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Working Group on Indoor Air Quality: Inorganic Fibres and Other Particulate Matter

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TARGET 21

Protection against air pollution

By 1995, all people of the Region should be effectively protected against recognized health risks from air pollution.

Index:

AIR POLLUTANTS - adverse effects
SYNTHETIC FIBRES - adverse effects
MINERALS - adverse effects
AIR QUALITY
AIR - analysis

The Working Group was convened to consider the state of knowledge concerning inorganic fibres in indoor air and their distribution in the population, and to assess what is known about the adverse health effects which might be caused by population exposure. The Working Group was organized with the cooperation and support of Health and Welfare Canada. It consisted of 18 temporary advisers from eight countries.

The Working Group considered mineral fibres which are of interest in common, non-industrial environments. Man-made mineral fibres (MMMF), most of which are also called man-made vitreous fibres (MMVF), are manufactured from various minerals, including glass and rock. They can be made as a continuous filament, in the form of insulation wool, or as refractory or special-purpose fibres. Asbestos fibres exist in a variety of forms with different qualities, but commercially they have been used mostly in the form of chrysotile. The Working Group evaluated the application of all these fibres in the indoor environment, including the sources and sinks for fibres. Most release of mineral fibres in indoor air is associated with installation, maintenance and retrofitting of fibrous products.

The Group reviewed the analytical methods used in the characterization and measurement of mineral fibres and their concentration. In the indoor environment, fibres of organic origin often dominate the total fibres found, making their recognition very important. The uses of phase-contrast optical microscopy (PCM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM) were considered, with TEM having the greatest capacities for resolution and analysis of thin fibres. Sampling strategies can range from sedimentation plates for screening purposes to membrane filter and pump combination for quantitative measurements. The length of the sampling period should reflect the processes which might release fibres, as well as occupancy patterns.

Mean respirable fibre concentrations of MMMF in residences and public buildings have been reported at 40–200 F/m^3 of air. Outdoor air has been reported to contain MMMF at concentrations of 400–1700 F/m^3 in urban environments, and 40 F/m^3 in rural air. Asbestos fibres longer than 5 μm can be found in the indoor air in buildings at mean concentrations in the range of 70–200 F/m^3; if all asbestos fibres of any length are counted, then mean concentrations of $(0.5-1.0) \times 10^6$ F/m^3 can be obtained.

The Working Group considered the state of knowledge concerning the adverse health effects associated with exposure to mineral fibres of different types. Potential effects are interstitial pulmonary fibrosis (IPF), lung cancer and mesothelioma. The Group reviewed the recent toxicological data obtained in animal testing, and also the status of the major epidemiological studies involving cohorts of industrial workers. New toxicological studies using improved methodologies are showing animal carcinogenesis for ceramic fibres and for other MMMFs when the length is more than 5 μm and the fibre diameter is 1 μm or less.

The improved methods include uniform sizing of the fibres and better ways of administering them, which make it possible to introduce higher lung burdens into toxicological evaluations. New data also support a model in which the durability of the mineral fibre, its length and its diameter determine the toxicological effects in animal models.

Epidemiological studies have been limited in number, and are based on cohorts of workers in different mineral-fibre industries. The exposure/effect relationships are difficult to establish because the exposures are very poorly documented. With the best estimates of exposure it appears that different industrial processes produce different slopes for the exposure/effect relationship for a given mineral fibre. In the asbestos-cement industry, the risk for a given exposure is considerably lower than the same exposure in the asbestos-textile industry. The risk of mesothelioma seems to be much lower for chrysotile and anthophyllite than for crocidolite and amosite, and even for crocidolite the risk appears to depend on the percentage of fibres with a diameter of 0.1 µm or less.

For an asbestos fibre concentration indoors of 100 F/m^3, the lifetime excess risk of cancer is estimated to be in the order of 1 in 10^5 to 1 in 10^7. The Working Group considered different methods of prevention of exposure in indoor environments, ranging from recommending against the use of carcinogenic mineral fibres in buildings to implementation of detailed administrative procedures to assure effective containment. Such approaches should begin with a documented inventory, inspection and maintenance schedules aimed at preventing releases of fibres, and education and training of responsible personnel in the safeguards required. It is sometimes advantageous to enclose the asbestos-containing material, or to encapsulate it with a bonding agent or a sealer. The most extreme form of asbestos control is to remove it completely from a building using suitably safe methods, and to dispose of it in an approved manner.

Conclusions

1. Airborne contamination with asbestos is widespread and as a consequence asbestos fibres can be found in most human lungs.

2. The carcinogenic potential of mineral fibres increases with fibre length, and with their increasing durability.

3. All commonly used forms of asbestos have produced excess incidence of asbestosis, lung cancer and mesothelioma.

4. Elevated rates of lung cancer have been reported in rock- or slag-wool production workers. Current airborne MMMF concentrations in indoor environments are considered to represent an insignificant risk.

5. There have been special situations where environmental exposure to erionite and crocidolite have caused increased rates of mesothelioma.

6. The possibility of lung fibrosis is of concern only to people who repeatedly disturb fibrous materials, thus creating high local concentrations of airborne fibres. These people may also be at increased risk for lung cancer and mesothelioma.

7. Exposed, loose or friable thermal and acoustic insulation materials are the major sources of indoor exposure to mineral fibres.

8. The main causes of mineral-fibre release are installation, removal and damage of mineral fibre-containing materials, and demolition of buildings.

9. The great majority of buildings have airborne asbestos concentrations which do not represent a significant excess risk.

10. Exposure to MMMF can cause skin and eye irritation.

11. Average indoor levels of MMMF range up to 300 F/m^3 in buildings containing these materials. Average indoor levels of respirable asbestos range from 100 to 1000 F/m^3 (fibre length >5 µm) in buildings containing asbestos products. When loose, friable asbestos and MMMF materials are abraded, much higher levels are generated.

Recommendations

1. Standard methods for measuring indoor inorganic fibres should be established so that they can be determined and reported in terms of fibre length and diameter, with speciation of fibre type. Indoor samples should be collected over a one-week period.

2. Prior to their use in building products, mineral fibres should be systematically investigated with respect to the exposure and health effects likely to result.

3. All construction and operating documents, including those listing an inventory of inorganic fibre-containing materials in the building should be kept by the building manager, and referred to in the event of maintenance and repair.

4. The use of carcinogenic mineral fibres (such as asbestos and erionite) in construction should be avoided wherever reasonably possible.

5. Exposure to airborne mineral fibres should be kept as low as possible. Particular attention should be given to the management of loose, soft, friable and accessible mineral fibre-containing products.

6. Mineral fibres should be coated or covered with other materials to prevent fibre release and to minimize exposure of the public by inhalation and skin contact. In the event of contamination, mineral-fibre dust should be removed from the affected area before normal activity is resumed.

7. Precautions should be taken to reduce airborne-fibre exposure of people who disturb mineral fibre-containing materials during maintenance and repair.