Local authority, this document is meant for you

The WHO Regional Office for Europe is regularly approached to provide technical or practical advice on a large number of questions related to health and the environment.

Experts and many other partners have together drawn up a series of documents which will help you to solve your environment and health problems.

The recommendations are ranked by priority, so that strategies can be developed which are appropriate to the local context.

 identifies a recommendation which is basic for a safe and healthy environment. Actions based on these recommendations should be implemented by all local authorities immediately.

 identifies a recommendation which should show visible health gains and should be regarded as a priority for action throughout Europe.

 identifies a recommendation which is linked to improving the quality of life of your community. These are related to a healthier environment in your community.

The unranked recommendations are designed to help you draw up strategies at local level and will not, in general, have a direct effect on health.

This pamphlet has been written to enable local authorities to take fully informed decisions. The annexes contain practical information which will help technical personnel and those in charge of public relations in their daily work.

Titles already published or in preparation are listed on the back cover.

Scientific adviser

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Regional Adviser Environment and Health/Ecology.
WHO Regional Office for Europe
Asbestos and health

SUMMARY

Three types of asbestos have had wide commercial use: chrysotile, and the amphiboles amosite and crocidolite. They can all cause asbestosis, lung cancer and mesothelioma, when inhaled. Asbestos causes cancer in a dose-dependent manner, and although in some exposed populations no increased incidence of cancer has been observed, no threshold, below which no carcinogenic effect will occur, has been identified. Inhalation exposure to asbestos should thus be kept as low as technically possible. While chrysotile appears to present less of a risk for mesothelioma than crocidolite or amosite, no such difference is apparent in the induction of lung cancer or asbestosis. No consistent association has been observed between asbestos in food or drinking-water and disease.

WHO has recommended discontinuing the use of crocidolite and amosite, the spraying of any asbestos fibres and using safer substitutes for chrysotile if available. The ILO Convention on asbestos prohibits the use of crocidolite and spraying of any asbestos fibres. Twelve European and some non-European countries, and recently also the European Union, have decided to prohibit practically all use of asbestos, including that of chrysotile. Because of the earlier widespread use of asbestos especially in construction materials, asbestos exposure will continue to be a hazard for a long time. In addition, chrysotile is still extensively used in many countries especially in asbestos cement products.

This document outlines the health risks of asbestos exposure and how they can be minimised. It is based on the published views of WHO and ILO, and on the Directives of the European Communities.
The former headquarters of the European Commission at Berlaymont during asbestos removal operations.
Asbestos and its properties

Asbestos is the name given to a group of fibrous minerals that occur naturally in the earth’s crust. There are two basic groups of asbestos: serpentine and amphibole. Chrysotile (white asbestos) is the only commercially important member of the serpentine group and accounts for more than 95% of the current total world consumption of asbestos. The main members of the amphibole group of minerals are crocidolite (blue asbestos), amosite (brown asbestos), anthophyllite, tremolite and actinolite. Only chrysotile, crocidolite and amosite have found widespread commercial use; anthophyllite has been extensively used in the past in Finland. The properties of asbestos are a result of its fibrous nature. In general, asbestos minerals are non-volatile and chemically inert; they have high tensile strength, flexibility and durability, as well as heat insulation and flame retardant properties.

Sources of asbestos

Very low concentrations of asbestos fibres may be found in air because of natural erosion; however, the vast majority of human exposure is due to human activities including ore recovery and processing, manufacturing, application, use and disposal of asbestos-containing products. Fibres are also released during the construction and demolition of buildings; at present a major source of asbestos in many countries is building maintenance.

Asbestos is produced in 25 countries worldwide, seven of which are considered major producers: Brazil, Canada, China, Kazakhstan, the Russian federation, South Africa and Zimbabwe. In addition, the manufacture of asbestos-containing products takes place in more than 100 countries. Annual world production peaked at over 5 million tonnes but has been in decline since the mid-1970s; the current level is approximately 3 million tonnes.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>2 600 000</td>
<td>2 600 000</td>
<td>2 400 000</td>
<td>2 000 000</td>
<td>-</td>
</tr>
<tr>
<td>Russian federation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 400 000</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>300 000</td>
</tr>
<tr>
<td>Canada</td>
<td>710 357</td>
<td>701 227</td>
<td>685 627</td>
<td>689 000</td>
<td>585 000</td>
</tr>
<tr>
<td>China</td>
<td>150 000</td>
<td>181 000</td>
<td>221 000</td>
<td>230 000</td>
<td>240 000</td>
</tr>
<tr>
<td>Brazil</td>
<td>227 653</td>
<td>206 195</td>
<td>232 332</td>
<td>233 100</td>
<td>233 000</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>186 581</td>
<td>187 006</td>
<td>160 861</td>
<td>141 697</td>
<td>140 000</td>
</tr>
<tr>
<td>South Africa</td>
<td>145 678</td>
<td>156 594</td>
<td>145 791</td>
<td>148 525</td>
<td>123 951</td>
</tr>
<tr>
<td>Swaziland</td>
<td>22 804</td>
<td>27 291</td>
<td>35 938</td>
<td>13 888</td>
<td>35 000</td>
</tr>
<tr>
<td>Greece</td>
<td>71 114</td>
<td>73 300</td>
<td>65 993</td>
<td>5 500</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>94 549</td>
<td>44 348</td>
<td>3 862</td>
<td>3 000</td>
<td>1 500</td>
</tr>
<tr>
<td><strong>World production</strong></td>
<td><strong>4 310 989</strong></td>
<td><strong>4 259 399</strong></td>
<td><strong>4 002 538</strong></td>
<td><strong>3 533 065</strong></td>
<td><strong>3 120 524</strong></td>
</tr>
</tbody>
</table>

*(including minor producers)*
Asbestosis

Asbestosis results from the inhalation of small fibres of asbestos that are deposited in the lung, causing the formation of tissue scars (fibrosis) and pleural thickening. Lung fibrosis leads to impaired breathing and even death. Asbestosis occurs in workers with generally prolonged heavy exposures to asbestos dust. Overt clinical symptoms are unlikely to appear until approximately 20 years after onset of exposure, although at very high exposures asbestosis has been reported already after three years. Asbestosis has been observed also in populations living in the vicinity of intense uncontrolled sources of asbestos emissions.

Lung cancer

Cases of lung cancer in patients with asbestosis were first described in the 1930's, and the causality of the association of lung cancer and asbestos exposure was confirmed in the mid-1950s. It usually takes 20–40 years between the first exposure to asbestos fibres and the onset of the disease. Asbestos-exposed smokers are at a considerably greater risk of developing lung cancer than asbestos-exposed nonsmokers. Asbestos and the chemicals in cigarette smoke have a synergistic effect on the risk of lung cancer; the combined exposures give a greater risk than the sum of risks produced by asbestos exposure alone or by smoking alone.
## Products in which asbestos may be found

<table>
<thead>
<tr>
<th>Product</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose asbestos fibre mixtures,</td>
<td>Thermal insulation, fireproofing, noise abating materials</td>
</tr>
<tr>
<td>in friable combination with inorganic materials,</td>
<td></td>
</tr>
<tr>
<td>cement gypsum, hydrous calcium silicate, basic</td>
<td></td>
</tr>
<tr>
<td>magnesium carbonate, diatomaceous earth</td>
<td></td>
</tr>
<tr>
<td>Asbestos-cement sheets and pipe products</td>
<td>Water supply and sewage piping; Drainpipes and guttering; Interior</td>
</tr>
<tr>
<td></td>
<td>wall panels; Cladding and roofing panels; Casings for electrical</td>
</tr>
<tr>
<td></td>
<td>wires; Fire protection material; Chemical tanks; Electrical switchboards and components</td>
</tr>
<tr>
<td>Asbestos friction products</td>
<td>Clutch facings; Brake linings for road and railway vehicles;</td>
</tr>
<tr>
<td></td>
<td>Industrial friction materials</td>
</tr>
<tr>
<td>Asbestos paper products</td>
<td>Table pads and heat-protective mats; Heat and electrical wire</td>
</tr>
<tr>
<td></td>
<td>insulation; Industrial filters for beverages; Small appliance</td>
</tr>
<tr>
<td></td>
<td>components; Underlying material for sheet flooring</td>
</tr>
<tr>
<td>Asbestos textile products</td>
<td>Packing components; Heat and fire-resistant clothing; Fireproof</td>
</tr>
<tr>
<td></td>
<td>curtains</td>
</tr>
<tr>
<td>Asbestos felt products</td>
<td>Noise insulation</td>
</tr>
<tr>
<td>Other asbestos products</td>
<td>Ceiling and floor tiles; Gaskets and packings; Paints, coatings</td>
</tr>
<tr>
<td></td>
<td>and sealants; Caulking and patching tape; Plastics</td>
</tr>
</tbody>
</table>

## Mesothelioma

Mesothelioma is a cancer of the linings of lungs and chest (pleura) or the abdominal cavities (peritoneum). Most mesotheliomas caused by asbestos occur in the pleura. This form of fatal cancer usually takes more than 30 years, and sometimes more than 50, to develop. In addition to occupationally exposed subjects, increased incidence rates have been observed in non-occupationally exposed individuals living in the same household as asbestos workers, or in the vicinity of asbestos emission sources such as shipyards or asbestos insulation industries. The rates of mesothelioma are increasing in many Western countries, following the pattern of increasing asbestos use in the 1940-50s. Smoking does not influence the development of mesothelioma.
Main health related properties of fibres

The main characteristics of asbestos fibres that relate to the incidence and severity of asbestos-related diseases are the dimensions (diameter and length), durability in tissues and type of the fibre. The health risk also depends on the technological process; the same type of asbestos fibre may be associated with different risks in different industries. For instance, for chrysotile, the relative risk of lung cancer is greater in the textile manufacturing industry than in cement production at similar levels (measured as total particle or fibre counts, but not considering possible differences in fibre dimensions) of exposure. The reasons for this variation are unclear. Only fibres thinner than 3 μm (1), having an aerodynamic diameter (2) of about 10 μm, can enter the conducting airways of the respiratory tract, and cause respiratory disease. There is evidence that longer asbestos fibres are more dangerous than shorter ones; the most hazardous asbestos fibres are those longer than 5–8 μm and thinner than 1.5 μm. For this reason, in the regulations of many countries, as well as in the WHO recommended method for the determination of airborne fibre number concentrations (3), asbestos fibres to be measured in occupational environmental assessment (“regulated fibres”) have a width of less than 3 μm, a length of more than 5 μm, and a length to width ratio of at least 3:1.

Primary lung cancer

Asbestos in buildings

Two main types of asbestos-containing products have been used in building construction. The first is low-density, friable (4) materials such as asbestos-containing sprayed insulation and asbestos-containing thermal insulation for pipes and boilers. When this material is damaged or disturbed, or when maintenance, renovation or demolition work is carried out, fibres can be released, sometimes at high levels. The second is high-density, hard materials in which asbestos fibres are embedded in a matrix and are unlikely to be released during normal use. Fibres can be released, however, during rough mechanical operations such as sanding, grinding, cutting or demolition. Erosion, weathering and aging processes have also been reported to release fibres, but to a much lesser degree. Examples of this category are asbestos-cement pipes and sheets, floor tiles, and ceiling materials.

Levels of asbestos

Numerous buildings have been analysed for levels of exposure to asbestos fibres of building occupants, custodians or janitors, and maintenance workers. Fibre concentrations in public buildings during normal

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1) 1μm is a millionth of a meter.
2) The aerodynamic diameter of a fibre is the diameter of a spherical particle of unit density having the same sedimentation velocity as the fibre.
4) "Friable" refers to the condition of materials that can be easily crumbled into small pieces by hand pressure.
use, where there is no repair or renovation, are within the range of those measured in ambient air, even where friable asbestos-containing materials were extensively used. Building workers, however, particularly plumbers, gas fitters, carpenters and electricians, are a risk group.

Janitorial, custodial, maintenance and renovation work may disturb or damage asbestos-containing material and thereby generate high exposures. The Health Effects Institute in the United States (HEI) (5) estimated that, with proper controls, the exposure to maintenance personnel can be kept below 0.1 f/ml [the current occupational permissible limit of the US Occupational Safety and Health Administration (OSHA)], but that, without adequate controls, exposures can exceed 10 f/ml. They also stated that workers involved in asbestos removal may be exposed to concentrations as high as 10–100 f/ml during dry removal, and as high as 1 f/ml during wet removal with air exhaust.

Controlling the risk of asbestos exposure in buildings

The ILO Convention in 1986 (6) decrees that:

- Demolition of plants or structures containing friable asbestos insulation materials, and removal of asbestos from buildings or structures in which asbestos is liable to become airborne, shall be undertaken only by employers who are recognised by the competent authority as qualified to carry out such work and who have been empowered to undertake such work;

- the employer or contractor shall be required before starting demolition work to draw up a work plan specifying the measures to be taken, including measures to provide all necessary protection to the workers, to limit the release of asbestos dust into the air; and to provide for the disposal of waste containing asbestos;

- the workers or their representatives shall be consulted on the work plan.

The main recommendations of the IPCS group of experts on the reduction of asbestos in the environment relating to asbestos-containing materials in buildings were (7):

- the presence of friable asbestos-containing materials, having the potential for fibre release, should be identified by inspections, and, so far as possible, proper maintenance ensured. In all such buildings special attention should be given to approved cleaning methods to prevent dust accumulation becoming a source of airborne asbestos;

- in situations where fibre release presents a significant risk, repair, encapsulation or enclosure should be undertaken wherever practicable. Removal of asbestos-containing material should only be considered if there is no satisfactory alternative;

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if removal is undertaken, it should be by trained or licensed workers using procedures to ensure their own safety and that of the general public and future occupants. This may require environmental measurement before, during, and after the work is undertaken;

- when a building is to be demolished, friable asbestos-containing materials should first be removed with priority given to thermal and sprayed insulation;

- high-density asbestos products such as asbestos cement and asbestos fire-board in normal condition and use should not create an unacceptable hazard, but care is needed to contain airborne dust during installation and maintenance of these products.

Asbestos fibres in drinking-water and food

Both amphiboles (amosite and tremolite) and chrysotile have been extensively tested in lifetime experiments in different animal species by oral administration but have demonstrated no consistent evidence of an association between cancer and ingestion of asbestos in drinking-water or food. Data on crocidolite are more limited, but similarly negative. Doses as high as 250 mg per week, or 1% of asbestos in diet, or 50 mg/litre drinking water have been used; the dose of 250 mg/week would be equivalent to about 70 000 times the amount ingested in the most contaminated drinking-waters, and the dose of 1% in diet practically 1 million times \(^{(6,9)}\).

Cancer of the gastrointestinal tract is the main concern when considering cancer risks of asbestos in drinking water as it is there that the fibre concentrations would be highest. In addition, as indicated above, several studies on occupationally exposed asbestos workers have produced relative risks around 1.0 to 2.0. \(^{(6,9)}\)

### Risk of lung cancer and mesothelioma in different historical cohort studies among amphibole-exposed workers \(^{(6)}\)

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Period of observation</th>
<th>Mesothelioma cases</th>
<th>Lung cancer cases</th>
<th>Relative risk of lung cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacture, mixed</td>
<td>1941 – 1979</td>
<td>8</td>
<td>143</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1947 – 1980</td>
<td>5</td>
<td>57</td>
<td>1.96</td>
</tr>
<tr>
<td></td>
<td>1944 – 1976</td>
<td>3</td>
<td>44</td>
<td>1.72</td>
</tr>
<tr>
<td>Manufacture, amosite</td>
<td>1941 – 1973</td>
<td>11</td>
<td>84</td>
<td>6.29</td>
</tr>
<tr>
<td>Insulation, mixed</td>
<td>1943 – 1962</td>
<td>7</td>
<td>42</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>1933 – 1975</td>
<td>46</td>
<td>103</td>
<td>2.38</td>
</tr>
<tr>
<td>Shipyards</td>
<td>1947 – 1978</td>
<td>31</td>
<td>84</td>
<td>0.84</td>
</tr>
<tr>
<td>Manufacture, mixed</td>
<td>1936 – 1975</td>
<td>21</td>
<td>27</td>
<td>8.44</td>
</tr>
<tr>
<td>mixed (females)</td>
<td>1941 – 1979</td>
<td>2</td>
<td>6</td>
<td>0.53</td>
</tr>
<tr>
<td>Various (females)</td>
<td></td>
<td>7</td>
<td>27</td>
<td>2.06</td>
</tr>
</tbody>
</table>

### Risk of lung cancer and mesothelioma in different historical cohort studies among chrysotile-exposed workers (26)

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Mesothelioma cases</th>
<th>Percentage of mesothelioma deaths</th>
<th>Lung cancer cases</th>
<th>Relative risk of lung cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining &amp; milling</td>
<td>25</td>
<td>0.8</td>
<td>315</td>
<td>1.39</td>
</tr>
<tr>
<td>Asbestos cement production</td>
<td>2</td>
<td>0.57</td>
<td>30</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>1.58</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0.26</td>
<td>35</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Not given</td>
<td>70</td>
<td>1.32</td>
</tr>
<tr>
<td>Textile manufacture</td>
<td>2</td>
<td>0.16</td>
<td>126</td>
<td>1.97</td>
</tr>
<tr>
<td>Friction material production</td>
<td>3</td>
<td>Not given</td>
<td>84</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>Not given</td>
<td>73</td>
<td>1.49</td>
</tr>
<tr>
<td>Mixed products</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td>Not given</td>
<td>Not given</td>
<td>21</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0.64</td>
<td>19</td>
<td>2.34</td>
</tr>
<tr>
<td></td>
<td>Not given</td>
<td>Not given</td>
<td>18</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Because of differences in exposure between the studies, differences in relative risks between studies do not necessarily indicate different carcinogenic potencies.

Exposed groups have reported an increased incidence of gastrointestinal cancer; this is particularly true of studies where there was a large relative risk of lung cancer.

Association between cancer and asbestos exposure from drinking water has been studied in ecological studies on nine populations. Although some cancer sites showed elevated risks in individual studies, there was no consistent evidence of an association between the incidence or mortality of cancer and the level of asbestos in drinking-water. In some of the areas studied, asbestos fibre concentrations in water were up to 200 million fibres per litre. The IPCS working group concluded that studies, such as those described above, are considered to be insensitive because of the large number of confounding variables, which are difficult to eliminate, and the potential to underestimate cancer risk due to population mobility over a latent period of several decades. In the more powerful case-control study conducted in the Puget sound area, which included data on individual exposures based on length of residence and water source, there was no consistent evidence of a cancer risk due to the ingestion of asbestos in drinking water. Thus, the studies conducted to date provide little convincing evidence of an association between asbestos in public water supplies and cancer induction (8,10). Asbestos is not listed in the European Council list of materials restricted in drinking water (11-13).

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(11) Official Journal of the European Communities, C326/38, 1995
Asbestos waste disposal

The asbestos emission from the collection, transportation, storage and disposal of asbestos-containing waste material should be reduced as much as possible. If practical, asbestos material should be identified and segregated from other material before collection. This is difficult in the case of building demolition and renovation, when it is often impossible to distinguish asbestos from other material.

The main recommendations of the IPCS group of experts relating to asbestos waste disposal were as follows (see also WHO pamphlet: Hazardous waste):

- Friable asbestos-containing waste should be carefully bagged and disposed of, preferably in landfill sites according to well-defined national regulations. Prior to transportation, friable asbestos-containing waste should be adequately wetted. It should be transported in leak-tight containers in covered vehicles to a disposal site and disposed of in accordance with well-defined national regulations;
- Disposal sites should be subject to specific provisions to avoid environmental contamination at any stage during use or after closure;
- Demolition debris contaminated with asbestos should be minimised to the extent possible, kept wet, and transported rapidly in bulk to a disposal site;
- Asbestos waste should be adequately covered prior to compaction and covered further within the same day that the waste is deposited at the site. When a disposal site is closed or inactive for a period of over a year, a final cover should be applied that is sufficient to prevent uncovering of the waste by wind or water erosion;
- A surfactant solution (wetting agent) should be used when wetting waste from friable asbestos-containing materials prior to removal;
- In addition, records on the locations of asbestos waste should be kept in archives of local authorities.

Legislation of the European Union

By the early 1980s it had become clear that legislation on asbestos was needed at European level. In 1983, a Directive (14) was introduced on the protection of workers against the risks from exposure to asbestos, which required employers to assess the risk to workers of any exposure to asbestos and to take preventative measures. It prohibited the application of asbestos by spraying, established maximum exposure limit values, and introduced a range of protective measures. In 1991, a new Directive (15) lowered the maximum exposure levels to 0.6 f/ml for chrysotile asbestos and 0.3 f/ml for all other forms of asbestos. The European Commission has started consultations with Member States on the need to decrease occupational exposure to asbestos.

## Asbestos fibre concentrations (f/ml) in industrial and environmental air samples

<table>
<thead>
<tr>
<th>Period</th>
<th>Environment</th>
<th>Country</th>
<th>Asbestos fibre concentration f/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical estimate</td>
<td>Insulation in ships</td>
<td>International</td>
<td>5-200</td>
</tr>
<tr>
<td></td>
<td>Insulation in buildings</td>
<td></td>
<td>3 - 70</td>
</tr>
<tr>
<td></td>
<td>Mines</td>
<td></td>
<td>5 - 80</td>
</tr>
<tr>
<td></td>
<td>Textile industry</td>
<td>International</td>
<td>5 - 80</td>
</tr>
<tr>
<td></td>
<td>Asbestos cement production</td>
<td></td>
<td>3 - 40</td>
</tr>
<tr>
<td></td>
<td>Asbestos cement construction</td>
<td></td>
<td>3 - 20</td>
</tr>
<tr>
<td>1972-1978</td>
<td>Asbestos cement</td>
<td>UK</td>
<td>95% &lt; 1</td>
</tr>
<tr>
<td></td>
<td>Millboard/paper</td>
<td>UK</td>
<td>98.2 % &lt; 1</td>
</tr>
<tr>
<td></td>
<td>Friction materials</td>
<td>UK</td>
<td>95% &lt; 2</td>
</tr>
<tr>
<td></td>
<td>Textiles</td>
<td>UK</td>
<td>95% &lt; 2</td>
</tr>
<tr>
<td></td>
<td>Insulation board</td>
<td>UK</td>
<td>88.6% &lt; 2</td>
</tr>
<tr>
<td>1984</td>
<td>Asbestos cement</td>
<td>France</td>
<td>97.4% &lt; 1</td>
</tr>
<tr>
<td></td>
<td>Friction materials</td>
<td>France</td>
<td>84% &lt; 1</td>
</tr>
<tr>
<td></td>
<td>Textile</td>
<td>France</td>
<td>85.4% &lt; 1</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>France</td>
<td>98.2 % &lt; 1</td>
</tr>
<tr>
<td>Pre-1985</td>
<td>Ambient urban air</td>
<td>Austria, Canada,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Federal Republic of Germany,</td>
<td>&lt;0.0001 - 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Africa, United States</td>
<td>(most samples &lt;0.001)</td>
</tr>
<tr>
<td>Post-1985</td>
<td>Ambient urban air</td>
<td>Canada, Italy, Japan, Slovakia,</td>
<td>0.0001 - 0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switzerland, United Kingdom,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States</td>
<td></td>
</tr>
<tr>
<td>Pre-1985</td>
<td>Public buildings</td>
<td>Canada, Federal Republic of Germany,</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States</td>
<td></td>
</tr>
<tr>
<td>Post-1985</td>
<td>Public buildings</td>
<td>Belgium, Canada, Slovakia,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>United Kingdom, United States</td>
<td>0.00005 - 0.0045</td>
</tr>
</tbody>
</table>

Only 0.67% of fibres in indoor air were longer than 5 μm.
Source: summarized from data presented in Environmental Health Criteria 53 and 203.

Further, and a proposal for an amendment of the prevailing Directive is expected early in 2000. In 1983, the first Community-wide restrictions on the marketing of asbestos were issued (16). The directive banned the marketing and use of crocidolite (with a few exceptions) and introduced mandatory warning labels for all asbestos-containing products. In 1985 and 1991 (19,20), this ban was extended to cover all uses of other amphiboles, and 14 specified uses of chrysotile. Finally, in 1999 (21), the European Commission decided to phase out all uses and introduce a total ban of all asbestos types, a policy that several member countries had adopted already earlier. The Directive introduces prohibition on the placing on the market and use of asbestos fibres, and products containing asbestos fibres “added intentionally”. The only exceptions to the general prohibition concern chrysotile asbestos, which is allowed in diaphragms in existing chlorine electrolysis plants (new installations using chrysotile-
containing diaphragms are not permitted), and chrysotile asbestos which occurs naturally in rocks or soil, as it is not "intentionally added"; the military use of asbestos is also allowed.

Classification, packaging and labelling

In line with the classification of IARC (22), all types of asbestos are classified as "Category 1: carcinogens" and must be labelled with the phrase: "May cause cancer" (22).

Prevention and reduction of environmental pollution

In 1987, the Council of European Communities adopted a Directive on the prevention and reduction of environmental pollution, including control of wastes containing asbestos (23). The Directive controls the emissions of asbestos into air and water; it stipulates that asbestos emissions into the air, asbestos discharges into the aquatic environment, and solid asbestos waste should be, as far as reasonably practicable, reduced at source and prevented. The best available technology not entailing excessive cost should be used. The concentration of asbestos emitted through discharge ducts into the air should not exceed a limit value of 0.1 mg/m³ of air discharged. Member states may exempt from the obligation plants which emit less than 5 000 m³/hour total gaseous discharge, where the discharge of asbestos into the air is not more than 0.5 g/hour. Regarding aqueous effluents, the limit value is 30 g total suspended matter per m³ of effluent.

### Occupational exposure limits* for asbestos (limit)

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Chrysotile</th>
<th>Other forms of asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.50</td>
<td>0.15</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Finland</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>France</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Greece</td>
<td>1.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Italy</td>
<td>0.60</td>
<td>0.20</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Spain</td>
<td>0.60</td>
<td>0.30</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>USA</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>EU (1991)</td>
<td>0.60</td>
<td>0.30</td>
</tr>
</tbody>
</table>

*These are related to phase contrast optical microscopy. Occupational exposure limits address a population of healthy adults exposed for a maximum of 8 hours a day, 5 days a week.

Some unresolved issues

Scientists and regulators differ on a number of points in respect of the consequences of exposure to asbestos fibres. These are discussed below.

Potency of different types of asbestos fibres

Some epidemiological studies indicate\(^{(24,25)}\) that amphiboles, especially crocidolite, are more potent inducers of mesothelioma than chrysotile. An old WHO assessment expressed the view that a similar difference could also exist in the potency of amphiboles and chrysotile as inducers of lung cancer\(^{(25)}\). Based on this concept (but also based on considerations of feasibility), lower exposure limits have been set in some countries for amphiboles than for chrysotile (Belgium, Greece, Italy, the Netherlands, Spain, United Kingdom).

More recent experimental and epidemiological evidence, however, does not support the idea that there is a significant difference in potency between fibres of different asbestos types as far as asbestosis or lung cancer are concerned. Accordingly, in several countries occupational exposure limits are set for asbestos fibres without differentiating between the types of asbestos (Austria, Denmark, Finland, France, Germany, USA).

Dose-response relationships and possible thresholds

There is no doubt that for all the asbestos-related diseases, there is a relationship between the dose of asbestos and the response: the higher the concentration and duration of exposure, the higher the prevalence of the disease or mortality. The form of the dose–response curve, however, particularly at low doses, is unknown. Debate continues as to whether the dose-response relationship is linear or
not, especially for cancer. Linearity would generally mean that no exposure threshold exists, or, in other words, that any exposure to asbestos can cause disease. On the other hand, a threshold would mean that a completely safe exposure to asbestos would exist.

It is generally considered that there is no threshold in the carcinogenicity of chemicals which induce cancer by an effect on the genetic material, i.e. are genotoxic, while for non-genotoxic carcinogens a threshold may exist. The mechanism(s) of the carcinogenicity of asbestos is/are unknown. Epidemiological studies, because of their inherent insensitivity at low frequencies of effect, i.e. cancer, cannot resolve the question of the threshold or its absence. In most cases even experimental animal carcinogenicity studies cannot give an answer because of statistical problems. The issue of a threshold is further complicated by differences in individual sensitivity: even at levels of exposure that do not induce cancer in an average person, cancer may be induced in people with higher than average sensitivity.

The question of eventual thresholds bears special importance with relation to the risk of asbestos-related diseases among the general public, where the exposures are generally very low. In 1977, the Commission of European Communities stated about the public health risks of exposure to asbestos:

"It can be concluded that it is impossible to come to a reliable quantitative assessment of the risk of malignancies for the general public. It is possible that there is a level of exposure (perhaps already achieved in the general public) where the risk is negligibly small".

The following can be found in the conclusions of an IPCS task group:

"In the general population the risks of mesothelioma and lung cancer attributable to asbestos cannot be quantified reliably and are probably undetectably low... The risk of asbestosis is virtually zero".

One of the conclusions of the latest international evaluation by an IPCS group of experts in 1998 was:

"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."

### Estimates of past asbestos exposures

Current deaths from asbestos-associated cancer are the consequence of exposure 20–50 years ago, or more. Occupational exposure in the distant past, undoubtedly, was considerably higher than today, at least in the developed countries. At that time however, techniques of exposure measurement did not specifically determine asbestos fibres, but concentrations of total airborne dust. From the total dust data, concentrations of airborne asbestos fibres were estimated using different assumptions and approximations. Thus, although the relative estima-

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Permissible exposure limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938</td>
<td>Public Health Service</td>
<td>5 mppcf * (guidance, no legal effect)</td>
</tr>
<tr>
<td>1960</td>
<td>Department of Labor</td>
<td>5 mppcf</td>
</tr>
<tr>
<td>1969</td>
<td>Department of Labor</td>
<td>12 f/ml**</td>
</tr>
<tr>
<td>1971</td>
<td>OSHA, Department of Labor</td>
<td>12 f/ml</td>
</tr>
<tr>
<td>1972</td>
<td></td>
<td>5 f/ml</td>
</tr>
<tr>
<td>1976</td>
<td></td>
<td>2 f/ml</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td>0.2 f/ml</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>0.1 f/ml</td>
</tr>
</tbody>
</table>

*Million particles per cubic foot, not referring specifically to asbestos fibres.
** Fibres per millilitre, referring specifically to asbestos fibres.
tes of exposure in an individual study are likely to be quite consistent, extrapolation to different exposure situations is very difficult, and induces important uncertainties. In consequence, the current predictions of mortality or morbidity among subjects exposed to considerably lower exposure levels and different exposure situations, remain uncertain.

Persistence of fibres in tissues and carcinogenic potency

The persistence of amphiboles in tissues is greater than that of chrysotile. While chrysotile fibres, when deposited in the lung, split, gradually dissolve and in many cases disappear, the fibres of amphiboles persist for very long periods, sometimes a lifetime. The difference in persistence may be a factor contributing to the lower potency of chrysotile to induce mesothelioma, compared to amphiboles. Chrysotile, however, is equally potent as an inducer of lung cancer in experimental animals; this may be related to the initial increase of chrysotile fibre numbers because of the longitudinal splitting.

Replacement of asbestos

There are numerous products in which fibres are practically irreplaceable. Many of these contain asbestos fibres. As the production and use of asbestos fibres is being restricted and even prohibited, substitute fibres become of greater and greater importance. Many substitute fibres have been proposed, and several are already in use, such as man-made mineral fibres (fibres of glass wool, rock wool, slag wool, and ceramic fibres) or synthetic organic fibres (polyamide, polyolefin, carbon/graphite, polyester, polyacrylonitrile, polyurethane, polytetrafluoroethylene). Polyvinyl-chloride (PVC) and iron ductile pipes have been also considered as a substitute for asbestos-cement pipes.

It is apparent that the replacement must not only be technically equal to asbestos but must also be either devoid of the harmful effects of asbestos or at least be safer - either because of inherently smaller carcinogenic potency or because of lower exposure potential.

The primary measure to be taken to protect the health of workers in the view of ILO (6,27) is, provided it is technically practicable, the replacement of asbestos or certain types of asbestos or products containing asbestos by other materials or products or the use of alternative technology, scientifically evaluated as harmless or less harmful, whenever this is possible.

In 1993, IPCS concluded (28):

“All fibres that are breathable and biopersistent must undergo testing for toxicity and carcinogenicity. Exposures to these fibres should be controlled to the same degree as that required for asbestos until data supporting a lesser degree of control become available.”

In 1989, the US Environmental Protection Agency (EPA) issued the “Asbestos Ban and Phase-out Rule”, which would have prohibited nearly all uses of asbestos in the USA by 1996. In 1991, however, a US Court of Appeals struck down the ruling because EPA had not performed an adequate risk assessment of the replacement materials.

The European Union has prohibited the use of all

(27) ILO Recommendation No. 172 concerning safety in the use of asbestos, 1986.
asbestos fibre types in the member countries, no later than by 1 January 2005\textsuperscript{(21)}. This ban includes the use of chrysotile in asbestos cement, friction products as well as seals and gaskets. The Scientific Committee of the European Commission considered that the major replacement alternatives of chrysotile (cellulose fibres, polyvinyl alcohol, and p-aramid fibres) are likely to present a lower risk of cancer and lung fibrosis than chrysotile. The only exception to the ban is for chrysotile in diaphragms which are used for electrolysis in certain chlorine plants. The diaphragms are a special case because they are the only current use of chrysotile asbestos for which it is not technically possible to substitute without creating a safety problem (i.e. explosion hazard). On the other hand, the risk to human health from this use of chrysotile is extremely low because it is undertaken in a closed system on-site; diaphragms are not marketed.
Local authorities are advised to implement a series of measures concerning control of exposure to asbestos.

**Recommendation 1**

![Medicine Icon] Prohibit and restrict the uses of asbestos

Prohibit and enforce the prohibition of production and use of amphibole asbestos fibres and products containing them. Prohibit and enforce the prohibition of the production and use of chrysotile fibres and products containing them or restrict chrysotile to essential uses in which no safer alternatives are available.

**Recommendation 3**

![Medicine Icon] Prevent emissions of asbestos into the air and other environment

Set and enforce limit values for the release of asbestos into the air. Asbestos waste should be wetted, transported covered, buried at specified landfills, and impregnated with agents that form a crust resistant to erosion.

**Recommendation 2**

![Medicine Icon] Minimise inhalation exposure to asbestos

Adopt technologies and working procedures in which the generation of asbestos dust is absent or minimal. When asbestos generation cannot be fully prevented, provide the workforce with appropriate protective devices and make sure that they are used properly. Keep airborne asbestos fibre concentrations as low as possible, and promulgate and enforce appropriate occupational exposure limits for asbestos. Monitor the exposure to verify that it remains within the specified limits. Consider health surveillance of exposed workers. Demolition of structures containing asbestos, and reparations and removal of asbestos from structures in which asbestos is liable to become airborne, should be subject to authorisation, which should be granted only to employers or contractors who are recognised as qualified to carry out such work safely.

**Recommendation 4**

![Medicine Icon] Communicate

All products containing asbestos should be labelled using phrases such as "Warning - contains asbestos". "Breathing asbestos fibres is dangerous to health"; and "Follow safety instructions". Workers liable to be exposed to asbestos must be provided with:

- adequate information on the health hazards involved;
- instructions and periodic training on measures to prevent and control exposure to asbestos, especially on correct work practices and on the use of personal protective equipment;
- Educational measures should draw attention to the particular danger created by the combination of smoking and exposure to asbestos.

Increase awareness among the general public of the hazards of demolition, removal and reparations of friable asbestos insulation in buildings while disseminating accurate information on the very small or non-existent hazard involved with the mere presence of undisturbed asbestos in buildings.
Main International References

The document draws heavily on the following references that the reader may wish to consult to obtain more detailed information.


Asbestos
and health

TECHNICAL ANNEX

Table of contents

- Main activities of international organizations 20
- Main conclusions of WHO expert group meetings 21
- Most recent report from an IPCS Task Group 23
Historical development and main activities of international organisations

Owing to the widespread use and exposure and the serious health effects of asbestos fibres, the International Labour Organisation (ILO) and WHO have coordinated attention to the problem of evaluation and control of the health risks of asbestos exposure.

The first evaluation of asbestos hazard in humans by IARC in 1972 (1) can be summarised as follows: there is substantial evidence that the risk of lung carcinoma and mesothelioma was small in workers in chrysotile mines and mills, and the same is possibly true for amosite. Some crocidolite mining areas and mills have been associated with a higher risk of mesothelioma, and mesotheliomas had been observed in populations living in the neighbourhood of mines and among families of asbestos workers. An important excess risk of lung cancer has usually resulted from past heavy exposures. The risk of lung carcinomas seems to be related to asbestosis.

In manufacturing and application industries mesotheliomas have been caused by exposure to crocidolite, and less frequently to amosite and chrysotile. The period between first exposure and development of tumours is long, usually more than 30 years. The tumours can occur in the absence of other asbestos-related disease.

At the present time, there is no evidence that exposure of the general population to past levels of asbestos dust in the ambient air, or in beverages, drinking-water, food or pharmaceutical preparations increases the risk of cancer.

Cigarette smoking enhances the risk of lung carcinoma in asbestos workers to a much greater degree than in the rest of the population.

In 1977, IARC (2) reported that, in humans, occupational exposure to chrysotile, amosite, anthophyllite and mixed fibres containing crocidolite has resulted in a high incidence of lung cancer; a predominantly tremolite material mixed with anthophyllite and small amounts of chrysotile has also caused an increased incidence of lung cancer. Many pleural and peritoneal mesotheliomas had been observed after occupational exposure to crocidolite, amosite and chrysotile. An excess risk of gastrointestinal tract cancers has been demonstrated in groups exposed occupationally to amosite, chrysotile or mixed fibres containing crocidolite. An excess of cancers of the larynx was also observed in exposed workers. Mesotheliomas occur in individuals living in the neighbourhood of asbestos factories and crocidolite mines and in household contacts of asbestos workers.

Both cigarette smoking and occupational exposure to asbestos fibres independently increase lung cancer incidence, but when they are present together they act in a multiplicative fashion.

The presence of asbestos and asbestiform minerals from natural sources in the environment, other than mines or quarries, has only recently shown itself to be a further potential problem.

At present, it is not possible to assess whether there is a level of exposure in humans below which an increase of cancer would not occur.

The ILO Code of Practice (3) gave general guidelines on the monitoring of the workplace, protection and supervision of the health of workers, recommendations for packaging, handling and transport of asbestos, disposal of asbestos waste, and control of asbestos exposure in specific activities.

The International ILO Conference adopted the Asbestos Convention No. 162 (4) and Recommendation No.172 (5) in 1986. They contain general principles on regulation and policies at the national level; responsibilities of employers and workers; protective, preventive and control measures; surveillance of the working environment and the health of workers. They emphasize information and education of all involved. Part III of the Convention on protective and preventive measures emphasized some special measures to be instituted to protect the health of workers when technically practicable. These include replacement by other materials scientifically evaluated as harmless or less harmful, and total or partial prohibition. The recommendation to prohibit the use of one type of asbestos, crocidolite (Article 11), and one technique, spraying of all forms of asbestos (Article 12), is particularly important. The competent national authority must prescribe exposure limits; the employer is also charged with the task of not only ensuring that the exposure limits are complied with but also of reducing the

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(1) IARC Monographs on the Evaluation of Carcinogenic Risk of chemicals to man. No. 2, 1973
(3) Safety in the use of asbestos, ILO, 1984
(05) ILO Recommendation No. 172 concerning safety in the use of asbestos, 1986.
exposure to as low a level as is reasonably practicable (Article 15). Attention is also given to safety in demolition of buildings, removal of asbestos, prevention of exposure of the household of the workers, monitoring of exposure, medical examinations of the workers, waste disposal as well as information, education and training.

In 1987, IARC (6) classified asbestos (actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite) in group 1 — agents carcinogenic to humans, based on sufficient evidence of carcinogenicity both in humans and in animals. As regards the hazard to humans, IARC concluded:

The studies of the carcinogenic effects of asbestos exposure show that occupational exposure to chrysotile, amosite and anthophyllite asbestos and to mixtures containing crocidolite, results in an increased risk of lung cancer, as does exposure to minerals containing tremolite and actinolite and to tremolitic material mixed with anthophyllite and small amounts of chrysotile. Mesotheliomas have been observed after occupational exposure to crocidolite, amosite, tremolitic material and chrysotile asbestos. Gastrointestinal cancers occurred at an increased incidence in groups occupationally exposed to crocidolite, amosite, chrysotile or mixed fibres containing crocidolite, although not all studies are consistent in this respect. An excess of laryngeal cancer has also been observed in some groups of exposed workers. No clear excess of cancer has been associated with the presence of asbestos fibres in drinking water. Mesotheliomas have occurred in individuals living in the neighbourhood of asbestos factories and mines and in people living with asbestos workers.

**Main publications of ILO and WHO concerning asbestos**

- **1973, 1977** WHO/IARC* Evaluation of Carcinogenic Risk of Chemicals to Man (1,2)
- **1984** ILO Code of Practice on Safety in the Use of Asbestos (3)
- **1986** ILO Asbestos Convention No 162 (4)
- **1986** ILO Asbestos Recommendation No 172 (5)
- **1986** WHO/IPCS* Environmental Health Criteria Document for Asbestos and Other Natural Mineral Fibres (6)
- **1987** WHO/IARC* Evaluation of Carcinogenic Risks to Humans (6)
- **1989** WHO/OCH*** Occupational Exposure Limits for Asbestos (8)
- **1989** WHO/IPCS** Environmental Reduction of Asbestos (9)
- **1998** WHO/IPCS** Environmental Health Criteria Document for Chrysotile (10)

* International Agency for Research on Cancer  
** International Programme on Chemical Safety  
*** Occupational Health

**Main conclusions of WHO expert groups (1986, 1989 and 1996)**

Reports by WHO/IPCS (7,8) and WHO/OCH (9) covered practically all the currently available health-related scientific information on asbestos at that time. The evidence of effects in humans and the main conclusions are presented below.

There is no substantial evidence of a threshold for asbestos exposure below which cancer does not occur. However, there is a body of opinion that holds that there is a threshold and in a number of recently published studies of chrysotile asbestos workers, no excess of asbestos-related disease has been demonstrated (9).

For chrysotile asbestos, urgent steps should be taken to lower the occupational exposure limit to 2 f/ml. The countries should move quickly to lower the occupational exposure limit (9) to 1 f/ml.

Prohibition of the use of crocidolite and amosite is recommended as soon as possible; in the interim, restricted use should be exercised with great care to ensure that exposure is less than that permitted for chrysotile (9).

Extrapolated quantitative estimates of lung cancer and mesothelioma risks for the general population vary over many orders of magnitude; risks cannot be quantified reliably but are probably undetectably low. The risk of asbestosis in the general population is virtually zero (7).

There is no consistent, convincing evidence that ingested asbestos is hazardous to health and there is no need to establish a guideline value for asbestos in drinking-water (8).

Three specific issues were considered in the report of the IPCS Expert Group Meeting on Environmental Reduction of Asbestos (10):

1. asbestos in public buildings;  
2. asbestos in maintenance and use of vehicles; and  
3. transportation, storage and disposal of asbestos.

The main recommendations related to points 1 and 3 are presented within the main text of this pamphlet.

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Aspects of asbestos effects in humans (7),(8)

- All types of asbestos induce asbestosis, lung cancer and mesothelioma, when inhaled.
- Pleural mesothelioma can be produced by all types of asbestos fibres but lower risk is suggested from exposure to chrysotile compared to that from exposure to amphiboles.
- No such potency difference seems to exist between chrysotile and amphiboles as inducers of lung cancer or asbestosis.
- Peritoneal mesothelioma has not been observed after exposure to chrysotile.
- Amphiboles and chrysotile have similar potency as inducers of lung cancer in experimental animals.
- Lung cancer risk is considerably higher among asbestos-exposed smokers compared to non-smokers, while smoking does not enhance the induction of asbestos-induced mesothelioma.
- The risks of lung cancer among workers exposed to chrysotile in mining, asbestos cement production and friction material manufacture is markedly lower than among those exposed in asbestos textile production.

Epidemiological studies on the relationship between asbestos in drinking water and cancer.
(EHC 53)

<table>
<thead>
<tr>
<th>Study area/Study type</th>
<th>Fibre type</th>
<th>Exposed population</th>
<th>Exposure (fibres/litre)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, Minnesota /ecological</td>
<td>Amphibole (mine tailings)</td>
<td>~100 000</td>
<td>1 to 65x10⁴ for 15–20 years</td>
<td>No evidence of increased risk of gastrointestinal cancers</td>
</tr>
<tr>
<td>Connecticut /ecological</td>
<td>Chrysotile (asbestos-cement pipe)</td>
<td>~580 000</td>
<td>1 x 10⁴ for 20 years</td>
<td>Largely negative results attributed to low concentrations of asbestos fibres in drinking-water</td>
</tr>
<tr>
<td>Florida /ecological</td>
<td>Chrysotile (asbestos-cement pipe)</td>
<td>~200 000</td>
<td>&lt;10 x 10⁴ for 40 years</td>
<td>No evidence of an association between the use of asbestos cement pipe and deaths due to gastrointestinal and related cancers, limited sensitivity and analysis</td>
</tr>
<tr>
<td>Quebec /ecological</td>
<td>Chrysotile mining activities</td>
<td>~30 000</td>
<td>~200 x 10⁴ for 80 years</td>
<td>No consistent, convincing evidence of increased cancer risks attributable to ingestion of drinking-water contaminated by asbestos</td>
</tr>
<tr>
<td>Quebec /ecological</td>
<td>Chrysotile mining activities and natural erosion</td>
<td>~125 000</td>
<td>~100 x 10⁶ for 80 years</td>
<td>No consistent, convincing evidence of increased cancer risks attributable to ingestion of drinking-water contaminated by asbestos</td>
</tr>
<tr>
<td>California /ecological</td>
<td>Chrysotile</td>
<td>~3 000 000</td>
<td>~36x10⁶ to ~60 years</td>
<td>Evidence of positive association and exposure–response relationships between asbestos concentration in drinking-water and cancer incidence</td>
</tr>
<tr>
<td>Utah /ecological</td>
<td>Chrysotile (asbestos-cement pipe)</td>
<td>24 000</td>
<td>Unknown during 20 – 30 years</td>
<td>Positive association for gall bladder cancer in females and kidney cancer and leukaemia in males, but study did not control for sex, socioeconomic status, population density and migration</td>
</tr>
<tr>
<td>Washington (Puget Sound) /case-control</td>
<td>Chrysotile</td>
<td>Population of Seattle, Everett and Tacoma metropolitan areas</td>
<td>~ 200 x 10⁴ for 60 years</td>
<td>Study did not provide evidence of a cancer risk due to the ingestion of asbestos in drinking-water</td>
</tr>
</tbody>
</table>

Source: Environmental Health Criteria No. 53 88
Most recent report from an IPCS Task Group

As mentioned previously, ILO\(^\text{(4)}\) in 1986, recommended the discontinuation of the use of crocidolite asbestos, while WHO\(^\text{(9)}\) in 1989, recommended the prohibition of the use of both crocidolite and amosite. Taking into consideration these recommendations and the widespread production and use of chrysotile asbestos in the world, IPCS was requested to update the part of its 1986 Environmental Health Criteria document\(^\text{(7)}\) that concerns the health effects of chrysotile asbestos. The condensed summary, as well as the conclusions and recommendations of this group of experts\(^\text{(11)}\) are presented below.

Evaluation

There is an exposure–response relationship for all chrysotile-related diseases: fibrosis, lung cancer and mesothelioma. Reduction of exposure through introduction of control measures should significantly reduce risks; construction and demolition operations may present special control problems.

There are marked uncertainties in the dose-response analyses for asbestosis. However, it seems that asbestotic changes are common following prolonged exposures of 5 f/ml 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 sub-clinical 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 manifestations.

Risk of lung cancer increases with increasing exposure, although the slopes of the linear dose–response relationships (expressed as the increase in lung cancer risk per unit of cumulative exposure (fibre/ml x years) varied widely between different industries. Textiles produce by far the highest risk (slopes 0.01–0.03). Risks in the production of cement products (slopes 0.0003–0.0007), in manufacturing friction materials (slopes 0.0005–0.0006) and in chrysotile mining (slopes 0.0006–0.0017) are lower. The relative risk of lung cancer in the textile manufacturing sector is some 10 to 30 times greater than those in chrysotile mining. The reasons for this variation are not clear. Estimation of the risk of mesothelioma is complicated by the rarity of the disease, the lack of mortality rates in the population used as reference, and problems in diagnosis and reporting. In many cases, therefore, risks have generally not been calculated, and cruder indicators have been used, such as absolute numbers of cases and deaths and ratios of mesotheliomas over lung cancers or total deaths.

All of the observed 38 cases of mesothelioma in the chrysotile mining and milling sectors in Quebec in the period 1966–1988 were pleural with the exception of one of low diagnostic probability. None occurred in workers exposed for less than two years. There was a clear dose-response relationship, with crude rates of mesothelioma (cases/1000 person-years) ranging from 0.15 for those with cumulative exposure less than 100 mppcf-years (approximately 3500 f/ml x years), to 0.97 for those with exposure of 300 mppcf-years (approximately 10500 f/ml x years).

Proportions of deaths attributable to mesotheliomas in cohort studies in the various mining and production sectors ranged 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 hypothesised 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 tremolite has not been resolved.

Epidemiological studies of populations of workers using chrysotile-containing products 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.

Conclusions and Recommendations

Exposure to chrysotile asbestos poses risks for asbestosis, lung cancer and mesothelioma in a dose-dependent manner. No threshold has been identified for carcinogenic risks. Where safer substitute materials are available for chrysotile, they should be considered for use. Some asbestos-containing products pose particular concern and chrysotile use in those circumstances is not recommended. These include friable products with high exposure potential. Construction materials are of particular concern for several reasons. The construction industry work force 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 potential to deteriorate and create exposures.

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 f/ml. Personal protective equipment can further reduce individual exposures where engineering controls and work practices prove insufficient. Asbestos exposure and cigarette smoking have been shown to interact to greatly increase the risk of lung cancer. Those who have been exposed to asbestos can substantially reduce their lung cancer risk by avoiding smoking.

European Health21 target 13
Settings for health: By the year 2015, people in the Region should have greater opportunities to live in healthy physical and social environments at home, at school, at the workplace and in the local community.

Asbestos and health
(Local authorities, health and environment briefing pamphlet series; 25)

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Titles available or in preparation as of February 2000

Air
- Air and health
- Indoor air quality
- Transport and air
- Air pollution from wastes and solvents
- Energy and air
- Monitoring of air quality
- Asthma and respiratory allergies
- Air pollution and global effects
- Smog warning

Solid wastes
- Solid waste and health
- Landfill
- Waste incineration
- Waste collection
- Health care waste
- Biological treatment of waste
- Recycling
- Waste minimisation
- Toxic waste in the city

Accidents
- Local policy for accident prevention
- Child accident prevention
- Accidents and the elderly
- Home safety
- Road safety
- Fire safety
- Water safety
- Play and leisure
- Nursery and school safety

Water
- Water and health
- Monitoring of water quality
- Lead and water
- Nitrates
- Algal blooms
- Protection of drinking-water sources
- Drinking-water disinfection
- Treatments I
- Treatments II
- Leaks and meters
- Safety of distribution
- Rain water
- On-site sanitation
- Sewerage and waste water treatment plants
- Maintenance and management of waste water networks
- Recreational waters

Town planning
- Town planning and health
- Tools for town planning
- Travelling in cities
- Green cities, blue cities
- Urban networks
- City governance
- Urban health and socio-cultural aspects
- The city of the future
- Urban indicators
- Neighbourhood facilities
- Contaminated land
- Walking and cycling

Housing
- Housing and health
- Sick building syndrome
- Asbestos and housing
- Kitchen and health
- Lead and housing
- Energy and housing
- Moulds and moisture

Radiation
- Radon
- UV rays
- Before, during and after radiation emergencies
- Electromagnetic fields
- Radioactive wastes

Hygiene
- Rodents
- Mosquitoes
- Birds
- Pets
- Cockroaches
- Cleaning the city

Noise
- Noise and health
- Traffic noise
- Quieting the city activities
- Noise and music
- Noise at schools
- Sports and noise
- Community noise
- Dealing with noise complaints
- Measuring noise and insulating buildings
- Healthy soundscape

Toxicology
- Lead and health
- Allergies and the environment
- Carbon monoxide poisoning
- Pesticides and health
- Mercury and health
- Asbestos and health
- Adverse reactions to food

For further information, please refer to our WEB site:
http://www.who.dk/environment/pamphlets
Shaping up environment and health

Three milestones for Europe:

<table>
<thead>
<tr>
<th>Policy</th>
<th>Frankfurt’89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning process</td>
<td>Helsinki’94</td>
</tr>
<tr>
<td>Implementation of actions</td>
<td>London’99</td>
</tr>
</tbody>
</table>

WHO drafts the agenda for the next century.

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