

FINE PARTICULATE MATTER (PM_{2.5})

Characteristics

Fine particulate matter (PM_{2.5}) refers to airborne solid or liquid particles that are 2.5 microns or less in diameter. It is either emitted directly (primary PM) or formed in the atmosphere from precursor emissions (secondary PM). Important precursors of secondary PM are nitrogen oxides, sulphur dioxide, ammonia, and volatile organic compounds. The chemical composition of particles can vary widely and depends on location, time of year, and weather.

Primary PM_{2.5} is formed by combustion processes including: forest fires or residential wood fires; burning of fossil fuels in motor vehicles, furnaces, boilers, and heaters; and certain industrial processes. Secondary fine particles are created when chemicals react in the atmosphere and grow through particle-particle or gas-particle interactions.

Fine particulates undergo removal from the atmosphere by interaction with rainfall or by dry deposition. Particulate matter can be measured in real time by Tapered Element Oscillating Microbalance (TEOM, detection limit of 0.1 µg m⁻³), and Beta Attenuation Monitor (BAM, detection limit of less than 5 µg m⁻³); and periodically by filter based methods (detection limit of 1 µg m⁻³).

Effects

Extensive scientific studies indicate that there can be significant health and environmental effects associated with PM_{2.5}. Due to its small size, PM_{2.5} can accumulate in the respiratory system and may be associated with health effects such as chronic bronchitis, and decreased lung function. Sensitive groups that appear to be at greatest risk to such effects include children, the elderly, and individuals with cardiopulmonary disease, such as asthma. Several ambient PM constituents can cause health effects including: acidic aerosols, metals, diesel emissions, silica, and bioaerosols. Most of the toxicology data on PM are derived from controlled exposure studies in humans and laboratory animals. Controlled exposures of healthy or asthmatic subjects to acid aerosols (i.e. H₂SO₄) have been observed to cause mild lower respiratory symptoms (such as cough) and produce functional changes in the respiratory tract. Air concentrations associated with these symptoms ranged from 100-1000 µg m⁻³ for exposure periods ranging from 1-3 hours. Long-term exposures (weeks/month) of laboratory animals to 500 µg m⁻³ of H₂SO₄ are associated with reductions in pulmonary mechanical functions such as lung capacity. Controlled human exposures to PM constituents other than acid aerosols are limited.

PM_{2.5} can cause reduced visibility as the fine fraction particles scatter light effectively, reducing the distance for which the atmosphere is clear. The photochemical haze results when light scattering particles form through the reaction of chemical substances in the atmosphere. This ultimately causes the view of distant objects to be obscured by the haze. This can be especially problematic in scenic tourist destinations, as this may reduce the area's desirability as a tourist destination.

Canada Wide Standards

In June 2000, the federal, provincial, and territorial governments except Quebec signed the Canada-wide Standards (CWS) for Particulate Matter and Ozone. The Canada-wide Standards for PM and ozone are an important step towards the long-term goal of minimizing the risks of these substances to human health and the environment. They represent a balance between achieving

the best health and environmental protection possible and the feasibility and costs of reducing the substance emissions that contribute to PM and ground-level ozone in ambient air.

The CWS and related provisions for PM are:

- A CWS for PM_{2.5} of 30 µg m⁻³, 24 hour averaging time, by year 2010.
- Achievement to be based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years.

Also included in the CWS are provisions for “Keeping Clean Areas Clean and Continuous Improvement” (KCAC/CI) that apply at ambient concentrations below the numeric CWS, as well as provisions on monitoring and reporting of progress and activities.

In November 2000, the Alberta’s Clean Air Strategic Alliance’s (CASA) board of directors agreed to establish a PM and ozone project team to develop the Alberta implementation plan for the CWS. The project team developed a PM and ozone management framework for Alberta, meeting and in some cases going beyond the provisions of the CWS. The framework recognizes that different implementation strategies may have to be used for areas with different PM_{2.5} and ozone concentrations. The framework also recognizes the importance of taking pro-active actions to ensure that areas with ambient PM_{2.5} and ozone concentrations currently below the CWS remain clean. In addition, although the requirement for national reporting of the CWS is limited to monitoring stations that fall within population areas of 100,000 or more, the project team recommended that the CWS be applied to the whole province.

Alberta Ambient Air Quality Objectives

Alberta ambient air quality objectives are issued by Alberta Environment, under Section 14 (1), the *Environmental Protection and Enhancement Act, 1992* (EPEA). Based upon the available information, Alberta hereby adopts:

- From the Canada-wide Standards, an Alberta Ambient Air Quality Objective for fine particulate matter (PM_{2.5}) of 30 µg m⁻³ as a 24-hour average concentration.

Alberta Ambient Air Quality Guidelines

Alberta ambient air quality guidelines are issued by Alberta Environment, under Section 14 (4), the *Environmental Protection and Enhancement Act, 1992* (EPEA). From the statistical equivalent of the 24-hour CWS.

- An Alberta Ambient Air Quality Guideline for fine particulate matter (PM_{2.5}) of 80 µg m⁻³ as a 1-hour average concentration to be used for monitoring and reporting of the Ambient Air Quality Index..

References

Canadian Council Of Ministers of the Environment (CCME). Canada-wide Standard: Particulate Matter and Ground-Level Ozone. www.ccme.ca/initiatives/standards.html. Accessed March 25, 2004.

Clean Air Strategic Alliance (CASA). Particulate Matter and Ozone Management Framework http://www.casahome.org/uploads/PMO3_ManagementFrameworkSEP-18-2003.pdf.

Fu, L., Myrick, B., et al. 2000. One-hour equivalent of a 24-hour average particulate matter standard and its potential application in the index of the quality of the air (IQUA). Presented at the Air and Waste Management Association (AWMA) Conference, Banff, Alberta. April 10-12, 2000.

U.S. EPA. 1996. Air Quality Criteria for Particulate Matter: Volume II of III. U.S. Environmental Protection Agency, Office of Research and Development. Washington, D.C. April 1996.