is charged with the responsibility for carrying out a portion of the plan.
- (n) *Indian Reservation* means any Federally recognized reservation established by treaty, agreement, executive order, or act of Congress.
- (o) *Indian Governing Body* means the governing body of any tribe, band, or group of Indians subject to the jurisdiction of the United States and recognized by the United States as possessing power of self-government.
- (p) *Aerometric Information Retrieval System (AIRS)-Air Quality Subsystem (AQS)* is EPA's computerized system for storing and reporting of information relating to ambient air quality data.
- (q) *Storage and Retrieval of Aerometric Data (SAROAD)* system is a computerized system which stores and reports information relating to ambient air quality. The SAROAD system has been replaced with the AIRS-AQS system; however, the SAROAD data reporting format continues to be used by some States and local air pollution agencies as an interface to AIRS on an interim basis.
- (r) *SAROAD site identification form* is one of the several forms in the SAROAD system. It is the form which provides a complete description of the site (and its surroundings) of an ambient air quality monitoring station.
- (s) *Traceable* means that a local standard has been compared and certified, either directly or via not more than one intermediate standard, to a primary standard such as a National Institute of Standards and Technology Standard Reference Material (NIST SRM) or a USEPA/NIST-approved Certified Reference Material (CRM).
- (t) *Urban area population* means the population defined in the most recent decennial U.S. Census of Population Report.
- (u) *TSP* (total suspended particulates) means particulate matter as measured by the method described in appendix B of part 50 of this chapter.
- (v) *PM₁₀* means particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers as measured by a reference method based on appendix J of part 50 of this chapter and designated in accordance with part 53 of this chapter or by an equivalent method designated in accordance with part 53 of this chapter.
- (w) *Pb* means lead.
- (x) *PAMS* means Photochemical Assessment Monitoring Stations.
- (y) *VOC* means volatile organic compounds.
- (z) *Meteorological measurements* means measurements of wind speed, wind direction, barometric pressure, temperature, relative humidity, and solar radiation.
- (aa) *Point analyzer* is an automated analytical method that measures pollutant concentration in an ambient air sample extracted from the atmosphere at a specific inlet probe point and that has been designated as a reference or equivalent method in accordance with part 53 of this chapter.
- (bb) *Probe* is the actual inlet where an air sample is extracted from the atmosphere for delivery to a sampler or point analyzer for pollutant analysis.
- (cc) *Open path analyzer* is an automated analytical method that measures the average atmospheric pollutant concentration in situ along one or more monitoring paths having a monitoring path length of 5 meters or more and that has been designated as a reference or equivalent method under the provisions of part 53 of this chapter.

(dd) *Monitoring path* for an open path analyzer is the actual path in space between two geographical locations over which the pollutant concentration is measured and averaged.

(ee) *Monitoring path length* of an open path analyzer is the length of the monitoring path in the atmosphere over which the average pollutant concentration measurement (path-averaged concentration) is determined. See also, optical measurement path length.

(ff) *Optical measurement path length* is the actual length of the optical beam over which measurement of the pollutant is determined. The path-integrated pollutant concentration measured by the analyzer is divided by the optical measurement path length to determine the path-averaged concentration. Generally, the optical measurement path length is:

(1) Equal to the monitoring path length for a (bistatic) system having a transmitter and a receiver at opposite ends of the monitoring path;

(2) Equal to twice the monitoring path length for a (monostatic) system having a transmitter and receiver at one end of the monitoring path and a mirror or retroreflector at the other end; or

(3) Equal to some multiple of the monitoring path length for more complex systems having multiple passes of the measurement beam through the monitoring path.

(gg) *Effective concentration* pertains to testing an open path analyzer with a high-concentration calibration or audit standard gas contained in a short test cell inserted into the optical measurement beam of the instrument. Effective concentration is the equivalent ambient-level concentration that would produce the same spectral absorbance over the actual atmospheric monitoring path length as produced by the high-concentration gas in the short test cell. Quantitatively, effective concentration is equal to the actual concentration of the gas standard in the test cell multiplied by the ratio of the path length of the test cell to the actual atmospheric monitoring path length.

(hh) *Corrected concentration* pertains to the result of an accuracy or precision assessment test of an open path

analyzer in which a high-concentration test or audit standard gas contained in a short test cell is inserted into the optical measurement beam of the instrument. When the pollutant concentration measured by the analyzer in such a test includes both the pollutant concentration in the test cell and the concentration in the atmosphere, the atmospheric pollutant concentration must be subtracted from the test measurement to obtain the corrected concentration test result. The corrected concentration is equal to the measured concentration minus the average of the atmospheric pollutant concentrations measured (without the test cell) immediately before and immediately after the test.

(ii) *Monitor* is a generic term for an instrument, sampler, analyzer, or other device that measures or assists in the measurement of atmospheric air pollutants and which is acceptable for use in ambient air surveillance under the provisions of appendix C to this part, including both point and open path analyzers that have been designated as either reference or equivalent methods under part 53 of this chapter and air samplers that are specified as part of a manual method that has been designated as a reference or equivalent method under part 53 of this chapter.

[44 FR 27571, May 10, 1979, as amended at 48 FR 2529, Jan. 20, 1983; 51 FR 9586, Mar. 19, 1986; 52 FR 24739, July 1, 1987; 58 FR 8467, Feb. 12, 1993; 59 FR 41628, 41629, Aug. 12, 1994; 60 FR 52319, Oct. 6, 1995]

§ 58.2 Purpose.

(a) This part contains criteria and requirements for ambient air quality monitoring and requirements for reporting ambient air quality data and information. The monitoring criteria pertain to the following areas:

(1) Quality assurance procedures for monitor operation and data handling.

(2) Methodology used in monitoring stations.

(3) Operating schedule.

(4) Siting parameters for instruments or instrument probes.

(b) The requirements pertaining to provisions for an air quality surveillance system in the State Implementation Plan are contained in this part.

(c) This part also acts to establish a national ambient air quality monitoring network for the purpose of providing timely air quality data upon which to base national assessments and policy decisions. This network will be operated by the States and will consist of certain selected stations from the States' SLAMS networks. These selected stations will remain as SLAMS and will continue to meet any applicable requirements on SLAMS. The stations, however, will also be designated as National Air Monitoring Stations (NAMS) and will be subject to additional data reporting and monitoring methodology requirements as contained in subpart D of this part.

(d) This section also acts to establish a Photochemical Assessment Monitoring Stations (PAMS) network as a subset of the State's SLAMS network for the purpose of enhanced monitoring in O₃ nonattainment areas listed as serious, severe, or extreme. The PAMS network will be subject to the data reporting and monitoring methodology requirements as contained in subpart E of this part.

(e) Requirements for the daily reporting of an index of ambient air quality, to insure that the population of major urban areas are informed daily of local air quality conditions, are also included in this part.

[44 FR 27571, May 10, 1979, as amended at 58 FR 8467, Feb. 12, 1993]

§ 58.3 Applicability.

This part applies to:

- (a) State air pollution control agencies.
- (b) Any local air pollution control agency or Indian governing body to which the State has delegated authority to operate a portion of the State's SLAMS network.
- (c) Owners or operators of proposed sources.

Subpart B—Monitoring Criteria

§ 58.10 Quality assurance.

(a) Appendix A to this part contains quality assurance criteria to be followed when operating the SLAMS network.

(b) Appendix B to this part contains the quality assurance criteria to be followed by the owner or operator of a proposed source when operating a PSD station.

§ 58.11 Monitoring methods.

Appendix C to this part contains the criteria to be followed in determining acceptable monitoring methods or instruments for use in SLAMS.

§ 58.12 Siting of instruments or instrument probes.

Appendix E to this part contains criteria for siting instruments or instrument probes for SLAMS.

§ 58.13 Operating schedule.

Ambient air quality data collected at any SLAMS must be collected as follows:

- (a) For continuous analyzers—consecutive hourly averages except during:
 - (1) Periods of routine maintenance,
 - (2) Periods of instrument calibration,

or

- (3) Periods or seasons exempted by the Regional Administrator.
- (b) For manual methods (excluding PM₁₀ samplers and PAMS VOC samplers), at least one 24-hour sample must be obtained every sixth day except during periods or seasons exempted by the Regional Administrator.

(c) For PAMS VOC samplers, samples must be obtained as specified in sections 4.3 and 4.4 of appendix D to this part. Area-specific PAMS operating schedules must be included as part of the network description required by § 58.40 and must be approved by the Administrator.

(d) For PM₁₀ samplers—a 24-hour sample must be taken from midnight to midnight (local time) to ensure national consistency. The sampling shall be conducted on the following schedules which are based on either the first year of PM₁₀ monitoring or a long-term selective PM₁₀ monitoring plan:

- (1) *First year PM₁₀ monitoring.* The sampling frequency for the first year (12 consecutive months) of ambient PM₁₀ monitoring shall be based on the monitoring area's SIP area grouping (I, II, III) which is described in the PM₁₀ SIP Development Guideline and the Preamble to part 51 of this chapter. In

general, the SIP groupings are defined in terms of the estimated probability of not attaining the PM₁₀ NAAQS. Procedures to develop these probabilities are found in Pace, T., et al. "Procedures for Estimating Probability of Nonattainment of a PM₁₀ NAAQS Using Total Suspended Particulate or Inhalable Particulate Data." OAQPS, U.S. Environmental Protection Agency, Research Triangle Park, N. C. December 1986. The most recent 3 calendar years of air quality data must be used in this determination. The SIP area groupings are divided into three categories: Group I—areas whose probability is greater than or equal to 95 percent; Group II—areas whose probability is greater than or equal to 20 percent to less than 95 percent probability, and Group III—areas whose probability is less than 20 percent. The use of the term "monitoring area" as it applies to the required sampling frequencies of the "monitoring area" is as follows: First, any urbanized area as defined by the U.S. Bureau of Census; second, any incorporated place such as a city or town as defined by the U.S. Bureau of Census or group of cities or towns; and third, any "monitoring area" designated by the responsible air pollution control agency. In designating these latter "monitoring areas", the control agency should consider technical factors such as the types of emissions, their spatial distribution, meteorology, and topography and how these factors contribute to the uniqueness of the "monitoring area" thereby distinguishing it from other designated "monitoring areas". The starting date for this first year of PM₁₀ monitoring may begin prior to the effective date of promulgation of this regulation.

(i) For Group I areas, everyday PM₁₀ sampling is required for at least one PM₁₀ site which must be located in the area of expected maximum concentration. The remainder require every sixth day sampling.

(ii) For Group II areas, every other day sampling is required for at least one PM₁₀ site which must be located in the area of expected maximum concentration. The remainder require every sixth day sampling.

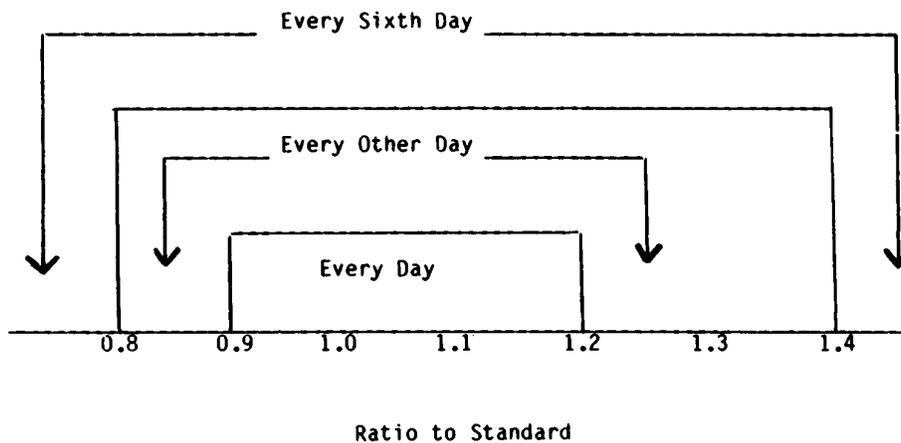
(iii) For Group III areas, a minimum of one in six day sampling is required.

If a monitoring site in a Group III or Group II area later records levels exceeding the short term (24-hour) PM₁₀ NAAQS, as described in part 50 appendix K, and the monitoring frequency was less than everyday, then everyday sampling must be initiated in the area of expected maximum concentration no later than 90 days following the end of the calendar quarter in which the exceedance occurred and continue for the subsequent four calendar quarters.

(2) *Long term monitoring selective sampling.* To be eligible for the long term selective sampling plan, the first year of PM₁₀ sampling, or its equivalent, must be conducted. A complete year comprises all four calendar quarters with each quarter containing data from 75 percent of the scheduled sampling days. The equivalent to one year of PM₁₀ sampling to be completed within one year of the effective date of promulgation is defined as follows: First, for everyday sampling: 2 years of every other day sampling or 2 years of every sixth day sampling and 1 year of every other day sampling or 3 years of every sixth day sampling; second, for every other day sampling: 3 years of every sixth day sampling. After one year of PM₁₀ monitoring or its equivalent has been obtained, the minimum monitoring schedule for the site in the area of expected maximum concentration shall be based on the relative level of that monitoring site concentration with respect to the level of the controlling standard. For those areas in which the short-term (24-hour) standard is controlling i.e., has the highest ratio, the selective sampling requirements are illustrated in Figure 1. If the operating agency were able to demonstrate, by a combination of historical TSP data and at least one year of PM₁₀ data that there were certain periods of the year where conditions preclude violation of the PM₁₀ 24-hour standard, the increased sampling frequency for those periods or seasons may be exempted by the Regional Administrator and revert back to once in six days. The minimum sampling schedule for all other sites in the area would be once every six days. For those areas in which the annual standard is the controlling standard, the minimum sampling schedule for all monitors in the area would be once

every six days. During the annual review of the SLAMS network, the most recent year of data must be considered to estimate the air quality status for the controlling air quality standard (24-hour or annual). Statistical models such as analysis of concentration frequency distributions as described in "Guideline for the Interpretation of Ozone Air Quality Standards," EPA-450/479-003, U.S. Environmental Protection Agency, Research Triangle Park, N.C., January 1979, should be used. Adjustments to the monitoring schedule must be made on the basis of the annual review. The site having the highest concentration in the most current year must be given first consideration when selecting the site for the more frequent sampling schedule. Other factors such as major change in sources of PM₁₀ emissions or in sampling site characteristics could influence the location of the expected maximum con-

centration site. Also, the use of the most recent three years of data might in some cases, be justified in order to provide a more representative data base from which to estimate current air quality status and to provide stability to the network. This multiyear consideration would reduce the possibility of an anomalous year biasing a site selected for accelerated sampling. If the maximum concentration site based on the most current year is not selected for the more frequent operating schedule, documentation of the justification for selection of an alternate site must be submitted to the Regional Office for approval during the annual review process. It should be noted that minimum data completeness criteria, number of years of data and sampling frequency for judging attainment of the NAAQS are discussed in appendix K of part 50.



[44 FR 27571, May 10, 1979, as amended at 52 FR 24739, July 1, 1987; 58 FR 8467, Feb. 12, 1993]

§ 58.14 Special purpose monitors.

(a) Any ambient air quality monitoring station other than a SLAMS or PSD station from which the State intends to use the data as part of a demonstration of attainment or nonattain-

ment or in computing a design value for control purposes of the National Ambient Air Quality Standards (NAAQS) must meet the requirements for SLAMS described in § 58.22 and, after January 1, 1983, must also meet the requirements for SLAMS as described in § 58.13 and appendices A and E to this part.

(b) Any ambient air quality monitoring station other than a SLAMS or PSD station from which the State intends to use the data for SIP-related functions other than as described in paragraph (a) of this section is not necessarily required to comply with the requirements for a SLAMS station under paragraph (a) but must be operated in accordance with a monitoring schedule, methodology, quality assurance procedures, and probe or instrument-siting specifications approved by the Regional Administrator.

[46 FR 44164, Sept. 3, 1981]

Subpart C—State and Local Air Monitoring Stations (SLAMS)

§ 58.20 Air quality surveillance: Plan content.

By January 1, 1980, the State shall adopt and submit to the Administrator a revision to the plan which will:

(a) Provide for the establishment of an air quality surveillance system that consists of a network of monitoring stations designated as State and Local Air Monitoring Stations (SLAMS) which measure ambient concentrations of those pollutants for which standards have been established in part 50 of this chapter. SLAMS (including NAMS) designated as PAMS will also obtain ambient concentrations of speciated VOC and NO_x, and meteorological measurements. PAMS may therefore be located at existing SLAMS or NAMS sites when appropriate.

(b) Provide for meeting the requirements of appendices A, C, D, and E to this part.

(c) Provide for the operation of at least one SLAMS per criteria pollutant except Pb during any stage of an air pollution episode as defined in the plan.

(d) Provide for the review of the air quality surveillance system on an annual basis to determine if the system meets the monitoring objectives defined in appendix D to this part. Such review must identify needed modifications to the network such as termination or relocation of unnecessary stations or establishment of new stations which are necessary.

(e) Provide for having a SLAMS network description available for public inspection and submission to the Administrator upon request. The network description must be available at the time of plan revision submittal except for Pb which must be available by December 1, 1981 and for PM₁₀ monitors which must be available by 6 months after the effective date of promulgation and must contain the following information for each SLAMS:

(1) The AIRS site identification form for existing stations.

(2) The proposed location for scheduled stations.

(3) The sampling and analysis method.

(4) The operating schedule.

(5) The monitoring objective and spatial scale of representativeness as defined in appendix D to this part.

(6) A schedule for: (i) Locating, placing into operation, and making available the AIRS site identification form for each SLAMS which is not located and operating at the time of plan revision submittal, (ii) implementing quality assurance procedures of appendix A to this part for each SLAMS for which such procedures are not implemented at the time of plan revision submittal, and (iii) resiting each SLAMS which does not meet the requirements of appendix E to this part at the time of plan revision submittal.

(f) Within 9 months after;

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O₃ nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme, affected States shall adopt and submit a plan revision to the Administrator.

The plan revision will provide for the establishment and maintenance of PAMS. Each PAMS site will provide for the monitoring of ambient concentrations of criteria pollutants (O₃, NO₂), and non-criteria pollutants (NO_x, NO, and speciated VOC) as stipulated in section 4.2 of appendix D, and meteorological measurements. The PAMS network is part of the SLAMS network, and the plan provisions in paragraphs (a) through (f) of this section

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will apply to the revision. Since NAMS sites are also part of the SLAMS network, some PAMS sites may be coincident with NAMS sites and may be designated as both PAMS and NAMS.

[44 FR 27571, May 10, 1979, as amended at 46 FR 44164, Sept. 3, 1981; 52 FR 24740, July 1, 1987; 58 FR 8467, Feb. 12, 1993; 59 FR 41628, Aug. 12, 1994]

§ 58.21 SLAMS network design.

The design criteria for SLAMS contained in appendix D to this part must be used in designing the SLAMS network. The State shall consult with the Regional Administrator during the network design process. The final network design will be subject to the approval of the Regional Administrator.

§ 58.22 SLAMS methodology.

Each SLAMS must meet the monitoring methodology requirements of appendix C to this part at the time the station is put into operation as a SLAMS.

§ 58.23 Monitoring network completion.

By January 1, 1983, with the exception of PM₁₀ samplers whose probability of nonattainment of the PM₁₀ ambient standard is greater than or equal to 20 percent which shall be by 1 year after the effective date of promulgation and the remaining PM₁₀ samplers which shall be by 2 years after the effective date of promulgation:

(a) Each station in the SLAMS network must be in operation, be sited in accordance with the criteria in appendix E to this part, and be located as described on the station's AIRS site identification form, and

(b) The quality assurance requirements of appendix A to this part must be fully implemented.

[44 FR 27571, May 10, 1979, as amended at 52 FR 24740, July 1, 1987; 59 FR 41628, Aug. 12, 1994]

§ 58.24 [Reserved]

§ 58.25 System modification.

The State shall annually develop and implement a schedule to modify the ambient air quality monitoring network to eliminate any unnecessary stations or to correct any inadequacies in-

dicated by the result of the annual review required by § 58.20(d). The State shall consult with the Regional Administrator during the development of the schedule to modify the monitoring program. The final schedule and modifications will be subject to the approval of the Regional Administrator. Nothing in this section will preclude the State, with the approval of the Regional Administrator, from making modifications to the SLAMS network for reasons other than those resulting from the annual review.

§ 58.26 Annual SLAMS summary report.

(a) The State shall submit to the Administrator (through the appropriate Regional Office) an annual summary report of all the ambient air quality monitoring data from all monitoring stations designated State and Local Air Monitoring Stations (SLAMS). The annual report must be submitted by July 1 of each year for data collected from January 1 to December 31 of the previous year.

(b) The annual summary report must contain:

(1) The information specified in appendix F,

(2) The location, date, pollution source, and duration of each incident of air pollution during which ambient levels of a pollutant reached or exceeded the level specified by § 51.16(a) of this chapter as a level which could cause significant harm to the health of persons.

(c) The senior air pollution control officer in the State or his designee shall certify that the annual summary report is accurate to the best of his knowledge.

[44 FR 27571, May 10, 1979, as amended at 51 FR 9586, Mar. 19, 1986]

§ 58.27 Compliance date for air quality data reporting.

The annual air quality data reporting requirements of § 58.26 apply to data collected after December 31, 1980. Data collected before January 1, 1981, must be reported under the reporting procedures in effect before the effective date of subpart C of this part.

§ 58.28 SLAMS data submittal.

The State shall submit all of the SLAMS data according to the same data submittal requirements as defined for NAMS in section 58.35. The State shall also submit any portion or all of the SLAMS data to the appropriate Regional Administrator upon request.

[59 FR 41628, Aug. 12, 1994]

Subpart D—National Air Monitoring Stations (NAMS)

§ 58.30 NAMS network establishment.

(a) By January 1, 1980, with the exception of Pb, which shall be by December 1, 1981, and PM₁₀ samplers, which shall be by 6 months after the effective date of promulgation, the State shall:

(1) Establish, through the operation of stations or through a schedule for locating and placing stations into operation, that portion of a National Ambient Air Quality Monitoring Network which is in that State, and

(2) Submit to the Administrator (through the appropriate Regional Office) a description of that State's portion of the network.

(b) Hereinafter, the portion of the national network in any State will be referred to as the NAMS network.

(c) The stations in the NAMS network must be stations from the SLAMS network required by § 58.20.

(d) The requirements of appendix D to this part must be met when designing the NAMS network. The process of designing the NAMS network must be part of the process of designing the SLAMS network as explained in appendix D to this part.

[44 FR 27571, May 10, 1979, as amended at 46 FR 44164, Sept. 3, 1981; 52 FR 24740, July 1, 1987]

§ 58.31 NAMS network description.

The NAMS network description required by § 58.30 must contain the following for all stations, existing or scheduled:

(a) The AIRS site identification form for existing stations.

(b) The proposed location for scheduled stations.

(c) Identity of the urban area represented.

(d) The sampling and analysis method.

(e) The operating schedule.

(f) The monitoring objective and spatial scale of representativeness as defined in appendix D to this part.

(g) A schedule for:

(1) Locating, placing into operation, and submitting the AIRS site identification form for each NAMS which is not located and operating at the time of network description submittal,

(2) Implementing quality assurance procedures of appendix A to this part for each NAMS for which such procedures are not implemented at the time of network description submittal, and

(3) Resiting each NAMS which does not meet the requirements of appendix E to this part at the time of network description submittal.

[44 FR 27571, May 10, 1979, as amended at 59 FR 41628, Aug. 12, 1994]

§ 58.32 NAMS approval.

The NAMS network required by § 58.30 is subject to the approval of the Administrator. Such approval will be contingent upon completion of the network description as outlined in § 58.31 and upon conformance to the NAMS design criteria contained in appendix D to this part.

§ 58.33 NAMS methodology.

Each NAMS must meet the monitoring methodology requirements of appendix C to this part applicable to NAMS at the time the station is put into operation as a NAMS.

§ 58.34 NAMS network completion.

By January 1, 1981, with the exception of Pb, which shall be by July 1, 1982 and PM₁₀ samplers, which shall be by 1 year after the effective date of promulgation:

(a) Each NAMS must be in operation, be sited in accordance with the criteria in appendix E to this part, and be located as described in the station's AIRS site identification form; and

(b) The quality assurance requirements of appendix A to this part must be fully implemented for all NAMS.

[44 FR 27571, May 10, 1979, as amended at 46 FR 44164, Sept. 3, 1981; 52 FR 24740, July 1, 1987; 59 FR 41628, Aug. 12, 1994]

§ 58.35 NAMS data submittal.

(a) The requirements of this section apply to those stations designated as both SLAMS and NAMS by the network description required by §§ 58.20 and 58.30.

(b) The State shall report to the Administrator all ambient air quality data for SO₂, CO, O₃, NO₂, Pb, and PM-10 and information specified by the AIRS Users Guide (Volume II, Air Quality Data Coding, and Volume III, Air Quality Data Storage) to be coded into the AIRS-AQS format. Such air quality data and information must be submitted directly to the AIRS-AQS via either electronic transmission or magnetic tape, in the format of the AIRS-AQS, and in accordance with the quarterly schedule described in paragraph (c) of this section.

(c) The specific quarterly reporting periods are January 1-March 31, April 1-June 30, July 1-September 30, and October 1-December 31. The data and information reported for each reporting period must:

(1) Contain all data and information gathered during the reporting period.

(2) Be received in the AIRS-AQS within 90 days after the end of the quarterly reporting period. For example, the data for the reporting period January 1-March 31, 1994 are due on or before June 30, 1994.

(d) Air quality data submitted for each reporting period must be edited, validated, and entered into the AIRS-AQS for updating (within the time limits specified in paragraph (c) of this section) pursuant to appropriate AIRS-AQS procedures. The procedures for editing and validating data are described in the AIRS Users Guide, Volume II Air Quality Data Coding.

(e) This section does not permit a State to exempt those SLAMS which are also designated as NAMS from all or any of the reporting requirements applicable to SLAMS in Section 58.26.

[44 FR 27571, May 10, 1979, as amended at 46 FR 44164, Sept. 3, 1981; 51 FR 9586, Mar. 19, 1986; 52 FR 24740, July 1, 1987; 59 FR 41628, Aug. 12, 1994]

§ 58.36 System modification.

During the annual SLAMS Network Review specified in § 58.20, any changes to the NAMS network identified by the

EPA and/or proposed by the State and agreed to by the EPA will be evaluated. These modifications should address changes invoked by a new census and changes to the network due to changing air quality levels, emission patterns, etc. The State shall be given one year (until the next annual evaluation) to implement the appropriate changes to the NAMS network.

[51 FR 9586, Mar. 19, 1986]

Subpart E—Photochemical Assessment Monitoring Stations (PAMS)

SOURCE: 58 FR 8468, Feb. 12, 1993, unless otherwise noted.

§ 58.40 PAMS network establishment.

(a) In addition to the plan revision, the State shall submit a photochemical assessment monitoring network description including a schedule for implementation to the Administrator within 6 months after;

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O₃ nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme O₃ nonattainment.

The network description will apply to all serious, severe, and extreme O₃ nonattainment areas within the State. Some O₃ nonattainment areas may extend beyond State or Regional boundaries. In instances where PAMS network design criteria as defined in appendix D to this part require monitoring stations located in different States and/or Regions, the network description and implementation schedule should be submitted jointly by the States involved. When appropriate, such cooperation and joint network design submittals are preferred. Network descriptions shall be submitted through the appropriate Regional Office(s). Alternative networks, including different monitoring schedules, periods, or methods, may be submitted, but they must include a demonstration that they satisfy the monitoring data uses and fulfill the PAMS monitoring

objectives described in sections 4.1 and 4.2 of appendix D to this part.

(b) For purposes of plan development and approval, the stations established or designated as PAMS must be stations from the SLAMS network or become part of the SLAMS network required by § 58.20.

(c) The requirements of appendix D to this part applicable to PAMS must be met when designing the PAMS network.

§ 58.41 PAMS network description.

The PAMS network description required by § 58.40 must contain the following:

(a) Identification of the monitoring area represented.

(b) The AIRS site identification form for existing stations.

(c) The proposed location for scheduled stations.

(d) Identification of the site type and location within the PAMS network design for each station as defined in appendix D to this part except that during any year, a State may choose to submit detailed information for the site scheduled to begin operation during that year's PAMS monitoring season, and defer submittal of detailed information on the remaining sites until succeeding years. Such deferred network design phases should be submitted to EPA for approval no later than January 1 of the first year of scheduled operation. As a minimum, general information on each deferred site should be submitted each year until final approval of the complete network is obtained from the Administrator.

(e) The sampling and analysis method for each of the measurements.

(f) The operating schedule for each of the measurements.

(g) An O₃ event forecasting scheme, if appropriate.

(h) A schedule for implementation. This schedule should include the following:

(1) A timetable for locating and submitting the AIRS site identification form for each scheduled PAMS that is not located at the time of submittal of the network description;

(2) A timetable for phasing-in operation of the required number and type

of sites as defined in appendix D to this part; and

(3) A schedule for implementing the quality assurance procedures of appendix A to this part for each PAMS.

§ 58.42 PAMS approval.

The PAMS network required by § 58.40 is subject to the approval of the Administrator. Such approval will be contingent upon completion of each phase of the network description as outlined in § 58.41 and upon conformance to the PAMS network design criteria contained in appendix D to this part.

§ 58.43 PAMS methodology.

PAMS monitors must meet the monitoring methodology requirements of appendix C to this part applicable to PAMS.

§ 58.44 PAMS network completion.

(a) The complete, operational PAMS network will be phased in as described 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 O₃ nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme O₃ 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 O₃ 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 on a daily basis through prominent notice an air quality index in accordance with the requirements of appendix G to this part.

(b) Reporting must commence by January 1, 1981, for all urban areas with a population exceeding 500,000, and by January 1, 1983, for all urban areas with a population exceeding 200,000.

(c) The population of an urban area for purposes of index reporting is the most recent U.S. census population figure as defined in § 58.1 paragraph (s).

[44 FR 27571, May 10, 1979, as amended at 51 FR 9586, Mar. 19, 1986. Redesignated at 58 FR 8467, Feb. 12, 1993]

Subpart G—Federal Monitoring

SOURCE: 44 FR 27571, May 10, 1979. 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.

APPENDICES TO PART 58

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

1. General Information.

This appendix specifies the minimum quality assurance requirements applicable to SLAMS air monitoring data submitted to EPA. States 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 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 SLAMS data quality are required to be reported to EPA periodically.

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.

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 agency 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 State to develop a quality assurance system that is most efficient and effective for its own circumstances.

2. Quality Assurance Requirements

2.1 Each State 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
- (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 appropriate Regional Administrator, or his designee. The Quality Assurance Program will be reviewed during the annual system audit 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 SLAMS 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 the respective operation and instruction manuals associated with those analyzers. Quality assurance guidance for meteorological systems at PAMS is contained in reference 3. Quality assurance procedures for VOC, NO_x (including NO and NO₂), O₃, and carbonyl measurements at PAMS must be consistent with EPA guidance. This guidance, and any other pertinent information from appropriate sources, should be used by the States in developing their quality assurance programs.

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) Quality control procedures for air pollution episode monitoring;
- (12) Recording and validating data;
- (13) Data quality assessment (precision and accuracy);
- (14) Documentation of quality control information.

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 concentration for CO, SO₂, and NO₂ must be traceable to either a National Institute of Standards and Technology (NIST) 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 the Quality Assurance Division (MD-77), Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

General guidance and recommended techniques for certifying gaseous working standards against an SRM or CRM are provided 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 SRMs.

2.3.2 Test concentrations for O₃ 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 O₃.

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

2.4 National Performance and System Audit Programs

Agencies operating SLAMS network stations shall be subject to annual EPA systems audits of their ambient air monitoring program and are required to participate in EPA's National Performance Audit Program. These audits are described in section 1.4.16 of Reference 2 and section 2.0.11 of Reference 3. For instructions, agencies should contact either the appropriate EPA Regional Quality

Assurance Coordinator or the Quality Assurance Division (MD-77B), Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

3. Data Quality Assessment Requirements

All ambient monitoring methods or analyzers used in SLAMS shall be tested periodically, as described in this section 3, to quantitatively assess the quality of the SLAMS data being routinely produced. Measurement accuracy and precision are estimated for both automated and manual methods. The individual results of these tests for each method or analyzer shall be reported to EPA as specified in section 4. EPA will then calculate quarterly integrated estimates of precision and accuracy applicable to the SLAMS data as described in section 5. 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.

The integrated data quality assessment estimates will be calculated on the basis of "reporting organizations." 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 monitor the same pollutant and for which precision or accuracy 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.

Each reporting organization shall be defined such that precision or accuracy among all stations in the organization can be expected to be reasonably homogeneous, as a result of common factors. Common factors that should be considered by States in defining reporting organizations include: (1) operation by a common team of field operators, (2) common calibration facilities, and (3) support by a common laboratory or headquarters. 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 for guidance. All definitions of reporting organizations shall be subject to final approval by the appropriate EPA Regional Office.

Assessment results shall be reported as specified in section 4. Concentration and flow standards must be as specified in sections 2.3 or 3.4. In addition, working standards and equipment used for accuracy audits must not be the same standards and equipment used for routine calibrations. 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 measure-

ments reported from analyzers or analytical systems (indicated concentrations) should be based on stable readings and must be derived by means of the same calibration curve and data processing system used to obtain the routine air monitoring data (see Reference 1 and Reference 3, section 2.0.9.1.3(d)). Table A-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 SO₂, NO₂, O₃, 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 SO₂, NO₂, and O₃ 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 SO₂, NO₂, and O₃, or 0 to 100 ppm for CO, use precision check gases of appropriately higher concentration as approved by the appropriate Regional Administrator or the Regional Administrator's designee. However, the results of precision checks at concentration levels other than those specified above do not need be reported to the EPA. 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.

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 adjustment is encouraged where possible.

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.

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.

3.2 Accuracy of Automated Methods. Each calendar quarter (during which analyzers are operated), audit at least 25 percent of the SLAMS analyzers that monitor for SO₂, NO₂, O₃, 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.

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	0.35-0.45	0.35-0.45	35-45

Audit level	Concentration range, ppm		CO
	SO ₂ , O ₃	NO ₂	
4	0.80-0.90	80-90

NO₂ audit gas for chemiluminescence-type NO₂ 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 at the site. These errors may be minimized by modifying the GPT technique to lower the NO concentrations remaining in the NO₂ audit gas to levels closer to typical ambient NO concentrations at the site.

To audit SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm for SO₂, NO₂, and O₃ or 0 to 100 ppm for CO, use audit gases of appropriately higher concentration as approved by the appropriate Regional Administrator or his designee. The results of audits at concentration levels other than those shown in the above table need not be reported to EPA.

The standards from which audit gas test concentrations are obtained must meet the specifications of section 2.3. Working or transfer standards and equipment used for auditing must not be the same as the standards and equipment used for calibration and spanning, but may be referenced to the same NIST SRM, CRM, or primary UV photometer. The auditor should not be the operator or 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 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 for certain CO analyzer does not apply for audits.

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. 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 re-verified to within ± 3 percent to validate the audit, since the monitoring path length is critical to the determination of the effective concentration.

Report both the audit test concentrations (effective concentrations for open path analyzers) 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.

3.3 Precision of Manual Methods. For each network of manual methods, 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 particulate matter, a network for measuring PM_{10} shall be separate from a TSP network. 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, alternate sites approved by the Regional Administrator may be selected.

In determining the number of collocated sites required, monitoring networks for Pb 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.

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.

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. The every-6-day schedule used by many monitoring agencies is recommended. Report the measurements from both samplers at each collocated sampling site, including measurements falling below the limits specified in 5.3.1. The percent differences in measured concentration ($\mu\text{g}/\text{m}^3$) between the two collocated samplers are used to calculate precision as described in section 5.3.

3.4 Accuracy of Manual Methods. The accuracy of manual sampling methods is assessed by auditing a portion of the measurement process. For particulate matter methods, the flow rate during sample collection is audited. For SO_2 and NO_2 methods, the analytical measurement is audited. For Pb methods, the flow rate and analytical measurement are audited.

3.4.1 Particulate matter methods. Each calendar quarter, audit the flow rate of at least 25 percent of the samplers such that each sampler is audited at least once per year. If there are fewer than four 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 as described in section 2.3.3. 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 flow rates and the corresponding flow rates indicated by the sampler's normally used flow indicator. The percent differences between these flow rates are used to calculate accuracy as described in section 5.4.1.

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 SO₂ Methods. Prepare audit solutions from a working sulfite-tetrachloromercurate (TCM) solution as described in section 10.2 of the SO₂ Reference Method (appendix A of part 50 of this chapter). 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.

Prepare audit samples in each of the concentration ranges of 0.2-0.3, 0.5-0.6, and 0.8-0.9 µg SO₂/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 SO₂/ml) and the corresponding indicated concentrations (in µg SO₂/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2.

3.4.3 NO₂ Methods. Prepare audit solutions from a working sodium nitrite solution as described in the appropriate equivalent method (see Reference 4). 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 NO₂/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 NO₂/ml) and the corresponding indicated concentrations (in µg NO₂/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2.

3.4.4 Pb Methods. For the Pb Reference Method (appendix G of part 50 of this chapter), 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. For agencies operating both TSP and Pb networks, 25 percent of the total number of high-volume samplers are to be audited each quarter.

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 1.9 cm by 20.3 cm (¾ inch by 8 inch) unexposed glass fiber filter strips 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, ¹ µg/m ³
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.

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

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.

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.

4. Reporting Requirements

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 the Atmospheric Research and Exposure Assessment Laboratory (MD-75), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711 (AREAL/RTP). Whenever there is a change in this list of monitoring sites in a reporting organization, report this change to the Regional Office and to AREAL/RTP.

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 and accuracy tests it has carried out during the quarter. The quarterly reports of precision and accuracy data must be submitted consistent with the data reporting requirements specified for air quality data as set forth in §58.35(c). Each organization shall report all collocated measurements including those falling below the levels specified in section 5.3.1. Do not 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, or from

tests of methods or analyzers not approved for use in SLAMS monitoring networks under Appendix C of this part.

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

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

Calculation of estimates of integrated precision and accuracy are carried out by EPA according to the following procedures. Reporting organizations should report the results of individual precision and accuracy tests as specified in sections 3 and 4 even though they may elect to carry out some or all of the calculations in this section on their own.

5.1 Precision of Automated Methods. Estimates of the precision of automated methods are calculated from the results of biweekly precision checks as specified in section 3.1. 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. The percentage 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.

$$d_i = \frac{Y_i - X_i}{X_i} \times 100 \quad (1)$$

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.

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

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

5.1.2 Precision for Reporting Organization. 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.

$$D = \frac{1}{k} \sum_{j=1}^k d_j \tag{4}$$

$$D = \frac{n_1 d_1 + n_2 d_2 + \dots + n_j d_j + \dots + n_k d_k}{n_1 + n_2 + \dots + n_j + \dots + n_k} \tag{4a}$$

$$S_a = \sqrt{\frac{1}{k} \sum_{j=1}^k S_j^2} \tag{5}$$

$$S_a = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2 + \dots + (n_j - 1)S_j^2 + \dots + (n_k - 1)S_k^2}{n_1 + n_2 + \dots + n_j + \dots + n_k - k}} \tag{5a}$$

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.

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

Upper 95 Percent Probability
Limit = D + 1.96 S_a (6)

Lower 95 Percent Probability
Limit = D - 1.96 S_a (7)

5.2 Accuracy of Automated Methods. Estimates of the accuracy of automated methods are calculated from the results of independent audits as described in section 3.2. 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.

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. For each audit concentration level, the average (D) of the individual percentage differences (d_i) for all n analyzers measuring a given pollutant audited during the quarter is calculated using equation 8.

$$D = \frac{1}{n} \sum_{i=1}^n d_i \tag{8}$$

For each concentration level, the standard deviation (S_a) of all the individual percentage differences for all analyzers audited during the quarter is calculated, for each pollutant, using equation 9.

$$S_a = \sqrt{\frac{1}{n-1} \left[\sum_{i=1}^n d_i^2 - \frac{1}{n} \left(\sum_{i=1}^n d_i \right)^2 \right]} \quad (9)$$

For reporting organizations having four or fewer analyzers for a particular pollutant, only one audit is required each quarter, and the average and standard deviation cannot be calculated. 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.

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. Estimates of precision of manual methods are calculated from the results obtained from collocated samplers as described in section 3.3. 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. 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:

- TSP: 20 µg/m³,
- SO₂: 45 µg/m³,
- NO₂: 30 µg/m³,
- Pb: 0.15 µg/m³, and
- PM₁₀: 20 µg/m³.

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

$$d_i = \frac{Y_i - X_i}{(Y_i + X_i) / 2} \times 100 \quad (10)$$

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

5.3.2 Precision for Reporting Organization. For each pollutant, the average percentage difference (D) and the pooled stand-

ard 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.

The 95 Percent Probability Limits for the integrated precision for a reporting organization are calculated using equations 11 and 12.

$$\text{Upper 95 Percent Probability Limit} = D + 1.96 S_a / \sqrt{2} \quad (11)$$

$$\text{Lower 95 Percent Probability Limit} = D - 1.96 S_a / \sqrt{2} \quad (12)$$

5.4 Accuracy of Manual Methods. Estimates of the accuracy of manual methods are calculated from the results of independent audits as described in Section 3.4. 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 (including reference method Pb samplers).

(1) *Single Sampler Accuracy.* For the flow rate audit described in Section 3.4.1, 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.

(b) *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 SO₂, NO₂, and Pb.

(a) *Single Analysis-Day Accuracy.* For each of the audits of the analytical methods for SO₂, NO₂, and Pb described in section 3.4.2, 3.4.3, and 3.4.4, the percentage difference (d_i) 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, NO₂, and Pb indicated by the analytical method.

(b) *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_n) 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.

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TABLE A-1.—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 checks at concentration between .08 & .10 ppm (8 & 10 ppm for CO) ² .	Each analyzer	Once per 2 weeks	Actual concentration ² & measured concentration. ³
Manual methods including lead.	Collocated samplers	1 site for 1-5 sites; 2 sites for 6-20 sites; 3 sites > 20 sites (sites with highest conc.).	Once per week	Two concentration measurements.
Accuracy: Automated methods for SO ₂ , NO ₂ , O ₃ , and CO.	Response checks 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 & 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 & 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 sample flow rate as for TSP. 2. Check 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 & measured (indicated) concentration of audit samples (µg Pb/strip).

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

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APPENDIX B—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) Data 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, SO₂, and NO₂ 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 SO₂, NO₂, O₃, 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 SO₂, NO₂, and O₃ 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 SO₂, NO₂, O₃, 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

NO₂ audit gas for chemiluminescence-type NO₂ 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 NO₂ 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 re-verified 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 PM₁₀ 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 (µg/m³) 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 PM₁₀ 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/m ³
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 µg/m³ is based on sampling at 1.7 m³/min for 24 hours on 20.3 cm x 25.4 cm (8 inch x 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 analyzed. The difference between the audit concentration (in µg Pb/strip) and the analyst's measured concentration (in µg 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.

$$d_i = \frac{Y_i - X_i}{X_i} \times 100 \tag{1}$$

where:

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

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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.

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

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

where n is the number of precision checks on the instrument made during their 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.

$$\text{Upper 95 Percent Probability Limit} = d_j + 1.96 S_j \quad (4)$$

$$\text{Lower 95 Percent Probability Limit} = d_j - 1.96 S_j \quad (5)$$

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 collocated 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.

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

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

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

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 be- tween .08 & .10 ppm (8 & 10 ppm for CO) ² .	Each analyzer	Once per 2 weeks	Actual concentration ² & measured concentra- tion. 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 sys- tem with Pb audit strips.	1. Each sampler. 2. Analytical system	1. Once/quarter. 2. Each quarter Pb samples are ana- lyzed.	1. Same as for TSP. 2. Actual concentration & measured concen- tration 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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- “Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I—Principles.” EPA-600/9-76-005. March 1976. Available from U.S Environmental Protection Agency, Atmospheric Research and Exposure Assessment Laboratory (MD-77), Research Triangle Park, NC 27711.
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- Paur, R.J. and F.F. McElroy. Technical Assistance Document for the Calibration of Ambient Ozone Monitors. EPA-600/4-79-057.

U.S. Environmental Protection Agency, Atmospheric Research and Exposure Assessment Laboratory (MD-77), Research Triangle Park, NC 27711, September, 1979.

7. McElroy, F.F. Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone. EPA-600/4-79-056. U.S. Environmental Protection Agency, Atmospheric Research and Exposure Assessment Laboratory (MD-77), Research Triangle Park, NC 27711, September, 1979.

[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—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 For purposes of showing compliance with the NAAQS for particulate matter, the high volume sampler described in appendix B of part 50 of this chapter may be used in a

SLAMS as long as the ambient concentration of particles measured by the high volume sampler is below the PM₁₀ NAAQS.

If the TSP sampler measures a single value which is higher than the PM₁₀ 24-hour standard or has an annual average greater than the PM₁₀ annual standard, the high volume sampler designated as a substitute PM₁₀ sampler must be replaced with a PM₁₀ sampler. For the 24-hour standard, the TSP sampler should be replaced with a PM₁₀ sampler before the end of the calendar quarter following the quarter in which the exceedance occurred. For the annual standard, the PM₁₀ sampler should be operating by June 30 of the year following the exceedance.

In order to maintain historical continuity of ambient particulate matter trends and patterns, for PM₁₀ NAMS that were previously TSP NAMS, the TSP high volume sampler must be concurrently operated with the PM₁₀ sampler for a one-year period beginning with the PM₁₀ NAMS start up date. The operating schedule for the TSP sampler must be at least once every six days regardless of the PM₁₀ 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—2.5 [Reserved]

2.6 Use of Methods With Higher, Non-conforming 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, 2.5, or 2.6.2 must be submitted to: Director, Atmospheric Research and Exposure Assessment Laboratory, Department E (MD 75), United States Environmental Protection Agency, Environmental Research Center, 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.

3.0 National Air Monitoring Stations (NAMS)

3.1 Methods used in those SLAMS which are also designated as NAMS to measure SO₂, CO, NO₂, or O₃ must be automated reference or equivalent methods (continuous analyzers).

4.0 Photochemical Assessment Monitoring Stations (PAMS)

4.1 Methods used for O₃ monitoring at PAMS must be automated reference or equivalent methods as defined in §50.1 of this chapter.

4.2 Methods used for NO, NO₂ and NO_x monitoring at PAMS should be automated reference or equivalent methods as defined for NO₂ in §50.1 of this chapter. If alternative NO, NO₂ 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 PM₁₀ during air pollution episodes (see §51.152 of this chapter) the measurement method must be:

5.1.1 Either the "Staggered PM₁₀" method or the "PM₁₀ Sampling Over Short Sampling Times" method, both of which are based on the reference method for PM₁₀ and are described in reference 1: or

5.1.2 Any other method for measuring PM₁₀:

5.1.2.1 Which has a measurement range or ranges appropriate to accurately measure air pollution episode concentration of PM₁₀.

5.1.2.2 Which has a sample period appropriate for short-term PM₁₀ measurements, and

5.1.2.3 For which a quantitative relationship to a reference or equivalent method for PM₁₀ has been established at the use site. Procedures for establishing a quantitative site-specific relationship are contained in reference 1.

5.2 Quality Assurance. PM₁₀ 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 PM₁₀ reference method.

6.0 References

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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.

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APPENDIX D—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 (SO₂) Design Criteria for SLAMS

2.4 Carbon Monoxide (CO) Design Criteria for SLAMS

2.5 Ozone (O₃) Design Criteria for SLAMS

2.6 Nitrogen Dioxide (NO₂) Design Criteria for SLAMS

2.7 Lead (Pb) Design Criteria for SLAMS

2.8 PM₁₀ Design Criteria for SLAMS

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

3.1 [Reserved]

3.2 Sulfur Dioxide (SO₂) Design Criteria for NAMS

3.3 Carbon Monoxide (CO) Design Criteria for NAMS

3.4 Ozone (O₃) Design Criteria for NAMS

3.5 Nitrogen Dioxide (NO₂) Design Criteria for NAMS

3.6 Lead (Pb) Design Criteria for NAMS

3.7 PM₁₀ Design Criteria for NAMS

4. Summary

5. 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) and Photochemical Assessment Monitoring Stations (PAMS). These criteria will also be used by EPA in evaluating the adequacy of the SLAMS/NAMS/PAMS networks.

The network of stations which comprise SLAMS should be designed to meet a minimum of four 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; and (4) to determine general background concentration levels. Of these four basic ambient air monitoring network design objectives, attempts to measure in areas of maximum concentrations and maximum population exposures (these can be exclusive or coincident) are primary due to the combination of prevailing needs and constraints.

It should be noted that this appendix contains no criteria for determining the total number of stations in SLAMS networks, except that a minimum number of lead SLAMS is prescribed. The optimum size of a particular SLAMS network involves tradeoffs between data needs and available resources which the 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 (some-times urban).
Population	Neighborhood, urban.
Source impact	Micro, middle, neighborhood.
General/background	Neighborhood, regional.

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 2.2-2.6 does not include all of the possible scales for each pollutant. The scales which are discussed are those which 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.

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.

Substantive 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 monitor-

ing 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 (SO₂) Design Criteria for SLAMS

The spatial scales for SO₂ SLAMS monitoring are the middle, neighborhood, urban, and regional scales. Because of the nature of SO₂ 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 SO₂ 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 SO₂ 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 SO₂ emission rates and population density. Thus, neighborhood scale measurements may be associated with baseline con-

centrations in areas of projected growth and in studies of population responses to exposure to SO₂. 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 SO₂ 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 SO₂ air quality as generated by diffusion models⁵ 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 inter-neighborhood 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 (O₃) 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 (O₃) 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 O₃ concentrations would occur. Trees also may have a strong scavenging effect on O₃ and may tend to suppress O₃ 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 O₃ monitor and must be used to relocate an existing station or to locate any new O₃ 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 NO₂/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 O₃ 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	November.
Alaska	April	October.
Arizona	January	December.
Arkansas	March	November.
California	January	December.
Colorado	March	September.
Connecticut	April	October.
Delaware	April	October.
District of Columbia	April	October.
Florida	January	December.
Georgia	March	November.
Hawaii	January	December.
Idaho	April	October.
Illinois	April	October.
Indiana	April	September.
Iowa	April	October.
Kansas	April	October.
Kentucky	April	October.
Louisiana	January	December.
Maine	April	October.
Maryland	April	October.
Massachusetts	April	October.
Michigan	April	September.
Minnesota	April	October.
Mississippi	March	November.
Missouri	April	October.
Montana	June	September.
Nebraska	April	October.
Nevada	January	December.
New Hampshire	April	October.
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	April	October.
Pennsylvania	April	October.
Puerto Rico	January	December.
Rhode Island	April	October.
South Carolina	April	October.
South Dakota	June	September.
Tennessee	April	October.

OZONE MONITORING SEASON BY STATE—
Continued

State	Begin month	End month
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	October.
Virginia	April	October.
Washington	April	October.
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 (NO₂) 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 NO₂ 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 NO₂ 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 O₃ would also apply to NO₂.

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 NO₂ station and must be used to relocate an existing station or to locate any new NO₂ 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 NO₂.

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 NO₂ 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 NO₂. The dilution of the emissions further downwind from the source should be considered along with the need for reaction time for NO₂ 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 NO₂ alone. This will occur downwind of sources based on winter wind direction or in areas where there are high ozone concentrations and high density NO₂ 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 NO₂ levels can be determined. Nitrogen dioxide concentrations are likely to decline rather rapidly outside the urban area. Therefore, the best location for measuring NO₂ concentrations will be in neighborhoods near the edge of the city.

2.7 Lead (Pb) Design Criteria for SLAMS. Presently, about 90 percent of the lead concentration in air originates from automobile exhaust, while the remaining 10 percent comes from industrial processes and stationary combustion sources. (6) The most important spatial scales to effectively characterize the emissions from both mobile and stationary 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 would also be needed.

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. Because of the very steep ambient Pb gradients resulting from Pb emissions from mobile sources, (7) the dimensions of the microscale for Pb generally would not extend beyond 15 meters from the roadway. Emissions from stationary 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 lead air quality levels in areas up to several city blocks in size with dimensions on the order of approximately 100 meters to 500 meters. However, the dimensions for middle scale roadway type stations would probably be on the order of 50-150 meters because of the exponential decrease in lead concentration with increasing distances from roadways. The middle scale may for example, include schools and playgrounds in center city areas which are close to major roadways. Pb monitors in such areas are desirable because of the higher sensitivity of children to exposures to Pb concentrations. (7) 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 lead.

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 city-wide 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 would be most applicable to sparsely populated areas and could provide information on background air quality and interregional pollutant transport.

Monitoring data for ambient Pb levels are required in major urbanized areas, particularly where Pb levels have been shown or are expected to be of significant concern such locations are to be expected in urban areas having high population densities and accompanying high traffic densities. 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 urbanized area which has a population exceeding 500,000. Also, as a minimum, there must be two stations in any area where lead concentrations currently exceed or have exceeded $1.5 \mu\text{g}/\text{m}^3$ quarterly arithmetic mean measured since January 1, 1974. For those areas less than 500,000 population where the lead concentrations have exceeded $1.5 \mu\text{g}/\text{m}^3$ quarterly arithmetic mean, the Regional Administrator may waive the requirement for establishing SLAMS provided the State can dem-

onstrate that measured lead concentrations have not exceeded the NAAQS for the eight quarters preceding the lead monitoring plan submission required by §58.20. For locations where monitors are not being operated at the time of the Pb monitoring plan submission, data showing attainment during the final eight quarters of operation will generally provide the basis for the waiver. 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, one of the stations must be a category (a) type station and the second a category (b) station. Both of these categories of stations are defined in section 3. For areas where the predominant lead levels come from automotive sources, the category (a) station must be a microscale or middle scale station located near a major roadway [$>30,000$ average daily traffic, (ADT)] in order to measure maximum Pb concentrations from mobile sources. In areas where there are no roadways exceeding 30,000 ADT, the station should be located near the roadway with the largest traffic volume. Studies (7, 8) indicate that lead levels decrease exponentially with distance from roadways. Thus, the higher concentrations are close to the roadway and stations located in such areas because of the steep concentration gradients, are most often found to represent the microscale and middle scale dimension. For areas where predominant lead levels come from point sources, the category (a) station generally represents the microscale or middle scale impact of the point source. However, in a few cases, sufficient mixing may occur during transport of the emissions from the source to the ground so that the category (a) station represents a neighborhood scale. The required category (b) station must be a neighborhood scale station since the microscale and middle scale station would not represent the air quality over large geographical areas and frequently may not be located in highly populated areas. It is recognized that in certain areas, a middle scale station may be located at schools or playgrounds near major roadways. However, in most cases, they are not located in such areas and since children (7) are the segment of the population most susceptible to the effects of lead and are more likely to live and play in the residential section of the urban area, the category (b) station should be located in residential areas having a combination of high population and traffic density. In the case where lead levels come primarily from point sources, the category (b) station generally

represents a neighborhood scale impact of the point source.

To locate monitoring stations, it will be necessary to obtain background information such as stationary and mobile source emissions inventories, morning and evening traffic patterns, 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. Reference 9 provides additional guidance on locating sites to meet specific urban area monitoring objectives and must 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.

Guidance on locating monitoring stations in the vicinity of stationary lead sources is given in reference 10. This reference provides assistance in designing a network to meet the monitoring objective of determining the impact of point sources on ambient Pb levels.

2.8 PM_{10} Design Criteria for SLAMS

As with other pollutants measured in the SLAMS network, the first step in designing the PM_{10} network is to collect the necessary background information. Various studies^{11, 12, 13, 14, 15, 16} have documented the major source categories of particulate matter and their contribution to ambient levels in various locations throughout the country. Because the sources for PM_{10} are similar to those for TSP, the procedures for collecting the necessary background information for PM_{10} are also similar. 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 PM_{10} have been identified on a map, modeling may be used to provide an estimate of PM_{10} concentrations throughout the area of interest. After completing the first step, existing TSP SLAMS or other particulate matter stations should be evaluated to determine their potential as candidates for SLAMS designation. Stations meeting one or more of the four 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 PM_{10} stations, the procedures in reference 17 should be used.

If existing TSP samplers meet the quality assurance requirements of appendix A, the PM_{10} siting requirements of appendix E, and are located in areas of suspected maximum concentrations are described in section 3 of appendix D, and if the TSP levels are below the ambient PM_{10} standards, TSP samplers may continue to be used as substitutes for PM_{10} SLAMS samplers under the provisions of section 2.2 of appendix C.

The most important spatial scales to effectively characterize the emissions of PM_{10} from both mobile and stationary sources are the micro, middle and neighborhood scales. For purposes of establishing monitoring stations to represent large homogenous areas other than the above scales of representativeness, urban or regional scale stations would also be needed.

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. Because of the very steep ambient PM_{10} gradients resulting from mobile sources, the dimensions of the microscale for PM_{10} generally would not extend beyond 15 meters from the roadway, but could continue the length of the roadway which could be several kilometers. Microscale PM_{10} 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 "hotspot" control measures.

Middle Scale—Much of the measurement of short-term public exposure to PM_{10} is on this 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 public health effects of particulate matter pollution. 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.

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 PM₁₀ concentrations, as well as the land use and land surface characteristics. 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. This category also includes industrial and commercial neighborhoods, as well as residential.

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.

Urban Scale—This class of measurement would be made to characterize the PM₁₀ concentration over an entire metropolitan area. Such measurements would be useful for assessing trends in city-wide air quality, and hence, the effectiveness of large scale air pollution control strategies.

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 PM₁₀ emissions, losses and transport.

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 and PM₁₀, neighborhood scale for SO₂, and NO₂, and urban scale for O₃).

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 NO₂). 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 TSP and SO₂ 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 non-attainment 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 (SO₂) 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 SO₂ 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 SO₂ 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 and Radiation (OAR).

TABLE 3—SO₂ 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 SO₂ NAMS which would be required nationwide ranges from approximately 200 to 300. This number of NAMS SO₂ monitors is sufficient for national trend purposes due to the low background SO₂ levels, and the fact that air quality is very sensitive to SO₂ 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 SO₂ 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 SO₂ NAMS (see Table 3). This includes SO₂ air quality levels within populated parts of urbanized areas, that are affected by one or two point sources of SO₂ if the impact of the source(s) extends over a reasonably broad geographic scale (neighborhood or larger). Maximum SO₂ 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 TSP, and perhaps, SO₂, 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).

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 (O₃) 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 O₃ 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 O₃ 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 (NO₂) 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 NO₂ 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 NO₂ 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 NO₂ 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 NO₂ produced from the reaction of NO with O₃ 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, two of the SLAMS located in urbanized areas with populations greater than 500,000 will be designated as NAMS. One of the stations must be a microscale or middle scale category (a) station, located adjacent to a major roadway (≥30,000 ADT) or near the roadway with the largest traffic volume if the volume is less than 30,000 ADT. A microscale location is preferred, but a middle scale is also acceptable if a suitable microscale location cannot be found.

The second station must be a neighborhood scale category (b) station located in a highly populated residential section of the urbanized area where traffic density is high, preferably (≥30,000 ADT) or near the roadway with the largest traffic volume if the volume is less than 30,000 ADT.

In certain urbanized areas greater than 500,000 population, point sources may have a significant impact on air quality lead levels in populated areas. To measure the impact of such sources, other monitors in the SLAMS network would normally be used.

3.7 PM₁₀, Design Criteria for NAMS

Table 4 indicates the approximate number of permanent stations required in urban areas to characterize national and regional PM₁₀ air quality trends and geographical patterns. The number of stations in areas where urban 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.

It is recognized that no PM₁₀ samplers will be designated as PM₁₀ reference or equivalent methods until, at the earliest, approximately six months after promulgation of PM₁₀ NAAQS and the reference and equivalent method requirements. Even though non-designated PM₁₀ samplers will have been commercially available, and a small number of samplers will have been in use by EPA, other agencies, and industry, there will not be enough ambient PM₁₀ data to determine ambient PM₁₀ levels for all areas of the country. Accordingly, EPA has provided guidance¹⁸ on converting ambient IP₁₅ data to ambient PM₁₀ data. Ambient IP₁₅ data are data from high volume samplers utilizing quartz filters or dichotomous samplers, both with inlets designed to collect particles nominally 15 μm and below. Also included in the guidance are procedures for calculating from ambient TSP data the probability that an area will be nonattainment for PM₁₀. For determining the appropriate number of NAMS per area, the converted IP₁₅ data or the probabilities of PM₁₀ nonattainment are used in Table 4, unless ambient PM₁₀ data are available. If only one monitor is required

in an urbanized area, it must be a category (a) type. 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 urban areas 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 PM₁₀ ambient levels. If an evaluation of the sources of PM₁₀ as described in section 2.8 indicates that the maximum concentration area is predominantly influenced by roadway emissions, then the category (a) station should be located adjacent to a major road and should be a microscale or middle scale. A microscale is preferable but a middle scale is also acceptable if a suitable microscale location cannot be found. However, if the predominant influence in the suspected maximum concentration area is expected to be industrial emissions, and/or combustion products (from other than an isolated single source), the category (a) station should be a middle scale or neighborhood scale. A middle scale exposure is preferable to a neighborhood scale in representing the maximum concentration impact from multiple sources, other than vehicular, but a neighborhood scale is acceptable, especially in large residential areas that burn oil, wood, and/or coal for space heating.

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 one station for category (b) neighborhood scale objectives as discussed in section 3. Where three or more stations are required, the mix of category (a) and (b) stations is to be determined on a case-by-case basis. 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 insure 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. As required under the provisions of section 2.2 of appendix C, all PM₁₀ NAMS that were previously designated as TSP NAMS must concurrently collect ambient TSP and PM₁₀ data for a one-year period beginning when each NAMS PM₁₀ sampler is put into operation.

TABLE 4—PM₁₀ NATIONAL AIR MONITORING STATION CRITERIA

[Approximate Number of Stations per Area]^a

Population category	High concentration ^{b, c}	Medium concentration ^{c, e}	Low concentration ^{d, e}
>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
100,000-250,000	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 areas are those for which: Ambient PM₁₀ data or ambient IP_{1.5} data converted to PM₁₀ show ambient concentrations exceeding either PM₁₀ NAAQS by 20 percent or more; or the probability of PM₁₀ nonattainment, calculated from TSP data, is 95 percent or greater.

^c Medium concentration areas are those for which: Ambient PM₁₀ data or ambient IP_{1.5} data converted to PM₁₀ show ambient concentrations exceeding either 80 percent of the PM₁₀ NAAQS, or the probability of PM₁₀ nonattainment, calculated from TSP data, is ≥20 percent and <95 percent.

^d Low concentration areas are those for which: Ambient PM₁₀ data or ambient IP_{1.5} data converted to PM₁₀ show ambient concentrations less than 80 percent of the PM₁₀ NAAQS; or the probability of PM₁₀ nonattainment, calculated from TSP data, is less than 20 percent.

^e Procedures for estimating ambient PM₁₀ concentrations from IP_{1.5} ambient air measurements or for estimating the probability of nonattainment for PM₁₀ given observed TSP data are provided in reference 18.

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

In order to obtain more comprehensive and representative data on O₃ air pollution, the 1990 Clean Air Act Amendments require enhanced monitoring for ozone (O₃), oxides of nitrogen (NO, NO₂, and NO_x), and monitoring for VOC in O₃ 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 O₃ exceedances and providing input for attainment/nonattainment decisions. In addition, PAMS data will help resolve the roles of transported and locally emitted O₃ precursors in producing an observed exceedance and may be utilized to identify specific sources emitting excessive concentrations of O₃ precursors and potentially contributing to observed exceedances of the O₃ NAAQS. The

PAMS data will enhance the characterization of O₃ concentrations and provide critical information on the precursors which cause O₃, 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 O₃ 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 photo-

chemical 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 O₃ trends database. Multiple statistical indicators will be tracked, including O₃ and its precursors during the events encompassing the days during each year with the highest O₃ 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 O₃ and O₃ 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 O₃ 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 O₃, 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 O₃ precursor source areas and predominant wind directions associated with high O₃ events. Specific monitoring objectives are associated with each location. The overall design should enable characterization of precursor emission sources within the area, transport of O₃ and its precursors into and out of the area, and the photochemical processes related to O₃ 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 O₃, NO, NO₂, NO_x, VOC (including carbonyls), and VOC species, determining spatial and diurnal variability of O₃, NO, NO₂, 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 O₃ 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 O₃ 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 O₃ days or on those days which exhibit the potential for producing high O₃ levels, i.e., O₃-conductive 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 O₃ 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 NO₂ and O₃.

Type (3) sites are intended to monitor maximum O₃ 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 O₃ days or on those days which exhibit the potential for producing high O₃ 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 O₃ (this site may coincide with an existing maximum concentration O₃ monitoring site),
- Evaluation of future photochemical grid modeling applications,
- Future development and evaluation of control strategies,
- Development of pollutant trends, and
- Characterization of O₃ pollutant exposures.

Type (4) sites are established to characterize the extreme downwind transported O₃ 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 O₃ 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

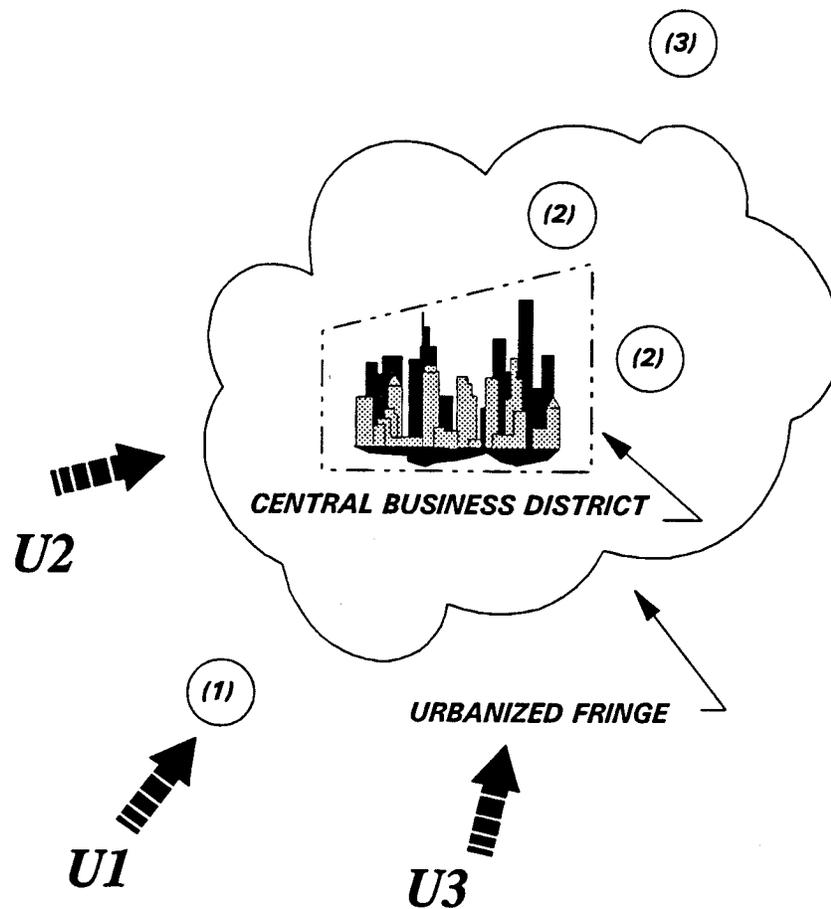
schemes for specifying the location of this site may be submitted as a part of the network description required by §§58.40 and 58.41. Data measured at type (4) sites will be used principally for the following purposes:

- Development and evaluation of O₃ 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 non-attainment area, irrespective of its proximity to other affected areas, must fulfill the requirements for isolated areas as described in section 4 of appendix D, as an example,

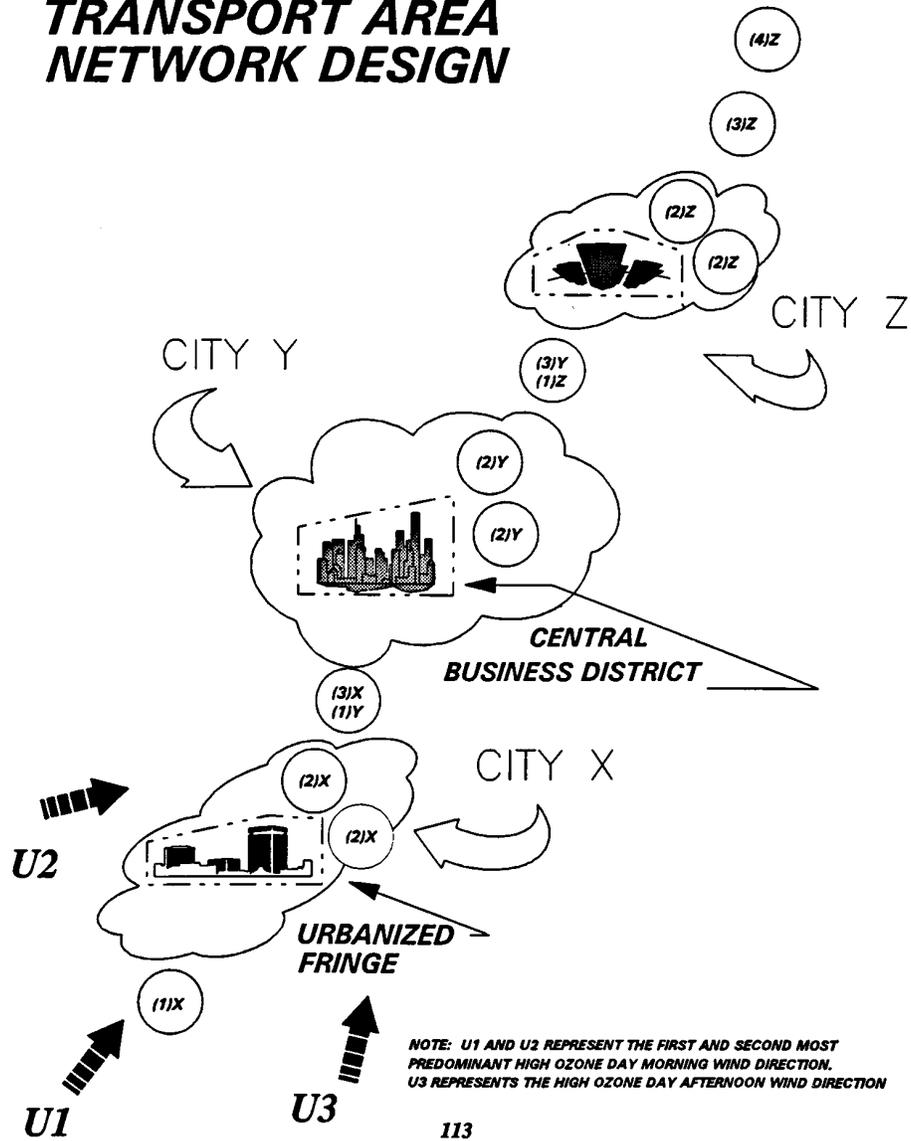
and illustrated by Figure 1. States containing areas which experience significant impact from long-range transport or are proximate to other nonattainment areas (even in other States) should collectively submit a network description which contains alternative sites to those that would be required for an isolated area. Such a submittal should, as a guide, be based on the example provided in Figure 2, 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 appendix D. EPA recognizes that specific monitoring sites identified for one area may serve to fulfill the monitoring objectives for a different site in another area; for example, a downwind site for one area may suffice as an upwind site for another. These alternative network designs must also be reviewed and approved by the Administrator.

FIGURE 1 - ISOLATED AREA NETWORK DESIGN (4)



NOTE: U1 AND U2 REPRESENT THE FIRST AND SECOND MOST PREDOMINANT HIGH OZONE DAY MORNING WIND DIRECTION. U3 REPRESENTS THE HIGH OZONE DAY AFTERNOON WIND DIRECTION.

FIGURE 2 - MULTI-AREA AND TRANSPORT AREA NETWORK DESIGN



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 O₃ transport. The alternative PAMS data should be usable for the corroboration and verification of O₃ 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 O₃ 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 O₃ 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 O₃ values are expected in each area; however, precursor monitoring during the entire O₃ 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 O₃ monitors must adhere to the O₃ 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 encom-

passes 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 O₃ 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 O₃ non-attainment 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	D or F ⁵
	(2)	A or C	
500,000 to 1,000,000	(1)	A or C	E
	(2)	B	
	(3)	A or C	
1,000,000 to 2,000,000	(1)	A or C	E
	(2)	B	
	(3)	A or C	
More than 2,000,000	(1)	A or C	E
	(2)	B	
	(3)	A or C	
	(4)	A or C	

¹ O₃ and NO_x (including NO and NO₂) monitoring should be continuous measurements.

² Whichever area is larger.

³ See Figure 1.

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 O₃ 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 O₃ 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 O₃ precursor emissions and toxic air pollutants,
- The type (3) site which provides a maximum O₃ measurement and total conversion of O₃ precursors,
- The type (1) site which delineates the effect of incoming precursor emissions and concentrations of O₃ 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 O₃ precursor emissions and toxic air pollutants in the second-most predominant morning wind direction on high O₃ days.

Note also that O₃ event (peak day) monitoring will require the development of a scheme for forecasting such high O₃ days or will necessitate the stipulation of what meteorological conditions constitute a potential high O₃ day; monitoring could then be triggered only via meteorological projections. The O₃ 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 O₃ nonattainment area to serious, severe, or extreme, or (3) the designation of a new area

and classification to serious, severe, or extreme O₃ 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 O₃ nonattainment area to serious, severe, or extreme, or (3) the designation of a new area and classification to serious, severe, or extreme O₃ 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 5 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, where additional scales may be allowed for NAMS purposes.

TABLE 5—SUMMARY OF SPATIAL SCALES FOR SLAMS AND REQUIRED SCALES FOR NAMS

Spatial Scale	Scale Applicable for SLAMS						Scales Required for NAMS					
	SO ₂	CO	O ₃	NO ₂	Pb	PM ₁₀	SO ₂	CO	O ₃	NO ₂	Pb	PM ₁₀
Micro		✓				✓		✓				✓
Middle	✓	✓	✓		✓	✓					✓	✓
Neighborhood	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Urban	✓		✓	✓	✓	✓			✓	✓		
Regional	✓		✓		✓	✓						✓

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EFFECTIVE DATE NOTE: At 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. A notice will be published in the FEDERAL REGISTER once approval has been obtained.

APPENDIX E—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 (SO₂), Ozone (O₃), and Nitrogen Dioxide (NO₂)

Open path analyzers may be used to measure SO₂, O₃, and NO₂ at SLAMS/NAMS sites for middle, neighborhood, urban, and regional scale measurement applications. Additional information on SO₂, NO₂, and O₃ 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 SO₂ and O₃ Monitoring Only)

Local minor sources of SO₂ can cause inappropriately high concentrations of SO₂ in the vicinity of probes and monitoring paths for SO₂. Similarly, local sources of nitric oxide (NO) and ozone-reactive hydrocarbons can have a scavenging effect causing unrepresentatively low concentrations of O₃ in the vicinity of probes and monitoring paths for O₃. 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 SO₂ 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 SO₂ near a point source of SO₂ 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 SO₂, O₃, or NO₂. 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 SO₂, O₃, or NO₂ 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 O₃ than for other criteria pollutants, strong consideration of this effect must be given to locating an O₃ probe or monitoring path to avoid this problem.

2.5 Spacing From Roadways (Applicable to O₃ and NO₂ Only)

In siting an O₃ analyzer, it is important to minimize destructive interferences from sources of NO, since NO readily reacts with O₃. In siting NO₂ 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 $3\pm\frac{1}{2}$ 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. Several studies (5, 14-15) on the relationship between roadway placement of lead samplers and measured ambient concentrations do not typically indicate large gradients within the first 6 to 7 meters above ground level. Similar to monitoring for other pollutants, optimal placement of the sampler inlet for lead 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 lead monitor. Given these considerations, the sampler inlet for microscale lead 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. Numerous 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

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

Roadway average daily traffic vehicles per day	Separation distance between roadways and stations, meters		
	Micro-scale	Middle scale	Neighborhood urban regional scale
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 lead particles and obstruct normal wind flow patterns. For microscale and middle scale category (a) roadway sites there must not be any tree(s) between the source of the lead, i.e., the vehicles on the roadway, 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 (PM₁₀)

8.1 Vertical Placement—Although there are limited studies on the PM₁₀ 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. PM₁₀, 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 PM₁₀ 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 PM₁₀ monitor. Given these considerations, the sampler inlet for microscale PM₁₀ 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.

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 deposition 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 PM₁₀ sampler siting.

The intent is to locate category (a) NAMS sites in areas of highest concentrations

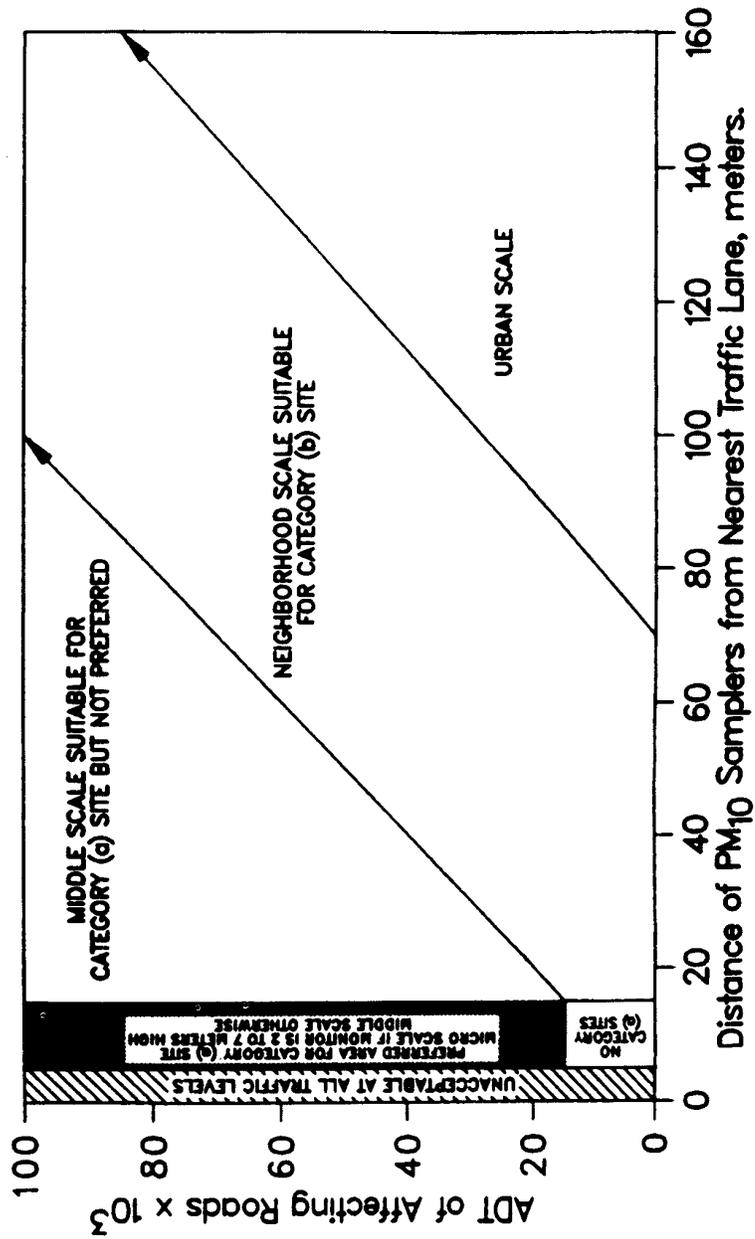
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whether it be from mobile or multiple stationary sources. If the area is primarily affected by mobile sources and the maximum concentration area(s) is judged to be a traffic corridor or street canyon location, then the monitors should be located near 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 be-

tween 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_{10} 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 PM₁₀ 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, SO₂, NO₂, and O₃, special probe material must be used for point analyzers. Studies²⁰⁻²⁴ 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 EPA²⁵ 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 studies²⁷⁻²⁸ 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

²⁰⁻²⁸ See References at end of this appendix.

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.

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 O₃. 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 O₃ 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.
^AMonitoring path for open path analyzers is applicable only to middle or neighborhood scale CO monitoring and all applicable scales for monitoring SO₂, O₃, O₃ precursors, and NO₂.
^BWhen probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouses located on roof.
^CShould 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.
^DDistance 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).
^EMust have unrestricted airflow 270° around the probe or sampler; 180° if the probe is on the side of a building.
^FThe 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.
^GFor microscale CO monitoring sites, the probe must be >10 meters from a street intersection and preferably at a midblock location.
^HFor collocated Pb and PM–10 samplers, a 2–4 meter separation distance between collocated samplers must be met.

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APPENDIX F—ANNUAL SLAMS AIR QUALITY INFORMATION

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2. Required information
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 - 2.1.1 Site and Monitoring Information
 - 2.1.2 Annual Summary Statistics
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 - 2.2.1 Site and Monitoring Information
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 - 2.7 Particulate Matter (PM₁₀)
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 - 2.7.2 Annual Summary Statistics
 - 2.7.3 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, Fed-

eral 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/m³ rounds to 101 ug/m³ and 0.1245 ppm rounds to 0.12 ppm.

2.1 Sulfur Dioxide (SO₂)

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 ($\mu\text{g}/\text{m}^3$) 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 ($\mu\text{g}/\text{m}^3$)
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 ($\mu\text{g}/\text{m}^3$)
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 ($\mu\text{g}/\text{m}^3$) 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 ($\mu\text{g}/\text{m}^3$)
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 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]

APPENDIX G—UNIFORM AIR QUALITY INDEX AND DAILY REPORTING

1. General.
2. Definitions.
3. Monitoring data.
4. Geographic applicability.
5. Daily index report.
6. Prominent public notice.
7. Uniform air quality index.
 - 7.1 Uniform index computation.
 - 7.2 Example computation.
8. Exceptions.
9. Reporting agency recordkeeping.
10. Basis for PSI.
11. Additional information.
12. References.

1. *General.* This appendix describes the uniform air quality index to be used by States in reporting the daily air quality index required by §58.40.

2. *Definitions*

a. The uniform air quality required for the daily reporting of air quality is a modified form of the Pollutant Standards Index (PSI).

b. *Reporting agency* means the applicable State agency or, in metropolitan areas, a local air pollution control agency designated by the State to carry out the provisions of §58.40.

c. *Reporting area* means the geographical area for which the daily index is representative for the reporting period. This area(s) may be the total urban area (or subpart thereof) or each of any number of distinct geographical subregions of the urban area deemed necessary by the reporting agency for adequate presentation of local air quality conditions.

d. *Reporting day* means the calendar day during which the daily report is given.

e. *Reporting period* means the time interval for which the daily report is representative. Normally, the reporting period is the 24-hour period immediately preceding the time of the report and should coincide to the extent practicable with the reporting day. In cases where the index will be forecasted the reporting period will include portions of the reporting day for which no monitoring data are available at the time of the report.

f. *Critical pollutant* means the pollutant with the highest subindex during the reporting period.

g. *Subindex* means the calculated index value for a single pollutant as described in section 7.

3. *Monitoring Data*

The monitoring data used to prepare the daily index report must be based on data obtained from the SLAMS network (or portions thereof) required under 40 CFR 58.20. Air quality measurements need not be made on reporting days for which the agency does not ordinarily schedule monitoring to occur. For example, PM₁₀ measurements are to be included in the index calculations on days for which data are required (minimum of one sample per 6 days), but may be excluded on other days. PM₁₀ measurements from samplers other than the reference or equivalent method sampler, may be included in index calculations provided such measurements can be quantitatively related to reference or equivalent method measurements.

Data used to calculate the daily index (and respective subindices) should come from the most recent sampling period. The index should be based on data obtained during the 24-hour period for which the index is reported. No monitoring data are to be used for index calculations for which the end of the sampling period precedes the reporting day by more than 24-hours. To the extent practicable, agencies should forecast the index using whatever procedures are most accurate and reasonable through consideration of local meteorological and topographical conditions and the availability of data and forecasting expertise.

4. *Geographic Applicability*

Generally, the area contained within the geographic boundaries of the urban area is sufficient for purposes of calculating and reporting the index. The exception occurs in cases where a significant air quality problem exists (PSI greater than 100) in highly populated areas adjacent to, but outside of, the urban area. For example, ozone concentrations are often highest downwind and outside the urban area.

Agencies should report a separate air quality index for each subregion of the urban area which is likely to have air quality significantly different from other portions of the urban area if such data are readily available. At a minimum, the subregion subject to the highest index values shall be included in the index computation. This subregion shall be selected by the reporting agency after past air quality has been reviewed to determine which monitoring stations typically record the highest pollutant concentrations.

5. *Daily Index Report*

The daily index report must be based on the uniform air quality index described in section 7 and contain the following information: (1) The reporting area(s); (2) the report-

ing period; (3) the critical pollutant; (4) the subindex corresponding to the critical pollutant; and (5) the descriptor word according to the following system:

Index Range and Descriptor Category

0 to 50.....	"Good"
51 to 100.....	"Moderate"
101 to 199.....	"Unhealthful"
200 to 299.....	"Very Unhealthful"
300 and above.....	"Hazardous"

Reporting agencies should, at their discretion, report additional information such as the following: (1) Pollutants other than the critical pollutants and their individual subindices; (2) subindices and respective pollutant names for each of a number of distinct reporting areas within the urban area; (3) actual pollutant concentration values; and (4) causes for unusual PSI readings, such as high background air quality levels and other natural phenomena.

6. *Prominent Public Notice*

The reporting agency shall make prominent public notice of the daily index report on at least 5 days per week. Prominent public notification consists of at a minimum: (1) Furnishing the daily report to one or more of the appropriate news media (radio, television, newspapers); and (2) making the daily index report publicly available at one or more places of public access. Index reports also may be disseminated by means of recorded messages.

7. *Uniform Air Quality Index*

The uniform index is based on the pollutants standards index (PSI) structure (see section 10), which includes the five pollutants for which primary National Ambient Air Quality Standards (NAAQS) have been established. These pollutants are: Particulate matter (PM₁₀), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃) and nitrogen dioxide (NO₂). For each pollutant, a subindex is calculated from a segmented linear function that transforms ambient concentrations onto a scale extending from 0 through 500, with 100 corresponding to the primary NAAQS concentrations and 500 corresponding to the significant harm levels established in §51.16 of this chapter. In order to achieve relative uniformity for intermediate PSI values of 200, 300, and 400 among the several pollutants, their effects were approximately normalized by using the breakpoints corresponding to the Alert, Warning and Emergency levels in the example episode criteria. (1) However, because many factors, including meteorological conditions, are taken into account before triggering episode control actions, the reported PSI values and the calling of an episode do not always correspond. It should be recognized that over time with new information on effects, the actual concentrations corresponding to the PSI values

may change. The PSI values themselves and their health implications, however, should remain the same. Similarly, concentrations and conditions leading to administrative episode actions may change.

The breakpoint used in defining each of the five pollutant subindices are listed in gravimetric units (Table 1) and in volumetric units (Table 2). The individual computational scheme is defined below for calculating the pollutant subindex values.

7.1 Uniform index computation. Each subindex i , is calculated by using a segmented linear function (Figures 1-6) that relates pollutant concentration, X_i , to subindex value, I_i . A segmented linear function consists of straight-line segments joining discrete coordinates (i.e., breakpoints). For pollutant i and segment j , the coordinates of the j th breakpoint are represented by subindex value $I_{i,j}$ and concentration $X_{i,j}$ giving the ordered pair $(X_{i,j}, I_{i,j})$. If the observed concentration is X_i , the corresponding subindex value I_i is calculated using the following equation over the concentration range:

$$X_{i,j} \leq X_i \leq X_{i,j+1}$$

$$I_i = \frac{I_{i,j+1} - I_{i,j}}{X_{i,j+1} - X_{i,j}} (X_i - X_{i,j}) + I_{i,j} \quad (1)$$

for $X_{i,j} \leq X_i \leq X_{i,j+1}$

$$I_i = \frac{I_{1,3} - I_{1,2}}{X_{1,3} - X_{1,2}} (283 - X_{1,2}) + I_{1,2} = \frac{200 - 100}{350 - 150} (283 - 150) + 100 = \frac{100}{200} \times 133 + 100 = 167$$

Therefore, the PM_{10} subindex is $I=167$. If four other pollutant subindices calculated in a similar manner from observations on the same data were: $I_2=0$, $I_3=0$, $I_4=20$, and $I_5=30$, then the overall index is reported as the maximum of these values:

$$PSI = \max(167, 0, 0, 20, 30) = 167$$

where X_i = observed concentration for i th pollutant

$I_{i,j}$ = PSI value for i th pollutant and j th breakpoint (Table 1 or 2)

$I_{i,j+1}$ = PSI value for i th pollutant and $(j + 1)$ th breakpoint (Table 1 or 2)

$X_{i,j}$ = concentration for i th pollutant and j th breakpoint (Table 1 or 2)

$X_{i,j+1}$ = concentration for i th pollutant and $(j + 1)$ th breakpoint (Table 1 or 2)

Finally, the overall index is calculated as the maximum of subindices:

$$PSI = \max (I_1, I_2, \dots, I_i, \dots, I_n)$$

n = number of pollutants (including pollutant combinations)

7.2 Example computation. Suppose a PM_{10} 24-hour concentration of $283 \mu\text{g}/\text{m}^3$ is observed. The PM_{10} subindex is calculated using equation 1 as follows: In Table 1, the observed concentration of $X_i=283 \mu\text{g}/\text{m}^3$ lies between 150 and $350 \mu\text{g}/\text{m}^3$, therefore this computation is carried out for the second segment ($j=2$). For this segment, $X_{1,2}=150$ and $X_{1,3}=350$, with corresponding subindex values for $I_{1,2}=100$ and $I_{1,3}=200$. The computation is as follows:

where

I_i = subindex for i th pollutant

A typical report might contain the following statement: "Today's air quality index is 161 which is regarded as unhealthy. The responsible pollutant is particulate matter. This report represents conditions prevailing over most of the downtown urban area for the previous 24-hour period ending at noon today." If the index were forecast for the

next day, the following additional language might also be used: "The current forecast is for improved air quality tomorrow with the index not expected to exceed 80."

8. *Exceptions.*

In many urban areas, a given air pollutant may exhibit low concentrations repetitively. At the discretion of the reporting agency, pollutants for which PSI values are consistently below 50 for an extended period (for example, a season or year) may be excluded in calculations of the daily index. Also, in situations where the PSI value has not exceeded 50, as calculated by the critical pollutant, for the previous calendar year, the requirement to measure and report the PSI will be left up to the discretion of the reporting agency.

Because the index is for the purpose of achieving national uniformity of daily air quality reports, the following variations are not permitted unless approved by the EPA Administrator:

- a. Exclusion of pollutants described in section 7 from index calculations except as permitted above.
- b. Incorporation of pollutants and/or pollutant combinations into the index not described in section 7.
- c. Use of breakpoints other than those given in Table 1 or 2.
- d. Use of descriptor words other than those given in section 5.

9. *Reporting Agency Recordkeeping.*

The reporting agency shall keep annual records of the frequency with which reporting index values occur in each of the index descriptor categories. These records must also indicate the pollutant monitors in the SLAMS network being used for purposes of calculating the index for each reporting area. Such records must be made available for inspection at the request of the Administrator.

10. *Basis for PSI.*

The development and evaluation of the PSI index structure have been documented extensively. (2-12) The index was created as a result of a joint EPA/CEQ study (2) which identified problems resulting from the diversity of indices used in the United States and Canada. This report proposed design principles that could be used to develop a nationally uniform index to meet the needs of State and local agencies. The design principles on which PSI is based, along with previous versions of the index, have been presented in various scientific reports, (3, 4) articles in technical journals, (4, 5, 11) and at various scientific meetings and conferences. (7-10) Most recently, the history of the development of PSI along with its scientific rationale, has been summarized in a book. (6) In September 1976, PSI was published in the FEDERAL REGISTER (13) for use by State and

local air pollution control agencies on a voluntary basis.

11. *Additional Information*

A variety of computational techniques have been developed to assist the user in calculating PSI in an accurate, convenient and rapid manner. (6) The primary techniques available are graphs (linear and logarithmic), nomograms, tables, and computer approaches. An EPA report (14) describes each technique, lists its advantages and disadvantages, includes examples of the methods, and provides nomograms and tables in both gravimetric and volumetric units. The nomograms are considered to be the most efficient way of computing the index and should be of greatest assistance to State and local agencies. Computer approaches for calculating PSI also are available. (15) These approaches lend themselves to applications with programmable hand calculators, mini-computers, or large-scale digital computers. A general computer program, Index Plot, used in an earlier evaluation of PSI, (11) is available from EPA and is fully documented. (15) This computer program is useful for analyzing air quality data by means of PSI over relatively long periods (a month, a season, or a year). It plots the time series of daily index values on the line printer, generates and plots a histogram and cumulative frequencies of PSI values, computes summary data by subindex and descriptor category, computes overall statistics for PSI, and inventories all missing values in the data set. Agencies can use this program to translate all historical data collected at any station into the corresponding PSI values, and, thus, retain for recordkeeping purposes a uniform retrospective record of air quality. (11, 15) Requests for these reports should be addressed to the Environmental Protection Agency, Library, MD-35, Research Triangle Park, NC 27711.

Additional information on descriptive language to report with the index is provided in an earlier report (1) and in the air quality criteria documents published for each air pollutant. (16-20) Additional information on meteorological forecasting services from the National Weather Service also is available in the literature. (21, 22)

Additional information on the health effects of each air pollutant used in PSI is available in a brochure entitled, "Measuring Air Quality: The New Pollutant Standards Index," Printing Management Office (PM-215), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460.

12. *References*

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2. Thom, Gary C., and Wayne R. Ott., *Air Pollution Indices: A Compendium and Assessment of Indices Used in the United States and Canada*, joint study supported by the Council on Environmental Quality and the U.S. Environmental Protection Agency, December 1975, and reprinted by Ann Arbor Science Publishers, Ann Arbor, MI, 1976.
3. "A Recommended Air Pollution Index," report prepared by the Federal Interagency Task Force on Air Quality Indicators, Council on Environmental Quality, Environmental Protection Agency, and Department of Commerce, September 1976.
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13. FEDERAL REGISTER, Vol. 41, September 7, 1976, pp. 37660-37671.
14. Wallace, Lance A., and Wayne R. Ott, "Rapid Techniques for Calculating the Pollutant Standards Index (PSI)," U.S. Environmental Protection Agency, Washington, DC Report No. EPA-600/4-78-002, March 1978.
15. Ott, Wayne R., "A FORTRAN Program for Computing the Pollutant Standards Index (PSI)," U.S. Environmental Protection Agency, Washington, DC, Report No. EPA-600/4-78-001, May 1978.
16. "Air Quality Criteria for Particulate Matter," USDEHEW, PHS, CPEHS, NAPCA, Washington, DC, January 1969, No. AP-49.
17. "Air Quality Criteria for Sulfur Oxides," USDHEW, PHS, CPEHS, NAPCA, Washington, DC, January 1969, No. AP-50.
18. "Air Quality Criteria for Carbon Monoxide," USDHEW, PHS, CPEHS, Washington, DC, March 1970, No. AP-42.
19. "Air Quality Criteria for Photochemical Oxidants," USDHEW, PHS, CPEHS, Washington, DC, March 1970, No. AP-63.
20. "Air Quality Criteria for Nitrogen Dioxide," EPA, APCO, Washington, DC, January 1971, No. AP-84.
21. *National Weather Service Operations Manual Air Pollution Weather Forecasts*, WSOM Issuance 75-13, Part C, Chapter 30, April 1975.
22. *National Weather Service Technical Procedures Bulletin* No. 122: "Air Stagnation Guidance for Facsimile and Teletype (3rd Edition)," October 21, 1974. (supercedes previous TPB's Nos. 52, 58 and 69).

TABLE 1—BREAKPOINTS FOR PSI IN METRIC UNITS¹

PSI value (ψ)	24-hr. PM µg/m ³	24-hr. SO ₂ µg/m ³	8-hr. CO mg/m ³	1-hr. O ₃ µg/m ³	1-hr. NO ₂ µg/m ³
50	50	80	5	120	(²)
100	150	365	10	235	(²)
200	350	800	17	400	1,130
300	420	1,600	34	800	2,260
400	500	2,100	46	1,000	3,000
500	600	2,620	57.5	1,200	3,750

¹ At 25°C and 760 mm Hg.

² No index value reported at these concentration levels because there is no short-term NAAQS.

TABLE 2—BREAKPOINTS FOR PSI
[Parts per million]

PSI value (ψ)	24-hr. SO ₂	8-hr. CO	1-hr. O ₃	1-hr. NO ₂
50	0.03	4.5	.06	(¹)
100	0.14	9	.12	(¹)
200	0.30	15	0.2	0.6
300	0.60	30	0.4	1.2
400	0.80	40	0.5	1.6
500	1.00	50	0.6	2.0

¹ No index value reported at these concentration levels because there is no short-term NAAQS.

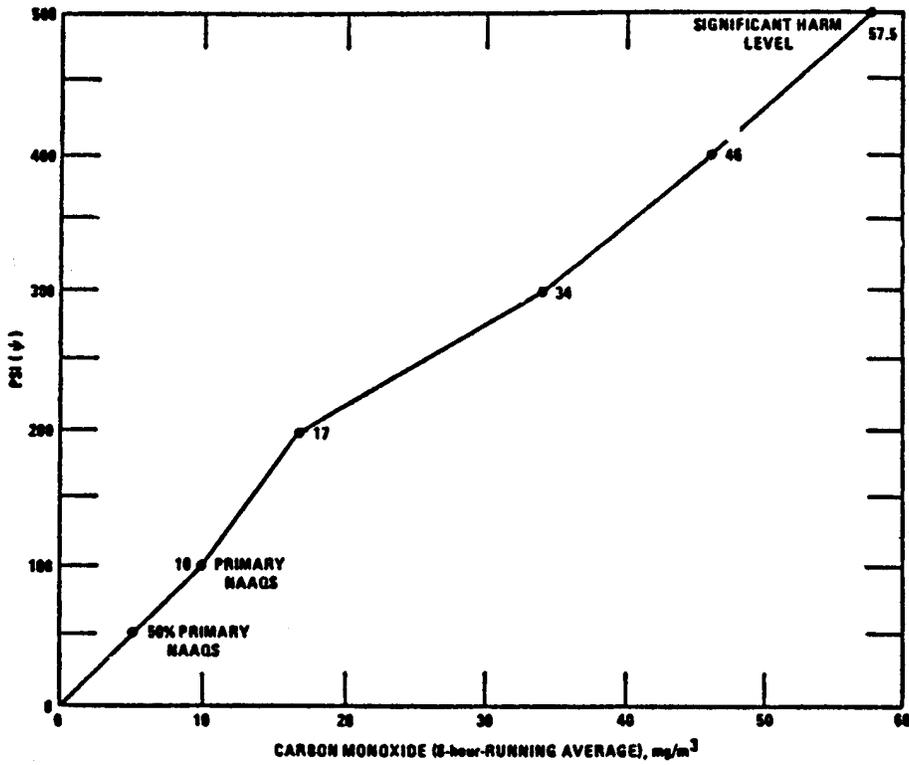


Figure 1. PSI function for carbon monoxide.

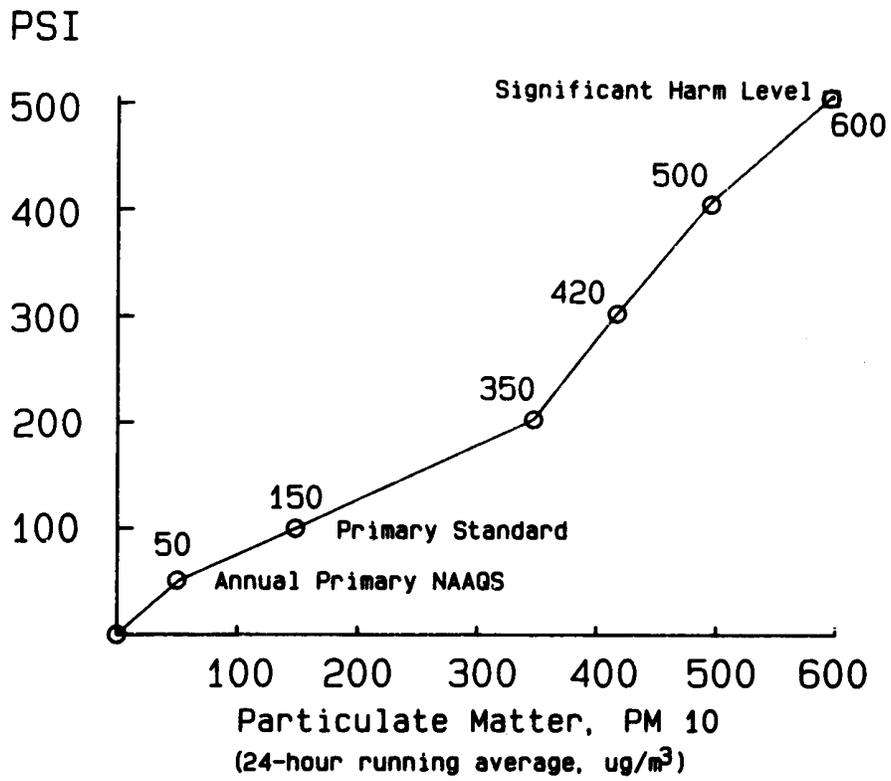


Figure 2. PSI Function for Suspended Particulate Matter, PM 10

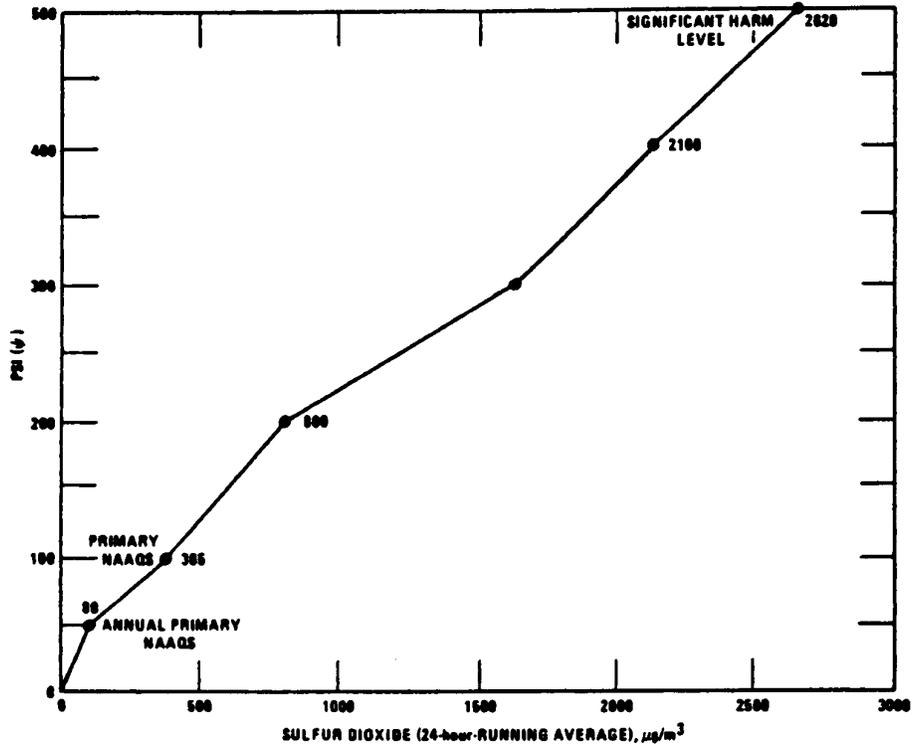


Figure 3. PSI function for sulfur dioxide.

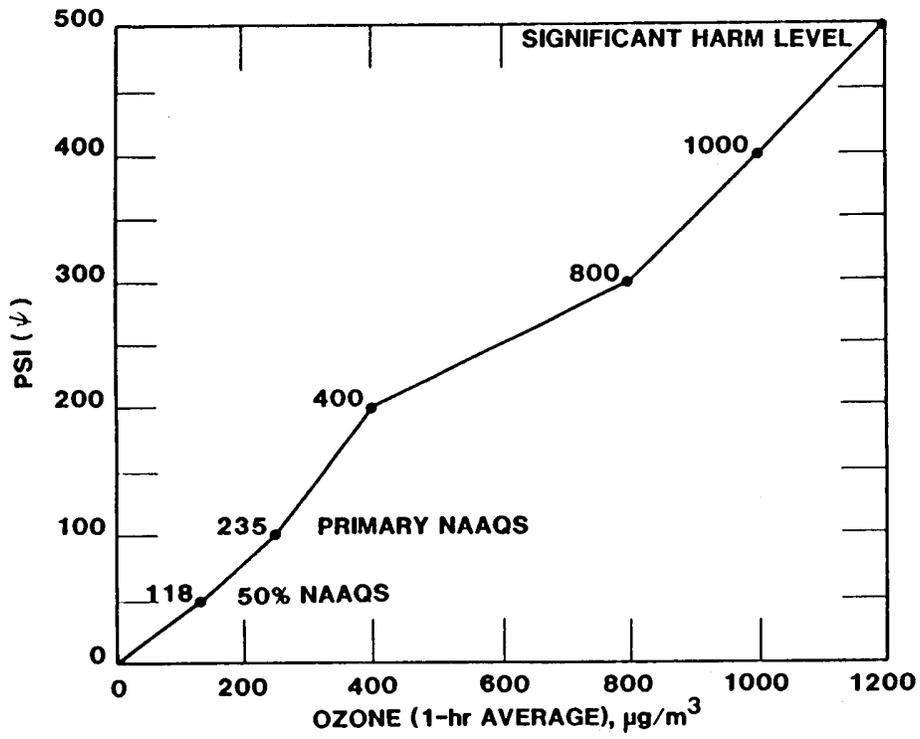


Figure 4. PSI function for ozone.

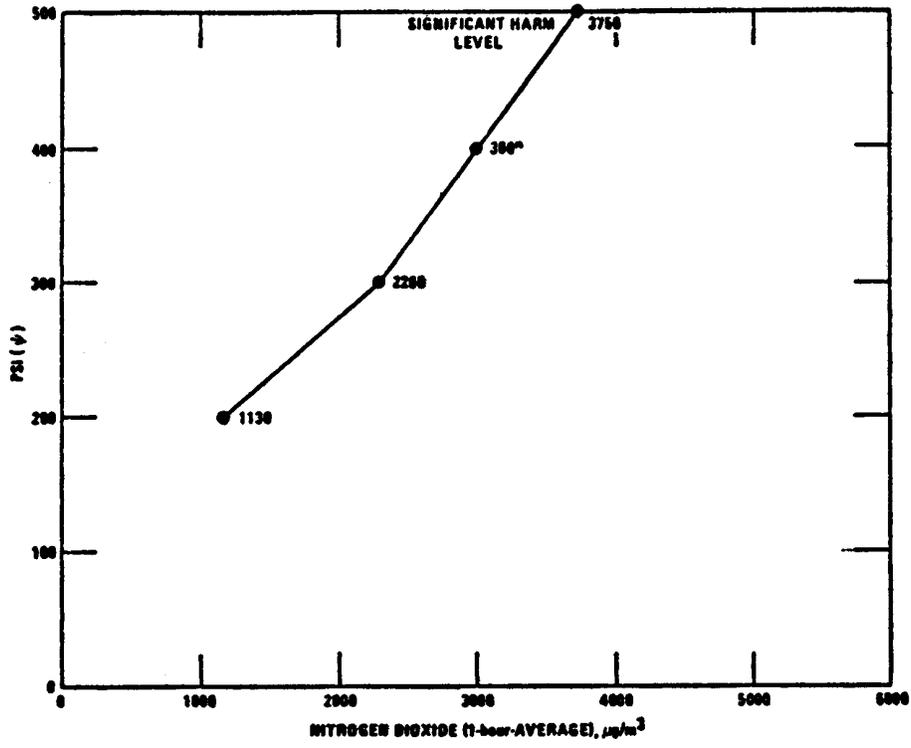


Figure 5. PSI function for nitrogen dioxide.

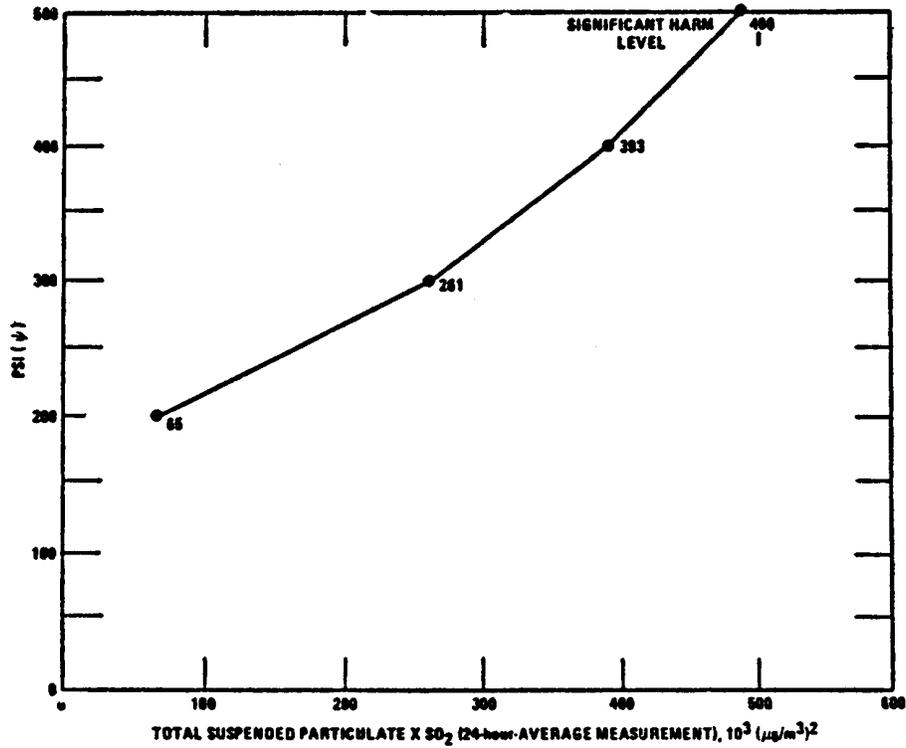


Figure 6. PSI function for product of total suspended particulate and sulfur dioxide.

[44 FR 27571, May 10, 1979; 44 FR 65070, Nov. 9, 1979; 44 FR 72592, Dec. 14, 1979, as amended at 51 FR 9600, Mar. 19, 1986; 52 FR 24749, 24750, July 1, 1987; 59 FR 41628, Aug. 12, 1994]

PART 59—[RESERVED]