



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

MEMORANDUM

SUBJECT: Options for Lead NAAQS Indicator: Monitoring Implications

FROM: Kevin Cavender, OAQPS/AQAD/AAMG

TO: Lead NAAQS Review Docket (OAR-2006-0735)

This memorandum discusses monitoring considerations with regard to the indicator for the lead (Pb) national ambient air quality standard (NAAQS). The purpose of this memorandum is to provide a basis for consultation with the Clean Air Scientific Advisory Committee (CASAC) Ambient Air Monitoring & Methods (AAMM) Subcommittee on March 25, 2008. The following sections summarize the background with regard to the current Pb NAAQS indicator, options for addressing issues associated with the current indicator, and the development of scaling factors for consideration in relating Pb-PM₁₀ and Pb-TSP concentrations.

BACKGROUND

The indicator for the current Pb NAAQS, set in 1978 (43 FR 46246), is Pb in total suspended particulate matter (Pb-TSP). EPA's selection of Pb-TSP as the indicator for the standard was based on explicit recognition both of the significance of ingestion as an exposure pathway for Pb that had deposited from the air and of the potential for Pb deposited from the air to become resuspended in respirable size particles in the air and available for human inhalation exposure. As stated in the 1978 final rule, "a significant component of exposure can be ingestion of materials contaminated by deposition of lead from the air," and that, "in addition to the indirect route of ingestion and absorption from the gastrointestinal tract, non-respirable Pb in the environment may, at some point become respirable through weathering or mechanical action" (43 FR 46251).

Lead data to be used in determination of compliance with the Pb NAAQS must be collected and analyzed using a Federal Reference Method (FRM) or a Federal Equivalent Method (FEM) for Pb-TSP. The current FRM for Pb sampling and analyses is based on the use of a high-volume TSP sampler to collect the sample and the use of atomic absorption for the analysis of Pb in the sample (40 CFR 50 Appendix G). In addition, all 21 currently approved FEMs are based on the use of high-volume TSP samplers.

In the current review of the Pb NAAQS, issues have been identified with regard to the use of the high-volume TSP samplers. The Clean Air Science Advisory Committee (CASAC) has commented that TSP samplers have poor precision, that the upper particle cut size varies widely as a function of wind speed and direction, and that the spatial non-homogeneity of very coarse

particles cannot be efficiently captured by a national monitoring network (Henderson, 2007a, b). For these reasons, CASAC has recommended considering a change in the Pb indicator to allow sample collection using low volume PM₁₀ samplers.

In the Advance Notice of Proposed rulemaking (ANPR) the agency suggested that the use of Pb-PM₁₀ data may be useful if a site specific relationship between Pb-PM₁₀ and Pb-TSP was developed based on collocated monitoring data (72 FR 71539). In CASAC's comments on the ANPR, it reiterated its concerns over the continued use of the Pb-TSP as the indicator and high volume TSP as the primary measurement method (Henderson, 2008). It also commented on the development of site specific relationships, stating that it felt that the uncertainty in the Pb-TSP measurements made the development of site specific relationships of little value. Instead, it felt, considering the degree of uncertainty in other aspects of setting the Pb NAAQS, it would be appropriate to develop general "scaling factors" from the available collocated Pb-PM₁₀ and Pb-TSP data that could be used at multiple monitoring sites with similar characteristics. CASAC recognized there are different relationships in areas near sources that would need to be addressed. Comments received on the ANPR from the public were mixed with several commenters agreeing with CASAC that the indicator should be changed, while several others commented that the indicator should remain Pb-TSP because large particles contribute to Pb exposure and health risk.

The following considerations with regard to Pb-TSP as the Pb NAAQS indicator were recognized in the ANPR.

- Focuses on all Pb particle sizes which are important to health.
- Uses the existing Pb-TSP network.
- Precision and bias of Pb-TSP are acceptable for continued use.
- Uses existing FRM and FEM criteria.
- Any expansion of Pb network would expand usage of outdated technology high-volume TSP sampling methodology.
- Any increase in monitoring frequency would require placement of additional monitors at each site (expanding footprint and power requirements) because high-volume samplers are not capable of sequential sampling.
- Does not take advantage of existing, larger, PM₁₀ network.
- While EPA could develop an improved Pb-TSP based on the low-volume sampler, it would likely not be available for monitoring agencies use in the near term.

OPTIONS FOR ADDRESSING ISSUES RAISED REGARDING Pb-TSP

Two options are described here that address, to various extent, issues raised by CASAC and some public commenters on the ANPR with regard to Pb-TSP. These options include: (1) maintaining Pb-TSP as the indicator and allowing Pb-PM₁₀ monitoring data to be used in lieu of Pb-TSP data; and (2) revising the indicator to Pb in PM₁₀ (Pb-PM₁₀). Each of these options is discussed below.

Maintain Pb-TSP as Indicator and Accept Adjusted Monitoring Data using Pb-PM₁₀

One option that would recognize a role for Pb-PM₁₀ data in Pb NAAQS monitoring is to maintain Pb-TSP as the NAAQS indicator, but accept both Pb-TSP monitoring data and Pb-PM₁₀ monitoring data for use in determining attainment with the NAAQS. While Pb-TSP data could be used, as reported, for NAAQS attainment demonstrations, Pb-PM₁₀ data would be multiplied by a “scaling factor” to make the data “equivalent” to Pb-TSP. Additional aspects to this option might require Pb-TSP (only) for situations where data indicate ambient Pb-TSP concentrations approaching or exceeding the Pb NAAQS. Potential scaling factors are addressed later in this memorandum.

This option addresses many of the concerns regarding Pb-TSP raised by CASAC or public commenters in the following ways:

- By retaining Pb-TSP as the lead indicator it is clear that EPA is concerned with all Pb particle sizes as all Pb particle sizes are important to exposure and associated health risk.
- Makes use of the existing Pb-TSP network in addition to a large portion of the existing PM₁₀ network with just the additional cost of analyzing the filters for Pb content. EPA will be able to complete mandatory designations based on the existing Pb-TSP network, possibly supplemented by new Pb-PM₁₀ monitors (depending on the final data handling provisions regarding how many years of data are required to determine nonattainment or attainment.)
- Monitoring agencies would have the option of buying modern low-volume PM₁₀ samplers rather than high-volume TSP samplers if network expansion is needed.
- Low-volume PM₁₀ samplers are capable of sequential sampling (i.e., the ability to collect more than one sample between operator visits) which may be especially important if the sampling frequency is increased to 1 in 3 day sampling or higher.
- Multiple “scaling factors” can be developed which will allow for reflecting different relationships between Pb-TSP and Pb-PM₁₀ in different areas (e.g., a source-oriented scaling factor can be used near sources, while a non source-oriented scaling factor can be used for general population monitors).
- Monitoring agencies would have the option of using Pb-TSP monitors if they do not believe the scaling factors are appropriate for their situations. For situations in which a monitoring agency, or EPA, believes that Pb-PM₁₀ monitoring (with adjustment) might underestimate Pb-TSP concentrations and thus lead to a control strategy that did not sufficiently control important sources of Pb-TSP, a Pb-TSP monitor could be deployed.
- Leaves the possibility of development of an improved Pb-TSP FRM based on the low volume sampler.

Other considerations for this option include:

- Decisions are needed on which scaling factor is most appropriate to use for a given monitoring location.
- The available data from which scaling factors could be developed are somewhat limited.
- A Federal Reference Method (FRM) and Federal Equivalent Method criteria (FEM criteria) for Pb-PM₁₀ would need to be developed.

Change Indicator to Pb-PM₁₀

This option involves a revision of the indicator from Pb-TSP to Pb-PM₁₀. Restricting sample collection to the smaller size fraction of Pb particles (i.e., Pb-PM₁₀) would have ramifications with regard to the level of the NAAQS because of the fact that all size Pb particles contribute to exposure and associated health effects. For example, the standard level for the NAAQS associated with a Pb-PM₁₀ indicator for the NAAQS might be derived from a level identified in terms of Pb-TSP using a scaling factor to account for the difference in Pb concentration between Pb-PM₁₀ and Pb-TSP.

This option addresses many of the comments made regarding Pb-TSP by CASAC and some public commentors in the following ways::

- The low volume PM₁₀ sampler provides better precision and size selection characteristics which would make the data more comparable across sites.
- Many existing PM₁₀ monitors could be used with just the additional cost of analyzing the filters for Pb content.
- Any expansion of the network would be based on low-volume PM₁₀ samplers.
- Low-volume PM₁₀ samplers are capable of sequential sampling (i.e., the ability to collect more than one sample between operator visits) which may be especially important if the sampling frequency is increased to 1 in 3 day sampling or higher.
- Network synergies could be gained by moving all PM sampling to the low-volume sampler.

Other considerations for this option include:

- The NAAQS level for a Pb-PM₁₀ indicator could be derived using a scaling factor that relates a target concentration in terms of all size particles (e.g., Pb-TSP) to the concentration in terms of Pb-PM₁₀.
 - If an “average” factor is used to set the Pb-PM₁₀ level, areas with relatively more large particles would be able to exceed the Pb-TSP target without exceeding the NAAQS.
 - Conversely, if a “conservative” factor is selected, areas with few large particles could exceed the NAAQS while not exceeding the Pb-TSP target concentration.
- Existing TSP monitors would need to be replaced with Pb-PM₁₀ monitors. This might leave many more areas unclassifiable at the time of initial designations.
- There might be misunderstanding with regard to the fact that all sized Pb particles (including particles larger than PM₁₀) contribute to Pb exposures and associated health effects.
- A Pb-PM₁₀ indicator may not be appropriate for sources that emit predominately very coarse Pb, resulting in the potential for areas to be classified as attainment (and therefore not subject to controls) when the actual Pb-TSP concentrations are higher than the Pb-TSP target concentration.
- A FRM and FEM criteria for Pb-PM₁₀ would need to be developed.

DEVELOPMENT OF SCALING FACTORS

A way to relate ambient Pb-TSP concentrations to Pb-PM₁₀ concentrations is needed in the options described above. One approach to estimating ambient Pb-TSP concentrations from Pb-PM₁₀ monitoring data (needed for first option) is to develop “scaling factors” which when multiplied by Pb-PM₁₀ monitoring data would provide an estimate of Pb-TSP concentrations. The following paragraphs describe an analysis conducted in an effort to develop a number of potential scaling factors.

Data

Data on collocated Pb-TSP and Pb-PM₁₀ data were obtained from the Air Quality System (AQS), EPA's repository of ambient air quality data. Due to varying method detection limit issues, the data used in the analysis were limited to those pairs of data where both the Pb-TSP and the Pb-PM₁₀ measurement were above 0.01 ug/m³. Based on these data requirements, we obtained collocated Pb-TSP and Pb-PM₁₀ data for 33 sites between the years 1993 and 2006.

In addition, we identified data from a study where collocated Pb-TSP and Pb-PM₁₀ data were collected near a primary lead smelter in Montana (Brion, 1988). This data set contained data at much higher concentrations than the other data obtained from AQS.

Analysis

While the data are limited, a number of relationships can be developed based on the available collocated Pb-TSP and Pb-PM₁₀ data. This section presents relationships for source-oriented monitors and non source-oriented monitors (i.e., monitors that are not dominated by emissions from an industrial source of Pb) developed from the available data.

Non Source-Oriented Monitor Relationship. For the purpose of this analysis, we determined if a site was source-oriented or not by reviewing its AQS classification, using the National Emissions Inventory (NEI) to determine if a 0.5 tons per year or more Pb source is (or was) nearby, and by reviewing satellite maps for each monitoring location. The majority of the sites with collocated Pb-TSP and Pb-PM₁₀ data were identified as non source-oriented (31 of the 33 sites and a total of over 1200 data pairs). The data from these sites were plotted (Figure 1) and a linear regression was performed which showed a strong linear relationship between the Pb-PM₁₀ and Pb-TSP data ($r^2 = 0.86$). The solid line in Figure 1 represents a best fit line based on linear regression of the available data ($\text{Pb-TSP} = \text{Pb-PM}_{10} * 1.014 + 0.006$).

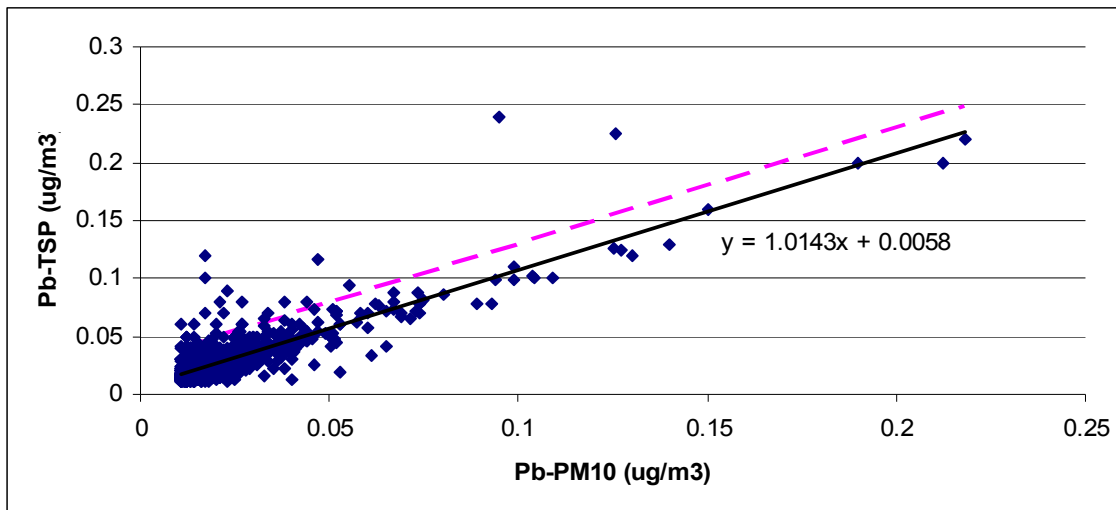


Figure 1. Plot of non-source oriented Pb-TSP and Pb-PM₁₀ data

A relationship developed based on a linear regression will still not perfectly predict any given measurement even when a strong relationship is present. In fact, 40% of the Pb-TSP estimates would be underestimates (i.e., the measured data are above the solid line) using this relationship as compared to the actual Pb-TSP data. Therefore, it would be possible to underestimate the average Pb-TSP concentration over a period of time based on Pb-PM₁₀ data resulting in the potential to misclassify an area as in attainment when it is actually in non-attainment of the NAAQS.

To reduce the potential for such misclassifications, it may be desirable to include a factor to account for the potential error in the estimate. To account for this potential error, we calculated the standard deviation of the estimation error as the standard deviation of the difference between the actual Pb-TSP measurement and the predicted Pb-TSP based on the linear regression. The standard deviation of the estimation error was estimated at 0.011. The dashed line in Figure 1 represents the linear regression plus two standard deviations of the estimation error ($\text{Pb-TSP} = \text{Pb-PM}_{10} * 1.014 + 0.028$). As can be seen in Figure 1, the majority of the data (90% of the data) would fall under the dashed line representing this approach, leading to considerably fewer underpredictions and therefore less possibility of misclassifying an area as in attainment when it was in fact in non-attainment of the NAAQS. An alternative, less inclusive relationship can be created by only adding one standard deviation ($\text{Pb-TSP} = \text{Pb-PM}_{10} * 1.014 + 0.017$), in which case 83% of the data would fall below the relationship. Other approaches for addressing the potential error may also be appropriate and will be explored in developing the Notice of Proposed Rulemaking.

Source oriented relationship. A number of factors will affect the relationship between Pb-TSP and Pb-PM₁₀ at source oriented sites including the size distribution of the emissions and the distance between the emission points and the monitor. Therefore, we would expect the relationship of Pb-TSP and Pb-PM₁₀ to vary significantly from site to site. This indicates limitations of using a single relationship to estimate Pb-TSP air concentrations based on Pb-PM₁₀ monitored data at all source oriented monitors.

Nonetheless, we evaluated the relationships for the source oriented monitoring sites. We identified two source oriented sites with collocated Pb-TSP and Pb-PM₁₀. We performed separate linear regressions for each of these sites, and a linear regression based on the combined data. Table 1 summarizes the results of these regressions. Figure 2 represents the best fit line based on the combined data set (Pb-TSP = 2.0*Pb-PM₁₀+0).

Table 1. Summary of Linear Regressions for Two Source Oriented Monitors

AQS Site ID	Slope	Intercept	R Squared
202090020	1.39	0.011	0.98
Primary Lead Smelter	2.2	0 ¹	0.94
Combined	2.0	0 ²	0.95

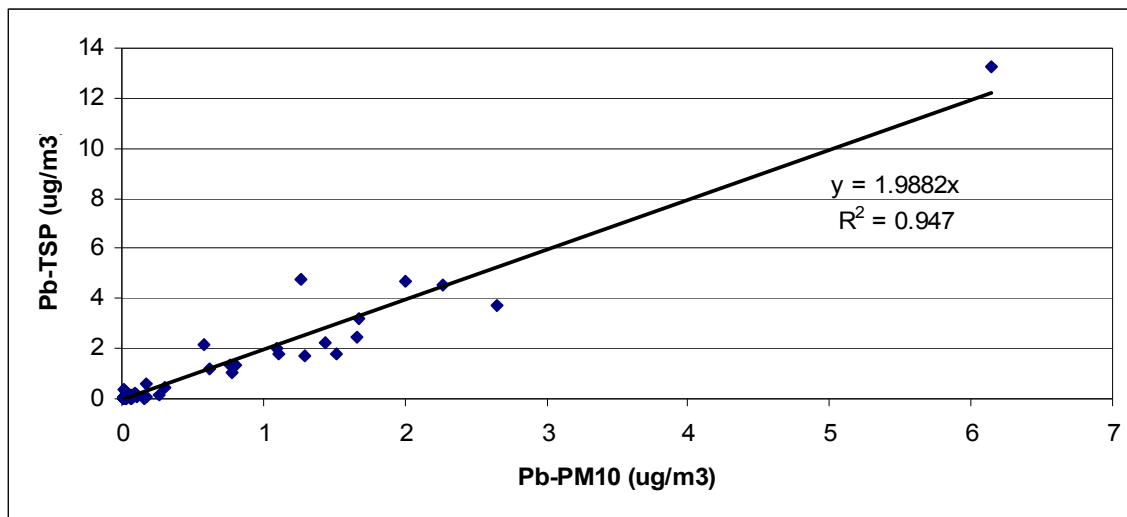


Figure 2. Plot of source oriented Pb-TSP and Pb-PM₁₀ data

As can be seen in Table 1, the regressions for the two source-oriented sites differ substantially, although both show a strong linear relationship, indicating additional limitations with the use of a single relationship to estimate Pb-TSP air concentrations based on Pb-PM₁₀ monitored data.

One option to addressing this variation among different source-oriented sites might be to use an estimate for the relationship between Pb-TSP and Pb-PM₁₀ based on the source sites showing the greatest difference. In this case, we might select the relationship based on the data from the primary lead smelter study (Pb-TSP = 2.2*Pb-PM₁₀+0) with or without an additional factor to account for potential error. However, this relationship is necessarily limited by the availability of data from only two types of sources. Data from other source types may indicate alternate relationships.

¹ Original regression gave a negative zero intercept. The regression was repeated forcing the intercept to 0 to avoid negative values for the Pb-TSP estimates.

² Same as footnote 1.

REFERENCE

Henderson, Rogene, Clean Air Scientific Advisory Committee, March 27, 2007. "Clean Air Scientific Advisory Committee's (CASAC) Review of the 1st Draft Lead Staff Paper and Draft Lead Exposure and Risk Assessments", EPA-CASAC-07-003

Henderson, Rogene, Clean Air Scientific Advisory Committee, January 22, 2008. "Clean Air Scientific Advisory Committee's (CASAC) Review of Advance Notice of Proposed Rulemaking (ANPR) for the NAAQS for Leads", EPA-CASAC-08-007

Brion, Gail, USEPA, July 22, 1988. "Col-located PM-10/Hi-Vol Results for E. Helena".