

# GUIDANCE FOR FINE PARTICULATE MATTER (PM<sub>2.5</sub>) IN RESIDENTIAL INDOOR AIR

## Background

Fine particulate matter ( $PM_{2.5}$ ) is a general term for all small particles found in air measuring equal to or less than 2.5 µm in aerodynamic diameter. It is a complex mixture whose constituents vary in size, shape, density, surface area, and chemical composition (Health Canada and Environment Canada 1999; US EPA 2009). In 1987, Health Canada published Exposure Guidelines for Residential Indoor Air Quality, which set maximum acceptable long- and short-term exposure ranges for  $PM_{2.5}$  in homes. These guidelines are being revised to reflect the most up-to-date science on the health effects and residential exposure for  $PM_{2.5}$ .

### Exposure

Indoor PM<sub>2.5</sub> is composed of indoor-generated PM<sub>2.5</sub> from sources such as smoking, cooking, and cleaning, and PM<sub>2.5</sub> that has infiltrated from the outside. In studies conducted by Health Canada in different Canadian cities, average indoor PM<sub>2.5</sub> concentrations were less than 15  $\mu$ g/m<sup>3</sup> in homes without smokers, and less than 35  $\mu$ g/m<sup>3</sup> in homes with smokers (Health Canada 2010). In general, indoor PM<sub>2.5</sub> levels were lower than outdoor concentrations measured directly outside the home, except in homes with smokers.

### **Health Effects**

Outdoor  $PM_{2.5}$ , as measured at area monitoring stations, has been shown in a large number of studies to be strongly associated with cardiovascular and respiratory mortality and morbidity endpoints (Health Canada and Environment Canada 1999; WHO 2005; US EPA 2009). There is no recognized threshold of health effects for outdoor  $PM_{2.5}$  regardless of where exposure occurs (i.e., indoors or outdoors), and there is evidence that adverse health effects occur at current levels of exposure.

A much smaller number of studies have investigated the relationship between indoor  $PM_{2.5}$  and health. There is some evidence for a relationship between indoor  $PM_{2.5}$  levels and declines in lung function and increases in exhaled nitric oxide, a marker of airway inflammation, in asthmatic children (Koenig et al. 2003; Delfino et al.

2004; Koenig et al. 2005; Trenga et al. 2006). However, changes in exhaled nitric oxide were more strongly associated with outdoor  $PM_{2.5}$  than indoor  $PM_{2.5}$  (Koenig et al. 2003; Koenig et al. 2005; Allen et al. 2008). Associations between indoor  $PM_{2.5}$  and subtle changes in markers of cardiovascular disease have also been observed in older adults (Delfino et al. 2008; Liu et al. 2009; Allen et al. 2011).

#### Guidance

The acceptable long- and short-term exposure ranges established in the 1987 exposure guidelines should be rescinded and replaced with this new guidance focusing on indoor source control to minimize long-term exposure to  $PM_{2.5}$  indoors.

Indoor levels of  $PM_{2.5}$  should be kept as low as possible, as there is no apparent threshold for the health effects of  $PM_{2.5}$ . It is impossible to entirely eliminate  $PM_{2.5}$  indoors, as among its sources are essential and everyday activities, such as cooking and cleaning, as well as infiltration from outdoor sources, over which residents have little or no control. However, any reduction in  $PM_{2.5}$ would be expected to result in health benefits, especially for sensitive individuals, such as those with underlying health conditions, the elderly or children.

The focus should be on reducing indoor sources over which homeowners and residents have some degree of control. The main recommended strategies to reduce exposure to the major sources of indoor-generated  $PM_{2.5}$  are:

- Cessation of smoking
- Use of a stove top fan while cooking

Other actions to reduce indoor  $PM_{2.5}$  levels include ensuring there is adequate ventilation, especially when doing activities that may generate  $PM_{2.5}$ . The potential benefits of ventilation, however, may be reduced or eliminated, if outdoor  $PM_{2.5}$  levels are high. There is also evidence that some in-duct air filters or portable air cleaners with filters may help reduce indoor  $PM_{2.5}$  levels. Filter efficiency, however, is highly variable among products and the effectiveness of filters as a method to reduce indoor  $PM_{2.5}$  will depend on the product used and how it is maintained. A discussion of how to properly select and maintain air filters and portable air cleaners is beyond the scope of this document.

The above recommendations are consistent with Health



Canada guidance to homeowners to focus on identifying the potential sources of contaminants in the home, and then on improving air quality through source control, improved ventilation and other remedial measures such as air filtration. Identification of potential sources is, in most situations, more informative and cost-effective than indoor air quality testing and comparison of measured values to quantitative guideline values.

Quantitative residential indoor air guidelines may be of use to public health and building professionals for the interpretation of results of indoor air quality studies and for the development of performance standards. With respect to indoor PM<sub>2.5</sub>, Health Canada is not proposing a specific maximum exposure limit, but is recommending that indoor  $PM_{25}$ , at a minimum, be lower than  $PM_{25}$  outside the home. Having an indoor level that is greater than the outdoor level indicates a strong indoor source(s) of PM<sub>2.5</sub> that needs to be addressed. The ratio of indoor to residential outdoor PM2.5 levels can therefore serve to highlight situations where strategies to reduce indoorgenerated PM<sub>2.5</sub> are necessary and will be most effective. The recommended PM<sub>2.5</sub> reduction strategies can be employed in all homes. However, for those homes with a ratio of indoor to outdoor PM<sub>2.5</sub> levels greater than one, targeted efforts to identify and remove indoor sources of PM<sub>2.5</sub> are a priority.

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