



State of California



Governor Gray Davis

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Chairman

Office of Environmental
Health Hazard Assessment
Joan E. Denton, Ph.D.
Director

October 28, 2003

Dr. Mary Ross
United States Environmental Protection Agency
Office of Air Quality Planning and Standards, C539-01
Research Triangle Park, North Carolina 27711

Dear Dr. Ross:

We are writing in response to the United States Environmental Protection Agency's (USEPA) request for comments on the first draft of the document titled "Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper." We are pleased to continue our participation in USEPA's review of the National Ambient Air Quality Standards for PM and appreciate the opportunity to comment on the draft Staff Paper.

Staff from the California Air Resources Board (ARB) and the Office of Environmental Health Hazard Assessment have reviewed this draft and generally support your assessment and your proposed ranges for standards for PM_{2.5} and PM_{10-PM2.5}. Given the wealth of studies indicating health effects at the lower ends of the ranges, we believe adequate protection of public health necessitates a standard at or near the low end of the proposed ranges. We also concur that separate standards for fine and coarse particles are warranted, in light of the evidence for health effects from both size fractions. The rationale for standards at the low end of the ranges plus additional specific comments are in the attachment.

Please contact Bart Croes, Chief of the Research Division at the ARB, at (916) 323-4519 or bcroes@arb.ca.gov if you have any questions regarding our comments.

Sincerely,

/S/

Catherine Witherspoon
Executive Officer
Air Resources Board

/S/

Joan Denton, Ph.D., Director
Office of Environmental Health
Hazard Assessment

cc: Bart E. Croes, P.E., Chief
Research Division
Air Resources Board

**California Air Resources Board and
Office of Environmental Health Hazard Assessment Comments on the
Review of the National Ambient Air Quality Standards for Particulate
Matter: Policy Assessment of Scientific and Technical Information
OAQPS Staff Paper**

COMMENTS ON THE PROPOSED RANGES

We have reviewed the U.S. EPA Staff Paper on PM Criteria and generally support your assessment and your proposed ranges for standards for PM_{2.5} and PM_{10-PM_{2.5}}. However, given the wealth of studies indicating effects at the lower ends of the ranges, we believe adequate protection of public health necessitates a standard at or near the low end of the proposed range. We also concur that separate standards for fine and coarse particles are warranted, given the evidence for health effects from both size fractions. Our reasoning is as follows:

PM_{2.5} Annual Average

We concur with the Criteria Document (CD) assessment that there is a growing body of evidence confirming associations between PM_{2.5} and both mortality and morbidity and that PM_{2.5} is a probable contributing cause of observed PM-associated health effects (CD, p E-23).

The consideration of an annual standard for PM_{2.5} correctly places significant weight on the long-term exposure studies using the American Cancer Society (ACS) and Harvard Six-Cities studies data (Dockery et al., 1993; Pope et al., 1995; Krewski et al., 2000, Pope et al., 2002). In these studies, robust associations were reported between long-term exposure to PM_{2.5} and mortality. The mean PM_{2.5} concentrations were 18 $\mu\text{g}/\text{m}^3$ (range of 11.0 to 29.6 $\mu\text{g}/\text{m}^3$) in the Six-Cities study (Dockery et al., 1993), 20 $\mu\text{g}/\text{m}^3$ (range of 9.0 to 33.5 $\mu\text{g}/\text{m}^3$) in the original ACS study (Pope et al., 1995), and approximately 14 $\mu\text{g}/\text{m}^3$ in the most recent analysis of the ACS cohort (Pope et al., 2002). Thresholds were not apparent in any of these studies and the authors suggested that the associations were linear or near linear. However, the precise period(s) of relevant exposure are currently unknown. Graphical analyses of these studies (Dockery et al., 1993, Figure 3 and Krewski et al., 2000, page 162) suggest a continuum of effects down to lower levels. In the ACS study, uncertainty in the risk estimates becomes apparent at around 13 $\mu\text{g}/\text{m}^3$, where the confidence bounds widen substantially as the concentrations extend further away from the study means. In the Dockery et al. (1993) study, the relative risks are similar for the cities at the lowest long-term PM_{2.5} concentrations of 11 and 12.5 $\mu\text{g}/\text{m}^3$. Larger increases in risk were not observed until the long-term PM_{2.5} mean equaled at least 14.9 $\mu\text{g}/\text{m}^3$. However, a margin of safety should be factored into the formulation of the standard and adverse health impacts may occur below the mean concentrations. We note that in the Staff Paper, U.S. EPA cites studies in the U.S. and Canada that indicate associations between daily counts of cardiovascular mortality and the long-term mean of 24-hour

exposures to PM_{2.5} in the range of 13 to 14 $\mu\text{g}/\text{m}^3$. For these reasons, the State of California determined that an annual standard of 12 $\mu\text{g}/\text{m}^3$ should be the goal for the long-term concentration of PM_{2.5}. We urge you to propose a standard at the low end of your proposed range of 12 to 15 $\mu\text{g}/\text{m}^3$ for an annual average for PM_{2.5}.

Although the risks per $\mu\text{g}/\text{m}^3$ of PM₁₀ or PM_{2.5} are relatively small, when the magnitude of the exposure to PM (i.e., the mean concentrations) and the sizes of exposed population are considered, the total health effects are likely to be substantial. For example, in California, we utilized a methodology similar to that used by U.S. EPA for estimating the benefits of Section 812 of the Clean Air Act and for several regulatory impact analyses (ARB, 2002). We estimated that, relative to an annual average of 12 $\mu\text{g}/\text{m}^3$, current exposures to PM_{2.5} were associated with 6,500 premature deaths per year (95% C.I. = 3,200 to 9,800), assuming all other factors remain the same. Nationwide estimates provided by Shprentz (1996) indicate that approximately 41,000 premature deaths per year could be avoided by attainment of this fine particle concentration.

Finally, the Staff Paper states the ongoing concern for potential confounding by weather in the daily time-series studies (p 6-6). The Staff Paper would be served by noting that the results of case-crossover studies, which are less subject to confounding by weather than time-series investigations, corroborate those found in the daily time-series studies.

PM_{2.5} 24-hour Average

There have been hundreds of published papers reporting associations between short-term (i.e., daily) exposures to PM₁₀ and both mortality and morbidity. Although there have been fewer such studies examining relationships of these outcomes with PM_{2.5}, it is clear that the current federal standard (24-hour average concentration of 65 $\mu\text{g}/\text{m}^3$) is not health-protective. Existing epidemiologic studies have found associations between PM_{2.5} and both mortality and morbidity when the maximum concentrations barely reached (and sometimes never exceeded) this level. Therefore, we support your decision to propose a standard below the current 24-hour standard. Given the number of studies that find effects when concentrations are below 30 $\mu\text{g}/\text{m}^3$, as cited in your Appendix A, we urge you to propose a standard at the low end of your proposed range of 30 to 50 $\mu\text{g}/\text{m}^3$. Specifically, we support, as does the existing science, a 24-hour standard at the lowest value of your proposed range, 30 $\mu\text{g}/\text{m}^3$. We also believe that the current statistical form of the standard, the 98th percentile, will not offer adequate public health protection. Our analysis indicated that more than one excursion above the standard would be incompatible with public health. We therefore propose that the national standard should be revised to at least the 99th percentile, which would be more closely aligned with the new California PM standards..

PM₁₀/Coarse Particles

In our review of the California ambient air quality standards for particulate matter last year, we retained an annual average standard for PM₁₀, but lowered it from 30 to 20 $\mu\text{g}/\text{m}^3$. The PM₁₀ metric encompasses both fine and coarse particles. Multiple studies in which the health impacts of PM_{2.5} and the coarse mode have been examined have reported adverse effects associated with both metrics, as well as with PM₁₀. Our

concern for controlling coarse particles was based on many of the studies cited in the Criteria Document that demonstrate associations between the coarse fraction of PM₁₀ and both mortality and morbidity (Appendix A). Our evaluation of the relevant literature, however, led us to retain the PM₁₀ standard rather than develop a separate coarse particle standard, largely because the database for PM₁₀, which has been the principal particle metric used for at least 15 years, is substantially more robust than that for the coarse fraction. Nevertheless, we support the proposal in the staff paper, to set a standard for coarse particles, given the scientific evidence documenting an effect of particles within the size cut of PM₁₀, but greater than PM_{2.5}.

The consideration of an annual standard for coarse particles should place some weight on the studies of mortality related to long-term PM exposure using the Harvard Six-Cities data (Dockery et al., 1993) and the American Cancer Society cohort (Pope et al., 1995; 2002). In the study by Dockery et al. (1993), the long-term average for PM₁₀ (measured as PM₁₅) ranged from 18 to 46.5 $\mu\text{g}/\text{m}^3$ in the six cities, with an overall mean of 30 $\mu\text{g}/\text{m}^3$. Visual inspection of graphs of this study's results suggests a continuum of effects down to the lowest levels, with no evidence for a threshold (recognizing that it would be difficult to detect a threshold graphically in this set of six data points corresponding to the six cities). The city with the lowest long-term average of 18 $\mu\text{g}/\text{m}^3$ PM₁₀ was Portage, WI. However, the relevant periods of exposure associated with long-term effects are unknown. In the absence of better information, it was reasonable to select the mean long-term PM₁₀ level (30 $\mu\text{g}/\text{m}^3$) as a starting point for recommending the annual standard, to which a margin of safety is added.

Pope et al. (1995) reported effects on mortality associated with PM_{2.5}, but not PM₁₀, in the analysis of the American Cancer Society cohort. Likewise, reanalysis of the 1995 ACS study also suggests associations of mortality with long-term exposure to PM_{2.5}, but not PM₁₀ (Krewski et al., 2000). However, the recent findings of the ACS (Pope et al., 2002) suggest an association between long-term exposure to both PM₁₀ and PM₁₅ with cardiovascular mortality.

Several investigations, including the Children's Health Study (McConnell et al., 1999) and the Harvard Six-Cities Study (Dockery et al., 1989), have also reported associations between long-term PM exposures and morbidity, including bronchitis, exacerbation of asthma, and reductions in lung function. In these studies, the long-term (one- or multi-year) mean PM₁₀ concentrations ranged from about 21 to 35 $\mu\text{g}/\text{m}^3$. Some of the morbidity studies, however, may be capturing the effects of exposure to multiple pollutants. For instance, in the Children's Health Study, the associations of adverse health outcomes with PM₁₀ and PM_{2.5} could not be statistically disentangled from the co-pollutants NO₂ and acid vapors.

In our review of the literature for the California PM standard (ARB, 2002), we noted that the epidemiological studies of daily exposure to PM₁₀ demonstrate effects on mortality at long-term mean concentrations as low as 14 $\mu\text{g}/\text{m}^3$ of PM₁₀. Many of the studies have long-term means or medians in the range of 25 to 35 $\mu\text{g}/\text{m}^3$. The annual averages of these short-term exposure studies are relevant, since associations are observed throughout a wide range of exposures and not only at the extreme values. As indicated in the CD, the general findings of these studies did not appear to be significantly impacted by the software problems associated with the general additive

model (GAM). A coarse particle standard at the lowest concentration of the proposed range of 13 to 30 $\mu\text{g}/\text{m}^3$ would typically correspond to a PM10 concentration of 25 $\mu\text{g}/\text{m}^3$, which is not as health protective as California's new annual PM10 standard of 20 $\mu\text{g}/\text{m}^3$. However, when coupled with an annual average PM2.5 concentration of 12 $\mu\text{g}/\text{m}^3$, a coarse particle standard of 13 $\mu\text{g}/\text{m}^3$ would provide far greater protection of public health than the current national PM10 standard. Therefore, we recommend that U.S. EPA adopt a coarse particle standard at the lowest value of the proposed range.

References

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Dockery DW, Speizer FH, Stram DO, Ware JH, Spengler JD, Ferris BG Jr (1989). Effects of inhalable particles on respiratory health of children. *American Review of Respiratory Diseases* 139:587-94.

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Krewski D, Burnett R, Goldberg MS, Koover K, Siemiatycki J, Jerrett M et al. (2000). Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. *Res Rep Health Eff Inst* (A special report of the Institute's Particle Epidemiology Reanalysis Project).

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Pope CA III, Burnett RT, Thun MJ et al. (2002) Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *JAMA* 287:1132-1141.

Shprentz, D (1996) *Breathtaking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities*. Natural Resources Defense Council. May.

SPECIFIC COMMENTS ON THE DOCUMENT

Page 2-9, under 2.2.3, 1st paragraph, 1st sentence: need to add nitrate to the list of items found predominately in fine particles. This is a minor correction, but important in regards to secondary PM formation in California.

Page 2-9: It would be more appropriate to use the term "elemental carbon" rather than "black carbon" here and throughout the document.

Page 2-14: In the first sentence in Section 2.3.2, add ammonia to the list of precursors to secondary PM.

Page 2-18: Although continuous methods for nitrate, sulfate, and carbon have not yet been deployed in routine networks, they have been used extensively at many of the U.S. EPA Supersites, and in special studies such as the California Regional PM10/PM2.5 Air Quality Study.

Page 2-20: While we recognize that the regional categorization in Section 2.5 is intended to support broad comparisons, there are significant variations within California that may influence the conclusions drawn. For example, it appears that the region classified as Southern California includes both the South Coast Air Basin as well as Owens Lake and Coachella Valley. However, both Owens Lake and Coachella Valley experience periodic severe windblown dust events that are distinctly different in magnitude and composition from the pattern observed in the urbanized portion of the South Coast Air Basin. In addition, it is difficult to determine from Figure 2-3 which sites in California are classified as Southern California, and which are classified as Northwest. However, all sites in the San Joaquin Valley should be classified together in one region as they exhibit generally comparable patterns and respond to common meteorological factors within the air basin.

Page 2-54: The data ranges reported for annual average PM concentrations appear reasonable. However, we do not feel use of the 99th percentile is appropriate for establishing a range for 24-hour background concentrations. Section 3.3.3 and Appendix 3E of the 4th Draft of EPA's Criteria Document provide a more balanced description of the frequency distribution, including reporting of the 90th percentile rather than the 99th percentile. As stated in Appendix 3E, "For most sites, the variability in concentrations on a quarterly basis increases substantially beyond the 90th percentile level... Perhaps the most striking features seen in Figures 3E4(a-d) and Figures 3E5(a-d) are the concentration changes associated with the P95 and P99 events, which represent extreme events." As shown in the figures in Appendix 3E, there can also be seasonal variability in the frequency distribution of the concentrations, as well as differences in composition. These factors should be discussed and considered as well in specifying appropriate 24-hour background concentrations.

Page 4-26, Table 4-8: It would be useful to provide the source of information for the background concentrations.

General comment: The document leans toward the eastern U.S. in regards to secondary PM formation. Since the majority of the nonattainment areas are in the west, there should be more discussion on situations specific to the west.