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Air



GUIDELINE FOR LEAD MONITORING IN THE VICINITY OF POINT SOURCES



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IN THE VICINITY OF POINT SOURCES

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Office of Air Quality Planning and Standards
and
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FOREWORD

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1. INTRODUCTION

The purpose of this guideline is to define the minimum criteria which should be followed when designing and operating a minimum network in the environs of lead point sources. Criteria are provided for both meteorological (section 2) and ambient lead monitoring (section 3). Meteorological monitoring is needed if adequate meteorological information is not already available to ensure the proper location of ambient lead samplers. The guideline defines minimum quality assurance requirements (section 4) to assure the collection of adequate ambient air quality data. Section 5 discusses the data reporting procedures for the ambient lead data as well as the quality assurance data.

Specifically, ambient lead monitoring is necessary in the vicinity of primary and secondary lead smelters and primary copper smelters. This monitoring, which is independent of monitoring around permanent urban sites,¹ should operate for at least a year to determine if these lead sources are causing violations of the national standard for lead. Also, a secondary objective of the monitoring requirements is to obtain much needed information concerning the nature, extent and impact of fugitive lead emissions generated by these lead sources.

States should recognize that at least 1 to 2 years may be required to accomplish the monitoring program described herein. As described in section 3, ambient monitoring will entail at least 1 full year of monitoring operation. If at least 1 year of meteorological data is not available to describe the atmospheric conditions in the area of concern, the monitoring program should also include an initial 1 year period for meteorological monitoring.

The desire for comparability in monitoring data requires adherence to some consistent set of guidelines. Therefore, the criteria discussed below must be followed to the maximum extent possible to ensure uniform collection of air quality data that are comparable and compatible. To achieve this goal, the specific criteria that are prefaced with a 'must' are defined as a requirement and exceptions must be approved by the State in those cases where the State requires the source to conduct ambient lead monitoring. Siting criteria that are prefaced with a 'should' are defined as a goal to meet for consistency, but are not a requirement.

2. METEOROLOGICAL MONITORING

2.1 Introduction

The primary purpose of obtaining one or more years of meteorological data is to determine optimum placement of ambient lead monitors; i.e., to maximize the probability that the highest ambient calendar quarterly lead concentrations will be detected and that good estimates of ambient background concentrations will be obtained. The particular azimuths from the source in which the monitors should be placed will be determined by the most frequent wind direction during each calendar quarter.

2.2 Meteorological Data Required

To determine the proper placement of background monitors and to detect the maximum impact of stack and fugitive emissions, quarterly surface wind and precipitation roses must be used for guidance.* The quarterly roses must be based upon a minimum of 1 year of continuous precipitation and wind speed and direction data. It is essential that such data be representative of atmospheric conditions at the source. The representativeness of the data is dependent upon (1) the proximity of the meteorological monitoring site to the area under consideration; (2) the complexity of the topography of the area; (3) the exposure of the meteorological sensors; and (4) the period of time during which the data are collected. More information for determining representativeness is presented in reference 2.

Site-specific data are always preferable to data collected off-site. Off-site meteorological data may be used in lieu of site-specific data only if it is agreed by source owner and the appropriate State or local air pollution control agency (hereafter called the State agency) that the off-site data are reasonably representative of atmospheric conditions in the area under consideration. The off-site meteorological data for wind and precipitation roses can sometimes be derived from routine measurements by National Weather Service (NWS) stations. The data are available as individual observations and in summarized form

*In cases where it is necessary to site monitors on elevated terrain features, considerably more detailed wind data will be required in order to adequately describe the wind field over the area of concern.

from the National Climatic Center, Federal Building, Asheville, North Carolina 28801. On the other hand, if the nearest source of off-site data is considerably removed from the area under consideration, and especially if there are significant terrain features, urban areas, or large bodies of water nearby, it will be necessary to have site-specific meteorological data.

In some cases, it will be necessary that data be collected at more than one site in order to provide a reasonable representation of atmospheric conditions over the entire area of concern. Atmospheric conditions may vary considerably over the area. In some cases, e.g., complex terrain, it will not be feasible to adequately monitor the entire meteorological field of concern. Then the only recourse is to site the stations in areas where characteristic and significant airflow patterns are likely to be encountered. In any event, one of the meteorological stations should be located so that it represents atmospheric conditions in the immediate vicinity of the source.

A minimum of 1 year of meteorological data (summarized by calendar quarters) must be available. If more than 1 year of data is available, it is recommended that such data be included in the analysis. Such a multiyear data base allows for more comprehensive consideration of variations in meteorological conditions that occur from year to year. A 5-year period of record will usually yield an adequate meteorological data base for considering such year-to-year variations. In all cases, the meteorological data used must be of at least the quality of data collected by the NWS. When meteorological monitoring is performed at the site, it must be continued during the lead air quality monitoring year. If the lead air quality monitoring is extended past 1 year, then the meteorological monitoring must also be continued.

2.3 Exposure of Meteorological Instruments

Measurements of most meteorological parameters are affected by the exposure of the sensor. To obtain comparable observations at different sites, the exposures must be similar. Also, the exposure should be such that the measured parameters provide a good representation of pollutant transport and dispersion within the area that the monitoring site is

supposed to represent. For example, if wind flow data over a fairly broad area are desired, the wind sensors should be away from the immediate influence of trees and buildings, steep slopes, ridges, cliffs, or hollows.

The standard exposure of wind instruments over level open terrain is 10 meters above the ground. Open terrain is defined as an area where the distance between the anemometer and any obstruction to the wind flow is at least five times the height of the obstruction. Where a standard exposure is unobtainable at this height, the anemometer should be installed at such a height that its indications are reasonably unaffected by local obstructions and represent as closely as possible what the wind at 10 meters would be in the absence of the obstructions. Detailed guidance on assessing adverse aerodynamic effects due to local obstructions is contained in reference 3.

In locating wind sensors in rough terrain or valley situations, it will be necessary to determine how important local effects such as channeling, slope and valley winds, etc., are, or whether the flow outside those zones of influence is to be measured. If the analysis concerns emissions from a tall stack, it may be desirable to avoid the local influences. On the other hand, if pollution from low-level sources is the main concern, the local influences may be important.

If the source emission point is substantially above the standard 10-meter level for wind measurements, additional wind measurements at the height of the emission point and at plume height are desirable. Such measurements are used to determine the wind regime in which the effluent plume is transported away from the source. (The wind speed and direction 50 to 100 meters or more above the surface are often considerably different than at the 10-meter level.) An instrumented tower is the most common means of obtaining meteorological measurements at several elevations in the lower part of the atmospheric boundary layer. For wind instruments mounted on the side of a tower, precautions must be taken to ensure that the wind measurements are not unduly influenced by the tower. Turbulence in the immediate wake of a tower (even a lattice-type tower) can be severe. Thus, depending on the supporting structure, wind measuring equipment should be mounted (e.g., on booms) at least one structure

width away from the structure, and two systems mounted on opposite sides of the structure will sometimes be necessary. A wind instrument mounted on top of a tower should be mounted at least one tower width above the top. If there is no alternative to mounting instruments on a stack, the increased turbulence problem must be explicitly resolved to the satisfaction of the State agency.⁴

Precipitation collectors must be located so obstructions do not prevent the precipitation from falling into the collector opening or force precipitation into the opening. Several collectors may be required for adequate spatial resolution in complex topographic regimes.

Additional information and guidance on siting and exposure of meteorological instruments are contained in reference 5.

2.4 Meteorological Instrumentation - Specifications

2.4.1 Wind Systems

Wind instrumentation must yield reasonably accurate and precise data. Accuracies and allowable errors are expressed in this section as absolute values for digital systems; errors in analog systems may be 50 percent greater. For example, an allowable error expressed as 5 percent means the recorded value should be within ± 5 percent of the true value for digital systems, and ± 7.5 percent for analog systems. Records should be dated, and should be accurate to within 10 minutes. Wind speed and direction (or vector components) should be recorded continuously on strip charts. All variables may be recorded digitally or on multipoint recorders at intervals not to exceed 60 seconds for a given variable. When the use of existing representative meteorological data is approved by the State agency, the instrumentation should meet, as a minimum, NWS standards.^{6,7}

Wind direction and wind speed systems should exhibit a starting threshold of less than 0.5 meters per second (m/s) wind speed (at 10 degrees deflection for direction vanes). Wind speed systems should be accurate above the starting threshold to within 0.25 m/sec at speeds equal to or less than 5 m/s. At speeds higher than 5 m/s, the error should not exceed 5 percent of the observed speed (maximum error not to exceed 2.5 m/s). The damping ratio of the wind vane should be between

0.4 and 0.55 and the distance constant should not exceed 5 m. Wind direction system errors should not exceed 3 degrees from true 10-minute or greater averages, including sensor orientation errors. Wind vane orientation procedures should be documented.

In complex terrain, downwash of plumes due to significant terrain relief may pose a problem. If such a problem potentially exists, it may be necessary to also measure the vertical component of the wind at the proposed site, and as close as possible to stack height. The starting threshold from the vertical wind speed component should be less than 0.25 m/s. Required accuracy for the vertical speed component is as specified for horizontal speeds.

2.4.2 Precipitation

A recording precipitation collector should have a resolution of 0.25 mm (0.01 inches) liquid precipitation per hour at precipitation rates up to 7.6 cm/hour. Accuracy should be within 10 percent of the recorded value. A heated system should be used to assure proper measurement of frozen precipitation. Also, a suitable windscreen should be used.

3.5 Quality Assurance for Meteorological Data

New equipment requires only the field checkout and calibration procedures recommended by the manufacturer. Used equipment should receive an appropriate examination (overhaul, if necessary) and calibration prior to initial installation to assure the acquisition of the maximum amount of usable data within the error limits specified in section 2.4. Inspection, servicing and calibration of equipment must be scheduled throughout the measurement program at appropriate intervals to assure at least 90 percent data retrieval for each variable measured. In addition, missing data periods must not show marked correlation with the various meteorological cycles.

Calibration of systems should be accomplished no less frequently than once every 6 months. In corrosive or dusty areas, the interval should be reduced to assure adequate and valid data acquisition.

If satisfactory calibration of a measuring system can be provided only by the manufacturer or in special laboratories, such as wind-tunnel facilities, arrangements should be made for such calibrations prior to acquisition of the equipment. A parts inventory should be maintained at

a readily accessible location to minimize delays in restoring operations after system failures.

An independent meteorological audit (by other than one who conducts the routine calibration and operation of the network) should be performed to provide an on-site calibration of instruments as well as an evaluation of (1) the network installation; (2) inspection, maintenance and calibration procedures and logging thereof; (3) data reduction procedures, including spot checking of data; and (4) data logging and tabulation procedures. The on-site visit (requiring as little as 1 day in many cases) should be made within 60 days after the network is first in full operation, and a written audit/evaluation should be provided to the source owner. This report should be retained by the owner. Any problems should be corrected and duly noted as to action taken in an addendum to the audit report. A reproducible copy of the audit report and the addendum should be furnished to the State agency.

Such independent meteorological audit-evaluations should be performed about each 6 months. The last such inspection should be made no more than 30 days prior to the termination of the measurement program, and while the measurement operation is in progress.

2.5 Meteorological Data Format and Reporting

Because of the different data requirements for different types of analyses that might be used to evaluate various facilities, there is no fixed format that applies to all data sets. However, a generalization can be made: all meteorological parameters must be collated in chronological order and tabulated according to observation time, and be furnished to the State agency upon request. Also, graphic portrayals of wind and precipitation roses should be made available to the State agency. All units should be in the SI system (International System of Units). All input data (in the format required by the analytical procedures selected) used in, and all results of, the air quality analyses must be furnished to the State agency upon request. Meteorological monitoring should be continuous beginning with the initiation of the meteorological data base collection program through the air quality monitoring program unless deviations are approved in writing from the State.

3. AMBIENT AIR QUALITY MONITORING

3.1 Monitoring Objective and Data Uses

The objective for conducting point source ambient lead monitoring is to determine the impact of individual point sources at ground level areas impacted by the source. The major point sources of interest, as far as ambient monitoring is concerned, are primary and secondary lead smelters and primary copper smelters. The ambient concentrations measured, as a minimum, must include background concentrations and peak concentration levels for stack emissions and fugitive emissions.

These monitoring data will then be used as appropriate for one or more of the following purposes:

- a. determining compliance with the NAAQS;
- b. determining the degree of overall control needed to attain the NAAQS;
- c. developing or revising SIP to attain/maintain the NAAQS;
- d. establishing baseline concentrations; and
- e. aiding modeling efforts to quantify fugitive emissions (additional sites may be needed for this purpose).

3.2 Monitoring Considerations

Ambient lead monitoring conducted in the vicinity of point sources would normally be performed by the owner or operator of the source. In some cases, the State agency may choose to perform the monitoring in lieu of the source owner or operator. Regardless of who performs the lead monitoring, it is necessary to have adequate and representative meteorological data as discussed in section 2 before any lead monitoring is initiated.

3.3 Air Quality Pollutants to be Monitored

Although lead is the major pollutant to be measured by the point source lead monitoring network, additional pollutant analyses on the monitors used to measure lead may be required at some future time. Therefore, all filters should be retained by the source owner or operator for at least 3 years after collection.

3.4 Number and Location of Monitors

Proper monitoring site location is important in order to meet the specified monitoring objective and multiple data uses. An upwind background

monitor is necessary to measure the ambient lead concentrations where the air quality impact from the source under study would be minimal. Such concentrations must be known in order to optimize the degree of control necessary to attain and maintain the NAAQS. Monitors should also be located around the source to measure the impact of both fugitive and stack emissions. Factors, such as the emission rate from the source, wind speed, and wind direction must be taken into account by dispersion modeling techniques using acceptable meteorological data as discussed in section 2.

A monitoring network around a source must be designed to measure the impact of both fugitive and stack emissions. To meet these objectives requires different network configurations. The following is a description of one type of network design which incorporates a minimum number of monitors to provide sufficient data to estimate the emission impacts. Changes from this type of network may be approved by the State agency because the ultimate placement and number of monitors are decided on a case-by-case basis due to many different factors, such as meteorological conditions, terrain, and other sources of lead which may be nearby. In complex terrain situations, additional sites may be needed.

- Background Monitor Using Predominant Wind Direction Data

One background monitor is required to measure the lead being transported into the area around the source. This monitor should be located upwind of the source in the predominant wind direction where the contributions from the source would be minimal. However, this monitor should not be located so far upwind that it fails to represent the actual background in the area about the source.

- Impact of Stack Emission Monitors

Modeling is used to estimate the two areas having the highest concentrations of lead resulting from stack emissions by the source. A monitor would then be located in each of these two areas to measure the impact of the stack emissions.

- Fugitive Emissions Impact Monitors Using Predominant Wind Direction Data

The siting of monitors to measure the fugitive emission impacts is more complex than for background and stack impact monitors because these emissions may be emitted in a diffuse manner from buildings, i.e., windows, doors, roof vents, etc., or may be re-entrained from areas around the source. The land area affected by the fugitive emissions is

therefore hard to define. Consequently, two monitors to measure the impact of the fugitive emissions must be located downwind of the source based on the predominant wind direction. The first monitor must be located close to the fence line of the source and the second monitor must be located further downwind at a distance not to exceed one mile. Although the primary use of these data will be to determine compliance with the NAAQS, a secondary use would be to determine or quantify fugitive emissions. The resulting downwind concentrations from the fugitive emissions can be back-calculated through diffusion equations or models, taking into account the variables of topography and meteorology. These downwind sites provide two data points in the back-calculations to determine the fugitive emissions.

- Stack and Fugitive Emission Impact Monitors Using Second Most Frequent Wind Direction Data

There may be some situations where the wind directions around a lead source would be significantly different from one season to another. In order to determine the fugitive and stack emission impacts over these additional areas, the same procedure as discussed above for fugitive emission monitoring would be repeated by using the second most frequent wind direction. This would result in two additional monitors.

In some of the cases discussed above, two or more of these locations may coincide and thereby reduce the number of monitoring stations. However, for cases where other sources of lead have a significant impact around the source under study, additional monitors may be needed to assess this impact. Additional monitors may also be needed if the fugitive emissions originate from a large area at the source, i.e., from several buildings or sources that are spread out.

For cases where two lead sources are located in close proximity to one another, some sharing of monitoring should be used to avoid duplication. Joint use of a meteorological tower and equipment, background lead monitors, and downwind lead monitors may be acceptable if approved by the State.

3.4.1 Special Concerns for Location of Monitors

When modeling is used to determine the general area where lead monitors will be located, some of the modeled locations may be within the confines of the source's boundary. However, monitors should be placed in those locations satisfying the definition of ambient air.

Ambient air is defined in 40 CFR 50.1(e) as "that portion of the atmosphere external to buildings, to which the general public has access." Therefore, if the modeled locations are within the source's boundary, the monitors should be located downwind at the source's boundary, or at the nearest location where the general public has access.

In some cases, it is simply not practical to place monitors at the locations indicated by the model. Some examples of such locations might be open bodies of water, rivers, swamps, cliffs, etc. The source and the State should determine on a case-by-case basis alternate locations.

3.5 Duration and Frequency of Sampling

A minimum of one 24-hour sample every sixth day is necessary, but more frequent sampling is encouraged. The lead monitoring should be conducted for a minimum of 1 year. If the data show that the lead NAAQS is not being exceeded, most or all of the sampling network could be discontinued. This would be jointly determined by the State and the lead source owner or operator after a review of the data. If the data show that the NAAQS is threatened (concentrations are equal to or greater than 90 percent of the NAAQS), or is being exceeded, then in general monitoring should be continued for an additional year. Such additional monitoring would be helpful in assessing the effects of emission control efforts. In all cases, the monitoring data should be reviewed periodically, and the State and the source owner or operator should jointly determine how long the monitoring program will be continued. If the monitoring is continued past the initial year, some adjustments in the monitor location(s) might be necessary to account for other sources of lead which may not have been in existence when the monitoring was begun.

3.5 Sample Method and Procedures

Particulates for lead analysis must be collected in accordance with the reference method as described in 40 CFR 50. The analysis method must be either the reference method as described in 40 CFR 50¹⁰ or an equivalent method as described in 40 CFR 53.¹¹ The results will be compared against the calendar quarter standard of $1.5 \mu\text{g}/\text{m}^3$. Each filter must be analyzed separately. In the interest of economy and quality assurance, the filter samples should be accumulated and the analysis of each filter should be performed concurrently with other filters. The analysis frequency of these batches must be at least once per quarter.

3.7 Monitor Siting

The desire for comparability in monitoring data requires adherence to some consistent set of guidelines. Therefore, the probe siting criteria discussed below must be followed to the maximum extent possible to ensure uniform collection of air quality data that are comparable and compatible.

Before proceeding with the discussion of the lead monitor siting criteria, it is important to expand on the discussion in section 3.4 of the location of monitors. In particular, reference is made to two monitoring objectives.

- Case 1: Monitors should be located so as to determine the maximum concentration from the lead source.
- Case 2: Monitors should be located so as to determine where the combined impact of the existing lead point source and other existing sources would be expected to result in the highest concentrations.

For Case 1, the driving force for locating the siting area of the monitor as well as the specific location of the instrument shelter is the objective of measuring the maximum impact from the lead source itself. Two Case 1 examples follow. Consider the situation in which a source emits lead from an elevated stack. Under these circumstances, sufficient mixing generally occurs during the transport of the emissions from the stack to the ground so that vertical gradients near ground level are small, thus, a range of sampler heights of 2-15 meters is acceptable. For the same objective (maximum concentration from lead source), consider another example in which lead is emitted from a ground level source. In this case, the concentration gradient near the ground might be large, thereby requiring a much narrower range of acceptable probe heights. For ground level sources emitting lead with steep vertical concentration gradients, efforts should be made to locate lead monitors 2 to 7 meters above ground level. The 7 meter height allows for placement on a one story building and is reasonably close to representing the breathing zone.

For Case 2, in which monitors are located so as to determine the maximum impact area of the existing lead point source as well as other existing sources, the critical element to keep in mind is to locate the monitors so as to maximize the combined effect. The placement of the

instrument shelter will vary depending upon which source is the predominant influence on the maximum impact area. As an extreme example, consider the situation where an elevated source emits lead into an urban area resulting in a combined lead impact coincident to an area adjacent to a heavily traveled traffic corridor. Since lead emissions from traffic along corridors produce fairly steep concentration gradients near the roadway and the higher concentrations are found closer to ground level, the monitor should be located to measure these higher levels. Thus, in this example, the traffic corridor has the major influence on the combined impact and therefore controls the monitor placement. Similar to the Case 1 example for a ground level source, the monitor height in this example should be located 2 to 7 meters above ground level.

As another example, consider the case where lead emissions from an elevated source impact on an urban area that is only slightly affected by lead emissions from a roadway. The combined impact area in this case is far enough away from the two sources (the elevated source and motor vehicles from the roadway) to allow considerable mixing to occur. As a result, only small vertical concentration gradients exist at the impact area. Consequently, the acceptable monitor height would be in the range of 2-15 meters.

3.7.1 Vertical Placement

Breathing height is the most desirable location for the vertical placement of the Pb monitor. However, practical factors previously mentioned may require that the monitor be located somewhat above what would normally be considered "breathing height." In so locating the sampler, consideration must be given to ground level emissions (whether they be stationary or mobile sources) with steep vertical concentration gradients. Placing the shelter too high could result in measured concentrations significantly lower than those at the level breathed by the general public. Accordingly, samplers for monitoring ground level sources must be located between 2 to 7 meters above ground level. In contrast, samplers monitoring elevated sources, as noted previously in section 3.7 may be located with the sampler inlet over a wider range of heights. An acceptable range for monitoring emissions from elevated sources is therefore from 2 to 15 meters above ground level.

3.7.2 Spacing from Obstructions

A minimum of 2 meters of separation from walls, parapets, and penthouses is required for samplers located on a roof or other structure. No furnace or incineration flues should be nearby. The height of the flues and the type, quality, and quantity of waste or fuel burned determine the separation distances from flues. For example, if the emissions from the chimney have a high lead content and there is a high probability that the plume would impact on the sampler during most of the sampling period, then other buildings/locations in the area that are free from the described sources should be chosen for the monitoring site. The sampler should be placed at least 20 meters from trees, since trees absorb particles as well as adversely affect airflow.

The sampler must be located away from obstacles such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler. There must also be unrestricted airflow in an arc of at least 270° around the sampler, and the predominant direction for the season of greatest pollution concentration potential must be included in the 270° arc.

3.7.3 Spacing from Roads

For those situations discussed in section 3.7.1 where the emissions from a proposed source would impact close to a major roadway (greater than approximately 30,000 average daily traffic), the air intake for the monitor must be located within 15-30 meters from the edge of the nearest traffic lane. Monitors located in this area would thus measure the combined impact from the proposed source and the roadway. The sampler air intake must be 2 to 7 meters above ground level.

3.7.4 Other Considerations

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

3.8 Monitoring Plan

A monitoring plan prepared by the source must be submitted and approved by the State before the lead monitoring is started. The number and location of the monitors will need to be determined on a case-by-case basis by the source and reviewed by the State. The review and approval of the source monitoring plan by the State could result in the elimination of any unnecessary monitoring and should ensure that the monitoring locations are optimum for purposes of determining maximum pollutant concentrations. Table 1 lists the types of information that should be included in the monitoring plan.

TABLE 1. MINIMUM CONTENTS OF LEAD MONITORING PLAN

- I. SOURCE ENVIRONMENT DESCRIPTION (within 2 km of the lead source)
 - topographical description
 - land-use description
 - topographical map of source and environs (including location of existing stationary sources, roadways, and monitoring sites)
 - climatological description
 - quarterly wind roses (from meteorological data collected at the lead source or other representative meteorological data)
- II. SAMPLING PROGRAM DESCRIPTION
 - time period for which lead will be measured
 - rationale for location of monitors
 - rationale for joint utilization of monitoring network by other lead sources
- III. MONITOR SITE DESCRIPTION
 - Universal Transverse Mercator (UTM) coordinates
 - height of sampler (air intake) above ground
 - distance from obstructions and heights of obstructions
 - distance from other lead sources (stationary and mobile)
 - photographs of each site (five photos: one in each cardinal direction looking out from each existing sampler or where a future sampler will be located, and one closeup of each existing sampler or where a future sampler will be located. Ground cover should be included in the closeup photograph.)
- IV. MONITOR DESCRIPTION
 - description of calibration system to be used
 - type of flow control and flow recorder (if used)
- V. DATA REPORTING
 - format of data submission
 - frequency of data reporting
- VI. QUALITY ASSURANCE PROGRAM
 - calibration frequency
 - independent audit program
 - internal quality control procedures
 - data precision and accuracy calculation procedures

4. QUALITY ASSURANCE FOR AIR QUALITY DATA

4.1 General Information

The activities described here are the minimum quality assurance requirements associated with the operation of a point source ambient lead monitoring network. These requirements are regarded as the minimum necessary to assure monitoring data of adequate quality to the State agency. Operators of the network are encouraged to develop and implement quality assurance programs more extensive than the minimum required or continue such programs where they already exist.

Quality assurance consists of two distinct and equally important functions. One function assesses the quality of the monitoring data by estimating the precision and accuracy of the data obtained. The other function controls, and improves as required, the quality of the monitoring data by proper use of policies and procedures in obtaining the data. These two functions are interdependent. When the assessment function indicates that the data quality is inadequate, the control effort must be increased until the data quality is acceptable.

Assessment of data quality is an activity based on the principles of statistics. In order to provide uniformity in the assessment and reporting of data quality, the assessment procedures are specified explicitly in section 4.3.

4.2 Quality Control Requirements

4.2.1 Quality Assurance Plan - Each operator must develop and implement a quality assurance plan consisting of policies, procedures, specifications, standards and documentation necessary to:

(a) Provide data of adequate quality to meet State agency requirements.

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

Primary guidance for establishing quality control procedures is contained in references 8, 9, and 10. The quality assurance plan must address at least the following factors (specific references to quality control guidance are recommended):

(a) Selection of method. The reference method must be used for sampling. This is the high-volume sampler operated between 1.13 and 1.70 m³/min (40 to 60 ft³/min). See reference 9, sections 2.2 and 2.8, and reference 10. For chemical analysis of lead, the reference method or an approved equivalent method may be used. See reference 10 for the reference method and reference 11 for approved equivalent methods.

(b) Calibration. See reference 9, sections 2.2.2 and 2.8.2, and reference 10.

(c) Preventive maintenance. See reference 9, sections 2.2.7 and 2.8.7, and reference 10.

(d) Control checks and their frequency. See reference 9, section 2.0.9, and reference 10.

(e) Control limits to take corrective action. See reference 8, Appendix P, and reference 9, section 2.0.9.

(f) Data validation. See reference 8, section 1.4.17, and reference 10.

(g) Auditing. See sections 4.2.2, 4.2.3, and 4.3.2 of this document; reference 9, sections 2.2.8 and 2.8.8, and reference 10.

The quality assurance plan must be approved by the State agency.

4.2.2 System Audit - Semiannually, the State agency or regional EPA must conduct system audits of the ambient lead monitoring network. See section 1.4.16 of reference 8 for a description of a system audit. The purposes of system audits are: (1) to provide verification that the capability exists for submitting quality monitoring data, and (2) to identify problems that may affect the gathering and reporting of quality monitoring data to the State agency.

During the system audit, the required quality control activities described in the quality assurance plan (section 4.2.1) and the quality assessment activities described in section 4.3 should be reviewed. As an aid in the selection and review of other agency activities that may affect the gathering and reporting of quality monitoring data, the following references should be used: reference 9, section 2.2.8, Table 8.2, reference 9, section 2.8.8, Table 8.1, and reference 10.

4.2.3 EPA's National Performance Audit Program - Operators must participate in the following national performance audit program conducted by USEPA:

(a) The annual blind performance audit of the high-volume sampler flow rate using reference flow devices.

(b) The semi-annual blind performance audit for lead analysis using glass fiber filter strips containing lead.

Instructions for participating in the national performance audit program may be obtained from the appropriate USEPA Regional Quality

Control Coordinator, or from the Quality Assurance Division at the address given in reference 8.

4.3 Quality Assessment Requirements

4.3.1 Assessment of Monitoring Data for Precision - For each monitoring network, one sampling site must have collocated samplers. A site with the highest expected 24-hour pollutant concentration must be selected. The two high-volume samplers must be located within 4 meters of each other but at least 2 meters apart to preclude airflow interference. Calibration, sampling and analysis must be the same for both collocated samplers and must be the same as for all other samplers in the network. Both samplers at the collocated site must be operated at the same time, namely, every sixth calendar day. The differences in concentration ($\mu\text{g}/\text{m}^3$) between the collocated samplers are used to calculate precision as described in section 4.3.3.

4.3.2 Assessment of Monitoring Data for Accuracy - Each calendar quarter, audit the flow rate of each high-volume sampler at least once. The flow rate audit is conducted using a reference flow device described in section 2.2.8, pages 3-5, of reference 9, or a similar device. It is required that the audit device be calibrated using a flow standard different from the one used to routinely calibrate the flow of the high-volume sampler being audited. With the audit device and a normal glass fiber filter in place, operate a high-volume sampler at its normal flow rate. Great care must be used in auditing high-volume samplers having flow controllers because the introduction of resistance plates in the audit device can cause abnormal flow patterns at the point of flow

sensing. For this reason, the orifice of the flow audit device should be used without resistance plates in auditing flow controlled high-volume samplers, or other steps should be taken to assure that flow patterns are not perturbed at the point of flow sensing. The difference in flow rates (in m^3/min) between the audit flow measurement and the flow indicated by the sampler's normal flow indicator is used to calculate sampling accuracy as described in section 4.3.4.

Each calendar quarter, audit the lead analysis using glass fiber filter strips containing a known quantity of lead. Audit samples are prepared by depositing a lead solution on 3/4 inch by 8 inch glass fiber filter strips. Prepare blind audit samples in the following concentration ranges:

<u>Range</u>	<u>Conc. μg Pb/strip</u>	<u>Conc. μg Pb/m^3*</u>
1	100 to 300	0.5 to 1.5
2	600 to 1000	3.0 to 5.0

*Calculation of lead concentration in $\mu g/m^3$ is based on sampling at 1.7 m^3/min for 24 hours on an 8 inch x 10 inch glass fiber filter.

Analyze at least one audit sample in each of the two ranges each day that samples are analyzed. If samples are analyzed only once per quarter, analyze at least two audit samples in each of the two ranges. The difference between the audit concentration (in μg Pb/strip) and the analyst's measured concentration (in μg Pb/strip) are used to calculate analysis accuracy as described in section 4.3.4. It is required that the audit samples be prepared using reagents different from those used to calibrate the lead analytical equipment being audited.

If the routine network operators are used to perform the audit, these operators must not know the audit values (both reference flow device and lead filter strips) prior to the audit. This means another individual must administer the audit program.

4.3.3 Calculation of Monitoring Data Precision - Estimates of precision are calculated from results obtained from the collocation of two samplers at one sampling site as described in section 4.3.1. Each owner, at the end of each quarter shall calculate and report a precision probability interval using collocation sampler results. Directions for calculation are given below and directions for reporting are given in section 5.

From the paired measurements described in section 4.3.1, let Y_i represent the concentration of pollutant measured by Sampler Y and X_i represent the concentration of pollutant measured by Sampler X during the i^{th} sampling period. Calculate the percentage difference (d_i) using equation 1.

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

Calculate the average percentage difference (\bar{d}_j) and standard deviation (S_j) using equations 2 and 3, respectively.

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

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

Where n is the number of precision checks of the high-volume sampler made during the sampling quarter. For example, n is 15 if collocated samplers are operated every sixth day during a quarter.

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

$$\text{Upper 95 Percent Probability Limit} = \bar{d}_j + 1.96 S_j / \sqrt{2} \quad (4)$$

$$\text{Lower 95 Percent Probability Limit} = \bar{d}_j - 1.96 S_j / \sqrt{2} \quad (5)$$

As an example, consider the following lead data obtained using collocated high-volume samplers operated every sixth day with analysis of all samples at the end of the calendar quarter.

Sampling Day	Sampler Y_i ug/m	Sampler X_i ug/m	Difference, d_i Percent
1	1.81	1.72	5
2	2.01	1.82	10
3	--	1.72	--
4	1.50	1.41	5
5	1.25	1.15	8
6	1.42	1.54	-8
7	1.53	1.51	2
8	1.70	1.82	-7
9	2.14	2.02	6
10	2.23	2.10	6
11	2.05	1.94	6
12	1.55	1.87	-9
13	1.52	1.47	7
14	1.34	1.40	-4
15	1.40	1.52	-2
			<hr/>
			$\Sigma = +26$

Applying equations 2 and 3:

$$\bar{d}_j = +25/14 = 1.9\%$$

$$s_j = \left[\frac{720 - (25)^2/14}{13} \right]^{1/2} = 7.2\%$$

Applying equations 4 and 5:

$$\text{Upper Limit} = 1.9 + 1.96(7.2)/\sqrt{2} = 11.9 \text{ or } 12\%$$

$$\text{Lower Limit} = 1.9 - 1.96(7.2)/\sqrt{2} = -8.1 \text{ or } -8\%$$

-8 is reported as the lower probability limit, and +12 would be reported as the upper probability limit for the lead measurement precision.

4.3.4 Calculation of Monitoring Data Accuracy - Estimates of accuracy are calculated separately for the sampling and analytical portions of the lead measurements from audits described in section 4.3.2.

Each operator, at the end of each quarter, shall calculate and report the percentage difference for each high-volume sampler audited during the quarter. Directions for calculation are given here and directions for reporting are given in section 5.

For the flow rate audit described in section 4.3.2, let X_j represent the known flow rate and Y_j represent the measured flow rate. Calculate the percentage difference (d_j) using equation 6.

For example, assume the following information results from a flow rate audit.

Measured flow rate, $Y = 52$ cfm

Known flow rate, $x = 50$ cfm

$$d_i = \frac{Y_i - X_i}{X_i} \times 100 \quad (6)$$

$$d_i = \frac{52 - 50}{50} \times 100 = +4\%$$

+4 would be reported as the percentage difference.

Each operator, at the end of each quarter, shall calculate and report an accuracy probability interval for the two concentration ranges audited for lead analysis. Directions for calculation are given here and directions for reporting are given in section 5.

For the audit of lead analysis described in section 4.3.2, let X_i represent the known value of the audit sample and Y_i the measured value. Calculate the percentage difference (d_i) for each audit at each of the two concentration ranges using equation 6. Calculate the average percent difference (\bar{d}_j) and standard deviation (S_j) using equations 2 and 3, respectively. Calculate the 95 percent probability limits for lead analysis accuracy using equations 7 and 8.

$$\text{Upper 95 Percent Probability Limit} = \bar{d}_j + 1.96 S_j \quad (7)$$

$$\text{Lower 95 Percent Probability Limit} = \bar{d}_j - 1.96 S_j \quad (8)$$

As an example, assume the following information is obtained for lead analysis audits on three different analysis days.

Analysis Day	Concentration Ranges, ug/strip			
	100 to 300		500 to 1000	
	Meas. Y	Known X	Meas. Y	Known X
1	180	170	740	710
2	270	250	780	750
3	215	200	690	650

Using equation 6, the individual percentage differences are calculated. The average percent differences and standard deviations are calculated using equations 2 and 3, respectively, and the 95 percent probability limits are calculated using equations 7 and 8. The following values are obtained.

Calculation Step	Concentration Ranges, $\mu\text{g}/\text{strip}$		Comment
	100 to 300	600 to 1000	
d_j , Day 1	5.9%	4.2%	Equation 6
d_j , Day 2	8.0%	-1.3%	Equation 6
d_j , Day 3	7.5%	6.2%	Equation 6
\bar{d}_j	7.13%	3.03%	Equation 2
s_j	1.10%	3.88%	Equation 3
$\bar{d}_j - 1.96 s_j$	9.29%	10.63%	Equation 7
$\bar{d}_j - 1.96 s_j$	4.97%	-4.57%	Equation 8

The probability limits for the 100 to 300 $\mu\text{g}/\text{strip}$ concentration range would be 9.3% for the upper limit and 5.0% for the lower limit; for the 600 to 1000 $\mu\text{g}/\text{strip}$ concentration range the upper limit would be 10.6% and the lower limit -4.6%.

5. DATA REPORTING

A summary of the lead monitoring data, all individual lead values, and the meteorological quality assurance data (discussed in section 2.6) must be submitted to the State agency on a quarterly basis and should be submitted within 30 days after the quarter ends. When reporting the ambient lead concentration for the collocated sampling site, as discussed in section 4.3.1, the concentration from the routine sampler must be reported for this site. The State agency should also transmit the data to the appropriate EPA Regional Office quarterly. The individual lead values are to be submitted in SAROAD format, preferably in machine readable form. A printout of what is on the tape or cards should be included. Deviations from these reporting requirements will need to be negotiated with the State and appropriate EPA Regional Office. All raw data not previously submitted (i.e., calibration data, flow rates, etc.) should be retained for 1 year and submitted upon request to the State. The periodic submission of data is intended to identify any problems in the data as they may occur. At least 80 percent of the possible individual 24-hour values (with a one in six day sampling schedule) must be obtained by the source in any sampling period.

The monitoring data must be reviewed in light of the detailed work history of the source. This would ensure that the monitoring data were collected during a time that would be representative of normal operating conditions at the source.

At the end of each quarter, the operator must calculate precision and accuracy from activities described in sections 4.3.3 and 4.3.4. The precision estimate must be calculated based on the one collocated sampling site. A sampling accuracy estimate must be calculated for each high volume sampler site and one estimate must be calculated for analysis accuracy. This precision and accuracy data must be submitted with the air monitoring data to the State agency. If, during the quarter, the operator participates in and receives the results from the EPA national performance audit program, these results must also be reported. All data used to calculate reported estimates of precision and accuracy including collocated sampler and audit results must be made available to the State agency upon request.

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