資料4

Environmental Health Criteria 203

CHRYSOTILE ASBESTOS

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f/ml for sanding. Following clean-up and introduction of controls, levels were 0.5 to 1.7 f/ml.

There is potential for widespread exposure of maintenance personnel to mixed asbestos fibre types due to the large quantities of friable asbestos materials still in place. In buildings where there are control plans, personal exposure of building maintenance personnel in the USA, expressed as 8-h time-weighted averages, was between 0.002 and 0.02 f/ml. These values are the same order of magnitude as exposures reported during telecommunication switch work (0.009 f/ml) and above-ceiling work (0.037 f/ml), although higher concentrations have been reported in utility space work (0.5 f/ml). Concentrations may be considerably higher where control plans have not been introduced. For example, in one case, short-term episodic concentrations ranged from 1.6 f/ml during sweeping to 15.5 f/ml during cleaning (dusting off) of library books in a building with a very friable chrysotile-containing surface formulation. Most other values, presented as 8-h time-weighted averages, are about two orders of magnitude less.

Although few data on exposures among users of asbestos-containing products in industries such as construction were identified, available data clearly demonstrate the need for appropriate engineering controls and work practices for minimizing exposures to chrysotile both in production and use. It should be noted that construction and demolition operations present special control problems.

9.2.2 General population exposure

Sources of chrysotile in ambient air are both natural and anthropogenic. Most airborne fibres in the general environment are short (< 5 µm).

Few recent data on concentrations of chrysotile in air in the vicinity of point sources have been identified. Concentrations around the Shibani chrysotile mine in Zimbabwe ranged from below the limit of detection of the method (<0.01 f/ml) to 0.02 f/ml (fibres longer than 5 µm).

Based on surveys conducted before 1986, concentrations (fibres > 5 µm in length) in outdoor air measured in five countries (Austria, Canada, Germany, South Africa and USA) ranged between 0.0001 and about 0.01 f/ml, with levels in most samples being less than 0.001 f/ml. Means or medians were between 0.00005 and 0.02 f/ml, based on more recent determinations in seven countries (Canada, Italy, Japan, Slovak Republic, Switzerland, United Kingdom and USA).

Fibre concentrations in public buildings during normal use where there is no extensive repair or renovation are within the range of those measured in ambient air, even where friable asbestos-containing materials were extensively used. Concentrations (fibres > 5 µm in length) in buildings in Germany and Canada reported before 1986 were generally less than 0.002 f/ml. In more recent surveys in five countries (Belgium, Canada, Slovak Republic, United Kingdom and USA) mean values were between 0.00005 and 0.0045 f/ml. Only 0.67% of chrysotile fibres were longer than 5 µm.

9.3 Health effects

9.3.1 Occupational exposure

Adverse health effects associated with occupational exposure to chrysotile are fibrosis (asbestosis), lung cancer and mesothelioma. These effects have also been observed in animals exposed to chrysotile by inhalation and other routes of administration. Based on available data in miners and millers, there is an interaction between tobacco smoke and chrysotile in the induction of lung cancer which appears to be less than multiplicative. Epidemiological evidence that chrysotile asbestos is associated with an increased risk of cancer at other sites is inconclusive.

Emphasis in this evaluation is on those studies that contribute to our understanding of the health risks associated with exposure to chrysotile, especially those that characterize at least to some extent, the exposure–response relationship. It should be noted, however, that exposure–response relationships have relied upon reconstruction of historical exposures. This is often problematic, due to lack of historical exposure measurements, and changes in measurement methods that have required use of conversion factors which are highly variable. Moreover, there are wide variations in exposure characteristics, including fibre size distributions, which are not well characterized in traditional measures of exposure.

The Task Group noted that there is an exposure–response relationship for all chrysotile-related diseases. Reduction of exposure through introduction of control measures should significantly reduce risks. Construction and demolition operations may present special control problems.

9.3.1.1 *Fibrosis*

The non-malignant lung diseases associated with exposure to chrysotile comprise a somewhat complex mixture of clinical and pathological syndromes not readily definable for epidemiological study. The prime concern has been asbestosis, generally implying a disease associated with diffuse interstitial pulmonary fibrosis accompanied by varying degrees of pleural involvement.

Studies of workers exposed to chrysotile asbestos in different sectors have broadly demonstrated exposure–response relationships for chrysotile-induced asbestosis, in so far as increasing levels of exposure have produced increases in the incidence and severity of disease. However, there are difficulties in defining this relationship, due to factors such as uncertainties in diagnosis, and the possibility of disease progression on cessation of exposure.

Furthermore, some variations in risk estimates are evident among the available studies. The reason for the variations is not entirely clear, but may relate to uncertainties in exposure estimates, airborne fibre size distributions in the various industry sectors and statistical models. Asbestotic changes are common following prolonged exposures of 5 to 20 f/ml. The risk at lower exposure levels is not known but the Task Group found no reason to doubt that, although there may be subclinical changes induced by chrysotile at levels of occupational exposure under well-controlled conditions, even if fibrotic changes in the lungs occur, they are unlikely to progress to the point of clinical manifestation.

9.3.1.2 *Lung cancer*

Exposure–response relationships for lung cancer have been estimated for chrysotile mining and milling operations and for production of chrysotile asbestos textiles, asbestos-cement products and asbestos friction products. Risks increased with increasing exposure. The slopes of the linear dose–response relationships (expressed as the increase in the lung cancer relative risk per unit of cumulative exposure (fibre/ml-years)) were all positive (although some not signficantly) but varied widely. Textiles produce the highest risk (slopes 0.01 to 0.03). Risks for production of cement products (slopes 0.0003-0.007), friction materials (slopes 0.0005-0.0006) and chrysotile mining (0.0006-0.0017) are lower.

The relative risks of lung cancer in the textile manufacturing sector in relation to estimated cumulative exposure are, therefore, some 10 to 30 times greater than those observed in chrysotile mining. The reasons for this variation in risk are not clear.

9.3.1.3 *Mesothelioma*

Estimation of the risk of mesothelioma is complicated in epidemiological studies by factors such as the rarity of the disease, the lack of mortality rates in the populations used as reference, and problems in diagnosis and reporting. In many cases, therefore, risks have not been calculated, and cruder indicators have been used, such as absolute numbers of cases and death and ratios of mesothelioma over lung cancers or total deaths.

Based on data reviewed in this monograph, the largest number of mesotheliomas has occurred in the chrysotile mining and milling sector. All of the observed 38 cases were pleural with the exception of one of low diagnostic probability, which was pleuro-peritoneal. None occurred in workers exposed for less than 2 years. There was a clear dose–response relationship, with crude rates of mesotheliomas (cases/1000 person-years) ranging from 0.15 for those with cumulative exposure less than 3500 mpcm (< 100 mpcf-years) to 0.97 for those with exposures of 10 500 mpcm (300 mpcf-years).

Proportions of deaths attributable to mesotheliomas in cohort studies in the various mining and production sectors range from 0 to 0.8%. Caution should be exercised in interpreting these proportions, as studies do not provide comparable data stratifying deaths by exposure intensity, duration of exposure or time since first exposure.

There is evidence that fibrous tremolite causes mesothelioma in humans. Since commercial chrysotile may contain fibrous tremolite, it has been hypothesized that the latter may contribute to the induction of mesotheliomas in some populations exposed primarily to chrysotile. The extent to which the observed excesses of mesothelioma might be attributed to the fibrous tremolite content has not been resolved.

Epidemiological studies of populations of workers using chrysotile-containing products in applications such as construction have not been identified, although for workers with mixed exposures to chrysotile and the amphiboles, by far the greatest proportion of mesotheliomas occurs in users of asbestos-containing products rather than in those involved in their production.

9.3.2 *General environment*

Data on incidence or mortality of disease in household contacts of chrysotile workers or in populations exposed to airborne chrysotile in the vicinity of point sources reported since EHC 53 was published in 1986 have not been identified. More recent studies of populations exposed to chrysotile in drinking-water have likewise not been identified.

9.4 Effects on the environment

The impact of chrysotile/serpentine presence and degradation on the environment and lower life forms is difficult to gauge. Observed perturbations are many but their long-term impact is virtually unknown.

10. CONCLUSIONS AND RECOMMENDATIONS FOR PROTECTION OF HUMAN HEALTH

a) Exposure to chrysotile asbestos poses increased risks for asbestosis, lung cancer and mesothelioma in a dose-dependent manner. No threshold has been identified for carcinogenic risks.

b) Where safer substitute materials for chrysotile are available, they should be considered for use.

c) Some asbestos-containing products pose particular concern and chrysotile use in these circumstances is not recommended. These uses include friable products with high exposure potential. Construction materials are of particular concern for several reasons. The construction industry workforce is large and measures to control asbestos are difficult to institute. In-place building materials may also pose risk to those carrying out alterations, maintenance and demolition. Minerals in place have the potential to deteriorate and create exposures.

d) Control measures, including engineering controls and work practices, should be used in circumstances where occupational exposure to chrysotile can occur. Data from industries where control technologies have been applied have demonstrated the feasibility of controlling exposure to levels generally below 0.5 fibres/ml. Personal protective equipment can further reduce individual exposure where engineering controls and work practices prove insufficient.

e) Asbestos exposure and cigarette smoking have been shown to interact to increase greatly the risk of lung cancer. Those who have been exposed to asbestos can substantially reduce their lung cancer risk by avoiding smoking.

11. FURTHER RESEARCH

(a) Research and guidance are needed concerning the economic and practical feasibility of substitution for chrysotile asbestos, as well as the use of engineering controls and work practices in developing countries for controlling asbestos exposure.

(b) Further research is needed to understand more fully the molecular and cellular mechanisms by which asbestos causes fibrosis and cancer. The significance of physical and chemical properties (e.g., fibre dimension, surface properties) of fibres and their biopersistence in the lung to their biological and pathogenic effects needs further elucidation. Dose–response information from animal studies for various asbestos fibre types is needed to evaluate the differential risk of exposure to chrysotile and tremolite.

(c) Epidemiological studies of populations exposed to pure chrysotile (i.e. without appreciable amphiboles) are needed.

(d) The combined effects of chrysotile and other insoluble respirable particles needs further study.

(e) More epidemiological data are needed concerning cancer risks for populations exposed to fibre levels below 1 fibre/ml, as well as continued surveillance of asbestos-exposed populations.