

**Review of Ambient Air Quality Standards for Particulate Matter
June 28, 2001 Board Presentation**

**Summary of Dr. Drechsler's Presentation
Air Resources Board**

The concerns about the health effects due to exposure to particulate matter are well founded. There exist a large body of evidence associating exposure to particulate matter with premature death and cardiorespiratory diseases, including asthma, bronchitis, and cardiac arrhythmia. Elevated concentrations of particulate matter also reduce visibility. Staff of the Air Resources Board (ARB) and the Office of Environmental Health Hazard Assessment (OEHHA) are evaluating the scientific literature on PM health effects to determine how to revise the Ambient Air Quality Standards for Particulate Matter.

An ambient air quality standard is the legal definition of clean air. Under California law, standards are based solely on health and welfare considerations. Costs and feasibility are not factors in setting ambient air quality standards. They play a role only when specific control and implementation measures are proposed for adoption.

Ambient air quality standards form the foundation of ARB's programs to achieve clean air for all Californians. The Board's efforts, including pollutant monitoring, emissions inventory development, air quality modeling, and control strategy development are directed toward achieving these clean air goals in California.

The Federal Clean Air Act, which authorizes the USEPA to set national ambient air quality standards, also permits states to adopt additional, or more protective state standards. California has exercised this right by authorizing the Air Resources Board to set California-specific ambient air quality standards for a variety of air pollutants, including particulate matter and sulfates. The Board has been concerned about the health effects of particulate matter for many years. In 1982 the Board set the current California ambient air quality standard for particulate matter (PM₁₀) at a level that is more protective of public health than the national PM₁₀ standard that is currently in effect. USEPA has never set a separate standard for sulfates, although California did so in 1977.

An ambient air quality standard has four elements. First is definition of the pollutant, in this case, particulate matter and sulfates. It also includes an averaging time (for example, 24-hour average), a concentration to be achieved, and specification of the monitoring method to determine attainment.

The current California ambient air quality standard for particulate matter is based on the mass of ambient particles of 10 microns or less in aerodynamic diameter, or PM₁₀. The standard was based on PM₁₀ because particulate matter 10

microns or less in diameter is inhalable, and can penetrate deep into the lungs. California has two standards for PM₁₀, an annual average of 30 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), which protects against long-term health effects, and a 24-hour average of 50 $\mu\text{g}/\text{m}^3$, which protects against short-term health effects. The current sulfates standard is a 24-hour average of 25 $\mu\text{g}/\text{m}^3$ (measured as total suspended particulates). The USEPA is in the process of reviewing their ambient air quality standards for particulate matter and expect to promulgate new particulate standards in 2003.

Particulate matter is a complex mixture composed of small droplets of liquid, dry solid fragments, and solid cores with liquid coatings. Particles vary widely in size, shape and chemical composition, and arise from many sources. Particulate matter is not a single chemical entity like, for example, ozone. It includes many chemical species that arise from a wide variety of sources. A few examples are metals, nitrates, soil, and carbon. Also, note that sulfates are a sub-fraction of particulate matter.

PM₁₀ can also be divided into several size fractions. Coarse particles are between 2.5 and 10 microns in diameter, and arise primarily from natural processes. Fine particles are defined as being less than 2.5 microns in diameter and arise primarily from combustion processes. Particles less than 0.1 micron in diameter are referred to as ultrafine particles. These are freshly emitted from combustion sources. They have almost no mass, but the absolute number of particles in this size category is very large. This represents a new and growing area of research. Adverse health effects have been associated with all inhalable particles, PM₁₀, as well as the PM_{2.5} and ultrafine sub-fractions of PM₁₀.

The potential for particulate matter to induce adverse health effects is related to particle size. Particles of 10 microns or less in aerodynamic diameter can be inhaled deep into the lungs where they can induce tissue damage and various adverse health effects. Particles larger than 10 microns in diameter are generally filtered out in the nasal passages, and do not enter the lungs to any great extent. To give you some perspective on how small these particles are, the human hair is approximately 60 microns in diameter. Therefore, PM₁₀ particles are one sixth the size in diameter of a human hair. PM_{2.5} particles are one 24th the size of the human hair. Measuring the concentration of PM_{2.5} in the air only captures the particles that are 2.5 microns or less in diameter while omitting all those particles larger than 2.5 microns in diameter. Thus, PM_{2.5} is a subset of PM₁₀.

Particulate matter arises from natural sources and processes, for example, soil and wind-blown dust, fires, and sea-salt aerosol. Other particles are by-products of various combustion or industrial processes. Still others enter the ambient air by condensation and other processes. Some particles are directly emitted, while others form in the atmosphere through gas-to-particle conversion reactions.

Only Lake County is in attainment with the current California standard for PM10. The frequency of 24-hour standard exceedances in 1998 ranged from 0 to 264 days, and in 1999, from 0 to 306 days, depending on air basin. This means that most California citizens are exposed to PM10-polluted air on a few to many days per year. The entire state is in attainment with the sulfates standard.

Ultimately, the particulate matter standards review process necessitates making a number of decisions. ARB and OEHHA staff are studying the scientific literature to determine what particulate matter size, averaging times, and concentrations are the most appropriate to ensure protection of the health of all of California's citizens. We are also reviewing and evaluating the scientific literature to determine whether the separate sulfates standard is still needed. The monitoring method is also a part of the standard. Currently particulate matter and sulfates are monitored with 24-hour filter-based particle-sampling methods that are typically operated every sixth day. These methods are not readily amenable to short-term averaging, for example for times less than 24 hours. Also, the one-out-of-six-day monitoring schedule does not adequately characterize exposure. The Monitoring and Laboratory Division is currently evaluating several new continuous monitoring methods to determine what monitoring strategy will be most useful. Use of these new methods would allow multiple averaging times, both long- and short-term, from the output of a single analyzer.

The standards promulgation process begins with a draft report prepared by staff from ARB and OEHHA that is released for public review and comment. The first public review draft of the staff report is expected to be released in late September, 2001. This will be followed by a public comment period, and several public workshops. The report will also undergo peer review by the Air Quality Advisory Committee, OEHHA's outside peer review panel, at a public meeting in November. ARB and OEHHA staff will then revise the draft report to incorporate the comments of the public and the Air Quality Advisory Committee, and re-release it for further public comment in early March 2002. ARB staff expect to bring the Board our recommendations for the particulate matter and sulfates standards at the April 2002 Board Hearing. Recommendations will include all of the elements of the standards, along with evaluation of the supporting science. The recommendations will be summarized in a document that contains staff's best advice. At the hearing the Board will consider recommendations and make a decision on the new particulate matter standards.

Summary of Dr. Ostro's Presentation Office of Environmental Health Hazard Assessment

As mentioned above, the concerns about particulate matter are well founded. To date, a number studies have found significant associations between PM and mortality and morbidity (illness). Observed effects have been related to both short- and long-term exposure to particulate matter.

Typically, epidemiology studies provide the majority of information related to air pollution health effects. Recent animal toxicity studies support many of the epidemiologic findings while controlled human exposure studies attempt to collect data on humans under real world conditions.

Epidemiological studies have several advantages and disadvantages. Advantages include eliminating the need, and thus the uncertainty, associated with taking toxicological results from one species (e.g. rats) and applying their results to another species (e.g. humans). Also, they allow for one to examine multiple exposures, outcomes, and subgroups (e.g. children, elderly, and asthmatics) to be evaluated in a single study. Disadvantages include uncertainties associated with imprecise measurements of health related outcomes and a limit in the range of outcomes one can measure.

There are several types of epidemiological study designs employed to evaluate air pollution. The most prevalent include time-series and prospective cohort studies. Time series mortality studies examine associations between daily changes in pollution and daily death rates in a specified area, control for factors that change daily (e.g. weather), minimizes the confounding of factors such as smoking, alcohol use, and occupational exposure that are not expected to change daily and be associated with PM, and examine effects of short-term exposures. Prospective cohort studies focus on individual data, follows a specific group of people over time, looks at longer term exposure, and may allow for a determination of life years lost.

Results of time series mortality studies have been finding consistent association between PM and daily mortality, even at very low concentrations. In addition, studies have not been able to identify a threshold concentration or level at which these associations *do not* occur, especially when considering sensitive subgroups like the elderly, infants, and those with chronic heart or lung disease. Results of cohort studies like the American Cancer Society Cohort Study found mortality associated with fine particles and sulfates, a 4% increase in mortality per 10 $\mu\text{g}/\text{m}^3$ increase in PM₁₀, and a loss of life expectancy.

Morbidity effects associated with PM included increases in hospitalization, emergency room, and MD visits for cardiovascular or respiratory causes such as cardiovascular outcomes, asthma exacerbation, acute and chronic bronchitis,

loss in lung function, and loss in work time as well as increased absenteeism in schools.

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