

Specifically, larger particles ($>10\text{ }\mu\text{m}$) tend to be removed by the respiratory clearance mechanisms whereas smaller particles are deposited deeper in the lungs. Also, particles scatter light obstructing visibility.

The emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters of fine and coarse particles are distinct. Fine particles are directly emitted from combustion sources and are formed secondarily from gaseous precursors such as oxides of nitrogen (NO_x). Fine particles are generally composed of sulfate, nitrate, chloride, ammonium compounds, organic carbon, elemental carbon, and metals. Aircraft engines emit NO_x which react in the atmosphere to form secondary $\text{PM}_{2.5}$ (namely ammonium nitrate). Combustion of coal, oil, diesel, gasoline, and wood, as well as high temperature process sources such as smelters and steel mills, produce emissions that contribute to fine particle formation. In contrast, coarse particles are typically mechanically generated by crushing or grinding. They include resuspended dusts and crustal material from paved roads, unpaved roads, construction, farming, and mining activities. These coarse particles can be either natural in source such as road dust or anthropogenic. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometers, while coarse particles deposit to the earth within minutes to hours and within tens of kilometers from the emission source.

The relative contribution of various chemical components to $\text{PM}_{2.5}$ varies by region of the country. Data on $\text{PM}_{2.5}$ composition are available from the EPA Speciation Trends Network in 2001 and the Interagency Monitoring of *PRO*TECTED Visual Environments (IMPROVE) network in 1999 covering both urban and rural areas in numerous regions of the U.S. These data show that nitrates formed from NO_x also play a major role in the western U.S., especially in the California area where it is responsible for about a quarter of the ambient $\text{PM}_{2.5}$ concentrations.

a. Health Effects of $\text{PM}_{2.5}$

Scientific studies show ambient PM is associated with a series of adverse health effects. These health effects are discussed in detail in the EPA Criteria Document for PM as well as the draft

updates of this document released in the past year.^{51,52}

As described in these documents, health effects associated with short-term variation in ambient particulate matter (PM) have been indicated by epidemiologic studies showing associations between exposure and increased hospital admissions for ischemic heart disease, heart failure, respiratory disease, including chronic obstructive pulmonary disease (COPD) and pneumonia. Short-term elevations in ambient PM have also been associated with increased cough, lower respiratory symptoms, and decrements in lung function. Short-term variations in ambient PM have also been associated with increases in total and cardiorespiratory daily mortality. Studies examining populations exposed to different levels of air pollution over a number of years, including the Harvard Six Cities Study and the American Cancer Society Study suggest an association between exposure to ambient $\text{PM}_{2.5}$ and premature mortality, including deaths attributed to lung cancer.^{53,54} Two studies further analyzing the Harvard Six Cities Study's air quality data have also established a specific influence of mobile source-related $\text{PM}_{2.5}$ on daily mortality⁵⁵ and a concentration-response function for mobile source-associated $\text{PM}_{2.5}$ and daily mortality.⁵⁶

b. Current and Projected Levels

There are NAAQS for both PM_{10} and $\text{PM}_{2.5}$. Violations of the annual $\text{PM}_{2.5}$ standard are much more widespread than are violations of the PM_{10} standards. Figure III-1 at the beginning of this air quality section highlighted

monitor locations measuring concentrations above the level of the NAAQS. As can be seen from that figure, high ambient levels are widespread throughout the country. Today's proposed aircraft NO_x standards should contribute to attainment and maintenance of the existing PM NAAQS since NO_x contributes to the secondary formation of $\text{PM}_{2.5}$.

The NAAQS for $\text{PM}_{2.5}$ were established by EPA in 1997 (62 FR 38651, July 18, 1997). The short term (24-hour) standard is set at a level of $65\text{ }\mu\text{g}/\text{m}^3$ based on the 98th percentile concentration averaged over three years. (This air quality statistic compared to the standard is referred to as the "design value.") The long-term standard specifies an expected annual arithmetic mean not to exceed $15\text{ }\mu\text{g}/\text{m}^3$ averaged over three years.

Current $\text{PM}_{2.5}$ monitored values for 1999–2001, which cover counties having about 75 percent of the country's population, indicate that at least 65 million people in 129 counties live in areas where annual design values of ambient fine PM violate the $\text{PM}_{2.5}$ NAAQS. There are an additional 9 million people in 20 counties where levels above the NAAQS are being measured, but there are insufficient data at this time to calculate a design value in accordance with the standard, and thus determine whether these areas are violating the $\text{PM}_{2.5}$ NAAQS. In total, this represents 37 percent of the counties and 64 percent of the population in the areas with monitors with levels above the NAAQS.⁵⁷ Furthermore, an additional 14 million people live in 41 counties that have air quality measurements within 10 percent of the level of the standard. These areas, although not currently violating the standard, would also benefit from the additional reductions from this proposed rule in order to help ensure long term maintenance.

The air quality modeling performed for the recent Nonroad Diesel Engines and Fuel Control proposed rule also indicates that similar conditions are likely to continue to exist in the future

⁵¹ U.S. EPA (1996.) Air Quality Criteria for Particulate Matter—Volumes I, II, and III, EPA, Office of Research and Development. Report No. EPA/600/P-95/001a-cF. This material is available electronically at <http://www.epa.gov/ttn/oarpg/ticd.html>. Available in Docket A-99-06, Document Nos. IV-A-30, IV-A-31, and IV-A-32.

⁵² U.S. EPA (2002). Air Quality Criteria for Particulate Matter—Volumes I and II (Third External Review Draft) This material is available electronically at <http://cfpub.epa.gov/ncea/cfm/partmatt.cfm>. Available in Docket A-2001-28, Document Nos. II-A-98 and II-A-71.

⁵³ Dockery, DW; Pope, CA, III; Xu, X; *et al.* (1993) An association between air pollution and mortality in six U.S. cities. *N Engl J Med* 329:1753–1759.

⁵⁴ Pope, CA, III; Thun, MJ; Namboordiri, MM; *et al.* (1995) Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. *Am J Respir Crit Care Med* 151:669–674.

⁵⁵ Laden F; Neas LM; Dockery DW; *et al.* (2000) Association of fine particulate matter from different sources with daily mortality in six U.S. cities. *Environ Health Perspect* 108(10):941–947.

⁵⁶ Schwartz J; Laden F; Zanobetti A. (2002) The concentration-response relation between $\text{PM}_{2.5}$ and daily deaths. *Environ Health Perspect* 110(10): 1025–1029.

⁵⁷ Memorandum to Docket A-2001-11 from Fred Dimmick, Group Leader, Air Trends Group, "Summary of Currently Available Air Quality Data and Ambient Concentrations for Ozone and Particulate Matter," December 3, 2002. A copy of this document is available in Docket No. OAR 2002-0030.