LESSON 2
Particulate Matter Standards

Goal

To familiarize you with the various clean air and particulate matter regulations and guidance documents.

Objectives

After completion of this lesson you should be able to:

1. identify the requirements to monitor ambient air for particulate matter in accordance with the National Ambient Air Quality Standards (NAAQS).
2. identify available network design guidance documents and uses for each of those documents.

Reading Assignment Topics

- History of the Clean Air Act (CAA) and NAAQS for particulate matter
- Particulate matter standards
- Network design guidance documents

Procedure

1. Read pages 6 through 15 of this manual.
2. Read sections 1.0 through 1.3 (pages 1-2 through 1-3) of *Guidance for the Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}.*
3. Complete the review exercise.
4. Check your answers using the answer key in Appendix A.
5. Review the pages from any material you missed.
6. Continue to Lesson 3

Reading Material

History of Particulate Matter Standards

Passed by Congress in 1970, the Clean Air Act (CAA) directs the U.S. Environmental Protection Agency (EPA) to identify and set national ambient air quality standards for pollutants that cause adverse effects to public health and the environment. The EPA has set National Ambient Air Quality Standards (NAAQS) for six common air pollutants — ground-level ozone (smog), carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, and particulate matter (measured as $PM_{2.5}$ and PM_{10}.) For each of these six pollutants, EPA has set health-based or "primary" standards to protect public health, and welfare-based or "secondary" standards to protect the environment, e.g. crops, vegetation, wildlife, buildings and national monuments, visibility, etc.

In 1971, the EPA set the NAAQS for total suspended particulates (TSP). That standard encompassed all forms of airborne particulate matter that may remain suspended in the atmosphere at 260 $\mu g/m^3$ for a 24 hour concentration and 75 $\mu g/m^3$ for an annual geometric average concentration. In 1987, the EPA replaced the TSP standard for inhalable particles with an aerodynamic diameter of 10 μm (PM_{10}) or less at 150 $\mu g/m^3$ for a 24 hour concentration and 50 $\mu g/m^3$ for an annual geometric average concentration.

Since the 1980s, the EPA has required States to monitor for PM_{10}. Recent health studies have indicated that the small particles included in PM_{10} can pose serious health threats. In December, 1996, EPA proposed new monitoring requirements for fine particles, those with an aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$), in conjunction with the proposed NAAQS for fine particles. This rule established monitoring protocols and the basis for a $PM_{2.5}$ monitoring network. On July 18, 1997, the final rules were promulgated. They became effective on September 16, 1997.

To ensure national consistency in air pollution monitoring, a Federal Reference Method is used for making comparisons to the standards. The Federal Reference Method is the ambient sampling device that defines the measurement of particulate matter.

Particulate Matter Standards

With the final rule, 40 CFR Part 50, the EPA changed the NAAQS for particulate matter by changing the form of the existing 24-hour standard for PM_{10} and adding a new indicator for $PM_{2.5}$.

Primary $PM_{2.5}$ Standards

Two new primary $PM_{2.5}$ standards, set at 15 μg/m^3, annual arithmetic mean, and 65 μg/m^3, 24-hour average, were added to provide increased protection against the PM-related health effects found in community studies. EPA also established a new Federal Reference Method to measure fine particles which define $PM_{2.5}$.

The EPA's scientific review concluded that it is most appropriate to consider fine and course mode particles as separate subclasses of pollutants. Statistically, significant positive associations have been found between fine particle concentrations and mortality and morbidity end points in studies conducted in a number of geographic locations in the U.S., Canada, and other countries. By contrast, the recent review found less direct epidemiological or toxicological evidence regarding the potential effects of coarse fraction particles at typical ambient concentrations.

The final rule establishes a new form for the annual particulate standards. Areas will be in compliance with the new annual $PM_{2.5}$ standard when the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations, from single or multiple community-oriented monitors, is less than or equal to 15 μg/m^3. The use of averages from single or multiple community-oriented sites is more closely linked to the underlying health effects information, which relates area wide health statistics to averaged measurements of area wide air quality. EPA believes this annual standard will provide a more protective target that will reduce area-wide population exposure to fine particles. Additionally, supplemental protection is afforded by a 24-hour standard, which is directed at peak concentrations and localized hot spots.

Year	Site 1	Site 2	Site 3	Site 4	Mean
1	12.7	–	–	–	12.7
2	13.3	17.4	14.7	–	15.1
3	12.9	16.7	12.3	20.1	15.5
3-Year Average					**14.4**

Table 2-1. Example of Attainment for $PM_{2.5}$ Annual Standard.

Table 2-1 illustrates an example that demonstrates how the annual standard would be applied. In the first year, concentrations are recorded at only one properly site air quality monitor, and the mean concentration is 12.7 μg/m^3. In the second year as the monitoring network grows, there are three valid monitoring sites. In this case, the mean concentrations for each site are averaged together to give an annual network average of 15.1 $\mu g/m^3$. In the third year there are four valid monitoring sites in the area. The mean values of each site are averaged together, resulting in a network mean of 15.5 $\mu g/m^3$.

Attainment of the standard is then determined by calculating a three-year average of the network means. In this example, the three-year average is 14.4 $\mu g/m^3$, indicating attainment of the standard.

The new 24-hour $PM_{2.5}$ standard is based on the 98th percentile of 24-hour $PM_{2.5}$ concentrations in a year (averaged over 3 years), at the population-oriented monitoring site with the highest measured values in an area. In other words, an area would be in attainment of the standard if the 98th percentile concentration averaged over three years is less than or equal to 65 $\mu g/m^3$. A monitoring site with the highest reading in an area would be the basis for the comparison.

Year	98th Percentile Concentration
1	68
2	57
3	60
3-Year Average	62

Table 2-2. Example of Attainment for $PM_{2.5}$ 24-Hour Standard.

Looking at the example in Table 2-2, the 98th percentile concentration at the population-oriented monitor recording the highest $PM_{2.5}$ concentrations in the area is 68 $\mu g/m^3$ in year one. In the second year, the 98th percentile concentration is 57 $\mu g/m^3$, and in the third year, 60 $\mu g/m^3$. The 3-year average of the 98th percentile concentrations is 62 $\mu g/m^3$. The area is in attainment of the standard.

The 24-hour standard will limit peak concentration in areas with high seasonal concentrations and in areas with localized hot spots due to particular sources. This form will reduce the impact of a single, high exposure event that may be due to unusual meteorological conditions, and would thus provide a more stable basis for effective control programs.

The percentile form compensates for missing data and less-than-every-day monitoring, thereby reducing or eliminating the need for complex procedures previously required for the PM_{10} attainment test. The forms of both the 24-hour and annual standard were adjusted to provide additional protection for community settings with higher than average concentrations within an area.

Revised Primary PM_{10} Standards

Based on its assessment of the health and other available information, EPA retained the annual PM_{10} standard of 50 $\mu g/m^3$ to protect against effects from both long- and short-term exposure to coarse fraction particles. EPA revised the PM_{10} 24-hour standard of 150 $\mu g/m^3$ by replacing the 1-expected-exceedance form of the PM_{10} 24-hour standard to the 99th percentile concentration-based form, averaged over 3 years. The concentration-based percentile form is a more stable target for control programs and eliminates the need for complex data handling for missing values.

Secondary PM Standards

EPA set the secondary standards identical to the final primary standards, in conjunction with establishment of a regional haze program. This approach provides appropriate protection against the welfare effects associated with particulate pollution including visibility impairment, soiling, and material damage.

$PM_{2.5}$ Monitoring Requirements

The final rule, 40 CFR Part 58, established a new criteria for placement of State and local air monitors (SLAMS), new schedules for data collection, and new procedures for ensuring the quality of particulate matter data.

Network Design

The new $PM_{2.5}$ network will consist of community-oriented or core monitors — many will be required to sample every day (or continuously) — and supplementary monitors which are allowed to sample less frequently. The core monitors are required in all of the largest metropolitan areas. The supplementary monitors will provide coverage in small cities and rural areas, some of which are intended to study the long-range transport of fine particles.

Frequent measurements will be focused in the most heavily polluted or densely populated areas and are important to understand the temporal behavior of $PM_{2.5}$. These monitors will also more precisely establish peak concentrations. This information will allow States to design effective emission control strategies to assure protection of public health.

The network of required monitors will be phased in over a two to three year period beginning in 1997. The regulations specify the following minimum requirements:

> In 1998, all metropolitan areas with at least 500,000 people are required to have at least one core monitor and each State is required to have at least two additional monitors. Additional monitoring sites

will also be established. Areas will be selected for monitoring by the State; States will select monitoring sites according to the likelihood of observing high $PM_{2.5}$ concentrations and based on the size of the affected population. In addition, one $PM_{2.5}$ site would be collocated at one PAMS monitoring site in each of the "serious," "severe," or "extreme" ozone nonattainment areas in order to study the relationship between ozone and fine particles. During the subsequent years, all other required core and other non-core monitors will be added, including those needed to study regional transport.

In addition, special purpose monitors (SPMs) may be used to identify potential $PM_{2.5}$ problem areas and help define the boundaries, clarify diurnal patterns, determine the spatial scale of high concentration areas, and help characterize the chemical composition of PM (using alternative samplers and supplemental analyzers), especially on high concentration days or during special studies. Special purpose monitors are an important part of the overall PM monitoring program, and the EPA is financially supporting their operation.

The new network design and siting requirements encourage the placement of $PM_{2.5}$ monitors outside population centers in more rural areas for two reasons:

1. to provide the air quality data necessary to facilitate implementation of the NAAQS and
2. to 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.

The network will also assist in reporting data to the public, especially during air pollution episodes. To these ends, additional monitoring requirements include the use of continuous particulate matter measuring devices (such as nephelometers) at some core monitoring sites.

Selected monitors will be set up to track long-term trends of $PM_{2.5}$ and its chemical constituents. This is necessary to understand the emission sources contributing to fine particles, study the effectiveness of emission control programs, and better understand trends in population exposure to fine particles. Additional monitors will also be established to measure the chemical constituents of $PM_{2.5}$ on an as needed basis.

Reference and Equivalent Samplers

The EPA has established a new Federal Reference Method for $PM_{2.5}$. Specifications for the reference method sampler allow various sampler manufacturers to design and fabricate samplers that will meet the specifications.

Three classes of equivalent methods are established. Class I equivalent methods provide capability for collection of several sequential samples automatically without intermediate operator service. This will permit easier and more cost efficient sampling on a daily basis. Class II equivalent methods include all other filter based methods that produce a 24-hour measurement. Finally, Class III equivalent methods include both continuous or semi-continuous methods.

Comparison to the Standards with Monitoring Data

Comparisons to the $PM_{2.5}$ annual standard will be based on data from core monitoring locations in order to provide increased protection against the PM-related health effects found in the community-based health studies. This may involve the maximum individual core monitor or a community-wide spatial average based on eligible core sites within a community monitoring zone. Additional population-oriented monitoring stations will be located in areas reflective of the highest measured values within each metropolitan area and elsewhere throughout the State for comparison to the 24-hour standards.

States will be divided into monitoring planning areas that in turn may contain community monitoring averaging zones. These zones are intended to contain reasonably homogenous air quality, influenced by similar sources of $PM_{2.5}$, and provide the basis for the selection of monitoring sites for community-wide air quality averaging. The designation of monitoring planning areas, community monitoring zones, and core sites eligible for comparison to the annual standard will be proposed by the State and are subject to EPA review and approval.

Finally, in order to encourage the deployment of SPMs, nonattainment designations will not be based on data produced at a SPM site, with any monitoring method, for the first two complete calendar years of its operation.

The rationale for this concept is based on the need for the nation to begin building a monitoring infrastructure from "ground zero." The EPA needs to build this infrastructure because $PM_{2.5}$ is a complex problem that cannot be addressed without data that will identify the sources of $PM_{2.5}$ and the location of problem areas.

Data Collection and Reporting

The ambient concentration of $PM_{2.5}$ (total mass) will be directly compared with the standards. Compositional analysis is essential to understanding $PM_{2.5}$. In addition, chemical analysis, required at approximately 50 sites nationwide, is encouraged in all monitoring areas. Following data collection, archiving collected $PM_{2.5}$ filters will be required for 1 year. These filters will be stored for possible subsequent compositional analysis that will help identify $PM_{2.5}$ emission sources and develop effective control programs.

The concentration of the total mass of $PM_{2.5}$ derived from the network of $PM_{2.5}$ samplers will be reported to the EPA. Although not required, the results from chemical analysis should also be reported to the EPA.

Because of the costs associated with conducting filter analysis on a routine basis, the standard only requires filters to be archived so they are available for analysis on an "as needed" basis. Archiving will help identify PM emission sources and develop effective control programs. The evaluation process will include the following considerations:

1) whether specific monitoring sites should be designated for such analyses.
2) the criteria to be used to select sites for speciated sampling and analysis.
3) the extent and frequency to which speciation should be required by EPA for at least some monitoring stations.
4) the need for monitoring methodologies not previously described that may be needed to facilitate compositional analysis.

Quality Assurance

EPA's standards for $PM_{2.5}$ require great attention in order to achieve data of high quality with minimal imprecision and relative error. This will reduce the chance that $PM_{2.5}$ measurements could lead to an unwarranted health risk to the population when measurements underestimate true concentrations or unnecessary control requirements when the true concentrations are over estimated.

Enhanced quality assurance will be required in all areas relating to sampler performance, manufacturing, and operation. A new operational requirement involves auditing each monitoring location using a Federal Reference Method sampler. This will ensure consistent data collection nationwide. The user agency will be required to obtain four 24 hour measurements with a reference method "audit" sampler for 25 percent of all routinely operating $PM_{2.5}$ SLAMS monitors. In addition, 25 percent of all $PM_{2.5}$ SLAMS samplers will be permanently collocated with a Federal reference or Federal equivalent $PM_{2.5}$ sampler. These data will be used to identify reporting organizations or individual sites that have abnormal bias or precision and instruments that are not operating properly. Data from these audits and collocated samplers will be also used to assess operating performance nationally.

PM_{10} Monitoring

Under the new rules, 40 CFR Parts 50 and 58, many of the previous monitoring approaches for PM_{10} will be retained. The principle modifications involve a change in the sampling frequency and a reduction in the number of data collection locations. The monitoring methods allowed for PM_{10} remain the same. The frequency of sampling will be changed to once in 3 days and the number of sampling locations are expected to be fewer because the $PM_{2.5}$ standards will likely be the controlling standards in most situations.

The network design and siting requirements for the annual and 24-hour PM_{10} NAAQS will continue to emphasize identification of locations with maximum concentrations.

The revised network will ensure continuation of the analysis of national trends in PM_{10}, maintenance of air surveillance in areas with established PM emission control programs, and protection of public health from additional growth in PM_{10} emissions.

PM_{10} sites should be collocated with new $PM_{2.5}$ sites at key population-oriented monitoring stations. The collocated sites will provide a better definition of fine and coarse contributions and a better understanding of exposure, emission controls, and atmospheric processes.

Network Design Guidance Documents

Guidance for the Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}

This guidance document provides a method and rationale for designing monitoring networks to determine compliance with newly enacted $PM_{2.5}$ and PM_{10} National Ambient Air Quality Standards. The guidance defines concepts and terms of network design, presents a methodology for defining planning areas and community monitoring zones, identifies data resources and the uses of those resources for network design, and provides some practical examples of applying the guidance.

Guidance for the Sampling and Analysis for $PM_{2.5}$ and PM_{10}

When the NAAQS for particulates was reevaluated, it was recognized that $PM_{2.5}$ and PM_{10} mass concentrations are indicators of adverse health effects. Chemical speciation, however, was deemed essential for establishing more specific relationships between particle concentrations and their sources. Chemical speciation facilitates understanding of PM temporal and spatial variations, source/receptor relationships, and the effectiveness of emissions reduction strategies. Establishment of a chemical speciation monitoring network and interpretation of the resulting mass and speciated chemical data will also prepare the scientific community for the next review of the NAAQS and revision of the air quality criteria document.

This guidance document describes $PM_{2.5}$ sampling equipment and methods that acquire filter deposits amenable to different chemical analyses, including Federal Reference Methods (FRM), Federal Equivalent Methods (FEM), and IMPROVE (Interagency Monitoring of Protected Visual Environments) methods. In addition, it identifies artifacts and interferences that result from filter sampling and handling and describes methods to minimize them. It associates chemical components found in suspended particles with analytical methods to quantify them and describes how those methods can be efficiently and accurately applied to many samples. The document provides guidance to evaluate the feasibility and practicality of different sampling and analysis combinations for a variety of monitoring situations and data uses. Finally, it specifies procedures for unifying field sampling and laboratory measurements to obtain data sets of defined accuracy, precision, validity, and equivalence.

Guidance for the Continuous Monitoring for $PM_{2.5}$ and PM_{10}

This guidance provides a survey of alternatives for continuous *in situ* measurements of suspended particles, their chemical components, and their gaseous precursors. Recent and anticipated advances in measurement technology are making available reliable and practical instruments for particle quantification over averaging times ranging from minutes to hours. These devices are advantageous because they provide instantaneous, telemetered results and can use limited manpower more efficiently than manual, filter-based methods. Commonly used continuous particle monitors measure inertial mass, electron absorption, light absorption, and light scattering properties of fine particles. Sulfur monitors can detect sulfate particles when the particles are reduced to a sulfur-containing gas. Electrical mobility and time of flight are other aerosol properties that are amenable to continuous measurement. The measurement principles, as well as the operating environments, differ from those of the $PM_{2.5}$ Federal Reference Method (FRM), and these differences vary between monitoring locations and time of year. These differences are caused by the different properties quantified by different measurement methods, modification of the aerosol by the sampling and analysis train, and different calibration methods. When the causes of these differences are understood, they can be used advantageously to determine where and when: 1) correlation's can be made with FRM measurements or mathematical adjustments can be made to provide good predictors of $PM_{2.5}$; 2) the differences can be related to a specific particle or source characteristic; and 3) Federal equivalence with FRMs is expected.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements

This QA Handbook provides information and guidance for those who must make judgments about the validity of data and accuracy of measurement systems. Methods described in the handbook objectively define the quality of measurements so that the non-meteorologist can communicate with the meteorologist, engineer, or environmental scientist with precision of meaning.

Electronic copies of all these guidance documents are available for downloading at EPA's Ambient Monitoring Technology Information Center (AMTIC) web site. The internet web address is:

http://www.epa.gov/ttn/amtic/amticpm.html

Review Exercise

1. True or False? One of the NAAQS for mass concentrations of particulates with an aerodynamic diameter lower than 2.5 μm is a 3 year annual average of $PM_{2.5}$ not to exceed 15 μg/m^3 from a single community-oriented monitoring site or the spatial average of eligible community-oriented monitoring sites in a monitoring area.

   a. True

   b. False

2. True or False? One of the NAAQS for mass concentrations of particulates with an aerodynamic diameter lower than 2.5 μm is a 3 year annual average of $PM_{2.5}$ not to exceed 15 μg/m^3 from any population-oriented monitoring site in a monitoring area.

   a. True

   b. False

3. One of the NAAQS for mass concentrations of particulates with an aerodynamic diameter lower than 10 μm is a 24-hour average of PM_{10} not to exceed ____ μg/m^3 for a 3 year average of annual ____ percentiles any monitoring site in a monitoring area.

   a. 50, 98th

   b. 50, 99th

   c. 150, 98th

   d. 150, 99th

4. The new network design and siting requirements encourges the placement of $PM_{2.5}$ monitors outside population centers in more rural areas

   a. to provide the air quality data necessary to facilitate implementation of the NAAQS

   b. to augment the existing visibility fine particle monitoring network.

   c. both a and b.

   d. neither a nor b.

Match the appropriate EPA document in column A with its primary use in column B. Answers maybe used once, more than once, or not at all.

Column A	Column B
5. ___ *Guidance for the Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}*	a. provides a survey of alternatives for *in situ* measurements of suspended particles, their chemical components, and their gaseous precursors
6. ___ *Guidance for the Sampling and Analysis for $PM_{2.5}$ and PM_{10}*	b. provides information and guidance about the validity of data and the accuracy of measurement systems
7. ___ *Guidance for the Continuous Monitoring for $PM_{2.5}$ and PM_{10}*	c. presents a methodology for defining planning areas and community monitoring zones
8. ___ *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements*	d. identifies artifacts and interferences that result from filter sampling and handling, and describes methods to minimize those artifacts and interferences

9. What are the four objectives of the EPA's *Guidance for the Network Design and Optimum Site Exposure for* $PM_{2.5}$ *and* PM_{10} document?

-
-
-
-

10. What are the four primary NAAQS that apply to mass concentrations of particulates with aerodynamic diameters lower than 10 µm and 2.5 µm?

-
-
-
-

Required Readings

GUIDANCE FOR NETWORK DESIGN AND OPTIMUM SITE EXPOSURE FOR $PM_{2.5}$ AND PM_{10}

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DISCLAIMER

The development of this document has been funded by the U.S. Environmental Protection Agency, under cooperative agreement CX824291-01-1, and by the Desert Research Institute of the University and Community College System of Nevada. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. The examples presented in this guidance for Alabama and California were selected for illustration purposes only, and they are not intended to represent the actual networks that might be implemented by the responsible agencies. This guidance represents EPA's current views on these issues and do not bind the States and public as a matter of law. This document has not been subject to the Agency's peer and administrative review, and does not necessarily represent Agency policy.

ABSTRACT

This guidance provides a method and rationale for designing monitoring networks to determine compliance with newly enacted $PM_{2.5}$ and PM_{10} National Ambient Air Quality Standards. It defines concepts and terms of network design, presents a methodology for defining planning areas and community monitoring zones, identifies data resources and the uses of those resources for network design, and provides some practical examples of applying the guidance. $PM_{2.5}$ monitoring sites are to be population-oriented, measuring exposures where people live, work, and play. For comparison to the annual $PM_{2.5}$ standard, the locations must be community-oriented and as such, these do not necessarily correspond to the locations of highest PM concentrations in an area. Existing Metropolitan Statistical Areas are first examined to determine where the majority of the people live in each state. These are then broken down into smaller populated entities which may include county, zip code, census tract, or census block boundaries. Combinations of these population entities are combined to define Metropolitan Planning Areas. These may be further sub-divided into Community Monitoring Zones, based on examination of existing PM measurements, source locations, terrain, and meteorology. Finally, $PM_{2.5}$ monitors are located at specific sites that represent neighborhood or urban scales to determine compliance with the annual standard and at maximum, population oriented locations for comparison with the 24-hour standard. Transport and background sites are located between and away from planning areas to determine regional increments to PM measured within the planning area.

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1.0 INTRODUCTION

This document provides guidance for locating monitoring stations to measure compliance with national standards for Suspended Particulate Matter (PM) in the atmosphere. PM has been shown to adversely affect public health when susceptible populations are exposed to excessive concentrations (U.S. EPA, 1996; Vedal, 1997). National Ambient Air Quality Standards (NAAQS) for PM have been established to minimize the adverse effects of PM on the majority of U.S. residents. This guidance document is based on the new NAAQS (U.S. EPA, 1997). This document may be revised where necessary as it is further refined by actual application to network design during the implementation of the new monitoring program. The NAAQS apply to the mass concentrations of particulates with aerodynamic diameters lower than 10 µm (PM_{10}) and 2.5 µm ($PM_{2.5}$) and are described as follows (U.S. EPA, 1997):

- Twenty-four hour average $PM_{2.5}$ not to exceed 65 µg/m^3 for a three-year average of annual 98th percentiles at any population-oriented monitoring site in a monitoring area.

- Three-year annual average $PM_{2.5}$ not to exceed 15 µg/m^3 concentrations from a single community-oriented monitoring site or the spatial average of eligible community-oriented monitoring sites in a monitoring area.

- Twenty-four hour average PM_{10} not to exceed 150 µg/m^3 for a three-year average of annual 99th percentiles at any monitoring site in a monitoring area.

- Three-year average PM_{10} not to exceed 50 µg/m^3 for three annual average concentrations at any monitoring site in a monitoring area.

The $PM_{2.5}$ NAAQS are new. While the PM_{10} NAAQS retain the same values as the prior NAAQS (U.S. EPA, 1987), their form is new. Previously, the PM NAAQS applied to the highest 24-hour or annual averages found within a monitoring planning area, and monitoring networks were often designed to measure these highest values. These networks did not necessarily represent the overall exposure of populations to excessive PM concentrations. Some data from these networks were disregarded by epidemiologists as being unrelated to health indicators such as hospital admissions and death. Air quality districts may have been reluctant to locate source-oriented monitors that might assist in understanding source impacts because such monitors might cause a large area to be designated in non-attainment of NAAQS.

The new forms for these standards are intended to provide more robust measures for the PM indicator. While PM_{10} network design and siting criteria are unchanged, new $PM_{2.5}$ monitoring networks to determine compliance or non-compliance are intended to best represent the exposure of populations that might be affected by elevated $PM_{2.5}$ concentrations. As used in this document, the word compliance means attainment of a NAAQS. This involves new concepts of spatial averaging and the operation of some monitoring sites for $PM_{2.5}$ measurements that are not eligible for comparison to one or both of the $PM_{2.5}$ NAAQS. Special Purpose Monitoring sites that help to understand the causes of non-compliance are encouraged by excluding their data from the compliance determination during the first two years of their operation. The number of monitors in the existing PM_{10} network will likely decrease as new $PM_{2.5}$ sites are established. The $PM_{2.5}$ sites may or may not be collocated with PM_{10} monitoring locations. This guidance for network design and optimum site exposure of PM_{10} and $PM_{2.5}$ monitors describes how particulate monitoring networks can comply with these intentions.

1.1 Objectives of Guidance

The objectives of the guidance specified here are to:

- Define concepts and terms of network design.
- Present a methodology for defining planning areas and selecting and evaluating monitoring sites in a network.
- Summarize the availability and usage of existing resources for network design.
- Demonstrate the methodology in practical applications.

This guidance builds upon the guidance specified by Koch and Rector (1987) for PM_{10} monitoring associated with the previous PM NAAQS. It also considers recent advances in sampling theory, the availability of different types of data over the Internet and on CD-ROM, and the practical experience of different air quality management districts.

Network design guidance must be more specific than in the past with respect to types of sites and what they represent. It should identify data available to make judgments on site selection and define methods to use these data for those judgments. It should provide methods to evaluate the extent to which these judgments were valid. This guidance intends to provide this specificity.

1.2 Schedule and Approvals for Network Design and Implementation

The implementation of network design, operation and evaluation for the revised PM NAAQS follows this schedule:

- **July 18, 1997:** Standards were promulgated.
- **September 16, 1997:** Standards became effective.
- **October–December, 1997:** Guidance is applied by state and local agencies in test areas and procedures are refined. Network deployment is completed.
- **January 1, 1998:** Network design guidance is finalized and the regulated requirement of $PM_{2.5}$ monitoring commences.

- **July 1, 1998:** Each state submits a PM monitoring network description to its EPA Regional Administrator describing its network.

- **September 16, 1998:** Commence operation of at least one core $PM_{2.5}$ SLAMS site in each MSA with population greater than 500,000, one site in each PAMS area, and two additional SLAMS sites per state. See footnote [1].

- **July 1, 1999, 2000, 2001, 2002, etc.:** State and local agencies submit annual monitoring reports and network evaluations, based on data from previous calendar year.

- **September 16, 1999:** Commence operation of other required SLAMS sites (including all required core SLAMS, required regional background and regional transport SLAMS, continuous PM monitors in areas with population greater than 1 million, and all additional required $PM_{2.5}$ SLAMS). See footnote [1].

- **September 16, 2000:** Commence operation of additional sites (e.g., sites classified as SLAMS/SPM to complete the mature network). See footnote.[1]

1.3 Related Documents

Other documents related to PM monitoring networks are:

- The Federal Register for July 18, 1997, pages 38652-38760 and 38764-38854, describe the proposed new PM standards, monitoring requirements, and designation of reference and equivalent methods for $PM_{2.5}$ (U.S. EPA, 1997).

[1] Network deployment schedules as defined by 40 CFR part 58. Accelerated schedule may be dictated by additional guidance and EPA policy.

APPENDIX A
Answers to Review Exercises

Lesson 2

1. a
2. b
3. d
4. c
5. c
6. d
7. a
8. b
9.
   - define concepts and terms of network design.
   - summarize the availability and usage of existing resources for network design.
   - demonstrate the methodology in practical applications.
   - present a methodology for defining planning areas and selecting and evaluating monitoring sites in a network.
10.
   - Twenty-four hour average $PM_{2.5}$ not to exceed 65 µg/m^3 for a three-year average of annual 98th percentiles at any population-oriented monitoring site in a monitoring area.
   - Three-year annual average $PM_{2.5}$ not to exceed 15 µg/m^3 concentrations from a single community-oriented monitoring site or the spatial average of eligible community-oriented monitoring sites in a monitoring area.
   - Twenty-four hour average PM_{10} not to exceed 150 µg/m^3 for a three-year average of annual with percentiles at any monitoring site in a monitoring area.
   - Three-year average PM_{10} not to exceed 50 µg/m^3 for three annual average concentrations at any monitoring site in a monitoring area.

Lesson 3

1. less than 0.08 µm
2. from 0.08 µm to 2.5 µm
3. greater than 2.5 µm