ANNEX 3

Update of published asbestos concentrations in buildings under normal use and occupation. (By G.Burdett, HSL)

Introduction

At the last WATCH meeting there was an action 4.49 (iv) for HSE/HSL to summarise the knowledge it has on airborne levels of asbestos in buildings for the next WATCH meeting. This is a summary of peer-reviewed data for airborne concentrations during normal occupation. The data collected by HSL has been published in the peer-reviewed literature. HSE enquiries to Department of Communities and Local Government designed to establish what information they hold resulted in finding that their source information in fact was taken from HSE. A search of HPA web site suggests HPA have not published data.

The review carried out by the Health Effects Institute–Asbestos Research (HEI-AR) in 1991 was used as a starting point for this update of published literature for asbestos exposures in buildings. The HEI review collected all the available asbestos fibre concentration data to determine the average levels of airborne asbestos exposure. This covered outdoor air, occupant exposure in buildings and maintenance workers who disturb asbestos materials. The results were as far as possible expressed in terms of phase contrast microscopy (PCM) equivalent fibre concentrations (fibres of the dimensions that would be counted by PCM – the index used for occupational exposure measurement and epidemiology). In practice the measurements are made by analytical electron microscopy so the asbestos fibres can be separated from the non-asbestos fibres.

As individual sample measurements were usually below the limit of quantification, an average value for a building or an environment was calculated (e.g. by summing the volume of air analysed for individual samples and dividing this into the number of the asbestos fibres counted from these samples). This gives a measure of the average asbestos fibre concentration, which is the most useful statistic for estimating risk. However, as pointed out in the HEI report this average is sensitive to a single high sample, which is often related to maintenance activity being carried out. These maintenance activities were included in the HEI and previous UK estimates (Doll and Peto, 1985), as maintenance work was carried out in buildings under normal occupation and was sampled when it was found.

The average asbestos fibre concentrations from the data reviewed in the HEI report are given in table 1, along with the published studies/reviews since the HEI report. Only measurements based on methods that can distinguish the asbestos fibres have been included but several of the studies have other limitations, which are briefly summarised below. It is important to note that nearly all the studies measured buildings under normal occupation and use.

Summary of publications since the HEI report.

The most recent UK review (MRC, 1995) listed the studies carried out but did not attempt to calculate the average level but adopted the previous measured concentrations for UK asbestos containing buildings (0.0005 f/ml).

Recent publications with quantitative measurements on airborne asbestos exposures in buildings since this review are essentially limited to a US, Italian and a UK study. A personal sampling strategy that included a variety of environments and a Polish

study outside buildings has also been summarised in table 1. As the same issues of limit of quantification apply an average has been given when possible.

The newer publications that were available do not show that levels in buildings are greater than previously monitored and summarised by the HEI. If anything, the averages calculated are lower than the average summarised by the HEI and found in UK buildings (see figures 1 & 2). Several of these studies cover several years of monitoring in buildings.

One recent Polish study with limited analytical sensitivity did report increased levels outside asbestos degraded asbestos cement buildings. No measurements were taken inside buildings and the measurements do not accord with other measurements outside asbestos cement buildings, so it is difficult to put this study in context.

The personal sampling study by Schnieder et al., 1996, will have only part of the sampling time in buildings and include general environmental exposure as well, so it is only an approximate estimate of the building concentration.

Then Italian school study did not list data in a way that an overall average could be calculated. Measured airborne asbestos concentrations were generally (83%) below 0.0004 f/ml. An approximate average of ~0.00025 f/ml was assigned to this study for this analysis based on the data given in the paper. The study recommended management of asbestos in buildings as any measurable levels were generally due to the poor condition of internal asbestos cement panels (i.e. visible damage).

The US study was by far the most extensive and focussed of the published studies and was carried out over a long time period. This showed an increased concentration in asbestos containing buildings compared to their immediate outdoor environment - this was about a factor of 4 for public and commercial buildings and 5 for schools when sampled under normal occupation.

The UK study was focussed on a particular type of system built asbestos containing buildings. The schools were sampled after remedial action but with the asbestos still in place, while the office was as found.

When there is damage to the asbestos, higher airborne concentrations may occur, particularly when the damage or disturbance is taking place. Often this damage is related to human activity (e.g. maintenance work on the asbestos materials) but damage can be caused by other causes such as water ingress or animal activity (Ganor et al., 1991). This is why a more explicit duty to manage asbestos was introduced into UK legislation to prevent and minimise peak releases and to check for any new damage or deterioration, which would indicate that a disturbance and airborne release had occurred.

Conclusions

There are very few published studies of airborne asbestos concentrations in buildings since the HEI-AR review. What has been published suggests that there is no increase in the average occupant exposure in normally occupied buildings and the average concentrations may be even be lower than assessed by the HEI report and the earlier UK study. This reduction may be due to less maintenance work being carried out in the buildings during sampling in the later studies.

Measures such as the introduction of a duty to manage asbestos, the progressive removal of asbestos from buildings and the prohibitions on installing new asbestos materials, should act to reduce the asbestos exposure to buildings occupants.

Table 1: Update of publications giving quantitative airborne asbestos fibre measurements in buildings during normal occupation since the HEI-AR review on asbestos in the non-occupational environment (units are in PCM equivalent fibres/ml).

Study	No of buildings or people and (air samples)	Types of buildings / or person sampled	Arithmetic average indoor in asbestos containing buildings (f/ml)	Arithmetic average outdoors (f/ml)	Special observations
HEI – Review (1992) Non litigation data	198 (1377)	All buildings (occupied). Including:	0.00027	~0.00001 rural ~0.0001 urban	Includes some maintenance and custodial work and cable pulling gave highest value. Excluding highest value (sample) average becomes:
		Schools and colleges	0.00051		0.00038 (mechanical room)
		Residences	0.00019		
		Public and commercial	0.00020		0.00008 (during cable pulling)
HEI Review – Litigation data	171	Schools and colleges	0.00011	0.00005	
	10	Residences	BLD		
	50	Public and commercial	0.00006		

Review by MRC Institute for Environmental Health (1997)		Buildings containing asbestos material	~0.0005	0 – ~0.0002	Review and tabulation of previous individual studies carried out no detailed calculation of averages.
Schneider et al. (1996)					
	5 (40)	School children	0.000044		Personal sampling, sample changed once in 24 hours for day and night
	5 (40)	Retired persons	0.000066		
	5 (40)	Office workers	0.000010		
	5(40)	Taxi drivers	0.000105		
Italian Schools Campopiano et al. (2004)	59 (132)	Schools during normal occupation	83% <0.0004 Max 0.0022 Average ~0.00025		Building containing ACMs (vinyl tile and Asbestos cement) Chrysotile only found although AC had amosite
US schools and public buildings with asbestos containing materials. Lee and Van Orden, (2008).	752 (3978) 752 (1678)	All indoor All Outdoor	0.00012	 0.00002	Max for building = 0.004 90% of buildings had no PCME asbestos fibres detected
	371	Schools during normal occupation	0.0001		
	752	All buildings	0.00008		
Polish city urban air asbestos measurements outside asbestos cement buildings. Krakowiak et al. (2009)	27 (41)	Close to degraded AC buildings		0.0018	SEM study debris on ground limited analytical sensitivity no averages given.
	24 (42)	100-500 m from buildings		<0.0010	
	11 (17)	Close to buildings with no ACMs		<0.0010	

UK Schools with CLASP construction. Burdett et al. (2009)	7 (28)	Schools during normal occupation after remediation / sealing gaps.	Average <0.00005	Not done	Mainly asbestos insulating boards in columns with metal cladding around it
	1 (8)	Office in normal use sampled during day time for 4 weeks	Average <0.00003	Not done	Mainly asbestos insulating boards in columns

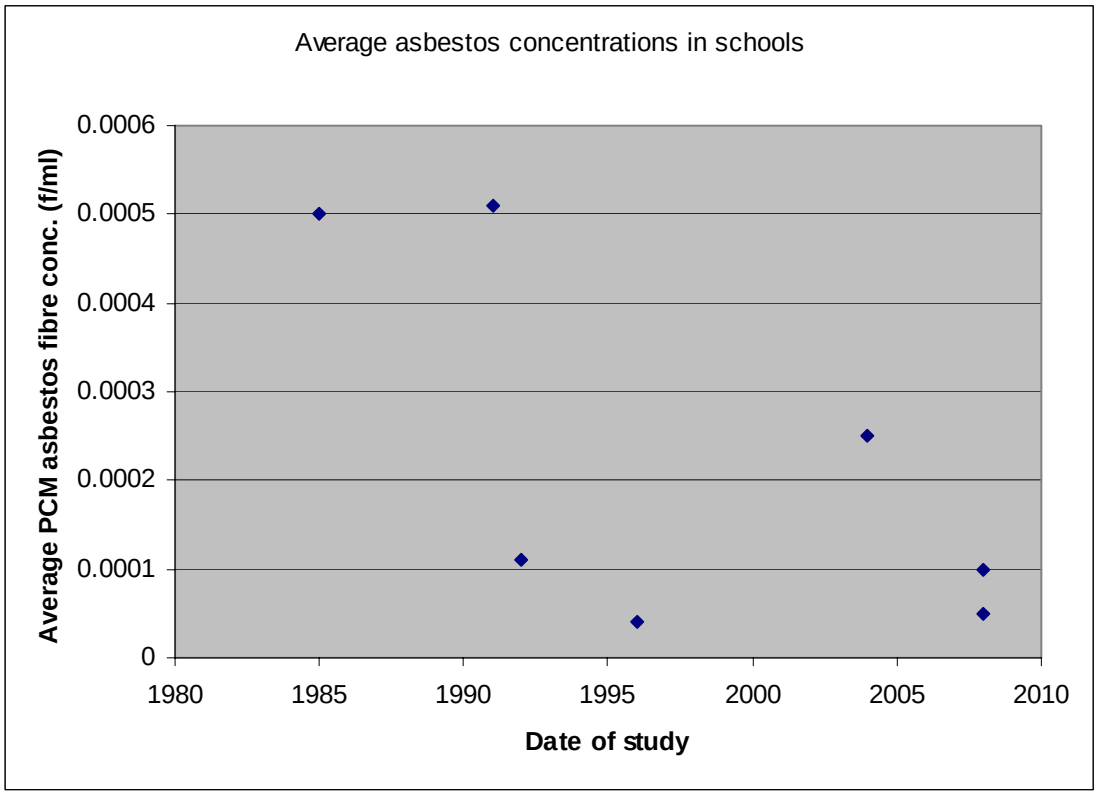

Figure 1: Study average asbestos concentration v date of study reported for schools.

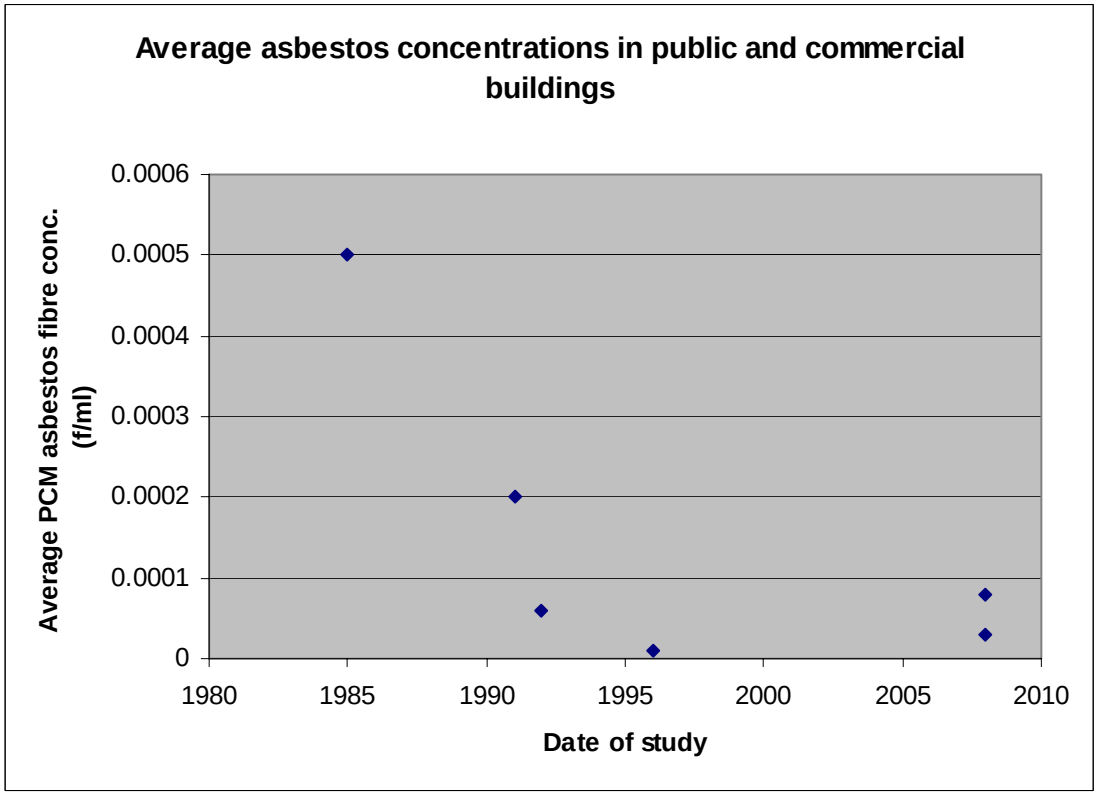

Figure 2: Study average asbestos concentration v date of study reported for public and commercial buildings

References

Burdett G, Cottrell, S and Taylor, C.(2009) Airborne Fibre and Asbestos Concentrations in System Built Schools. J. Phys.: Conf. Ser. 151 012023 (19pp) doi: 10.1088/1742-6596/151/1/012023

Campopiano A, Casciardi S, Fioravanti F, Ramires D. (2004) Airborne asbestos levels in schools in Italy. J Occup Environ Hyg. Apr;1(4):256-61.

Doll R. and Peto J. (1985) Asbestos effects on health of exposure to asbestos. HMSO, ISBN 0 11 883803 2.

Krakowiak E, Gorny RL, Cembrzynska J, Sakol G, Boissier-Draghi M, Anczyk E: Environmental exposure to airborne asbestos fibres in a highly urbanized city. Ann Agric Environ Med. 2009, 16, 121-128.

Gaynor E., Fischbein A., Brenner S. and Froom P., Extreme airborne asbestos concentrations in a public building. Brit. J. Indust. Med., 49, 468–488.

HEI-AR, Asbestos in Public and Commercial Buildings A Literature Review and Synthesis of Current Knowledge, Health Effects Institute - Asbestos Research 1991-01-01, Available from HEI publications.

Lee R.J., Van Orden D.R. (2008) Airborne asbestos in buildings. Regul.Toxicol. Pharmacol., 50, 218-225.

MRC Institute for Environmental Health. (1997) Fibrous materials in the environment: a review of asbestos and man-made mineral fibres. ISBN 1899110178, 9781899110179

Schneider T., Burdett G., Martinon L., Brochard P., Guillemin M., Teichert U., Draeger U. (1996): Ubiquitous fiber exposure in selected sampling sites in Europe. Scand J Work Environ Health. 22, 274-284.