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Revised Requirements for Designation of Reference and Equivalent Methods for $PM_{2.5}$ and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 53 and 58

[AD–FRL–5725–6]

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Revised Requirements for Designation of Reference and Equivalent Methods for $PM_{2.5}$ and Ambient Air Quality Surveillance for Particulate Matter

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: This final rule revises the 40 CFR part 58 ambient air quality surveillance regulations to include provisions for $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers), as measured by a new reference method being published in 40 CFR part 50, Appendix L, elsewhere in this issue of the **Federal Register** or by an equivalent method designed in accordance with requirements being promulgated in 40 CFR part 53. In addition, this rule also revises existing ambient air quality monitoring requirements for PM_{10} (particles with an aerodynamic diameter less than or equal to 10 micrometers). These revisions address network design and siting, quality assurance (QA) and quality control (QC), operating schedule, network completion, system modifications, data reporting, and other monitoring subjects.

EFFECTIVE DATE: This regulation is effective September 16, 1997.

ADDRESSES: All comments received relative to this rule have been placed in Docket A-96-51, located in the Air Docket (LE-131), Environmental Protection Agency, 401 M St., SW., Washington, DC 20460. The docket may be inspected between 8 a.m. and 5:30 p.m., Monday through Friday, excluding legal holidays. A reasonable fee may be charged for copying.

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I. Authority

Section 110, 301(a), 313, and 319 of the Clean Air Act (Act) as amended 42 U.S.C. 7410, 7601(a), 7613, 7619.

II. Introduction

A. Revision to the Particulate Matter NAAQS

Elsewhere in this issue of the **Federal Register**, EPA announced revisions to the national ambient air quality standards (NAAQS) for particulate matter (PM). In that document EPA amends the current suite of PM standards by adding $PM_{2.5}$ standards and by revising the form of the current 24–hour PM_{10} standard. Specifically, EPA is adding two primary $PM_{2.5}$ standards set at 15 $\mu g/m^3$, annual mean, and 65 $\mu g/m^3$, 24–hour average. The annual $PM_{2.5}$ standard would be met when the 3–year average of the annual arithmetic mean $PM_{2.5}$ concentrations is less than or equal to 15 $\mu g/m^3$ from single or multiple community-oriented monitors in accordance with 40 CFR part 50, Appendix K and requirements set forth in this final rule. The 24–hour $PM_{2.5}$ standard would be met when the 3–year average of the 98th percentile of 24–hour $PM_{2.5}$ concentrations at each population-oriented monitor within an area is less than or equal to 65 $\mu g/m^3$.

EPA also retained the current annual PM_{10} standard at the level of 50 $\mu g/m^3$ which would be met when the 3–year average of the annual arithmetic PM_{10} concentrations at each monitor within an area is less than or equal to 50 $\mu g/m^3$. Further, EPA retained the current 24–hour PM_{10} standard at the level of 150 $\mu g/m^3$, but revised the form such that the standard would be met when the 3–year average of the 99th percentile of the monitored concentrations at the highest monitor in an area is less than or equal to 150 $\mu g/m^3$.

In the part 50 final rule published elsewhere in this issue of the **Federal Register**, EPA is also revising the current secondary standards for PM by making them identical to the suite of primary standards. The suite of $PM_{2.5}$ and PM_{10} standards, in conjunction with the establishment of a regional haze program under section 169A of the Clean Air Act (the Act), are intended to protect against PM-related welfare effects including soiling and materials damage and visibility impairment.

As discussed in the part 50 final rule for the PM NAAQS, the $PM_{2.5}$ standards are intended to protect against exposures to fine particulate pollution, while the PM_{10} standards are intended to protect against coarse fraction particles as measured by PM_{10}.

For $PM_{2.5}$, the annual standard is intended to protect against both long- and short-term exposures to fine particle pollution. Under this approach, the $PM_{2.5}$ 24–hour standard would serve as a supplement to $PM_{2.5}$ annual standard to provide additional protection against days with high $PM_{2.5}$ concentrations, localized ''hot spots,'' and risks arising from seasonal emissions that would not be well controlled by a national annual standard.

In specifying that the calculation of the annual arithmetic mean for an area (for purposes of comparison to level of $PM_{2.5}$ annual standard) should be accomplished by comparing the annual mean from a community-oriented monitor that is representative of average community-wide exposure, or averaging the annual arithmetic means derived from multiple, community-oriented monitoring sites, EPA took into account several factors. As discussed in the part 50 final rule, many of the community-oriented epidemiologic studies examined in this review used spatial averages, when multiple monitoring sites were available, to characterize area-wide PM exposure levels and associated public health risk. In those studies that used only one monitoring location, the selected site was chosen to

represent community-wide exposures, not the highest value likely to be experienced within the community. Because the annual $PM_{2.5}$ standard is intended to reduce aggregate population risk from both long- and short-term exposures by lowering the broad distribution of PM concentrations across the community, an annual standard based on monitoring data reflecting average community wide exposure would better reflect area-wide $PM_{2.5}$ exposure levels and associated health risks than would a standard based on concentrations from a single monitor with the highest measured values in the area. The concept of average community exposures is not appropriate for PM_{10} because the spatial distribution of coarse particles is different and tends to be more localized in its behavior.

Finally, under the policy approach presented in the part 50 final rule, the 24–hour $PM_{2.5}$ standard is intended to supplement an annual $PM_{2.5}$ standard by providing protection against peak 24–hour concentrations arising from situations that would not be well-controlled by an annual standard. Accordingly, the 24–hour $PM_{2.5}$ standard will be based on the single population-oriented monitoring site within a monitoring planning area with the highest measured values.

In EPA's judgment, an annual $PM_{2.5}$ standard based on monitoring data representative of community average air quality, established in conjunction with a 24–hour standard based on the population-oriented monitoring site with the highest measured values, will provide the most appropriate target for reducing area-wide population exposure to fine particle pollution and will be most consistent with the underlying epidemiological data base.

B. Air Quality Monitoring Requirements

A new Federal Reference Method (FRM) for $PM_{2.5}$ is promulgated in a new Appendix L to 40 CFR part 50. Section 319 of the Act requires that uniform criteria be followed when measuring ambient air quality. To satisfy these requirements, EPA established procedures on February 10, 1975, in 40 CFR part 53 for the determination and designation of reference or equivalent monitoring methods (40 FR 7049). Accordingly, new provisions are added to 40 CFR part 53 so that each reference method for $PM_{2.5}$, based on a particular sampler, will be formally designed as such by EPA. Similarly, samplers demonstrated as equivalent to the FRM can also be designated. Furthermore, section 110(a)(2)(C) of the Act requires ambient air quality monitoring for purposes of the State Implementation Plans (SIPs) and for reporting data quality to EPA. Uniform criteria to be followed when measuring air quality and provisions for daily air pollution index reporting are required by section 319 of the Act.[1] To satisfy these requirements, on May 10, 1979 (44 FR 27558), EPA established 40 CFR part 58 which provided detailed requirements for air quality monitoring, data reporting, and surveillance for all of the pollutants for which national ambient air quality standards have been established (criteria pollutants). Provisions were promulgated subsequently for PM measured as PM_{10} on July 1, 1987 (52 FR 24740); provisions for $PM_{2.5}$ are published in this final rule.

On December 13, 1996, these rules were proposed in the **Federal Register** as amendments to 40 CFR parts 53 and 58. The intent of the monitoring method designations and air quality surveillance requirements being promulgated today are to establish a revised particulate matter monitoring network that will produce air quality data utilizing uniform criteria for the purpose of comparison to the revised primary and secondary PM NAAQS and to facilitate implementation of a forthcoming regional haze program. The effective date of today's monitoring regulation is September 16, 1997.

III. Discussion of Regulatory Revisions and Major Comments on 40 CFR Part 53

A. Designation of Reference and Equivalent Methods for $PM_{2.5}$

Provisions for EPA designation of reference and equivalent methods for PM_{10} and gaseous criteria pollutants have been previously established and are set forth in 40 CFR part 53. On December 13, 1996, EPA proposed to amend part 53 to add new provisions to govern designation of reference and equivalent method for $PM_{2.5}$. The December 13th notice proposed new, detailed sampler testing and other requirements that would apply to candidate reference and equivalent $PM_{2.5}$ methods and describes how EPA proposed to determine whether a candidate method should be designated as either a reference or equivalent method. The notice further solicited public comments on the proposed new provisions. Those provisions, modified somewhat based on the public comments received, are being promulgated today as amended part 53.

As for the other criteria air pollutants, reference methods for $PM_{2.5}$ are intended to provide for uniform, reproduceable measurements of $PM_{2.5}$ concentrations in ambient air to serve as a measurement standard for the primary purpose of making comparisons to the NAAQS. Equivalent methods for $PM_{2.5}$ allow for the consideration and introduction of new and innovative $PM_{2.5}$ measurement technologies for this same purpose, provided such new technologies can be shown to provide $PM_{2.5}$ measurements comparable to reference measurements under a variety of typical monitoring conditions.

[1]EPA intends to develop and propose for public comment a revised Pollutant Standards Index that will address $PM_{2.5}$ as well as PM_{10}, at a later date.

B. Reference Method Designation Requirements

The new reference method for $PM_{2.5}$, described in 40 CFR part 50, Appendix L contains a combination of design and performance specifications to define the reference method $PM_{2.5}$ sampler. The performance-based specifications for the reference method sampler allow manufacturers to design and fabricate different samplers that would meet all reference method requirements. Accordingly, multiple $PM_{2.5}$ reference methods are expected to become available from several manufacturers, as is the case for reference methods for PM_{10} and most gaseous criteria pollutants. Each reference method for $PM_{2.5}$, based on a particular sampler, will be formally designated as such by EPA under the new provisions added to 40 CFR part 53.

The requirements for designation of $PM_{2.5}$ reference methods are set forth in subparts A and E of 40 CFR part 53. These requirements include specific tests to show conformance with all design and performance specifications, an operational field precision test, a comprehensive operation/instruction manual, and documentation of an adequate manufacturing and testing quality system. Subpart A, which has been amended to add provisions for $PM_{2.5}$ methods, sets forth the general requirements for both reference and equivalent methods and for the process under which applications are submitted and reference and equivalent method are designated. New subpart E, which is devoted exclusively to $PM_{2.5}$ methods, describes the test procedures and related requirements for candidate reference methods.

C. Equivalent Method Designation Requirements

The requirements for designation of equivalent methods for $PM_{2.5}$ are also set forth in amended part 53. The general requirements are set forth in subpart A. All candidate equivalent methods are subject to the field tests for operational precision and comparability to reference method measurements, which are specified in subpart C. Both subparts A and C have been amended to include the provisions for $PM_{2.5}$ methods.

To minimize the number and extent of performance tests to which candidate equivalent methods must be subjected, three classes of equivalent methods are defined.

Class I equivalent methods are based on samplers that have relatively small deviations from the specifications for reference method samplers. Therefore, in addition to the tests and other requirements applicable reference method samplers, candidate Class I equivalent samplers must be tested only to make sure that the modifications do not significantly compromise sampler performance. The additional test requirements for most Class I candidate equivalent methods are a test for possible loss of $PM_{2.5}$ in any new or modified

components in the sampler inlet upstream of the sample filter, and the field testing for comparability to reference method samplers. These additional tests are described in subparts E and C, respectively.

Class II equivalent methods include all other $PM_{2.5}$ methods that are based on a 24–hour integrated filter sample that is subjected to subsequent moisture equilibration and gravimetric mass analysis. A sampler associated with a Class II equivalent method will generally have one or more substantial deviations from the design or performance specifications of the reference method, such that it cannot qualify as a Class I equivalent method. These samplers may have a different inlet, a different particle size separator, a different volumetric flow rate, a different filter or filter face velocity, or other significant differences. More extensive performance testing is required for designation of Class II candidate equivalent methods, with the specific tests required depending on the nature and extent of the differences between the candidate sampler and the specifications for reference method samplers. These tests may include a full wind tunnel evaluation, a wind tunnel inlet aspiration test, a static fractionator test, a fractionator loading test, a volatility test, and field testing against reference method samplers. The tests and their specific applicability to various types of candidate Class II equivalent method samplers are set forth in the new subpart F.

Finally, Class III equivalent methods include any candidate $PM_{2.5}$ methods that cannot qualify as either Class I or Class II. This class includes any filter-based integrated sampling method having other than a 24–hour $PM_{2.5}$ sample collection interval followed by moisture equilibration and gravimetric mass. More importantly, Class III also includes filter-based continuous or semi-continuous methods, such as beta attenuation instruments, harmonic oscillating element instruments, and other complete in situ monitor types. Non-filter-based methods such as nephelometry or other optical instruments will also fall into the Class III category.

The testing requirements for designation of Class III candidate methods are the most stringent, because quantitative comparability to the reference method will have to be shown under various potential particle size distributions and aerosol composition. However, because of the variety of measurement principles and types of methods possible for Class III candidate equivalent methods, the test requirements must be individually selected or specifically designed or adapted for each such type of method. Therefore, EPA has determined that it is not practical to attempt to develop and explicitly describe the test procedures and performance requirements for all of these potential Class III methods a priori. Rather, the specific test procedures and performance requirements applicable to each Class III candidate method will be determined by EPA on a case-by-case basis upon request, in connection with each proposed or anticipated application for a Class III equivalent method determination.

D. Proposed Reference and Equivalent Method Requirements

The proposed changes to 40 CFR part 53 to provide for designation of reference and equivalent methods for $PM_{2.5}$ consisted of revisions to subparts A and C, and new subparts E and F. The proposed revisions to subpart A included new definitions applicable to $PM_{2.5}$ methods and clarifications of existing definitions, clarifications of the reference and equivalent method designation requirements for all pollutants including the new classes of equivalent methods for $PM_{2.5}$, and requirements for $PM_{2.5}$ samplers to be manufactured in an International Organization for Standardization (ISO) 9001-registered facility (or equivalent). Additional proposed changes included clarifications of the test data and other information required to be submitted in applications for a reference or equivalent method determination, clarification of requirements for product warranty and content of operation or instruction manuals, an increased time limit for processing applications; and provisions for providing EPA with a candidate test $PM_{2.5}$ sampler or analyzer to evaluate in connection with an application for reference or equivalent method determination.

Revisions to subpart C included new procedures and specifications for comparing candidate equivalent methods for $PM_{2.5}$ to reference method samplers. The entirely new subpart E described the technical procedures for testing the physical (design) and performance characteristics of reference methods and Class I equivalent candidate methods for $PM_{2.5}$. The new subpart F described the procedures for testing the performance characteristics of Class II equivalent methods for $PM_{2.5}$.

E. Changes to the Proposed Method Designation Requirements

The tests of the design and performance characteristics of candidate samplers for designating reference methods as well as equivalent methods are intimately related to the specifications for reference methods in 40 CFR part 50, Appendix L. Many of the concerns expressed by commenters regarding the reference method for $PM_{2.5}$ in 40 CFR part 50, Appendix L also apply to some of the provisions of part 53. Other comments were more directly concerned with the provisions of 40 CFR part 53, and these comments are summarized in this unit.

Several commenters addressed the responsibilities of EPA and manufacturers in the method designation process. Specific comments included the suggestions that: (1) It would be more appropriate for EPA to conduct the necessary testing of a candidate method before designating a reference method; (2) that EPA should clarify how it will respond to possible poor sampler performance under extreme environmental conditions encountered in some areas of the United States, since the samplers are not required to meet such extreme conditions; (3) that EPA should clarify that specifications for completing sampler modifications or retrofits to work in nonstandard environments should be included as part of a sampler purchase contract; and (4) that EPA should clarify that the required method specifications must be met throughout the warranty period and that the applicant accepts responsibility and liability for ensuring conformance or resolving nonconformities, including all necessary components of the system, regardless of the original manufacturer.

The new provisions contained in the modified 40 CFR part 53 require the applicant to submit information and documentation to demonstrate that the applicant's candidate reference method sampler meets all design specifications set forth in 40 CFR part 50, Appendix L. The provisions also require the applicant to carry out specific tests to demonstrate that the candidate reference or equivalent method meets all performance specifications. The nature of these tests and the requirement that they be carried out by the applicant rather than by EPA is consistent with the previously established requirements in 40 CFR part 53 for designating reference or equivalent methods for other criteria pollutants. Section 53.9 clearly states that a sampler sold as part of a designated method must meet the applicable performance specifications for at least 1 year after delivery. Section 53.9 further requires that ISO 9001 registration of the manufacturing facility be maintained and that a Product Manufacturing Checklist signed by a certified ISO auditor be submitted annually to verify manufacturing quality control.

In response to concerns about the performance of the sampler under extreme weather conditions, EPA has established sampler specifications that are intended to cover reasonably normal environmental conditions at about 95 percent of expected monitoring sites. The performance tests in subpart E address essentially all of these operational requirements. Specification of the sampler performance for sites with extreme environmental conditions would substantially raise the cost of the sampler for users, most of whom do not require the extra capability. EPA strongly recommends that users requiring operation of samplers under extreme environmental conditions develop supplemental specifications for modified samplers to cover those specific conditions. Sampler manufacturers have indicated a commitment to respond to such special operational needs.

Documentation is required to demonstrate that samplers to be sold as reference or equivalent methods for $PM_{2.5}$ will be

manufactured under an effective quality control system. Although some commenters supported the general quality assurance concepts contained in the proposed method, several questioned the inclusion of the ISO 9001-registration requirement. EPA believes that the ISO 9001-registration requirement and related provisions are the most cost-effective way to ensure that samplers are manufactured in a facility conforming to internationally recognized quality system standards.

Several comments questioned the proposed requirement that each $PM_{2.5}$ sampler model be subjected to a specific annual evaluation of performance and meet certain operating performance specifications. In response to these comments, this requirement has been deleted. However, EPA will review the performance of each $PM_{2.5}$ sampler model on an annual basis, and if compelling evidence indicates a significant bias or other operational problem, the EPA Administrator may make a preliminary finding to cancel a reference or equivalent method designation in accordance with the provisions of § 53.11 in subpart A.

Otherwise, the provisions of 40 CFR part 53 have been retained to conform with the requirements described in 40 CFR part 50, Appendix L. The proposed revisions to subparts A and C have been retained with no substantive changes. However, minor technical and editorial changes have been made to subparts A and C to clarify or simplify proposed provisions. Subpart E has undergone extensive revision and reorganization. Although these changes do not affect the objectives and nature of the tests, they are intended to make the test requirements easier to understand and the tests easier to perform. The changes were based on EPA's own experience in performing tests of prototype candidate samplers and on comments from prospective sampler manufacturers. Subpart F has also been revised to some extent. The changes to subpart F are not substantive in nature, but numerous technical and editorial changes were made to clarify the test requirements and make the tests, particularly the volatility test, more straightforward to carry out.

All testing related to an application for a $PM_{2.5}$ reference or equivalent method determination under 40 CFR part 53 must be carried out in accordance with American National Standards Institute/American Society for Quality Control (ANSI/ASQC) E4 standards. These requirements are necessary to ensure that all samplers or analyzers sold as reference or equivalent methods are manufactured and tested to the high standards required to achieve the needed data quality. These procedures are in keeping with the developing international standards for manufacturing and testing in this and other industries.

IV. Discussion of Regulatory Revisions and Major Comments on Part 58

The following discussion presents an overview of the final part 58 monitoring regulation. This is followed by a detailed discussion of the basic concepts outlined in the December 13, 1996 monitoring proposal and addresses those comments received on the proposed part 58 regulations that EPA considered to be most relevant to the changes and additions adopted in the final rule. Comments not addressed in this preamble are found in a Summary and Response to Comment document that has been placed in Docket A-96-51. Those parts of the proposed regulations which were not commented on have not been changed. The items are discussed in the order in which they appear in the regulation.

A. Overview of Part 58 Regulatory Requirements

The requirements set forth in this rule simultaneously preserve the underlying intent of the revised NAAQS and respond positively to the very substantial and reasoned comments received on the proposal. Specifically, the major monitoring requirements and principles set forth by the revised part 58 regulation include:

1. *$PM_{2.5}$ network design*. Community-oriented (core) monitors that represent community-wide average exposure, form the basis of $PM_{2.5}$ network design. This approach is consistent with the data bases used to develop the NAAQS. While all population-oriented monitoring locations are eligible for comparison to the 24–hour $PM_{2.5}$ NAAQS, only locations representative of neighborhood or larger spatial scales are eligible for comparison to the annual NAAQS. Community monitoring zones with constrained criteria may be also used to define monitors acceptable for spatial averaging for comparison to the annual NAAQS. Monitoring for regional transport and regional background is required to assist with implementation of the air quality management program. The combination of emphasis on well-sited community-oriented monitors and the feasibility by the States to select the preferred community monitoring approach reduces complexity associated with network design and planning. The number of required core $PM_{2.5}$ State and Local Air Monitoring Stations (SLAMS), and other $PM_{2.5}$ SLAMS results in a minimum national requirement of approximately 850 $PM_{2.5}$ sites (compared to 629 proposed); the total $PM_{2.5}$ network is projected to approach 1,500 $PM_{2.5}$ sites. Exceptions to the minimum number of required samplers may be approved by the EPA Regional Administrator. As proposed, the mature network of 1,500 $PM_{2.5}$ sites would be in place within 3 years. The phase-in of the required network has been reduced from 3 to 2 years.

2. *PM_{10} monitoring networks*. Requirements for PM_{10} network design and siting are unchanged. Reductions in PM_{10} networks are encouraged in areas of low concentrations where the PM_{10} NAAQS are not expected to be violated.

3. *Sampling frequencies*. The sampling frequencies stipulated in 40 CFR 58.13 for both $PM_{2.5}$ and PM_{10}, have been modified to reflect a one in 3–day minimum requirement. Required every day sampling at certain core sites may be reduced to one in 3–day sampling after at least 3 complete years of data collection with a reference or equivalent method or when collocated with a correlated acceptable continuous (CAC) fine particulate monitor; background and regional transport may also sample once every third day. Exceptions to the minimum requirement may be approved by the EPA Regional Administrator for seasonal or year-round sampling.

4. *Chemical speciation*. A modest chemical speciation network of 50 $PM_{2.5}$ sites that provides a first order characterization of the metals, ions, and carbon constituents of $PM_{2.5}$ is a requirement of this rule. These sites will be part of the National Air Monitoring Stations (NAMS) network and will provide national consistency for trends purposes and serve as a model for other chemical speciation efforts. This required network represents a small fraction of all the chemical speciation work that EPA expects to support with Federal funds. Additional efforts may be used to enhance the required network and tailor the collection and analysis of speciated data to the needs of individual areas.

5. *Quality assurance*. The QA program is collectively based on a variety of QA tools resulting in a program which is more efficient, less costly, and relaxes the burden on State and local agencies. The key program requirements include:

a. Independent field audits with a $PM_{2.5}$ FRM are used to evaluate the bias of $PM_{2.5}$ measurements. The number of $PM_{2.5}$ audited sites compared to the proposal are reduced from all non-collocated sites to 25 percent of all SLAMS sites (including NAMS) and the audit frequency per site is reduced from 6 to 4 visits per year.

b. Flow checks will also be used to evaluate bias of $PM_{2.5}$ and PM_{10} measurements and are conducted on a quarterly basis as proposed.

c. Collocation with $PM_{2.5}$ FRM and Federal Equivalent Methods (FEM) samplers at SLAMS sites is used to judge precision. The number of collocated sites per reporting organization is 25 percent of all $PM_{2.5}$ SLAMS sites (20 percent were proposed) and approximately 20 percent of all PM_{10} SLAMS sites (which is current practice).

d. Systems audits are used to evaluate an agency's QA system and will be performed by EPA every 3 years as originally proposed.

In an effort to assist the State and local agencies in achieving the data quality

objectives of the $PM_{2.5}$ monitoring program, an incentive program has been established that is based on network performance and maturity that can reduce these QA requirements.

6. *Moratorium on the use of special purpose monitor (SPM) data*. The moratorium on the use of $PM_{2.5}$ data (§ 58.14) collected by SPMs, has been changed from the first 3 calendar years following the effective date of this rule to the first 2 complete calendar years of operation of a new SPM. If such monitors produce valid data for more than 2 years, then all historical data for that site may be used for regulatory purposes.

7. *Monitoring methodology*. Appendix C has been revised to allow the use of Interagency Monitoring of Protected Visual Environments (IMPROVE) samplers at regional transport and regional background sites to satisfy the SLAMS requirements.

8. *PM monitoring network description*. The State shall submit a PM monitoring network description to the EPA Regional Administrator by July 1, 1998, which describes the PM monitoring network, its intended community monitoring approach for comparison to the annual $PM_{2.5}$ standard, use of non-population-oriented special purpose $PM_{2.5}$ monitors or alternative samplers, and proposed exceptions to EPA's requirements for minimum number of monitors or sampling frequency. The description shall be available for pubic inspection and EPA shall review and approve/disapprove the document within 60 days. A State air monitoring report with proposed network revisions, if any, shall be submitted annually.

EPA believes that the aforesaid revisions to the rule, as proposed, provide a firm basis for the uniform implementation of a national particulate monitoring network which is responsive to a revised NAAQS expressed as $PM_{2.5}$. The following is a section-by-section discussion of comments received and any resulting modifications to the proposal.

B. Section 58.1 - Definitions

EPA proposed to add several definitions applicable to PM monitoring. This consisted of revising the definition of the term traceable and definitions of the terms Consolidated Metropolitan Statistical Area (CMSA), core SLAMS, equivalent methods, Metropolitan Statistical Area (MSA), monitoring planning area (MPA), monitoring plan, $PM_{2.5}$, Primary Metropolitan Statistical Area (PMSA), population-oriented, reference method, spatial averaging zone (SAZ), SPM fine monitors, and Annual State Monitoring Report. In response to comments, EPA is modifying the proposed approach and is introducing new terminology and definitions. First, EPA is changing the definition of core SLAMS monitors to describe community-oriented monitors that are representative of neighborhood or larger spatial scales and will be key monitoring entities in the new $PM_{2.5}$ SLAMS network. As discussed later, a subset of these monitors will be required to sample everyday in the most populated metropolitan areas with the stated emphasis on community-oriented monitoring. Although very important, the background and regional transport monitors in the SLAMS network are no longer called core sites. Secondly, EPA is replacing the definition of spatial averaging zone with a definition of community monitoring zone (CMZ). This is consistent with the intent of the annual $PM_{2.5}$ standard, that is to be judged at monitoring stations that are representative of community-wide air quality. EPA is also renaming the PM monitoring plan as the PM monitoring network description. EPA's rationale for these changes, together with a more complete description of community monitoring zones, are discussed in 40 CFR part 58, Appendix D.

In addition, several commenters addressed the definition of population-oriented monitoring, objecting to the narrowness of the definition with respect to industrial areas, and noting that if people are present in an area, the site should be considered population-oriented.

EPA assessed these comments and concluded that the definition of population-oriented monitoring or sites proposed in § 58.1 is essentially appropriate and as such will provide monitoring agencies with the flexibility to design networks that are consistent with the population-oriented approach described by the $PM_{2.5}$ standards. Therefore EPA is retaining this definition in the final rule with a minor simplifying change as follows: population-oriented monitoring (or sites) applies to residential areas, commercial areas, recreational areas, industrial areas and other areas where a substantial number of people may spend a significant fraction of their day. The definition of population-oriented monitoring will be further deliniated in future EPA guidance. As proposed, the final rule states that all population-oriented $PM_{2.5}$ monitoring locations shall be eligible for comparison to both the 24–hour PM_{10} and $PM_{2.5}$ standards. In order to make these concepts clearer for the final rule, however, several changes to the proposed language were made in the final rule regarding eligibility of monitoring sites for comparisons to the $PM_{2.5}$ NAAQS. First, the new $PM_{2.5}$ network will place emphasis on community-oriented monitoring for making comparisons to both the annual and 24–hour $PM_{2.5}$ NAAQS. Secondly, as proposed, unique population-oriented microscale and middle-scale monitoring sites shall only be used for comparisons to the 24–hour NAAQS. Furthermore, violations detected at rural background and regional transport sites are more appropriately addressed by the implementation program which EPA is developing.

C. Section 58.13 - Operating Schedule

EPA proposed that core $PM_{2.5}$ SLAMS (including NAMS and core SLAMS collocated at Photochemical Assessment Monitoring Stations (PAMS) sites) would be required to sample every day, unless an exception is approved by EPA during established seasons of low PM pollution during which time a minimum of one in 6-day sampling would be permitted. The proposal stated that non-core SLAMS sites would generally be required to sample a minimum of once every sixth day, although episodic or seasonal sampling could also be possible (e.g., in areas where significant violations of the 24–hour NAAQS are expected or at sites heavily influenced by regional transport or episodic conditions). The proposed and final rule state that special purpose monitors may sample on any sampling schedule. The proposal also recognized that although daily sampling with manual methods is labor intensive due to site visits and filter equilibration and weighing, semi-automatic sequential samplers are anticipated to be approvable as FRMs or Class I equivalent samplers (under the provisions of part 53) that will simplify the data collection process. Finally, EPA proposed that alternative $PM_{2.5}$ operating schedules that combine intermittent sampling with the use of acceptable continuous fine particulate samplers are approvable at some core sites. This alternative was intended to give the States additional flexibility in designing their $PM_{2.5}$ monitoring networks and to permit data from continuous instruments to be telemetered. This would facilitate public reporting of fine particulate concentrations, and allow air pollution alerts to be issued, and allow episodic controls to be implemented (as currently done in woodburning areas for PM_{10}). Furthermore, this alternative would permit monitoring agencies to take advantage of new and improved monitoring technologies that should become available during the first few years following the promulgation of this rule. As proposed, applicability does not apply to areas with population greater than 1 million during the first 2 years of required sampling.

Many commenters supported daily $PM_{2.5}$ sampling, citing the need to target sources, aid enforcement, and provide exposure measurements for future community health studies. Additionally, commenters supported daily $PM_{2.5}$ sampling to cover the most polluted and most populated areas and to capture all violations. Other commenters supported daily sampling but suggested limiting it to key locations or seasons (e.g., only the largest metropolitan areas or those areas with the highest $PM_{2.5}$ concentrations, only during seasons when high values are likely). Other commenters suggested allowing a reduction in sampling frequency to one in 6 days under certain conditions; for example, at sites that have demonstrated attainment, at

sites with CAC analyzers, following the third year of data collection, and during the portion of the year with low $PM_{2.5}$ concentrations at a site with a district seasonal pattern.

In addition, a number of commenters suggested a delay of everyday sampling until the Class I equivalent samplers are available. It was noted that over the short-term, only designated manual samplers capable of collecting single 24–hour samples, could be available. Consequently, to meet an everyday sampling schedule, several samplers would need to be installed at each everyday sampling site to satisfy the daily schedule, and cover weekend and holiday sampling periods.

Based on its review of these comments, EPA is retaining its everyday sampling schedule for certain community-oriented (core) SLAMS (i.e., two monitoring sites in each MSA greater than 500,000 population and SLAMS collocated at PAMS for a total of 313 nationwide). The remaining SLAMS including NAMS and other core SLAMS are required to sample every third day.

Because of concerns over the potential unavailability of Class I sequential samplers, EPA is allowing a waiver of the everyday or every third day sampling schedule, when appropriate, in those situations where such sampling is not needed. This waiver would expire 1 calendar year from the time a sequential sampler has been approved by EPA. When the waiver is granted for every day sampling, one in 3-day sampling would be required. As proposed, EPA encourages the use of a supplemental CAC analyzer as a means of facilitating a reduction of the reference or equivalent method everyday sampling schedule to once in 3 days. The CAC monitoring option, however, will not be allowed in areas greater than 1 million population that have high $PM_{2.5}$ concentrations during the first 2 years of daily data collection. A minimum frequency of one in 6–day sampling is still required during periods for which exemptions to everyday or every third day sampling are allowed for $PM_{2.5}$ SLAMS.

For PM_{10}, the EPA Administrator proposed that one in 6-day sampling should be sufficient to support the proposed PM_{10} NAAQS and a less dense monitoring network would also be needed.

A number of commenters supported the typical one in 6–day sampling frequency for PM_{10}. On the other hand, a number of commenters opposed the proposed reduction in PM_{10} sampling frequency to one in 6 days, stating that one in 6–day sampling is inadequate to evaluate impacts on the 24–hour PM_{10} standard, especially in areas with episodic events or localized hot spots, and that extreme pollutant conditions could be missed.

In response to the general concerns that sampling for PM_{10} is not sufficient and in accordance with the choice of the 99th percentile as the form of the 24–hour PM_{10} standards as discussed in 40 CFR part 50, EPA has changed the minimum required sampling frequency from one sample every 6 days to one sample in every 3 days.

The specified minimum sampling frequency of one in 3 days for $PM_{2.5}$ and PM_{10} will provide for a more statistically stable representation of actual air quality at each monitor as discussed in 40 CFR part 50. Further, increasing the sampling frequency from one in 6- to one in 3-days will ensure that the 24–hour NAAQS comparisons are not based on the highest measured values per year, and thus will significantly reduce the chances of incorrectly classifying a ''clean'' area as nonattainment, and at the same time provide enough information to confidently classify ''dirty'' areas as nonattainment without requiring those areas to sample every day.

EPA believes that once in 6–day sampling is sufficient to estimate an annual mean concentration for $PM_{2.5}$ or PM_{10}. Furthermore, every day or every third day sampling is not generally needed during periods of the lowest ambient PM concentrations. Therefore, EPA is allowing exemptions to the every day or the one in 3-day sampling requirement to individual areas with the approval of the EPA Regional Administrator, in accordance with forthcoming EPA guidance. In general, exemptions to the minimum one in 3-day sampling frequency will be approvable when existing information suggests that maximum 24–hour measurements are less than the level of the standard. In these cases, a minimum of one in 6-day sampling will be required to ensure that sufficient data are available to calculate an annual average concentration. Areas adopting less frequent sampling would be advised of the risks involved in such a choice; namely, that a single high value in 1 year could end up causing the area to be declared in violation of the 24–hour NAAQS. The guidance will also recommend that more frequent sampling be considered for those areas that are relatively close to the level of the standard. For example, areas whose $PM_{2.5}$ or PM_{10} data indicate that they meet the annual PM NAAQS, but have the potential to not meet the 24–hour PM NAAQS will be encouraged to sample everyday for $PM_{2.5}$ or PM_{10}, as appropriate, during the high PM seasons in order to better assess their status to the standards. While such an option may be more costly for individual areas, the risk of inaccurately declaring an attainment area to be nonattainment would be reduced.

D. Section 58.14 - Special Purpose Monitors

EPA proposed that special purpose monitoring (SPM) is needed in a new $PM_{2.5}$ monitoring program to help identify potential problems, to help define boundaries of problem areas, to better define temporal (e.g., diurnal) patterns, to determine the spatial scale of high concentration areas, and to help characterize the chemical composition of PM (using alternative samplers and supplemental analyzers), especially on high concentration days or during special studies. It was proposed, however, that data from SPMs would not be used for attainment/nonattainment designations if the monitor is located in an unpopulated area, if the monitoring method is not a reference or equivalent method or does not meet the requirements of section 2.4 of 40 CFR part 58, Appendix C. Moreover, in order to encourage the deployment of SPMs, EPA proposed that nonattainment designations will not be based on data produced at an SPM site with any monitoring method for a period of 3 years following the promulgation date of the NAAQS.

Numerous commenters opposed the proposed 3-year exclusion of SPM data as a basis for NAAQS violations, noting that all measured violations from all monitors should be used for nonattainment designations. Other commenters supported the exclusion, suggesting that SPM data should always be considered exploratory in nature and should remain exempt from inclusion in regulatory data bases.

EPA has revisited its position on SPMs in light of these comments. In order to encourage the deployment of SPMs, EPA has decided to continue to provide States with the flexibility to exempt SPM data from regulatory use, but limit the period of the moratorium to the first 2 complete calendar years of operation of a new SPM. Given the currently limited amount of $PM_{2.5}$ data and the complexity of the $PM_{2.5}$ air quality problem, the Agency feels that this approach still provides a significant incentive for States to engage in additional monitoring and thereby collect data that would supplement the data collected at SLAMS sites. This can be very helpful for establishing an optimum network design, for a better understanding of the impacts of specific emission sources, and for other planning purposes. If a monitoring site satisfies all applicable part 58 requirements including use of reference or equivalent methods, meeting siting criteria, and other requirements as explained in § 58.14 and it continues to collect data beyond the first 2 complete calendar years of its operation, the data from such SPM sites would then be generally eligible for comparisons to the NAAQS. One exception is when a monitoring agency intends to evaluate a special situation which is not representative of population-oriented monitoring. In this case, the data from the special purpose monitor would not be used for comparison to the $PM_{2.5}$ standards. A second exception is when the agency intends to evaluate a unique impact area that represents a small spatial scale (micro or middle). In this case, the site would only be eligible for comparison to the 24–hour NAAQS. Although SPM data will be exempt from regulatory use during the 2–year moratorium, EPA emphasizes that SPM data

should nevertheless be considered in the State's PM monitoring network description and in the design of its overall SLAMS network. Moreover, SPM sites reporting values greater than the level of a NAAQS should be considered during the annual network review in accordance with § 58.25, and summary data from SPM sites must be included in the annual State Air Monitoring report described in § 58.26.

E. Section 58.15 - Designation of Monitoring Sites

The proposed monitoring regulations defined categories of sites that would be eligible for comparisons to the annual or 24–hour NAAQS. This included certain sites that could be used for comparison to both standards (B sites), to only the daily standard (D sites) and certain special purpose monitors (O sites) that potentially would not be used for comparison to any standard. Due to significant concern regarding the complexity of implementing those concepts to handle a small number of unique monitoring situations, the final rule has eliminated the coding of sites as type B, D, and O sites. Therefore, § 58.15 has been deleted in its entirety. The principal reasons also include the emphasis on community-oriented monitors, the new terminology and modified approach associated with CMZs, and more precise descriptions of SLAMS and SPMs. The final rule provides a more streamlined and simplified monitoring approach that retains the basic community average air quality exposure tenets of the $PM_{2.5}$ annual NAAQS and, as proposed, recognizes that population-oriented hot spot monitoring may be more reflective of situations applicable to the purposes of the 24–hour $PM_{2.5}$ standard.

The changes to community monitoring and site categorization are well integrated. EPA agrees with public comment that the proposed spatial averaging approach may not have been properly communicated by suggesting that it allowed averaging of monitors across widely disparate areas not reflective of average community-oriented exposure and a homogeneous emission source mix. EPA believes that by clarifying the criteria that determine which monitors can be averaged together (i.e., monitors in areas affected by similar emission sources), along with emphasizing that well sited community-oriented monitors should be used, environmental equity concerns and related issues are effectively addressed. First, a single SLAMS or SPM that adequately represents a local area can reflect its own community monitoring area. If its annual average concentrations are more than 20 percent higher than the surrounding average $PM_{2.5}$ air quality, it would not be eligible to be averaged in with the surrounding sites of the larger geographic domain. In addition, unique population-oriented hot spot impact sites are not eligible for comparison to the annual $PM_{2.5}$ NAAQS and are only eligible for comparison to the 24–hour NAAQS. Additional details about CMZs are provided later.

F. Section 58.20 - Air Quality Surveillance: Plan Content

Although no comments were received on proposed changes to this section, the title was inadvertently stated as Plan Control; this title has been changed to Plan Content. In addition, the first sentence of paragraph (d) has been changed by deleting the words ''section 2.8 of'' and the words ''as well as the minimum requirements for networks of SLAMS stations for $PM_{2.5}$ described in section 2.8.2 of 40 CFR part 58, Appendix D.'' Since § 58.20 requires an annual review of the air quality surveillance system for all SLAMS, these changes were instituted for clarity. The reference to $PM_{2.5}$ in the third sentence of § 58.20 was retained to ensure that the review includes the unique requirements of the $PM_{2.5}$ monitoring network.

The proposal indicated that a detailed Particulate Matter Monitoring Plan (see § 58.1, as proposed) must be prepared by the affected air pollution control agency and submitted to EPA for approval. This plan was designed to comprehensively describe the Agency's $PM_{2.5}$ and PM_{10} air quality surveillance networks. Comments received noted that the term PM monitoring plan could be confused with the network description required by § 58.20. Accordingly, EPA has replaced references to the ''PM Monitoring Plan or monitoring plan'' in this final rule with references to the ''particulate matter monitoring network description or PM monitoring network description.'' The Agency notes, however, that the rule published today requires a more expanded and comprehensive network description for PM than has previously been required for other networks. Therefore, a new paragraph (f) has been added to § 58.20 to delineate the requirements for PM monitoring network descriptions. According to § 58.20(e), as amended, this network description must be submitted to the EPA Regional Administrator for approval.

To ensure opportunities for public review and inspection of the monitoring network, States must maintain information and records on such items as the station location, monitoring objectives, spatial scale of representativeness, optional CMZs, and schedule for completion of the network. Such information and records are included in a State's PM monitoring network description. The PM monitoring network description prepared by States and submitted to EPA for approval should be viewed as a long-term network of SLAMS and NAMS sites that meet the variety of monitoring objectives specified in 40 CFR part 58, Appendix D of these regulations. These objectives include determining compliance with air quality standards, developing appropriate control strategies as required, and preparing short- and long-term air quality trends. However, modifications to the network can be made without a formal SIP revision thus encouraging States to make any needed yearly (or alternate schedule as determined by the EPA Regional Administrator) changes to the SLAMS network to make it more responsive to data needs and resource constraints. In order to avoid making major modifications to the PM monitoring network description during the annual review, the detailed network, including monitoring planning areas and CMZs, should be carefully planned and designed to provide a stable base of air quality data. Since no formal SIP revision (that entails **Federal Register** proposal and public comment) is required for the PM monitoring network description revisions, EPA encourages public involvement in the review of a State's PM monitoring network description particularly when the spatial averaging monitoring approach is selected for comparisons to the annual standard.

G. Section 58.23 - Monitoring Network Completion

EPA proposed that the PM networks would be expected to be completed within 3 years of the effective date of promulgation. While new $PM_{2.5}$ networks are developed, reductions in existing PM_{10} networks would be considered. The proposal stated that during the first year, a minimum of one monitoring planning area per State would be required to have core $PM_{2.5}$ SLAMS. This area would be selected by the State according to the likelihood of observing high $PM_{2.5}$ concentrations and according to the size of the affected population. In addition, one $PM_{2.5}$ site was proposed to be collocated at one PAMS site in each of the PAMS areas. During the second year, all other core population-oriented $PM_{2.5}$ SLAMS, and all core background and transport sites, were proposed to be fully operational. During the third year, any additional required $PM_{2.5}$ (non-core) SLAMS was proposed to be fully deployed and all NAMS sites would be selected from core SLAMS and proposed to EPA for approval.

Several commenters discussed the proposed phase-in schedule. One commenter supported an accelerated phase-in schedule, while other commenters supported a longer phase-in period. Several State commenters expressed reservations about their ability to meet the proposed phase-in schedule, due to limited resources and the unavailability of monitoring equipment. One commenter felt that the phase-in should require one core monitor in each of a few geographically diverse areas per State, as this would provide more valuable information than only one per MPA.

As noted in the comments on 40 CFR part 58, Appendix D, a large number of commenters cited the immediate need for an

expansive $PM_{2.5}$ monitoring network to provide adequate monitoring data to satisfy the monitoring objectives of the SLAMS network, in particular, to provide 3 years of $PM_{2.5}$ data in order to make comparisons with the NAAQS. As noted in the discussion below on resources and costs, the Agency's grant allocations for fiscal years 1997-1998 include significant resources to accelerate the implementation schedule and increase the number of monitoring sites included in today's final rule. In view of these actions, the Agency is accelerating the SLAMS monitoring network completion schedule to require at least one core monitor in each MSA greater than 500,000 population plus one $PM_{2.5}$ site to be collocated with a PAMS site in each PAMS area and at least 2 additional SLAMS per State to be in operation by 1998; to require all other required SLAMS including required regional transport and regional background sites to be in operation by 1999; and to encourage all additional sites (to complete the network) to be in operation by 2000. In addition, the States should have at least one core SLAMS to be deployed in all areas expected to have the potential for high $PM_{2.5}$ concentrations, in accordance with EPA guidance, to be in operation by 1998 which will be supported with funding from EPA's section 105 grant program.

H. Section 58.25 - System Modification

The preamble to the proposal noted that although no changes to the regulatory language were proposed for this section, the annual monitoring system modifications review must include changes to $PM_{2.5}$ site designations (e.g., NAAQS comparison sites), and the number or boundaries of monitoring planning areas and/or spatial averaging zones, now referred to as community monitoring zones. This information is included for explanatory purposes only and does not necessitate changes to the regulatory language.

I. Section 58.26 - Annual State Monitoring Report

Under the current regulations, States are required to submit an annual SLAMS data summary report. EPA proposed that this report shall be expanded to: (1) Describe the proposed changes to the State's PM Monitoring Network Description, as defined in § 58.20; (2) include a new brief narrative report to describe the findings of the annual SLAMS network review, reflecting within the year and proposed changes to the State air quality surveillance system; and (3) provide information on PM SPMs and other PM sites noted in the PM monitoring network description regardless of whether data from the stations are submitted to EPA (including number of monitoring stations, general locations, monitoring objective, scale of measurement, and appropriate concentration statistics to characterize PM air quality such as number of measurements, averaging time, and maximum, minimum, and average concentration). The latter is for EPA to ensure that a proper mix of permanent and temporary monitoring locations are used and that populated areas throughout the Nation are monitored, and to provide needed flexibility in the State monitoring program.

In addition, the proposed changes to the PM monitoring network description included changes to existing PM networks. The proposed changes to existing PM networks included modifications to the number, size, or boundaries of MPAs or SAZ's, number and location of PM SLAMS; number or location of core $PM_{2.5}$ SLAMS; alternative sampling frequencies proposed for $PM_{2.5}$ SLAMS (including core $PM_{2.5}$ SLAMS and $PM_{2.5}$ NAMS); core $PM_{2.5}$ SLAMS to be designated $PM_{2.5}$ NAMS; and PM SLAMS to be designated PM NAMS. SPM's with measured values greater than the level of the NAAQS would become part of the SLAMS network. The proposed changes would be developed in close consultation with the appropriate EPA Regional Office and submitted to the appropriate Regional Office for approval. The portion of the document pertaining to NAMS would be submitted to the EPA Administrator (through the appropriate Regional Office).

Finally, as a continuation of current regulations, the States would be required to submit the annual SLAMS summary report and to certify to the EPA Administrator that the SLAMS data submitted are accurate and in conformance with applicable part 58 requirements. Under the proposed revisions, States would also be required to submit annual summaries of SPM data to the EPA Regional Administrator for sites included in their PM monitoring network description and to certify that such data are similarly accurate and likewise in conformance with applicable part 58 requirements or other requirements approved by the EPA Regional Administrator, if these data are intended to be used for SIP purposes. All of the proposed changes described above did not receive substantive comment and were retained in the final rule.

During the first 3 years following promulgation, the proposal stated that the State's PM monitoring description (changed to PM monitoring network description) and any modifications of it would be submitted to EPA by July 1 (starting on the year following promulgation) or by alternate annual date to be negotiated between the State and EPA Regional Administrator, with review and approval/disapproval by the EPA Regional Administrator was proposed to occur within 45 days. After the initial 3–year period or once an SAZ (now called CMZ) has been determined to be violating any $PM_{2.5}$ NAAQS, then changes to a MPA would require public review and notification to ensure that the appropriate monitoring locations and site types are included.

Several commenters addressed the requirements for the Annual State Monitoring Report. Some commenters felt that the 45-day review was too restrictive and should be extended to 60 days. Other commenters felt that the annual review requirement was reasonable in the short-term, but should be reconsidered after 3 years.

In response to these comments, the Agency is extending the Regional review period to 60 days. After the first 3 years, the required annual review can be reconsidered and its schedule revised as determined by the EPA Regional Administrator. As discussed earlier in this preamble, EPA will entertain suggestions for modifications to the published monitoring network requirements. States can request exemptions from specific required elements of the network design (e.g., required number of core SLAMS sites, other SLAMS sites, sampling frequency, etc.) through the Annual Monitoring Report.

J. Section 58.30 - NAMS Network Establishment

The preamble to the proposal called for States to submit a NAMS network description (which is to be derived from the core $PM_{2.5}$ SLAMS) of each State's SLAMS network to the EPA Administrator (through the appropriate EPA Regional Office) within 6 months of the effective date of the final rule. At the same time, a State's NAMS PM_{10} network must be reaffirmed if no changes are made to the existing network and if changed must also be fully described and documented in a submittal to the EPA Administrator (through the appropriate EPA Regional Office). The proposed § 58.34 stated that the NAMS Network completion shall be by 3 years after the effective date of the final rule. This has not been changed in this final rule. However, the proposed revisions to this section inadvertently called for the $PM_{2.5}$ network description to be submitted 3 years after the effective date of promulgation. The final rule has been changed to read July 1, 1998.

K. Section 58.31 - NAMS Network Description

The term spatial averaging zone was used in the proposed revisions to this section. In the final rule, this term has been replaced by the term community monitoring zone (CMZ).

L. Section 58.34 - NAMS Network Completion

The preamble to the proposal called for changes to the NAMS PM_{10} network to be completed by 1 year after the effective date of the final rule and to the NAMS $PM_{2.5}$ network to be completed by 3 years after the effective date of the final rule. The proposed rule incorrectly stated 6 months instead of 1 year for the PM_{10} network to be completed. The final rule has been changed to read 1 year after the effective date of these regulations for PM_{10} and 3 years after the effective date of these regulations for $PM_{2.5}$.

M. Section 58.35 - NAMS Data Submittal

The proposed revision to this section added $PM_{2.5}$ as an additional indicator of PM to the list of pollutants that must submit air quality data and associated information to the EPA Administrator as specified in the AIRS Users Guide. This section is promulgated as proposed.

N. Appendix A - Quality Assurance Requirements for SLAMS

1. *Summary of proposal*. The proposal addressed the fact that enhanced QA and QC procedures were required in the areas of sampler operation, filter handling, data quality assessment, and other operator-related aspects of the $PM_{2.5}$ measurement process. These enhanced QA/QC procedures were necessary for meeting the data quality objectives for ambient $PM_{2.5}$ monitoring.

Most operational QC aspects were specified in 40 CFR part 58, Appendix A in general terms. However, for $PM_{2.5}$, explicit, more stringent, requirements were proposed for sample filter treatment--including the moisture equilibration protocol, weighing procedures, temperature limits for collected samples, and time limits for prompt analysis of samples. Details concerning these operator-related procedures were proposed to be published as a new section 2.12 of EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II to assist monitoring personnel in maintaining high standards of data quality.

Procedures were proposed for assessing the resulting quality of the monitoring data in 40 CFR part 58, Appendix A. Perhaps the most significant new data quality assessment requirement proposed for $PM_{2.5}$ monitoring was the requirement that each $PM_{2.5}$ SLAMS monitor was to be audited at least six times per year. This was the first time a requirement had been proposed to assess the relative accuracy of the mass concentration measured by a PM SLAMS monitor. Each of these six audits would have been performed by the monitoring agency and would have consisted of concurrent operation of a collocated reference method audit sampler along with the $PM_{2.5}$ SLAMS monitor. The data from these collocated audits were proposed to have been used by EPA to assess the performance of the $PM_{2.5}$ SLAMS monitor and to identify reporting organizations or individual sites that had abnormal bias or inadequate precision for the year.

Other data assessment requirements proposed for $PM_{2.5}$ monitoring networks were patterned after the current requirements for PM_{10} networks and were intended to supplement the audit procedure. The proposal required $PM_{2.5}$ network monitors to be subject to precision and accuracy assessments for both manual and automated methods, using procedures similar or identical to the current procedures required for PM_{10} monitoring networks. Results of the field tests performed by the monitoring agencies (including the field tests) would have been sent to EPA. EPA then would have carried out the specified calculations which would have become part of the annual assessment of the quality of the monitoring data.

Although the proposed QA requirements for $PM_{2.5}$ would have resulted in an increase in quality assessment requirement for PM monitoring, the additional QA/QC checks would have incurred more cost to the monitoring agency. Some of the proposed new QA/QC assessment requirements would have somewhat overlapped the information provided by other checks, such as the periodic flow rate checks and the use of collocated samplers in monitoring networks.

A revision to 40 CFR part 58, Appendix A, was also proposed to provide for technical system audits to be performed by EPA at least every 3 years rather than every year. This change to a less frequent system audit schedule recognized the fact that for many well established agencies, an extensive system audit and rigorous inspection may not have been necessary every year. The determination of the extent and frequency of system audits at an even lower frequency than the proposed 3-year interval was being left up to the discretion of the appropriate EPA Regional Office, based on an evaluation of the Agency's data quality measures. This change would have afforded both EPA and the air monitoring agencies flexibility to manage their air monitoring resources to better address the most critical data quality issues.

2. *The $PM_{2.5}$ QA system*. Based upon public comments, the Agency has reviewed 40 CFR part 58, Appendix A and re-evaluated several aspects of the QA and QC quality control system used to assess the particulate monitoring data. The requirements associated with the PM_{10} QA system remained unchanged by these modifications. Specifically for $PM_{2.5}$, the major modifications include focusing 80 percent of the QA resources to sites with concentrations of greater than or equal to 90 percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area), increasing the amount of collocated monitors to 25 percent of the total number of SLAMS monitors within a reporting organization, and changing the FRM audit procedures to an independent assessment of the bias of the $PM_{2.5}$ monitoring network. The FRM audits were reduced in number to 25 percent of the SLAMS monitors at a frequency of 4 times per year. All modifications are discussed in detail in the following paragraphs.

In response to comments that the proposed QA requirements were inadequate, and in order to clarify the intent of the quality system, EPA is incorporating the concept and definition of a quality system into section 2, Quality System Requirements. EPA defines QA as an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer. QC is defined as the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer. A quality system is defined as a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

The Agency used the data quality objective (DQO) process to specifically develop the QA system for the new $PM_{2.5}$ program. The DQO process is a systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specific use. Meeting the new data quality objectives for ambient $PM_{2.5}$ monitoring requires a combination of QA and QC procedures to evaluate and control data measurement uncertainty. For this reason, EPA has developed a quality system specifically for $PM_{2.5}$ which incorporates procedures to quantify total measurement uncertainty, as it relates to total precision and total bias, within the $PM_{2.5}$ monitoring network. In order to clarify the tools used in the QA system, the Agency has included definitions in 40 CFR part 58, Appendix A. Total bias is defined as the systematic or persistent distortion of a measurement process which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). Total precision is defined as a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions, expressed generally in terms of the standard deviation. Accuracy is defined as the degree of agreement between an observed value and an accepted reference value, accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations. The Agency will use various QA tools to quantify this measurement uncertainty; this includes collocation of monitors at various $PM_{2.5}$ sites, use of operational flow checks, and implementation of an independent FRM audit.

The measurement system represents the entire data collection activity. This activity includes the initial equilibration, weighing, and transportation of the filters to the sampler; calibration, maintenance, and proper operation of the instrument; handling/placement of the filters; proper operation of the instrument (sample collection); removal/

handling/transportation of the filter from the sampler to the laboratory; weighing, storage, and archival of the sampled filter; and finally, data analysis and reporting. Additional or supplemental detailed quality assurance procedures and guidance for all operator-related aspects of the $PM_{2.5}$ monitoring process will be published as a new section 2.12 of EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods to assist monitoring personnel in maintaining high standards of data quality.

To clarify the requirements and guidance concerning the SLAMS ambient air network, the Agency has developed Quality Assurance Division (QAD) requirements documents, which are referenced in section 2.2. For simplification, the Agency has removed the list of pertinent operational procedures from this section and has replaced the list with the updated reference. In response to comments about potential difficulties in following the requirements in ANSI E-4, EPA has instead required quality assurance and control programs to follow the requirements for quality assurance project plans contained in EPA requirements for quality assurance project plans for environmental data operations, EPA QA/R-5 an EPA QAD document.

EPA received many comments on the proposed bimonthly audits for each $PM_{2.5}$ site as proposed in section 6.0 of Appendix A. Commenters expressed concerns about the excessive burden the requirement would put on State and local air pollution control agencies, the length of time involved with the process, and the quality control, reliability, and logistical aspects of a portable audit device.

Based upon these comments, the Agency re-assessed its position concerning the number of sites and the frequency of audits that the State and local agencies perform. The Agency feels that independent FRM audits are essential to reaching the goal of the data quality objectives for $PM_{2.5}$ because these audits evaluate the total bias for each designated $PM_{2.5}$ Federal Reference and Equivalent monitoring method within the monitoring network. Therefore, the Agency has modified the proposed audit program to make it independent and also to reduce the burden on State and local agencies. Section 6.0 as proposed has been deleted, with remaining data quality assessment requirements for $PM_{2.5}$ included in section 3.5 of 40 CFR part 58, Appendix A. The resulting data will be assessed at three distinct levels--single monitor level, reporting organization level, and at a national level. Details of the assessment process will be published in EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods.

Commenters endorsed the reduction in the frequency of systems audits from every year to every 3 years as proposed in section 2.5. Therefore, the requirement for a 3–year schedule for system audits remains unchanged.

3. *Evaluation of measurement uncertainty*. EPA received several comments on the procedures used to address the quality assurance of the data as proposed in section 3 of the Appendix. Commenters were concerned about the limited resources available to properly comply with all aspects of the proposed quality system. In the initial deployment of the SLAMS $PM_{2.5}$ network, special QA emphasis should be placed on those sites likely to be involved in possible nonattainment decisions. Once the initial attainment/nonattainment designations have been made, the Agency recommends focusing 80 percent of the QA activity (collocated monitors and FRM audits) at sites with concentrations greater than or equal to 90 percent of the mean annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area); this percentage will be 100 percent if all sites have concentrations above either NAAQS. The remaining 20 percent of the QA activity would be at sites with concentrations less than 90 percent of the $PM_{2.5}$ NAAQS. If an organization has no sites at concentration ranges greater than or equal to 90 percent of the $PM_{2.5}$ NAAQS, the Agency recommends 60 percent of the QA activity be at sites among the highest 25 percent for all $PM_{2.5}$ sites in the network. The Agency understands the initial selection of sites will likely be subjective and based upon the experience of State and local organizations.

Other data assessment requirements for $PM_{2.5}$ monitoring networks are patterned after the current requirements for PM_{10} networks and are intended to quantify the monitoring network's total precision and bias. $PM_{2.5}$ network monitors will be subject to performance assessments for both manual and automated methods, using procedures similar or identical to the current procedures required for PM_{10} monitoring networks. The Agency received several comments describing incentives for acceptable performance in the QA field. In response to these concerns, EPA intends to reduce the QA burden in accordance with network monitoring and acceptable performance of the QA program. Based upon EPA's yearly data quality assessment, acceptable performance could result in a reduction in the frequencies of QA/QC requirements. Additional details for the incentive program will be provided in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods.

The Agency believes that to develop a national, consistent monitoring network with quantifiable data quality, a quality system must be developed that permits maximum flexibility yet ensures that the measurement uncertainty is known and under control. For this reason, the Agency has removed the requirement in section 3.3.5 that the paired monitors have the same FRM or equivalent sampler designation number, but now formalizes the 6-day sampling schedule for collocated monitors into the regulation; this was previously described in guidance.

With regard to the requirements for evaluating measurement uncertainty, the estimates of bias within the monitoring network will be evaluated with flow audits (section 3.5.1) and independent FRM audits (see comments concerning section 3.5.3). An audit of the operational flow rate determines bias as performed by the local operators of manual methods for $PM_{2.5}$ with each sampler each calendar quarter. Using a flow rate transfer standard, each sampler will be audited at its normal operating flow rate. The percent differences between the standard and sampler flow rates will be used to evaluate instrument-specific bias.

Specifically, for Federal Reference and Equivalent automated methods, an additional assessment of the precision will consist of a one-point precision check performed at least once every 2 weeks on each automated analyzer used to measure $PM_{2.5}$. This precision check is performed by checking the operational flow rate of the analyzer, using a procedure similar to that currently used for PM_{10} network assessments. In addition, an alternative procedure may be used where, under certain specific conditions, it is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter without the use of an external flow rate transfer standard. This alternative procedure is also made applicable to PM_{10} methods.

With regard to the proposed requirements in section 3.5.2, (Measurement of precision using collocated procedures for automated and manual methods of $PM_{2.5}$) several commenters felt that invalid data or data of questionable quality should not be a part of the data base, since the general public and many end-users of the data such as consultants and modelers do not always make distinctions about data. Data reporting requirements specify that all valid monitoring data be reported to AIRS. EPA believes that the requirement contained in section 4.1 to report all QA/QC measurements including results from invalid tests is necessary to fully assess the performance of reporting organizations and to allow EPA to recommend appropriate corrective actions. Such data will be flagged so that it will not be utilized for quantitative assessments of precision, bias, and accuracy. EPA also received many comments on the use of collocated samplers to assess precision. Most of these comments advocated an increase in the number of collocated monitors as an alternative to reduce the burden of the independent audit system. Based upon these comments, EPA has reassessed its position on the number of collocated monitors and now requires 25 percent of the total number of monitors for each designated Federal Rand Equivalent Method within a reporting

organization to be collocated. To further assess the total precision and bias of the monitoring network, half of the collocated monitors for each designated Federal Reference and Equivalent Method must be collocated with a Federal Reference Method (FRM) designated monitor and half must be collocated with a monitor of the same designated method type as the primary monitor. An example is shown in Table A-2 in 40 CFR part 58, Appendix A.

The Agency received numerous comments concerning the burden of the proposed FRM audit procedures for $PM_{2.5}$ (section 3.5.3), which consisted of having every site audited six times each year with a portable FRM audit sampler. In response to these comments, EPA has reduced the number of audits to 25 percent of the total number of SLAMS $PM_{2.5}$ sites to be audited 4 times each year. In addition, EPA has reduced the burden of the State and local agencies responsibility for implementing the audits by providing access to the existing EPA National Performance Audit Program (NPAP) or other comparable programs. The details concerning the assessment of the resulting data will be published in EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods.

4. *Reporting requirements*. EPA received several comments concerning the adequacy of QA reporting requirements (section 4). The Agency has addressed these comments by strongly encouraging earlier QA data submittal in order to assist the State and local agencies in controlling and evaluating the quality of the ambient air SLAMS data.

5. *Data quality assessment*. In response to several comments concerning the adequacy of the QA data assessment procedures for the $PM_{2.5}$ program, including parts of proposed section 6.0, EPA developed a new section 5.5 to consolidate and simplify the procedures and calculations for the precision, accuracy, and bias measurements used to quantify $PM_{2.5}$ data quality. The quality assurance system has been nested in such a manner that will allow for the assessment of total measurement bias and precision, as well as portions of the measurement system (i.e. field operations, laboratory operations, etc.). Four distinct quality control checks and audits are implemented to evaluate total measurement uncertainty: (1) Determine instrument accuracy and instrument bias from flow rate audits, (2) determine precision from collocated monitors where the duplicate monitor has the same method designation, (3) determine a portion of the measurement bias from collocated monitors where the duplicate sampler is an FRM device, and (4) determine total measurement bias from FRM audits. This design will allow for early identification of data quality issues in the measurement phases (field/laboratory operations) where they may be occurring and therefore, effective implementation of corrective actions.

6. *FRM audit requirements*. The Agency received many comments concerned with the burden the proposed FRM audit system (the deleted Section 6: Annual Operational Evaluation of $PM_{2.5}$ Methods) would put upon the individual State and local air pollution agencies. Based upon the numerous comments, the Agency has re-assessed its position concerning the audit system. The Agency reduced this burden by providing the State and local agencies the flexibility to access the existing NPAP program or comparable program, additionally reducing the burden to 25 percent of the total number of SLAMS $PM_{2.5}$ sites each year, and reducing the frequency of the audits to 4 per year. EPA has removed section 6.0 from the regulations and incorporated the appropriate information into other sections within 40 CFR part 58, Appendix A. Additional information will be provided in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods.

O. Appendix C - Ambient Air Quality Monitoring Methodology

EPA proposed that 40 CFR part 53, subpart C, be amended to allow the use of certain PM_{10} monitors as surrogates for $PM_{2.5}$ monitors for purposes of demonstrating compliance with the NAAQS. The proposal further stated however, following the measurement of a PM_{10} concentration higher than the 24–hour $PM_{2.5}$ standard or an annual average concentration higher than the annual average $PM_{2.5}$ standard, the PM_{10} monitor would have to be replaced with a $PM_{2.5}$ monitor. In the proposal of Appendix C, EPA also discussed the use of several types of $PM_{2.5}$ samplers at a SLAMS that are not designated as a reference or equivalent method under 40 CFR part 53. First, EPA proposed the use of certain nonreference/nonequivalent $PM_{2.5}$ methods that could be used at a particular SLAMS site to make comparisons to the NAAQS if it met the basic requirements of the test for comparability to a reference method sampler for $PM_{2.5}$, as specified of 40 CFR part 53, subpart C in each of the four seasons of the year at the site at which it is intended to be used. A method that meets this test would then be further subjected to the operating precision and accuracy requirements specified in the proposed Appendix A to 40 CFR part 53, at twice the normal evaluation interval. A method that meets these proposed requirements would not become an equivalent method, but the method could be used at that particular SLAMS site for any regulatory purpose. Second, EPA discussed the use of CAC methods described in § 58.13(f) which are intended to supplement a reference or equivalent manual method at certain SLAMS, so that the manual method could reduce its sampling frequency from every day to once in 3 days. In addition, the proposed Appendix C clarifies that the monitoring data obtained with CAC methods would be restricted to use for the purposes of the proposed § 58.13(f) and would not be used for making comparisons to the NAAQS. Finally, the proposal also described samplers for fine particulate matter used in the IMPROVE network (hereafter termed IMPROVED samplers) and clarified that IMPROVE samplers, although not designated as equivalent methods, could be used in SLAMS for monitoring regional background concentrations of fine particulate matter.

Some commenters questioned the proposed use of PM_{10} samplers as substitutes for $PM_{2.5}$ samplers to satisfy requirements for $PM_{2.5}$ SLAMS monitoring. EPA reassessed the logic behind this proposal and agreed with commenters that substitute samplers should not be allowed. In order for a PM_{10} sampler to be a substitute $PM_{2.5}$ sampler, the annual average PM_{10} would have to be less than 15 $\mu g/m^3$ and the annual maximum 24–hour PM_{10} would have to be less than 65 $\mu g/m^3$. This situation would not be representative of community-oriented monitoring, would only exist at a few rural locations and would not even provide useful information about $PM_{2.5}$ background concentrations; therefore EPA has deleted this provision from Appendix C.

Appendix C is being amended to add a new section 2.4 continuing provisions that allow the use of a $PM_{2.5}$ method that had not been designated as a reference or equivalent method under 40 CFR part 53 at a SLAMS under special conditions. Such a method will be allowed to be used at a particular SLAMS site to make comparisons to the NAAQS if it meets the basic requirements of the test for comparability to a reference method sampler for $PM_{2.5}$, as specified in 40 CFR part 53, subpart C, in each of the four seasons of the year at the site at which it is intended to be used. A method that meets this test will then be further subjected to the operating precision and accuracy requirements specified in 40 CFR part 53, Appendix A, at twice the normal evaluation interval. A method that meets these requirements will not become an equivalent method, but can be used at that particular SLAMS site for any regulatory purpose. The method will be assigned a special method code, and data obtained with the method will be accepted into AIRS as if they had been obtained with a reference or equivalent method. This provision will allow the use of non-conventional $PM_{2.5}$ methods, such as optical or open path measurement methods, which would be difficult to test under the equivalent method test procedures proposed for 40 CFR part 53.

In addition, Appendix C is being amended to add a new section 2.5 to clarify that CAC methods for $PM_{2.5}$ approved for use in a SLAMS under new provisions in § 58.13(f) will not become de facto equivalent methods as proposed. This applies to methods that have not been designated equivalent or do not satisfy the requirements of section 2.4 previously described. In response to

recommendations that IMPROVE samplers be allowed for use at core background and core transport sites, EPA is revising section 2.9 to define IMPROVE samplers for fine particulate matter and clarify that IMPROVE samplers, although not designated as equivalent methods, could be used in SLAMS for monitoring regional background and regional transport concentrations of fine particulate matter.

Finally, minor changes are being made to section 2.7.1 to update the address to which requests for approval for the use of methods under the various provisions of Appendix C should be sent, and section 5 to add additional references.

P. Appendix D - Network Design For State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS) and Photochemical Assessment Monitoring Stations (PAMS)

1. *Section 2.8.1 - Specific design criteria for $PM_{2.5}$.* The proposed regulation contained language regarding the implementation of spatial averaging through the design of $PM_{2.5}$ monitoring networks. MPAs and SAZs were introduced to conform to the population-oriented, spatial averaging approach taken in the proposed $PM_{2.5}$ NAAQS under 40 CFR part 50. While this proposed approach is more directly related to the epidemiological studies used as the basis for the proposed revisions to the particulate matter NAAQS, it recognized that the use of MPAs and SAZs introduced greater complexity into the network design process and the comparison of observed values to the level of the $PM_{2.5}$ annual NAAQS.

A great number of comments were received concerning the communication and complexity of spatial averaging, the selection of monitors, and the need for providing flexibility in specifying network designs and spatial averaging given that the nature and sources of fine particles vary from one area to another.

In response to concerns about the implementation and communication of spatial averaging, EPA is clarifying the requirement for SAZs by changing some terminology. EPA is also making it clear that the annual mean $PM_{2.5}$ from a single properly sited monitor that is representative of community-wide exposures or an average of annual mean $PM_{2.5}$ concentrations produced by one or more of such monitors that meet siting requirements and other constraints as set forth in this rulemaking can be compared to the $PM_{2.5}$ annual standard. Specifically, this rule indicates that comparisons to the annual $PM_{2.5}$ standard can be made through the use of individual monitors or the annual average of monitors in specific CMZs. Community-oriented monitors should be used for these comparisons. This approach will provide State and local agencies with additional flexibility in defining community-wide air quality and in designing monitoring networks. The annual average $PM_{2.5}$ concentration from one or more monitoring sites within a CMZ may be averaged to produce an alternative indicator of annual average community-wide air quality. However, the criteria for establishing CMZs have been modified (compared to the previous SAZs) so that initial monitors will be located in those areas expected to have the highest community-oriented concentrations. It should be noted that many of the sites meeting the siting, monitoring methodology, and other monitoring requirements in 40 CFR part 58 include population-oriented SPMs and industrial monitors.

The eligible core monitors in a CMZ still must be properly sited and meet the constraints specified in section 2.8.1.6 of 40 CFR part 58, Appendix D. The term SAZ has been replaced with CMZ and zone throughout Appendix D. If the State chooses to make comparisons to the annual $PM_{2.5}$ NAAQS directly with individual monitors that use the siting requirements of section 2.8.1.6.3 of 40 CFR part 58, Appendix D then it is not required to perform the analyses needed to establish a CMZ. A State still would be expected to justify that the site meets the specified siting requirements and is representative of community-wide exposures. Then it would not be expected, apriori, to define the boundaries of zones within which the monitoring data would be averaged. This section, that was proposed as ''Monitoring Planning Areas and Spatial Averaging Zones,'' has been retitled as ''Specific Design Criteria for $PM_{2.5}$.''

2. *Section 2.8.1.3 - Core monitoring stations for $PM_{2.5}$.* The proposed regulations described requirements for the numbers of SLAMS sites including core SLAMS. To provide a minimal $PM_{2.5}$ network in all high population areas for protection of the annual and 24–hour PM NAAQS, each required MPA was proposed to have at least two core monitors. The new core monitoring locations would be an important part of the basic PM-fine SLAMS regulatory network. These sites are intended to primarily reflect community-wide air pollution in residential areas or where people spend a substantial part of the day. In addition to the population-oriented monitoring sites, core monitors would also be established for regional background and regional transport monitoring.

To permit interface with measurements of ozone precursors and related emission sources that may contribute to $PM_{2.5}$, an additional core monitor collocated at a PAMS site was proposed to be required in those MSAs where both PAMS and $PM_{2.5}$ monitoring are required. The core monitor to be collocated at a PAMS site would be considered to be part of the MPA $PM_{2.5}$ SLAMS network and would not be considered to be a part of the PAMS network as described in section 4 of 40 CFR part 58, Appendix D. Each SAZ in a required MPA was proposed to have at least one core monitor; SAZs in optional MPAs were proposed to have at least one core monitor; and SAZs were proposed to have at least one core site for every four SLAMS.

Several commenters addressed issues related to the number of core SLAMS, population-oriented SLAMS, and other SLAMS. Numerous commenters supported increasing the number of stations while few supported decreasing the number of stations. In addition, some commenters addressing the issue of spatial averaging also suggested that more monitors might be needed to address less populated areas and areas near hot spots. A few commenters suggested that large States or geographic areas might require several regional background or regional transport sites and that increased monitoring in rural or remote areas would be needed to establish naturally occurring concentrations produced by biogenic sources.

EPA agrees with commenters that more monitors are needed to address smaller communities, larger MSAs with several source categories of fine particulate emissions, to address coverage for multiple sites in optional CMZs, regional transport monitoring upwind of the major population centers in the country, and additional sites near population-oriented pollution hot spots. Accordingly, EPA has revised the regulation to increase the number of required core SLAMS and other SLAMS. These changes result in approximately 220 more required sampling sites, nationally, as compared to the number proposed (850 versus 629). At least one core SLAMS is now required in any MSA with a population greater than 200,000. EPA is requiring additional sites in all MSAs with population greater than 1 million in accordance with the following table:

Table 1.—Required Number of Core SLAMS According to MSA Population

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

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

This section, which was proposed as section 2.8.2.1, has been renumbered as section 2.8.1.3.

As discussed in § 58.13, Operating Schedule, all $PM_{2.5}$ SLAMS are required to have a minimum operating schedule of once every 3 days, except for a subset of at least two core $PM_{2.5}$ sites per MSA with population greater than 500,000 and one site

in each PAMS area that is required to conduct daily sampling as proposed.

3. *Section 2.8.1.4 - Other $PM_{2.5}$* SLAMS locations. EPA is retaining the requirement to have a minimum of one regional background and one regional transport site per State and recognizing the need for exceptions when appropriate, particularly in small States; however, these sites are no longer designated as core SLAMS. EPA also is requiring additional SLAMS monitors based upon the State population less the population in all required MSA monitoring areas (i.e., MSAs greater than 200,000), to provide population coverage throughout the State, particularly in States with fewer urbanized areas. For this remaining population there should be one additional SLAMS per 200,000 population. These additional sites may be used to satisfy any SLAMS objective anywhere in the State including population areas (large cities or small towns) or regional transport in rural areas. The requirement for the additional SLAMS is over and above the requirement for one regional background and regional transport site per State as mentioned above. This section, which was proposed as section 2.8.2.2, has been renumbered as section 2.8.1.4. For planning purposes, EPA expects that the total number of sites in a mature, fully-developed $PM_{2.5}$ network will exceed these required minimums. The projected total number is 1,500 sites, as compared to the proposed 1,200 sites. This is an increase of 25 percent compared to the number proposed and is based on the recognized need for more monitoring in smaller communities, more monitors in larger MSAs with several source categories of fine particulate emissions, the possible need for multiple sites in optional CMZs, the need to support regional transport monitoring upwind of the major population centers in the country, and the need for additional sites near pollution hot spots.

4. *Section 2.8.1.5 - Additional $PM_{2.5}$ Analysis Requirements*. EPA recognizes the need for chemical speciation of particulate matter. Such data are needed to characterize $PM_{2.5}$ composition and to better understand the sources and processes leading to elevated $PM_{2.5}$ concentrations. Because of the costs associated with conducting filter analysis on a routine basis, however the proposal only required filters to be archived so they would be available for subsequent chemical analysis on an as needed basis. EPA recognizes that there is a need for speciation and other specialized monitoring efforts that were not specifically required by the proposed rule. Accordingly, EPA intended to give these PM monitoring efforts high priority in its section 105 grants program.

Many commenters supported the concept of chemical speciation, noting that speciation was essential for identifying all of the components of fine particles and developing control strategies. Some commenters recommended that the program be conducted under national or regional supervision to ensure consistency and reduce costs, and that routine chemical analyses are conducted in a centralized laboratory. EPA also received several comments on the proposed archival requirements. Some commenters suggested that if chemical speciation was required, the filter archival requirement could be eliminated. Other commenters noted that the long-term archival requirements placed additional resource burdens on agencies, and that possible filter degradation and/or bias could result from archiving samples prior to analysis.

Based on these comments, the Agency reassessed its position concerning chemical speciation as an optional part of the $PM_{2.5}$ monitoring program. Although speciation is resource intensive, EPA believes that its overall value in satisfying control strategy and other data needs justifies the added expense. Chemical speciation is critically important for the implementation efforts associated with air quality programs. Specific subject areas supported by chemical speciation include source attribution analysis (i.e., determining the likely mix of sources impacting a site) and emission inventory and air quality model evaluation. Emission inventory and modeling tools are used to develop sound emission reduction strategies. Speciated data are especially critical for air quality model evaluation since resolved chemical measurements provide greater assurance that acceptable model behavior results from appropriate process characterization rather than through the collective effect of compensating errors. Speciated data provide greater ability to identify the causes of poor model performance and implement corrective actions. After strategies are developed and controls are implemented, chemically resolved $PM_{2.5}$ data provide a tracking and feedback mechanism to assess the effectiveness of controls and, if necessary, provide a basis for adjustment. Chemical speciation provides an additional quality check on data consistency since a basis for comparing the sum of individual components (i.e., speciated data) with total mass measurement is available. Also, speciated data supports the forthcoming regional haze program by providing a basis for developing reliable estimates of seasonal and annual average visibility conditions. Chemically resolved data should provide more complete data for future health studies. EPA believes that speciation should be part of the final $PM_{2.5}$ monitoring program due to the collective value of speciation. However, the Agency also believes that flexibility must be provided to the States to tailor efforts to the needs of specific areas. Based on public comments, a minimum chemical speciation trends network will be required to address the needs discussed above.

Based on this requirement to collect speciated data at NAMS sites, EPA is eliminating the requirement to archive filters from NAMS. However, all other SLAMS sites will still be required to archive filters for a minimum of 1 year after collection. Access to these archived filters for chemical speciation would be helpful in cases where: (1) Exceedances or near exceedances of the standard have occurred and additional information and data are needed to determine more precisely possible sources contributing to the exceedances or high concentrations, and (2) certain sites may have shown marked differences in air quality trends at the local or national level for no apparent reason and analysis of filters from more than one site might be required to determine the reason(s) for the differences. EPA intends to assign a high priority to this program through its section 105 grant allocation program and will issue guidance describing the monitoring methods and scenarios under which speciation should be performed. The FRM described in 40 CFR part 50, Appendix L, is finalized as a single-filter based method. Therefore, supplementary monitoring equipment that, for example, permits the use of additional filter media will be needed to perform the appropriate speciation. Additional details on the monitoring methodology for performing speciation and related information on filter handling and/or storage will be addressed in forthcoming EPA guidance.

EPA is now instructing the States to initiate chemical speciation in accordance with forthcoming EPA guidance at $PM_{2.5}$ core sites collocated at approximately 25 PAMS sites and at approximately 25 other core sites for a total of approximately 50 sites nationwide. These sites would be selected as candidates for future NAMS designation. Depending on available resources, chemical speciation could be expanded to additional sites in the second and third years. The requirement to collect speciated data will be reexamined after 5 years of data collection. Based on this review, the EPA Administrator may exempt some sites from collecting speciated data. At a minimum, chemical speciation will include analysis for metals and other elemental constituents, selected anions and cations, and carbon.

EPA recognizes that advantages related to consistency, quality assurance and scales of economy would result from using centralized laboratories for conducting chemical analyses. However, EPA is concerned about the available laboratory capacity for meeting the needs of a national $PM_{2.5}$ speciation network. Several options are under consideration that include developing new central and regional laboratories and exploring the use of existing federal and State facilities. This section, which was proposed as section 2.8.2.4, has been renumbered as section 2.8.1.5.

5. *Section 3.7.6 - NAMS speciation*. Consistent with the previous discussion on speciation, the requirement to establish a subset of approximately 50 NAMS sites for routine speciation is described in a new

section 3.7.6 of 40 CFR part 58, Appendix D. The approximately 50 sites will include the ones collocated at PAMS and approximately 25 other sites to be selected by the EPA Administrator, in consultation with the Regional Administrators and the States. After 5 years of data collection, the EPA Administrator may exempt some sites from collecting speciated data. The number of NAMS sites at which speciation will be performed each year and the number of samples per year will be determined in accordance with EPA guidance. The subsequent sections of section 3.7 have been renumbered accordingly.

Q. Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

The proposed revisions to this Appendix consisted of relatively minor changes in the siting criteria to expand the requirements to include $PM_{2.5}$. Minor changes were made to the example monitoring location in section 8.1 of the proposed revisions to 40 CFR part 58, Appendix E, to replace ''mid-town Manhattan in New York City'' with ''central business district of a Metropolitan area.''

R. Appendix F - Annual Summary Statistics

A new section was proposed to be added to 40 CFR part 58, Appendix F, to include annual summary statistics for $PM_{2.5}$. No changes were made to the proposed revisions.

S. Review of Network Design and Siting Requirements for PM

1. *PM_{10}*. The network design and siting requirements for the annual and 24–hour PM_{10} NAAQS will continue to emphasize identification of locations at maximum concentrations. The PM_{10} network itself, however, will be revised because the new $PM_{2.5}$ standards will likely be the controlling standards in most situations.

The new network for PM_{10} will be derived from the existing network of SLAMS, NAMS, and other monitors generically classified as SPMs which include industrial and special study monitors. Population-oriented PM_{10} NAMS will generally be maintained as will other key sampling locations in existing nonattainment areas, and in areas whose concentrations are near the levels of the revised PM_{10} NAAQS. Currently approved reference or equivalent PM_{10} samplers can continue to be utilized. The revised network will ensure that analysis of national trends in PM_{10} can be continued, that air surveillance in areas with established PM emission control programs can be maintained, and that the PM_{10} NAAQS will not be jeopardized by additional growth in PM_{10} emissions. PM_{10} sites should be collocated with new $PM_{2.5}$ sites at key community-oriented monitoring stations so that better definition of fine and coarse contributions to PM_{10} can be determined to provide a better understanding of exposure, emission controls, and atmospheric processes. PM_{10} sites not needed for trends or with maximum concentrations less than 60 percent of the NAAQS should be discontinued in a longer-term PM_{10} network.[2] The sampling frequency at all PM_{10} sites can be changed to a minimum of once in 3 days, which will be sufficient to make comparisons with the new PM_{10} standards at most locations. Locations without high 24–hour concentrations of PM_{10} (e.g., 140 $\mu g/m^3$) may be exempted from this provision, and their sampling frequency reduced to a minimum of once in 6 days.

2. *$PM_{2.5}$*. Consistency with the new $PM_{2.5}$ NAAQS demands the adoption of new perspectives for identifying and establishing monitoring stations for the $PM_{2.5}$ ambient air monitoring network. First, sites which are representative of community-wide air quality shall be the principal focus of the new $PM_{2.5}$ monitoring program; however, all eligible population-oriented $PM_{2.5}$ sites (including regional background and regional transport sites) will be used for comparisons to the new NAAQS. Second, eligible SLAMS and other eligible SPMs may be averaged within properly defined CMZs to better characterize exposure and air quality for comparison to the annual $PM_{2.5}$ NAAQS. Third, population-oriented $PM_{2.5}$ SLAMS and SPMs representative of unique microscale or middle scale impact sites would not be eligible for comparison to the annual $PM_{2.5}$ NAAQS and would only be compared to the 24–hour $PM_{2.5}$ NAAQS. The 24–hour $PM_{2.5}$ NAAQS is intended to supplement the annual $PM_{2.5}$ standard by providing additional protection at these small spatial scales. A violation of the annual $PM_{2.5}$ NAAQS at localized hot spot and other areas of a small spatial scale (i.e., less than 0.5km in diameter) are not reflective of the data used to establish the annual $PM_{2.5}$ NAAQS. It is also not indicative of a greater area-wide problem which would initiate the need for an area-wide implementation strategy. Clearly, the combination of careful network design, i.e., one that identifies the differences in monitor locations, and an implementation policy that strives to develop effective strategies optimizing regional and local efforts is required to address the intent of the $PM_{2.5}$ NAAQS.

The new network for $PM_{2.5}$ consists of a core network of community-oriented SLAMS monitors (including certain SLAMS collocated at PAMS), other SLAMS monitors (including background and regional transport sites), a NAMS network for long-term monitoring for trends purposes, and a supplementary network of SPMs. Daily sampling is required at a subset of core SLAMS located in MSAs with population greater than 500,000 and at core SLAMS collocated at PAMS sites. This will provide more accurate and complete information on population exposure. One in 3-day sampling is required at NAMS and at all other SLAMS, except when exempted by the Regional Administrator, in which case one in 6-day sampling is required. Frequent measurements are important to characterize the day-to-day variability in $PM_{2.5}$ concentrations, and to understand episodic behavior of $PM_{2.5}$. Routine chemical speciation of $PM_{2.5}$ will be required for a small subset of the core SLAMS. This is necessary to establish and track effective emission control strategies to assure protection of the NAAQS. These sites shall be part of the future $PM_{2.5}$ NAMS network. Overall, many of the new $PM_{2.5}$ sites are expected to be located at existing PM_{10} sites, that are representative of monitoring oriented exposures and would be collocated with some PAMS sites.

The concepts that address the intent of $PM_{2.5}$ network for making comparisons to the NAAQS are embodied through: (1) Monitoring planning areas; (2) specially coded sites including community-oriented (core) SLAMS, regional transport and regional background SLAMS, and other SLAMS or SPMs whose data would be used to compare to the levels of the annual and 24–hour $PM_{2.5}$ NAAQS; (3) SLAMS or SPMs representative of unique population-oriented microscale or middle scale locations that are only eligible for comparison to the 24–hour $PM_{2.5}$ NAAQS, and (4) individual community-oriented sites or CMZs to correspond to the spatial averaging approach defined by the annual $PM_{2.5}$ NAAQS.

Core sites are community-representative monitoring sites which are among the most important SLAMS for identifying areas that are in violation of the $PM_{2.5}$ NAAQS and to be used for the associated SIP planning process. Because of their generally larger spatial scales of representativeness, the core sites are the sites most likely to be eligible for spatial averaging and are also vital in order to establish the boundaries of potential areas of violation of the NAAQS that would be reflective of the areas of highest population exposure to fine particles. Core sites are neighborhood scale in their spatial dimensions. Core SLAMS and specific SPM monitoring locations which are eligible for spatial averaging must be identified in the PM monitoring network description, satisfy criteria outlined in Appendix D, and be approved by EPA. In accordance with information to be specified by the AIRS guidance, the State shall assign the appropriate monitoring site code when reporting these data to EPA.

Regional transport and regional background sites are located outside major metropolitan areas and would generally be upwind of one or more high concentration $PM_{2.5}$ impact areas. These sites are expected to be in areas of relatively low population density or in unpopulated regions. The collection of data at these sites is encouraged

[2]Memorandum from William F. Hunt, Jr., Director, Emissions, Monitoring, and Analysis Division dated April 22, 1997, to EPA Regional Directors entitled Ambient Monitoring Reengineering (found in Docket A-96-51).

because they are critical for the complete understanding of potential pollutant transport and for the development and evaluation of emission control strategies. Although violations of the NAAQS may be observed at these sites, the interpretation and use of such data observed at regional transport and regional background locations will be addressed in the PM implementation program.

SLAMS monitoring locations generally should reflect the population-oriented emphasis of the new NAAQS' population risk management approach and its data would be used for NAAQS comparisons. SPMs, on the other hand, could represent a variety of monitoring situations, some of which are not appropriate for comparison to the $PM_{2.5}$ standards. This includes monitoring at non-population-oriented hot spots or special emissions characterization sites that do not meet EPA siting criteria or required SLAMS monitoring methodology, but provide valuable planning information to support the SIP process. In addition, certain SLAMS and SPMs that represent small spatial scales (i.e., sites that are classified as microscale or middle scale, in accordance with Appendix D) would not represent average, community-oriented air quality. In general, such locations would be relatively close to a single PM emission source or a collection of small local sources. An example of such a location is a unique microscale site in a non-residential part of an urban area and which may be zoned industrial. Clearly, such a site should not be called a SLAMS. There might also be SLAMS sites in residential districts which are representative of small maximum concentration impact areas. Due to the greater spatial homogeneity of fine particles, the existence of such small scale impact locations is expected to be much less than that for coarse particles. When SLAMS or SPMs do represent small, unique population-oriented impact areas, they should be used for comparison to the 24–hour $PM_{2.5}$ standard but not for the annual standard. This is especially true when the site is dominated by a single emission source. In general, these types of small impact sites may be surrounded by broader areas of more homogeneous concentrations which are reflective of community-wide air quality. However, if the State chooses to monitor at a unique population-oriented microscale or middle scale location and the monitoring station meets all applicable 40 CFR part 58 requirements (including monitoring methodology), then the data shall be used only for comparison to the 24–hour $PM_{2.5}$ standard. This is consistent with the underlying rationale of the $PM_{2.5}$ NAAQS. Such monitors would require a special AIRS code when their data are submitted to EPA, as specified by AIRS guidance.

Exceptions to the use of micro and middle scale $PM_{2.5}$ for comparison only to the 24–hour standard may exist when micro or middle scale $PM_{2.5}$ sites represent several small areas in the monitoring domain which collectively identify a larger region of localized high concentration. For example, there may be two or more disjoint middle scale impact areas in a single residential district that are not predominantly influenced by a single $PM_{2.5}$ emission source. In this case, these small scale sites should be used for comparison to the annual NAAQS. This is because their annual average ambient air concentrations can be interpreted as if they collectively represent a larger scale. In a sense, this situation can be viewed as a neighborhood of small scale impact areas. These concepts and associated requirements are discussed in section 2.8.1 of 40 CFR part 58, Appendix D.

The new network design and siting requirements encourage the placement of $PM_{2.5}$ monitors both within and outside of population centers in order to: (1) Provide air quality data necessary to facilitate implementation of the $PM_{2.5}$ NAAQS, and (2) augment the existing visibility fine particle monitoring network. The coordination of these two monitoring objectives will facilitate implementation of a regional haze program and lead to an integrated monitoring program for fine particles.

To achieve the appropriate level of air quality surveillance in such areas, EPA believes it is important to coordinate and integrate the regional background and regional transport monitoring sites specified in this final rule with the existing IMPROVE monitors that have been in place in a number of locations around the country since the late 1980s to characterize fine particulate levels and visibility in mandatory Federal Class I areas (e.g., certain national parks and wilderness areas). The need for coordination and integration of visibility-oriented monitoring sites will increase when EPA proposes rules under section 169A of the Act to supplement the secondary NAAQS in addressing regional haze. More detailed guidance on monitoring and assessment requirements will be forthcoming to support this program. This will include details on topics such as monitor placement, monitoring methodology, duration of sampling and frequency of sampling. It is anticipated, however, that the existing IMPROVE network, together with sites established under this rule, would be an integral part of the network for determining reasonable progress under a regional haze program.

In the meantime, EPA recommends that States, in conjunction with EPA and Federal land managers, explore opportunities for expanding and managing $PM_{2.5}$ and visibility monitoring networks in the most efficient and effective ways to meet the collective goals of these programs. It is EPA's intent that monitoring conducted for purposes of the $PM_{2.5}$ primary and secondary NAAQS (including regional background and regional transport sites), and for visibility protection be undertaken as one coordinated national $PM_{2.5}$ monitoring program, rather than as a number of independent networks.

Although the major emphasis of the new $PM_{2.5}$ network is compliance monitoring in support of the NAAQS, the network is also intended to assist in reporting of data to the general public, especially during air pollution episodes and to assist in the SIP planning process. To these ends, additional monitoring and analyses are suggested concerning the location of nephelometers (or other continuous PM measuring devices) at some core monitoring sites and the collection of meteorological data at core SLAMS sites (including background and regional transport sites).

T. Resources and Cost Estimates for New PM Networks

The proposed rules contained a discussion of the costs associated with the start-up and implementation of a $PM_{2.5}$ network and the phase-down of the existing PM_{10} network.

1. *Resources and costs*. Several commenters expressed concern about the costs of the proposed monitoring and QA/QC requirements. Most commenters wanted EPA to provide the funds to meet the increased effort and costs with new monies to the agencies, noting that implementing the network in a timely manner will depend heavily on timely grant assistance from EPA.

Numerous commenters expressed concern that either not enough monitoring money was projected or that the program would be an unfunded mandate. Commenters felt that EPA should budget the funds necessary to develop an adequate $PM_{2.5}$ network that will support all SIP obligations, including support for speciation. Funds to implement a new monitoring network should include one-time funding to procure sampling, calibration, laboratory, and audit equipment, plus annual funding to support field and laboratory operations.

Several commenters felt that EPA estimates were too low, citing underestimates for additional operational, analytical, and equipment costs including daily sampling; speciation; startup for new monitoring locations; laboratory modifications; operator training; travel; data collection and reporting; greater QA equipment and manpower needs; field testing of reference and equivalent methods; and continuous monitors. No commenter felt that EPA estimates were too high.

A few commenters addressed the suggested portions of the total monitoring program cost for speciation. Several commenters suggested that the cost of requiring speciation could be reduced by limiting the requirement to a subset of the daily monitoring sites, or offset by eliminating the requirement for daily sampling, noting that any cost savings would be overwhelmed by the greater number of $PM_{2.5}$ sites and the number of sites conducting everyday sampling.

EPA understands the complexities and resource demands required by State and local agencies in establishing and implementing the new regulations. In its review of the comments on the use of the proposed Federal reference sampler and associated quality assurance requirements, the Agency has published more cost-effective requirements with this final rule for monitoring network design, methodology, and quality assurance. Likewise, EPA recognizes the subsequent need for it to provide technical and financial assistance. In this regard, some control agencies have used FY-97 grant allocations to procure $PM_{2.5}$ prototype instruments or upgrade their filter weighing facilities. Additionally, the Agency has designated approximately $10,935,000 in section 105 grant monies for distribution to States in FY-98. EPA intends to assign a high priority to the $PM_{2.5}$ monitoring program through its section 105 grants, and additional grant dollars have been earmarked by EPA for subsequent years which should ensure successful implementation of the $PM_{2.5}$ monitoring program.

2. *Revised cost analysis*. In response to comments on cost estimation and new requirements described earlier, EPA has revised its estimates for the projected PM_{10} and $PM_{2.5}$ networks. EPA believes that it has both improved its cost estimates and more adequately addressed the needs for the PM monitoring program. The net costs associated with the final PM rules promulgated today include the start-up and implementation costs associated with the new $PM_{2.5}$ network and the cost savings associated with phase-down of the existing PM_{10} network. The estimated costs in the preamble have been revised to reflect changes to the regulations based on comments received on the proposed changes in 40 CFR parts 50, 53, and 58. In particular, $PM_{2.5}$ network costs have been revised to reflect an increase in the number of sites to 1,500, newer cost estimates for prototype samplers, equipping many sites with sequential samplers to provide for greater operational flexibility, reducing the number and frequency of audits with federal reference method samplers, and providing for additional multi-filter sampling to determine $PM_{2.5}$ constituent species. In addition, PM_{10} network costs have been revised to reflect an increase in the remaining number of PM_{10} sites to 900 and a sampling frequency of once every 3 days (instead of once every 6 days, as proposed) for those sites that previously had been sampling everyday, every 2 days, or every 6 days.

Table 2 shows the $PM_{2.5}$ network phase-in data including number of sites and samplers, costs for capital equipment, sampling and quality assurance, filter analyses, and special studies. Table 3 provides a breakdown of the costs associated with the filter analyses. Table 4 provides a breakdown of the phase-down costs for the PM_{10} network. The costs are shown for a current network of approximately 1,650 sites in 1997 and the phase-down to a future projected network of 900 sites. Table 5 shows the cost of PM monitoring according to sampling frequency and the type of PM monitor. Details of this information can be found in the Information Collection Request for these requirements. Tables 2 through 5 follow.

TABLE 2.—$PM_{2.5}$ NETWORK COSTS

[Thousands of Actual Dollars]

Year	Number of Sites	Number of Samplers [1]	Capital Cost	Sampling & QA	Filter Analysis [2]	Special Studies	Total Cost
1997	0	0	$4,500	.....	.....	.....	$4,500
1998	724	861	$8,963	$10,216	$472	$1,426	$18,225
1999	1,200	1,512	$14,877	$17,938	$2,325	$3,004	$38,143
2000	1,500	1,887	$7,155	$26,697	$3,649	.....	$37,502

[1] The $PM_{2.5}$ network includes a mature network of 332 collocated samplers for QA purposes.
[2] Three different types of filter analyses are anticipated (exceedance analyses, screening analyses, and detailed analyses).

TABLE 3.—COST FOR $PM_{2.5}$ FILTER ANALYSES

Type of Filter Analysis	Estimated Cost per Sample
Exceedance Analysis	$200
High $PM_{2.5}$ concentration events are analyzed for particle size and composition utilizing optical or electron microscopy	.....
Screening Analysis	$150
Multi-filter analyses including (1) x-ray fluorescence (XRF) for elemental composition (crustal material, sulfur, and heavy metals); (2) ion chromatography for ions such as sulfate, nitrate, and chloride; (3) thermal-optical analysis for elemental/organic/total carbon	.....
Detailed Analysis	$400
Analysis for speciated organic composition	.....

TABLE 4.—PM_{10} NETWORK COSTS

[Thousands of Actual Dollars]

Year	Number of Sites	Number of Samplers[1]	Capital Cost to Remove Sites	Operation & Maintenance Cost	Total Cost
1997	1,650	1,810	.....	$15,861	$15,861
1998	1,450	1,610	$137	$13,358	$13,495
1999	1,250	1,410	$89	$11,946	$12,035
2000	900	1,060	$159	$9,134	$9,293

[1] The PM_{10} network includes 160 collocated samplers for QA purposes.

TABLE 5.—COSTS FOR PARTICULATE MONITORING

[In 1997 Dollars]

PM Monitor and Sampling Frequency	One-Time Capital Cost	Annual Operation & Maintenance Cost
PM_{10} 1-in-6 day sampling schedule	$7,700 to $14,800	$8,000 to $8,900
PM_{10} 1-in-3 day sampling schedule	$7,700 to $19,400	$12,400
$PM_{2.5}$ 1-in-6 day sampling schedule	$9,300 to $20,700	$11,300 to $12,500
$PM_{2.5}$ 1-in-3 day sampling schedule	$12,800 to $20,700	$17,000 to $18,600
$PM_{2.5}$ every day sampling	$12,900 to $20,700	$20,700 to $22,200
Nephelometer (continuous)	$21,000	$19,700

V. References

(1) Information Collection Request, 40 CFR Part 58, Ambient Air Quality Surveillance, OMB #2060-0084, EPA ICR No. 0940.14, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

VI. Regulatory Assessment Requirements

A. Regulatory Impact Analysis

Under Executive Order 12866 (58 FR 51735, October 4, 1993), the Agency must determine whether the regulatory action is ''significant'' and therefore subject to Office of Management and Budget (OMB) review and to the requirements of the Executive Order. The Order defines ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another Agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations or recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

It has been determined that this rule is not a ''significant regulatory action'' under the terms of the Executive Order 12866 and is therefore not subject to formal OMB review. However, this rule is being reviewed by OMB under Reporting and Recordkeeping Requirements.

B. Paperwork Reduction Act

The information collection requirements contained in this rule have been submitted for approval to OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. An Information Collection Request document has been prepared by EPA (ICR No. 0940.14) and a copy may be obtained from Sandy Farmer, Information Policy Branch, EPA, 401 M St., SW., Mail Code 2137, Washington, DC 20460; or by calling (202) 260-2740.

1. *Need and use of the collection*. The main use for the collection of the data is to implement the air quality standards. The various parameters reported as part of this ICR are necessary to ensure that the information and data collected by State and local agencies to assess the nation's air quality are defensible, of known quality, and meet EPA's data quality goals of completeness, precision, and accuracy.

The need and authority for this information collection is contained in section 110(a)(2)(C) of the Act, that requires ambient air quality monitoring for purposes of the SIP and reporting of the data to EPA, and section 319, that requires the reporting of a daily air pollution index. The legal authority for this requirement is the Ambient Air Quality Surveillance Regulations, 40 CFR 58.20, 58.21, 58.25, 58.26, 58.28, 58.30, 58.31, 58.35, and 58.36.

EPA's Office of Air Quality Planning and Standards uses ambient air monitoring data for a wide variety of purposes, including making NAAQS attainment/nonattainment decisions; determining the effectiveness of air pollution control programs; evaluating the effects of air pollution levels on public health; tracking the progress of SIPs; providing dispersion modeling support; developing responsible, cost-effective control strategies; reconciling emission inventories; and developing air quality trends. The collection of $PM_{2.5}$ data is necessary to support the $PM_{2.5}$ NAAQS, and the information collected will have practical utility as a data analysis tool.

The State and local agencies with responsibility for reporting ambient air quality data and information as requested by these regulations will submit these data electronically to the U.S. EPA's Aerometric Information Retrieval System, Air Quality Subsystem (AIRS-AQS). Quality assurance/quality control records and monitoring network documentation are also maintained by each State/local agency, in AIRS-AQS electronic format where possible.

2. *Reporting and recordkeeping burden*. The total annual collection and reporting burden associated with this rule is estimated to be 785,430 hours. Of this total, 778,826 hours are estimated to be for data reporting, or an average of 5,991 hours for the estimated 130 respondents. The remainder of 6,604 hours for recordkeeping burden averages 51 hours for the estimated 130 respondents. The capital operation/maintenance costs associated with this rule are estimated to be $32,463,626. These estimates include time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The frequency of data reporting for the NAMS and the SLAMS air quality data as well as the associated precision and accuracy data are submitted to EPA according to the schedule defined in 40 CFR part 58. This regulation currently requires that State and local air quality management agencies report their data within 90 days after the end of the quarter during which the data were collected. The annual SLAMS report is submitted by July 1 of each year for data collected from January 1 through December 31 of the previous year in accordance with 40 CFR part 58.26. This certification also implies that all SPM data to be used for regulatory purposes by the affected State or local air quality management agency have been submitted by July 1.

3. *Burden*. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purpose of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An Agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations

are listed in 40 CFR part 9 and 48 CFR Chapter 15.

C. Impact on Small Entities

Pursuant to section 605(b) of the Regulatory Flexibility Act, 5 U.S.C. 605(b), the EPA Administrator certifies that this rule will not have a significant economic impact on a substantial number of small entities. This rulemaking package does not impose any additional requirements on small entities because it applies to governments whose jurisdictions cover more than 200,000 population. Under the Regulatory Flexibility Act, governments are small entities only if they have jurisdictions of less than 50,000 people. In addition, this rule imposes no enforceable duties on small businesses.

D. Unfunded Mandates Reform Act of 1995

Under sections 202, 203, and 205 of the Unfunded Mandates Reform Act of 1995 signed into law on March 22, 1995, EPA must undertake various actions in association with proposed or final rules that include a Federal mandate that may result in estimated costs of $100 million or more to the private sector, or to State or local governments in the aggregate.

EPA has determined that this rule does not contain a Federal mandate that may result in an administrative burden of $100 million or more for State and local governments, in the aggregate, or the private sector in any one year. The Agency's economic analysis indicates that the total incremental administrative cost will be approximately $56,611,000 in 1997 dollars for the 3 years to phase in the network, or an average of $18,820,000 per year for the 3-year implementation period. Table 6 shows how this 3-year average was derived for the various cost elements of monitoring. While this table represents the 3-year period 1998-2000, the total cost for $PM_{2.5}$ monitoring include the initial capital costs anticipated in 1997. In addition, this rule imposes no enforceable duties on small businesses.

Table 6.—Cost Elements for PM Monitoring

Administrative Cost Based on 3-year Average (thousands of constant 1997 dollars)*

Cost/Element	Current	Revised			Net Change
	PM_{10}	PM_{10}	$PM_{2.5}$	Totals	
Network design		$0	$1,174	$1,174	$1,174
Site installation		$0	$1,532	$1,532	$1,532
Sampling & analysis	$3,518	$2,528	$7,915	$10,443	$6,926
Maintenance	$1,658	$1,192	$2,285	$3,477	$1,818
Data management	$2,098	$1,508	$3,370	$4,878	$2,780
Quality assurance	$2,940	$2,113	$3,342	$5,455	$2,515
Supervision	$3,350	$2,408	$3,068	$5,476	$2,125
Summary	$13,564	$9,749	$22,684	$32,433	$18,820
*Totals are rounded					

List of Subjects in 40 CFR Parts 53 and 58

Environmental protection, Administrative practice and procedure, Air pollution control, Intergovernmental relations, Reporting and recordkeeping requirements.

Dated: July 16, 1997.

Carol M. Browner,

Administrator.

For the reasons set forth in the preamble, title 40, chapter I, parts 53 and 58 of the Code of Federal Regulations are amended as follows:

PART 53—[AMENDED]

1. In part 53:

a. The authority citation for part 53 continues to read as follows:

Authority: Sec. 301(a) of the Clean Air Act (42 U.S.C. Sec. 1857g(a)) as amended by sec. 15(c)(2) of Pub. L. 91-604, 84 Stat. 1713, unless otherwise noted.

b. Subpart A is revised to read as follows:

Subpart A—General Provisions

Sec.

53.1 Definitions.
53.2 General requirements for a reference method determination.
53.3 General requirements for an equivalent method determination.
53.4 Applications for reference or equivalent method determinations.
53.5 Processing of applications.
53.6 Right to witness conduct of tests.
53.7 Testing of methods at the initiative of the Administrator.
53.8 Designation of reference and equivalent methods.
53.9 Conditions of designation.
53.10 Appeal from rejection of application.
53.11 Cancellation of reference or equivalent method designation.
53.12 Request for hearing on cancellation.
53.13 Hearings.
53.14 Modification of a reference or equivalent method.
53.15 Trade secrets and confidential or privileged information.
53.16 Supersession of reference methods.

Tables to Subpart A of Part 53

Table A-1.—Summary of Applicable Requirements for Reference Equivalent Methods for Air Monitoring of Criteria Pollutants

Appendix A to Subpart A of Part 53—References

Subpart A—General Provisions

§ 53.1 Definitions.

Terms used but not defined in this part shall have the meaning given them by the Act.

Act means the Clean Air Act (42 U.S.C. 1857-1857l), as amended.

Administrator means the Administrator of the Environmental Protection Agency or the Administrator's authorized representative.

Agency means the Environmental Protection Agency.

Applicant means a person or entity who submits an application for a reference or equivalent method determination under § 53.4, or a person or entity who assumes the rights and obligations of an applicant under § 53.7. Applicant may include a manufacturer, distributor, supplier, or vendor.

Automated method or analyzer means a method for measuring concentrations of an ambient air pollutant in which sample collection (if necessary), analysis, and measurement are performed automatically by an instrument.

Candidate method means a method for measuring the concentration of an air pollutant in the ambient air for which an application for a reference method determination or an equivalent method determination is submitted in accordance with § 53.4, or a method tested at the initiative of the Administrator in accordance with § 53.7.

Class I equivalent method means an equivalent method for $PM_{2.5}$ which is based on a sampler that is very similar to the sampler specified for reference methods in Appendix L of this part, with only minor deviations or modifications, as determined by EPA.

Class II equivalent method means an equivalent method for $PM_{2.5}$ that utilizes a $PM_{2.5}$ sampler in which an integrated $PM_{2.5}$ sample is obtained from the atmosphere by

filtration and is subjected to a subsequent filter conditioning process followed by a gravimetric mass determination, but which is not a Class I equivalent method because of substantial deviations from the design specifications of the sampler specified for reference methods in Appendix L of part 50 of this chapter, as determined by EPA.

Class III equivalent method means an equivalent method for $PM_{2.5}$ that has been determined by EPA not to be a Class I or Class II equivalent method. This fourth type of $PM_{2.5}$ method includes alternative equivalent method samplers and continuous analyzers, based on designs and measurement principles different from those specified for reference methods (e.g., a means for estimating aerosol mass concentration other than by conventional integrated filtration followed by equilibration and gravimetric analysis. These samplers (or monitors) are those deemed to be substantially different from reference method samplers and are likely to use components and methods other than those specified for reference method samplers.

Collocated describes two or more air samplers, analyzers, or other instruments which sampler the ambient air that are operated silmultaneously while located side by side, separated by a distance that is large enough to preclude the air sampled by any of the devices from being affected by any of the other devices, but small enough so that all devices obtain identical or uniform ambient air samples that are equally representative of the general area in which the group of devices is located.

Equivalent method means a method for measuring the concentration of an air pollutant in the ambient air that has been designated as an equivalent method in accordance with this part; it does not include a method for which an equivalent method designation has been canceled in accordance with § 53.11 or § 53.16.

ISO 9001-registered facility means a manufacturing facility that is either:

(1) An International Organization for Standardization (ISO) 9001-registered manufacturing facility, registered to the ISO 9001 standard (by the Registrar Accreditation Board (RAB) of the American Society for Quality Control (ASQC) in the United States), with registration maintained continuously.

(2) A facility that can be demonstrated, on the basis of information submitted to the EPA, to be operated according to an EPA-approved and periodically audited quality system which meets, to the extent appropriate, the same general requirements as an ISO 9001-registered facility for the design and manufacture of designated reference and equivalent method samplers and monitors.

ISO-certified auditor means an auditor who is either certified by the Registrar Accreditation Board (in the United States) as being qualified to audit quality systems using the requirements of recognized standards such as ISO 9001, or who, based on information submitted to the EPA, meets the same general requirements as provided for ISO-certified auditors.

Manual method means a method for measuring concentrations of an ambient air pollutant in which sample collection, analysis, or measurement, or some combination therof, is performed manually. A method for PM_{10} or $PM_{2.5}$ which utilizes a sampler that requires manual preparation, loading, and weighing of filter samples is considered a manual method even though the sampler may be capable of automatically collecting a series of sequential samples.

$PM_{2.5}$ sampler means a device, associated with a manual method for measuring $PM_{2.5}$, designed to collect $PM_{2.5}$ from an ambient air sample, but lacking the ability to automatically analyze or measure the collected sample to determine the mass concentrations of $PM_{2.5}$ in the sampled air.

PM_{10} sampler means a device, associated with a manual method for measuring PM_{10}, designed to collect PM_{10} from an ambient air sample, but lacking the ability to automatically analyze or measure the collected sample to determine the mass concentrations of PM_{10} in the sampled air.

Reference method means a method of sampling and analyzing the ambient air for an air pollutant that is specified as a reference method in an appendix to part 50 of this chapter, or a method that has been designated as a reference method in accordance with this part; it does not include a method for which a reference method designation has been canceled in accordance with § 53.11 or § 53.16.

Sequential samples for PM samplers means two or more PM samples for sequential (but not necessarily contiguous) time periods that are collected automatically by the same sampler without the need for intervening operator service.

Test analyzer means an analyzer subjected to testing as part of a candidate method in accordance with subparts B, C, D, E, or F of this part, as applicable. Test sampler means a PM_{10} sampler or a $PM_{2.5}$ sampler subjected to testing as part of a candidate method in accordance with subparts C, D, E, or F of this part.

Ultimate purchaser means the first person or entity who purchases a reference method or an equivalent method for purposes other than resale.

§ 53.2 General requirements for a reference method determination.

The following general requirements for a reference method determination are summarized in Table A-1 of this subpart.

(a) *Manual methods.* (1) For measuring sulfur dioxide (SO_2) and lead, Appendices A and G of part 50 of this chapter specify unique manual reference methods for those pollutants. Except as provided in § 53.16, other manual methods for SO_2 and lead will not be considered for reference method determinations under this part.

(2) A reference method for measuring PM_{10} must be a manual method that meets all requirements specified in Appendix J of part 50 of this chapter and must include a PM_{10} sampler that has been shown in accordance with this part to meet all requirements specified in subparts A and D of this part.

(3) A reference method for measuring $PM_{2.5}$ must be a manual method that meets all requirements specified in Appendix L of part 50 of this chapter and must include a $PM_{2.5}$ sampler that has been shown in accordance with this part to meet the applicable requirements specified in subparts A and E of this part. Further, reference method samplers must be manufactured in an ISO 9001-registered facility, as defined in § 53.1 and as set forth in § 53.51, and the Product Manufacturing Checklist set forth in subpart E of this part must be completed by an ISO-certified auditor, as defined in § 53.1, and submitted to EPA annually to retain a $PM_{2.5}$ reference method designation.

(b) *Automated methods.* An automated reference method for measuring carbon monoxide (CO), ozone (O_3), and nitrogen dioxide (NO_2) must utilize the measurement principle and calibration procedure specified in the appropriate appendix to part 50 of this chapter and must have been shown in accordance with this part to meet the requirements specified in subpart B of this part.

§ 53.3 General requirements for an equivalent method determination.

(a) *Manual methods.* A manual equivalent method must have been shown in accordance with this part to satisfy the applicable requirements specified in subpart C of this part. In addition, PM_{10} or $PM_{2.5}$ samplers associated with manual equivalent methods for PM_{10} or $PM_{2.5}$ must have been shown in accordance with this part to satisfy the following additional requirements:

(1) A PM_{10} sampler associated with a manual method for PM_{10} must satisfy the requirements of subpart D of this part.

(2) A $PM_{2.5}$ Class I equivalent method sampler must satisfy all requirements of subparts C and E of this part, which include appropriate demonstration that each and every deviation or modification from the reference method sampler specifications does not significantly alter the performance of the sampler.

(3) A $PM_{2.5}$ Class II equivalent method sampler must satisfy the applicable requirements of subparts C, E, and F of this part.

(4) Requirements for $PM_{2.5}$ Class III equivalent method samplers are not provided in this part because of the wide range of non-filter-based measurement technologies that could be applied and the likelihood that these

requirements will have to be specifically adapted for each such type of technology. Specific requirements will be developed as needed and may include selected requirements from subparts C, E, or F of this part or other requirements not contained in this part.

(5) All designated equivalent methods for $PM_{2.5}$ must be manufactured in an ISO 9001-registered facility, as defined in § 53.1 and as set forth in § 53.51, and the Product Manufacturing Checklist set forth in subpart E of this part must be completed by an ISO-certified auditor, as defined in § 53.1, and submitted to EPA annually to retain a $PM_{2.5}$ equivalent method designation.

(b) *Automated methods.* (1) Automated equivalent methods for pollutants other than $PM_{2.5}$ or PM_{10} must have been shown in accordance with this part to satisfy the requirements specified in subparts B and C of this part.

(2) Automated equivalent methods for PM_{10} must have been shown in accordance with this part to satisfy the requirements of subparts C and D of this part.

(3) Requirements for $PM_{2.5}$ Class III automated equivalent methods for $PM_{2.5}$ are not provided in this part because of the wide range of non-filter-based measurement technologies that could be applied and the likelihood that these requirements will have to be specifically adapted for each such type of technology. Specific requirements will be developed as needed and may include selected requirements from subparts C, E, or F of this part or other requirements not contained in this part.

(4) All designated equivalent methods for $PM_{2.5}$ must be manufactured in an ISO 9001-registered facility, as set forth in subpart E of this part, and the Product Manufacturing Checklist set forth in subpart E of this part must be completed by an ISO-certified auditor and submitted to EPA annually to retain a $PM_{2.5}$ equivalent method designation.

(5) All designated equivalent methods for $PM_{2.5}$ must also meet annual requirements for network operating performance determined as set forth in section 6 of Appendix A of part 58 of this chapter.

§ 53.4 Applications for reference or equivalent method determinations.

(a) Applications for reference or equivalent method determinations shall be submitted in duplicate to: Director, National Exposure Research Laboratory, Department E (MD-77B), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

(b) Each application shall be signed by an authorized representative of the applicant, shall be marked in accordance with § 53.15 (if applicable), and shall contain the following:

(1) A clear identification of the candidate method, which will distinguish it from all other methods such that the method may be referred to unambiguously. This identification must consist of a unique series of descriptors such as title, identification number, analyte, measurement principle, manufacturer, brand, model, etc., as necessary to distinguish the method from all other methods or method variations, both within and outside the applicant's organization.

(2) A detailed description of the candidate method, including but not limited to the following: The measurement principle, manufacturer, name, model number and other forms of identification, a list of the significant components, schematic diagrams, design drawings, and a detailed description of the apparatus and measurement procedures. Drawings and descriptions pertaining to candidate methods or samplers for $PM_{2.5}$ must meet all applicable requirements in Reference 1 of Appendix A of this subpart, using appropriate graphical, nomenclature, and mathematical conventions such as those specified in References 3 and 4 of Appendix A of this subpart.

(3) A copy of a comprehensive operation or instruction manual providing a complete and detailed description of the operational, maintenance, and calibration procedures prescribed for field use of the candidate method and all instruments utilized as part of that method (under § 53.9(a)).

(i) As a minimum this manual shall include:

(A) Description of the method and associated instruments.

(B) Explanation of all indicators, information displays, and controls.

(C) Complete setup and installation instructions, including any additional materials or supplies required.

(D) Details of all initial or startup checks or acceptance tests and any auxiliary equipment required.

(E) Complete operational instructions.

(F) Calibration procedures and required calibration equipment and standards.

(G) Instructions for verification of correct or proper operation.

(H) Trouble-shooting guidance and suggested corrective actions for abnormal operation.

(I) Required or recommended routine, periodic, and preventative maintenance and maintenance schedules.

(J) Any calculations required to derive final concentration measurements.

(K) Appropriate references to Appendix L of part 50 of this chapter; Reference 6 of Appendix A of this subpart; and any other pertinent guidelines.

(ii) The manual shall also include adequate warning of potential safety hazards that may result from normal use and/or malfunction of the method and a description of necessary safety precautions. (See § 53.9(b).) However, the previous requirement shall not be interpreted to constitute or imply any warranty of safety of the method by EPA. For samplers and automated methods, the manual shall include a clear description of all procedures pertaining to installation, operation, preventive maintenance, and troubleshooting and shall also include parts identification diagrams. The manual may be used to satisfy the requirements of paragraphs (b)(1) and (b)(2) of this section to the extent that it includes information necessary to meet those requirements.

(4) A statement that the candidate method has been tested in accordance with the procedures described in subparts B, C, D, E, and/or F of this part, as applicable.

(5) Descriptions of test facilities and test configurations, test data, records, calculations, and test results as specified in subparts B, C, D, E, and/or F of this part, as applicable. Data must be sufficiently detailed to meet appropriate principles described in paragraphs 4 through 6 of Reference 2 of Appendix A of this subpart, Part b, sections 3.3.1 (paragraph 1) and 3.5.1 (paragraphs 2 and 3) and in paragraphs 1 through 3 of Reference 5 (section 4.8, Records) of Appendix A of this subpart. Salient requirements from these references include the following:

(i) The applicant shall maintain and include records of all relevant measuring equipment, including the make, type, and serial number or other identification, and most recent calibration with identification of the measurement standard or standards used and their National Institute of Standards and Technology (NIST) traceability. These records shall demonstrate the measurement capability of each item of measuring equipment used for the application and include a description and justification (if needed) of the measurement setup or configuration in which it was used for the tests. The calibration results shall be recorded and identified in sufficient detail so that the traceability of all measurements can be determined and any measurement could be reproduced under conditions close to the original conditions, if necessary, to resolve any anomalies.

(ii) Test data shall be collected according to the standards of good practice and by qualified personnel. Test anomalies or irregularities shall be documented and explained or justified. The impact and significance of the deviation on test results and conclusions shall be determined. Data collected shall correspond directly to the specified test requirement and be labeled and identified clearly so that results can be verified and evaluated against the test requirement. Calculations or data manipulations must be explained in detail so that they can be verified.

(6) A statement that the method, analyzer, or sampler tested in accordance with this part is representative of the candidate method described in the application.

(c) For candidate automated methods and candidate manual methods for PM_{10} and $PM_{2.5}$, the application shall also contain the following:

(1) A detailed description of the quality system that will be utilized, if the candidate method is designated as a reference or equivalent method, to ensure that all analyzers or samplers offered for sale under that designation will have essentially the same performance characteristics as the analyzer(s) or samplers tested in accordance with this part. In addition, the quality system requirements for candidate methods for $PM_{2.5}$ must be described in sufficient detail, based on the elements described in section 4 of Reference 1 (Quality System Requirements) of Appendix A of this subpart. Further clarification is provided in the following sections of Reference 2 of Appendix A of this subpart: Part A (Management Systems), sections 2.2 (Quality System and Description), 2.3 (Personnel Qualification and Training), 2.4 (Procurement of Items and Services), 2.5 (Documents and Records), and 2.7 (Planning); Part B (Collection and Evaluation of Environmental Data), sections 3.1 (Planning and Scoping), 3.2 (Design of Data Collection Operations), and 3.5 (Assessment and Verification of Data Usability); and Part C (Operation of Environmental Technology), sections 4.1 (Planning), 4.2 (Design of Systems), and 4.4 (Operation of Systems).

(2) A description of the durability characteristics of such analyzers or samplers (see § 53.9(c)). For methods for $PM_{2.5}$, the warranty program must ensure that the required specifications (see Table A-1 of this subpart) will be met throughout the warranty period and that the applicant accepts responsibility and liability for ensuring this conformance or for resolving any nonconformities, including all necessary components of the system, regardless of the original manufacturer. The warranty program must be described in sufficient detail to meet appropriate provisions of the ANSI/ASQC and ISO 9001 standards (References 1 and 2 in Appendix A of this subpart) for controlling conformance and resolving nonconformance, particularly sections 4.12, 4.13, and 4.14 of Reference 1 in Appendix A of this subpart.

(i) Section 4.12 in Appendix A of this subpart requires the manufacturer to establish and maintain a system of procedures for identifying and maintaining the identification of inspection and test status throughout all phases of manufacturing to ensure that only instruments that have passed the required inspections and tests are released for sale.

(ii) Section 4.13 in Appendix A of this subpart requires documented procedures for control of nonconforming product, including review and acceptable alternatives for disposition; section 4.14 in Appendix A of this subpart requires documented procedures for implementing corrective (4.14.2) and preventive (4.14.3) action to eliminate the causes of actual or potential nonconformities. In particular, section 4.14.3 requires that potential causes of nonconformities be eliminated by using information such as service reports and customer complaints to eliminate potential causes of nonconformities.

(d) For candidate reference or equivalent methods for $PM_{2.5}$, the applicant shall provide to EPA for test purposes one sampler or analyzer that is representative of the sampler or analyzer associated with the candidate method. The sampler or analyzer shall be shipped FOB destination to Department E, (MD-77B), U.S. EPA, 79 T.W. Alexander Drive, Research Triangle Park, NC 27711, scheduled to arrive concurrent with or within 30 days of the arrival of the other application materials. This analyzer or sampler may be subjected to various tests that EPA determines to be necessary or appropriate under § 53.5(f), and such tests may include special tests not described in this part. If the instrument submitted under this paragraph malfunctions, becomes inoperative, or fails to perform as represented in the application before the necessary EPA testing is completed, the applicant shall be afforded an opportunity to repair or replace the device at no cost to EPA. Upon completion of EPA testing, the analyzer or sampler submitted under this paragraph shall be repacked by EPA for return shipment to the applicant, using the same packing materials used for shipping the instrument to EPA unless alternative packing is provided by the applicant. Arrangements for, and the cost of, return shipment shall be the responsibility of the applicant. EPA does not warrant or assume any liability for the condition of the analyzer or sampler upon return to the applicant.

§ 53.5 Processing of applications.

After receiving an application for a reference or equivalent method determination, the Administrator will publish notice of the application in the **Federal Register** and, within 120 calendar days after receipt of the application, take one or more of the following actions:

(a) Send notice to the applicant, in accordance with § 53.8, that the candidate method has been determined to be a reference or equivalent method.

(b) Send notice to the applicant that the application has been rejected, including a statement of reasons for rejection.

(c) Send notice to the applicant that additional information must be submitted before a determination can be made and specify the additional information that is needed (in such cases, the 120–day period shall commence upon receipt of the additional information).

(d) Send notice to the applicant that additional test data must be submitted and specify what tests are necessary and how the tests shall be interpreted (in such cases, the 120–day period shall commence upon receipt of the additional test data).

(e) Send notice to the applicant that the application has been found to be substantially deficient or incomplete and cannot be processed until additional information is submitted to complete the application and specify the general areas of substantial deficiency.

(f) Send notice to the applicant that additional tests will be conducted by the Administrator, specifying the nature of and reasons for the additional tests and the estimated time required (in such cases, the 120–day period shall commence 1 calendar day after the additional tests have been completed).

§ 53.6 Right to witness conduct of tests.

(a) Submission of an application for a reference or equivalent method determination shall constitute consent for the Administrator or the Administrator's authorized representative, upon presentation of appropriate credentials, to witness or observe any tests required by this part in connection with the application or in connection with any modification or intended modification of the method by the applicant.

(b) The applicant shall have the right to witness or observe any test conducted by the Administrator in connection with the application or in connection with any modification or intended modification of the method by the applicant.

(c) Any tests by either party that are to be witnessed or observed by the other party shall be conducted at a time and place mutually agreeable to both parties.

§ 53.7 Testing of methods at the initiative of the Administrator.

(a) In the absence of an application for a reference or equivalent method determination, the Administrator may conduct the tests required by this part for such a determination, may compile such other information as may be necessary in the judgment of the Administrator to make such a determination, and on the basis of the tests and information may determine that a method satisfies applicable requirements of this part.

(b) In the absence of an application requesting the Administrator to consider revising an appendix to part 50 of this chapter in accordance with § 53.16, the Administrator may conduct such tests and compile such information as may be necessary in the Administrator's judgment to make a determination under § 53.16(d) and on the basis of the tests and information make such a determination.

(c) If a method tested in accordance with this section is designated as a reference or equivalent method in accordance with § 53.8 or is specified or designated as a reference method in accordance with § 53.16, any person or entity who offers the method for sale as a reference or equivalent method thereafter shall assume the rights and obligations of an applicant for purposes of this part, with the exception of those pertaining to submission and processing of applications.

§ 53.8 Designation of reference and equivalent methods.

(a) A candidate method determined by the Administrator to satisfy the applicable requirements of this part shall be designated as a reference method or equivalent method (as applicable), and a notice of the designation shall be submitted for publication in the **Federal Register** not later than 15 days after the determination is made.

(b) A notice indicating that the method has been determined to be a reference method or an equivalent method shall be sent to the applicant. This notice shall constitute proof of the determination until a notice of designation is published in accordance with paragraph (a) of this section.

(c) The Administrator will maintain a current list of methods designated as reference or equivalent methods in accordance with this part and will send a copy of the list to any person or group upon request. A copy of the list will be available for inspection or copying at EPA Regional Offices.

§ 53.9 Conditions of designation.

Designation of a candidate method as a reference method or equivalent method shall be conditioned to the applicant's compliance with the following requirements. Failure to comply with any of the requirements shall constitute a ground for cancellation of the designation in accordance with § 53.11.

(a) Any method offered for sale as a reference or equivalent method shall be accompanied by a copy of the manual referred to in § 53.4(b)(3) when delivered to any ultimate purchaser.

(b) Any method offered for sale as a reference or equivalent method shall generate no unreasonable hazard to operators or to the environment during normal use or when malfunctioning.

(c) Any analyzer, PM_{10} sampler, or $PM_{2.5}$ sampler offered for sale as part of a reference or equivalent method shall function within the limits of the performance specifications referred to in § 53.20(a), § 53.30(a), § 53.50, or § 53.60, as applicable, for at least 1 year after delivery and acceptance when maintained and operated in accordance with the manual referred to in § 53.4(b)(3).

(d) Any analyzer, PM_{10} sampler, or $PM_{2.5}$ sampler offered for sale as a reference or equivalent method shall bear a prominent, permanently affixed label or sticker indicating that the analyzer or sampler has been designated by EPA as a reference method or as an equivalent method (as applicable) in accordance with this part and displaying any designated method identification number that may be assigned by EPA.

(e) If an analyzer is offered for sale as a reference or equivalent method and has one or more selectable ranges, the label or sticker required by paragraph (d) of this section shall be placed in close proximity to the range selector and shall indicate clearly which range or ranges have been designated as parts of the reference or equivalent method.

(f) An applicant who offers analyzers, PM_{10} samplers, or $PM_{2.5}$ samplers for sale as reference or equivalent methods shall maintain an accurate and current list of the names and mailing addresses of all ultimate purchasers of such analyzers or samplers. For a period of 7 years after publication of the reference or equivalent method designation applicable to such an analyzer or sampler, the applicant shall notify all ultimate purchasers of the analyzer or $PM_{2.5}$ or PM_{10} sampler within 30 days if the designation has been canceled in accordance with § 53.11 or § 53.16 or if adjustment of the analyzer or sampler is necessary under § 53.11(b).

(g) If an applicant modifies an analyzer, PM_{10} sampler, or $PM_{2.5}$ sampler that has been designated as a reference or equivalent method, the applicant shall not sell the modified analyzer or sampler as a reference or equivalent method nor attach a label or sticker to the modified analyzer or sampler under paragraph (d) or (e) of this section until the applicant has received notice under § 53.14(c) that the existing designation or a new designation will apply to the modified analyzer, PM_{10} sampler, or $PM_{2.5}$ sampler or has applied for and received notice under § 53.8(b) of a new reference or equivalent method determination for the modified analyzer or sampler.

(h) An applicant who has offered $PM_{2.5}$ samplers or analyzers for sale as part of a reference or equivalent method may continue to do so only so long as the facility in which the samplers or analyzers are manufactured continues to be an ISO 9001-registered facility, as set forth in subpart E of this part. In the event that the ISO 9001 registration for the facility is withdrawn, suspended, or otherwise becomes inapplicable, either permanently or for some specified time interval, such that the facility is no longer an ISO 9001-registered facility, the applicant shall notify EPA within 30 days of the date the facility becomes other than an ISO 9001-registered facility, and upon such notification, EPA shall issue a preliminary finding and notification of possible cancellation of the reference or equivalent method designation under § 53.11.

(i) An applicant who has offered $PM_{2.5}$ samplers or analyzers for sale as part of a reference or equivalent method may continue to do so only so long as updates of the Product Manufacturing Checklist set forth in subpart E of this part are submitted annually. In the event that an annual Checklist update is not received by EPA within 12 months of the date of the last such submitted Checklist or Checklist update, EPA shall notify the applicant within 30 days that the Checklist update has not been received and shall, within 30 days from the issuance of such notification, issue a preliminary finding and notification of possible cancellation of the reference or equivalent method designation under § 53.11.

§ 53.10 Appeal from rejection of application.

Any applicant whose application for a reference or equivalent method determination has been rejected may appeal the Administrator's decision by taking one or more of the following actions:

(a) The applicant may submit new or additional information in support of the application.

(b) The applicant may request that the Administrator reconsider the data and information already submitted.

(c) The applicant may request that any test conducted by the Administrator that was a material factor in the decision to reject the application be repeated.

§ 53.11 Cancellation of reference or equivalent method designation.

(a) *Preliminary finding*. If the Administrator makes a preliminary finding on the basis of any available information that a representative sample of a method designated as a reference or equivalent method and offered for sale as such does not fully satisfy the requirements of this part or that there is any violation of the requirements set forth in § 53.9, the Administrator may initiate proceedings to cancel the designation in accordance with the following procedures.

(b) *Notification and opportunity to demonstrate or achieve compliance*. (1) After making a preliminary finding in accordance with paragraph (a) of this section, the Administrator will send notice of the preliminary finding to the applicant, together with a statement of the facts and reasons on which the preliminary finding is based, and will publish notice of the preliminary finding in the **Federal Register**.

(2) The applicant will be afforded an opportunity to demonstrate or to achieve compliance with the requirements of this part within 60 days after publication of notice in accordance with paragraph (b)(1) of this section or within such further period as the Administrator may allow, by demonstrating to the satisfaction of the Administrator that the method in question satisfies the requirements of this part, by commencing a program to make any adjustments that are necessary to bring the method into compliance, or by taking such action as may be necessary to cure any violation of the requirements of § 53.9. If adjustments are necessary to bring the method into compliance, all such adjustments shall be made within a reasonable time as determined by the Administrator. If the applicant demonstrates or achieves compliance in accordance with this paragraph (b)(2), the Administrator will publish notice of such demonstration or achievement in the **Federal Register**.

(c) *Request for hearing*. Within 60 days after publication of a notice in accordance

with paragraph (b)(1) of this section, the applicant or any interested person may request a hearing as provided in § 53.12.

(d) *Notice of cancellation.* If, at the end of the period referred to in paragraph (b)(2) of this section, the Administrator determines that the reference or equivalent method designation should be canceled, a notice of cancellation will be published in the **Federal Register** and the designation will be deleted from the list maintained under § 53.8(c). If a hearing has been requested and granted in accordance with § 53.12, action under this paragraph (d) will be taken only after completion of proceedings (including any administrative review) conducted in accordance with § 53.13 and only if the decision of the Administrator reached in such proceedings is that the designation in question should be canceled.

§ 53.12 Request for hearing on cancellation.

Within 60 days after publication of a notice in accordance with § 53.11(b)(1), the applicant or any interested person may request a hearing on the Administrator's action. If, after reviewing the request and supporting data, the Administrator finds that the request raises a substantial issue of fact, a hearing will be granted in accordance with § 53.13 with respect to such issue. The request shall be in writing, signed by an authorized representative of the applicant or interested person, and shall include a statement specifying:

(a) Any objections to the Administrator's action.

(b) Data or other information in support of such objections.

§ 53.13 Hearings.

(a)(1) After granting a request for a hearing under § 53.12, the Administrator will designate a presiding officer for the hearing.

(2) If a time and place for the hearing have not been fixed by the Administrator, the hearing will be held as soon as practicable at a time and place fixed by the presiding officer, except that the hearing shall in no case be held sooner than 30 days after publication of a notice of hearing in the **Federal Register**.

(3) For purposes of the hearing, the parties shall include EPA, the applicant or interested person(s) who requested the hearing, and any person permitted to intervene in accordance with paragraph (c) of this section.

(4) The Deputy General Counsel or the Deputy General Counsel's representative will represent EPA in any hearing under this section.

(5) Each party other than EPA may be represented by counsel or by any other duly authorized representative.

(b)(1) Upon appointment, the presiding officer will establish a hearing file. The file shall contain copies of the notices issued by the Administrator pursuant to § 53.11(b)(1), together with any accompanying material, the request for a hearing and supporting data submitted therewith, the notice of hearing published in accordance with paragraph (a)(2) of this section, and correspondence and other material data relevant to the hearing.

(2) The hearing file shall be available for inspection by the parties or their representatives at the office of the presiding officer, except to the extent that it contains information identified in accordance with § 53.15.

(c) The presiding officer may permit any interested person to intervene in the hearing upon such a showing of interest as the presiding officer may require; provided that permission to intervene may be denied in the interest of expediting the hearing where it appears that the interests of the person seeking to intervene will be adequately represented by another party (or by other parties), including EPA.

(d)(1) The presiding officer, upon the request of any party or at the officer's discretion, may arrange for a prehearing conference at a time and place specified by the officer to consider the following:

(i) Simplification of the issues.

(ii) Stipulations, admissions of fact, and the introduction of documents.

(iii) Limitation of the number of expert witnesses.

(iv) Possibility of agreement on disposing of all or any of the issues in dispute.

(v) Such other matters as may aid in the disposition of the hearing, including such additional tests as may be agreed upon by the parties.

(2) The results of the conference shall be reduced to writing by the presiding officer and made part of the record.

(e)(1) Hearings shall be conducted by the presiding officer in an informal but orderly and expeditious manner. The parties may offer oral or written evidence, subject to exclusion by the presiding officer of irrelevant, immaterial, or repetitious evidence.

(2) Witnesses shall be placed under oath.

(3) Any witness may be examined or cross-examined by the presiding officer, the parties, or their representatives. The presiding officer may, at his/her discretion, limit cross-examination to relevant and material issues.

(4) Hearings shall be reported verbatim. Copies of transcripts of proceedings may be purchased from the reporter.

(5) All written statements, charts, tabulations, and data offered in evidence at the hearing shall, upon a showing satisfactory to the presiding officer of their authenticity, relevancy, and materiality, be received in evidence and shall constitute part of the record.

(6) Oral argument shall be permitted. The presiding officer may limit oral presentations to relevant and material issues and designate the amount of time allowed for oral argument.

(f)(1) The presiding officer shall make an initial decision which shall include written findings and conclusions and the reasons therefore on all the material issues of fact, law, or discretion presented on the record. The findings, conclusions, and written decision shall be provided to the parties and made part of the record. The initial decision shall become the decision of the Administrator without further proceedings unless there is an appeal to, or review on motion of, the Administrator within 30 calendar days after the initial decision is filed.

(2) On appeal from or review of the initial decision, the Administrator will have all the powers consistent with making the initial decision, including the discretion to require or allow briefs, oral argument, the taking of additional evidence or the remanding to the presiding officer for additional proceedings. The decision by the Administrator will include written findings and conclusions and the reasons or basis therefore on all the material issues of fact, law, or discretion presented on the appeal or considered in the review.

§ 53.14 Modification of a reference or equivalent method.

(a) An applicant who offers a method for sale as a reference or equivalent method shall report to the EPA Administrator prior to implementation any intended modification of the method, including but not limited to modifications of design or construction or of operational and maintenance procedures specified in the operation manual (see § 53.9(g)). The report shall be signed by an authorized representative of the applicant, marked in accordance with § 53.15 (if applicable), and addressed as specified in § 53.4(a).

(b) A report submitted under paragraph (a) of this section shall include:

(1) A description, in such detail as may be appropriate, of the intended modification.

(2) A brief statement of the applicant's belief that the modification will, will not, or may affect the performance characteristics of the method.

(3) A brief statement of the probable effect if the applicant believes the modification will or may affect the performance characteristics of the method.

(4) Such further information, including test data, as may be necessary to explain and support any statement required by paragraphs (b)(2) and (b)(3) of this section.

(c) Within 30 calendar days after receiving a report under paragraph (a) of this section, the Administrator will take one or more of the following actions:

(1) Notify the applicant that the designation will continue to apply to the method if the modification is implemented.

(2) Send notice to the applicant that a new designation will apply to the method (as modified) if the modification is implemented, submit notice of the determination for publication in the **Federal Register**, and

revise or supplement the list referred to in § 53.8(c) to reflect the determination.

(3) Send notice to the applicant that the designation will not apply to the method (as modified) if the modification is implemented and submit notice of the determination for publication in the **Federal Register**.

(4) Send notice to the applicant that additional information must be submitted before a determination can be made and specify the additional information that is needed (in such cases, the 30–day period shall commence upon receipt of the additional information).

(5) Send notice to the applicant that additional tests are necessary and specify what tests are necessary and how they shall be interpreted (in such cases, the 30–day period shall commence upon receipt of the additional test data).

(6) Send notice to the applicant that additional tests will be conducted by the Administrator and specify the reasons for and the nature of the additional tests (in such cases, the 30–day period shall commence 1 calendar day after the additional tests are completed).

(d) An applicant who has received a notice under paragraph (c)(3) of this section may appeal the Administrator's action as follows:

(1) The applicant may submit new or additional information pertinent to the intended modification.

(2) The applicant may request the Administrator to reconsider data and information already submitted.

(3) The applicant may request that the Administrator repeat any test conducted that was a material factor in the Administrator's determination. A representative of the applicant may be present during the performance of any such retest.

§ 53.15 Trade secrets and confidential or privileged information.

Any information submitted under this part that is claimed to be a trade secret or confidential or privileged information shall be marked or otherwise clearly identified as such in the submittal. Information so identified will be treated in accordance with part 2 of this chapter (concerning public information).

§ 53.16 Supersession of reference methods.

(a) This section prescribes procedures and criteria applicable to requests that the Administrator specify a new reference method, or a new measurement principle and calibration procedure on which reference methods shall be based, by revision of the appropriate appendix to part 50 of this chapter. Such action will ordinarily be taken only if the Administrator determines that a candidate method or a variation thereof is substantially superior to the existing reference method(s).

(b) In exercising discretion under this section, the Administrator will consider:

(1) The benefits, in terms of the requirements and purposes of the Act, that would result from specifying a new reference method or a new measurement principle and calibration procedure.

(2) The potential economic consequences of such action for State and local control agencies.

(3) Any disruption of State and local air quality monitoring programs that might result from such action.

(c) An applicant who wishes the Administrator to consider revising an appendix to part 50 of this chapter on the ground that the applicant's candidate method is substantially superior to the existing reference method(s) shall submit an application for a reference or equivalent method determination in accordance with § 53.4 and shall indicate therein that such consideration is desired. The application shall include, in addition to the information required by § 53.4, data and any other information supporting the applicant's claim that the candidate method is substantially superior to the existing reference method(s).

(d) After receiving an application under paragraph (c) of this section, the Administrator will publish notice of its receipt in the **Federal Register** and, within 120 calendar days after receipt of the application, take one of the following actions:

(1) Determine that it is appropriate to propose a revision of the appendix to part 50 of this chapter in question and send notice of the determination to the applicant.

(2) Determine that it is inappropriate to propose a revision of the appendix to part 50 of this chapter in question, determine whether the candidate method is a reference or equivalent method, and send notice of the determinations, including a statement of reasons for the determination not to propose a revision, to the applicant.

(3) Send notice to the applicant that additional information must be submitted before a determination can be made and specify the additional information that is needed (in such cases, the 120–day period shall commence upon receipt of the additional information).

(4) Send notice to the applicant that additional tests are necessary, specifying what tests are necessary and how the test shall be interpreted (in such cases, the 120–day period shall commence upon receipt of the additional test data).

(5) Send notice to the applicant that additional tests will be conducted by the Administrator, specifying the nature of and reasons for the additional tests and the estimated time required (in such cases, the 120–day period shall commence 1 calendar day after the additional tests have been completed).

(e)(1)(i) After making a determination under paragraph (d)(1) of this section, the Administrator will publish a notice of proposed rulemaking in the **Federal Register**. The notice of proposed rulemaking will indicate that the Administrator proposes:

(A) To revise the appendix to part 50 of this chapter in question.

(B) Where the appendix specifies a measurement principle and calibration procedure, to cancel reference method designations based on the appendix.

(C) To cancel equivalent method designations based on the existing reference method(s).

(ii) The notice of proposed rulemaking will include the terms or substance of the proposed revision, will indicate what period(s) of time the Administrator proposes to allow for replacement of existing methods under section 2.3 of Appendix C to part 58 of this chapter, and will solicit public comments on the proposal with particular reference to the considerations set forth in paragraphs (a) and (b) of this section.

(2)(i) If, after consideration of comments received, the Administrator determines that the appendix to part 50 in question should be revised, the Administrator will, by publication in the **Federal Register**:

(A) Promulgate the proposed revision, with such modifications as may be appropriate in view of comments received.

(B) Where the appendix to part 50 (prior to revision) specifies a measurement principle and calibration procedure, cancel reference method designations based on the appendix.

(C) Cancel equivalent method designations based on the existing reference method(s).

(D) Specify the period(s) that will be allowed for replacement of existing methods under section 2.3 of Appendix C to part 58 of this chapter, with such modifications from the proposed period(s) as may be appropriate in view of comments received.

(3) Canceled designations will be deleted from the list maintained under § 53.8(c). The requirements and procedures for cancellation set forth in § 53.11 shall be inapplicable to cancellation of reference or equivalent method designations under this section.

(4) If the appendix to part 50 of this chapter in question is revised to specify a new measurement principle and calibration procedure on which the applicant's candidate method is based, the Administrator will take appropriate action under § 53.5 to determine whether the candidate method is a reference method.

(5) Upon taking action under paragraph (e)(2) of this section, the Administrator will send notice of the action to all applicants for whose methods reference and equivalent method designations are canceled by such action.

(f) An applicant who has received notice of a determination under paragraph (d)(2) of this section may appeal the determination by taking one or more of the following actions:

(1) The applicant may submit new or additional information in support of the application.

(2) The applicant may request that the Administrator reconsider the data and information already submitted.

(3) The applicant may request that any test conducted by the Administrator that was a material factor in making the determination be repeated.

Tables to Subpart A of Part 53

TABLE A–1.—SUMMARY OF APPLICABLE REQUIREMENTS FOR REFERENCE AND EQUIVALENT METHODS FOR AIR MONITORING OF CRITERIA POLLUTANTS

Pollutant	Ref. or Equivalent	Manual or Automated	Applicable part 50 Appendix	Applicable Subparts of part 53					
				A	B	C	D	E	F
SO_2	Reference	Manual	A	.....	.....	.....	.....	.....	.....
		Manual		✔	.....	✔	.....	.....	.....
	Equivalent	Automated		✔	✔	✔	.....	.....	.....
CO	Reference	Automated	C	✔	✔	.....	.....	.....	.....
		Manual		✔	.....	✔	.....	.....	.....
	Equivalent	Automated		✔	✔	✔	.....	.....	.....
O_3	Reference	Automated	D	✔	✔	.....	.....	.....	.....
		Manual		✔	.....	✔	.....	.....	.....
	Equivalent	Automated		✔	✔	✔	.....	.....	.....
NO_2	Reference	Automated	F	✔	✔	.....	.....	.....	.....
		Manual		✔	.....	✔	.....	.....	.....
	Equivalent	Automated		✔	✔	✔	.....	.....	.....
Pb	Reference	Manual	G	.....	.....	.....	.....	.....	.....
	Equivalent	Manual		✔	.....	✔	.....	.....	.....
PM_{10}	Reference	Manual	J	✔	.....	.....	✔	.....	.....
		Manual		✔	.....	✔	✔	.....	.....
	Equivalent	Automated		✔	.....	✔	✔	.....	.....
$PM_{2.5}$	Reference	Manual	L	✔	.....	.....	.....	✔	.....
	Equivalent Class I	Manual	L	✔	.....	✔	.....	✔	.....
	Equivalent Class II	Manual	L	✔	.....	✔	.....	✔	✔
	Equivalent Class III	Manual or Automated		✔	.....	✔[1]	.....	✔[1]	✔[1]

[1] Note: Because of the wide variety of potential devices possible, the specific requirements applicable to a Class III candidate equivalent method for $PM_{2.5}$ are not specified explicitly in this part but, instead, shall be determined on a case-by-case basis for each such candidiate method.

Appendix A to Subpart A of Part 53—References

(1) American National Standard Quality Systems-Model for Quality Assurance in Design, Development, Production, Installation, and Servicing, ANSI/ISO/ASQC Q9001-1994. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(2) American National Standard—Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E41994. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(3) Dimensioning and Tolerancing, ASME Y14.5M-1994. Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

(4) Mathematical Definition of Dimensioning and Tolerancing Principles, ASME Y14.5.1M-1994. Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

(5) ISO 10012, Quality Assurance Requirements for Measuring Equipment-Part 1: Meteorological confirmation system for measuring equipment):1992(E). Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(6) Copies of section 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, EPA/600/R-94/038b, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

c. Subpart C is revised to read as follows:

Subpart C—Procedures for Determining Comparability Between Candidate Methods and Reference Methods

Sec.

53.30 General provisions.
53.31 Test conditions.
53.32 Test procedures for methods for SO_2, CO, O_3, and NO_2.
53.33 Test procedure for methods for lead.
53.34 Test procedure for methods for PM_{10} and $PM_{2.5}$.

Tables to Subpart C of Part 53

Table C-1.—Test Concentration Ranges, Number of Measurements Required, and Maximum Discrepancy Specification
Table C-2.—Sequence of Test Measurements
Table C-3.—Test Specifications for Lead Methods
Table C-4.—Test Specifications for PM_{10} and $PM_{2.5}$ Methods

Figures to Subpart C of Part 53

Figure C-1.—Suggested Format for Reporting Test Results

Appendix A to Subpart C of Part 53—References

Subpart C—Procedures for Determining Comparability Between Candidate Methods and Reference Methods

§ 53.30 General provisions.

(a) *Determination of comparability*. The test procedures prescribed in this subpart shall be used to determine if a candidate method is comparable to a reference method when both methods measure pollutant concentrations in ambient air.

(1) Comparability is shown for SO_2, CO, O_3, and NO_2 methods when the differences between:

(i) Measurements made by a candidate manual method or by a test analyzer representative of a candidate automated method.

(ii) Measurements made simultaneously by a reference method, are less than or equal to the values specified in the last column of Table C-1 of this subpart.

(2) Comparability is shown for lead methods when the differences between:

(i) Measurements made by a candidate method.

(ii) Measurements made by the reference method on simultaneously collected lead samples (or the same sample, if applicable), are less than or equal to the value specified in Table C-3 of this subpart.

(3) Comparability is shown for PM_{10} and $PM_{2.5}$ methods when the relationship between:

(i) Measurements made by a candidate method.

(ii) Measurements made by a reference method on simultaneously collected samples (or the same sample, if applicable) at each of two test sites, is such that the linear regression parameters (slope, intercept, and

correlation coefficient) describing the relationship meet the values specified in Table C-4 of this subpart.

(b) *Selection of test sites*—(1) *All methods*. Each test site shall be in a predominately urban area which can be shown to have at least moderate concentrations of various pollutants. The site shall be clearly identified and shall be justified as an appropriate test site with suitable supporting evidence such as maps, population density data, vehicular traffic data, emission inventories, pollutant measurements from previous years, concurrent pollutant measurements, and meteorological data. If approval of a proposed test site is desired prior to conducting the tests, a written request for approval of the test site or sites must be submitted prior to conducting the tests and must include the supporting and justification information required. The Administrator may exercise discretion in selecting a different site (or sites) for any additional tests the Administrator decides to conduct.

(2) *Methods for* SO_2, CO, O_3, and NO_2. All test measurements are to be made at the same test site. If necessary, the concentration of pollutant in the sampled ambient air may be augmented with artificially generated pollutant to facilitate measurements in the specified ranges described under paragraph (d)(2) of this section.

(3) *Methods for Pb*. Test measurements may be made at any number of test sites. Augmentation of pollutant concentrations is not permitted, hence an appropriate test site or sites must be selected to provide lead concentrations in the specified range.

(4) *Methods for* PM_{10}. Test measurements must be made, or derived from particulate samples collected, at not less than two test sites, each of which must be located in a geographical area characterized by ambient particulate matter that is significantly different in nature and composition from that at the other test site(s). Augmentation of pollutant concentrations is not permitted, hence appropriate test sites must be selected to provide PM_{10} concentrations in the specified range. The tests at the two sites may be conducted in different calendar seasons, if appropriate, to provide PM_{10} concentrations in the specified ranges.

(5) *Methods for* $PM_{2.5}$. Augmentation of pollutant concentrations is not permitted, hence appropriate test sites must be selected to provide $PM_{2.5}$ concentrations and $PM_{2.5}/PM_{10}$ ratios (if applicable) in the specified ranges.

(i) Where only one test site is required, as specified in Table C-4 of this subpart, the site need only meet the $PM_{2.5}$ ambient concentration levels required by § 53.34(c)(3).

(ii) Where two sites are required, as specified in Table C-4 of this subpart, each site must be selected to provide the ambient concentration levels required by § 53.34(c)(3). In addition, one site must be selected such that all acceptable test sample sets, as defined in § 53.34(c)(3), have a $PM_{2.5}/PM_{10}$ ratio of more than 0.75; the other site must be selected such that all acceptable test sample sets, as defined in § 53.34(c)(3), have a $PM_{2.5}/PM_{10}$ ratio of less than 0.40. At least two reference method PM_{10} samplers shall be collocated with the candidate and reference method $PM_{2.5}$ samplers and operated simultaneously with the other samplers at each test site to measure concurrent ambient concentrations of PM_{10} to determine the $PM_{2.5}/PM_{10}$ ratio for each sample set. The $PM_{2.5}/PM_{10}$ ratio for each sample set shall be the average of the $PM_{2.5}$ concentration, as determined in § 53.34(c)(1), divided by the average PM_{10} concentration, as measured by the PM_{10} samplers. The tests at the two sites may be conducted in different calendar seasons, if appropriate, to provide $PM_{2.5}$ concentrations and $PM_{2.5}/PM_{10}$ ratios in the specified ranges.

(c) *Test atmosphere*. Ambient air sampled at an appropriate test site or sites shall be used for these tests. Simultaneous concentration measurements shall be made in each of the concentration ranges specified in Tables C-1, C-3, or C-4 of this subpart, as appropriate.

(d) *Sample collection*—(1) *All methods*. All test concentration measurements or samples shall be taken in such a way that both the candidate method and the reference method receive air samples that are homogenous or as nearly identical as practical.

(2) *Methods for* SO_2, CO, O_3, and NO_2. Ambient air shall be sampled from a common intake and distribution manifold designed to deliver homogenous air samples to both methods. Precautions shall be taken in the design and construction of this manifold to minimize the removal of particulates and trace gases, and to ensure that identical samples reach the two methods. If necessary, the concentration of pollutant in the sampled ambient air may be augmented with artificially-generated pollutant. However, at all times the air sample measured by the candidate and reference methods under test shall consist of not less than 80 percent ambient air by volume. Schematic drawings, physical illustrations, descriptions, and complete details of the manifold system and the augmentation system (if used) shall be submitted.

(3) *Methods for Pb,* PM_{10} and $PM_{2.5}$. The ambient air intake points of all the candidate and reference method collocated samplers for lead, PM_{10} or $PM_{2.5}$ shall be positioned at the same height above the ground level, and between 2 and 4 meters apart. The samplers shall be oriented in a manner that will minimize spatial and wind directional effects on sample collection.

(4) PM_{10} *methods employing the same sampling procedure as the reference method but a different analytical method*. Candidate methods for PM_{10} which employ a sampler and sample collection procedure that are identical to the sampler and sample collection procedure specified in the reference method, but use a different analytical procedure, may be tested by analyzing common samples. The common samples shall be collected according to the sample collection procedure specified by the reference method and shall be analyzed in accordance with the analytical procedures of both the candidate method and the reference method.

(e) *Submission of test data and other information*. All recorder charts, calibration data, records, test results, procedural descriptions and details, and other documentation obtained from (or pertinent to) these tests shall be identified, dated, signed by the analyst performing the test, and submitted. For candidate methods for $PM_{2.5}$, all submitted information must meet the requirements of the ANSI/ASQC E4 Standard, sections 3.3.1, paragraphs 1 and 2 (Reference 1 of Appendix A of this subpart).

§ 53.31 Test conditions.

(a) *All methods.* All test measurements made or test samples collected by means of a sample manifold as specified in § 53.30(d)(2) shall be at a room temperature between 20 °C and 30 °C, and at a line voltage between 105 and 125 volts. All methods shall be calibrated as specified in paragraph (c) of this section prior to initiation of the tests.

(b) *Samplers and automated methods*. (1) Setup and start-up of the test analyzer, test sampler(s), and reference method (if applicable) shall be in strict accordance with the applicable operation manual(s). If the test analyzer does not have an integral strip chart or digital data recorder, connect the analyzer output to a suitable strip chart or digital data recorder. This recorder shall have a chart width of at least 25 centimeters, a response time of 1 second or less, a deadband of not more than 0.25 percent of full scale, and capability of either reading measurements at least 5 percent below zero or offsetting the zero by at least 5 percent. Digital data shall be recorded at appropriate time intervals such that trend plots similar to a strip chart recording may be constructed with a similar or suitable level of detail.

(2) Other data acquisition components may be used along with the chart recorder during the conduct of these tests. Use of the chart recorder is intended only to facilitate visual evaluation of data submitted.

(3) Allow adequate warmup or stabilization time as indicated in the applicable operation manual(s) before beginning the tests.

(c) *Calibration*. The reference method shall be calibrated according to the appropriate appendix to part 50 of this chapter (if it is a manual method) or according to the applicable operation manual(s) (if it is an automated method). A candidate manual method (or portion thereof) shall be calibrated, according to the applicable operation manual(s), if such calibration is a part of the method.

(d) *Range*. (1) Except as provided in paragraph (d)(2) of this section, each method shall be operated in the range specified for the reference method in the appropriate appendix to part 50 of this chapter (for manual reference methods), or specified in Table B-1 of subpart B of this part (for automated reference methods).

(2) For a candidate method having more than one selectable range, one range must be that specified in Table B-1 of subpart B of this part and a test analyzer representative of the method must pass the tests required by this subpart while operated on that range. The tests may be repeated for a broader range (i.e., one extending to higher concentrations) than the one specified in Table B-1 of subpart B of this part, provided that the range does not extend to concentrations more than two times the upper range limit specified in Table B-1 of subpart B of this part and that the test analyzer has passed the tests required by subpart B of this part (if applicable) for the broader range. If the tests required by this subpart are conducted or passed only for the range specified in Table B-1 of subpart B of this part, any equivalent method determination with respect to the method will be limited to that range. If the tests are passed for both the specified range and a broader range (or ranges), any such determination will include the broader range(s) as well as the specified range. Appropriate test data shall be submitted for each range sought to be included in such a determination.

(e) *Operation of automated methods*. (1) Once the test analyzer has been set up and calibrated and tests started, manual adjustment or normal periodic maintenance as specified in the manual referred to in § 53.4(b)(3) is permitted only every 3 days. Automatic adjustments which the test analyzer performs by itself are permitted at any time. The submitted records shall show clearly when manual adjustments were made and describe the operations performed.

(2) All test measurements shall be made with the same test analyzer; use of multiple test analyzers is not permitted. The test analyzer shall be operated continuously during the entire series of test measurements.

(3) If a test analyzer should malfunction during any of these tests, the entire set of measurements shall be repeated, and a detailed explanation of the malfunction, remedial action taken, and whether recalibration was necessary (along with all pertinent records and charts) shall be submitted.

§ 53.32 Test procedures for methods for SO_2, CO, O_3, and NO_2.

(a) Conduct the first set of simultaneous measurements with the candidate and reference methods:

(1) Table C-1 of this subpart specifies the type (1- or 24–hour) and number of measurements to be made in each of the three test concentration ranges.

(2) The pollutant concentration must fall within the specified range as measured by the reference method.

(3) The measurements shall be made in the sequence specified in Table C-2 of this subpart, except for the 1-hour SO_2 measurements, which are all in the high range.

(b) For each pair of measurements, determine the difference (discrepancy) between the candidate method measurement and reference method measurement. A discrepancy which exceeds the discrepancy specified in Table C-1 of this subpart constitutes a failure. Figure C-1 of this subpart contains a suggested format for reporting the test results.

(c) The results of the first set of measurements shall be interpreted as follows:

(1) Zero failures. The candidate method passes the test for comparability.

(2) Three or more failures. The candidate method fails the test for comparability.

(3) One or two failures. Conduct a second set of simultaneous measurements as specified in Table C-1 of this subpart. The results of the combined total of first-set and second-set measurements shall be interpreted as follows:

(i) One or two failures. The candidate method passes the test for comparability.

(ii) Three or more failures. The candidate method fails the test for comparability.

(4) For SO_2, the 1-hour and 24–hour measurements shall be interpreted separately, and the candidate method must pass the tests for both 1- and 24–hour measurements to pass the test for comparability.

(d) A 1-hour measurement consists of the integral of the instantaneous concentration over a 60-minute continuous period divided by the time period. Integration of the instantaneous concentration may be performed by any appropriate means such as chemical, electronic, mechanical, visual judgment, or by calculating the mean of not less than 12 equally spaced instantaneous readings. Appropriate allowances or corrections shall be made in cases where significant errors could occur due to characteristic lag time or rise/fall time differences between the candidate and reference methods. Details of the means of integration and any corrections shall be submitted.

(e) A 24–hour measurement consists of the integral of the instantaneous concentration over a 24–hour continuous period divided by the time period. This integration may be performed by any appropriate means such as chemical, electronic, mechanical, or by calculating the mean of 24 sequential 1-hour measurements.

(f) For ozone and carbon monoxide, no more than six 1-hour measurements shall be made per day. For sulfur dioxide, no more than four 1-hour measurements or one 24–hour measurement shall be made per day. One-hour measurements may be made concurrently with 24–hour measurements if appropriate.

(g) For applicable methods, control or calibration checks may be performed once per day without adjusting the test analyzer or method. These checks may be used as a basis for a linear interpolation-type correction to be applied to the measurements to correct for drift. If such a correction is used, it shall be applied to all measurements made with the method, and the correction procedure shall become a part of the method.

§ 53.33 Test procedure for methods for lead.

(a) *Sample collection*. Collect simultaneous 24–hour samples (filters) of lead at the test site or sites with both the reference and candidate methods until at least 10 filter pairs have been obtained. If the conditions of § 53.30(d)(4) apply, collect at least 10 common samples (filters) in accordance with § 53.30(d)(4) and divide each to form the filter pairs.

(b) *Audit samples*. Three audit samples must be obtained from the address given in § 53.4(a). The audit samples are 3/4 x 8-inch glass fiber strips containing known amounts of lead at the following nominal levels: 100 µg/strip; 300 µg/strip; 750 µg/strip. The true amount of lead, in total µg/strip, will be provided with each audit sample.

(c) *Filter analysis*. (1) For both the reference method samples and the audit samples, analyze each filter extract three times in accordance with the reference method analytical procedure. The analysis of replicates should not be performed sequentially, i.e., a single sample should not be analyzed three times in sequence. Calculate the indicated lead concentrations for the reference method samples in $\mu g/m^3$ for each analysis of each filter. Calculate the indicated total lead amount for the audit samples in µg/strip for each analysis of each strip. Label these test results as R_{1A}, R_{1B}, R_{1C}, R_{2A}, R_{2B}, ..., Q_{1A}, Q_{1B}, Q_{1C}, ..., where R denotes results from the reference method samples; Q denotes results from the audit samples; 1, 2, 3 indicate the filter number, and A, B, C indicate the first, second, and third analysis of each filter, respectively.

(2) For the candidate method samples, analyze each sample filter or filter extract three times and calculate, in accordance with the candidate method, the indicated lead concentrates in $\mu g/m^3$ for each analysis of each filter. Label these test results as C_{1A}, C_{1B}, C_{2C}, ..., where C denotes results from the candidate method. For candidate methods which provide a direct measurement of lead concentrations without a separable procedure, $C_{1A}=C_{1B}=C_{1C}$, $C_{2A}=C_{2B}=C_{2C}$, etc.

(d) *Average lead concentration*. For the reference method, calculate the average lead concentration for each filter by averaging the concentrations calculated from the three analyses:

Equation 1

$$R_{i\ ave} = \frac{R_{iA} + R_{iB} + R_{iC}}{3}$$

where:
i is the filter number.

(e) *Acceptable filter pairs*. Disregard all filter pairs for which the lead concentration as determined in the previous paragraph (d) of this section by the average of the three reference method determinations, falls outside the range of 0.5 to 4.0 μg/m³. All remaining filter pairs must be subjected to both of the following tests for precision and comparability. At least five filter pairs must be within the 0.5 to 4.0 μg/m³ range for the tests to be valid.

(f) *Test for precision*. (1) Calculate the precision (P) of the analysis (in percent) for each filter and for each method, as the maximum minus the minimum divided by the average of the three concentration values, as follows:

Equation 2

$$P_{Ri} = \frac{R_{i\ max} - R_{i\ min}}{R_{i\ ave}} \text{ x } 100\%$$

or

Equation 3

$$P_{Ci} = \frac{C_{i\ max} - C_{i\ min}}{C_{i\ ave}} \text{ x } 100\%$$

where:
i indicates the filter number.

(2) If any reference method precision value (P_{Ri}) exceeds 15 percent, the precision of the reference method analytical procedure is out of control. Corrective action must be taken to determine the source(s) of imprecision and the reference method determinations must be repeated according to paragraph (c) of this section, or the entire test procedure (starting with paragraph (a) of this section) must be repeated.

(3) If any candidate method precision value (P_{Ci}) exceeds 15 percent, the candidate method fails the precision test.

(4) The candidate method passes this test if all precision values (i.e., all P_{Ri}'s and all P_{Ci}'s) are less than 15 percent.

(g) *Test for accuracy*. (1)(i) For the audit samples calculate the average lead concentration for each strip by averaging the concentrations calculated from the three analyses:

Equation 4

$$Q_{i\ ave} = \frac{Q_{iA} + Q_{iB} + Q_{iC}}{3}$$

where:
i is audit sample number.

(ii) Calculate the percent difference (D_q) between the indicated lead concentration for each audit sample and the true lead concentration (T_q) as follows:

Equation 5

$$D_{qi} = \frac{Q_{i\ ave} - T_{qi}}{T_{qi}} \text{ x } 100\%$$

(2) If any difference value (D_{qi}) exceeds ±5 percent, the accuracy of the reference method analytical procedure is out of control. Corrective action must be taken to determine the source of the error(s) (e.g., calibration standard discrepancies, extraction problems, etc.) and the reference method and audit sample determinations must be repeated according to paragraph (c) of this section, or the entire test procedure (starting with paragraph (a) of this section) must be repeated.

(h) *Test for comparability*. (1) For each filter pair, calculate all nine possible percent differences (D) between the reference and candidate methods, using all nine possible combinations of the three determinations (A, B, and C) for each method, as:

Equation 6

$$D_{in} = \frac{C_{ij} - R_{ik}}{R_{ik}} \text{ x } 100\%$$

where:
i is the filter number, and n numbers from 1 to 9 for the nine possible difference combinations for the three determinations for each method (j= A, B, C, candidate; k= A, B, C, reference).

(2) If none of the percent differences (D) exceeds ± 20 percent, the candidate method passes the test for comparability.

(3) If one or more of the percent differences (D) exceeds ± 20 percent, the candidate method fails the test for comparability.

(i) The candidate method must pass both the precision test (paragraph (f) of this section) and the comparability test (paragraph (h) of this section) to qualify for designation as an equivalent method.

§ 53.34 Test procedure for methods for PM_{10} and $PM_{2.5}$.

(a) *Collocated measurements*. Set up three reference method samplers collocated with three candidate method samplers or analyzers at each of the number of test sites specified in Table C-4 of this subpart. At each site, obtain as many sets of simultaneous PM_{10} or $PM_{2.5}$ measurements as necessary (see paragraph (c)(3) of this section), each set consisting of three reference method and three candidate method measurements, all obtained simultaneously. For $PM_{2.5}$ candidate Class II equivalent methods, at least two collocated PM_{10} reference method samplers are also required to obtain $PM_{2.5}/PM_{10}$ ratios for each sample set. Candidate PM_{10} method measurements shall be 24–hour integrated measurements; $PM_{2.5}$ measurements may be either 24- or 48–hour integrated measurements. All collocated measurements in a sample set must cover the same 24- or 48–hour time period. For samplers, retrieve the samples promptly after sample collection and analyze each sample according to the reference method or candidate method, as appropriate, and determine the PM_{10} or $PM_{2.5}$ concentration in μg/m³. If the conditions of § 53.30(d)(4) apply, collect sample sets only with the three reference method samplers. Guidance for quality assurance procedures for $PM_{2.5}$ methods is found in section 2.12 of the Quality Assurance Handbook (Reference 6 of Appendix A to subpart A of this part).

(b) *Sequential samplers*. For sequential samplers, the sampler shall be configured for the maximum number of sequential samples and shall be set for automatic collection of all samples sequentially such that the test samples are collected equally, to the extent possible, among all available sequential channels or utilizing the full available sequential capability.

(c) *Test for comparability and precision*. (1) For each of the measurement sets, calculate the average PM_{10} or $PM_{2.5}$ concentration obtained with the reference method samplers:

Equation 7

$$\overline{R}_j = \frac{\sum_{i=1}^{3} R_{ij}}{3}$$

where:
R denotes results from the reference method;
i is the sampler number; and
j is the set.

(2)(i)(A) For each of the measurement sets, calculate the precision of the reference method PM_{10} or $PM_{2.5}$ measurements as:

Equation 8

$$P_j = \sqrt{\frac{\sum_{i=1}^{3} R_{ij}^2 - \frac{1}{3}\left(\sum_{i=1}^{3} R_{ij}\right)^2}{2}}$$

(B) If the corresponding j is below:

80 μg/m³ for PM_{10} methods.

40 μg/m³ for 24–hour $PM_{2.5}$ at single test sites for Class I candidate methods.

40 μg/m³ for 24–hour $PM_{2.5}$ at sites having $PM_{2.5}/PM_{10}$ ratios >0.75.

30 μg/m³ for 48–hour $PM_{2.5}$ at single test sites for Class I candidate methods.

30 μg/m³ for 48–hour $PM_{2.5}$ at sites having $PM_{2.5}/PM_{10}$ ratios >0.75.

30 μg/m³ for 24–hour $PM_{2.5}$ at sites having $PM_{2.5}/PM_{10}$ ratios <0.40.

20 μg/m³ for 48–hour $PM_{2.5}$ at sites having $PM_{2.5}/PM_{10}$ ratios >0.75.

(ii) Otherwise, calculate the precision of the reference method PM_{10} or $PM_{2.5}$ measurements as:

Equation 9

$$RP_j = \frac{1}{\overline{R}_j}\sqrt{\frac{\sum_{i=1}^{3} R_{ij}^2 - \frac{1}{3}\left(\sum_{i=1}^{3} R_{ij}\right)^2}{2}} \text{ x } 100\%$$

(3) If j falls outside the acceptable concentration range specified in Table C-4 of this subpart for any set, or if Pj or RPj, as applicable, exceeds the value specified in Table C-4 of this subpart for any set, that set of measurements shall be discarded. For each site, Table C-4 of this subpart specifies the minimum number of sample sets required for various conditions, and § 53.30(b)(5) specifies the $PM_{2.5}/PM_{10}$ ratio requirements applicable to Class II candidate equivalent methods. Additional measurement sets shall be collected and analyzed, as necessary, to provide a minimum of 10 acceptable measurement sets for each test site. If more than 10 measurement sets are collected that meet the above criteria, all such measurement sets shall be used to demonstrate comparability.

(4) For each of the acceptable measurement sets, calculate the average PM_{10} or $PM_{2.5}$ concentration obtained with the candidate method samplers:

Equation 10

$$\overline{C}_j = \frac{\sum_{i=1}^{3} C_{ij}}{3}$$

where:
C denotes results from the candidate method;
i is the sampler number; and
j is the set.

(5) For each site, plot the average PM_{10} or $PM_{2.5}$ measurements obtained with the candidate method (C_j) against the corresponding average PM_{10} or $PM_{2.5}$ measurements obtained with the reference method (R_j). For each site, calculate and record the linear regression slope and intercept, and the correlation coefficient.

(6) If the linear regression parameters calculated under paragraph (c)(5) of this section meet the values specified in Table C-4 of this subpart for all test sites, the candidate method passes the test for comparability.

Tables to Subpart C of Part 53

TABLE C–1.—TEST CONCENTRATION RANGES, NUMBER OF MEASUREMENTS REQUIRED, AND MAXIMUM DISCREPANCY SPECIFICATION

Pollutant	Concentration Range Parts per Million	Simultaneous Measurements Required				Maximum Discrepancy Specification, Parts per Million
		1–hr		24–hr		
		First Set	Second Set	First Set	Second Set	
Ozone	Low 0.06 to 0.10	5	6	.....	.....	0.02
	Med 0.15 to 0.25	5	6	.....	.....	.03
	High 0.35 to 0.45	4	6	.....	.....	.04
	Total	14	18	.....	.....	.....
Carbon Monoxide	Low 7 to 11	5	6	.....	.....	1.5
	Med 20 to 30	5	6	.....	.....	2.0
	High 35 to 45	4	6	.....	.....	3.0
	Total	14	18	.....	.....	.....
Sulfur Dioxide	Low 0.02 to 0.05	.....	.....	3	3	0.02
	Med 0.10 to 0.15	.....	.....	2	3	.03
	High 0.30 to 0.50	7	8	2	2	.04
	Total	7	8	7	8	.....
Nitrogen Dioxide	Low 0.02 to 0.08	.....	.....	3	3	0.02
	Med 0.10 to 0.20	.....	.....	2	3	.03
	High 0.25 to 0.35	.....	.....	2	2	.03
	Total	.....	.....	7	8	.....

TABLE C–2.—SEQUENCE OF TEST MEASUREMENTS

Measurement	Concentration Range	
	First Set	Second Set
1	Low	Medium
2	High	High
3	Medium	Low
4	High	High
5	Low	Medium
6	Medium	Low
7	Low	Medium
8	Medium	Low
9	High	High

TABLE C–2.—SEQUENCE OF TEST MEASUREMENTS—Continued

Measurement	Concentration Range	
	First Set	Second Set
10	Medium	Low
11	High	Medium
12	Low	High
13	Medium	Medium
14	Low	High
15		Low
16		Medium
17		Low
18		High

TABLE C–3.—TEST SPECIFICATIONS FOR LEAD METHODS

Concentration range, μg/m³	0.5–4.0
Minimum number of 24-hr measurements	5
Maximum analytical precision, percent	5
Maximum analytical accuracy, percent	±5
Maximum difference, percent of reference method	±20

TABLE C–4.—TEST SPECIFICATIONS FOR PM_{10} AND $PM_{2.5}$ METHODS

Specification	PM_{10}	$PM_{2.5}$	
		Class I	Class II
Acceptable concentration range (R_j), μg/m³	30–300	10–200	10–200
Minimum number of test sites	2	1	2
Number of candidate method samplers per site	3	3	3
Number of reference method samplers per site	3	3	3
Minimum number of acceptable sample sets per site for PM_{10}:			
R_j < 80 μg/m³	3		
R_j > 80 μg/m³	3		
Total	10		
Minimum number of acceptable sample sets per site for $PM_{2.5}$:			
Single test site for Class I candidate equivalent methods:			
R_j < 40 μg/m³ for 24-hr or R_j < 30 μg/m³ for 48-hr samples		3	
R_j > 40 μg/m³ for 24-hr or R_j > 30 μg/m³ for 48-hr samples		3	
Sites at which the $PM_{2.5}/PM_{10}$ ratio must be > 0.75:			
R_j < 40 μg/m³ for 24-hr or R_j < 30 μg/m³ for 48-hr samples			3
R_j > 40 μg/m³ for 24-hr or R_j > 30 μg/m³ for 48-hr samples			3
Sites at which the $PM_{2.5}/PM_{10}$ ratio must be < 0.40:			
R_j < 30 μg/m³ for 24-hr or R_j < 20 μg/m³ for 48-hr samples			3
R_j > 30 μg/m³ for 24-hr or R_j > 20 μg/m³ for 48-hr samples			3
Total, each site		10	10
Precision of replicate reference method measurements, P_j or RP_j respectively, maximum.	5 μg/m³ or 7%	2 μg/m³ or 5%	2 μg/m³ or 5%
Slope of regression relationship	1±0.1	1±0.05	1±0.05
Intercept of regression relationship, μg/m³	0±5	0±1	0±1
Correlation of reference method and candidate method measurements	≥0.97	≥0.97	≥0.97

Figures to Subpart C of Part 53

Figure C-1.—Suggested Format for Reporting Test Results

Candidate Method———————————————————————

Reference Method———————————————————————

Applicant———————————————————————

☐ First Set ☐ Second Set ☐ Type ☐ 1 Hour ☐ 24 Hour

Concentration Range		Date	Time	Concentration, ppm		Difference	Table C-1 Spec.	Pass or Fail
				Candidate	Reference			
Low ——— ppm to ——— ppm	1							
	2							
	3							
	4							
	5							
	6							
Medium ——— ppm to ——— ppm	1							
	2							
	3							
	4							
	5							
	6							
High ——— ppm to ——— ppm	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
							Total Failures:	

Appendix A to Subpart C of Part 53--References

(1) American National Standard--Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E4-1994. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

d. Subpart E is added to read as follows:

Subpart E—Procedures for Testing Physical (Design) and Performance Characteristics of Reference Methods and Class I Equivalent Methods for $PM_{2.5}$

Sec.

53.50 General provisions.
53.51 Demonstration of compliance with design specifications and manufacturing and test requirements.
53.52 Leak check test.
53.53 Test for flow rate accuracy, regulation, measurement accuracy, and cut-off.
53.54 Test for proper sampler operation following power interruptions.
53.55 Test for effect of variations in power line voltage and ambient temperature.
53.56 Test for effect of variations in ambient pressure.
53.57 Test for filter temperature control during sampling and post-sampling periods.
53.58 Operational field precision and blank test.

53.59 Aerosol transport test for Class I equivalent method samplers.

Tables to Subpart E of Part 53

Table E-1.—Summary of Test Requirements for Reference and Class I Equivalent Methods for $PM_{2.5}$.
Table E-2.—Spectral Energy Distribution and Permitted Tolerance for Conducting Radiative Tests.

Figures to Subpart E of Part 53

Figure E-1—Designation Testing Checklist
Figure E-2—Product Manufacturing Checklist

Appendix A to Subpart E of Part 53—References

Subpart E—Procedures for Testing Physical (Design) and Performance Characteristics of Reference Methods and Class I Equivalent Methods for $PM_{2.5}$

§ 53.50 General provisions.

(a) This subpart sets forth the specific tests that must be carried out and the test results, evidence, documentation, and other materials that must be provided to EPA to demonstrate that a $PM_{2.5}$ sampler associated with a candidate reference method or Class I equivalent method meets all design and performance specifications set forth in 40 CFR part 50, Appendix L, as well as additional requirements specified in this subpart E. Some of these tests may also be applicable to portions of a candidate Class II equivalent method sampler, as determined under subpart F of this part. Some or all of these tests may also be applicable to a candidate Class III equivalent method sampler, as may be determined under § 53.3(a)(4) or § 53.3(b)(3).

(b) Samplers associated with candidate reference methods for $PM_{2.5}$ shall be subject to the provisions, specifications, and test procedures prescribed in §§ 53.51 through 53.58. Samplers associated with candidate Class I equivalent methods for $PM_{2.5}$ shall be subject to the provisions, specifications, and test procedures prescribed in all sections of this subpart. Samplers associated with candidate Class II equivalent methods for $PM_{2.5}$ shall be subject to the provisions, specifications, and test procedures prescribed in all applicable sections of this subpart, as specified in subpart F of this part.

(c) The provisions of § 53.51 pertain to test results and documentation required to demonstrate compliance of a candidate method sampler with the design specifications set forth in 40 CFR part 50, Appendix L. The test procedures prescribed in §§ 53.52 through 53.59 pertain to performance tests required to demonstrate compliance of a candidate method sampler with the performance specifications set forth in 40 CFR part 50, Appendix L, as well as additional requirements specified in this subpart E. These latter test procedures shall be used to test the performance of candidate samplers against the performance specifications and requirements specified in each procedure and summarized in Table E-1 of this subpart.

(d) Test procedures prescribed in § 53.59 do not apply to candidate reference method samplers. These procedures apply primarily to candidate Class I equivalent method samplers for $PM_{2.5}$ which have a sample air flow path configuration upstream of the sample filter that is modified with respect to that specified for the reference method sampler, as set forth in 40 CFR part 50, Appendix L, Figures L-1 to L-29, such as might be necessary to provide for sequential sample capability. The additional tests determine the adequacy of aerosol transport through any altered components or supplemental devices that are used in a candidate sampler upstream of the sample filter. In addition to the other test procedures in this subpart, these test procedures shall be used to further test the performance of such an equivalent method sampler against the performance specifications given in the procedure and summarized in Table E-1 of this subpart.

(e) A 10–day operational field test of measurement precision is required under § 53.58 for both candidate reference and equivalent method samplers. This test requires collocated operation of three candidate method samplers at a field test site. For candidate equivalent method samplers, this test may be combined and carried out concurrently with the test for comparability to the reference method specified under § 53.34, which requires collocated operation of three reference method samplers and three candidate equivalent method samplers.

(f) All tests and collection of test data shall be performed in accordance with the requirements of Reference 1, section 4.10.5 (ISO 9001) and Reference 2, Part B, section 3.3.1, paragraphs 1 and 2 and Part C, section 4.6 (ANSI/ASQC E4) in Appendix A of this subpart. All test data and other documentation obtained specifically from or pertinent to these tests shall be identified, dated, signed by the analyst performing the test, and submitted to EPA in accordance with subpart A of this part.

§ 53.51 Demonstration of compliance with design specifications and manufacturing and test requirements.

(a) *Overview*. (1) The subsequent paragraphs of this section specify certain documentation that must be submitted and tests that are required to demonstrate that samplers associated with a designated reference or equivalent method for $PM_{2.5}$ are properly manufactured to meet all applicable design and performance specifications and have been properly tested according to all applicable test requirements for such designation. Documentation is required to show that instruments and components of a $PM_{2.5}$ sampler are manufactured in an ISO 9001-registered facility under a quality system that meets ISO-9001 requirements for manufacturing quality control and testing.

(2) In addition, specific tests are required to verify that two critical features of reference method samplers impactor jet diameter and the surface finish of surfaces specified to be anodized meet the specifications of 40 CFR part 50, Appendix L. A checklist is required to provide certification by an ISO-certified auditor that all performance and other required tests have been properly and appropriately conducted, based on a reasonable and appropriate sample of the actual operations or their documented records. Following designation of the method, another checklist is required, initially and annually, to provide an ISO-certified auditor's certification that the sampler manufacturing process is being implemented under an adequate and appropriate quality system.

(3) For the purposes of this section, the definitions of ISO 9001-registered facility and ISO-certified auditor are found in § 53.1. An exception to the reliance by EPA on ISO affiliate audits is the requirement for the submission of the operation or instruction manual associated with the candidate method to EPA as part of the application. This manual is required under § 53.4(b)(3). EPA has determined that acceptable technical judgment for review of this manual may not be assured by ISO affiliates, and approval of this manual will therefore be performed by EPA.

(b) *ISO registration of manufacturing facility.* (1) The applicant must submit documentation verifying that the samplers identified and sold as part of a designated $PM_{2.5}$ reference or equivalent method will be manufactured in an ISO 9001-registered facility and that the manufacturing facility is maintained in compliance with all applicable ISO 9001 requirements (Reference 1 in Appendix A of this subpart). The documentation shall indicate the date of the original ISO 9001 registration for the facility and shall include a copy of the most recent certification of continued ISO 9001 facility registration. If the manufacturer does not wish to initiate or complete ISO 9001 registration for the manufacturing facility, documentation must be included in the application to EPA describing an alternative method to demonstrate that the facility meets the same general requirements as required for registration to ISO-9001. In this case, the applicant must provide documentation in the application to demonstrate, by required ISO-certified auditor's inspections, that a quality system is in place which is adequate to document and monitor that the sampler system components and final assembled samplers all conform to the design, performance and other requirements specified in this part and in 40 CFR part 50, Appendix L.

(2) Phase-in period. For a period of 1 year following the effective date of this subpart, a candidate reference or equivalent method

for $PM_{2.5}$ that utilizes a sampler manufactured in a facility that is not ISO 9001-registered or otherwise approved by EPA under paragraph (b)(1) of this section may be conditionally designated as a reference or equivalent method under this part. Such conditional designation will be considered on the basis of evidence submitted in association with the candidate method application showing that appropriate efforts are currently underway to seek ISO 9001 registration or alternative approval of the facility's quality system under paragraph (b)(1) of this section within the next 12 months. Such conditional designation shall expire 1 year after the date of the **Federal Register** notice of the conditional designation unless documentation verifying successful ISO 9001 registration for the facility or other EPA-acceptable quality system review and approval process of the production facility that will manufacture the samplers is submitted at least 30 days prior to the expiration date.

(c) *Sampler manufacturing quality control*. The manufacturer must ensure that all components used in the manufacture of $PM_{2.5}$ samplers to be sold as part of a reference or equivalent method and that are specified by design in 40 CFR part 50, Appendix L, are fabricated or manufactured exactly as specified. If the manufacturer's quality records show that its quality control (QC) and quality assurance (QA) system of standard process control inspections (of a set number and frequency of testing that is less than 100 percent) complies with the applicable QA provisions of section 4 of Reference 4 in Appendix A of this subpart and prevents nonconformances, 100 percent testing shall not be required until that conclusion is disproved by customer return or other independent manufacturer or customer test records. If problems are uncovered, inspection to verify conformance to the drawings, specifications, and tolerances shall be performed. Refer also to paragraph (e) of this section--final assembly and inspection requirements.

(d) *Specific tests and supporting documentation required to verify conformance to critical component specifications*.—(1) *Verification of $PM_{2.5}$* impactor jet diameter. The diameter of the jet of each impactor manufactured for a $PM_{2.5}$ sampler under the impactor design specifications set forth in 40 CFR part 50, Appendix L, shall be verified against the tolerance specified on the drawing, using standard, NIST-traceable ZZ go/no go plug gages. This test shall be a final check of the jet diameter following all fabrication operations, and a record shall be kept of this final check. The manufacturer shall submit evidence that this procedure is incorporated into the manufacturing procedure, that the test is or will be routinely implemented, and that an appropriate procedure is in place for the disposition of units that fail this tolerance test.

(2) *Verification of surface finish*. The anodization process used to treat surfaces specified to be anodized shall be verified by testing treated specimen surfaces for weight and corrosion resistance to ensure that the coating obtained conforms to the coating specification. The specimen surfaces shall be finished in accordance with military standard specification 8625F, Type II, Class I (Reference 4 in Appendix A of this subpart) in the same way the sampler surfaces are finished, and tested, prior to sealing, as specified in section 4.5.2 of Reference 4 in Appendix A of this subpart.

(e) *Final assembly and inspection requirements*. Each sampler shall be tested after manufacture and before delivery to the final user. Each manufacturer shall document its post-manufacturing test procedures. As a minimum, each test shall consist of the following: Tests of the overall integrity of the sampler, including leak tests; calibration or verification of the calibration of the flow measurement device, barometric pressure sensor, and temperature sensors; and operation of the sampler with a filter in place over a period of at least 48 hours. The results of each test shall be suitably documented and shall be subject to review by an ISO-certified auditor.

(f) *Manufacturer's audit checklists*. Manufacturers shall require an ISO-certified auditor to sign and date a statement indicating that the auditor is aware of the appropriate manufacturing specifications contained in 40 CFR part 50, Appendix L, and the test or verification requirements in this subpart. Manufacturers shall also require an ISO-certified auditor to complete the checklists, shown in Figures E-1 and E-2 of this subpart, which describe the manufacturer's ability to meet the requirements of the standard for both designation testing and product manufacture.

(1) *Designation testing checklist*. The completed statement and checklist as shown in Figure E-1 of this subpart shall be submitted with the application for reference or equivalent method determination.

(2) *Product manufacturing checklist*. Manufacturers shall require an ISO-certified auditor to complete a Product Manufacturing Checklist (Figure E-2 of this subpart), which evaluates the manufacturer on its ability to meet the requirements of the standard in maintaining quality control in the production of reference or equivalent devices. The initial completed checklist shall be submitted with the application for reference or equivalent method determination. Also, this checklist (Figure E-2 of this subpart) must be completed and submitted annually to retain a reference or equivalent method designation for a $PM_{2.5}$ method.

(3) *Phase-in period*. If the conditions of paragraph (b)(2) of this section apply, a candidate reference or equivalent method for $PM_{2.5}$ may be conditionally designated as a reference or equivalent method under this part 53 without the submission of the checklists described in paragraphs (f)(1) and (f)(2) of this section. Such conditional designation shall expire 1 year after the date of the **Federal Register** notice of the conditional designation unless the checklists are submitted at least 30 days prior to the expiration date.

§ 53.52 Leak check test.

(a) *Overview*. In section 7.4.6 of 40 CFR part 50, Appendix L, the sampler is required to include the facility, including components, instruments, operator controls, a written procedure, and other capabilities as necessary, to allow the operator to carry out a leak test of the sampler at a field monitoring site without additional equipment. This test procedure is intended to test the adequacy and effectiveness of the sampler's leak check facility. Because of the variety of potential sampler configurations and leak check procedures possible, some adaptation of this procedure may be necessary to accommodate the specific sampler under test. The test conditions and performance specifications associated with this test are summarized in Table E-1 of this subpart. The candidate test sampler must meet all test parameters and test specifications to successfully pass this test.

(b) *Technical definitions*. (1) External leakage includes the total flow rate of external ambient air which enters the sampler other than through the sampler inlet and which passes through any one or more of the impactor, filter, or flow rate measurement components.

(2) Internal leakage is the total sample air flow rate that passes through the filter holder assembly without passing through the sample filter.

(c) *Required test equipment*. (1) Flow rate measurement device, range 70 mL/min to 130 mL/min, 2 percent certified accuracy, NIST-traceable.

(2) Flow rate measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sampler flow rate at the top of the downtube.

(3) Impermeable membrane or disk, 47 mm nominal diameter.

(4) Means, such as a micro-valve, of providing a simulated leak flow rate through the sampler of approximately 80 mL/min under the conditions specified for the leak check in the sampler's leak check procedure.

(5) Teflon sample filter, as specified in section 6 of 40 CFR part 50, Appendix L.

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall

be checked at zero and one or more non-zero flow rates within 7 days of use for this test.

(e) *Test setup*. (1) The test sampler shall be set up for testing as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in its normal configuration for collecting $PM_{2.5}$ samples, except that the sample air inlet shall be removed and the flow rate measurement adaptor shall be installed on the sampler's downtube.

(2) The flow rate control device shall be set up to provide a constant, controlled flow rate of 80 mL/min into the sampler downtube under the conditions specified for the leak check in the sampler's leak check procedure.

(3) The flow rate measurement device shall be set up to measure the controlled flow rate of 80 mL/min into the sampler downtube under the conditions specified for the leak check in the sampler's leak check procedure.

(f) *Procedure*. (1) Install the impermeable membrane in a filter cassette and install the cassette into the sampler. Carry out the internal leak check procedure as described in the sampler's operation/instruction manual and verify that the leak check acceptance criterion specified in Table E-1 of this subpart is met.

(2) Replace the impermeable membrane with a Teflon filter and install the cassette in the sampler. Remove the inlet from the sampler and install the flow measurement adaptor on the sampler's downtube. Close the valve of the adaptor to seal the flow system. Conduct the external leak check procedure as described in the sampler's operation/ instruction manual and verify that the leak check acceptance criteria specified in Table E-1 of this subpart are met.

(3) Arrange the flow control device, flow rate measurement device, and other apparatus as necessary to provide a simulated leak flow rate of 80 mL/min into the test sampler through the downtube during the specified external leak check procedure. Carry out the external leak check procedure as described in the sampler's operation/instruction manual but with the simulated leak of 80 mL/min.

(g) *Test results*. The requirements for successful passage of this test are:

(1) That the leak check procedure indicates no significant external or internal leaks in the test sampler when no simulated leaks are introduced.

(2) That the leak check procedure properly identifies the occurrence of the simulated external leak of 80 mL/min.

§ 53.53 Test for flow rate accuracy, regulation, measurement accuracy, and cut-off.

(a) *Overview*. This test procedure is designed to evaluate a candidate sampler's flow rate accuracy with respect to the design flow rate, flow rate regulation, flow rate measurement accuracy, coefficient of variability measurement accuracy, and the flow rate cut-off function. The tests for the first four parameters shall be conducted over a 6–hour time period during which reference flow measurements are made at intervals not to exceed 5 minutes. The flow rate cut-off test, conducted separately, is intended to verify that the sampler carries out the required automatic sample flow rate cut-off function properly in the event of a low-flow condition. The test conditions and performance specifications associated with this test are summarized in Table E-1 of this subpart. The candidate test sampler must meet all test parameters and test specifications to successfully pass this test.

(b) *Technical definitions*. (1) Sample flow rate means the quantitative volumetric flow rate of the air stream caused by the sampler to enter the sampler inlet and pass through the sample filter, measured in actual volume units at the temperature and pressure of the air as it enters the inlet.

(2) The flow rate cut-off function requires the sampler to automatically stop sample flow and terminate the current sample collection if the sample flow rate deviates by more than the variation limits specified in Table E-1 of this subpart (±10 percent from the nominal sample flow rate) for more than 60 seconds during a sample collection period. The sampler is also required to properly notify the operator with a flag warning indication of the out-of-specification flow rate condition and if the flow rate cut-off results in an elapsed sample collection time of less than 23 hours.

(c) *Required test equipment*. (1) Flow rate meter, suitable for measuring and recording the actual volumetric sample flow rate at the sampler downtube, with a minimum range of 10 to 25 L/min, 2 percent certified, NIST-traceable accuracy. Optional capability for continuous (analog) recording capability or digital recording at intervals not to exceed 30 seconds is recommended. While a flow meter which provides a direct indication of volumetric flow rate is preferred for this test, an alternative certified flow measurement device may be used as long as appropriate volumetric flow rate corrections are made based on measurements of actual ambient temperature and pressure conditions.

(2) Ambient air temperature sensor, with a resolution of 0.1 °C and certified to be accurate to within 0.5 °C (if needed). If the certified flow meter does not provide direct volumetric flow rate readings, ambient air temperature measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(3) Barometer, range 600 mm Hg to 800 mm Hg, certified accurate to 2 mm Hg (if needed). If the certified flow meter does not provide direct volumetric flow rate readings, ambient pressure measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(4) Flow measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sample flow rate at the sampler downtube.

(5) Valve or other means to restrict or reduce the sample flow rate to a value at least 10 percent below the design flow rate (16.67 L/min). If appropriate, the valve of the flow measurement adaptor may be used for this purpose.

(6) Means for creating an additional pressure drop of 55 mm Hg in the sampler to simulate a heavily loaded filter, such as an orifice or flow restrictive plate installed in the filter holder or a valve or other flow restrictor temporarily installed in the flow path near the filter.

(7) Teflon sample filter, as specified in section 6 of 40 CFR part 50, Appendix L (if required).

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow-rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) Setup of the sampler shall be as required in this paragraph (e) and otherwise as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in its normal configuration for collecting $PM_{2.5}$ samples. A sample filter and (or) the device for creating an additional 55 mm Hg pressure drop shall be installed for the duration of these tests. The sampler's ambient temperature, ambient pressure, and flow rate measurement systems shall all be calibrated per the sampler's operation or instruction manual within 7 days prior to this test.

(2) The inlet of the candidate sampler shall be removed and the flow measurement adaptor installed on the sampler's downtube. A leak check as described in the sampler's operation or instruction manual shall be conducted and must be properly passed before other tests are carried out.

(3) The inlet of the flow measurement adaptor shall be connected to the outlet of the flow rate meter.

(4) For the flow rate cut-off test, the valve or means for reducing sampler flow rate shall be installed between the flow measurement adaptor and the downtube or in another location within the sampler such that the sampler flow rate can be manually restricted during the test.

(f) *Procedure*. (1) Set up the sampler as specified in paragraph (e) of this section and otherwise prepare the sampler for normal sample collection operation as directed in the sampler's operation or instruction manual. Set the sampler to automatically start a 6–hour sample collection period at a convenient time.

(2) During the 6–hour operational flow rate portion of the test, measure and record the sample flow rate with the flow rate meter at intervals not to exceed 5 minutes. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, ambient temperature and pressure shall be measured at the same frequency as that of the certified flow rate measurements. Note and record the actual start and stop times for the 6–hour flow rate test period.

(3) Following completion of the 6–hour flow rate test period, install the flow rate reduction device and change the sampler flow rate recording frequency to intervals of not more than 30 seconds. Reset the sampler to start a new sample collection period. Manually restrict the sampler flow rate such that the sampler flow rate is decreased slowly over several minutes to a flow rate slightly less than the flow rate cut-off value (15.0 L/min). Maintain this flow rate for at least 2.0 minutes or until the sampler stops the sample flow automatically. Manually terminate the sample period, if the sampler has not terminated it automatically.

(g) *Test results*. At the completion of the test, validate the test conditions and determine the test results as follows:

(1) *Mean sample flow rate*. (i) From the certified measurements (Q_{ref}) of the test sampler flow rate obtained by use of the flow rate meter, tabulate each flow rate measurement in units of L/min. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, each measured flow rate shall be corrected using its corresponding temperature and pressure measurement values. Calculate the mean flow rate for the sample period ($Q_{ref,ave}$) as follows:

Equation 1

$$Q_{ref,ave} = \frac{\sum_{i=1}^{n} Q_{ref,i}}{n}$$

where:
n equals the number of discrete certified flow rate measurements over the 6–hour test period.

(ii)(A) Calculate the percent difference between this mean flow rate value and the design value of 16.67 L/min, as follows:

Equation 2

$$\% \text{ Difference} = \frac{Q_{ref,ave} - 16.67}{16.67} \text{ x } 100\%$$

(B) To successfully pass the mean flow rate test, the percent difference calculated in Equation 2 of this paragraph (g)(1)(ii) must be within ±5 percent.

(2) *Sample flow rate regulation*. (i) From the certified measurements of the test sampler flow rate, calculate the sample coefficient of variation (CV) of the discrete measurements as follows:

Equation 3

$$\%CV_{ref} = \frac{1}{Q_{ref,ave}} \text{x} \sqrt{\frac{\sum_{i=1}^{n} Q_{ref,i}^2 - \frac{1}{n}\left(\sum_{i-1}^{n} Q_{ref,i}\right)^2}{n-1}} \text{x } 100\%$$

(ii) To successfully pass the flow rate regulation test, the calculated coefficient of variation for the certified flow rates must not exceed 2 percent.

(3) *Flow rate measurement accuracy*. (i) Using the mean volumetric flow rate reported by the candidate test sampler at the completion of the 6–hour test period ($Q_{ind,ave}$), determine the accuracy of the reported mean flow rate as:

Equation 4

$$\% \text{ Difference} = \frac{|Q_{ind,ave} - Q_{ref,ave}|}{Q_{ref,ave}} \text{ x } 100\%$$

(ii) To successfully pass the flow rate measurement accuracy test, the percent difference calculated in Equation 4 of this paragraph (g)(3) shall not exceed 2 percent.

(4) *Flow rate coefficient of variation measurement accuracy*. (i) Using the flow rate coefficient of variation indicated by the candidate test sampler at the completion of the 6–hour test ($\%CV_{ind}$), determine the accuracy of this reported coefficient of variation as:

Equation 5

$$\text{Difference } (\%) = |\%CV_{ind} - \%CV_{ref}|$$

(ii) To successfully pass the flow rate CV measurement accuracy test, the absolute difference in values calculated in Equation 5 of this paragraph (g)(4) must not exceed 0.3 (CV%).

(5) *Flow rate cut-off*. (i) Inspect the measurements of the sample flow rate during the flow rate cut-off test and determine the time at which the sample flow rate decreased to a value less than the cut-off value specified in Table E-1 of this subpart. To pass this test, the sampler must have automatically stopped the sample flow at least 30 seconds but not more than 90 seconds after the time at which the sampler flow rate was determined to have decreased to a value less than the cut-off value.

(ii) At the completion of the flow rate cut-off test, download the archived data from the test sampler and verify that the sampler's required Flow-out-of-spec and Incorrect sample period flag indicators are properly set.

§ 53.54 Test for proper sampler operation following power interruptions.

(a) *Overview*. (1) This test procedure is designed to test certain performance parameters of the candidate sampler during a test period in which power interruptions of various duration occur. The performance parameters tested are:

(i) Proper flow rate performance of the sampler.

(ii) Accuracy of the sampler's average flow rate, CV, and sample volume measurements.

(iii) Accuracy of the sampler's reported elapsed sampling time.

(iv) Accuracy of the reported time and duration of power interruptions.

(2) This test shall be conducted during operation of the test sampler over a continuous 6–hour test period during which the sampler's flow rate shall be measured and recorded at intervals not to exceed 5 minutes. The performance parameters tested under this procedure, the corresponding minimum performance specifications, and the applicable test conditions are summarized in Table E-1 of this subpart. Each performance parameter tested, as described or determined in the test procedure, must meet or exceed the associated performance specification to successfully pass this test.

(b) *Required test equipment*. (1) Flow rate meter, suitable for measuring and recording the actual volumetric sample flow rate at the sampler downtube, with a minimum range of 10 to 25 L/min, 2 percent certified, NIST-traceable accuracy. Optional capability for continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes is recommended. While a flow meter which provides a direct indication of volumetric flow rate is preferred for this test, an alternative certified flow measurement device may be used as long as appropriate volumetric flow rate corrections are made

based on measurements of actual ambient temperature and pressure conditions.

(2) Ambient air temperature sensor (if needed for volumetric corrections to flow rate measurements), with a resolution of 0.1 °C, certified accurate to within 0.5 °C, and continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(3) Barometer (if needed for volumetric corrections to flow rate measurements), range 600 mm Hg to 800 mm Hg, certified accurate to 2 mm Hg, with continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(4) Flow measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sample flow rate at the sampler downtube.

(5) Means for creating an additional pressure drop of 55 mm Hg in the sampler to simulate a heavily loaded filter, such as an orifice or flow restrictive plate installed in the filter holder or a valve or other flow restrictor temporarily installed in the flow path near the filter.

(6) Teflon sample filter, as specified in section 6 of 40 CFR part 50, Appendix L (if required).

(7) Time measurement system, accurate to within 10 seconds per day.

(c) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(d) *Test setup*. (1) Setup of the sampler shall be performed as required in this paragraph (d) and otherwise as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in its normal configuration for collecting $PM_{2.5}$ samples. A sample filter and (or) the device for creating an additional 55 mm Hg pressure drop shall be installed for the duration of these tests. The sampler's ambient temperature, ambient pressure, and flow measurement systems shall all be calibrated per the sampler's operating manual within 7 days prior to this test.

(2) The inlet of the candidate sampler shall be removed and the flow measurement adaptor installed on the sample downtube. A leak check as described in the sampler's operation or instruction manual shall be conducted and must be properly passed before other tests are carried out.

(3) The inlet of the flow measurement adaptor shall be connected to the outlet of the flow rate meter.

(e) *Procedure*. (1) Set up the sampler as specified in paragraph (d) of this section and otherwise prepare the sampler for normal sample collection operation as directed in the sampler's operation or instruction manual. Set the sampler to automatically start a 6–hour sample collection period at a convenient time.

(2) During the entire 6–hour operational flow rate portion of the test, measure and record the sample flow rate with the flow rate meter at intervals not to exceed 5 minutes. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, ambient temperature and pressure shall be measured at the same frequency as that of the certified flow rate measurements. Note and record the actual start and stop times for the 6–hour flow rate test period.

(3) During the 6–hour test period, interrupt the AC line electrical power to the sampler 5 times, with durations of 20 seconds, 40 seconds, 2 minutes, 7 minutes, and 20 minutes (respectively), with not less than 10 minutes of normal electrical power supplied between each power interruption. Record the hour and minute and duration of each power interruption.

(4) At the end of the test, terminate the sample period (if not automatically terminated by the sampler) and download all archived instrument data from the test sampler.

(f) *Test results*. At the completion of the sampling period, validate the test conditions and determine the test results as follows:

(1) *Mean sample flow rate*. (i) From the certified measurements (Q_{ref}) of the test sampler flow rate, tabulate each flow rate measurement in units of L/min. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, each measured flow rate shall be corrected using its corresponding temperature and pressure measurement values. Calculate the mean flow rate for the sample period ($Q_{ref,ave}$) as follows:

Equation 6

$$Q_{ref,ave} = \frac{\sum_{i=1}^{n} Q_{ref,i}}{n}$$

where:
n equals the number of discrete certified flow rate measurements over the 6–hour test period, excluding flow rate values obtained during periods of power interruption.

(ii)(A) Calculate the percent difference between this mean flow rate value and the design value of 16.67 L/min, as follows:

Equation 7

$$\% \text{ Difference} = \frac{Q_{ref,ave} - 16.67}{16.67} \text{ x } 100\%$$

(B) To successfully pass this test, the percent difference calculated in Equation 7 of this paragraph (f)(1)(ii) must be within ±5 percent.

(2) *Sample flow rate regulation*. (i) From the certified measurements of the test sampler flow rate, calculate the sample coefficient of variation of the discrete measurements as follows:

Equation 8

$$\%CV_{ref} = \frac{1}{Q_{ref,ave}} \text{ x } \sqrt{\frac{\sum_{i=1}^{n} Q_{ref,i}^2 - \frac{1}{n}\left(\sum_{i-1}^{n} Q_{ref,i}\right)^2}{n-1}} \text{ x } 100\%$$

(ii) To successfully pass this test, the calculated coefficient of variation for the certified flow rates must not exceed 2 percent.

(3) *Flow rate measurement accuracy*. (i) Using the mean volumetric flow rate reported by the candidate test sampler at the completion of the 6–hour test ($Q_{ind,ave}$), determine the accuracy of the reported mean flow rate as:

Equation 9

$$\% \text{ Difference} = \frac{|Q_{ind,ave} - Q_{ref,ave}|}{Q_{ref,ave}} \text{ x } 100\%$$

(ii) To successfully pass this test, the percent difference calculated in Equation 9 of this paragraph (f)(3) shall not exceed 2 percent.

(4) *Flow rate CV measurement accuracy*. (i) Using the flow rate coefficient of variation indicated by the candidate test sampler at the completion of the 6–hour test ($\%CV_{ind}$), determine the accuracy of the reported coefficient of variation as:

Equation 10

$$\text{Difference } (\%) = |\%CV_{ind} - \%CV_{ref}|$$

(ii) To successfully pass this test, the absolute difference in values calculated in

Equation 10 of this paragraph (f)(4) must not exceed 0.3 (CV%).

(5) Verify that the sampler properly provided a record and visual display of the correct year, month, day-of-month, hour, and minute with an accuracy of ± 2 minutes, of the start of each power interruption of duration greater than 60 seconds.

(6) Calculate the actual elapsed sample time, excluding the periods of electrical power interruption. Verify that the elapsed sample time reported by the sampler is accurate to within ± 20 seconds for the 6–hour test run.

(7) Calculate the sample volume as $Q_{ref,ave}$ the sample time, excluding periods of power interruption. Verify that the sample volume reported by the sampler is within 2 percent of the calculated sample volume to successfully pass this test.

(8) Inspect the downloaded instrument data from the test sampler and verify that all data are consistent with normal operation of the sampler.

§ 53.55 Test for effect of variations in power line voltage and ambient temperature.

(a) *Overview*. (1) This test procedure is a combined procedure to test various performance parameters under variations in power line voltage and ambient temperature. Tests shall be conducted in a temperature controlled environment over four 6–hour time periods during which reference temperature and flow rate measurements shall be made at intervals not to exceed 5 minutes. Specific parameters to be evaluated at line voltages of 105 and 125 volts and temperatures of -20 °C and +40 °C are as follows:

(i) Sample flow rate.

(ii) Flow rate regulation.

(iii) Flow rate measurement accuracy.

(iv) Coefficient of variability measurement accuracy.

(v) Ambient air temperature measurement accuracy.

(vi) Proper operation of the sampler when exposed to power line voltage and ambient temperature extremes.

(2) The performance parameters tested under this procedure, the corresponding minimum performance specifications, and the applicable test conditions are summarized in Table E-1 of this subpart. Each performance parameter tested, as described or determined in the test procedure, must meet or exceed the associated performance specification given. The candidate sampler must meet all specifications for the associated $PM_{2.5}$ method to pass this test procedure.

(b) *Technical definition*. Sample flow rate means the quantitative volumetric flow rate of the air stream caused by the sampler to enter the sampler inlet and pass through the sample filter, measured in actual volume units at the temperature and pressure of the air as it enters the inlet.

(c) *Required test equipment*. (1) Environmental chamber or other temperature-controlled environment or environments, capable of obtaining and maintaining temperatures at -20 °C and +40 °C as required for the test with an accuracy of ±2 °C. The test environment(s) must be capable of maintaining these temperatures within the specified limits continuously with the additional heat load of the operating test sampler in the environment. Henceforth, where the test procedures specify a test or environmental ''chamber,'' an alternative temperature-controlled environmental area or areas may be substituted, provided the required test temperatures and all other test requirements are met.

(2) Variable voltage AC power transformer, range 100 Vac to 130 Vac, with sufficient current capacity to operate the test sampler continuously under the test conditions.

(3) Flow rate meter, suitable for measuring and recording the actual volumetric sample flow rate at the sampler downtube, with a minimum range of 10 to 25 actual L/min, 2 percent certified, NIST-traceable accuracy. Optional capability for continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes is recommended. While a flow meter which provides a direct indication of volumetric flow rate is preferred for this test, an alternative certified flow measurement device may be used as long as appropriate volumetric flow rate corrections are made based on measurements of actual ambient temperature and pressure conditions.

(4) Ambient air temperature recorder, range -30 °C to +50 °C, with a resolution of 0.1 °C and certified accurate to within 0.5 °C. Ambient air temperature measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(5) Barometer, range 600 mm Hg to 800 mm Hg, certified accurate to 2 mm Hg. If the certified flow rate meter does not provide direct volumetric flow rate readings, ambient pressure measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(6) Flow measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sampler flow rate at the sampler downtube.

(7) Means for creating an additional pressure drop of 55 mm Hg in the sampler to simulate a heavily loaded filter, such as an orifice or flow restrictive plate installed in the filter holder or a valve or other flow restrictor temporarily installed in the flow path near the filter.

(8) AC RMS voltmeter, accurate to 1.0 volt.

(9) Teflon sample filter, as specified in section 6 of 40 CFR part 50, Appendix L (if required).

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) Setup of the sampler shall be performed as required in this paragraph (e) and otherwise as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in the temperature-controlled chamber in its normal configuration for collecting $PM_{2.5}$ samples. A sample filter and (or) the device for creating an additional 55 mm Hg pressure drop shall be installed for the duration of these tests. The sampler's ambient temperature, ambient pressure, and flow measurement systems shall all be calibrated per the sampler's operating manual within 7 days prior to this test.

(2) The inlet of the candidate sampler shall be removed and the flow measurement adaptor installed on the sampler's downtube. A leak check as described in the sampler's operation or instruction manual shall be conducted and must be properly passed before other tests are carried out.

(3) The inlet of the flow measurement adaptor shall be connected to the outlet of the flow rate meter.

(4) The ambient air temperature recorder shall be installed in the test chamber such that it will accurately measure the temperature of the air in the vicinity of the candidate sampler without being unduly affected by the chamber's air temperature control system.

(f) *Procedure*. (1) Set up the sampler as specified in paragraph (e) of this section and otherwise prepare the sampler for normal sample collection operation as directed in the sampler's operation or instruction manual.

(2) The test shall consist of four test runs, one at each of the following conditions of chamber temperature and electrical power line voltage (respectively):

(i) -20 °C ±2 °C and 105 ±1 Vac.

(ii) -20 °C ±2 °C and 125 ±1 Vac.

(iii) +40 °C ±2 °C and 105 ±1 Vac.

(iv) +40 °C ±2 °C and 125 ±1 Vac.

(3) For each of the four test runs, set the selected chamber temperature and power line voltage for the test run. Upon achieving each temperature setpoint in the chamber, the candidate sampler and flow meter shall be thermally equilibrated for a period of at least 2 hours prior to the test run. Following the thermal conditioning time, set the sampler to automatically start a 6–hour sample collection period at a convenient time.

(4) During each 6–hour test period:

(i) Measure and record the sample flow rate with the flow rate meter at intervals not to exceed 5 minutes. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, ambient temperature and pressure shall be measured at the same frequency as that of the certified flow rate measurements. Note and record the actual start and stop times for the 6–hour flow rate test period.

(ii) Determine and record the ambient (chamber) temperature indicated by the sampler and the corresponding ambient (chamber) temperature measured by the ambient temperature recorder specified in paragraph (c)(4) of this section at intervals not to exceed 5 minutes.

(iii) Measure the power line voltage to the sampler at intervals not greater than 1 hour.

(5) At the end of each test run, terminate the sample period (if not automatically terminated by the sampler) and download all archived instrument data from the test sampler.

(g) *Test results*. For each of the four test runs, examine the chamber temperature measurements and the power line voltage measurements. Verify that the temperature and line voltage met the requirements specified in paragraph (f) of this section at all times during the test run. If not, the test run is not valid and must be repeated. Determine the test results as follows:

(1) *Mean sample flow rate*. (i) From the certified measurements (Q_{ref}) of the test sampler flow rate, tabulate each flow rate measurement in units of L/min. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, each measured flow rate shall be corrected using its corresponding temperature and pressure measurement values. Calculate the mean flow rate for each sample period ($Q_{ref,ave}$) as follows:

Equation 11

$$Q_{ref,ave} = \frac{\sum_{i=1}^{n} Q_{ref,i}}{n}$$

where:

n equals the number of discrete certified flow rate measurements over each 6–hour test period.

(ii)(A) Calculate the percent difference between this mean flow rate value and the design value of 16.67 L/min, as follows:

Equation 12

$$\% \text{ Difference} = \frac{Q_{ref,ave} - 16.67}{16.67} \text{ x } 100\%$$

(B) To successfully pass this test, the percent difference calculated in Equation 12 of this paragraph (g)(1)(ii) must be within ±5 percent for each test run.

(2) *Sample flow rate regulation*. (i) From the certified measurements of the test sampler flow rate, calculate the sample coefficient of variation of the discrete measurements as follows:

Equation 13

$$\%CV_{ref} = \frac{1}{Q_{ref,ave}} \text{ x } \sqrt{\frac{\sum_{i=1}^{n} Q_{ref,i}^2 - \frac{1}{n}\left(\sum_{i-1}^{n} Q_{ref,i}\right)^2}{n-1}} \text{ x } 100\%$$

(ii) To successfully pass this test, the calculated coefficient of variation for the certified flow rates must not exceed 2 percent.

(3) *Flow rate measurement accuracy*. (i) Using the mean volumetric flow rate reported by the candidate test sampler at the completion of each 6–hour test ($Q_{ind,ave}$), determine the accuracy of the reported mean flow rate as:

Equation 14

$$\% \text{ Difference} = \frac{|Q_{ind,ave} - Q_{ref,ave}|}{Q_{ref,ave}} \text{ x } 100\%$$

(ii) To successfully pass this test, the percent difference calculated in Equation 14 of this paragraph (g)(3) shall not exceed 2 percent for each test run.

(4) *Flow rate coefficient of variation measurement accuracy*. (i) Using the flow rate coefficient of variation indicated by the candidate test sampler ($\%CV_{ind}$), determine the accuracy of the reported coefficient of variation as:

Equation 15

$$\text{Difference } \% = |\%CV_{ind} - \%CV_{ref}|$$

(ii) To successfully pass this test, the absolute difference calculated in Equation 15 of this paragraph (g)(4) must not exceed 0.3 (CV%) for each test run.

(5) *Ambient temperature measurement accuracy*. (i) Calculate the absolute value of the difference between the mean ambient air temperature indicated by the test sampler and the mean ambient (chamber) air temperature measured with the ambient air temperature recorder as:

Equation 16

$$T_{diff} = |T_{ind,ave} - T_{ref,ave}|$$

where:

$T_{ind,ave}$ = mean ambient air temperature indicated by the test sampler, °C; and

$T_{ref,ave}$ = mean ambient air temperature measured by the reference temperature instrument, °C.

(ii) The calculated temperature difference must be less than 2 °C for each test run.

(6) *Sampler functionality*. To pass the sampler functionality test, the following two conditions must both be met for each test run:

(i) The sampler must not shutdown during any portion of the 6–hour test.

(ii) An inspection of the downloaded data from the test sampler verifies that all the data are consistent with normal operation of the sampler.

§ 53.56 Test for effect of variations in ambient pressure.

(a) *Overview*. (1) This test procedure is designed to test various sampler performance parameters under variations in ambient (barometric) pressure. Tests shall be conducted in a pressure-controlled environment over two 6–hour time periods during which reference pressure and flow rate measurements shall be made at intervals not to exceed 5 minutes. Specific parameters to be evaluated at operating pressures of 600 and 800 mm Hg are as follows:

(i) Sample flow rate.

(ii) Flow rate regulation.

(iii) Flow rate measurement accuracy.

(iv) Coefficient of variability measurement accuracy.

(v) Ambient pressure measurement accuracy.

(vi) Proper operation of the sampler when exposed to ambient pressure extremes.

(2) The performance parameters tested under this procedure, the corresponding minimum performance specifications, and the applicable test conditions are summarized in Table E-1 of this subpart. Each performance parameter tested, as described or determined in the test procedure, must meet or exceed the associated performance specification given. The candidate sampler must meet all specifications for the associated $PM_{2.5}$ method to pass this test procedure.

(b) *Technical definition*. Sample flow rate means the quantitative volumetric flow rate of the air stream caused by the sampler to enter the sampler inlet and pass through the sample filter, measured in actual volume units at the temperature and pressure of the air as it enters the inlet.

(c) *Required test equipment*. (1) Hypobaric chamber or other pressure-controlled environment or environments, capable of obtaining and maintaining pressures at 600 mm Hg and 800 mm Hg required for the test

with an accuracy of 5 mm Hg. Henceforth, where the test procedures specify a test or environmental chamber, an alternative pressure-controlled environmental area or areas may be substituted, provided the test pressure requirements are met. Means for simulating ambient pressure using a closed-loop sample air system may also be approved for this test; such a proposed method for simulating the test pressure conditions may be described and submitted to EPA at the address given in § 53.4(a) prior to conducting the test for a specific individual determination of acceptability.

(2) Flow rate meter, suitable for measuring and recording the actual volumetric sampler flow rate at the sampler downtube, with a minimum range of 10 to 25 L/min, 2 percent certified, NIST-traceable accuracy. Optional capability for continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes is recommended. While a flow meter which provides a direct indication of volumetric flow rate is preferred for this test, an alternative certified flow measurement device may be used as long as appropriate volumetric flow rate corrections are made based on measurements of actual ambient temperature and pressure conditions.

(3) Ambient air temperature recorder (if needed for volumetric corrections to flow rate measurements) with a range -30 °C to +50 °C, certified accurate to within 0.5 °C. If the certified flow meter does not provide direct volumetric flow rate readings, ambient temperature measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(4) Barometer, range 600 mm Hg to 800 mm Hg, certified accurate to 2 mm Hg. Ambient air pressure measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(5) Flow measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sampler flow rate at the sampler downtube.

(6) Means for creating an additional pressure drop of 55 mm Hg in the sampler to simulate a heavily loaded filter, such as an orifice or flow restrictive plate installed in the filter holder or a valve or other flow restrictor temporarily installed in the flow path near the filter.

(7) Teflon sample filter, as specified in section 6 of 40 CFR part 50, Appendix L (if required).

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) Setup of the sampler shall be performed as required in this paragraph (e) and otherwise as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in the pressure-controlled chamber in its normal configuration for collecting $PM_{2.5}$ samples. A sample filter and (or) the device for creating an additional 55 mm Hg pressure drop shall be installed for the duration of these tests. The sampler's ambient temperature, ambient pressure, and flow measurement systems shall all be calibrated per the sampler's operating manual within 7 days prior to this test.

(2) The inlet of the candidate sampler shall be removed and the flow measurement adaptor installed on the sampler's downtube. A leak check as described in the sampler's operation or instruction manual shall be conducted and must be properly passed before other tests are carried out.

(3) The inlet of the flow measurement adaptor shall be connected to the outlet of the flow rate meter.

(4) The barometer shall be installed in the test chamber such that it will accurately measure the air pressure to which the candidate sampler is subjected.

(f) *Procedure*. (1) Set up the sampler as specified in paragraph (e) of this section and otherwise prepare the sampler for normal sample collection operation as directed in the sampler's operation or instruction manual.

(2) The test shall consist of two test runs, one at each of the following conditions of chamber pressure:

(i) 600 mm Hg.

(ii) 800 mm Hg.

(3) For each of the two test runs, set the selected chamber pressure for the test run. Upon achieving each pressure setpoint in the chamber, the candidate sampler shall be pressure-equilibrated for a period of at least 30 minutes prior to the test run. Following the conditioning time, set the sampler to automatically start a 6–hour sample collection period at a convenient time.

(4) During each 6–hour test period:

(i) Measure and record the sample flow rate with the flow rate meter at intervals not to exceed 5 minutes. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, ambient temperature and pressure shall be measured at the same frequency as that of the certified flow rate measurements. Note and record the actual start and stop times for the 6–hour flow rate test period.

(ii) Determine and record the ambient (chamber) pressure indicated by the sampler and the corresponding ambient (chamber) pressure measured by the barometer specified in paragraph (c)(4) of this section at intervals not to exceed 5 minutes.

(5) At the end of each test period, terminate the sample period (if not automatically terminated by the sampler) and download all archived instrument data from the test sampler.

(g) *Test results*. For each of the two test runs, examine the chamber pressure measurements. Verify that the pressure met the requirements specified in paragraph (f) of this section at all times during the test. If not, the test run is not valid and must be repeated. Determine the test results as follows:

(1) *Mean sample flow rate*. (i) From the certified measurements (Q_{ref}) of the test sampler flow rate, tabulate each flow rate measurement in units of L/min. If ambient temperature and pressure corrections are necessary to calculate volumetric flow rate, each measured flow rate shall be corrected using its corresponding temperature and pressure measurement values. Calculate the mean flow rate for the sample period ($Q_{ref,ave}$) as follows:

Equation 17

$$Q_{ref,ave} = \frac{\sum_{i=1}^{n} Q_{ref,i}}{n}$$

where:
n equals the number of discrete certified flow measurements over the 6–hour test period.

(ii)(A) Calculate the percent difference between this mean flow rate value and the design value of 16.67 L/min, as follows:

Equation 18

$$\% \text{ Difference} = \frac{Q_{ref,ave} - 16.67}{16.67} \times 100\%$$

(B) To successfully pass this test, the percent difference calculated in Equation 18 of this paragraph (g)(1) must be within ±5 percent for each test run.

(2) *Sample flow rate regulation*. (i) From the certified measurements of the test sampler flow rate, calculate the sample coefficient of variation of the discrete measurements as follows:

Equation 19

$$\%CV_{ref} = \frac{1}{Q_{ref,ave}} x \sqrt{\frac{\sum_{i=1}^{n} Q_{ref,i}^2 - \frac{1}{n}\left(\sum_{i-1}^{n} Q_{ref,i}\right)^2}{n-1}} x\ 100\%$$

(ii) To successfully pass this test, the calculated coefficient of variation for the certified flow rates must not exceed 2 percent.

(3) *Flow rate measurement accuracy*. (i) Using the mean volumetric flow rate reported by the candidate test sampler at the completion of each 6–hour test ($Q_{ind,ave}$), determine the accuracy of the reported mean flow rate as:

Equation 20

$$\%\ Difference = \frac{|Q_{ind,ave} - Q_{ref,ave}|}{Q_{ref,ave}} x\ 100\%$$

(ii) To successfully pass this test, the percent difference calculated in Equation 20 of this paragraph (g)(3) shall not exceed 2 percent for each test run.

(4) *Flow rate CV measurement accuracy*. (i) Using the flow rate coefficient of variation indicated by the candidate test sampler at the completion of the 6–hour test ($\%CV_{ind}$), determine the accuracy of the reported coefficient of variation as:

Equation 21

$$Difference\ (\%) = |\%CV_{ind} - \%CV_{ref}|$$

(ii) To successfully pass this test, the absolute difference in values calculated in Equation 21 of this paragraph (g)(4) must not exceed 0.3 (CV%) for each test run.

(5) *Ambient pressure measurement accuracy*. (i) Calculate the absolute difference between the mean ambient air pressure indicated by the test sampler and the ambient (chamber) air pressure measured with the reference barometer as:

Equation 22

$$P_{diff} = |P_{ind,ave} - P_{ref,ave}|$$

where:
$P_{ind,ave}$ = mean ambient pressure indicated by the test sampler, mm Hg; and
$P_{ref,ave}$ = mean barometric pressure measured by the reference barometer, mm Hg.

(ii) The calculated pressure difference must be less than 10 mm Hg for each test run to pass the test.

(6) *Sampler functionality*. To pass the sampler functionality test, the following two conditions must both be met for each test run:

(i) The sampler must not shut down during any part of the 6–hour tests; and

(ii) An inspection of the downloaded data from the test sampler verifies that all the data are consistent with normal operation of the sampler.

§ 53.57 Test for filter temperature control during sampling and post-sampling periods.

(a) *Overview*. This test is intended to measure the candidate sampler's ability to prevent excessive overheating of the $PM_{2.5}$ sample collection filter (or filters) under conditions of elevated solar insolation. The test evaluates radiative effects on filter temperature during a 4–hour period of active sampling as well as during a subsequent 4–hour non-sampling time period prior to filter retrieval. Tests shall be conducted in an environmental chamber which provides the proper radiant wavelengths and energies to adequately simulate the sun's radiant effects under clear conditions at sea level. For additional guidance on conducting solar radiative tests under controlled conditions, consult military standard specification 810-E (Reference 6 in Appendix A of this subpart). The performance parameters tested under this procedure, the corresponding minimum performance specifications, and the applicable test conditions are summarized in Table E-1 of this subpart. Each performance parameter tested, as described or determined in the test procedure, must meet or exceed the associated performance specification to successfully pass this test.

(b) *Technical definition*. Filter temperature control during sampling is the ability of a sampler to maintain the temperature of the particulate matter sample filter within the specified deviation (5 °C) from ambient temperature during any active sampling period. Post-sampling temperature control is the ability of a sampler to maintain the temperature of the particulate matter sample filter within the specified deviation from ambient temperature during the period from the end of active sample collection of the $PM_{2.5}$ sample by the sampler until the filter is retrieved from the sampler for laboratory analysis.

(c) *Required test equipment*. (1) Environmental chamber providing the means, such as a bank of solar-spectrum lamps, for generating or simulating thermal radiation in approximate spectral content and intensity equivalent to solar insolation of 1000 ± 50 W/m² inside the environmental chamber. To properly simulate the sun's radiative effects on the sampler, the solar bank must provide the spectral energy distribution and permitted tolerances specified in Table E-2 of this subpart. The solar radiation source area shall be such that the width of the candidate sampler shall not exceed one-half the dimensions of the solar bank. The solar bank shall be located a minimum of 76 cm (30 inches) from any surface of the candidate sampler. To meet requirements of the solar radiation tests, the chamber's internal volume shall be a minimum of 10 times that of the volume of the candidate sampler. Air velocity in the region of the sampler must be maintained continuously during the radiative tests at 2.0 ± 0.5 m/sec.

(2) Ambient air temperature recorder, range -30 °C to +50 °C, with a resolution of 0.1 °C and certified accurate to within 0.5 °C. Ambient air temperature measurements must be made using continuous (analog) recording capability or digital recording at intervals not to exceed 5 minutes.

(3) Flow measurement adaptor (40 CFR part 50, Appendix L, Figure L-30) or equivalent adaptor to facilitate measurement of sampler flow rate at the sampler downtube.

(4) Miniature temperature sensor(s), capable of being installed in the sampler without introducing air leakage and capable of measuring the sample air temperature within 1 cm of the center of the filter, downstream of the filter; with a resolution of 0.1 °C, certified accurate to within 0.5 °C, NIST-traceable, with continuous (analog) recording capability or digital recording at intervals of not more than 5 minutes.

(5) Solar radiometer, to measure the intensity of the simulated solar radiation in the test environment, range of 0 to approximately 1500 W/m². Optional capability for continuous (analog) recording or digital recording at intervals not to exceed 5 minutes is recommended.

(6) Sample filter or filters, as specified in section 6 of 40 CFR part 50, Appendix L.

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests. The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) Setup of the sampler shall be performed as required in this paragraph (e) and otherwise as described in the sampler's operation or instruction manual referred to in § 53.4(b)(3). The sampler shall be installed upright and set up in the solar radiation environmental chamber in its normal configuration for collecting $PM_{2.5}$ samples (with the inlet installed). The

sampler's ambient and filter temperature measurement systems shall be calibrated per the sampler's operating manual within 7 days prior to this test. A sample filter shall be installed for the duration of this test. For sequential samplers, a sample filter shall also be installed in each available sequential channel or station intended for collection of a sequential sample (or at least 5 additional filters for magazine-type sequential samplers) as directed by the sampler's operation or instruction manual.

(2) The miniature temperature sensor shall be temporarily installed in the test sampler such that it accurately measures the air temperature 1 cm from the center of the filter on the downstream side of the filter. The sensor shall be installed such that no external or internal air leakage is created by the sensor installation. The sensor's dimensions and installation shall be selected to minimize temperature measurement uncertainties due to thermal conduction along the sensor mounting structure or sensor conductors. For sequential samplers, similar temperature sensors shall also be temporarily installed in the test sampler to monitor the temperature 1 cm from the center of each filter stored in the sampler for sequential sample operation.

(3) The solar radiant energy source shall be installed in the test chamber such that the entire test sampler is irradiated in a manner similar to the way it would be irradiated by solar radiation if it were located outdoors in an open area on a sunny day, with the radiation arriving at an angle of between 30° and 45° from vertical. The intensity of the radiation received by all sampler surfaces that receive direct radiation shall average 1000 ± 50 W/m², measured in a plane perpendicular to the incident radiation. The incident radiation shall be oriented with respect to the sampler such that the area of the sampler's ambient temperature sensor (or temperature shield) receives full, direct radiation as it would or could during normal outdoor installation. Also, the temperature sensor must not be shielded or shaded from the radiation by a sampler part in a way that would not occur at other normal insolation angles or directions.

(4) The solar radiometer shall be installed in a location where it measures thermal radiation that is generally representative of the average thermal radiation intensity that the upper portion of the sampler and sampler inlet receive. The solar radiometer shall be oriented so that it measures the radiation in a plane perpendicular to its angle of incidence.

(5) The ambient air temperature recorder shall be installed in the test chamber such that it will accurately measure the temperature of the air in the chamber without being unduly affected by the chamber's air temperature control system or by the radiant energy from the solar radiation source that may be present inside the test chamber.

(f) *Procedure*. (1) Set up the sampler as specified in paragraph (e) of this section and otherwise prepare the sampler for normal sample collection operation as directed in the sampler's operation or instruction manual.

(2) Remove the inlet of the candidate test sampler and install the flow measurement adaptor on the sampler's downtube. Conduct a leak check as described in the sampler's operation or instruction manual. The leak test must be properly passed before other tests are carried out.

(3) Remove the flow measurement adaptor from the downtube and re-install the sampling inlet.

(4) Activate the solar radiation source and verify that the resulting energy distribution prescribed in Table E-2 of this subpart is achieved.

(5) Program the test sampler to conduct a single sampling run of 4 continuous hours. During the 4-hour sampling run, measure and record the radiant flux, ambient temperature, and filter temperature (all filter temperatures for sequential samplers) at intervals not to exceed 5 minutes.

(6) At the completion of the 4–hour sampling phase, terminate the sample period, if not terminated automatically by the sampler. Continue to measure and record the radiant flux, ambient temperature, and filter temperature or temperatures for 4 additional hours at intervals not to exceed 5 minutes. At the completion of the 4–hour post-sampling period, discontinue the measurements and turn off the solar source.

(7) Download all archived sampler data from the test run.

(g) *Test results*. Chamber temperature control. Examine the continuous record of the chamber radiant flux and verify that the flux met the requirements specified in Table E-2 of this subpart at all times during the test. If not, the entire test is not valid and must be repeated.

(1) *Filter temperature measurement accuracy*. (i) For each 4–hour test period, calculate the absolute value of the difference between the mean filter temperature indicated by the sampler (active filter) and the mean filter temperature measured by the reference temperature sensor installed within 1 cm downstream of the (active) filter as:

Equation 23

$$T_{diff,filter} = |T_{ind,filter} - T_{ref,filter}|$$

where:
$T_{ind,filter}$ = mean filter temperature indicated by the test sampler, °C; and
$T_{ref,filter}$ = mean filter temperature measured by the reference temperature sensor, °C.

(ii) To successfully pass the indicated filter temperature accuracy test, the calculated difference between the measured means ($T_{diff,filter}$) must not exceed 2 °C for each 4-hour test period.

(2) *Ambient temperature measurement accuracy*. (i) For each 4-hour test period, calculate the absolute value of the difference between the mean ambient air temperature indicated by the test sampler and the mean ambient air temperature measured by the reference ambient air temperature recorder as:

Equation 24

$$T_{diff,ambient} = |T_{ind,ambient} - T_{ref,ambient}|$$

where:
$T_{ind,ambient}$ = mean ambient air temperature indicated by the test sampler, °C; and
$T_{ref,ambient}$ = mean ambient air temperature measured by the reference ambient air temperature recorder, °C.

(ii) To successfully pass the indicated ambient temperature accuracy test, the calculated difference between the measured means ($T_{diff,ambient}$) must not exceed 2 °C for each 4-hour test period.

(3) *Filter temperature control accuracy*. (i) For each temperature measurement interval over each 4–hour test period, calculate the difference between the filter temperature indicated by the reference temperature sensor and the ambient temperature indicated by the test sampler as:

Equation 25

$$T_{diff} = T_{ref,filter} - T_{ind,ambient}$$

(ii) Tabulate and inspect the calculated differences as a function of time. To successfully pass the indicated filter temperature control test, the calculated difference between the measured values must not exceed 5 °C for any consecutive intervals covering more than a 30–minute time period.

(iii) For sequential samplers, repeat the test calculations for each of the stored sequential sample filters. All stored filters must also meet the 5 °C temperature control test.

§ 53.58 Operational field precision and blank test.

(a) *Overview*. This test is intended to determine the operational precision of the candidate sampler during a minimum of 10 days of field operation, using three collocated test samplers. Measurements of $PM_{2.5}$ are made at a test site with all of the samplers and then compared to determine replicate precision. Candidate sequential samplers are also subject to a test for possible deposition of particulate matter on inactive filters during a period of storage in the sampler. This procedure is applicable to both reference and equivalent methods. In the case of equivalent methods, this test may be combined and conducted concurrently with the comparability test for equivalent methods (described in subpart C of this part), using three reference method samplers collocated with three candidate equivalent method samplers and meeting the applicable site and other requirements of subpart C of this part.

(b) *Technical definition*. (1) Field precision is defined as the standard deviation or relative standard deviation of a set of $PM_{2.5}$

measurements obtained concurrently with three or more collocated samplers in actual ambient air field operation.

(2) Storage deposition is defined as the mass of material inadvertently deposited on a sample filter that is stored in a sequential sampler either prior to or subsequent to the active sample collection period.

(c) *Test site*. Any outdoor test site having $PM_{2.5}$ concentrations that are reasonably uniform over the test area and that meet the minimum level requirement of paragraph (g)(2) of this section is acceptable for this test.

(d) *Required facilities and equipment*. (1) An appropriate test site and suitable electrical power to accommodate three test samplers are required.

(2) Teflon sample filters, as specified in section 6 of 40 CFR part 50, Appendix L, conditioned and preweighed as required by section 8 of 40 CFR part 50, Appendix L, as needed for the test samples.

(e) *Test setup*. (1) Three identical test samplers shall be installed at the test site in their normal configuration for collecting $PM_{2.5}$ samples in accordance with the instructions in the associated manual referred to in § 53.4(b)(3) and should be in accordance with applicable supplemental guidance provided in Reference 3 in Appendix A of this subpart. The test samplers' inlet openings shall be located at the same height above ground and between 2 and 4 meters apart horizontally. The samplers shall be arranged or oriented in a manner that will minimize the spatial and wind directional effects on sample collection of one sampler on any other sampler.

(2) Each test sampler shall be successfully leak checked, calibrated, and set up for normal operation in accordance with the instruction manual and with any applicable supplemental guidance provided in Reference 3 in Appendix A of this subpart.

(f) *Test procedure*. (1) Install a conditioned, preweighed filter in each test sampler and otherwise prepare each sampler for normal sample collection. Set identical sample collection start and stop times for each sampler. For sequential samplers, install a conditioned, preweighed specified filter in each available channel or station intended for automatic sequential sample filter collection (or at least 5 additional filters for magazine-type sequential samplers), as directed by the sampler's operation or instruction manual. Since the inactive sequential channels are used for the storage deposition part of the test, they may not be used to collect the active $PM_{2.5}$ test samples.

(2) Collect either a 24–hour or a 48–hour atmospheric $PM_{2.5}$ sample simultaneously with each of the three test samplers.

(3) Following sample collection, retrieve the collected sample from each sampler. For sequential samplers, retrieve the additional stored (blank, unsampled) filters after at least 5 days (120 hours) storage in the sampler if the active samples are 24–hour samples, or after at least 10 days (240 hours) if the active samples are 48–hour samples.

(4) Determine the measured $PM_{2.5}$ mass concentration for each sample in accordance with the applicable procedures prescribed for the candidate method in Appendix L, 40 CFR part 50 of this chapter, in the associated manual referred to in § 53.4(b)(3) and in accordance with supplemental guidance in Reference 2 in Appendix A of this subpart. For sequential samplers, also similarly determine the storage deposition as the net weight gain of each blank, unsampled filter after the 5–day (or 10–day) period of storage in the sampler.

(5) Repeat this procedure to obtain a total of 10 sets of any combination of 24–hour or 48–hour $PM_{2.5}$ measurements over 10 test periods. For sequential samplers, repeat the 5–day (or 10–day) storage test of additional blank filters once for a total of two sets of blank filters.

(g) *Calculations*. (1) Record the $PM_{2.5}$ concentration for each test sampler for each test period as $C_{i,j}$, where i is the sampler number (i=1,2,3) and j is the test period (j=1,2, . . . 10).

(2)(i) For each test period, calculate and record the average of the three measured $PM_{2.5}$ concentrations as C_j where j is the test period:

Equation 26

$$C_{ave,j} = \frac{1}{3} x \sum_{i=1}^{3} C_{i,j}$$

(ii) If $C_{ave,j} < 10\ \mu g/m^3$ for any test period, data from that test period are unacceptable, and an additional sample collection set must be obtained to replace the unacceptable data.

(3)(i) Calculate and record the precision for each of the 10 test days as:

Equation 27

$$P_j = \sqrt{\frac{\sum_{i=1}^{3} C_{i,j}^2 - \frac{1}{3}\left(\sum_{i=1}^{3} C_{i,j}\right)^2}{2}}$$

(ii) If $C_{ave,j}$ is below 40 $\mu g/m^3$ for 24–hour measurements or below 30 $\mu g/m^3$ for 48–hour measurements; or

Equation 28

$$RP_j = 100\%\ x\ \frac{1}{C_{ave,j}} \sqrt{\frac{\sum_{i=1}^{3} C_{i,j}^2 - \frac{1}{3}\left(\sum_{i=1}^{3} C_{i,j}\right)^2}{2}}$$

(iii) If $C_{ave,j}$ is above 40 $\mu g/m^3$ for 24-hour measurements or above 30 $\mu g/m^3$ for 48-hour measurements.

(h) *Test results*. (1) The candidate method passes the precision test if all 10 P_j or RP_j values meet the specifications in Table E-1 of this subpart.

(2) The candidate sequential sampler passes the blank filter storage deposition test if the average net storage deposition weight gain of each set of blank filters (total of the net weight gain of each blank filter divided by the number of filters in the set) from each test sampler (six sets in all) is less than 50 µg.

§ 53.59 Aerosol transport test for Class I equivalent method samplers.

(a) *Overview*. This test is intended to verify adequate aerosol transport through any modified or air flow splitting components that may be used in a Class I candidate equivalent method sampler such as may be necessary to achieve sequential sampling capability. This test is applicable to all Class I candidate samplers in which the aerosol flow path (the flow path through which sample air passes upstream of sample collection filter) differs from that specified for reference method samplers as specified in 40 CFR part 50, Appendix L. The test requirements and performance specifications for this test are summarized in Table E-1 of this subpart.

(b) *Technical definitions*. (1) Aerosol transport is the percentage of a laboratory challenge aerosol which penetrates to the active sample filter of the candidate equivalent method sampler.

(2) The active sample filter is the exclusive filter through which sample air is flowing during performance of this test.

(3) A no-flow filter is a sample filter through which no sample air is intended to flow during performance of this test.

(4) A channel is any of two or more flow paths that the aerosol may take, only one of which may be active at a time.

(5) An added component is any physical part of the sampler which is different in some way from that specified for a reference method sampler in 40 CFR part 50, Appendix L, such as a device or means to allow or cause the aerosol to be routed to one of several channels.

(c) *Required facilities and test equipment*. (1) Aerosol generation system, as specified in § 53.62(c)(2).

(2) Aerosol delivery system, as specified in § 53.64(c)(2).

(3) Particle size verification equipment, as specified in § 53.62(c)(3).

(4) Fluorometer, as specified in § 53.62(c)(7).

(5) Candidate test sampler, with the inlet and impactor or impactors removed, and with all internal surfaces of added components electroless nickel coated as specified in § 53.64(d)(2).

(6) Filters that are appropriate for use with fluorometric methods (e.g., glass fiber).

(d) *Calibration of test measurement instruments*. Submit documentation showing evidence of appropriately recent calibration, certification of calibration accuracy, and NIST-traceability (if required) of all measurement instruments used in the tests.

The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) The candidate test sampler shall have its inlet and impactor or impactors removed. The lower end of the down tube shall be reconnected to the filter holder, using an extension of the downtube, if necessary. If the candidate sampler has a separate impactor for each channel, then for this test, the filter holder assemblies must be connected to the physical location on the sampler where the impactors would normally connect.

(2) The test particle delivery system shall be connected to the sampler downtube so that the test aerosol is introduced at the top of the downtube.

(f) *Test procedure*. (1) All surfaces of the added or modified component or components which come in contact with the aerosol flow shall be thoroughly washed with 0.01 N NaOH and then dried.

(2) Generate aerosol. (i) Generate aerosol composed of oleic acid with a uranine fluorometric tag of 3 ± 0.25 μm aerodynamic diameter using a vibrating orifice aerosol generator according to conventions specified in § 53.61(g).

(ii) Check for the presence of satellites and adjust the generator to minimize their production.

(iii) Calculate the aerodynamic particle size using the operating parameters of the vibrating orifice aerosol generator. The calculated aerodynamic diameter must be 3 ± 0.25 μm aerodynamic diameter.

(3) Verify the particle size according to procedures specified in § 53.62(d)(4)(i).

(4) Collect particles on filters for a time period such that the relative error of the resulting measured fluorometric concentration for the active filter is less than 5 percent.

(5) Determine the quantity of material collected on the active filter using a calibrated fluorometer. Record the mass of fluorometric material for the active filter as $M_{active\ (i)}$ where i = the active channel number.

(6) Determine the quantity of material collected on each no-flow filter using a calibrated fluorometer. Record the mass of fluorometric material on each no-flow filter as $M_{no\text{-}flow}$.

(7) Using 0.01 N NaOH, wash the surfaces of the added component or components which contact the aerosol flow. Determine the quantity of material collected using a calibrated fluorometer. Record the mass of fluorometric material collected in the wash as M_{wash}.

(8) Calculate the aerosol transport as:

Equation 29

$$T_{(i)} = \frac{M_{active}}{M_{active+}M_{wash+}\sum M_{no\text{-}flow}} \times 100\%$$

where:
i = the active channel number.

(9) Repeat paragraphs (f)(1) through (8) of this section for each channel, making each channel in turn the exclusive active channel.

(g) *Test results*. The candidate Class I sampler passes the aerosol transport test if $T_{(i)}$ is at least 97 percent for each channel.

Tables to Subpart E of Part 53

Table E-1.—Summary of Test Requirements for Reference and Class I Equivalent Methods for $PM_{2.5}$

Subpart E Procedure	Performance Test	Performance Specification	Test Conditions	Part 50, Appendix L Reference
§ 53.52 Sampler leak check test	Sampler leak check facility	External leakage: 80 mL/min, max Internal leakage: 80 mL/min, max	Controlled leak flow rate of 80 mL/min	Sec. 7.4.6
§ 53.53 Base flow rate test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Cut-off	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. Flow rate cut-off if flow rate deviates more than 10% from design flow rate for >60 ± 30 seconds	(a) 6-hour normal operational test plus flow rate cut-off test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Variable flow restriction used for cut-off test	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.4 Sec. 7.4.5
§ 53.54 Power interruption test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Occurrence time of power interruptions 6. Elapsed sample time 7. Sample volume	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. ±2 min if >60 seconds 6. ±20 seconds 7. ±2%, max	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) 6 power interruptions of various durations	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.12 Sec. 7.4.13 Sec. 7.4.15.4 Sec. 7.4.15.5
§ 53.55 Temperature and line voltage effect test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Temperature meas. accuracy 6. Proper operation	1. 16.67 ± 5%, L/min 2. 2 %, max 3. 2 %, max 4. 0.3 %, max 5. 2 °C	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Ambient temperature at -20 and +40 °C (e) Line voltage: 105 Vac to 125 Vac	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.8 Sec. 7.4.15.1

Table E-1.—Summary of Test Requirements for Reference and Class I Equivalent Methods for $PM_{2.5}$—Continued

Subpart E Procedure	Performance Test	Performance Specification	Test Conditions	Part 50, Appendix L Reference
§ 53.56 Barometric pressure effect test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Pressure meas. accuracy 6. Proper operation	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. 10 mm Hg	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Barometric pressure at 600 and 800 mm Hg.	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.9
§ 53.57 Filter temperature control test	1. Filter temp meas. accuracy 2. Ambient temp. meas. accuracy 3. Filter temp control accuracy, sampling and non-sampling	1. 2 °C 2. 2 °C 3. Not more than 5 °C above ambient temp. for more than 30 min	(a) 4-hour simulated solar radiation, sampling (b) 4-hour simulated solar radiation, non-sampling (c) Solar flux of 1000 W/m^2	Sec. 7.4.8 Sec. 7.4.10 Sec. 7.4.11
§ 53.58 Field precision test	1. Measurement precision 2. Storage deposition test for sequential samplers	1. P_j <2 $\mu g/m^3$ for conc. <40 $\mu g/m^3$ (24-hr) or <30 $\mu g/m^3$ (48-hr); or RP_j < 5% for conc. >40 $\mu g/m3$ (24-hr) or >30 $\mu g/m3$ (48-hr) 2. 50 µg, max weight gain	(a) 3 collocated samplers at 1 site for at least 10 days (b) $PM_{2.5}$ conc.≤10 $\mu g/m^3$ (c) 24- or 48-hour samples (d) 5- or 10-day storage period for inactive stored filters	Sec. 5.1 Sec. 7.3.5 Sec. 8 Sec. 9 Sec. 10
The Following Requirement is Applicable to Candidate Equivalent Methods Only				
§ 53.59 Aerosol transport test	Aerosol transport	97%, min, for all channels	Determine aerosol transport through any new or modified components with respect to the reference method sampler before the filter for each channel.	

TABLE E-2.—SPECTRAL ENERGY DISTRIBUTION AND PERMITTED TOLERANCE FOR CONDUCTING RADIATIVE TESTS

Chacteristic	Spectral Region			
	Ultraviolet		Visible	Infrared
Bandwidth (µm)	0.28 to 0.32	10.32 to 0.40	0.40 to 0.78	0.78 to 3.00
Irradiance (W/m^2)	5	56	450 to 550	439
Allowed Tolerance	2± 35%	2± 25%	2± 10%	2± 10%

Figures to Subpart E of Part 53

Figure E-1.—Designation Testing Checklist

DESIGNATION TESTING CHECKLIST

Auditee _____ Auditor signature _____ Date _____

Compliance Status: Y = Yes N = No NA = Not applicable/Not available				
Verification			Verified by Direct Observation of Process or of Documented Evidence: Performance, Design or Application Spec. Corresponding to Sections of 40 CFR Part 53 or 40 CFR Part 50, Appendix L	Verification Comments (Includes documentation of who, what, where, when, why) (Doc. #, Rev. #, Rev. Date)
Y	N	NA		
			Performance Specification Tests Sample flow rate coefficient of variation (§ 53.53) (L 7.4.3)	
			Filter temperature control (sampling) (§ 53.57) (L 7.4.10)	
			Elapsed sample time accuracy (§ 53.54) (L 7.4.13)	
			Filter temperature control (post sampling) (§ 53.57) (L 7.4.10)	
			Application Specification Tests	
			Field Precision (§ 53.58) (L 5.1)	
			Meets all Appendix L requirements (part 53, subpart A, § 53.2(a)(3)) (part 53, subpart E, § 53.51(a),(d))	
			Filter Weighing (L-8)	
			Field Sampling Procedure (§ 53.30, .31, .34)	
			Design Specification Tests	
			Filter (L-6)	
			Range of Operational Conditions (L-7.4.7)	
The Following Requirements Apply Only to Class I Candidate Equivalent Methods				
			Aerosol Transport (§ 53.59)	

Figure E-2—Product Manufacturing Checklist

PRODUCT MANUFACTURING CHECKLIST

_____ _____ _____

Auditee | Auditor signature | Date

Compliance Status: Y = Yes N = No NA = Not applicable/Not available				
Verification			Verified by Direct Observation of Process or of Documented Evidence: Performance, Design or Application Spec. Corresponding to Sections of 40 CFR Part 53 or 40 CFR Part 50, Appendix L	Verification Comments (Includes documentation of who, what, where, when, why) (Doc. #, Rev. #, Rev. Date)
Y	N	NA		
			Performance Specification Tests	
			Assembled operational performance (Burn-in test) (§ 53.53)	
			Sample flow rate (§ 53.53) (L 7.4.1, L 7.4.2)	
			Sample flow rate regulation (§ 53.53) (L 7.4.3)	
			Flow rate and average flow rate measurement accuracy (§ 53.53) (L 7.4.5)	
			Ambient air temperature measurement accuracy (§ 53.55) (L 7.4.8)	
			Ambient barometric pressure measurement accuracy (§ 53.56) (L 7.4.9)	
			Sample flow rate cut-off (§ 53.53) (L 7.4.4)	
			Sampler leak check facility (§ 53.52) (L 7.4.6)	
			Application Specification Tests	
			Flow rate calibration transfer standard (L-9.2)	
			Operational /Instructional manual (L-7.4.18)	
			Design Specification Tests	
			Impactor (jet width) (§ 53.51(d)(1)) (L-7.3.4.1)	
			Surface finish (§ 53.51(d)(2)) (L-7.3.7)	

Appendix A to Subpart E of Part 53--References

(1) Quality systems--Model for quality assurance in design, development, production, installation and servicing, ISO 9001. July 1994. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(2) American National Standard--Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. ANSI/ASQC E4-1994. January 1995. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(3) Copies of section 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, EPA/600/R-94/038b, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

(4) Military standard specification (mil. spec.) 8625F, Type II, Class 1 as listed in Department of Defense Index of Specifications and Standards (DODISS), available from DODSSP-Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 1911-5094.

(5) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements. Revised March, 1995. EPA-600/R-94-038d. Available from U.S. EPA, ORD Publications Office, Center for Environmental Research Information (CERI), 26 West Martin Luther King Drive, Cincinnati, Ohio 45268-1072 (513-569-7562).

(6) Military standard specification (mil. spec.) 810-E as listed in Department of Defense Index of Specifications and Standards (DODISS), available from DODSSP-Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 1911-5094.

e. Subpart F is added to read as follows:

Subpart F—Procedures for Testing Performance Characteristics of Class II Equivalent Methods for $PM_{2.5}$

Sec.

53.60 General provisions.
53.61 Test conditions for $PM_{2.5}$ reference method equivalency.
53.62 Test procedure: Full wind tunnel test.
53.63 Test procedure: Wind tunnel inlet aspiration test.
53.64 Test procedure: Static fractionator test.
53.65 Test procedure: Loading test.
53.66 Test procedure: Volatility test.

Tables to Subpart F of Part 53

Table F-1—Performance Specifications for $PM_{2.5}$ Class II Equivalent Samplers
Table F-2—Particle Sizes and Wind Speeds for Full Wind Tunnel Test, Wind Tunnel Inlet Aspiration Test, and Static Chamber Test
Table F-3—Critical Parameters of Idealized Ambient Particle Size Distributions
Table F-4—Estimated Mass Concentration Measurement of $PM_{2.5}$ for Idealized Coarse Aerosol Size Distribution
Table F-5—Estimated Mass Concentration Measurement of $PM_{2.5}$ for Idealized ''Typical'' Coarse Aerosol Size Distribution
Table F-6 Estimated Mass Concentration Measurement of $PM_{2.5}$ for Idealized Fine Aerosol Size Distribution

Figures to Subpart F of Part 53

Figure F-1—Designation Testing Checklist

Appendix A to Subpart F of Part 53—References

Subpart F—Procedures for Testing Performance Characteristics of Class II Equivalent Methods for $PM_{2.5}$

§ 53.60 General provisions.

(a) This subpart sets forth the specific requirements that a $PM_{2.5}$ sampler associated with a candidate Class II equivalent method must meet to be designated as an equivalent method for $PM_{2.5}$. This subpart also sets forth the explicit test procedures that must be carried out and the test results, evidence, documentation, and other materials that must be provided to EPA to demonstrate that a sampler meets all specified requirements for designation as an equivalent method.

(b) A candidate method described in an application for a reference or equivalent method application submitted under § 53.4 shall be determined by the EPA to be a Class II candidate equivalent method on the basis of the definition of a Class II equivalent method given in § 53.1.

(c) Any sampler associated with a Class II candidate equivalent method (Class II sampler) must meet all requirements for reference method samplers and Class I equivalent method samplers specified in subpart E of this part, as appropriate. In addition, a Class II sampler must meet the additional requirements as specified in paragraph (d) of this section.

(d) Except as provided in paragraphs (d)(1), (2), and (3) of this section, all Class II samplers are subject to the additional tests and performance requirements specified in § 53.62 (full wind tunnel test), § 53.65 (loading test), and § 53.66 (volatility test). Alternative tests and performance requirements, as described in paragraphs (d)(1), (2), and (3) of this section, are optionally available for certain Class II samplers which meet the requirements for reference method or Class I samplers given in 40 CFR part 50, Appendix L, and in subpart E of this part, except for specific deviations of the inlet, fractionator, or filter.

(1) *Inlet deviation*. A sampler which has been determined to be a Class II sampler solely because the design or construction of its inlet deviates from the design or construction of the inlet specified in 40 CFR part 50, Appendix L, for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test), provided that it meets all requirements of § 53.63 (wind tunnel inlet aspiration test), § 53.65 (loading test), and § 53.66 (volatility test).

(2) *Fractionator deviation*. A sampler which has been determined to be a Class II sampler solely because the design or construction of its particle size fractionator deviates from the design or construction of the particle size fractionator specified in 40 CFR part 50, Appendix L for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test), provided that it meets all requirements of § 53.64 (static fractionator test), § 53.65 (loading test), and § 53.66 (volatility test).

(3) *Filter size deviation*. A sampler which has been determined to be a Class II sampler solely because its effective filtration area deviates from that of the reference method filter specified in 40 CFR part 50, Appendix L, for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test) nor § 53.65 (loading test), provided it meets all requirements of § 53.66 (volatility test).

(e) *The test specifications and acceptance criteria for each test are summarized in Table F-1 of this subpart*. The candidate sampler must demonstrate performance that meets the acceptance criteria for each applicable test to be designated as an equivalent method.

(f) *Overview of various test procedures for Class II samplers*—(1) *Full wind tunnel test*. This test procedure is designed to ensure that the candidate sampler's effectiveness (aspiration of an ambient aerosol and penetration of the sub 2.5-micron fraction to its sample filter) will be comparable to that of a reference method sampler. The candidate sampler is challenged at wind speeds of 2 and 24 km/hr with monodisperse aerosols of the size specified in Table F-2 of this subpart. The experimental test results are then integrated with three idealized ambient distributions (typical, fine, and coarse) to yield the expected mass concentration measurement for each. The acceptance criteria are based on the results of this numerical analysis and the particle diameter for which the sampler effectiveness is 50 percent.

(2) *Wind tunnel inlet aspiration test*. The wind tunnel inlet aspiration test directly compares the inlet of the candidate sampler to the inlet of a reference method sampler with the single-sized, liquid, monodisperse challenge aerosol specified in Table F-2 of this subpart at wind speeds of 2 km/hr and 24 km/hr. The acceptance criteria, presented in Table F-1 of this subpart, is based on the relative aspiration between the candidate inlet and the reference method inlet.

(3) *Static fractionator test*. The static fractionator test determines the effectiveness of the candidate sampler's 2.5-micron fractionator under static conditions for aerosols of the size specified in Table F-2 of this subpart. The numerical analysis procedures and acceptance criteria are identical to those in the full wind tunnel test.

(4) *Loading test*. The loading test is conducted to ensure that the performance of a candidate sampler is not significantly affected by the amount of particulate deposited on its interior surfaces between periodic cleanings. The candidate sampler is artificially loaded by sampling a test

environment containing aerosolized, standard test dust. The duration of the loading phase is dependent on both the time between cleaning as specified by the candidate method and the aerosol mass concentration in the test environment. After loading, the candidate's performance must then be evaluated by § 53.62 (full wind tunnel evaluation), § 53.64 (wind tunnel inlet aspiration test), or § 53.64 (static fractionator test). If the results of the appropriate test meet the criteria presented in Table F-1 of this subpart, then the candidate sampler passes the loading test under the condition that it be cleaned at least as often as the cleaning frequency proposed by the candidate method and that has been demonstrated to be acceptable by this test.

(5) *Volatility test*. The volatility test challenges the candidate sampler with a polydisperse, semi-volatile liquid aerosol. This aerosol is simultaneously sampled by the candidate method sampler and a reference method sampler for a specified time period. Clean air is then passed through the samplers during a blow-off time period. Residual mass is then calculated as the weight of the filter after the blow-off phase is subtracted from the initial weight of the filter. Acceptance criteria are based on a comparison of the residual mass measured by the candidate sampler (corrected for flow rate variations from that of the reference method) to the residual mass measured by the reference method sampler for several specified clean air sampling time periods.

(g) *Test data*. All test data and other documentation obtained from or pertinent to these tests shall be identified, dated, signed by the analyst performing the test, and submitted to EPA as part of the equivalent method application. Schematic drawings of each particle delivery system and other information showing complete procedural details of the test atmosphere generation, verification, and delivery techniques for each test performed shall be submitted to EPA. All pertinent calculations shall be clearly presented. In addition, manufacturers are required to submit as part of the application, a Designation Testing Checklist (Figure F-1 of this subpart) which has been completed and signed by an ISO-certified auditor.

§ 53.61 Test conditions for $PM_{2.5}$ reference method equivalency.

(a) *Sampler surface preparation*. Internal surfaces of the candidate sampler shall be cleaned and dried prior to performing any Class II sampler test in this subpart. The internal collection surfaces of the sampler shall then be prepared in strict accordance with the operating instructions specified in the sampler's operating manual referred to in section 7.4.18 of 40 CFR part 50, Appendix L.

(b) *Sampler setup*. Set up and start up of all test samplers shall be in strict accordance with the operating instructions specified in the manual referred to in section 7.4.18 of 40 CFR part 50, Appendix L, unless otherwise specified within this subpart.

(c) *Sampler adjustments*. Once the test sampler or samplers have been set up and the performance tests started, manual adjustment shall be permitted only between test points for all applicable tests. Manual adjustments and any periodic maintenance shall be limited to only those procedures prescribed in the manual referred to in section 7.4.18 of 40 CFR part 50, Appendix L. The submitted records shall clearly indicate when any manual adjustment or periodic maintenance was made and shall describe the operations performed.

(d) *Sampler malfunctions*. If a test sampler malfunctions during any of the applicable tests, that test run shall be repeated. A detailed explanation of all malfunctions and the remedial actions taken shall be submitted as part of the equivalent method application.

(e) *Particle concentration measurements*. All measurements of particle concentration must be made such that the relative error in measurement is less than 5.0 percent. Relative error is defined as (s × 100 percent)/(X), where s is the sample standard deviation of the particle concentration detector, X is the measured concentration, and the units of s and X are identical.

(f) *Operation of test measurement equipment*. All test measurement equipment shall be set up, calibrated, and maintained by qualified personnel according to the manufacturer's instructions. All appropriate calibration information and manuals for this equipment shall be kept on file.

(g) *Vibrating orifice aerosol generator conventions*. This section prescribes conventions regarding the use of the vibrating orifice aerosol generator (VOAG) for the size-selective performance tests outlined in §§ 53.62, 53.63, 53.64, and 53.65.

(1) *Particle aerodynamic diameter*. The VOAG produces near-monodisperse droplets through the controlled breakup of a liquid jet. When the liquid solution consists of a non-volatile solute dissolved in a volatile solvent, the droplets dry to form particles of near-monodisperse size.

(i) The physical diameter of a generated spherical particle can be calculated from the operating parameters of the VOAG as:

Equation 1

$$D_p = \left(\frac{6\ Q\ C_{vol}}{\pi\ f} \right)^{1/3}$$

where:
D_p = particle physical diameter, μm;
Q = liquid volumetric flow rate, μm^3/sec;
C_{vol} = volume concentration (particle volume produced per drop volume), dimensionless; and
f = frequency of applied vibrational signal, 1/sec.

(ii) A given particle's aerodynamic behavior is a function of its physical particle size, particle shape, and density. Aerodynamic diameter is defined as the diameter of a unit density (ρ_o = 1 g/m^3) sphere having the same settling velocity as the particle under consideration. For converting a spherical particle of known density to aerodynamic diameter, the governing relationship is:

Equation 2

$$D_{ae} = \frac{\sqrt{\rho_p}\sqrt{C_{D_p}}D_p}{\sqrt{\rho_o}\sqrt{C_{Dae}}}$$

where:
D_{ae} = particle aerodynamic diameter, μm;
ρ_p = particle density, g/cm^3;
ρ_o = aerodynamic particle density = 1 g/m^3;
C_{Dp} = Cunningham's slip correction factor for physical particle diameter, dimensionless; and
C_{Dae} = Cunningham's slip correction factor for aerodynamic particle diameter, dimensionless.

(iii) At room temperature and standard pressure, the Cunningham's slip correction factor is solely a function of particle diameter:

Equation 3

$$C_{Dae} = 1 + \frac{0.1659}{D_{ae}} + \frac{0.053}{D_{ae}}\ \exp\left(-8.33\ D_{ae}\right)$$

or

Equation 4

$$C_{D_p} = 1 + \frac{0.1659}{D_p} + \frac{0.053}{D_p}\ \exp\left(-8.33\ D_p\right)$$

(iv) Since the slip correction factor is itself a function of particle diameter, the aerodynamic diameter in Equation 2 of paragraph (g)(1)(ii) of this section cannot be solved directly but must be determined by iteration.

(2) *Solid particle generation*. (i) Solid particle tests performed in this subpart shall be conducted using particles composed of ammonium fluorescein. For use in the VOAG, liquid solutions of known volumetric concentration can be prepared by diluting fluorescein powder ($C_20H_{12}O_5$, FW = 332.31, CAS 2321-07-5) with aqueous ammonia. Guidelines for preparation of fluorescein solutions of the desired volume concentration (C_{vol}) are presented by Vanderpool and Rubow (1988) (Reference 2 in Appendix A of this subpart). For purposes of converting particle physical diameter to aerodynamic diameter, an ammonium fluorescein density of 1.35 g/cm^3 shall be used.

(ii) Mass deposits of ammonium fluorescein shall be extracted and analyzed using solutions of 0.01 N ammonium hydroxide.

(3) *Liquid particle generation*. (i) Tests prescribed in § 53.63 for inlet aspiration require the use of liquid particle tests composed of oleic acid tagged with uranine to enable subsequent fluorometric quantitation of collected aerosol mass deposits. Oleic acid ($C_{18}H_{34}O_2$, FW = 282.47, CAS 112-80-1) has a density of

0.8935 g/cm^3. Because the viscosity of oleic acid is relatively high, significant errors can occur when dispensing oleic acid using volumetric pipettes. For this reason, it is recommended that oleic acid solutions be prepared by quantifying dispensed oleic acid gravimetrically. The volume of oleic acid dispensed can then be calculated simply by dividing the dispensed mass by the oleic acid density.

(ii) Oleic acid solutions tagged with uranine shall be prepared as follows. A known mass of oleic acid shall first be diluted using absolute ethanol. The desired mass of the uranine tag should then be diluted in a separate container using absolute ethanol. Uranine ($C_{20}H_{10}O_5Na_2$, FW = 376.3, CAS 518-47-8) is the disodium salt of fluorescein and has a density of 1.53 g/cm^3. In preparing uranine tagged oleic acid particles, the uranine content shall not exceed 20 percent on a mass basis. Once both oleic acid and uranine solutions are properly prepared, they can then be combined and diluted to final volume using absolute ethanol.

(iii) Calculation of the physical diameter of the particles produced by the VOAG requires knowledge of the liquid solution's volume concentration (C_{vol}). Because uranine is essentially insoluble in oleic acid, the total particle volume is the sum of the oleic acid volume and the uranine volume. The volume concentration of the liquid solution shall be calculated as:

Equation 5

$$C_{vol} = \frac{V_u + V_{oleic}}{V_{sol}} = \frac{\left(M_u/\rho_u\right) + \left(M_{oleic}/\rho_{oleic}\right)}{V_{sol}}$$

where:
V_u = uranine volume, ml;
V_{oleic} = oleic acid volume, ml;
V_{sol} = total solution volume, ml;
M_u = uranine mass, g;
ρ_u = uranine density, g/cm^3;
M_{oleic} = oleic acid mass, g; and
ρ_{oleic} = oleic acid density, g/cm^3.

(iv) For purposes of converting the particles' physical diameter to aerodynamic diameter, the density of the generated particles shall be calculated as:

Equation 6

$$\rho_p = \frac{M_u + M_{oleic}}{\left(M_u/\rho_u\right) + \left(M_{oleic}/\rho_{oleic}\right)}$$

(v) Mass deposits of oleic acid shall be extracted and analyzed using solutions of 0.01 N sodium hydroxide.

§ 53.62 Test procedure: Full wind tunnel test.

(a) *Overview*. The full wind tunnel test evaluates the effectiveness of the candidate sampler at 2 km/hr and 24 km/hr for aerosols of the size specified in Table F-2 of this subpart (under the heading, ''Full Wind Tunnel Test''). For each wind speed, a smooth curve is fit to the effectiveness data and corrected for the presence of multiplets in the wind tunnel calibration aerosol. The cutpoint diameter (D_{p50}) at each wind speed is then determined from the corrected effectiveness curves. The two resultant penetration curves are then each numerically integrated with three idealized ambient particle size distributions to provide six estimates of measured mass concentration. Critical parameters for these idealized distributions are presented in Table F-3 of this subpart.

(b) *Technical definitions*. Effectiveness is the ratio (expressed as a percentage) of the mass concentration of particles of a specific size reaching the sampler filter or filters to the mass concentration of particles of the same size approaching the sampler.

(c) *Facilities and equipment required*—(1) *Wind tunnel*. The particle delivery system shall consist of a blower system and a wind tunnel having a test section of sufficiently large cross-sectional area such that the test sampler, or portion thereof, as installed in the test section for testing, blocks no more than 15 percent of the test section area. The wind tunnel blower system must be capable of maintaining uniform wind speeds at the 2 km/hr and 24 km/hr in the test section.

(2) *Aerosol generation system*. A vibrating orifice aerosol generator shall be used to produce monodisperse solid particles of ammonium fluorescein with equivalent aerodynamic diameters as specified in Table F-2 of this subpart. The geometric standard deviation for each particle size generated shall not exceed 1.1 (for primary particles) and the proportion of multiplets (doublets and triplets) in all test particle atmosphere shall not exceed 10 percent of the particle population. The aerodynamic particle diameter, as established by the operating parameters of the vibrating orifice aerosol generator, shall be within the tolerance specified in Table F-2 of this subpart.

(3) *Particle size verification equipment*. The size of the test particles shall be verified during this test by use of a suitable instrument (e.g., scanning electron microscope, optical particle sizer, time-of-flight apparatus). The instrument must be capable of measuring solid and liquid test particles with a size resolution of 0.1 μm or less. The accuracy of the particle size verification technique shall be 0.15 μm or better.

(4) *Wind speed measurement*. The wind speed in the wind tunnel shall be determined during the tests using an appropriate technique capable of a precision of 2 percent and an accuracy of 5 percent or better (e.g., hot-wire anemometry). For the wind speeds specified in Table F-2 of this subpart, the wind speed shall be measured at a minimum of 12 test points in a cross-sectional area of the test section of the wind tunnel. The mean wind speed in the test section must be within ± 10 percent of the value specified in Table F-2 of this subpart, and the variation at any test point in the test section may not exceed 10 percent of the measured mean.

(5) *Aerosol rake*. The cross-sectional uniformity of the particle concentration in the sampling zone of the test section shall be established during the tests using an array of isokinetic samplers, referred to as a rake. Not less than five evenly spaced isokinetic samplers shall be used to determine the particle concentration spatial uniformity in the sampling zone. The sampling zone shall be a rectangular area having a horizontal dimension not less than 1.2 times the width of the test sampler at its inlet opening and a vertical dimension not less than 25 centimeters.

(6) *Total aerosol isokinetic sampler*. After cross-sectional uniformity has been confirmed, a single isokinetic sampler may be used in place of the array of isokinetic samplers for the determination of particle mass concentration used in the calculation of sampling effectiveness of the test sampler in paragraph (d)(5) of this section. In this case, the array of isokinetic samplers must be used to demonstrate particle concentration uniformity prior to the replicate measurements of sampling effectiveness.

(7) *Fluorometer*. A fluorometer used for quantifying extracted aerosol mass deposits shall be set up, maintained, and calibrated according to the manufacturer's instructions. A series of calibration standards shall be prepared to encompass the minimum and maximum concentrations measured during size-selective tests. Prior to each calibration and measurement, the fluorometer shall be zeroed using an aliquot of the same solvent used for extracting aerosol mass deposits.

(8) *Sampler flow rate measurements*. All flow rate measurements used to calculate the test atmosphere concentrations and the test results must be accurate to within ± 2 percent, referenced to a NIST-traceable primary standard. Any necessary flow rate measurement corrections shall be clearly documented. All flow rate measurements shall be performed and reported in actual volumetric units.

(d) *Test procedures*—(1) *Establish and verify wind speed*. (i) Establish a wind speed specified in Table F-2 of this subpart.

(ii) Measure the wind speed at a minimum of 12 test points in a cross-sectional area of the test section of the wind tunnel using a device as described in paragraph (c)(4) of this section.

(iii) Verify that the mean wind speed in the test section of the wind tunnel during the tests is within 10 percent of the value specified in Table F-2 of this subpart. The wind speed measured at any test point in the test section shall not differ by more than 10 percent from the mean wind speed in the test section.

(2) *Generate aerosol*. (i) Generate particles of a size specified in Table F-2 of this subpart using a vibrating orifice aerosol generator.

(ii) Check for the presence of satellites and adjust the generator as necessary.

(iii) Calculate the physical particle size using the operating parameters of the vibrating orifice aerosol generator and record.

(iv) Determine the particle's aerodynamic diameter from the calculated physical diameter and the known density of the generated particle. The calculated aerodynamic diameter must be within the tolerance specified in Table F-2 of this subpart.

(3) *Introduce particles into the wind tunnel*. Introduce the generated particles into the wind tunnel and allow the particle concentration to stabilize.

(4) *Verify the quality of the test aerosol*. (i) Extract a representative sample of the aerosol from the sampling test zone and measure the size distribution of the collected particles using an appropriate sizing technique. If the measurement technique does not provide a direct measure of aerodynamic diameter, the geometric mean aerodynamic diameter of the challenge aerosol must be calculated using the known density of the particle and the measured mean physical diameter. The determined geometric mean aerodynamic diameter of the test aerosol must be within 0.15 μm of the aerodynamic diameter calculated from the operating parameters of the vibrating orifice aerosol generator. The geometric standard deviation of the primary particles must not exceed 1.1.

(ii) Determine the population of multiplets in the collected sample. The multiplet population of the particle test atmosphere must not exceed 10 percent of the total particle population.

(5) *Aerosol uniformity and concentration measurement*. (i) Install an array of five or more evenly spaced isokinetic samplers in the sampling zone (paragraph (c)(5) of this section). Collect particles on appropriate filters over a time period such that the relative error of the measured particle concentration is less than 5.0 percent.

(ii) Determine the quantity of material collected with each isokinetic sampler in the array using a calibrated fluorometer. Calculate and record the mass concentration for each isokinetic sampler as:

Equation 7

$$C_{iso(ij)} = \frac{M_{iso(ij)}}{Q_{(ij)} \times t_{(ij)}}$$

where:
i = replicate number;
j = isokinetic sampler number;
M_{iso} = mass of material collected with the isokinetic sampler;
Q = isokinetic sampler volumetric flow rate; and
t = sampling time.

(iii) Calculate and record the mean mass concentration as:

Equation 8

$$\overline{C}_{iso(i)} = \frac{\sum_{j=1}^{n} C_{iso(ij)}}{n}$$

where:
i = replicate number;
j = isokinetic sampler number; and
n = total number of isokinetic samplers.

(iv) Precision calculation. (A) Calculate the coefficient of variation of the mass concentration measurements as:

Equation 9

$$CV_{iso(i)} = \frac{\sqrt{\sum_{j=1}^{n} C_{iso(ij)}^2 - \frac{1}{n}\left(\sum_{j=1}^{n} C_{iso(ij)}\right)^2}}{n-1} / \overline{C}_{iso(i)} \times 100\%$$

where:
i = replicate number;
j = isokinetic sampler number; and
n = total number of isokinetic samplers.

(B) If the value of $CV_{iso(i)}$ for any replicate exceeds 10 percent, the particle concentration uniformity is unacceptable and step 5 must be repeated. If adjustment of the vibrating orifice aerosol generator or changes in the particle delivery system are necessary to achieve uniformity, steps 1 through 5 must be repeated. When an acceptable aerosol spatial uniformity is achieved, remove the array of isokinetic samplers from the wind tunnel.

(6) *Alternative measure of wind tunnel total concentration*. If a single isokinetic sampler is used to determine the mean aerosol concentration in the wind tunnel, install the sampler in the wind tunnel with the sampler nozzle centered in the sampling zone (paragraph (c)(6) of this section).

(i) Collect particles on an appropriate filter over a time period such that the relative error of the measured concentration is less than 5.0 percent.

(ii) Determine the quantity of material collected with the isokinetic sampler using a calibrated fluorometer.

(iii) Calculate and record the mass concentration as $C_{iso(i)}$ as in paragraph (d)(5)(ii) of this section.

(iv) Remove the isokinetic sampler from the wind tunnel.

(7) *Measure the aerosol with the candidate sampler*. (i) Install the test sampler (or portion thereof) in the wind tunnel with the sampler inlet opening centered in the sampling zone. To meet the maximum blockage limit of paragraph (c)(1) of this section or for convenience, part of the test sampler may be positioned external to the wind tunnel provided that neither the geometry of the sampler nor the length of any connecting tube or pipe is altered. Collect particles for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(ii) Remove the test sampler from the wind tunnel.

(iii) Determine the quantity of material collected with the test sampler using a calibrated fluorometer. Calculate and record the mass concentration for each replicate as:

Equation 10

$$C_{cand(i)} = \frac{M_{cand(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{cand} = mass of material collected with the candidate sampler;
Q = candidate sampler volumetric flow rate; and
t = sampling time.

(iv)(A) Calculate and record the sampling effectiveness of the candidate sampler as:

Equation 11

$$E_{(i)} = \frac{C_{cand(i)}}{\overline{C}_{iso(i)}} \times 100\%$$

where:
i = replicate number.

(B) If a single isokinetic sampler is used for the determination of particle mass concentration, replace $C_{iso(i)}$ with C_{iso}.

(8) *Replicate measurements and calculation of mean sampling effectiveness*. (i) Repeat steps in paragraphs (d)(5) through (d)(7) of this section, as appropriate, to obtain a minimum of three valid replicate measurements of sampling effectiveness.

(ii) Calculate and record the average sampling effectiveness of the test sampler for the particle size as:

Equation 12

$$\overline{E} = \frac{\sum_{i=1}^{n} E_{(i)}}{n}$$

where:
i = replicate number; and

n = number of replicates.

(iii) Sampling effectiveness precision. (A) Calculate and record the coefficient of variation for the replicate sampling effectiveness measurements of the test sampler as:

Equation 13

$$CV_E = \frac{\sqrt{\sum_{i=1}^{n} E_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} E_{(i)}\right)^2}}{n-1} \frac{1}{\overline{E}} \times 100\%$$

where:
i = replicate number, and
n = number of replicates.

(B) If the value of CV_E exceeds 10 percent, the test run (steps in paragraphs (d)(2) through (d)(8) of this section) must be repeated until an acceptable value is obtained.

(9) Repeat steps in paragraphs (d)(2) through (d)(8) of this section until the sampling effectiveness has been measured for all particle sizes specified in Table F-2 of this subpart.

(10) Repeat steps in paragraphs (d)(1) through (d)(9) of this section until tests have been successfully conducted for both wind speeds of 2 km/hr and 24 km/hr.

(e) *Calculations*—(1) *Graphical treatment of effectiveness data*. For each wind speed given in Table F-2 of this subpart, plot the particle average sampling effectiveness of the candidate sampler as a function of aerodynamic particle diameter (D_{ae}) on semi-logarithmic graph paper where the aerodynamic particle diameter is the particle size established by the parameters of the VOAG in conjunction with the known particle density. Construct a best-fit, smooth curve through the data by extrapolating the sampling effectiveness curve through 100 percent at an aerodynamic particle size of 0.5 μm and 0 percent at an aerodynamic particle size of 10 μm. Correction for the presence of multiplets shall be performed using the techniques presented by Marple, et al (1987). This multiplet-corrected effectiveness curve shall be used for all remaining calculations in this paragraph (e).

(2) *Cutpoint determination*. For each wind speed determine the sampler Dp_{50} cutpoint defined as the aerodynamic particle size corresponding to 50 percent effectiveness from the multiplet corrected smooth curve.

(3) *Expected mass concentration calculation*. For each wind speed, calculate the estimated mass concentration measurement for the test sampler under each particle size distribution (Tables F-4, F-5, and F-6 of this subpart) and compare it to the mass concentration predicted for the reference sampler as follows:

(i) Determine the value of corrected effectiveness using the best-fit, multiplet-corrected curve at each of the particle sizes specified in the first column of Table F-4 of this subpart. Record each corrected effectiveness value as a decimal between 0 and 1 in column 2 of Table F-4 of this subpart.

(ii) Calculate the interval estimated mass concentration measurement by multiplying the values of corrected effectiveness in column 2 by the interval mass concentration values in column 3 and enter the products in column 4 of Table F-4 of this subpart.

(iii) Calculate the estimated mass concentration measurement by summing the values in column 4 and entering the total as the estimated mass concentration measurement for the test sampler at the bottom of column 4 of Table F-4 of this subpart.

(iv) Calculate the estimated mass concentration ratio between the candidate method and the reference method as:

Equation 14

$$R_c = \frac{C_{cand(est)}}{C_{ref(est)}} \times 100\%$$

where:
$C_{cand(est)}$ = estimated mass concentration measurement for the test sampler, μg/m³; and
$C_{ref(est)}$ = estimated mass concentration measurement for the reference sampler, μg/m³ (calculated for the reference sampler and specified at the bottom of column 7 of Table F-4 of this subpart).

(v) Repeat steps in paragraphs (e) (1) through (e)(3) of this section for Tables F-5 and F-6 of this subpart.

(f) *Evaluation of test results*. The candidate method passes the wind tunnel effectiveness test if the R_c value for each wind speed meets the specification in Table F-1 of this subpart for each of the three particle size distributions.

§ 53.63 Test procedure: Wind tunnel inlet aspiration test.

(a) *Overview*. This test applies to a candidate sampler which differs from the reference method sampler only with respect to the design of the inlet. The purpose of this test is to ensure that the aspiration of a Class II candidate sampler is such that it representatively extracts an ambient aerosol at elevated wind speeds. This wind tunnel test uses a single-sized, liquid aerosol in conjunction with wind speeds of 2 km/hr and 24 km/hr. The test atmosphere concentration is alternately measured with the candidate sampler and a reference method device, both of which are operated without the 2.5-micron fractionation device installed. The test conditions are summarized in Table F-2 of this subpart (under the heading of ''wind tunnel inlet aspiration test''). The candidate sampler must meet or exceed the acceptance criteria given in Table F-1 of this subpart.

(b) *Technical definition*. Relative aspiration is the ratio (expressed as a percentage) of the aerosol mass concentration measured by the candidate sampler to that measured by a reference method sampler.

(c) *Facilities and equipment required*. The facilities and equipment are identical to those required for the full wind tunnel test (§ 53.62(c)).

(d) *Setup*. The candidate and reference method samplers shall be operated with the $PM_{2.5}$ fractionation device removed from the flow path throughout this entire test procedure. Modifications to accommodate this requirement shall be limited to removal of the fractionator and insertion of the filter holder directly into the downtube of the inlet.

(e) *Test procedure*—(1) *Establish the wind tunnel test atmosphere*. Follow the procedures in § 53.62(d)(1) through (d)(4) to establish a test atmosphere for one of the two wind speeds specified in Table F-2 of this subpart.

(2) *Measure the aerosol concentration with the reference sampler*. (i) Install the reference sampler (or portion thereof) in the wind tunnel with the sampler inlet opening centered in the sampling zone. To meet the maximum blockage limit of § 53.62(c)(1) or for convenience, part of the test sampler may be positioned external to the wind tunnel provided that neither the geometry of the sampler nor the length of any connecting tube or pipe is altered. Collect particles for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(ii) Determine the quantity of material collected with the reference method sampler using a calibrated fluorometer. Calculate and record the mass concentration as:

Equation 15

$$C_{ref(i)} = \frac{M_{ref(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{ref} = mass of material collected with the reference method sampler;
Q = reference method sampler volumetric flow rate; and
t = sampling time.

(iii) Remove the reference method sampler from the tunnel.

(3) *Measure the aerosol concentration with the candidate sampler*. (i) Install the candidate sampler (or portion thereof) in the wind tunnel with the sampler inlet centered in the sampling zone. To meet the maximum blockage limit of § 53.62(c)(1) or for convenience, part of the test sampler may be positioned external to the wind tunnel provided that neither the geometry of the sampler nor the length of any connecting tube or pipe is altered. Collect particles for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(ii) Determine the quantity of material collected with the candidate sampler using a calibrated fluorometer. Calculate and record the mass concentration as:

Equation 16

$$C_{cand(i)} = \frac{M_{cand(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{cand} = mass of material collected with the candidate sampler;
Q = candidate sampler volumetric flow rate; and
t = sampling time.

(iii) Remove the candidate sampler from the wind tunnel.

(4) Repeat steps in paragraphs (d) (2) and (d)(3) of this section. Alternately measure the tunnel concentration with the reference sampler and the candidate sampler until four reference sampler and three candidate sampler measurements of the wind tunnel concentration are obtained.

(5) *Calculations*. (i) Calculate and record aspiration ratio for each candidate sampler run as:

Equation 17

$$A_{(i)} = \frac{C_{cand(i)}}{\left(C_{ref(i)} + C_{ref(i+1)}\right) \times \frac{1}{2}}$$

where:
i = replicate number.

(ii) Calculate and record the mean aspiration ratio as:

Equation 18

$$\overline{A} = \frac{\sum_{i=1}^{n} A_{(i)}}{n}$$

where:
i = replicate number; and
n = total number of measurements of aspiration ratio.

(iii) Precision of the aspiration ratio. (A) Calculate and record the precision of the aspiration ratio measurements as the coefficient of variation as:

Equation 19

$$CV_A = \frac{\sqrt{\sum_{i=1}^{n} A_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} A_{(i)}\right)^2}}{n-1} / \overline{A}_{(i)} \times 100\%$$

where:
i = replicate number; and
n = total number of measurements of aspiration ratio.

(B) If the value of CV_A exceeds 10 percent, the entire test procedure must be repeated.

(f) *Evaluation of test results*. The candidate method passes the inlet aspiration test if all values of A meet the acceptance criteria specified in Table F-1 of this subpart.

§ 53.64 Test procedure: Static fractionator test.

(a) *Overview*. This test applies only to those candidate methods in which the sole deviation from the reference method is in the design of the 2.5-micron fractionation device. The purpose of this test is to ensure that the fractionation characteristics of the candidate fractionator are acceptably similar to that of the reference method sampler. It is recognized that various methodologies exist for quantifying fractionator effectiveness. The following commonly-employed techniques are provided for purposes of guidance. Other methodologies for determining sampler effectiveness may be used contingent upon prior approval by the Agency.

(1) *Wash-off method*. Effectiveness is determined by measuring the aerosol mass deposited on the candidate sampler's after filter versus the aerosol mass deposited in the fractionator. The material deposited in the fractionator is recovered by washing its internal surfaces. For these wash-off tests, a fluorometer must be used to quantitate the aerosol concentration. Note that if this technique is chosen, the candidate must be reloaded with coarse aerosol prior to each test point when reevaluating the curve as specified in the loading test.

(2) *Static chamber method*. Effectiveness is determined by measuring the aerosol mass concentration sampled by the candidate sampler's after filter versus that which exists in a static chamber. A calibrated fluorometer shall be used to quantify the collected aerosol deposits. The aerosol concentration is calculated as the measured aerosol mass divided by the sampled air volume.

(3) *Divided flow method*. Effectiveness is determined by comparing the aerosol concentration upstream of the candidate sampler's fractionator versus that concentration which exists downstream of the candidate fractionator. These tests may utilize either fluorometry or a real-time aerosol measuring device to determine the aerosol concentration.

(b) *Technical definition*. Effectiveness under static conditions is the ratio (expressed as a percentage) of the mass concentration of particles of a given size reaching the sampler filter to the mass concentration of particles of the same size existing in the test atmosphere.

(c) *Facilities and equipment required*—(1) *Aerosol generation*. Methods for generating aerosols shall be identical to those prescribed in § 53.62(c)(2).

(2) *Particle delivery system*. Acceptable apparatus for delivering the generated aerosols to the candidate fractionator is dependent on the effectiveness measurement methodology and shall be defined as follows:

(i) *Wash-off test apparatus*. The aerosol may be delivered to the candidate fractionator through direct piping (with or without an in-line mixing chamber). Validation particle size and quality shall be conducted at a point directly upstream of the fractionator.

(ii) *Static chamber test apparatus*. The aerosol shall be introduced into a chamber and sufficiently mixed such that the aerosol concentration within the chamber is spatially uniform. The chamber must be of sufficient size to house at least four total filter samplers in addition to the inlet of the candidate method size fractionator. Validation of particle size and quality shall be conducted on representative aerosol samples extracted from the chamber.

(iii) *Divided flow test apparatus*. The apparatus shall allow the aerosol concentration to be measured upstream and downstream of the fractionator. The aerosol shall be delivered to a manifold with two symmetrical branching legs. One of the legs, referred to as the bypass leg, shall allow the challenge aerosol to pass unfractionated to the detector. The other leg shall accommodate the fractionation device.

(3) *Particle concentration measurement*—(i) *Fluorometry*. Refer to § 53.62(c)(7).

(ii) *Number concentration measurement*. A number counting particle sizer may be used in conjunction with the divided flow test apparatus in lieu of fluorometric measurement. This device must have a minimum range of 1 to 10 μm, a resolution of 0.1 μm, and an accuracy of 0.15 μm such that primary particles may be distinguished from multiplets for all test aerosols. The measurement of number concentration shall be accomplished by integrating the primary particle peak.

(d) *Setup*—(1) *Remove the inlet and downtube from the candidate fractionator*. All tests procedures shall be conducted with the inlet and downtube removed from the candidate sampler.

(2) *Surface treatment of the fractionator*. Rinsing aluminum surfaces with alkaline solutions has been found to adversely affect subsequent fluorometric quantitation of aerosol mass deposits. If wash-off tests are to be used for quantifying aerosol penetration, internal surfaces of the fractionator must first be plated with electroless nickel. Specifications for this plating are specified in Society of Automotive Engineers Aerospace Material Specification (SAE AMS) 2404C, Electroless Nickel Plating (Reference 3 in Appendix A of Subpart F).

(e) *Test procedure: Wash-off method*—(1) *Clean the candidate sampler*. Note: The procedures in this step may be omitted if this test is being used to evaluate the fractionator after being loaded as specified in § 53.65.

(i) Clean and dry the internal surfaces of the candidate sampler.

(ii) Prepare the internal fractionator surfaces in strict accordance with the operating instructions specified in the sampler's operating manual referred to in section 7.4.18 of 40 CFR part 50, Appendix L.

(2) *Generate aerosol*. Follow the procedures for aerosol generation prescribed in § 53.62(d)(2).

(3) *Verify the quality of the test aerosol*. Follow the procedures for verification of test aerosol size and quality prescribed in § 53.62(d)(4).

(4) *Determine effectiveness for the particle size being produced*. (i) Collect particles downstream of the fractionator on an appropriate filter over a time period such that the relative error of the fluorometric measurement is less than 5.0 percent.

(ii) Determine the quantity of material collected on the after filter of the candidate method using a calibrated fluorometer. Calculate and record the aerosol mass concentration for the sampler filter as:

Equation 20

$$C_{cand(i)} = \frac{M_{cand(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{cand} = mass of material collected with the candidate sampler;
Q = candidate sampler volumetric flowrate; and
t = sampling time.

(iii) Wash all interior surfaces upstream of the filter and determine the quantity of material collected using a calibrated fluorometer. Calculate and record the fluorometric mass concentration of the sampler wash as:

Equation 21

$$C_{wash(i)} = \frac{M_{wash(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{wash} = mass of material washed from the interior surfaces of the fractionator;
Q = candidate sampler volumetric flowrate; and
t = sampling time.

(iv) Calculate and record the sampling effectiveness of the test sampler for this particle size as:

Equation 22

$$E_{(i)} = \frac{C_{wash(i)}}{C_{cand(i)} + C_{wash(i)}} \times 100\%$$

where:
i = replicate number.

(v) Repeat steps in paragraphs (e)(4) of this section, as appropriate, to obtain a minimum of three replicate measurements of sampling effectiveness. Note: The procedures for loading the candidate in § 53.65 must be repeated between repetitions if this test is being used to evaluate the fractionator after being loaded as specified in § 53.65.

(vi) Calculate and record the average sampling effectiveness of the test sampler as:

Equation 23

$$\overline{E} = \frac{\sum_{i=1}^{n} E_{(i)}}{n}$$

where:
i = replicate number; and
n = number of replicates.

(vii)(A) Calculate and record the coefficient of variation for the replicate sampling effectiveness measurements of the test sampler as:

Equation 24

$$CV_E = \frac{\sqrt{\sum_{i=1}^{n} E_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} E_{(i)}\right)^2}}{n-1} \times \frac{1}{\overline{E}} \times 100\%$$

where:
i = replicate number; and
n = total number of measurements.

(B) If the value of CV_E exceeds 10 percent, then steps in paragraphs (e) (2) through (e)(4) of this section must be repeated.

(5) Repeat steps in paragraphs (e) (1) through (e)(4) of this section for each particle size specified in Table F-2 of this subpart.

(f) *Test procedure: Static chamber method*—(1) *Generate aerosol*. Follow the procedures for aerosol generation prescribed in § 53.62(d)(2).

(2) *Verify the quality of the test aerosol*. Follow the procedures for verification of test aerosol size and quality prescribed in § 53.62(d)(4).

(3) *Introduce particles into chamber*. Introduce the particles into the static chamber and allow the particle concentration to stabilize.

(4) *Install and operate the candidate sampler's fractionator and its after-filter and at least four total filters*. (i) Install the fractionator and an array of four or more equally spaced total filter samplers such that the total filters surround and are in the same plane as the inlet of the fractionator.

(ii) Simultaneously collect particles onto appropriate filters with the total filter samplers and the fractionator for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(5) *Calculate the aerosol spatial uniformity in the chamber*. (i) Determine the quantity of material collected with each total filter sampler in the array using a calibrated fluorometer. Calculate and record the mass concentration for each total filter sampler as:

Equation 25

$$C_{total(ij)} = \frac{M_{total(ij)}}{Q_{(ij)} \times t_{(ij)}}$$

where:
i = replicate number;
j = total filter sampler number;
M_{total} = mass of material collected with the total filter sampler;
Q = total filter sampler volumetric flowrate; and
t = sample time.

(ii) Calculate and record the mean mass concentration as:

Equation 26

$$\overline{C}_{total(i)} = \frac{\sum_{j=1}^{n} C_{total(ij)}}{n}$$

where:
n = total number of samplers;
i = replicate number; and
j = filter sampler number.

(iii) (A) Calculate and record the coefficient of variation of the total mass concentration as:

Equation 27

$$CV_{total} = \frac{\sqrt{\sum_{j=1}^{n} C_{total(ij)}^2 - \frac{1}{n}\left(\sum_{j=1}^{n} C_{total(ij)}\right)^2}}{n-1} \times \frac{1}{\overline{C}_{total(i)}} \times 100\%$$

where:
i = replicate number;
j = total filter sampler number; and
n = number of total filter samplers.

(B) If the value of CV_{total} exceeds 10 percent, then the particle concentration uniformity is unacceptable, alterations to the static chamber test apparatus must be made, and steps in paragraphs (f)(1) through (f)(5) of this section must be repeated.

(6) *Determine the effectiveness of the candidate sampler*. (i) Determine the quantity of material collected on the candidate sampler's after filter using a calibrated fluorometer. Calculate and record the mass concentration for the candidate sampler as:

Equation 28

$$C_{cand(i)} = \frac{M_{cand(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number;
M_{cand} = mass of material collected with the candidate sampler;
Q = candidate sampler volumetric flowrate; and
t = sample time.

(ii) Calculate and record the sampling effectiveness of the candidate sampler as:

Equation 29

$$E_{(i)} = \frac{C_{cand(i)}}{\overline{C}_{total(i)}} \times 100\%$$

where:
i = replicate number.

(iii) Repeat step in paragraph (f)(4) through (f)(6) of this section, as appropriate, to obtain a minimum of three replicate measurements of sampling effectiveness.

(iv) Calculate and record the average sampling effectiveness of the test sampler as:

Equation 30

$$\overline{E} = \frac{\sum_{i=1}^{n} E_{(i)}}{n}$$

where:
i= replicate number.

(v)(A) Calculate and record the coefficient of variation for the replicate sampling effectiveness measurements of the test sampler as:

Equation 31

$$CV_E = \frac{\sqrt{\sum_{i=1}^{n} E_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} E_{(i)}\right)^2}}{n-1} \times \frac{1}{\overline{E}} \times 100\%$$

where:
i = replicate number; and
n = number of measurements of effectiveness.

(B) If the value of CV_E exceeds 10 percent, then the test run (steps in paragraphs (f)(2) through (f)(6) of this section) is unacceptable and must be repeated.

(7) Repeat steps in paragraphs (f)(1) through (f)(6) of this section for each particle size specified in Table F-2 of this subpart.

(g) *Test procedure: Divided flow method*—(1) *Generate calibration aerosol*. Follow the procedures for aerosol generation prescribed in § 53.62(d)(2).

(2) *Verify the quality of the calibration aerosol*. Follow the procedures for verification of calibration aerosol size and quality prescribed in § 53.62(d)(4).

(3) *Introduce aerosol*. Introduce the calibration aerosol into the static chamber and allow the particle concentration to stabilize.

(4) *Validate that transport is equal for the divided flow option*. (i) With fluorometry as a detector:

(A) Install a total filter on each leg of the divided flow apparatus.

(B) Collect particles simultaneously through both legs at 16.7 L/min onto an appropriate filter for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(C) Determine the quantity of material collected on each filter using a calibrated fluorometer. Calculate and record the mass concentration measured in each leg as:

Equation 32

$$C_{(i)} = \frac{M_{(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number,
M = mass of material collected with the total filter; and
Q = candidate sampler volumetric flowrate.

(D) Repeat steps in paragraphs (g)(4)(i)(A) through (g)(4)(i)(C) of this section until a minimum of three replicate measurements are performed.

(ii) With a number counting device such as an aerosol detector:

(A) Remove all flow obstructions from the flow paths of the two legs.

(B) Quantify the aerosol concentration of the primary particles in each leg of the apparatus.

(C) Repeat steps in paragraphs (g)(4)(ii)(A) through (g)(4)(ii)(B) of this section until a minimum of three replicate measurements are performed.

(iii) (A) Calculate the mean concentration and coefficient of variation as:

Equation 33

$$\overline{C} = \frac{\sum_{i=1}^{n} C_{(i)}}{n}$$

Equation 34

$$CV = \frac{\sqrt{\sum_{i=1}^{n} C_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} C_{(i)}\right)^2}}{n-1} \times \frac{1}{\overline{C}} \times 100\%$$

where:
i = replicate number; and
n = number of replicates.

(B) If the measured mean concentrations through the two legs do not agree within 5 percent, then adjustments may be made in the setup, and this step must be repeated.

(5) *Determine effectiveness*. Determine the sampling effectiveness of the test sampler with the inlet removed by one of the following procedures:

(i) With fluorometry as a detector:

(A) Prepare the divided flow apparatus for particle collection. Install a total filter into the bypass leg of the divided flow apparatus. Install the particle size fractionator with a total filter placed immediately downstream of it into the other leg.

(B) Collect particles simultaneously through both legs at 16.7 L/min onto appropriate filters for a time period such that the relative error of the measured concentration is less than 5.0 percent.

(C) Determine the quantity of material collected on each filter using a calibrated fluorometer. Calculate and record the mass concentration measured by the total filter and that measured after penetrating through the candidate fractionator as follows:

Equation 35

$$C_{total_{(i)}} = \frac{M_{total(i)}}{Q_{(i)} \times t_{(i)}}$$

Equation 36

$$C_{cand_{(i)}} = \frac{M_{cand(i)}}{Q_{(i)} \times t_{(i)}}$$

where:
i = replicate number.

(ii) With a number counting device as a detector:

(A) Install the particle size fractionator into one of the legs of the divided flow apparatus.

(B) Quantify and record the aerosol number concentration of the primary particles passing through the fractionator as $C_{cand(i)}$.

(C) Divert the flow from the leg containing the candidate fractionator to the bypass leg. Allow sufficient time for the aerosol concentration to stabilize.

(D) Quantify and record the aerosol number concentration of the primary particles passing through the bypass leg as $C_{total(i)}$.

(iii) Calculate and record sampling effectiveness of the candidate sampler as:

Equation 37

$$E_{(i)} = \frac{C_{cand(i)}}{\overline{C}_{total(i)}} \times 100\%$$

where:
i = replicate number.

(6) Repeat step in paragraph (g)(5) of this section, as appropriate, to obtain a minimum of three replicate measurements of sampling effectiveness.

(7) *Calculate the mean and coefficient of variation for replicate measurements of effectiveness*. (i) Calculate and record the mean sampling effectiveness of the candidate sampler as:

Equation 38

$$\overline{E} = \frac{\sum_{i=1}^{n} E_{(i)}}{n}$$

where:

i = replicate number.

(ii)(A) Calculate and record the coefficient of variation for the replicate sampling effectiveness measurements of the candidate sampler as:

Equation 39

$$CV_E = \frac{\sqrt{\sum_{i=1}^{n} E_{(i)}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} E_{(i)}\right)^2}}{n-1} \times \frac{1}{\overline{E}} \times 100\%$$

where:
i = replicate number; and
n = number of replicates.

(B) If the coefficient of variation is not less than 10 percent, then the test run must be repeated (steps in paragraphs (g)(1) through (g)(7) of this section).

(8) Repeat steps in paragraphs (g)(1) through (g)(7) of this section for each particle size specified in Table F-2 of this subpart.

(h) *Calculations*—(1) *Treatment of multiplets*. For all measurements made by fluorometric analysis, data shall be corrected for the presence of multiplets as described in § 53.62(f)(1). Data collected using a real-time device (as described in paragraph (c)(3)(ii)) of this section will not require multiplet correction.

(2) *Cutpoint determination*. For each wind speed determine the sampler Dp_{50} cutpoint defined as the aerodynamic particle size corresponding to 50 percent effectiveness from the multiplet corrected smooth curve.

(3) *Graphical analysis and numerical integration with ambient distributions*. Follow the steps outlined in § 53.62(e)(3) through (e)(4) to calculate the estimated concentration measurement ratio between the candidate sampler and a reference method sampler.

(i) *Test evaluation*. The candidate method passes the static fractionator test if the values of Rc and Dp_{50} for each distribution meets the specifications in Table F-1 of this subpart.

§ 53.65 Test procedure: Loading test.

(a) *Overview*. (1) The loading tests are designed to quantify any appreciable changes in a candidate method sampler's performance as a function of coarse aerosol collection. The candidate sampler is exposed to a mass of coarse aerosol equivalent to sampling a mass concentration of 150 μg/m³ over the time period that the manufacturer has specified between periodic cleaning. After loading, the candidate sampler is then evaluated by performing the test in § 53.62 (full wind tunnel test), § 53.63 (wind tunnel inlet aspiration test), or § 53.64 (static fractionator test). If the acceptance criteria are met for this evaluation test, then the candidate sampler is approved for multi-day sampling with the periodic maintenance schedule as specified by the candidate method. For example, if the candidate sampler passes the reevaluation tests following loading with an aerosol mass equivalent to sampling a 150 μg/m³ aerosol continuously for 7 days, then the sampler is approved for 7 day field operation before cleaning is required.

(b) *Technical definition*. Effectiveness after loading is the ratio (expressed as a percentage) of the mass concentration of particles of a given size reaching the sampler filter to the mass concentration of particles of the same size approaching the sampler.

(c) *Facilities and equipment required*—(1) *Particle delivery system*. The particle delivery system shall consist of a static chamber or a low velocity wind tunnel having a sufficiently large cross-sectional area such that the test sampler, or portion thereof, may be installed in the test section. At a minimum, the system must have a sufficiently large cross section to house the candidate sampler inlet as well as a collocated isokinetic nozzle for measuring total aerosol concentration. The mean velocity in the test section of the static chamber or wind tunnel shall not exceed 2 km/hr.

(2) *Aerosol generation equipment*. For purposes of these tests, the test aerosol shall be produced from commercially available, bulk Arizona road dust. To provide direct interlaboratory comparability of sampler loading characteristics, the bulk dust is specified as 0-10 μm ATD available from Powder Technology Incorporated (Burnsville, MN). A fluidized bed aerosol generator, Wright dust feeder, or sonic nozzle shall be used to efficiently deagglomerate the bulk test dust and transform it into an aerosol cloud. Other dust generators may be used contingent upon prior approval by the Agency.

(3) *Isokinetic sampler*. Mean aerosol concentration within the static chamber or wind tunnel shall be established using a single isokinetic sampler containing a preweighed high-efficiency total filter.

(4) *Analytic balance*. An analytical balance shall be used to determine the weight of the total filter in the isokinetic sampler. The precision and accuracy of this device shall be such that the relative measurement error is less than 5.0 percent for the difference between the initial and final weight of the total filter. The identical analytic balance shall be used to perform both initial and final weighing of the total filter.

(d) *Test procedure*. (1) Calculate and record the target time weighted concentration of Arizona road dust which is equivalent to exposing the sampler to an environment of 150 μg/m³ over the time between cleaning specified by the candidate sampler's operations manual as:

Equation 40

$$\text{Target TWC} = 150\,\mu g/m^3 \times t$$

where:
t = the number of hours specified by the candidate method prior to periodic cleaning.

(2) Clean the candidate sampler. (i) Clean and dry the internal surfaces of the candidate sampler.

(ii) Prepare the internal surfaces in strict accordance with the operating manual referred to in section 7.4.18 of 40 CFR part 50, Appendix L.

(3) Determine the preweight of the filter that shall be used in the isokinetic sampler. Record this value as InitWt.

(4) Install the candidate sampler's inlet and the isokinetic sampler within the test chamber or wind tunnel.

(5) Generate a dust cloud. (i) Generate a dust cloud composed of Arizona test dust.

(ii) Introduce the dust cloud into the chamber.

(iii) Allow sufficient time for the particle concentration to become steady within the chamber.

(6) Sample aerosol with a total filter and the candidate sampler. (i) Sample the aerosol for a time sufficient to produce an equivalent TWC equal to that of the target TWC ± 15 percent.

(ii) Record the sampling time as t.

(7) Determine the time weighted concentration. (i) Determine the postweight of the isokinetic sampler's total filter.

(ii) Record this value as FinalWt.

(iii) Calculate and record the TWC as:

Equation 41

$$TWC = \frac{(FinalWt - InitWt) \times t}{Q}$$

where:
Q = the flow rate of the candidate method.

(iv) If the value of TWC deviates from the target TWC ± 15 percent, then the loaded mass is unacceptable and the entire test procedure must be repeated.

(8) Determine the candidate sampler's effectiveness after loading. The candidate sampler's effectiveness as a function of particle aerodynamic diameter must then be evaluated by performing the test in § 53.62 (full wind tunnel test). A sampler which fits the category of inlet deviation in § 53.60(e)(1) may opt to perform the test in § 53.63 (inlet aspiration test) in lieu of the full wind tunnel test. A sampler which fits the category of fractionator deviation in § 53.60(e)(2) may opt to perform the test in § 53.64 (static fractionator test) in lieu of the full wind tunnel test.

(e) *Test results*. If the candidate sampler meets the acceptance criteria for the evaluation test performed in paragraph (d)(8) of this section, then the candidate sampler passes this test with the stipulation that the sampling train be cleaned as directed by and as frequently as that specified by the candidate sampler's operations manual.

§ 53.66 Test procedure: Volatility test.

(a) *Overview*. This test is designed to ensure that the candidate method's losses due to volatility when sampling semi-volatile ambient aerosol will be comparable to that of a federal reference method sampler. This is accomplished by challenging the candidate

sampler with a polydisperse, semi-volatile liquid aerosol in three distinct phases. During phase A of this test, the aerosol is elevated to a steady-state, test-specified mass concentration and the sample filters are conditioned and preweighed. In phase B, the challenge aerosol is simultaneously sampled by the candidate method sampler and a reference method sampler onto the preweighed filters for a specified time period. In phase C (the blow-off phase), aerosol and aerosol-vapor free air is sampled by the samplers for an additional time period to partially volatilize the aerosol on the filters. The candidate sampler passes the volatility test if the acceptance criteria presented in Table F-1 of this subpart are met or exceeded.

(b) *Technical definitions*. (1) Residual mass (RM) is defined as the weight of the filter after the blow-off phase subtracted from the initial weight of the filter.

(2) Corrected residual mass (CRM) is defined as the residual mass of the filter from the candidate sampler multiplied by the ratio of the reference method flow rate to the candidate method flow rate.

(c) *Facilities and equipment required*—(1) *Environmental chamber*. Because the nature of a volatile aerosol is greatly dependent upon environmental conditions, all phases of this test shall be conducted at a temperature of 22.0 ± 0.5 °C and a relative humidity of 40 ± 3 percent. For this reason, it is strongly advised that all weighing and experimental apparatus be housed in an environmental chamber capable of this level of control.

(2) *Aerosol generator*. The aerosol generator shall be a pressure nebulizer operated at 20 to 30 psig (140 to 207 kPa) to produce a polydisperse, semi-voltile aerosol with a mass median diameter larger than 1 μm and smaller than 2.5 μm. The nebulized liquid shall be A.C.S. reagent grade glycerol (C_3H_8O, FW = 92.09, CAS 56–81–5) of 99.5 percent minimum purity. For the purpose of this test the accepted mass median diameter is predicated on the stable aerosol inside the internal chamber and not on the aerosol emerging from the nebulizer nozzle. Aerosol monitoring and its stability are described in (c)(3) and (c)(4) of this section.

(3) *Aerosol monitoring equipment*. The evaporation and condensation dynamics of a volatile aerosol is greatly dependent upon the vapor pressure of the volatile component in the carrier gas. The size of an aerosol becomes fixed only when an equilibrium is established between the aerosol and the surrounding vapor; therefore, aerosol size measurement shall be used as a surrogate measure of this equilibrium. A suitable instrument with a range of 0.3 to 10 μm, an accuracy of 0.5 μm, and a resolution of 0.2 μm (e.g., an optical particle sizer, or a time-of-flight instrument) shall be used for this purpose. The parameter monitored for stability shall be the mass median instrument measured diameter (i.e. optical diameter if an optical particle counter is used). A stable aerosol shall be defined as an aerosol with a mass median diameter that has changed less than 0.25 μm over a 4 hour time period.

(4) *Internal chamber*. The time required to achieve a stable aerosol depends upon the time during which the aerosol is resident with the surrounding air. This is a function of the internal volume of the aerosol transport system and may be facilitated by recirculating the challenge aerosol. A chamber with a volume of 0.5 m^3 and a recirculating loop (airflow of approximately 500 cfm) is recommended for this purpose. In addition, a baffle is recommended to dissipate the jet of air that the recirculating loop can create. Furthermore, a HEPA filtered hole in the wall of the chamber is suggested to allow makeup air to enter the chamber or excess air to exit the chamber to maintain a system flow balance. The concentration inside the chamber shall be maintained at 1 mg/m^3 ± 20 percent to obtain consistent and significant filter loading.

(5) *Aerosol sampling manifold*. A manifold shall be used to extract the aerosol from the area in which it is equilibrated and transport it to the candidate method sampler, the reference method sampler, and the aerosol monitor. The losses in each leg of the manifold shall be equivalent such that the three devices will be exposed to an identical aerosol.

(6) *Chamber air temperature recorders*. Minimum range 15-25 °C, certified accuracy to within 0.2 °C, resolution of 0.1 °C. Measurement shall be made at the intake to the sampling manifold and adjacent to the weighing location.

(7) *Chamber air relative humidity recorders*. Minimum range 30 - 50 percent, certified accuracy to within 1 percent, resolution of 0.5 percent. Measurement shall be made at the intake to the sampling manifold and adjacent to the weighing location.

(8) *Clean air generation system*. A source of aerosol and aerosol-vapor free air is required for phase C of this test. This clean air shall be produced by filtering air through an absolute (HEPA) filter.

(9) *Balance*. Minimum range 0 - 200 mg, certified accuracy to within 10 μg, resolution of 1 μg.

(d) *Additional filter handling conditions*. (1) *Filter handling*. Careful handling of the filter during sampling, conditioning, and weighing is necessary to avoid errors due to damaged filters or loss of collected particles from the filters. All filters must be weighed immediately after phase A dynamic conditioning and phase C.

(2) *Dynamic conditioning of filters*. Total dynamic conditioning is required prior to the initial weight determined in phase A. Dynamic conditioning refers to pulling clean air from the clean air generation system through the filters. Total dynamic conditioning can be established by sequential filter weighing every 30 minutes following repetitive dynamic conditioning. The filters are considered sufficiently conditioned if the sequential weights are repeatable to ± 3 μg.

(3) *Static charge*. The following procedure is suggested for minimizing charge effects. Place six or more Polonium static control devices (PSCD) inside the microbalance weighing chamber, (MWC). Two of them must be placed horizontally on the floor of the MWC and the remainder placed vertically on the back wall of the MWC. Taping two PSCD's together or using double-sided tape will help to keep them from falling. Place the filter that is to be weighed on the horizontal PSCDs facing aerosol coated surface up. Close the MWC and wait 1 minute. Open the MWC and place the filter on the balance dish. Wait 1 minute. If the charges have been neutralized the weight will stabilize within 30-60 seconds. Repeat the procedure of neutralizing charges and weighing as prescribed above several times (typically 2-4 times) until consecutive weights will differ by no more than 3 micrograms. Record the last measured weight and use this value for all subsequent calculations.

(e) *Test procedure*—(1) *Phase A - Preliminary steps*. (i) Generate a polydisperse glycerol test aerosol.

(ii) Introduce the aerosol into the transport system.

(iii) Monitor the aerosol size and concentration until stability and level have been achieved.

(iv) Condition the candidate method sampler and reference method sampler filters until total dynamic conditioning is achieved as specified in paragraph (d)(2) of this section.

(v) Record the dynamically conditioned weight as $InitWt_c$ and $InitWt_r$ where c is the candidate method sampler and r is the reference method sampler.

(2) *Phase B - Aerosol loading*. (i) Install the dynamically conditioned filters into the appropriate samplers.

(ii) Attach the samplers to the manifold.

(iii) Operate the candidate and the reference samplers such that they simultaneously sample the test aerosol for 30 minutes.

(3) *Phase C - Blow-off*. (i) Alter the intake of the samplers to sample air from the clean air generation system.

(ii) Sample clean air for one of the required blow-off time durations (1, 2, 3, and 4 hours).

(iii) Remove the filters from the samplers.

(iv) Weigh the filters immediately and record this weight, $FinalWt_c$ and $FinalWt_r$, where c is the candidate method sampler and r is the reference method sampler.

(v) Calculate the residual mass for the reference method sampler:

Equation 41a

$$RM_{(ij)} = \left(FinalWt_r - InitWt_r\right)$$

where:

i = repetition number; and
j = blow-off time period.

(vi) Calculate the corrected residual mass for the candidate method sampler as:

Equation 41b

$$CRM_{(ij)} = \left(FinalWt_r - InitWt_r\right) \times \frac{Q_r}{Q_c}$$

where:
i = repetition number;
j = blow-off time period;
Q_c = candidate method sampler flow rate, and
Q_r = reference method sampler flow rate.

(4) Repeat steps in paragraph (e)(1) through (e)(3) of this section until three repetitions have been completed for each of the required blow-off time durations (1, 2, 3, and 4 hours).

(f) *Calculations and analysis.* (1) Perform a linear regression with the candidate method CRM as the dependent variable and the reference method RM as the independent variable.

(2) Determine the following regression parameters: slope, intercept, and correlation coefficient (r).

(g) *Test results.* The candidate method passes the volatility test if the regression parameters meet the acceptance criteria specified in Table F-1 of this subpart.

Tables to Subpart F of Part 53

TABLE F–1.—PERFORMANCE SPECIFICATIONS FOR $PM_{2.5}$ CLASS II EQUIVALENT SAMPLERS

Performance Test	Specifications	Acceptance Criteria
§ 53.62 Full Wind Tunnel Evaluation	Solid VOAG produced aerosol at 2 km/hr and 24 km/hr.	Dp_{50} = 2.5 μm ± 0.2 μm; Numerical Analysis Results: 95% ≤R_c≤105%
§ 53.63 Wind Tunnel Inlet Aspiration Test	Liquid VOAG produced aerosol at 2 km/hr and 24 km/hr	Relative Aspiration: 95% ≤A≤105%
§ 53.64 Static Fractionator Test	Evaluation of the fractionator under static conditions	Dp_{50} = 2.5 μm ± 0.2 μm; Numerical Analysis Results: 95% ≤R_c≤105%
§ 53.65 Loading Test	Loading of the clean candidate under laboratory conditions	Acceptance criteria as specified in the post-loading evaluation test (§ 53.62, § 53.63, or § 53.64)
§ 53.66 Volatility Test	Polydisperse liquid aerosol produced by air nebulization of A.C.S. reagent grade glycerol, 99.5% minimum purity	Regression Parameters Slope = 1 ± 0.1, Intercept = 0 ± 0.15 r ≥ 0.97

TABLE F–2.—PARTICLE SIZES AND WIND SPEEDS FOR FULL WIND TUNNEL TEST, WIND TUNNEL INLET ASPIRATION TEST, AND STATIC CHAMBER TEST

Primary Partical Mean Size[a] (μm)	Full Wind Tunnel Test		Inlet Aspiration Test		Static Fractionator Test	Volatility Test
	2 km/hr	24 km/hr	2 km/hr	24 km/hr		
1.5±0.25	S	S			S	
2.0±0.25	S	S			S	
2.2±0.25	S	S			S	
2.5±0.25	S	S			S	
2.8±0.25	S	S			S	
3.0±0.25			L	L		
3.5±0.25	S	S			S	
4.0±0.5	S	S			S	
Polydisperse Glycerol Aerosol						L

[a] Aerodynamic diameter.
S=Solid particles.
L=Liquid particles.

TABLE F–3.—CRITICAL PARAMETERS OF IDEALIZED AMBIENT PARTICLE SIZE DISTRIBUTIONS

Idealized Distribution	Fine Particle Mode			Coarse Particle Mode			$PM_{2.5}$/PM_{10} Ratio	FRM Sampler Expected Mass Conc. (μg/m³)
	MMD (μm)	Geo. Std. Dev.	Conc. (μg/m³)	MMD (μm)	Geo. Std. Dev.	Conc. (μg/m³)		
Coarse	0.50	2	12.0	10	2	88.0	0.27	13.814
"Typical"	0.50	2	33.3	10	2	66.7	0.55	34.284
Fine	0.85	2	85.0	15	2	15.0	0.94	78.539

TABLE F-4.—ESTIMATED MASS CONCENTRATION MEASUREMENT OF $PM_{2.5}$ FOR IDEALIZED COARSE AEROSOL SIZE DISTRIBUTION

Particle Aerodynamic Diameter (μm)	Test Sampler			Ideal Sampler		
	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<0.500	1.000	6.001		1.000	6.001	6.001
0.625		2.129		0.999	2.129	2.127
0.750		0.982		0.998	0.982	0.980
0.875		0.730		0.997	0.730	0.728
1.000		0.551		0.995	0.551	0.548
1.125		0.428		0.991	0.428	0.424
1.250		0.346		0.987	0.346	0.342
1.375		0.294		0.980	0.294	0.288
1.500		0.264		0.969	0.264	0.256
1.675		0.251		0.954	0.251	0.239
1.750		0.250		0.932	0.250	0.233
1.875		0.258		0.899	0.258	0.232
2.000		0.272		0.854	0.272	0.232
2.125		0.292		0.791	0.292	0.231
2.250		0.314		0.707	0.314	0.222
2.375		0.339		0.602	0.339	0.204
2.500		0.366		0.480	0.366	0.176
2.625		0.394		0.351	0.394	0.138
2.750		0.422		0.230	0.422	0.097
2.875		0.449		0.133	0.449	0.060
3.000		0.477		0.067	0.477	0.032
3.125		0.504		0.030	0.504	0.015
3.250		0.530		0.012	0.530	0.006
3.375		0.555		0.004	0.555	0.002
3.500		0.579		0.001	0.579	0.001
3.625		0.602		0.000000	0.602	0.000000
3.750		0.624		0.000000	0.624	0.000000
3.875		0.644		0.000000	0.644	0.000000
4.000		0.663		0.000000	0.663	0.000000
4.125		0.681		0.000000	0.681	0.000000
4.250		0.697		0.000000	0.697	0.000000
4.375		0.712		0.000000	0.712	0.000000
4.500		0.726		0.000000	0.726	0.000000
4.625		0.738		0.000000	0.738	0.000000
4.750		0.750		0.000000	0.750	0.000000
4.875		0.760		0.000000	0.760	0.000000
5.000		0.769		0.000000	0.769	0.000000
5.125		0.777		0.000000	0.777	0.000000
5.250		0.783		0.000000	0.783	0.000000
5.375		0.789		0.000000	0.789	0.000000
5.500		0.794		0.000000	0.794	0.000000
5.625		0.798		0.000000	0.798	0.000000
5.75		0.801		0.000000	0.801	0.000000
		$C_{sam(exp)}$=			$C_{ideal(exp)}$=	13.814

TABLE F-5.—ESTIMATED MASS CONCENTRATION MEASUREMENT OF $PM_{2.5}$ FOR IDEALIZED ''TYPICAL'' COARSE AEROSOL SIZE DISTRIBUTION

Particle Aerodynamic Diameter (μm)	Test Sampler			Ideal Sampler		
	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<0.500	1.000	16.651		1.000	16.651	16.651
0.625		5.899		0.999	5.899	5.893
0.750		2.708		0.998	2.708	2.703
0.875		1.996		0.997	1.996	1.990
1.000		1.478		0.995	1.478	1.471
1.125		1.108		0.991	1.108	1.098
1.250		0.846		0.987	0.846	0.835
1.375		0.661		0.980	0.661	0.648
1.500		0.532		0.969	0.532	0.516
1.675		0.444		0.954	0.444	0.424
1.750		0.384		0.932	0.384	0.358
1.875		0.347		0.899	0.347	0.312
2.000		0.325		0.854	0.325	0.277
2.125		0.314		0.791	0.314	0.248
2.250		0.312		0.707	0.312	0.221
2.375		0.316		0.602	0.316	0.190
2.500		0.325		0.480	0.325	0.156
2.625		0.336		0.351	0.336	0.118
2.750		0.350		0.230	0.350	0.081
2.875		0.366		0.133	0.366	0.049
3.000		0.382		0.067	0.382	0.026
3.125		0.399		0.030	0.399	0.012
3.250		0.416		0.012	0.416	0.005
3.375		0.432		0.004	0.432	0.002
3.500		0.449		0.001	0.449	0.000000
3.625		0.464		0.000000	0.464	0.000000
3.750		0.480		0.000000	0.480	0.000000
3.875		0.494		0.000000	0.494	0.000000
4.000		0.507		0.000000	0.507	0.000000
4.125		0.520		0.000000	0.520	0.000000
4.250				0.000000	0.532	0.000000
4.375				0.000000	0.543	0.000000
4.500				0.000000	0.553	0.000000
4.625				0.000000	0.562	0.000000
4.750				0.000000	0.570	0.000000
4.875				0.000000	0.577	0.000000
5.000				0.000000	0.584	0.000000
5.125				0.000000	0.590	0.000000
5.250				0.000000	0.595	0.000000
5.375				0.000000	0.599	0.000000
5.500				0.000000	0.603	0.000000
5.625				0.000000	0.605	0.000000
5.75				0.000000	0.608	0.000000
		$C_{sam(exp)}$=			$C_{ideal(exp)}$=	34.284

TABLE F-6.—ESTIMATED MASS CONCENTRATION MEASUREMENT OF $PM_{2.5}$ FOR IDEALIZED FINE AEROSOL SIZE DISTRIBUTION

Particle Aerodynamic Diameter (μm)	Test Sampler			Ideal Sampler		
	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)	Fractional Sampling Effectiveness	Interval Mass Concentration ($\mu g/m^3$)	Estimated Mass Concentration Measurement ($\mu g/m^3$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<0.500	1.000	18.868		1.000	18.868	18.868
0.625		13.412		0.999	13.412	13.399
0.750		8.014		0.998	8.014	7.998
0.875		6.984		0.997	6.984	6.963
1.000		5.954		0.995	5.954	5.924
1.125		5.015		0.991	5.015	4.970
1.250		4.197		0.987	4.197	4.142
1.375		3.503		0.980	3.503	3.433
1.500		2.921		0.969	2.921	2.830
1.675		2.438		0.954	2.438	2.326
1.750		2.039		0.932	2.039	1.900
1.875		1.709		0.899	1.709	1.536
2.000		1.437		0.854	1.437	1.227
2.125		1.212		0.791	1.212	0.959
2.250		1.026		0.707	1.026	0.725
2.375		0.873		0.602	0.873	0.526
2.500		0.745		0.480	0.745	0.358
2.625		0.638		0.351	0.638	0.224
2.750		0.550		0.230	0.550	0.127
2.875		0.476		0.133	0.476	0.063
3.000		0.414		0.067	0.414	0.028
3.125		0.362		0.030	0.362	0.011
3.250		0.319		0.012	0.319	0.004
3.375		0.282		0.004	0.282	0.001
3.500		0.252		0.001	0.252	0.000000
3.625		0.226		0.000000	0.226	0.000000
3.750		0.204		0.000000	0.204	0.000000
3.875		0.185		0.000000	0.185	0.000000
4.000		0.170		0.000000	0.170	0.000000
4.125		0.157		0.000000	0.157	0.000000
4.250		0.146		0.000000	0.146	0.000000
4.375		0.136		0.000000	0.136	0.000000
4.500		0.129		0.000000	0.129	0.000000
4.625		0.122		0.000000	0.122	0.000000
4.750		0.117		0.000000	0.117	0.000000
4.875		0.112		0.000000	0.112	0.000000
5.000		0.108		0.000000	0.108	0.000000
5.125		0.105		0.000000	0.105	0.000000
5.250		0.102		0.000000	0.102	0.000000
5.375		0.100		0.000000	0.100	0.000000
5.500		0.098		0.000000	0.098	0.000000
5.625		0.097		0.000000	0.097	0.000000
5.75		0.096		0.000000	0.096	0.000000
		$C_{sam(exp)}$=			$C_{ideal(exp)}$=	78.539

Figures to Subpart F of Part 53

Figure F-1. Designation Testing Checklist

DESIGNATION TESTING CHECKLIST FOR CLASS II

Auditee _____ Auditor signature _____ Date _____

Compliance Status: Y = Yes N = No NA = Not applicable/Not available				
Verification			Verified by Direct Observation of Process or of Documented Evidence: Performance, Design or Application Spec. Corresponding to Sections of 40 CFR Part 53, Subparts E and F	Verification Comments (Includes documentation of who, what, where, when, why) (Doc. #, Rev. #, Rev. Date)
Y	N	NA		
			Subpart E: Performance Specification Tests	
			Evaluation completed according to Subpart E §53.50 to §53.56	
			Subpart E: Class I Sequential Tests	
			Class II samplers that are also Class I (sequentialized) have passed the tests in §53.57	
			Subpart F: Performance Spec/Test	
			Evaluation of Physical Characteristics of Clean Sampler - One of these tests must be performed: §53.62 - Full Wind Tunnel §53.63 - Inlet Aspiration §53.64 - Static Fractionator	
			Evaluation of Physical Characteristics of Loaded Sampler §53.65 Loading Test One of the following tests must be performed for evaluation after loading: §53.62, §53.63, §53.64	
			Evaluation of the Volatile Characteristics of the Class II Sampler §53.66	

Appendix A to Subpart F of Part 53—References

(1) Marple, V.A., K.L. Rubow, W. Turner, and J.D. Spangler, Low Flow Rate Sharp Cut Impactors for Indoor Air Sampling: Design and Calibration., JAPCA, 37: 1303-1307 (1987).

(2) Vanderpool, R.W. and K.L. Rubow, Generation of Large, Solid Calibration Aerosols, J. of Aer. Sci. and Tech., 9:65-69 (1988).

(3) Society of Automotive Engineers Aerospace Material Specification (SAE AMS) 2404C, Electroless Nickel Planting, SAE, 400 Commonwealth Drive, Warrendale PA-15096, Revised 7-1-84, pp. 1-6.

PART 58—[AMENDED]

2. In part 58:

a. The authority citation for part 58 continues to read as follows:

Authority: 42 U.S.C. 7410, 7601(a), 7613, 7619.

b. Section 58.1 is amended by removing the existing alphabetic paragraph designations, by alphabetizing the existing definitions, by revising the definition *Traceable* and by adding in alphabetical order the following definitions to read as follows:

§ 58.1 Definitions.

* * * * *

Annual State air monitoring report is an annual report, prepared by control agencies and submitted to EPA for approval, that consists of an annual data summary report for all pollutants and a detailed report describing any proposed changes to their air quality surveillance network.

Community Monitoring Zone (CMZ) means an optional averaging area with established, well defined boundaries, such as county or census block, within a MPA that has relatively uniform concentrations of annual $PM_{2.5}$ as defined by Appendix D of this part. Two or more core SLAMS and other monitors within a CMZ that meet certain requirements as set forth in Appendix D of this part may be averaged for making comparisons to the annual $PM_{2.5}$ NAAQS.

Consolidated Metropolitan Statistical Area (CMSA) means the most recent area as designated by the U.S. Office of Management and Budget and population figures from the Bureau of the Census. The Department of Commerce provides that within metropolitan complexes of 1 million or more population, separate component areas are defined if specific criteria are met. Such areas are designated primary metropolitan statistical areas (PMSAs; and any area containing PMSAs is designated CMSA.

Core $PM_{2.5}$ SLAMS means community-oriented monitoring sites representative of community-wide exposures that are the basic component sites of the $PM_{2.5}$ SLAMS regulatory network. Core $PM_{2.5}$ SLAMS include community-oriented SLAMS monitors, and sites collocated at PAMS.

* * * * *

Correlated acceptable continuous (CAC) PM analyzer means an optional fine particulate matter analyzer that can be used to supplement a $PM_{2.5}$ reference or equivalent sampler, in accordance with the provisions of § 58.13(f).

* * * * *

Equivalent method means a method of sampling and analyzing the ambient air for an air pollutant that has been designated as an equivalent method in accordance with part 53 of this chapter; it does not include a method for which an equivalent method designation has been canceled in accordance with § 53.11 or § 53.16 of this chapter.

* * * * *

Metropolitan Statistical Area (MSA) means the most recent area as designated by the U.S. Office of Management and Budget and population figures from the U.S. Bureau of the Census. The Department of Commerce defines a metropolitan area as one of a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus.

* * * * *

Monitoring Planning Area (MPA) means a contiguous geographic area with established, well defined boundaries, such as a metropolitan statistical area, county or State, having a common area that is used for planning monitoring locations for $PM_{2.5}$. MPAs may cross State boundaries, such as the Philadelphia PA-NJ MSA, and be further subdivided into community monitoring zones. MPAs are generally oriented toward areas with populations greater than 200,000, but for convenience, those portions of a State that are not associated with MSAs can be considered as a single MPA. MPAs must be defined, where applicable, in a State PM monitoring network description.

* * * * *

Particulate matter monitoring network description, required by § 58.20(f), means a detailed plan, prepared by control agencies and submitted to EPA for approval, that describes their $PM_{2.5}$ and PM_{10} air quality surveillance network.

* * * * *

$PM_{2.5}$ means particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers as measured by a reference method based on 40 CFR part 50, Appendix L, and designated in accordance with part 53 of this chapter or by an equivalent method designated in accordance with part 53 of this chapter.

* * * * *

Population-oriented monitoring (or sites) applies to residential areas, commercial areas, recreational areas, industrial areas, and other areas where a substantial number of people may spend a significant fraction of their day.

Primary Metropolitan Statistical Area (PMSA) is a separate component of a consolidated metropolitan statistical area. For the purposes of this part, PMSA is used interchangeably with MSA.

* * * * *

Reference method means a method of sampling and analyzing the ambient air for an air pollutant that will be specified as a reference method in an appendix to part 50 of this chapter, or a method that has been designated as a reference method in accordance with this part; it does not include a method for which a reference method designation has been canceled in accordance with § 53.11 or § 53.16 of this chapter.

* * * * *

Special Purpose Monitor (SPM) is a generic term used for all monitors other than SLAMS, NAMS, PAMS, and PSD monitors included in an agency's monitoring network for monitors used in a special study whose data are officially reported to EPA.

* * * * *

Traceable means that a local standard has been compared and certified, either directly or via not more than one intermediate standard, to a National Institute of Standards and Technology (NIST)-certified primary standard such as a NIST-Traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS).

* * * * *

c. Section 58.13 is amended by revising paragraphs (b) and (d) and adding new paragraphs (e) and (f) to read as follows:

§ 58.13 Operating schedule.

* * * * *

(b) For manual methods (excluding PM_{10} samplers, $PM_{2.5}$ 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.

* * * * *

(d) For PM_{10} samplers--a 24–hour sample must be taken a minimum of every third day.

(e) For $PM_{2.5}$ samplers, a 24–hour sample is required everyday for certain core SLAMS, including certain PAMS, as described in section 2.8.1.3 of Appendix D of this part, except during seasons or periods of low $PM_{2.5}$ as otherwise exempted by the Regional Administrator. A waiver of the everyday sampling schedule for SLAMS may be granted by the Regional Administrator or designee, and for NAMS by the Administrator or designee, for 1 calendar year from the time a $PM_{2.5}$ sequential sampler (FRM or Class I equivalent) has been approved by EPA. A 24–hour sample must be taken a minimum of every third day for all other SLAMS, including NAMS, as described in section 2.8.1.3 of Appendix D of this part, except when exempted by the Regional Administrator in accordance with forthcoming EPA guidance. During periods for which exemptions to every third day or every day sampling are allowed for core $PM_{2.5}$ SLAMS, a minimum frequency of one in 6-day sampling is still required. However, alternative sampling frequencies are allowed for SLAMS sites that are principally intended for comparisons to the 24–hour NAAQS.

Such modifications must be approved by the Regional Administrator.

(f) *Alternatives to everyday sampling at sites with correlated acceptable continuous analyzers*. (1) Certain $PM_{2.5}$ core SLAMS sites located in monitoring planning areas (as described in section 2.8 of Appendix D of this part) are required to sample every day with a reference or equivalent method operating in accordance with part 53 of this chapter and section 2 of Appendix C of this part. However, in accordance with the monitoring priority as defined in paragraph (f)(2) of this section, established by the control agency and approved by EPA, a core SLAMS monitor may operate with a reference or equivalent method on a 1 in 3-day schedule and produce data that may be compared to the NAAQS, provided that it is collocated with an acceptable continuous fine particulate PM analyzer that is correlated with the reference or equivalent method. If the alternative sampling schedule is selected by the control agency and approved by EPA, the alternative schedule shall be implemented on January 1 of the year in which everyday sampling is required. The selection of correlated acceptable continuous PM analyzers and procedures for correlation with the intermittent reference or equivalent method shall be in accordance with procedures approved by the Regional Administrator. Unless the continuous fine particulate analyzer satisfies the requirements of section 2 of Appendix C of this part, however, the data derived from the correlated acceptable continuous monitor are not eligible for direct comparisons to the NAAQS in accordance with part 50 of this chapter.

(2) A Metropolitan Statistical Area (MSA) (or primary metropolitan statistical area) with greater than 1 million population and high concentrations of $PM_{2.5}$ (greater than or equal to 80 percent of the NAAQS) shall be a Priority 1 PM monitoring area. Other monitoring planning areas may be designated as Priority 2 PM monitoring areas.

(3) Core SLAMS having a correlated acceptable continuous analyzer collocated with a reference or equivalent method in a Priority 1 PM monitoring area may operate on the 1 in 3 sampling frequency only after reference or equivalent data are collected for at least 2 complete years.

(4) In all monitoring situations, with a correlated acceptable continuous alternative, FRM samplers or filter-based equivalent analyzers should preferably accompany the correlated acceptable continuous monitor.

d. Section 58.14 is revised to read as follows:

§ 58.14 Special purpose monitors.

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

(b) Based on the need, in transitioning to a $PM_{2.5}$ standard that newly addresses the ambient impacts of fine particles, to encourage a sufficiently extensive geographical deployment of $PM_{2.5}$ monitors and thus hasten the development of an adequate $PM_{2.5}$ ambient air quality monitoring infrastructure, $PM_{2.5}$ NAAQS violation determinations shall not be exclusively made based on data produced at a population-oriented SPM site during the first 2 complete calendar years of its operation. However, a notice of NAAQS violations resulting from population-oriented SPMs shall be reported to EPA in the State's annual monitoring report and be considered by the State in the design of its overall SLAMS network; these population-oriented SPMs should be considered to become a permanent SLAMS during the annual network review in accordance with § 58.25.

(c) 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) of this section 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.

e. Section 58.20 is amended by revising the section heading, paragraph (d), and the introductory text of paragraph (e), by designating the flush text at the end of the section as paragraph (i) and amending the third sentence by removing the words ''(a) through (f)'' and adding in their place, ''(a) through (h)'', by redesignating paragraph (f) as paragraph (h), and adding new paragraphs (f) and (g) to read as follows:

§ 58.20 Air quality surveillance: plan content.

* * * * *

(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 of this part. Such review must identify needed modifications to the network such as termination or relocation of unnecessary stations or establishment of new stations that are necessary. For $PM_{2.5}$, the review must identify needed changes to core SLAMS, monitoring planning areas, the chosen community monitoring approach including optional community monitoring zones, SLAMS, or SPMs.

(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 and must contain the following information for each SLAMS:

* * * * *

(f) Provide for having a PM monitoring network description available for public inspection which must provide for monitoring planning areas, and the community monitoring approach involving core monitors and optional community monitoring zones for $PM_{2.5}$. The PM monitoring network description for PM_{10} and $PM_{2.5}$ must be submitted to the Regional Administrator for approval by July 1, 1998, and must contain the following information for each PM SLAMS and $PM_{2.5}$ SPM:

(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, spatial scale of representativeness, and additionally for $PM_{2.5}$, the monitoring planning area, optional community monitoring zone, and the site code designation to identify which site will be identified as core SLAMS; and SLAMS or population-oriented SPMs, if any, that are microscale or middle scale in their representativeness as defined in Appendix D of 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 of this part for each SLAMS for which such procedures are not implemented at the time of plan revision submittal.

(iii) Resiting each SLAMS which does not meet the requirements of Appendix E of this part at the time of plan revision submittal.

(g) Provide for having a list of all $PM_{2.5}$ monitoring locations including SLAMS, NAMS, PAMS and population-oriented SPMs, that are included in the State's PM monitoring network description and are intended for comparison to the NAAQS, available for public inspection.

* * * * *

f. Section 58.23 is amended by revising the introductory text and adding a new paragraph (c) to read as follows:

§ 58.23 Monitoring network completion.

With the exception of the PM_{10} monitoring networks that shall be in place by March 16, 1998 and with the exception of the $PM_{2.5}$ monitoring networks as described in paragraph (c) of this section:

* * * * *

(c) Each $PM_{2.5}$ station in the SLAMS network must be in operation in accordance with the minimum requirements of Appendix D of this part, be sited in accordance with the criteria in Appendix E of this part, and be located as described on the station's AIRS site identification form, according to the following schedule:

(1) Within 1 year after September 16, 1997, at least one required core $PM_{2.5}$ SLAMS site in each MSA with population greater than 500,000, plus one site in each PAMS area, (plus at least two additional SLAMS sites per State) must be in operation.

(2) Within 2 years after September 16, 1997, all other required SLAMS, including all required core SLAMS, required regional background and regional transport SLAMS, continuous PM monitors in areas with greater than 1 million population, and all additional required $PM_{2.5}$ SLAMS must be in operation.

(3) Within 3 years after September 16, 1997, all additional sites (e.g., sites classified as SLAMS/SPM to complete the mature network) must be in operation.

g. Section 58.26 is amended by revising the section heading and the introductory text of paragraph (b), and adding paragraphs (d) and (e) to read as follows:

§ 58.26 Annual state air monitoring report.

* * * * *

(b) The SLAMS annual data summary report must contain:

* * * * *

(d) For PM monitoring and data—(1) The State shall submit a summary to the appropriate Regional Office (for SLAMS) or Administrator (through the Regional Office) (for NAMS) that details proposed changes to the PM Monitoring Network Description and to be in accordance with the annual network review requirements in § 58.25. This shall discuss the existing PM networks, including modifications to the number, size or boundaries of monitoring planning areas and optional community monitoring zones; number and location of PM_{10} and $PM_{2.5}$ SLAMS; number and location of core $PM_{2.5}$ SLAMS; alternative sampling frequencies proposed for $PM_{2.5}$ SLAMS (including core $PM_{2.5}$ SLAMS and $PM_{2.5}$ NAMS), core $PM_{2.5}$ SLAMS to be designated $PM_{2.5}$ NAMS; and PM_{10} and $PM_{2.5}$ SLAMS to be designated PM_{10} and $PM_{2.5}$ NAMS respectively.

(2) The State shall submit an annual summary to the appropriate Regional Office of all the ambient air quality monitoring PM data from all special purpose monitors that are described in the State's PM monitoring network description and are intended for SIP purposes. These include those population-oriented SPMs that are eligible for comparison to the PM NAAQS. The State shall certify the data in accordance with paragraph (c) of this section.

(e) The Annual State Air Monitoring Report shall be submitted to the Regional Administrator by July 1 or by an alternative annual date to be negotiated between the State and Regional Administrator. The Region shall provide review and approval/disapproval within 60 days. After 3 years following September 16, 1997, the schedule for submitting the required annual revised $PM_{2.5}$ monitoring network description may be altered based on a new schedule determined by the Regional Administrator. States may submit an alternative PM monitoring network description in which it requests exemptions from specific required elements of the network design (e.g., required number of core sites, other SLAMS, sampling frequency, etc.). After 3 years following September 16, 1997 or once a CMZ monitoring area has been determined to violate the NAAQS, then changes to an MPA monitoring network affecting the violating locations shall require public review and notification.

h. Section 58.30 is amended by revising the introductory text of paragraph (a) to read as follows:

§ 58.30 NAMS network establishment.

(a) By January 1, 1980, with the exception of PM_{10} and $PM_{2.5}$ samplers, which shall be by July 1, 1998, the State shall:

* * * * *

i. In § 58.31, paragraph (f) is revised to read as follows:

§ 58.31 NAMS network description.

* * * * *

(f) The monitoring objective, spatial scale of representativeness, and for $PM_{2.5}$, the monitoring planning area and community monitoring zone, as defined in Appendix D of this part.

* * * * *

j. In § 58.34, the introductory text is revised to read as follows:

§ 58.34 NAMS network completion.

With the exception of PM_{10} samplers, which shall be by 1 year after September 16, 1997, and $PM_{2.5}$, which shall be by 3 years after September 16, 1997:

* * * * *

k. In § 58.35, the first sentence of paragraph (b) is revised to read as follows:

§ 58.35 NAMS data submittal.

* * * * *

(b) The State shall report to the Administrator all ambient air quality data for SO^2, CO, O_3, NO_2, Pb, PM_{10}, and $PM_{2.5}$, 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. * * *

* * * * *

l. Revise Appendix A of part 58 to read as follows:

Appendix A—Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)

1. *General Information.*

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

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

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

1.4 Periodic assessments of SLAMS data quality are required to be reported to EPA. To provide national uniformity in this assessment and reporting of data quality for all SLAMS networks, specific assessment and reporting procedures are prescribed in detail in sections 3, 4, and 5 of this Appendix. On the other hand, the selection and extent of the QA and QC activities used by a monitoring agency depend on a number of local factors such as the field and laboratory conditions, the objectives for monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, pollutant concentration levels, etc. Therefore, the quality system requirements, in section 2 of this Appendix, are specified in general terms to allow each State to develop a quality assurance program that is most efficient and effective for its own circumstances while achieving the Ambient Air Quality Programs data quality objectives.

2. *Quality System Requirements.*

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

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

(b) Satisfy customers' expectations.

(c) Comply with applicable standards specifications.

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

(e) Reflect consideration of cost and economics.

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

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

(2) Minimize loss of air quality data due to malfunctions or out-of-control conditions. This quality assurance program must be described in detail, suitably documented in accordance with

Agency requirements (Reference 4 of this Appendix), and approved by the appropriate Regional Administrator, or the Regional Administrator's designee. The Quality Assurance Program will be reviewed during the systems audits described in section 2.5 of this Appendix.

2.2 Primary requirements and guidance documents for developing the quality assurance program are contained in References 2 through 7 of this Appendix, which also contain many suggested and required procedures, checks, and control specifications. Reference 7 of this Appendix describes specific guidance for the development of a QA Program for SLAMS. Many specific quality control checks and specifications for methods are included in the respective reference methods described in part 50 of this chapter or in the respective equivalent method descriptions available from EPA (Reference 8 of this Appendix). Similarly, quality control procedures related to specifically designated reference and equivalent method analyzers are contained in the respective operation or instruction manuals associated with those analyzers. Quality assurance guidance for meteorological systems at PAMS is contained in Reference 9 of this Appendix. Quality assurance procedures for VOC, NO_x (including NO and NO_2), O_3, and carbonyl measurements at PAMS must be consistent with Reference 15 of this Appendix. Reference 4 of this Appendix includes requirements for the development of quality assurance project plans, and quality assurance and control programs, and systems audits demonstrating attainment of the requirements.

2.3 Pollutant Concentration and Flow Rate Standards.

2.3.1 Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO_2, NO, and NO_2 must be traceable to either a National Institute of Standards and Technology (NIST) NIST-Traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS), certified in accordance with one of the procedures given in Reference 10 of this Appendix.

2.3.2 Test concentrations for O_3 must be obtained in accordance with the UV photometric calibration procedure specified in 40 CFR part 50, Appendix D, or by means of a certified ozone transfer standard. Consult References 11 and 12 of this Appendix for guidance on primary and transfer standards for O_3.

2.3.3 Flow rate measurements must be made by a flow measuring instrument that is traceable to an authoritative volume or other applicable standard. Guidance for certifying some types of flowmeters is provided in Reference 7 of this Appendix.

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

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

3. *Data Quality Assessment Requirements.*

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

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

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

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

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

3.0.3 Each reporting organization shall be defined such that measurement uncertainty among all stations in the organization can be expected to be reasonably homogeneous, as a result of common factors.

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

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

(2) Common calibration facilities.

(3) Oversight by a common quality assurance organization.

(4) Support by a common laboratory or headquarters.

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

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

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

3.1.1 Methods for SO_2, NO_2, O_3 and CO. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure SO_2, NO_2, O_3 and CO. The precision check is made by challenging the analyzer with a precision check gas of known concentration (effective concentration for open path analyzers) between 0.08 and 0.10 ppm for SO_2, NO_2, and O_3 analyzers, and between 8 and 10 ppm for CO analyzers. To check the precision of SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm SO_2, NO_2, and O_3, or 0 to 100 ppm for CO, use precision check gases of appropriately higher concentration as approved by the appropriate Regional Administrator or their designee. However, the results of precision checks at concentration levels other than those specified above need not be reported to EPA. The standards from which precision check test concentrations are obtained must meet the specifications of section 2.3 of this Appendix.

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

3.1.1.2 Open path analyzers are tested by inserting a test cell containing a precision check gas concentration into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and as appropriate, reflecting devices should be used during the test, and the normal monitoring configuration of the instrument should be altered as little as possible to accommodate the test cell for the test. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentration of the precision check gas in the test cell must be selected to produce an effective concentration in the range specified in section 3.1.1. Generally, the precision test concentration measurement will be the sum of the atmospheric pollutant concentration and the precision test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the precision check test from the precision test concentration measurement. If the difference between these before and after measurements is greater than 20 percent of the effective concentration of the test gas, discard the test result and repeat the test. If possible, open path analyzers should be tested during periods when the

atmospheric pollutant concentrations are relatively low and steady.

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

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

3.1.2.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix to check the analyzer's normal flow rate. Care should be used in selecting and using the flow rate measurement device such that it does not alter the normal operating flow rate of the analyzer. Report the actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.1.2.2 Alternative procedure:

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

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

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

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

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

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

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

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

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

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

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

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

3.2.1.3 NO concentrations substantially higher than 0.08 ppm, as may occur when using some gas phase titration (GPT) techniques, may lead to audit errors in chemiluminescence analyzers due to inevitable minor NO-NO_x channel imbalance. Such errors may be atypical of routine monitoring errors to the extent that such NO concentrations exceed typical ambient NO concentrations at the site. These errors may be minimized by modifying the GPT technique to lower the NO concentrations remaining in the NO_2 audit gas to levels closer to typical ambient NO concentrations at the site.

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

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

3.2.1.6 For point analyzers, the audit shall be carried out by allowing the analyzer to analyze the audit test atmosphere in its normal sampling mode such that the test atmosphere passes through all filters, scrubbers, conditioners, and other sample inlet components used during normal ambient sampling and as much of the ambient air inlet system as is practicable. The exception provided in section 3.1 of this Appendix for certain CO analyzers does not apply for audits.

3.2.1.7 Open path analyzers are audited by inserting a test cell containing the various audit gas concentrations into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and, as appropriate, reflecting devices should be used during the audit, and the normal monitoring configuration of the instrument should be modified as little as possible to accommodate the test cell for the audit. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentrations of the audit gas in the test cell must be selected to produce effective concentrations in the ranges specified in this section 3.2 of this Appendix. Generally, each audit concentration measurement result will be the sum of the atmospheric pollutant concentration and the audit test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the audit test (or preferably before and after each audit concentration level) from the audit concentration measurement. If the difference between the before and after measurements is greater than 20 percent of the effective concentration of the test gas standard, discard the test result for that concentration level and repeat the test for that level. If possible, open path analyzers should be audited during periods when the atmospheric pollutant concentrations are relatively low and steady. Also, the monitoring path length must be reverified to within ±3 percent to validate the audit, since the monitoring path length is critical to the determination of the effective concentration.

3.2.1.8 Report both the actual concentrations (effective concentrations for open path analyzers) of the audit gases and the corresponding concentration measurements (corrected concentrations, if applicable, for open path analyzers) indicated or produced by the analyzer being tested. The percent differences between these concentrations are used to assess the accuracy of the monitoring data as described in section 5.2 of this Appendix.

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

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

3.2.2.2 The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the

audit standard may be referenced to the same primary flow rate or volume standard. Great care must be used in auditing the flow rate to be certain that the flow measurement device does not alter the normal operating flow rate of the analyzer. Report the audit (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The percent differences between these flow rates are used to calculate accuracy (PM_{10}) as described in section 5.2 of this Appendix.

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

3.3.1 For each network of manual methods other than for $PM_{2.5}$, select one or more monitoring sites within the reporting organization for duplicate, collocated sampling as follows: for 1 to 5 sites, select 1 site; for 6 to 20 sites, select 2 sites; and for over 20 sites, select 3 sites. Where possible, additional collocated sampling is encouraged. For purposes of precision assessment, networks for measuring TSP and PM_{10} shall be considered separately from one another. PM_{10} and TSP sites having annual mean particulate matter concentrations among the highest 25 percent of the annual mean concentrations for all the sites in the network must be selected or, if such sites are impractical, alternative sites approved by the Regional Administrator may be selected.

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

3.3.3 The two collocated samplers must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.3.4 For each pair of collocated samplers, designate one sampler as the primary sampler whose samples will be used to report air quality for the site, and designate the other as the duplicate sampler. Each duplicate sampler must be operated concurrently with its associated routine sampler at least once per week. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the seven days of the week. A six-day sampling schedule is required. Report the measurements from both samplers at each collocated sampling site. The calculations for evaluating precision between the two collocated samplers are described in section 5.3 of this Appendix.

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

3.4.1 Procedures for PM_{10} and TSP.

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

3.4.1.2 Great care must be used in auditing high-volume particulate matter samplers having flow regulators because the introduction of resistance plates in the audit flow standard device can cause abnormal flow patterns at the point of flow sensing. For this reason, the flow audit standard should be used with a normal filter in place and without resistance plates in auditing flow-regulated high-volume samplers, or other steps should be taken to assure that flow patterns are not perturbed at the point of flow sensing.

3.4.2 SO_2 Methods.

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

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

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

3.4.4 Pb Methods.

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

3.4.4.2 Each calendar quarter, audit the Pb Reference Method analytical procedure using glass fiber filter strips containing a known quantity of Pb. These audit sample strips are prepared by depositing a Pb solution on unexposed glass fiber filter strips of dimensions 1.9 cm by 20.3 cm (3/4 inch by 8 inch) and allowing them to dry thoroughly. The audit samples must be prepared using batches of reagents different from those used to calibrate the Pb analytical equipment being audited. Prepare audit samples in the following concentration ranges:

Range	Pb Concentration, µg/Strip	Equivalent Ambient Pb Concentration, µg/m^3 [1]
1	100–300	0.5–1.5
2	600–1000	3.0–5.0

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

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

3.4.4.4 Analyze three audit samples in each of the two ranges each quarter samples are analyzed. The audit sample analyses shall be distributed as much as possible over the entire calendar quarter. Report the audit concentrations (in µg Pb/strip) and the corresponding measured concentrations (in µg Pb/strip) using unit code 77. The percent differences between the concentrations are used to calculate analytical accuracy as described in section 5.4.2 of this Appendix.

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

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

3.5.1 Flow Rate Audits.

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

3.5.1.1.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix to check the analyzer's normal flow rate. Care should be used in selecting and using the flow rate measurement device such that it does not alter the normal operating flow rate of the analyzer. Report the actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.5.1.1.2 Alternative procedure: It is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter without the use of an external flow rate transfer standard, provided that the flow meter is audited with an external flow rate transfer standard at least every 6 months; records of at least the three most recent flow audits of the instrument's internal flow meter over at least several weeks confirm that the flow meter is stable, verifiable and accurate to ±4%; and the instrument and flow meter give no indication of improper

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

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

3.5.1.2 Manual methods for $PM_{2.5}$. Each calendar quarter, audit the flow rate of each SLAMS $PM_{2.5}$ analyzer. The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Great care must be used in auditing the flow rate to be certain that the flow measurement device does not alter the normal operating flow rate of the analyzer. Report the audit (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The procedures used to calculate measurement uncertainty $PM_{2.5}$ are described in section 5.5 of this Appendix.

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

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

(1) Have 25 percent of the monitors collocated (values of .5 and greater round up).

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

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

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

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

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

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

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

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

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

3.5.2.2 The two collocated samplers must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.5.2.3 For each pair of collocated samplers, designate one sampler as the primary sampler whose samples will be used to report air quality for the site, and designate the other as the duplicate sampler. Each duplicate sampler must be operated concurrently with its associated primary sampler. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the 7 days of the week and therefore, a 6-day sampling schedule is required. Report the measurements from both samplers at each collocated sampling site. The calculations for evaluating precision between the two collocated samplers are described in section 5.5 of this Appendix.

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

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

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

(b) Have at least one monitor audited.

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

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

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

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

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

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

4. *Reporting Requirements*.

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

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

4.2 Annual Reports.

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

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

5. *Calculations for Data Quality Assessment*.

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

some or all of the calculations in this section on their own.

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

5.1.1 Single Analyzer Precision.

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

Equation 1

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

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

Equation 2

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

Equation 3

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

5.1.2 Precision for Reporting Organization.

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

Equation 4

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

Equation 4a

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

Equation 5

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

Equation 5a

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

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

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

Equation 6

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

Equation 7

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

5.2 Accuracy of Automated Methods Excluding $PM_{2.5}$. Estimates of the accuracy of automated methods are calculated from the results of independent audits as described in section 3.2 of this Appendix. At the end of each calendar quarter, an integrated accuracy probability interval for all SLAMS analyzers audited in the reporting organization is calculated for each pollutant. Separate probability limits are calculated for each audit concentration level in section 3.2 of this Appendix.

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

5.2.2 Accuracy for Reporting Organization.

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

Equation 8

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

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

Equation 9

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

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

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

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

5.3.1 Single Sampler Precision.

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

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

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

Equation 10

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

where:
Y_i is the pollutant concentration measurement obtained from the duplicate sampler; and
X_i is the concentration measurement obtained from the primary sampler designated for reporting air quality for the site.

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

5.3.2 Precision for Reporting Organization.

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

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

Equation 11

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

Equation 12

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

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

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

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

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

5.4.2 Analytical Methods for SO_2, NO_2, and Pb.

5.4.2.1 Single Analysis-Day Accuracy. For each of the audits of the analytical methods for SO_2, NO_2, and Pb described in sections 3.4.2, 3.4.3, and 3.4.4 of this Appendix, the percentage difference (d_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_2, NO_2, or Pb indicated by the analytical method.

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

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

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

(1) Flow rate audit.

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

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

(4) FRM audits.

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

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

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

Equation 13

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

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

Equation 14

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

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

Equation 15

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

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

Equation 16

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

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

Equation 17

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

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

Equation 18

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

5.5.2 Collocated Samplers, Where the Duplicate Sampler is not an FRM Device.

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

$PM_{2.5}$: 6 $\mu g/m^3$

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

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

Equation 19

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

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

Equation 20

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

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

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

Equation 21

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

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

Equation 22

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

Equation 23

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

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

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

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

Equation 24

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

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

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

Equation 25

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

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

5.5.3.1 Accuracy for a Single Check (d'_i). The percentage difference, d'_i, for each check is calculated by EPA using Equation 26, where X_i represents the concentration produced from the FRM sampler taken as the true value and Y_i represents concentration reported for the primary sampler, as follows:

Equation 26

$$d'_i = \frac{Y_i - X_i}{X_i} \times 100\%$$

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

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

Equation 27

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

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

Equation 28

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

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

Equation 29

$$\text{Lower Confidence Limit} = D'_{j,q} - t_{0.975,df} \times s'_{j,q}$$

Equation 30

$$\text{Upper Confidence Limit} = D'_{j,q} - t_{0.975,df} \times s'_{j,q}$$

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

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

Equation 31

$$D'_j = \frac{\sum_{q=1}^{4} \left(n_{j,q} D'_{j,q}\right)}{\sum_{q=1}^{4} n_{j,q}}$$

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

Equation 32

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

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

Equation 33

$$\text{Lower Confidence Limit} = D'_j - t_{0.975,df}\times se'_j$$

Equation 34

$$\text{Upper Confidence Limit} = D'_j - t_{0.975,df}\times se'_j$$

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

Equation 35

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

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

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

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

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

References in Appendix A of Part 58

(1) Rhodes, R.C. Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40 CFR part 58, Appendices A and B. EPA-600/4-83/023. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, June, 1983.

(2) American National Standard--Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. ANSI/ASQC E4-1994. January 1995. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(3) EPA Requirements for Quality Management Plans. EPA QA/R-2. August 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(4) EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. August 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(5) Guidance for the Data Quality Objectives Process. EPA QA/G-4. September 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(6) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 1--A Field Guide to Environmental Quality Assurance. EPA-600/R-94/038a. April 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(7) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II--Ambient Air Specific Methods EPA-600/R-94/038b. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(7a) Copies of section 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

(8) List of Designated Reference and Equivalent Methods. Available from U.S. Environmental Protection Agency, National Exposure Research Laboratory, Quality Assurance Branch, MD-77B, Research Triangle Park, NC 27711.

(9) 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.

(10) EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. EPA-600/R-93/224. September 1993. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(11) 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, Research Triangle Park, NC 27711, September, 1979.

(12) 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, Research Triangle Park, NC 27711, September, 1979.

(13) Musick, D.R. The Ambient Air Precision and Accuracy Program: 1995 Annual Report. EPA-454/R97001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, February 1997.

(14) Papp, M.L., J,B., Elkins, D.R., Musick and M.J., Messner, Data Quality Objectives for the $PM_{2.5}$. Monitoring Data, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. In preparation.

(15) Photochemical Assessment Monitoring Stations Implementation Manual. EPA-454/B-93-051, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, March 1994.

Tables to Appendix A of Part 58

TABLE A–1.—MINIMUM DATA ASSESSMENT REQUIREMENTS

Method	Assessment Method	Coverage	Minimum Frequency	Parameters Reported
Precision:				

TABLE A–1.—MINIMUM DATA ASSESSMENT REQUIREMENTS—Continued

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

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

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

Method Designation	Total # of Monitors	Total # Collocated	# of Collocated FRMs	# of Collocated Monitors of Same Type	# of Independent FRM Audits
FRM	25	6	6	n/a	6
Type A	10	3	2	1	3
Type C	2	1	1	0	1
Type D	6	2	1	1	2

m. Appendix C is amended by revising section 2.2 and adding sections 2.2.1 and 2.2.2, adding sections 2.4 through 2.5, revising section 2.7.1, and adding section 2.9 and references 4 through 6 to section 6.0 to read as follows:

Appendix C—Ambient Air Quality Monitoring Methodology

* * * * *

2.2 *Substitute PM_{10}* samplers.

2.2.1 For purposes of showing compliance with the NAAQS for particulate matter, a high volume TSP sampler described in 40 CFR part 50, Appendix B, may be used in a SLAMS in lieu of a PM_{10} monitor as long as the ambient concentrations of particles measured by the TSP sampler are below the PM_{10} NAAQS. If the TSP sampler measures a single value that is higher than the PM_{10} 24–hour standard, or if the annual average of its measurements is greater than the PM_{10} annual standard, the TSP sampler operating as a substitute PM_{10} sampler must be replaced with

a PM_{10} monitor. For a TSP measurement above the 24–hour standard, the TSP sampler should be replaced with a PM_{10} monitor before the end of the calendar quarter following the quarter in which the high concentration occurred. For a TSP annual average above the annual standard, the PM_{10} monitor should be operating by June 30 of the year following the exceedance.

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

* * * * *

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

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

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

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

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

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

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

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

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

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

2.4.5.1 A clear and unique description of the site at which the method or sampler will be used and tested, and a description of the nature or character of the site and the particulate matter that is expected to occur there.

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

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

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

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

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

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

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

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

* * * * *

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

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

* * * * *

6.0 *References.*

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

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

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

n. Appendix D is amended by revising in the table of contents the entries for 2.8, 3.7, 4., and 5. and adding an entry for 6., by revising the first three paragraphs and Table 1 of section 1., revising the second paragraph in section 2. and adding a new paragraph to the end of the section before section 2.1, revising section 2.8 and adding sections 2.8.0.1 through 2.8.2.3, revising the third and fifth paragraphs in section 3., revising section 3.7 and adding sections 3.7.1 through 3.7.7.4, revising the sixth paragraph in section 4.2 and redesignating Figures 1 and 2 as Figures 5 and 6 respectively, and revising the redesignated figures, revising footnote 3 of Table 2 of section 4.4, revising section 5. and reference 18 in section 6. to read as follows:

Appendix D—Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)

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2.8 Particulate Matter Design Criteria for SLAMS

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3.7 Particulate Matter Design Criteria for NAMS

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

5. Summary

6. References

1. *SLAMS Monitoring Objectives and Spatial Scales.*

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

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

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

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

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

(4) To determine general background concentration levels.

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

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

It should be noted that this Appendix contains no criteria for determining the total number of stations in SLAMS networks, except that a minimum number of lead SLAMS and $PM_{2.5}$ are prescribed and the minimal network introduced in § 58.20 is explained. The optimum size of a particular SLAMS network involves trade offs among data needs and available resources that EPA believes can best be resolved during the network design process.

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TABLE 1.—RELATIONSHIP AMONG MONITORING OBJECTIVES AND SCALE OF REPRESENTATIVENESS

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

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

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2. *SLAMS Network Design Procedures.*

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

* * * * *

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

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2.8 *Particulate Matter Design Criteria for SLAMS.*

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

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

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

2.8.0.3 Microscale—This scale would typify areas such as downtown street canyons and traffic corridors where the general public would be exposed to maximum concentrations from mobile sources. In some circumstances, the microscale is appropriate for particulate stations; core SLAMS on the microscale should, however, be limited to urban sites that are representative of long-term human exposure and of many such microenvironments in the area. In general, microscale particulate matter sites should be located near inhabited buildings or locations where the general public can be expected to be exposed to the concentration measured. Emissions from stationary sources such as primary and secondary smelters, power plants, and other large industrial processes may, under certain plume conditions, likewise result in high ground level concentrations at the microscale. In the latter case, the microscale would represent an area impacted by the plume with dimensions extending up to approximately 100 meters. Data collected at microscale stations provide information for evaluating and developing hot spot control measures. Unless these sites are indicative of population-oriented monitoring, they may be more appropriately classified as SPMs.

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

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

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

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

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

Development of effective pollution control strategies requires an understanding at regional geographical scales of the emission sources and atmospheric processes that are responsible for elevated $PM_{2.5}$ levels and may also be associated with elevated ozone and regional haze.

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

2.8.1.1 Monitoring Planning Areas.

Monitoring planning areas (MPAs) shall be used to conform to the community-oriented monitoring approach used for the $PM_{2.5}$ NAAQS given in part 50 of this chapter. MPAs are required to correspond to all metropolitan statistical areas (MSAs) with population greater than 200,000, and all other areas determined to be in violation of the $PM_{2.5}$ NAAQS.[1] MPAs for other designated parts of the State are optional. All MPAs shall be defined on the basis of existing, delineated mapping data such as State boundaries, county boundaries, zip codes, census blocks, or census block groups.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.8.1.3.2 The site situated in the area of expected maximum concentration is analogous to NAMS ''category a.'' [3] This will henceforth be termed a category a core SLAMS site. The site located in the area of poor air quality with high population density or representative of maximum population impact is analogous to NAMS, ''category b.'' This second site will be called a category b core SLAMS site.

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

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

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

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

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

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

2.8.1.4 Other $PM_{2.5}$ SLAMS Locations.

In addition to the required core sites described in section 2.8.1.3 of this Appendix, the State shall also install and operate on an every third day sampling schedule at least one SLAMS to monitor for regional background and at least one SLAMS to monitor regional transport. These monitoring stations may be at a community-oriented site and their requirement may be satisfied by a corresponding SLAMS monitor in an area having similar air quality in another State. The State shall also be required to establish additional SLAMS sites based on the total population outside the MSA(s) associated with monitoring planning areas that contain required core SLAMS. There shall be one such additional SLAMS for each 200,000 people. The minimum number of SLAMS may be deployed anywhere in the State to satisfy the

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

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

[3]The measured maximum concentrations at core population-oriented sites should be consistent with the averaging time of the NAAQS. Therefore, sites only with high concentrations for shorter averaging times (say 1-hour) should not be category ''a'' core SLAMS monitors.

SLAMS monitoring objectives including monitoring of small scale impacts which may not be community-oriented or for regional transport as described in section 1 of this Appendix. Other SLAMS may also be established and are encouraged in a State $PM_{2.5}$ network.

2.8.1.5 Additional $PM_{2.5}$ Analysis Requirements.

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

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

2.8.1.6 Community Monitoring Zones.

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

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

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

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

2.8.1.7 Selection of Monitoring Locations Within MPAs or CMZs.

2.8.1.7.1 Figure 1 of this Appendix illustrates a hypothetical monitoring planning area and shows the location of monitors in relation to population and areas of poor air quality. Figure 2 of this Appendix shows the same hypothetical MPA as Figure 1 of this Appendix and illustrates potential community monitoring zones and the location of core monitoring sites within them. Figure 3 of this Appendix illustrates which sites within the CMZs of the same MPA may be used for comparison to the $PM_{2.5}$ NAAQS.

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

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

Figure 1. Hypothetical Monitoring Planning Area

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

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

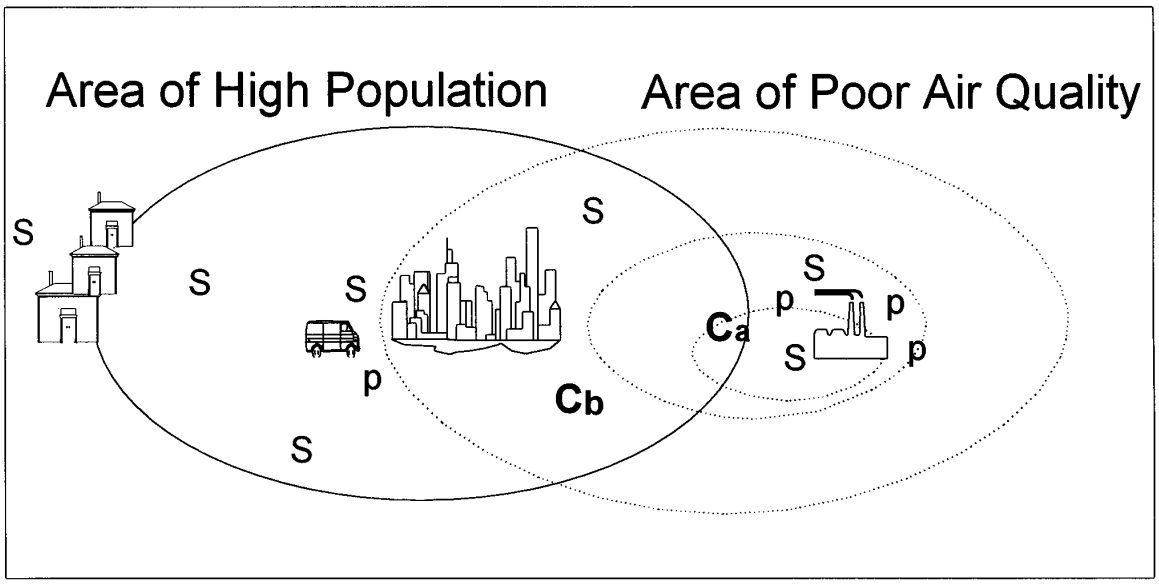
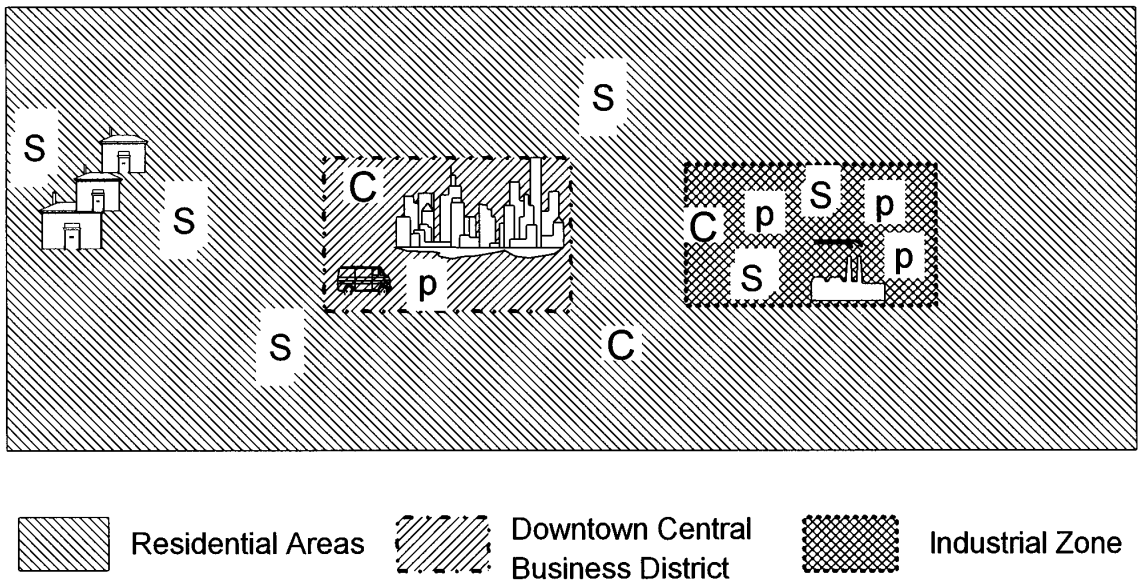


Figure 2. Hypothetical Monitoring Planning Area

Potential Community Monitoring Zones

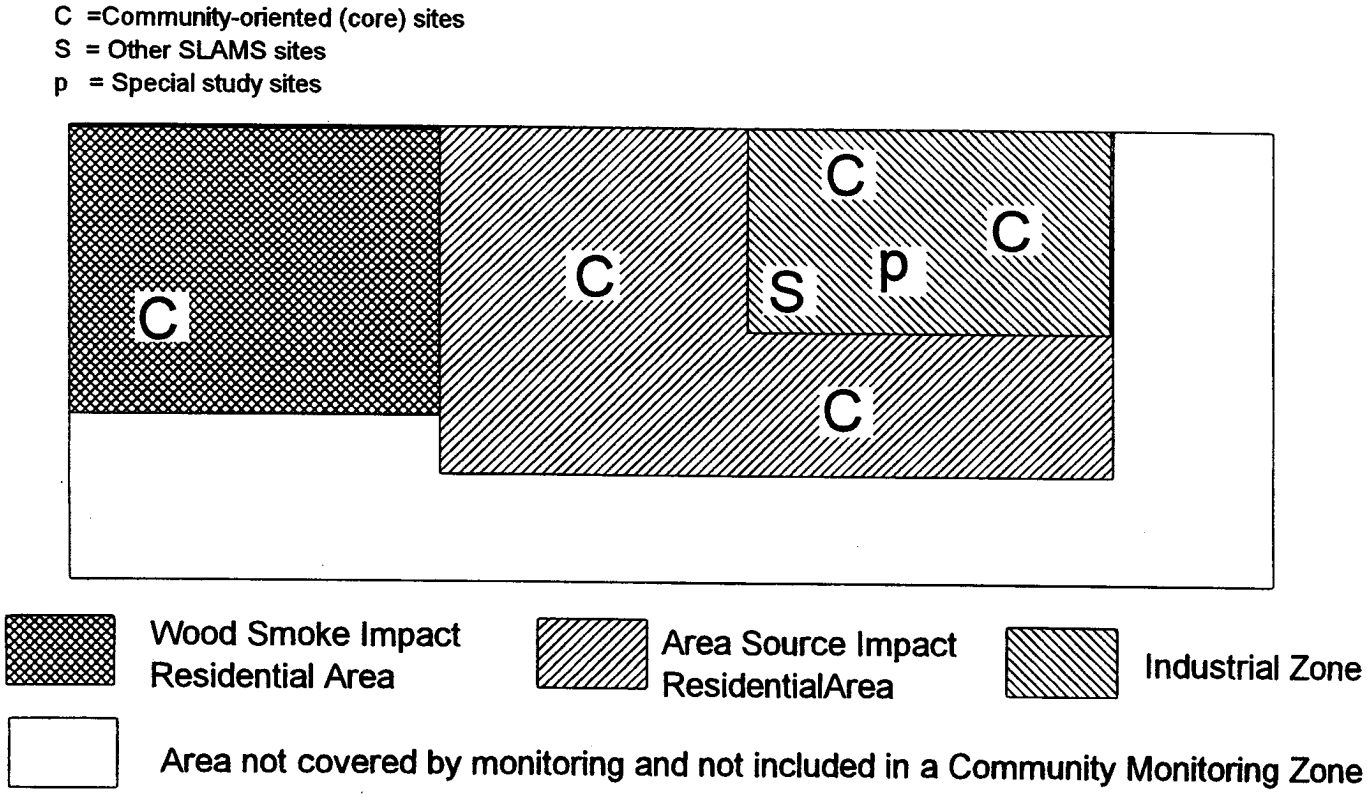
C=Core site S=other SLAMS site p=Special Purpose Monitor



2.8.1.7.4 Figure 3 of this Appendix illustrates how CMZs and $PM_{2.5}$ monitors might be located in a hypothetical MPA typical of a Western State. Western States with more localized sources of PM and larger geographic area could require a different mix of SLAMS and SPM monitors and may need more total monitors. As the networks are deployed, the available monitors may not be sufficient to completely represent all geographic portions of the Monitoring Planning Area. Due to the distribution of pollution and population and because of the number and spatial representativeness of monitors, the MPAs and CMZs may not cover the entire State.

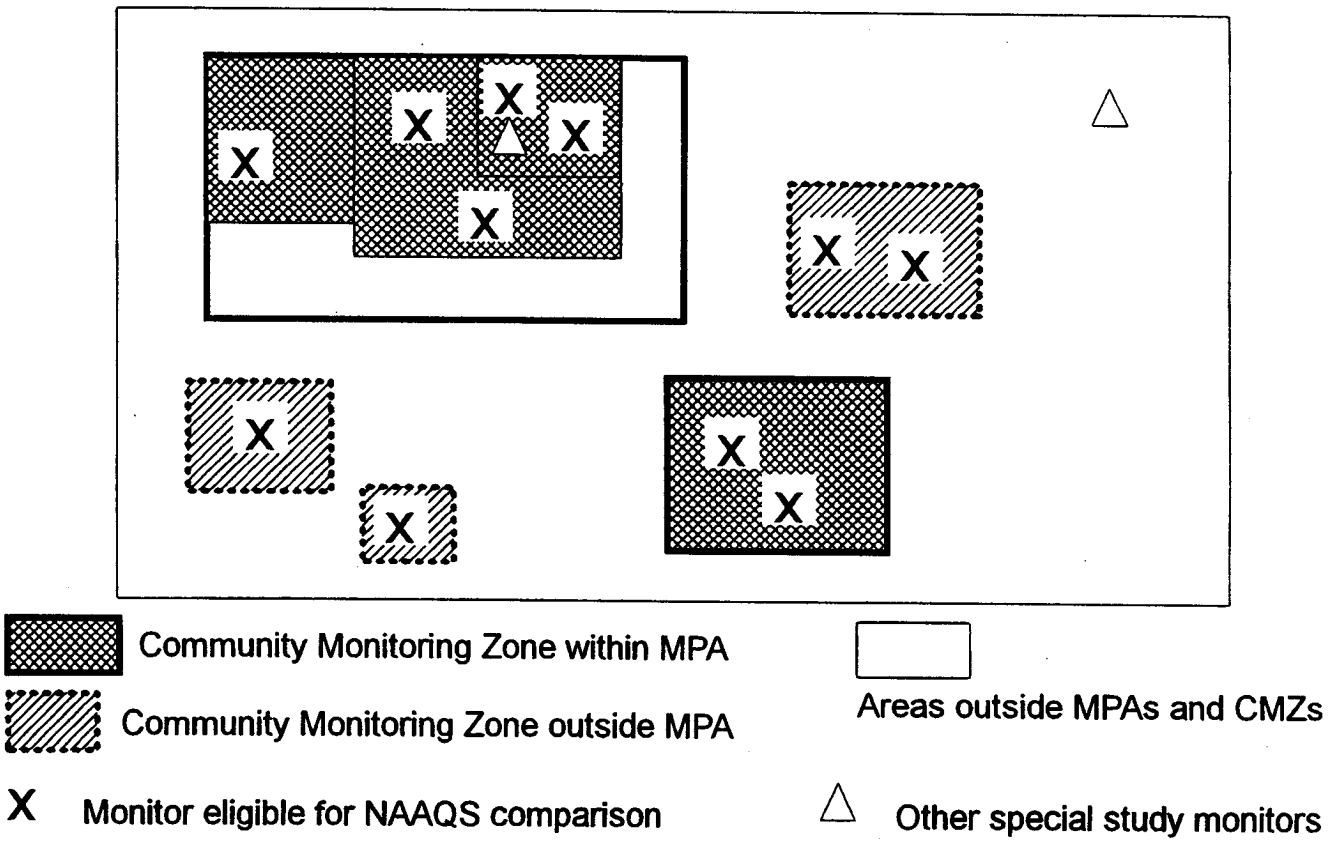
Figure 3. Hypothetical Monitoring Planning Area

Potential Community Monitoring Zones in Western MPA



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

Figure 4. MPAs and CMZs in Hypothetical State



2.8.2 *Substitute PM Monitoring Sites.*

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

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

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

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

* * * * *

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

* * * * *

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

* * * * *

3.7 *Particulate Matter Design Criteria for NAMS.*

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

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

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

3.7.4 The number of total $PM_{2.5}$ NAMS per Region will be based on recommendations of the EPA Regional Offices, in concert with their State and local agencies, in accordance with the network design goals described in sections 3.7.5 through 3.7.7 of this Appendix. The selected stations should represent the range of conditions occurring in the Regions and will consider factors such as total number or type of sources, ambient concentrations of particulate matter, and regional transport.

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

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

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

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

[Approximate Number of Stations per MSA][1]

Population Category	High Concentration[2]	Medium Concentration[3]	Low Concentration[4]
>1,000,000	6–10	4–8	2–4
500,000–1,000,000	4–8	2–4	1–2
250,000–500,000	3–4	1–2	0–1
100,000–250,000	1–2	0–1	0

[1] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.
[2] High concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding either PM_{10} NAAQS by 20 percent or more.
[3] Medium concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding 80 percent of the PM_{10} NAAQS.
[4] Low concentration areas are those for which ambient PM_{10} data show ambient concentrations less than 80 percent of the PM_{10} NAAQS.

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

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

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

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

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

EPA Region	Number of NAMS[1]	Percent of National Total
1	15 to 20	6 to 8
2	20 to 30	8 to 12

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

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

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

EPA Region	Number of NAMS [1]	Percent of National Total
Total	205–295	100

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

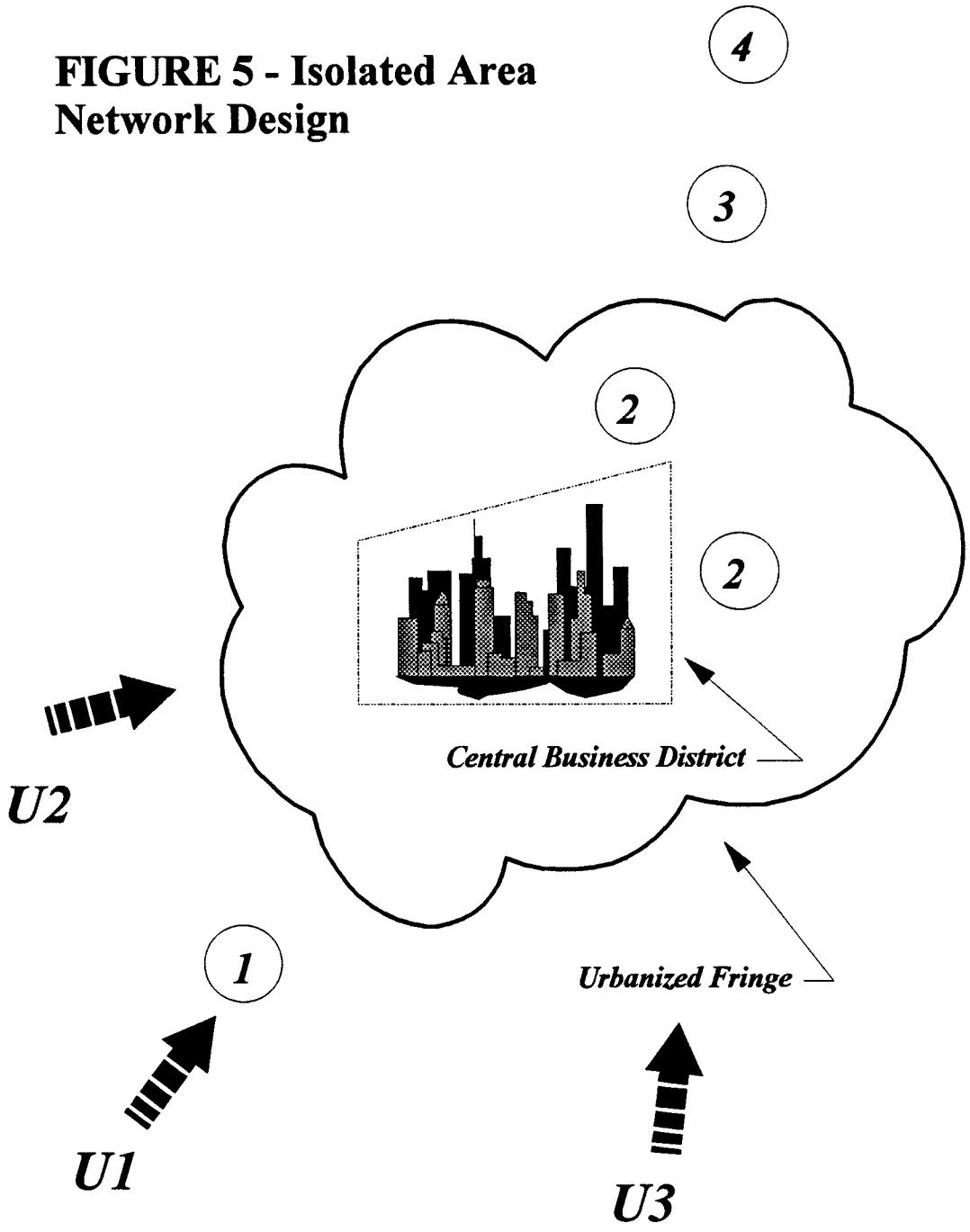
* * * * *

4.2 *PAMS Monitoring Objectives.*

* * * * *

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

FIGURE 5 - Isolated Area Network Design



LEGEND:

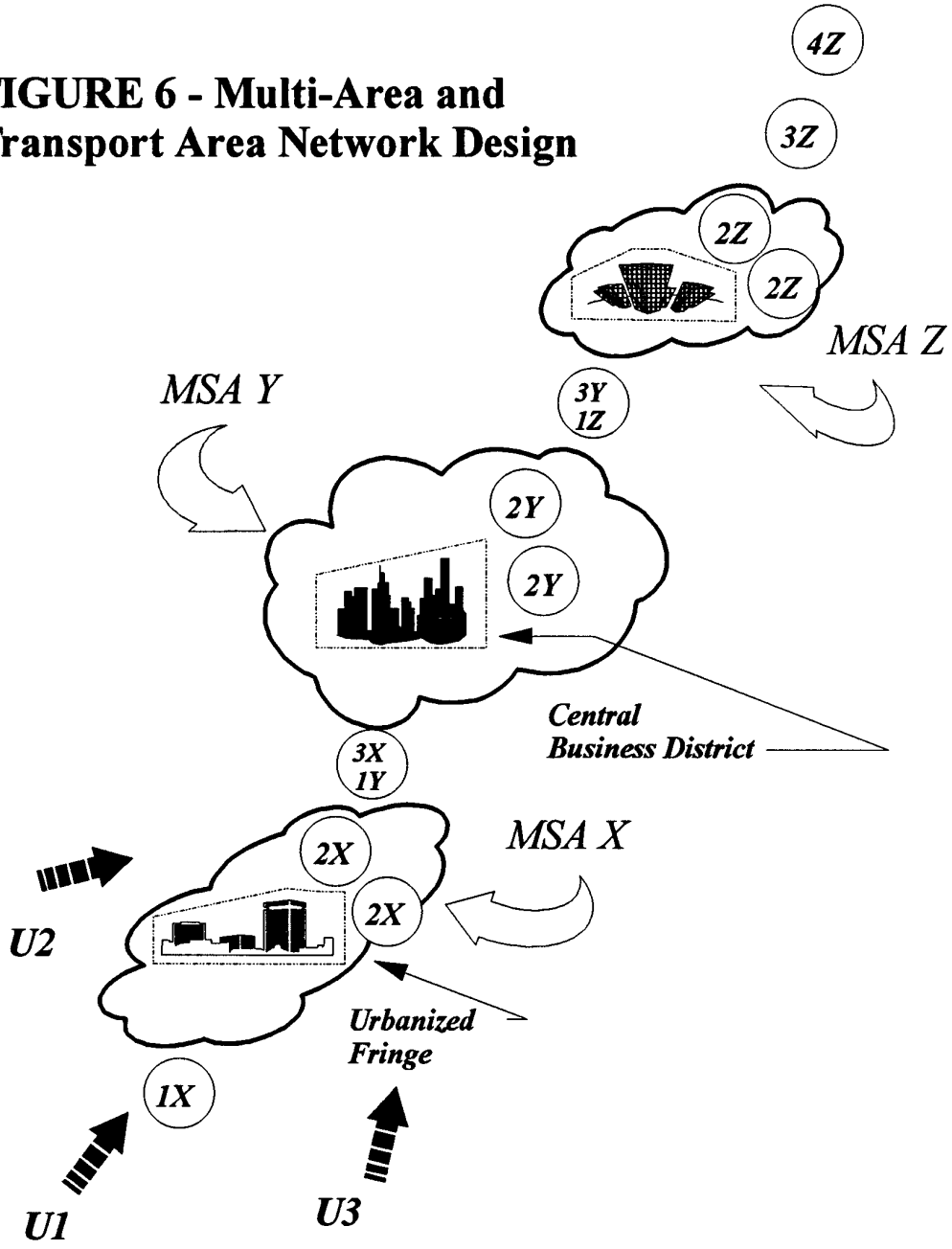
(1) - A circle denotes a PAMS Site. The number inside describes the Site number.

U1 - High ozone day predominant morning wind direction

U2 - Second most predominant high ozone day morning wind direction

U3 - High ozone day predominant afternoon wind direction

FIGURE 6 - Multi-Area and Transport Area Network Design



LEGEND:

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

U1 - High ozone day predominant morning wind direction

U2 - Second most predominant high ozone day morning wind direction

U3 - High ozone day predominant afternoon wind direction

* * * * *

4.4 *Minimum Monitoring Network Requirements.*

* * * * *

Table 2 * * *

[3]See Figure 5.

* * * * *

5. *Summary.*

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

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

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

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

6. *References.*

* * * * *

18. Watson et al. Guidance for Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC.

o. Appendix E is amended by revising the entry for 8. in the table of contents, by revising the heading to section 8., adding a sentence at the end of the first paragraph of section 8.1, and in section 8.3 removing the term ''PM_{10}'' wherever it appears and adding in its place ''PM'' to read as follows:

Appendix E—Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

* * * * *

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

* * * * *

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

8.1 Vertical Placement * * * Although microscale or middle scale stations are not the preferred spatial scale for $PM_{2.5}$ sites, there are situations where such sites are representative of several locations within an area where large segments of the population may live or work (e.g., central business district of Metropolitan area). In these cases, the sampler inlet for such microscale $PM_{2.5}$ stations must also be 2-7 meters above ground level.

* * * * *

p. Appendix F is amended by revising in the table of contents the entry for 2.7.3 and adding a new entry for 2.7.4, by redesignating section 2.7.3 as section 2.7.4 and adding a new section 2.7.3 to read as follows:

Appendix F—Annual SLAMS Air Quality Information

* * * * *

2.7.3 Annual Summary Statistics

2.7.4 Episode and Other Unscheduled Sampling Data

* * * * *

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

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

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