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TOXICOLOGICAL PROFILE FOR ASBESTOS (UPDATE)

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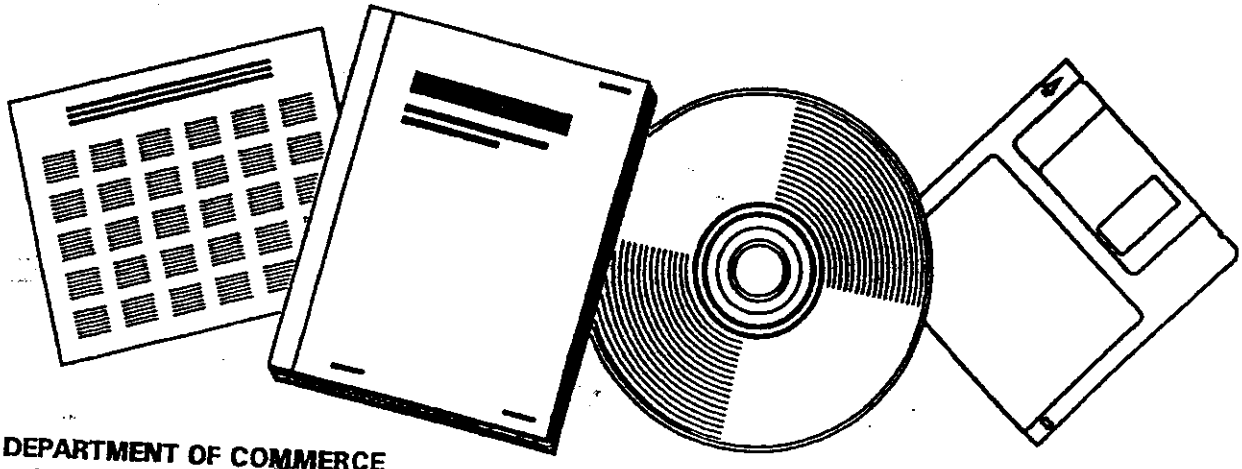

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

5.3.2 Transformation and Degradation

5.3.2.1 Air

Asbestos fibers in air are not considered to undergo any significant transformation or degradation (EPA 1979c).

5.3.2.2 Water

Asbestos fibers in water may undergo dissolution of some of the metal ion and hydroxyl ion content, but the basic silicate structure of the fiber remains intact (Choi and Smith 1972; Morgan and Holmes 1986).

Asbestos degrades in the environment very slowly (NRC 1984). Although the estimated half-life of asbestos in aquatic systems is not known, it is expected to be quite long (NRC 1984), and asbestos may persist in the environment for a decade or more following its release (EPA 1989f).

5.3.2.3 Sediment and Soil

Asbestos fibers in soil are not known to undergo significant transformation or degradation.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

Numerous measurements have been performed to determine the concentration of asbestos fibers in both outside and inside air. These studies have reported their results in a variety of units, including ng/m^3, TEM f/mL (fibers measured by transmission electron microscopy), and PCM f/mL (fibers measured by phase contrast microscopy). The conversion factors between these units are highly variable, depending on the size and length distribution of the fibers, and no single set of factors will be accurate for all samples. With this limitation in mind, the NRC (1984) suggested that crude approximations could be achieved by assuming that one phase contrast fiber per mL is about equal to 60 transmission electron microscope fibers per mL, and that both are about equal to 30 µg/m^3. Since

the health effects data regarding inhalation exposure to asbestos is usually expressed in terms of phase contrast fibers per mL, ambient air data reported in units of ng/m^3 or TEM f/mL are converted to units of PCM f/mL using the factors suggested by NRC (1984).

Ambient outdoor air, remote from any special sources, is generally found to contain 0.001–0.1 ng/m^3 of asbestos ($3x10^{-8}$ to $3x10^{-6}$ PCM f/mL) (NRC 1984). In urban areas, most ambient air concentrations range from 0.1 to 10 ng/m^3 ($3x10^{-6}$ to $3x10^{-4}$ PCM f/mL), but may range up to 100 ng/m^3 ($3x10^{-3}$ PCM f/mL) (EPA 1991b; IARC 1977; Nicholson and Pundsack 1973; Selikoff et al. 1972). The median concentration in United States cities has been estimated to be 2.3 ng/m^3 ($7x10^{-5}$ PCM f/mL) (NRC 1984). These levels are sufficiently low that they are not likely to be of significant health concern to most people. Near industrial operations involving asbestos, levels may be as high as 50–5,000 ng/m^3 ($1.5x10^{-3}$ to $1.5x10^{-1}$ PCM f/mL) (IARC 1977). A recent analysis of monitoring data for asbestos in ambient air world-wide estimated rural and urban levels at about $1x10^{-5}$ TEM f/mL ($2x10^{-7}$ PCM f/mL) and $1x10^{-4}$ TEM f/mL ($2x10^{-6}$ PCM f/mL), respectively (HEI 1991). Higher levels were measured near source-dominated locations.

Asbestos fibers are sometimes of potential concern in indoor air, due to disturbance of asbestos from a variety of building materials such as insulation, ceiling tiles, and floor tiles (EPA 1991b). Measured indoor air values range widely, depending on the amount, type, and condition (friability) of asbestos-containing materials used in the building. In a review of indoor air monitoring data from a variety of locations, Nicholson (1987) reported that arithmetic mean concentrations ranged from 1 to 200 ng/m^3 ($3x10^{-5}$ to $6x10^{-3}$ PCM f/mL). In a recent survey performed by EPA (1988c), levels of asbestos in 94 public buildings that contained asbestos ranged from 0 to 0.2 TEM f/mL (0 to $3x10^{-3}$ PCM f/mL), with an arithmetic mean concentration of 0.006 TEM f/mL (10^{-4} PCM f/mL) (Spengler et al. 1989). Analysis of data based on air samples from 198 ACM-containing buildings indicated mean asbestos levels ranging from $4x10^{-5}$ to $2.43x10^{-3}$ TEM f/mL ($7x10^{-7}$ to $4x10^{-5}$ PCM f/mL) (HEI 1991). Asbestos concentrations in 41 schools that contained asbestos ranged from 0 to 0.1 TEM f/mL (0 to $2x10^{-3}$ PCM f/mL), with an arithmetic mean of 0.03 TEM f/mL ($5x10^{-4}$ PCM f/mL) (EPA 1988c; Spengler et al. 1989). Another study reported average airborne asbestos fibers ≥5 micron concentrations of 0.00008 TEM f/mL and 0.000022 TEM f/mL in 43 nonschool buildings and 73 school buildings, respectively (Chesson et al. 1990; HEI 1992; Spengler et al. 1989). The average of measurements taken outdoors is comparable to the measured indoor level in these studies (Spengler et al. 1989). In general, direct comparison of levels inside and outside buildings that contain asbestos

indicate that typical (nondisturbed) indoor levels are usually low, but may be higher than outside (Chesson et al. 1990).

Asbestos may also be released to indoor air from the use of asbestos-contaminated household water (Hardy et al. 1992; Webber et al. 1988). Limited studies indicate that both amphibole and chrysotile fibers can be aerosolized by portable home humidifiers (Hardy et al. 1992). The airborne asbestos concentrations in the home were directly proportional to the asbestos concentrations in the water used in the humidifiers.

5.4.2 Water

The concentration of asbestos fibers in water (expressed as million TEM fibers per liter, MFL) ranges widely. Concentrations in most areas are less than 1 MFL (EPA 1979b), but values of 1–100 MFL and occasionally higher have been detected in areas contaminated by erosion from natural asbestos deposits (EPA 1976; Kanarek et al. 1980) or from mining operations (Sigurdson et al. 1981).

Release of asbestos from asbestos-cement pipes used in drinking water distribution systems may also be significant in some cases. The amount of asbestos contributed from asbestos-cement pipe is negligible in some locations (Hallenbeck et al. 1978), but may result in concentrations of 1–300 MFL at other locations (Craun et al. 1977; Howe et al. 1989; Kanarek et al. 1981). In one reported incident, grossly deteriorated asbestos-cement pipe in the water distribution system resulted in water concentrations of asbestos up to 1,850 MFL (Webber et al. 1989). The variability in the amount of fibers coming from asbestos-cement pipe appears to depend on a number of parameters, but is mostly related to characteristics of the water such as low pH and low hardness, which influence the rate at which the water can corrode the pipe (NAS 1982). The large majority of all fibers found in water are chrysotile, and are less than 5 μm in length (Hallenbeck et al. 1978; Millette et al. 1980; Pitt 1988).

5.4.3 Sediment and Soil

No studies were located regarding the concentration of asbestos fibers that occur in soil. Asbestos was found in about 80% of a number of samples of street dirt, at concentrations ranging from 100 million to 1 billion fibers per gram (f/g) (Pitt 1988). These were primarily chrysotile fibers and most were

less than 2 μm in length. It is likely that the main source of this asbestos was release from automobile brakes.

5.4.4 Other Environmental Media

In the past, filters made from asbestos were employed in the preparation of wines, beers, and other items consumed by humans, and asbestos concentrations in these materials ranged from 1 to 10 MFL (Cunningham and Pontefract 1973). Analysis of 47 brands of sake purchased in Japan during 1983–1985 indicated that asbestos concentrations in sake ranged from less than the detection limit (7.8×10^{-3} MFL) to 196 MFL (Ogino et al. 1988).

The use of asbestos filters in food or pharmaceutical preparation has been discontinued in the United States, and intake of asbestos through foods or drugs is now unlikely.

Asbestos fibers may be incorporated in sewage sludge as a result of their presence in wastewaters. Asbestos has been reported in municipal sewage sludges and sewage sludge composts from large and small cities in the United States (Manos et al. 1991, 1993; Patel-Mandlik et al. 1988). Asbestos was detected in 34 of 51 sludge ash samples at levels ranging from 1 to 10% by volume (Manos et al. 1991).

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

As noted above, the concentrations of asbestos found in indoor air, outdoor air, and drinking water vary widely, and it is not possible to calculate human exposure levels accurately except on a site-by-site basis. With this limitation in mind, Table 5-2 presents some rough estimates of exposure levels for a general population living in an urban or suburban area, and for asbestos workers. The exposure levels used for the general public are intended to represent the central portion of the typical range of exposures; thus, some persons could be exposed to higher levels, while others could be exposed to less. The workplace air concentration used to estimate worker exposure (0.1 f/mL) is the same as the current workplace exposure limit. Actual workplace exposures could be higher or lower. It has been estimated that about 568,000 workers in production and services industries and 114,000 construction industries may be exposed to asbestos in the workplace (OSHA 1990). Dose of fibers transferred to

TABLE 5-2. Summary of Typical General Population and Occupational Exposures

Exposed population	Exposure medium	Typical concentration	Assumed exposure	Dose	
				Lungs[a]	GI tract[b]
General population	Ambient (outdoor) air	$1x10^{-4}$ TEM f/mL[c] ($2x10^{-6}$ PCM f/mL)	20 m^3/day, 70 years (10% of time outdoors)[d]	0.00001 f-yr/mL	0.00006 MF/day[e]
	Indoor air[f]	$2x10^{-4}$ TEM f/mL[c] ($3x10^{-6}$ PCM f/mL)	20 m^3/day, 70 years (90% of time indoors)[d]	0.0002 f-yr/mL	0.001 MF/day
	Drinking water	1.0 MFL[g]	2 L/d		2 MF/day
Asbestos worker	Workplace air	0.1 PCM f/mL[h]	40 years, 8 m^3/day, 5 days/week, 49 weeks/year[i]	1.1 f-yr/mL[j]	8.1 MF/day[e,k]

[a]Dose to lungs expressed as phase contrast microscopy (PCM) fibers
[b]Dose to GI tract expressed as transmission electron microscopy (TEM) fibers (1 PCM fiber assumed to equal 60 TEM fibers) (NRC 1984)
[c]HEI 1991
[d]Approximate value, based on EPA 1989e
[e]Assumes 30% of inhaled fibers are transferred to stomach (NAS 1983)
[f]Applies only to buildings containing asbestos building materials
[g]Millette et al. 1979; concentration expressed as TEM fibers
[h]This value is arbitrarily assumed to be one-half of the occupational exposure limit of 0.2 PCM f/mL (OSHA 1986)
[i]NAS 1983
[j]Expressed in terms of average continuous exposure (20 m^3/day, 365 days/year), rather than in terms of years of occupational exposure (8 m^3/day, 5 days/week, 49 weeks/year)
[k]Daily dose (12 million fibers/day) adjusted to account for exposure 5 days/week, 49 weeks/year (NAS 1983)

f/mL = fibers per milliliter; L/d = liters per day; MF = million fibers; MFL = million fibers per liter; PCM = phase contrast microscopy; TEM = transmission election microscopy