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[71 FR 61313, Oct. 17, 2006, as amended at 73 FR 67061, Nov. 12, 2008; 75 FR 6534, Feb. 9, 2010]

## Appendix D to Part 58—Network Design Criteria for Ambient Air Quality Monitoring

1. Monitoring Objectives and Spatial Scales
2. General Monitoring Requirements
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### 1. Monitoring Objectives and Spatial Scales

The purpose of this appendix is to describe monitoring objectives and general criteria to be applied in establishing the required SLAMS ambient air quality monitoring stations and for choosing general locations for additional monitoring sites. This appendix also describes specific requirements for the number and location of FRM, FEM, and ARM sites for specific pollutants, NCore multipollutant sites, $PM_{10}$ mass sites, $PM_{2.5}$ mass sites, chemically-speciated $PM_{2.5}$ sites, and $O_3$ precursor measurements sites (PAMS). These criteria will be used by EPA in evaluating the adequacy of the air pollutant monitoring networks.

1.1 Monitoring Objectives. The ambient air monitoring networks must be designed to meet three basic monitoring objectives. These basic objectives are listed below. The appearance of any one objective in the order of this list is not based upon a prioritized scheme. Each objective is important and must be considered individually.

(a) Provide air pollution data to the general public in a timely manner. Data can be presented to the public in a number of attractive ways including through air quality maps, newspapers, Internet sites, and as part of weather forecasts and public advisories.

(b) Support compliance with ambient air quality standards and emissions strategy development. Data from FRM, FEM, and ARM monitors for NAAQS pollutants will be used for comparing an area's air pollution levels against the NAAQS. Data from monitors of various types can be used in the development of attainment and maintenance plans. SLAMS, and especially NCore station data, will be used to evaluate the regional air quality models used in developing emission strategies, and to track trends in air pollution abatement control measures' impact on improving air quality. In monitoring locations near major air pollution sources, source-oriented monitoring data can provide insight into how well industrial sources are controlling their pollutant emissions.

(c) Support for air pollution research studies. Air pollution data from the NCore network can be used to supplement data collected by researchers working on health effects assessments and atmospheric processes, or for monitoring methods development work.

1.1.1 In order to support the air quality management work indicated in the three basic air monitoring objectives, a network must be designed with a variety of types of monitoring sites. Monitoring sites must be capable of informing managers about many things including the peak air pollution levels, typical levels in populated areas, air pollution transported into and outside of a city or region, and air pollution levels near specific sources. To summarize some of these sites, here is a listing of six general site types:

(a) Sites located to determine the highest concentrations expected to occur in the area covered by the network.

(b) Sites located to measure typical concentrations in areas of high population density.

(c) Sites located to determine the impact of significant sources or source categories on air quality.

(d) Sites located to determine general background concentration levels.

(e) Sites located to determine the extent of regional pollutant transport among populated areas; and in support of secondary standards.

(f) Sites located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts.

1.1.2 This appendix contains criteria for the basic air monitoring requirements. The total number of monitoring sites that will serve the variety of data needs will be substantially higher than these minimum requirements provide. The optimum size of a particular network involves trade-offs among data needs and available resources. This regulation intends to provide for national air monitoring needs, and to lend support for the flexibility necessary to meet data collection needs of area air quality managers. The EPA, State, and local agencies will periodically collaborate on network design issues through the network assessment process outlined in §58.10.

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

1.2 Spatial Scales. (a) To clarify the nature of the link between general monitoring objectives, site types, and the physical location of a particular monitor, the concept of spatial scale of representativeness is defined. The goal in locating monitors is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring site type, air pollutant to be measured, and the monitoring objective.

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

(1) *Microscale*—Defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.

(2) *Middle scale*—Defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.

(3) *Neighborhood scale*—Defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range. The neighborhood and urban scales listed below have the potential to overlap in applications that concern secondarily formed or homogeneously distributed air pollutants.

(4) *Urban scale*—Defines concentrations within an area of city-like dimensions, on the order of 4 to 50 kilometers. Within a city, the geographic placement of sources may result in there being no single site that can be said to represent air quality on an urban scale.

(5) *Regional scale*—Defines usually a rural area of reasonably homogeneous geography without large sources, and extends from tens to hundreds of kilometers.

(6) *National and global scales*—These measurement scales represent concentrations characterizing the nation and the globe as a whole.

(c) Proper siting of a monitor requires specification of the monitoring objective, the types of sites necessary to meet the objective, and then the desired spatial scale of representativeness. For example, consider the case where the objective is to determine NAAQS compliance by understanding the maximum ozone concentrations for an area. Such areas would most likely be located downwind of a metropolitan area, quite likely in a suburban residential area where children and other susceptible individuals are likely to be outdoors. Sites located in these areas are most likely to represent an urban scale of measurement. In this example, physical location was determined by considering ozone precursor emission patterns, public activity, and meteorological characteristics affecting ozone formation and dispersion. Thus, spatial scale of representativeness was not used in the selection process but was a result of site location.

(d) In some cases, the physical location of a site is determined from joint consideration of both the basic monitoring objective and the type of monitoring site desired, or required by this appendix. For example, to determine $PM_{2.5}$ concentrations which are typical over a geographic area having relatively high $PM_{2.5}$ concentrations, a neighborhood scale site is more appropriate. Such a site would likely be located in a residential or commercial area having a high overall $PM_{2.5}$ emission density but not in the immediate vicinity of any single dominant source. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the monitoring site.

(e) In either case, classification of the monitor by its type and spatial scale of representativeness is necessary and will aid in interpretation of the monitoring data for a particular monitoring objective (e.g., public reporting, NAAQS compliance, or research support).

(f) Table D–1 of this appendix illustrates the relationship between the various site types that can be used to support the three basic monitoring objectives, and the scales of representativeness that are generally most appropriate for that type of site.

TABLE D–1 OF APPENDIX D TO PART 58—RELATIONSHIP BETWEEN SITE TYPES AND SCALES OF REPRESENTATIVENESS

| Site type | Appropriate siting scales |
|---|---|
| 1. Highest concentration .... | Micro, middle, neighborhood (*sometimes* urban or regional for secondarily formed pollutants). |
| 2. Population oriented ........ | Neighborhood, urban. |
| 3. Source impact ............... | Micro, middle, neighborhood. |
| 4. General/background & regional transport. | Urban, regional. |
| 5. Welfare-related impacts | Urban, regional. |

2. GENERAL MONITORING REQUIREMENTS

(a) The National ambient air monitoring system includes several types of monitoring stations, each targeting a key data collection need and each varying in technical sophistication.

(b) Research grade sites are platforms for scientific studies, either involved with health or welfare impacts, measurement methods development, or other atmospheric studies. These sites may be collaborative efforts between regulatory agencies and researchers with specific scientific objectives for each. Data from these sites might be collected with both traditional and experimental techniques, and data collection might involve specific laboratory analyses not common in routine measurement programs. The research grade sites are not required by regulation; however, they are included here due to their important role in supporting the air quality management program.

(c) The NCore multipollutant sites are sites that measure multiple pollutants in order to provide support to integrated air quality management data needs. NCore sites include both neighborhood and urban scale measurements in general, in a selection of metropolitan areas and a limited number of more rural locations. Continuous monitoring methods are to be used at the NCore sites when available for a pollutant to be measured, as it is important to have data collected over common time periods for integrated analyses. NCore multipollutant sites are intended to be long-term sites useful for a variety of applications including air quality trends analyses, model evaluation, and tracking metropolitan area statistics. As such, the NCore sites should be placed away from direct emission sources that could substantially impact the ability to detect area-wide concentrations. The Administrator must approve the NCore sites.

(d) Monitoring sites designated as SLAMS sites, but not as NCore sites, are intended to address specific air quality management interests, and as such, are frequently single-pollutant measurement sites. The EPA Regional Administrator must approve the SLAMS sites.

(e) This appendix uses the statistical-based definitions for metropolitan areas provided by the Office of Management and Budget and the Census Bureau. These areas are referred to as metropolitan statistical areas (MSA), micropolitan statistical areas, core-based statistical areas (CBSA), and combined statistical areas (CSA). A CBSA associated with at least one urbanized area of 50,000 population or greater is termed a Metropolitan Statistical Area (MSA). A CBSA associated with at least one urbanized cluster of at least 10,000 population or greater is termed a Micropolitan Statistical Area. CSA consist of two or more adjacent CBSA. In this appendix, the term MSA is used to refer to a Metropolitan Statistical Area. By definition, both MSA and CSA have a high degree of integration; however, many such areas cross State or other political boundaries. MSA and CSA may also cross more than one air shed. The EPA recognizes that State or local agencies must consider MSA/CSA boundaries and their own political boundaries and geographical characteristics in designing their air monitoring networks. The EPA recognizes that there may be situations where the EPA Regional Administrator and the affected State or local agencies may need to augment or to divide the overall MSA/CSA monitoring responsibilities and requirements among these various agencies to achieve an effective network design. Full monitoring requirements apply separately to each affected State or local agency in the absence of an agreement between the affected agencies and the EPA Regional Administrator.

3. DESIGN CRITERIA FOR NCORE SITES

(a) Each State (i.e. the fifty States, District of Columbia, Puerto Rico, and the Virgin Islands) is required to operate at least one NCore site. States may delegate this requirement to a local agency. States with many MSAs often also have multiple air sheds with unique characteristics and, often, elevated air pollution. These States include, at a minimum, California, Florida, Illinois, Michigan, New York, North Carolina, Ohio, Pennsylvania, and Texas. These States are required to identify one to two additional NCore sites in order to account for their unique situations. These additional sites shall be located to avoid proximity to large emission sources. Any State or local agency can propose additional candidate NCore sites or modifications to these requirements for approval by the Administrator. The NCore locations should be leveraged with other multipollutant air monitoring sites including PAMS sites, National Air Toxics Trends Stations (NATTS) sites, CASTNET sites, and STN sites. Site leveraging includes using the same monitoring platform and equipment to meet the objectives of the variety of programs where possible and advantageous.

(b) The NCore sites must measure, at a minimum, $PM_{2.5}$ particle mass using continuous and integrated/filter-based samplers, speciated $PM_{2.5}$, $PM_{10-2.5}$ particle mass, speciated $PM_{10-2.5}$, $O_3$, $SO_2$, CO, NO/$NO_y$, wind speed, wind direction, relative humidity, and ambient temperature. NCore sites in CBSA with a population of 500,000 people (as determined in the latest Census) or greater shall also measure Pb either as Pb-TSP or Pb-$PM_{10}$. The EPA Regional Administrator may approve an alternative location for the Pb measurement where the alternative location would be more appropriate for logistical reasons and the measurement would provide data on typical Pb concentrations in the CBSA.

(1) Although the measurement of $NO_y$ is required in support of a number of monitoring objectives, available commercial instruments may indicate little difference in their measurement of $NO_y$ compared to the conventional measurement of $NO_X$, particularly in areas with relatively fresh sources of nitrogen emissions. Therefore, in areas with negligible expected difference between $NO_y$ and $NO_X$ measured concentrations, the Administrator may allow for waivers that permit $NO_X$ monitoring to be substituted for the required $NO_y$ monitoring at applicable NCore sites.

(2) EPA recognizes that, in some cases, the physical location of the NCore site may not be suitable for representative meteorological measurements due to the site's physical surroundings. It is also possible that nearby meteorological measurements may be able to fulfill this data need. In these cases, the requirement for meteorological monitoring can be waived by the Administrator.

(c) [Reserved]

(d) Siting criteria are provided for urban and rural locations. Sites with significant historical records that do not meet siting criteria may be approved as NCore by the Administrator. Sites with the suite of NCore measurements that are explicitly designed for other monitoring objectives are exempt from these siting criteria (e.g., a near-roadway site).

(1) Urban NCore stations are to be generally located at urban or neighborhood scale to provide representative concentrations of exposure expected throughout the metropolitan area; however, a middle-scale site may be acceptable in cases where the site can represent many such locations throughout a metropolitan area.

(2) Rural NCore stations are to be located to the maximum extent practicable at a regional or larger scale away from any large local emission source, so that they represent ambient concentrations over an extensive area.

## 4. Pollutant-Specific Design Criteria for SLAMS Sites

4.1 Ozone ($O_3$) Design Criteria. (a) State, and where appropriate, local agencies must operate $O_3$ sites for various locations depending upon area size (in terms of population and geographic characteristics) and typical peak concentrations (expressed in percentages below, or near the $O_3$ NAAQS). Specific SLAMS $O_3$ site minimum requirements are included in Table D–2 of this appendix. The NCore sites are expected to complement the $O_3$ data collection that takes place at single-pollutant SLAMS sites, and both types of sites can be used to meet the network minimum requirements. The total number of $O_3$ sites needed to support the basic monitoring objectives of public data reporting, air quality mapping, compliance, and understanding $O_3$-related atmospheric processes will include more sites than these minimum numbers required in Table D–2 of this appendix. The EPA Regional Administrator and the responsible State or local air monitoring agency must work together to design and/or maintain the most appropriate $O_3$ network to service the variety of data needs in an area.

Table D–2 of Appendix D to Part 58—SLAMS Minimum $O_3$ Monitoring Requirements

| MSA population[1,2] | Most recent 3-year design value concentrations ≥85% of any $O_3$ NAAQS[3] | Most recent 3-year design value concentrations <85% of any $O_3$ NAAQS[3,4] |
|---|---|---|
| >10 million | 4 | 2 |
| 4–10 million | 3 | 1 |
| 350,000–<4 million | 2 | 1 |
| 50,000–<350,000[5] | 1 | 0 |

[1] Minimum monitoring requirements apply to the Metropolitan statistical area (MSA).

[2] Population based on latest available census figures.

[3] The ozone ($O_3$) National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.

[4] These minimum monitoring requirements apply in the absence of a design value.

[5] Metropolitan statistical areas (MSA) must contain an urbanized area of 50,000 or more population.

(b) Within an $O_3$ network, at least one $O_3$ site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that particular metropolitan area. More than one maximum concentration site may be necessary in some areas. Table D–2 of this appendix does not account for the full breadth of additional factors that would be considered in designing a complete $O_3$ monitoring program for an area. Some of these additional factors include geographic size, population density, complexity of terrain and meteorology, adjacent $O_3$ monitoring programs, air pollution transport from neighboring areas, and measured air quality in comparison to all forms of the $O_3$ NAAQS (i.e., 8-hour and 1-hour forms). Networks must be designed to account for all of these area characteristics. Network designs must be re-examined in periodic network assessments. Deviations from the above $O_3$ requirements are allowed if approved by the EPA Regional Administrator.

(c) The appropriate spatial scales for $O_3$ sites are neighborhood, urban, and regional. Since $O_3$ requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small scale spatial variability.

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

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

(3) *Regional scale*—This scale of measurement will be used to typify concentrations over large portions of a metropolitan area and even larger areas with dimensions of as much as hundreds of kilometers. Such measurements will be useful for assessing the $O_3$ that is transported to and from a metropolitan area, as well as background concentrations. In some situations, particularly when considering very large metropolitan areas with complex source mixtures, regional scale sites can be the maximum concentration location.

(d) EPA's technical guidance documents on $O_3$ monitoring network design should be used to evaluate the adequacy of each existing $O_3$ monitor, to relocate an existing site, or to locate any new $O_3$ sites.

(e) For locating a neighborhood scale site to measure typical city concentrations, a reasonably homogeneous geographical area near the center of the region should be selected which is also removed from the influence of major $NO_X$ sources. For an urban scale site to measure the high concentration areas, the emission inventories should be used to define the extent of the area of important nonmethane hydrocarbons and $NO_X$ emissions. The meteorological conditions that occur during periods of maximum photochemical activity should be determined. These periods can be identified by examining the meteorological conditions that occur on the highest $O_3$ air quality days. Trajectory analyses, an evaluation of wind and emission patterns on high $O_3$ days, can also be useful in evaluating an $O_3$ monitoring network. In areas without any previous $O_3$ air quality measurements, meteorological and $O_3$ precursor emissions information would be useful.

(f) Once the meteorological and air quality data are reviewed, the prospective maximum concentration monitor site should be selected in a direction from the city that is most likely to observe the highest $O_3$ concentrations, more specifically, downwind during periods of photochemical activity. In many cases, these maximum concentration $O_3$ sites will be located 10 to 30 miles or more downwind from the urban area where maximum $O_3$ precursor emissions originate. The downwind direction and appropriate distance should be determined from historical meteorological data collected on days which show the potential for producing high $O_3$ levels. Monitoring agencies are to consult with their EPA Regional Office when considering siting a maximum $O_3$ concentration site.

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

(h) For regional scale background monitoring sites, similar meteorological analysis as for the maximum concentration sites may also inform the decisions for locating regional scale sites. Regional scale sites may be located to provide data on $O_3$ transport between cities, as background sites, or for other data collection purposes. Consideration of both area characteristics, such as meteorology, and the data collection objectives, such as transport, must be jointly considered for a regional scale site to be useful.

(i) Since $O_3$ levels decrease significantly in the colder parts of the year in many areas, $O_3$ is required to be monitored at SLAMS monitoring sites only during the "ozone season" as designated in the AQS files on a State-by-State basis and described below in Table D–3 of this appendix. Deviations from the $O_3$ monitoring season must be approved by the EPA Regional Administrator, documented within the annual monitoring network plan, and updated in AQS. Information on how to analyze $O_3$ data to support a change to the $O_3$ season in support of the 8-hour standard for a specific State can be found in reference 8 to this appendix.

TABLE D–3 TO APPENDIX D OF PART 58—OZONE MONITORING SEASON BY STATE

| State | Begin month | End month |
|---|---|---|
| Alabama | March | October |
| Alaska | April | October |
| Arizona | January | December |
| Arkansas | March | November |
| California | January | December |
| Colorado | March | September |
| Connecticut | April | September |
| Delaware | April | October |
| District of Columbia | April | October |
| Florida | March | October |
| Georgia | March | October |
| Hawaii | January | December |
| Idaho | May | September |
| Illinois | April | October |
| Indiana | April | September |
| Iowa | April | October |
| Kansas | April | October |
| Kentucky | March | October |
| Louisiana AQCR 019,022 | March | October |
| Louisiana AQCR 106 | January | December |
| Maine | April | September |
| Maryland | April | October |
| Massachusetts | April | September |
| Michigan | April | September |
| Minnesota | April | October |
| Mississippi | March | October |
| Missouri | April | October |
| Montana | June | September |
| Nebraska | April | October |
| Nevada | January | December |
| New Hampshire | April | September |
| New Jersey | April | October |
| New Mexico | January | December |
| New York | April | October |
| North Carolina | April | October |
| North Dakota | May | September |
| Ohio | April | October |
| Oklahoma | March | November |
| Oregon | May | September |
| Pennsylvania | April | October |
| Puerto Rico | January | December |
| Rhode Island | April | September |
| South Carolina | April | October |
| South Dakota | June | September |
| Tennessee | March | October |
| Texas AQCR 106,153, 213, 214, 216. | January | December |
| Texas AQCR 022, 210, 211, 212, 215, 217, 218. | March | October |
| Utah | May | September |
| Vermont | April | September |
| Virginia | April | October |
| Washington | May | September |
| West Virginia | April | October |
| Wisconsin | April 15 | October 15 |
| Wyoming | April | October |
| American Samoa | January | December |
| Guam | January | December |
| Virgin Islands | January | December |

4.2 Carbon Monoxide (CO) Design Criteria. (a) There are no minimum requirements for the number of CO monitoring sites. Continued operation of existing SLAMS CO sites using FRM or FEM is required until discontinuation is approved by the EPA Regional Administrator. Where SLAMS CO monitoring is ongoing, at least one site must be a maximum concentration site for that area under investigation.

(b) Microscale and middle scale measurements are useful site classifications for SLAMS sites since most people have the potential for exposure on these scales. Carbon monoxide maxima occur primarily in areas near major roadways and intersections with high traffic density and often poor atmospheric ventilation.

(1) *Microscale*—This scale applies when air quality measurements are to be used to represent distributions within street canyons, over sidewalks, and near major roadways. In the case with carbon monoxide, microscale measurements in one location can often be considered as representative of other similar locations in a city.

(2) *Middle scale*—Middle scale measurements are intended to represent areas with dimensions from 100 meters to 0.5 kilometer. In certain cases, middle scale measurements may apply to areas that have a total length of several kilometers, such as "line" emission source areas. This type of emission sources areas would include air quality along a commercially developed street or shopping plaza, freeway corridors, parking lots and feeder streets.

(c) After the spatial scale and type of site has been determined to meet the monitoring objective for each location, the technical guidance in reference 2 of this appendix should be used to evaluate the adequacy of each existing CO site and must be used to relocate an existing site or to locate any new sites.

4.3 Nitrogen Dioxide ($NO_2$) Design Criteria

4.3.1 General Requirements

(a) State and, where appropriate, local agencies must operate a minimum number of required $NO_2$ monitoring sites as described below.

4.3.2 Requirement for Near-road $NO_2$ Monitors

(a) Within the $NO_2$ network, there must be one microscale near-road $NO_2$ monitoring station in each CBSA with a population of 500,000 or more persons to monitor a location of expected maximum hourly concentrations sited near a major road with high AADT counts as specified in paragraph 4.3.2(a)(1) of this appendix. An additional near-road $NO_2$ monitoring station is required for any CBSA with a population of 2,500,000 persons or more, or in any CBSA with a population of 500,000 or more persons that has one or more roadway segments with 250,000 or greater AADT counts to monitor a second location of expected maximum hourly concentrations. CBSA populations shall be based on the latest available census figures.

(1) The near-road $NO_2$ monitoring stations shall be selected by ranking all road segments within a CBSA by AADT and then identifying a location or locations adjacent

to those highest ranked road segments, considering fleet mix, roadway design, congestion patterns, terrain, and meteorology, where maximum hourly $NO_2$ concentrations are expected to occur and siting criteria can be met in accordance with appendix E of this part. Where a State or local air monitoring agency identifies multiple acceptable candidate sites where maximum hourly $NO_2$ concentrations are expected to occur, the monitoring agency shall consider the potential for population exposure in the criteria utilized to select the final site location. Where one CBSA is required to have two near-road $NO_2$ monitoring stations, the sites shall be differentiated from each other by one or more of the following factors: fleet mix; congestion patterns; terrain; geographic area within the CBSA; or different route, interstate, or freeway designation.

(b) Measurements at required near-road $NO_2$ monitor sites utilizing chemiluminescence FRMs must include at a minimum: NO, $NO_2$, and $NO_X$.

4.3.3 Requirement for Area-wide $NO_2$ Monitoring

(a) Within the $NO_2$ network, there must be one monitoring station in each CBSA with a population of 1,000,000 or more persons to monitor a location of expected highest $NO_2$ concentrations representing the neighborhood or larger spatial scales. PAMS sites collecting $NO_2$ data that are situated in an area of expected high $NO_2$ concentrations at the neighborhood or larger spatial scale may be used to satisfy this minimum monitoring requirement when the $NO_2$ monitor is operated year round. Emission inventories and meteorological analysis should be used to identify the appropriate locations within a CBSA for locating required area-wide $NO_2$ monitoring stations. CBSA populations shall be based on the latest available census figures.

4.3.4 Regional Administrator Required Monitoring

(a) The Regional Administrators, in collaboration with States, must require a minimum of forty additional $NO_2$ monitoring stations nationwide in any area, inside or outside of CBSAs, above the minimum monitoring requirements, with a primary focus on siting these monitors in locations to protect susceptible and vulnerable populations. The Regional Administrators, working with States, may also consider additional factors described in paragraph (b) below to require monitors beyond the minimum network requirement.

(b) The Regional Administrators may require monitors to be sited inside or outside of CBSAs in which:

(i) The required near-road monitors do not represent all locations of expected maximum hourly $NO_2$ concentrations in an area and $NO_2$ concentrations may be approaching or exceeding the NAAQS in that area;

(ii) Areas that are not required to have a monitor in accordance with the monitoring requirements and $NO_2$ concentrations may be approaching or exceeding the NAAQS; or

(iii) The minimum monitoring requirements for area-wide monitors are not sufficient to meet monitoring objectives.

(c) The Regional Administrator and the responsible State or local air monitoring agency should work together to design and/or maintain the most appropriate $NO_2$ network to address the data needs for an area, and include all monitors under this provision in the annual monitoring network plan.

4.3.5 $NO_2$ Monitoring Spatial Scales

(a) The most important spatial scale for near-road $NO_2$ monitoring stations to effectively characterize the maximum expected hourly $NO_2$ concentration due to mobile source emissions on major roadways is the microscale. The most important spatial scales for other monitoring stations characterizing maximum expected hourly $NO_2$ concentrations are the microscale and middle scale. The most important spatial scale for area-wide monitoring of high $NO_2$ concentrations is the neighborhood scale.

(1) *Microscale*—This scale represents areas in close proximity to major roadways or point and area sources. Emissions from roadways result in high ground level $NO_2$ concentrations at the microscale, where concentration gradients generally exhibit a marked decrease with increasing downwind distance from major roads. As noted in appendix E of this part, near-road $NO_2$ monitoring stations are required to be within 50 meters of target road segments in order to measure expected peak concentrations. Emissions from stationary point and area sources, and non-road sources may, under certain plume conditions, result in high ground level concentrations at the microscale. The microscale typically represents an area impacted by the plume with dimensions extending up to approximately 100 meters.

(2) *Middle scale*—This scale generally represents air quality levels in areas up to several city blocks in size with dimensions on the order of approximately 100 meters to 500 meters. The middle scale may include locations of expected maximum hourly concentrations due to proximity to major $NO_2$ point, area, and/or non-road sources.

(3) *Neighborhood scale*—The neighborhood scale represents air quality conditions throughout some relatively uniform land use areas with dimensions in the 0.5 to 4.0 kilometer range. Emissions from stationary point and area sources may, under certain plume conditions, result in high $NO_2$ concentrations at the neighborhood scale. Where a neighborhood site is located away from immediate $NO_2$ sources, the site may be useful in representing typical air quality values for

a larger residential area, and therefore suitable for population exposure and trends analyses.

(4) *Urban scale*—Measurements in this scale would be used to estimate concentrations over large portions of an urban area with dimensions from 4 to 50 kilometers. Such measurements would be useful for assessing trends in area-wide air quality, and hence, the effectiveness of large scale air pollution control strategies. Urban scale sites may also support other monitoring objectives of the $NO_2$ monitoring network identified in paragraph 4.3.4 above.

4.3.6 $NO_y$ Monitoring

(a) $NO/NO_y$ measurements are included within the NCore multi-pollutant site requirements and the PAMS program. These $NO/NO_y$ measurements will produce conservative estimates for $NO_2$ that can be used to ensure tracking continued compliance with the $NO_2$ NAAQS. $NO/NO_y$ monitors are used at these sites because it is important to collect data on total reactive nitrogen species for understanding $O_3$ photochemistry.

*4.4 Sulfur Dioxide ($SO_2$) Design Criteria.*

4.4.1 *General Requirements*. (a) State and, where appropriate, local agencies must operate a minimum number of required $SO_2$ monitoring sites as described below.

4.4.2 *Requirement for Monitoring by the Population Weighted Emissions Index*. (a) The population weighted emissions index (PWEI) shall be calculated by States for each core based statistical area (CBSA) they contain or share with another State or States for use in the implementation of or adjustment to the $SO_2$ monitoring network. The PWEI shall be calculated by multiplying the population of each CBSA, using the most current census data or estimates, and the total amount of $SO_2$ in tons per year emitted within the CBSA area, using an aggregate of the most recent county level emissions data available in the National Emissions Inventory for each county in each CBSA. The resulting product shall be divided by one million, providing a PWEI value, the units of which are million persons-tons per year. For any CBSA with a calculated PWEI value equal to or greater than 1,000,000, a minimum of three $SO_2$ monitors are required within that CBSA. For any CBSA with a calculated PWEI value equal to or greater than 100,000, but less than 1,000,000, a minimum of two $SO_2$ monitors are required within that CBSA. For any CBSA with a calculated PWEI value equal to or greater than 5,000, but less than 100,000, a minimum of one $SO_2$ monitor is required within that CBSA.

(1) The $SO_2$ monitoring site(s) required as a result of the calculated PWEI in each CBSA shall satisfy minimum monitoring requirements if the monitor is sited within the boundaries of the parent CBSA and is one of the following site types (as defined in section 1.1.1 of this appendix): population exposure, highest concentration, source impacts, general background, or regional transport. $SO_2$ monitors at NCore stations may satisfy minimum monitoring requirements if that monitor is located within a CBSA with minimally required monitors under this part. Any monitor that is sited outside of a CBSA with minimum monitoring requirements to assess the highest concentration resulting from the impact of significant sources or source categories existing within that CBSA shall be allowed to count towards minimum monitoring requirements for that CBSA.

4.4.3 *Regional Administrator Required Monitoring*. (a) The Regional Administrator may require additional $SO_2$ monitoring stations above the minimum number of monitors required in 4.4.2 of this part, where the minimum monitoring requirements are not sufficient to meet monitoring objectives. The Regional Administrator may require, at his/her discretion, additional monitors in situations where an area has the potential to have concentrations that may violate or contribute to the violation of the NAAQS, in areas impacted by sources which are not conducive to modeling, or in locations with susceptible and vulnerable populations, which are not monitored under the minimum monitoring provisions described above. The Regional Administrator and the responsible State or local air monitoring agency shall work together to design and/or maintain the most appropriate $SO_2$ network to provide sufficient data to meet monitoring objectives.

4.4.4 $SO_2$ *Monitoring Spatial Scales*. (a) The appropriate spatial scales for $SO_2$ SLAMS monitors are the microscale, middle, neighborhood, and urban scales. Monitors sited at the microscale, middle, and neighborhood scales are suitable for determining maximum hourly concentrations for $SO_2$. Monitors sited at urban scales are useful for identifying $SO_2$ transport, trends, and, if sited upwind of local sources, background concentrations.

(1) *Microscale*—This scale would typify areas in close proximity to $SO_2$ point and area sources. Emissions from stationary point and area sources, and non-road sources may, under certain plume conditions, result in high ground level concentrations at the microscale. The microscale typically represents an area impacted by the plume with dimensions extending up to approximately 100 meters.

(2) *Middle scale*—This scale generally represents air quality levels in areas up to several city blocks in size with dimensions on the order of approximately 100 meters to 500 meters. The middle scale may include locations of expected maximum short-term concentrations due to proximity to major $SO_2$ point, area, and/or non-road sources.

(3) *Neighborhood scale*—The neighborhood scale would characterize air quality conditions throughout some relatively uniform land use areas with dimensions in the 0.5 to 4.0 kilometer range. Emissions from stationary point and area sources may, under certain plume conditions, result in high $SO_2$ concentrations at the neighborhood scale. Where a neighborhood site is located away from immediate $SO_2$ sources, the site may be useful in representing typical air quality values for a larger residential area, and therefore suitable for population exposure and trends analyses.

(4) *Urban scale*—Measurements in this scale would be used to estimate concentrations over large portions of an urban area with dimensions from 4 to 50 kilometers. Such measurements would be useful for assessing trends in area-wide air quality, and hence, the effectiveness of large scale air pollution control strategies. Urban scale sites may also support other monitoring objectives of the $SO_2$ monitoring network such as identifying trends, and when monitors are sited upwind of local sources, background concentrations.

4.4.5 *NCore Monitoring*. (a) $SO_2$ measurements are included within the NCore multipollutant site requirements as described in paragraph (3)(b) of this appendix. NCore-based $SO_2$ measurements are primarily used to characterize $SO_2$ trends and assist in understanding $SO_2$ transport across representative areas in urban or rural locations and are also used for comparison with the $SO_2$ NAAQS. $SO_2$ monitors at NCore sites that exist in CBSAs with minimum monitoring requirements per section 4.4.2 above shall be allowed to count towards those minimum monitoring requirements.

4.5 *Lead (Pb) Design Criteria*. (a) State and, where appropriate, local agencies are required to conduct ambient air Pb monitoring near Pb sources which are expected to or have been shown to contribute to a maximum Pb concentration in ambient air in excess of the NAAQS, taking into account the logistics and potential for population exposure. At a minimum, there must be one source-oriented SLAMS site located to measure the maximum Pb concentration in ambient air resulting from each non-airport Pb source which emits 0.50 or more tons per year and from each airport which emits 1.0 or more tons per year based on either the most recent National Emission Inventory (*http://www.epa.gov/ttn/chief/eiinformation.html*) or other scientifically justifiable methods and data (such as improved emissions factors or site-specific data) taking into account logistics and the potential for population exposure.

(i) One monitor may be used to meet the requirement in paragraph 4.5(a) for all sources involved when the location of the maximum Pb concentration due to one Pb source is expected to also be impacted by Pb emissions from a nearby source (or multiple sources). This monitor must be sited, taking into account logistics and the potential for population exposure, where the Pb concentration from all sources combined is expected to be at its maximum.

(ii) The Regional Administrator may waive the requirement in paragraph 4.5(a) for monitoring near Pb sources if the State or, where appropriate, local agency can demonstrate the Pb source will not contribute to a maximum Pb concentration in ambient air in excess of 50 percent of the NAAQS (based on historical monitoring data, modeling, or other means). The waiver must be renewed once every 5 years as part of the network assessment required under §58.10(d).

(iii) State and, where appropriate, local agencies are required to conduct ambient air Pb monitoring near each of the airports listed in Table D–3A for a period of 12 consecutive months commencing no later than December 27, 2011. Monitors shall be sited to measure the maximum Pb concentration in ambient air, taking into account logistics and the potential for population exposure, and shall use an approved Pb-TSP Federal Reference Method or Federal Equivalent Method. Any monitor that exceeds 50 percent of the Pb NAAQS on a rolling 3-month average (as determined according to 40 CFR part 50, Appendix R) shall become a required monitor under paragraph 4.5(c) of this Appendix, and shall continue to monitor for Pb unless a waiver is granted allowing it to stop operating as allowed by the provisions in paragraph 4.5(a)(ii) of this appendix. Data collected shall be submitted to the Air Quality System database according to the requirements of 40 CFR part 58.16.

TABLE D–3A AIRPORTS TO BE MONITORED FOR LEAD

| Airport | County | State |
|---|---|---|
| Merrill Field | Anchorage. | AK |
| Pryor Field Regional | Limestone. | AL |
| Palo Alto Airport of Santa Clara County. | Santa Clara. | CA |
| McClellan-Palomar | San Diego. | CA |
| Reid-Hillview | Santa Clara. | CA |
| Gillespie Field | San Diego. | CA |
| San Carlos | San Mateo. | CA |
| Nantucket Memorial | Nantucket. | MA |
| Oakland County International | Oakland | MI |
| Republic | Suffolk | NY |
| Brookhaven | Suffolk | NY |
| Stinson Municipal | Bexar | TX |
| Northwest Regional | Denton | TX |
| Harvey Field | Snohomish. | WA |

TABLE D–3A AIRPORTS TO BE MONITORED FOR LEAD—Continued

| Airport | County | State |
|---|---|---|
| Auburn Municipal | King | WA |

(b) State and, where appropriate, local agencies are required to conduct non-source-oriented Pb monitoring at each NCore site required under paragraph 3 of this appendix in a CBSA with a population of 500,000 or more.

(c) The EPA Regional Administrator may require additional monitoring beyond the minimum monitoring requirements contained in paragraphs 4.5(a) and 4.5(b) where the likelihood of Pb air quality violations is significant or where the emissions density, topography, or population locations are complex and varied. EPA Regional Administrators may require additional monitoring at locations including, but not limited to, those near existing additional industrial sources of Pb, recently closed industrial sources of Pb, airports where piston-engine aircraft emit Pb, and other sources of re-entrained Pb dust.

(d) The most important spatial scales for source-oriented sites to effectively characterize the emissions from point sources are microscale and middle scale. The most important spatial scale for non-source-oriented sites to characterize typical lead concentrations in urban areas is the neighborhood scale. Monitor siting should be conducted in accordance with 4.5(a)(i) with respect to source-oriented sites.

(1) Microscale—This scale would typify areas in close proximity to lead point sources. Emissions from point sources such as primary and secondary lead smelters, and primary copper smelters may under fumigation conditions likewise result in high ground level concentrations at the microscale. In the latter case, the microscale would represent an area impacted by the plume with dimensions extending up to approximately 100 meters. Pb monitors in areas where the public has access, and particularly children have access, are desirable because of the higher sensitivity of children to exposures of elevated Pb concentrations.

(2) Middle scale—This scale generally represents Pb air quality levels in areas up to several city blocks in size with dimensions on the order of approximately 100 meters to 500 meters. The middle scale may for example, include schools and playgrounds in center city areas which are close to major Pb point sources. Pb monitors in such areas are desirable because of the higher sensitivity of children to exposures of elevated Pb concentrations (reference 3 of this appendix). Emissions from point sources frequently impact on areas at which single sites may be located to measure concentrations representing middle spatial scales.

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

(d) Technical guidance is found in references 4 and 5 of this appendix. These documents provide additional guidance on locating sites to meet specific urban area monitoring objectives and should be used in locating new sites or evaluating the adequacy of existing sites.

4.6 Particulate Matter ($PM_{10}$) Design Criteria.≤(a) Table D–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 D–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. Modifications from these $PM_{10}$ monitoring requirements must be approved by the Regional Administrator.

TABLE D–4 OF APPENDIX D TO PART 58—$PM_{10}$ MINIMUM MONITORING REQUIREMENTS (APPROXIMATE NUMBER OF STATIONS PER MSA) [1]

| Population category | High concentration [2] | Medium concentration [3] | Low concentration [4,5] |
|---|---|---|---|
| >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 numbers of stations per area will be jointly determined by EPA and the State agency.

[2] High concentration areas are those for which ambient PM10 data show ambient concentrations exceeding the $PM_{10}$ NAAQS by 20 percent or more.
[3] Medium concentration areas are those for which ambient PM10 data show ambient concentrations exceeding 80 percent of the $PM_{10}$ NAAQS.
[4] Low concentration areas are those for which ambient PM10 data show ambient concentrations less than 80 percent of the $PM_{10}$ NAAQS.
[5] These minimum monitoring requirements apply in the absence of a design value.

(b) Although microscale monitoring may be appropriate in some circumstances, the most important spatial scales to effectively characterize the emissions of $PM_{10}$ from both mobile and stationary sources are the middle scales and neighborhood scales.

(1) *Microscale*—This scale would typify areas such as downtown street canyons, traffic corridors, and fence line stationary source monitoring locations where the general public could be exposed to maximum $PM_{10}$ concentrations. 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 sites provide information for evaluating and developing hot spot control measures.

(2) *Middle scale*—Much of the short-term public exposure to coarse fraction particles ($PM_{10}$) is on this scale and on the neighborhood scale. People moving through downtown areas or living near major roadways or stationary sources, may encounter particulate pollution that would be adequately characterized by measurements of this spatial scale. Middle scale $PM_{10}$ measurements can be appropriate for the evaluation of possible short-term exposure public health effects. 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 seldomly swept parking lots associated with these sources could be an important source in addition to the vehicular emissions themselves.

(3) *Neighborhood scale*—Measurements in this category represent conditions throughout some reasonably homogeneous urban sub-region 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. 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. Neighborhood scale $PM_{10}$ sites provide information about trends and compliance with standards because they often represent conditions in areas where people commonly live and work for extended periods. 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.

4.7 Fine Particulate Matter ($PM_{2.5}$) Design Criteria.

4.7.1 General Requirements. (a) State, and where applicable local, agencies must operate the minimum number of required $PM_{2.5}$ SLAMS sites listed in Table D–5 of this appendix. The NCore sites are expected to complement the $PM_{2.5}$ data collection that takes place at non-NCore SLAMS sites, and both types of sites can be used to meet the minimum $PM_{2.5}$ network requirements. Deviations from these $PM_{2.5}$ monitoring requirements must be approved by the EPA Regional Administrator.

TABLE D–5 OF APPENDIX D TO PART 58—$PM_{2.5}$ MINIMUM MONITORING REQUIREMENTS

| MSA population [1,2] | Most recent 3-year design value ≥85% of any $PM_{2.5}$ NAAQS [3] | Most recent 3-year design value <85% of any $PM_{2.5}$ NAAQS [3, 4] |
|---|---|---|
| >1,000,000 ............ | 3 | 2 |
| 500,000–1,000,000 | 2 | 1 |
| 50,000–<500,000 [5] | 1 | 0 |

[1] Minimum monitoring requirements apply to the Metropolitan statistical area (MSA).
[2] Population based on latest available census figures.
[3] The $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.
[4] These minimum monitoring requirements apply in the absence of a design value.
[5] Metropolitan statistical areas (MSA) must contain an urbanized area of 50,000 or more population.

(b) Specific Design Criteria for $PM_{2.5}$. The required monitoring stations or sites must be sited to represent community-wide air quality. These sites can include sites collocated at PAMS. These monitoring stations will typically be at neighborhood or urban-scale; however, in certain instances where population-oriented micro-or middle-scale $PM_{2.5}$ monitoring are determined by the Regional Administrator to represent many such locations throughout a metropolitan area, these smaller scales can be considered to represent community-wide air quality.

(1) At least one monitoring station is to be sited in a population-oriented area of expected maximum concentration.

(2) For areas with more than one required SLAMS, a monitoring station is to be sited in an area of poor air quality.

(3) Additional technical guidance for siting $PM_{2.5}$ monitors is provided in references 6 and 7 of this appendix.

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

(1) *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 sites; community-oriented SLAMS sites measured at the microscale level 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 sites 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 SPM.

(2) *Middle scale*—People moving through downtown areas, or living near major roadways, encounter particle concentrations that would be adequately characterized by 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 microscale 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 number 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.

(3) *Neighborhood scale*—Measurements in this category would represent conditions throughout some reasonably homogeneous urban sub-region 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 the immediate neighborhood as well as neighborhoods of the same type in other parts of the city. $PM_{2.5}$ sites 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.

(4) *Urban scale*—This class of measurement would be used to characterize the particulate matter concentration over an entire metropolitan or rural area ranging in size from 4 to 50 kilometers. Such measurements would be useful for assessing trends in area-wide air quality, and hence, the effectiveness of large scale air pollution control strategies. Community-oriented $PM_{2.5}$ sites may have this scale.

(5) *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. Data characteristics of this scale would provide information about larger scale processes of particulate matter emissions, losses and transport. $PM_{2.5}$ transport contributes to elevated 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 $O_3$ and regional haze.

4.7.2 Requirement for Continuous $PM_{2.5}$ Monitoring. The State, or where appropriate, local agencies must operate continuous $PM_{2.5}$ analyzers equal to at least one-half (round up) the minimum required sites listed in Table D–5 of this appendix. At least one required continuous analyzer in each MSA must be collocated with one of the required FRM/FEM/ARM monitors, unless at least one of the required FRM/FEM/ARM monitors is itself a continuous FEM or ARM monitor in which case no collocation requirement applies. State and local air monitoring agencies must use methodologies and quality assurance/quality control (QA/QC) procedures approved by the EPA Regional Administrator for these required continuous analyzers.

4.7.3 Requirement for $PM_{2.5}$ Background and Transport Sites. Each State shall install and operate at least one $PM_{2.5}$ site to monitor for regional background and at least one $PM_{2.5}$ site to monitor regional transport. These monitoring sites may be at community-oriented sites and this requirement may be satisfied by a corresponding monitor in an area having similar air quality in another State. State and local air monitoring agencies must use methodologies and QA/QC procedures approved by the EPA Regional Administrator for these sites. Methods used at these sites may include non-federal reference method samplers such as IMPROVE or continuous $PM_{2.5}$ monitors.

4.7.4 $PM_{2.5}$ Chemical Speciation Site Requirements. Each State shall continue to conduct chemical speciation monitoring and analyses at sites designated to be part of the $PM_{2.5}$ Speciation Trends Network (STN). The selection and modification of these STN sites must be approved by the Administrator. The $PM_{2.5}$ chemical speciation urban trends sites shall include analysis for elements, selected anions and cations, and carbon. Samples must be collected using the monitoring methods and the sampling schedules approved by the Administrator. Chemical speciation is encouraged at additional sites where the chemically resolved data would be useful in developing State implementation plans and supporting atmospheric or health effects related studies.

4.7.5 Special Network Considerations Required When Using $PM_{2.5}$ Spatial Averaging Approaches. (a) The $PM_{2.5}$ NAAQS, specified in 40 CFR part 50, provides State and local air monitoring agencies with an option for spatially averaging $PM_{2.5}$ air quality data. More specifically, two or more community-oriented (i.e., sites in populated areas) $PM_{2.5}$ monitors may be averaged for comparison with the annual $PM_{2.5}$ NAAQS. This averaging approach is directly related to epidemiological studies used as the basis for the $PM_{2.5}$ annual NAAQS. Spatial averaging does not apply to comparisons with the daily $PM_{2.5}$ NAAQS.

(b) State and local agencies must carefully consider their approach for $PM_{2.5}$ network design when they intend to spatially average the data for compliance purposes. These State and local air monitoring agencies must define the area over which they intend to average $PM_{2.5}$ air quality concentrations. This area is defined as a Community Monitoring Zone (CMZ), which characterizes an area of relatively similar annual average air quality. State and local agencies can define a CMZ in a number of ways, including as part or all of a metropolitan area. These CMZ must be defined within a State or local agencies network description, as required in §58.10 of this part and approved by the EPA Regional Administrator. When more than one CMZ is described within an agency's network design plan, CMZs must not overlap in their geographical coverage. The criteria that must be used for evaluating the acceptability of spatial averaging are defined in appendix N to 40 CFR part 50.

4.8 Coarse Particulate Matter ($PM_{10-2.5}$) Design Criteria.

4.8.1 General Monitoring Requirements. (a) The only required monitors for $PM_{10-2.5}$ are those required at NCore Stations.

(b) Although microscale monitoring may be appropriate in some circumstances, middle and neighborhood scale measurements are the most important station classifications for $PM_{10-2.5}$ to assess the variation in coarse particle concentrations that would be expected across populated areas that are in proximity to large emissions sources.

(1) *Microscale*—This scale would typify relatively small areas immediately adjacent to: Industrial sources; locations experiencing ongoing construction, redevelopment, and soil disturbance; and heavily traveled roadways. Data collected at microscale stations would characterize exposure over areas of limited spatial extent and population exposure, and may provide information useful for evaluating and developing source-oriented control measures.

(2) *Middle scale*—People living or working near major roadways or industrial districts encounter particle concentrations that would be adequately characterized by this spatial scale. Thus, measurements of this type would be appropriate for the evaluation of public health effects of coarse particle exposure. Monitors located in populated areas that are nearly adjacent to large industrial point sources of coarse particles provide suitable locations for assessing maximum

population exposure levels and identifying areas of potentially poor air quality. Similarly, monitors located in populated areas that border dense networks of heavily-traveled traffic are appropriate for assessing the impacts of resuspended road dust. This scale also includes the characteristic concentrations for other areas with dimensions of a few hundred meters such as school grounds and parks that are nearly adjacent to major roadways and industrial point sources, locations exhibiting mixed residential and commercial development, and downtown areas featuring office buildings, shopping centers, and stadiums.

(3) *Neighborhood scale*—Measurements in this category would represent conditions throughout some reasonably homogeneous urban sub-region 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. This category includes suburban neighborhoods dominated by residences that are somewhat distant from major roadways and industrial districts but still impacted by urban sources, and areas of diverse land use where residences are interspersed with commercial and industrial neighborhoods. In some cases, a location carefully chosen to provide neighborhood scale data would represent the immediate neighborhood as well as neighborhoods of the same type in other parts of the city. The comparison of data from middle scale and neighborhood scale sites would provide valuable information for determining the variation of $PM_{10-2.5}$ levels across urban areas and assessing the spatial extent of elevated concentrations caused by major industrial point sources and heavily traveled roadways. Neighborhood scale sites would provide concentration data that are relevant to informing a large segment of the population of their exposure levels on a given day.

4.8.2 $PM_{10-2.5}$ Chemical Speciation Site Requirements. $PM_{10-2.5}$ chemical speciation monitoring and analyses is required at NCore sites. The selection and modification of these sites must be approved by the Administrator. Samples must be collected using the monitoring methods and the sampling schedules approved by the Administrator.

## 5. Network Design for Photochemical Assessment Monitoring Stations (PAMS)

The PAMS program provides more comprehensive data on $O_3$ air pollution in areas classified as serious, severe, or extreme nonattainment for $O_3$ than would otherwise be achieved through the NCore and SLAMS sites. More specifically, the PAMS program includes measurements for $O_3$, oxides of nitrogen, VOC, and meteorology.

5.1 PAMS Monitoring Objectives. PAMS design criteria are site specific. Concurrent measurements of $O_3$, oxides of nitrogen, speciated VOC, CO, and meteorology are obtained at PAMS sites. Design criteria for the PAMS network are based on locations relative to $O_3$ precursor source areas and predominant wind directions associated with high $O_3$ events. Specific monitoring objectives are associated with each location. The overall design should enable characterization of precursor emission sources within the area, transport of $O_3$ and its precursors, and the photochemical processes related to $O_3$ nonattainment. Specific objectives that must be addressed include assessing ambient trends in $O_3$, oxides of nitrogen, VOC species, and determining spatial and diurnal variability of $O_3$, oxides of nitrogen, and VOC species. Specific monitoring objectives associated with each of these sites may result in four distinct site types. Detailed guidance for the locating of these sites may be found in reference 9 of this appendix.

(a) Type 1 sites are established to characterize upwind background and transported $O_3$ and its precursor concentrations entering the area and will identify those areas which are subjected to transport.

(b) Type 2 sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants.

(c) Type 3 sites are intended to monitor maximum $O_3$ concentrations occurring downwind from the area of maximum precursor emissions.

(d) Type 4 sites are established to characterize the downwind transported $O_3$ and its precursor concentrations exiting the area and will identify those areas which are potentially contributing to overwhelming transport in other areas.

5.2 Monitoring Period. PAMS precursor monitoring must be conducted annually throughout the months of June, July and August (as a minimum) when peak $O_3$ values are expected in each area. Alternate precursor monitoring periods may be submitted for approval to the Administrator as a part of the annual monitoring network plan required by §58.10.

5.3 Minimum Monitoring Network Requirements. A Type 2 site is required for each area. Overall, only two sites are required for each area, providing all chemical measurements are made. For example, if a design includes two Type 2 sites, then a third site will be necessary to capture the $NO_y$ measurement. The minimum required number and type of monitoring sites and sampling requirements are listed in Table D–6 of this appendix. Any alternative plans may be put in place in lieu of these requirements, if approved by the Administrator.

TABLE D–6 OF APPENDIX D TO PART 58—MINIMUM REQUIRED PAMS MONITORING LOCATIONS AND FREQUENCIES

| Measurement | Where required | Sampling frequency (all daily except for upper air meteorology) [1] |
|---|---|---|
| Speciated VOC[2] | Two sites per area, one of which must be a Type 2 site. | During the PAMS monitoring period: (1) Hourly auto GC, or (2) Eight 3-hour canisters, or (3) 1 morning and 1 afternoon canister with a 3-hour or less averaging time plus Continuous Total Non-methane Hydrocarbon measurement. |
| Carbonyl sampling | Type 2 site in areas classified as serious or above for the 8-hour ozone standard. | 3-hour samples every day during the PAMS monitoring period. |
| $NO_X$ | All Type 2 sites | Hourly during the ozone monitoring season. [3] |
| $NO_y$ | One site per area at the Type 3 or Type 1 site | Hourly during the ozone monitoring season. |
| CO (ppb level) | One site per area at a Type 2 site | Hourly during the ozone monitoring season. |
| Ozone | All sites | Hourly during the ozone monitoring season. |
| Surface met | All sites | Hourly during the ozone monitoring season. |
| Upper air meteorology | One representative location within PAMS area | Sampling frequency must be approved as part of the annual monitoring network plan required in 40 CFR 58.10. |

[1] Daily or with an approved alternative plan.
[2] Speciated VOC is defined in the "Technical Assistance Document for Sampling and Analysis of Ozone Precursors", EPA/600–R–98/161, September 1998.
[3] Approved ozone monitoring season as stipulated in Table D–3 of this appendix.

5.4 Transition Period. A transition period is allowed for phasing in the operation of newly required PAMS programs (due generally to reclassification of an area into serious, severe, or extreme nonattainment for ozone). Following the date of redesignation or reclassification of any existing $O_3$ nonattainment area to serious, severe, or extreme, or the designation of a new area and classification to serious, severe, or extreme $O_3$ nonattainment, a State is allowed 1 year to develop plans for its PAMS implementation strategy. Subsequently, a minimum of one Type 2 site must be operating by the first month of the following approved PAMS season. Operation of the remaining site(s) must, at a minimum, be phased in at the rate of one site per year during subsequent years as outlined in the approved PAMS network description provided by the State.

6. REFERENCES

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