COMMITTEE ON CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

Asbestos levels in School Buildings

1. The Department for Education (DfE) has asked for advice from the COC on the relative sensitivity of children to asbestos to inform the discussions of its independent “Asbestos in Schools Steering Group”. In order for the COC to discuss the relative sensitivity of children to asbestos and the subsequent risk of mesothelioma, the exposure levels to which children are exposed to asbestos in schools is important. A large number of buildings in the world have been examined for airborne asbestos fibres within the past 20 years, and have yielded many thousands of air measurements (most unpublished). However, very few publications have specifically cited levels of asbestos in school buildings, with some reports from the UK, US and Italy. From these studies, we have obtained background levels of asbestos and also levels in specific school buildings in the UK. Here we also include details of re-enactment studies conducted in the UK to simulate the level of asbestos release into classrooms under routine classroom activities.

Measurement of asbestos levels

2. Normal procedure for the determination of airborne concentrations of asbestos fibres in buildings involves filtering air through a membrane filter. After some manipulations of the filter, the fibres are analysed either using an optical phase contrast microscope (PCM) or an electron microscope (EM); both the scanning electron microscope (SEM) and the transmission electron microscope (TEM) can be used for this purpose. The TEM is typically used for asbestos analysis due to limitations of the PCM and SEM related to visibility and identification of small or thin asbestos fibres and structures.

Outdoor Ambient levels

3. A review by the IEH in 1997 indicated that background outdoor (ambient) levels of respirable asbestos fibres may range from 0.000001 to 0.0001 f/ml (IEH, 1997). Assuming a respiratory rate of 8 l/min, the IEH found that this level of exposure would result in a 70 year lifetime exposure to asbestos fibres in the range 295 000 to 29 500 000 for everyone in the UK population. A summary of asbestos in air measurements by the WHO (2000) indicates that, for rural areas, the ambient concentrations are below 0.0001 f/ml and, for urban areas, the concentrations can range from 0.0001 f/ml to 0.001 f/ml. WHO (2000) provides estimates of typical lifetime cumulative asbestos exposures of members of the public in industrialised countries from ambient outdoor concentrations. For an urban population with moderate exposure an average exposure of 0.00003 f/ml is assumed for 70 years, resulting in an estimated cumulative exposure of 0.0021 f/ml-years and the inhalation of 15 million fibres. For a rural population a fibre concentration of 0.00001 f/ml is

assumed, resulting in an estimated cumulative exposure of 0.0007 f/ml and the inhalation of approximately 5 million fibres.

Ambient indoor levels in buildings

4. In the literature a wide range of background levels are reported. In the UK in 1991, the then Department of the Environment (DoE) estimated a level of regulated asbestos fibres in buildings of 0.0005 f/ml above background (DoE, 1991). The Health Effects Institute estimated mean concentrations of 0.00019 and 0.0002 f/ml in homes and public buildings (HEI, 1991). In 1997 the IEH reported that most indoor air concentrations of asbestos are below 0.0002 f/ml. WHO (2000) did not provides estimated of typical lifetime cumulative asbestos exposures of members of the public in industrialised countries from ambient indoor concentrations. However, in a 2007 HPA report on “The health impact of asbestos exposures from fires”, it comments on indoor asbestos estimates from one US study of 0.0004-0.0005 f/ml, where if these estimates were correct, they would result in a lifetime fibre burden of up to 200 million fibres (implying a cumulative exposure of 0.035 f/ml-years).

Ambient indoor levels in school buildings (Summary table at Annex A)

5. In 1991, The US Health Effects Institute (HEI) reviewed data from scientific articles, reports, and additional unpublished data to determine the concentrations of airborne asbestos fibres found in public and commercial buildings including schools. Data were presented in their review from litigation and non-litigation reports. For determination of airborne concentrations of asbestos fibres in buildings, air was filtered through a membrane filter and the fibres were analysed using an optical PCM or an electron microscope, mainly (TEM). They found that the mean concentration of fibres was 0.00051 f/mL from 48 schools and colleges (398 samples in total) from the non litigation data, with the 90th percentiles of 0.0016 f/ml reported. The mean concentration for 171 schools and colleges (1008 air samples in total) was 0.00011 f/ml from the data of the litigation reports.

6. Corn et al. (1991) examined a total of 473 air samples from 71 schools in their analysis of airborne asbestos concentration in schools. They found that the average concentration of asbestos structures (structures include all types of asbestos, namely fibres, bundles, clusters and matrices) in indoor samples was 0.02 structures(s)/cm^3 of total structures and 0.00023 s/cm^3 for structures ≥ 5 μM. The corresponding average concentrations for outdoor samples from outside 70 schools (94 samples taken) were 0.002 and 0.0 s/cm^3. The average concentration of all structures were significantly higher indoor than outdoor ($P < 0.001$). The highest single indoor or personal reading found in this study for structures ≥ 5 μM was 0.012 s/cm^3.

7. Nicholson et al. (1979) sampled 10 schools with visibly damaged asbestos in urban centres of New York and New Jersey and in suburban areas of Massachusetts and New Jersey in the US. Samples were taken over 4 to 8 hours in the 10 schools (1-5 samples per school) and the chrysotile asbestos

concentration ranged from 9 ng/m^3 to 1950 ng/m^3, with an average of 217 ng/m^3. The corresponding average concentration for outdoor samples taken at 3 of the schools was 14 ng/m^3, with a range from 3 to 30 ng/m^3. The authors emphasized that the schools were selected in testing on the basis of the presence of visible damage.

8. In an US EPA study, Constant (1983) analysed samples collected during a 5-day period in 25 schools that had asbestos surfacing materials, selected randomly from one single district in Colorado. A concentration of 6 ng/m^3 was measured in 31 samples of outdoor air taken at the same time as the indoor samples. A population weighted arithmetic mean concentration of 179 ng/m^3 was measured in 54 samples taken from rooms and areas of the schools with asbestos surfacing material. In 31 samples collected from areas and rooms of the schools with no asbestos surface material, the data showed an average concentration of 53 ng/m^3, indicating dispersal of asbestos from source to these areas.

7. Schneider et al. (1996) carried out a small scale study to assess personal exposure to respirable inorganic and organic fibres (natural and man-made) during normal human lives at three geographic sites in Europe. One of the sampling populations included a small group of five school children aged 13-14 yrs from a school in suburban Paris (one school, one class). The personal sampling involved sampling in their school building but also sampling in the general environment. The estimate of building concentration is only an approximation for this reason and it should be noted that the authors did not find materials containing asbestos in any of the buildings. Taking 40 air samples from 5 children, the arithmetic average indoor concentration of fibres was determined as 0.000044 f/ml.

8. Campopiano et al. (2004) carried out environmental investigations in Italian schools between 1992 and 2002 to evaluate the risk from asbestos exposure to students and school staff. The majority of schools (59 schools in total) selected for this study were built prior to 1980 and were selected by local health services as possessing real health risks and/or where charges has been filed by the parents of the students or school staff. Asbestos was mainly present in the vinyl floor coverings and panels of asbestos-cement used as partitions and ceilings. Analyses of the bulk samples confirmed that only chrysotile fibres were present in the vinyl-asbestos tiles while asbestos-cement products contained both amphiboles (amosite and crocidolite) and chrysotile. Sampling took place when schools were occupied and normal activities were taking place. They found that 83 % of the measured concentrations were lower than the detection limit of 0.0004 f/mL. 14 % of samples had concentrations between 0.0004 f/mL and 0.002 f/ml, with 3% of samples having concentrations greater than 0.02 f/ml. The authors noted that these 3% of cases corresponded to areas of school buildings in which ACM were severely damaged or undergoing continuing disturbance.

9. Lee and Van Orden (2008) examined the concentration of airborne asbestos in US buildings including schools under conditions of normal occupancy. Some of the data presented in their paper were previously published by Corn et al (1991) and Lee et al (1992). For school buildings, a total of 1615 indoor samples were taken from 317 schools. The average concentration of asbestos structures for all school indoor samples was 0.2735 s/ml; for asbestos structures ≥ 5 μM, the sample concentration averaged 0.00016 f/ml. The corresponding values for the outdoor samples were 0.0011 s/ml and 0.00003 f/ml, respectively. The authors found that for fibres ≥ 5 μM, there were significant differences between indoor and outdoor samples for schools ($p \leq 0.0001$). It should be noted that in school buildings, 90 % of the buildings contained total asbestos concentrations less than 0.05 s/ml and concentrations of asbestos fibres ≥ 5 μM less than 0.0006 f/ml.

10. Burdett and Jaffery (1986) determined the airborne concentration of asbestos and other fibres in 39 buildings containing asbestos materials used in their construction or present in warm-air heating systems. 4 schools were included in this study and had sealed sprayed amosite and chyrsotile asbestos on the ceilings with either some or slight damage. They found that the TEM asbestos fibre levels in one school ranged from <0.003 f/ml to 0.012 f/ml with an average of 0.002 f/ml. Combining the data for the four schools from a total of 36 samples analysed, the average asbestos fibre level was as <0.00078 f/ml.

11. Burdett et al. (2009) measured the airborne fibre concentrations in system build schools that contained AIBs enclosed in support columns by a protective steel casing, with particular focus on CLASP (Consortium of Local Authority Special Programme) system buildings in the UK. A variety of air monitoring tests were carried out to assess the potential for fibres to be released into the classroom, such as 1) before remediation work, 2) simulating direct impact disturbances, 3) post remediation work and 4) simulated and actual work exposures. The PCM fibre concentration data from Peak Release testing (banging the columns, slamming doors attached to or adjacent to columns as well as similar disturbances of window areas) exceeded 0.01 f/ml in 60 % of the 31 air samples taken, with the highest value in school buildings being determined as 0.44 f/ml. After remedial work of sealing gaps and holes in and around column castings, 95% of samples were below the limit of quantification (LOQ) of 0.01 f/ml, with a mean of 0.0004 f/ml and the highest determined concentration was 0.058 f/ml. The study also determined occupant exposures during normal classroom teaching activities in areas where remediation work had taken place. Using TEM, analysis of 28 samples from seven schools could not detect asbestos fibres inside the classrooms. Taken as a group representing occupied CLASP schools which had undergone remediation, the average level in schools was below the limit of detection (LOD) < 0.00005 f/ml, with an overall sensitivity of 0.0000016 f/ml. Although prior to the remediation no measurements were taken in the schools containing AIB materials in the columns, 5 weeks of continuous monitoring was carried out in an ex-school building, now an office. The calculated concentration of PCM asbestos fibres obtained during the continuous monitoring was equivalent to

an 95% upper confidence value of <0.00002 f/ml, with an analytical sensitivity of 0.000005 f/ml.

12. A report by the Inner London Education Authority, published in June 1987, was obtained on “Fibre Release from low level asbestos fibres”. The report contained details of concern expressed by a school safety representative at a south west London Boys Secondary School that unsupervised pupils were kicking or could kick asbestos panels containing amosite (15-30 %) around door frames at floor and ceiling levels and cause fibre release. Tests were conducted to simulate this abuse to establish airborne fibre levels under enclosed conditions. Air sampling was conducted using 4 stationary samplers and one personal sampler on the person conducting the simulated abuse. In the tests, door slamming and repeated kicking of the asbestos panels caused airborne fibre concentrations in the range of 0.16 to 0.87 f/ml to be released. Analysis of the fibres confirmed that the majority of fibres were amosite fibres. It was noted that these tests were designed to represent the “worse possible” case scenario (5 door slams and 100 kicks in a ten minute time period).

13. The Inner London Education Authority in November 1987 investigated in more detail the fibre release around door frames at floor and ceiling levels in the school described in their first report and carried out further measurements that more accurately reflect the normal exposure of those using the building. They conducted an initial reassurance test prior to any simulated abuse tests. They found that the airborne fibre concentration was above the environmental health adviser guidelines of 0.01 f/ml but examination of the filters by SEM showed that the highest asbestos concentration was 0.006 f/ml. Door slamming to simulate a worst case scenario (10 slams in total over a 5 minute period) showed the airborne fibre concentration was 0.02 f/ml, with the SEM analysis indicating that the asbestos concentration as 0.015 f/ml. In another door slamming test carried out to simulate a force estimated to be that of a teacher or infant school child, the airborne fibre concentrations was less than 0.01 f/ml with an asbestos concentration of 0.002 f/ml. The authors commented that the results obtained in this second study were not as high as those measured in the previous study and would carry out further tests as some of the test levels were close to the 0.01 f/ml level. The secretariat has not been furnished with any additional test results to date.

14. WATCH, a government scientific advisory committee, advises the Advisory Committee on Toxic Substances (ACTS) and HSE on scientific and technical issues relating to the assessment and control of health risks from chemicals. In 2006, it discussed at length its position on the most reliable estimate of the potential exposure of teachers and others from the use of drawing pins on asbestos insulating board (AIB) in a school classroom setting. The discussion at WATCH centred on differing results for estimates of potential exposure from the use of drawing pins from AIB in a classroom setting. The first study was undertaken by Robin Howie and Associates on behalf of Mr Michael Lees (Annex b) and the results lead to further studies by the Health and Safety Laboratory (HSL) (Annex c and d). Following discussion at the WATCH committee meeting, as outlined in the minutes,

(http://www.hse.gov.uk/aboutus/meetings/iacs/acts/watch/010206/minutes.pdf),

the consensus position of the WATCH committee was "a *"realistic worst-case" prediction for exposure of an operative under conceivable real-life conditions is 0.05 f/ml in a 25-minute period of drawing pin activity, which translates to an exposure of 0.005 f/ml as a 4h TWA (assuming that there is only one 25-minute period of pinning activity each day). A theoretical calculation based on an extreme assumption that every fibre released from pin holes during this period of drawing pin activity is inhaled gives an exposure value of approximately 1 f/ml in the 25-minute period, translating to 0.125 f/ml (4h TWA) or 0.063 f/ml (8h TWA), again assuming one activity period per day. The above estimates of a teacher's exposure exclude any further exposures to fibres released into the background classroom air; or from any fibres released from asbestos-containing debris which might have become lodged on the teacher or their clothes. The Committee also concluded that it was not possible from the data available from the HSL study to make a reliable exposure estimate for any other adults or children in the classroom environment where pin insertion into AIB was occurring"*.

15. In 2004, the Institute of Occupational Medicine (IOM) carried out an investigation in a school building after a school was closed following the discovery that asbestos insulating boards (AIB) had been removed without proper precautions by a contractor as part of a programme of window replacement (IOM, 2008). Air samples were collected to assess airborne fibre concentration either while the settled dust in the building was disturbed or without fibre concentrations. Samples of dust and debris were also collected from various surfaces in the school. Of 33 samples, 19 of these contained either a mixture of amosite and chryostile (brown and white) asbestos or amosite alone. Most of the air samples, which were collected when the investigator disturbed settled dust throughout the room, indicated concentrations less than the lowest detectable concentration of < 0.01 f/ml. Two samples had measurable concentrations of airborne fibres (0.011 f/ml and 0.05 f/ml). 4 samples showed concentration of between 0.013 f/ml and 0.02 f/ml in areas of aggressive disturbance in areas close to the windows. The study also estimated the exposure to asbestos for pupils and school staff using the available data and a theoretical modelling technique for use in studies of health workers. The exposure of the pupils was estimated to be very low on the day of the window removal work (0.002 f/ml). This was due to the fact that they came to school after the window removal work was completed and they were caught in the main hall away from classrooms. Exposure estimates for teachers are higher at a level of 0.02 f/ml because it was reported that they cleared their classroom after the work and before the children returned to their classroom. The estimated total likely risks for pupils (mesothelioma and lung cancer) were calculated as 0.0003 per thousand (0.3 per million). The estimated total likely risks for teachers (mesothelioma and lung cancer) were between 0.00007 and 0.0007 per thousand, depending on age and smoking status, with the higher risks for younger smokers. The maximum estimated lifetime risks associated with the incident in the school was calculated as 0.0005 per thousand for pupils and 0.001 for teachers. According to Cancer Research UK, in 2008 the European age standardised incidence of lung cancer for both male and females is 47.8 per 100,000 population. It has been estimated that the lifetime risk of developing lung

cancer in 2008 is 1 in 14 for men and 1 in 19 for women in the UK (Cancer Research UK). For mesothelioma, the European age-standardised incidence rate for both male and females is 2.9 per 100,000 population.

16. A retrospective assessment was undertaken by IOM Consulting Ltd, a subsidiary of the IOM, on the likely exposure to asbestos that may have arisen as a consequence of exposure to AIB contained within cupboards located in certain areas of a named school (IOM, 2009). The IOM predicted the risk to health that would have arisen for both pupils and teachers as a consequence of the estimated exposures. Information was gathered by interview with staff to ascertain 1) their past-use of cupboards which contained AIB, 2) the duration over which staff have worked in rooms with such cupboards and other data that would assist in the predication of likely future risk. Re-enactment tests of repeated accessing resources from the AIB affected cupboards were performed using the whole classroom as a working area. Fibre concentrations were determined in terms of asbestos fibres using SEM analysis. During the tests, the room was sealed and there was no ventilation. A second set of tests were also performed to determine the asbestos fibre concentrations produced when the cupboards were thoroughly cleaned by brushing. Previous sampling by First Order Red during sealing treatment of the AIB in the cupboards had determined fibre concentrations of 0.02 f/ml as analysed by PCM. In undertaking simulations within a small enclosure, First Order Red found concentrations of up to 1 f/ml (average 0.5 f/ml). In the IOM study, background samples determined asbestos fibre concentrations as <0.01 f/ml as determined by PCM. Under the test conditions, repeated assessing of resources produced asbestos fibre concentrations of 0.04 and 0.05 asbestos f/ml from the personal samples and ~0.02 asbestos f/ml on the fixed point samples taken 1.5 and 3.0 m from the cupboard. The SEM samples indicated that 40 % of fibres were asbestos. The re-enactment of the cleaning of the cupboard produced concentrations of 0.3 asbestos f/ml on two personal samples and between ~ 0.1 and 0.2 asbestos f/ml on the 5 fixed point samples. The SEM samples indicated that asbestos accounted for 66-92% of the fibres. Surface dust samples taken from within the cupboards also contained asbestos fibres. For the ventilation tests, they found that under normal occupancy of the classroom with open windows, rapid air exchange occurs even on a relatively calm day, However, when the windows were closed, the decay in concentration was slower with concentration only halving over 30 minutes.

17. For exposure estimates, the IOM report (2009) measured personal exposure during accessing resources under the test conditions at 0.05 asbestos f/ml. This value was taken as a worst case estimate of possible exposure to asbestos. The exposure estimate for normal accessing of the resources as described in the interviews gave a more likely concentration of less than one fifth of the value obtained in the tests (i.e 0.01 f/ml). Following conversion of cumulative exposure to an equivalent annual average concentration with the use of risk prediction models, the IOM report that for pupils who have attended the school for 5 years, exposure starting at 11years under likely case estimations, are not or do not become smokers, the predicted additional risk mesothelioma would be predicted to be just over 0.01

in 1,000, with the additional risk of lung cancer as 0.0004 in 1,000 for both male and females pupils. the IOM report that for pupils who have attended the school for 5 years, exposure starting at 11 years under worst-case assumption on exposure concentration and with twice the average number of classes in the affected rooms, are or do become smokers, the predicted additional risk mesothelioma would be predicted to be just over 0.11 and 0.12 in 1,000 male and females, respectively. The predicted additional risk of lung cancer was determined as 0.16 in 1,000 for males and 0.1 in 1,000 females pupils under these worst case scenario situation.

<u>Secretariat, October 2011</u>

<u>Questions for the Committee</u>

Have the committee any comments on the data provided from the above studies on the exposure of children to asbestos in school buildings?

Are the committee aware of any other studies that would provide background data on the asbestos exposure levels of children in schools?

References

Burdett G.J & Jaffrey, S.A.MT. Airborne asbestos concentrations in buildings. Ann Occup Hyg 1986. 30(2), 185 – 199.

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

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.

Constant, P. (1983). U.S. Environmental Protection Agency. Airborne asbestos levels in schools. Washington, DC: Office of Toxic Substances, USEPA. EPA-560/5-83-003

Corn M, Crump K, Farrai D et al (1991)*.* Airborne concentrations of asbestos in 71 school buildings*.* Regul Toxicol Pharmacol *13:*99-114*.*

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

HPA (2007) HPA CHaPD 003: The Public Health Significance of Asbestos Exposures from Large Scale Fires (Smith KR and Saunders PJ). http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1204013002817

IEH (1997). Fibrous materials in the environment – a review of asbestos and man-made mineral fibres (MRC Institute of Environmental Helath)

Inner London Education Authority (1987a). Fibre Release from low level asbestos panels (June 1987) (LSS/AP/52)

Inner London Education Authority (1987b). Fibre Release from asbestos panels around door panels (November 1987) (LSS/AP/78)

IOM (2008). A report on the likely risks from asbestos exposure at a school by John W Cherrie and Hilary Cowie (Report 628-00009)

IOM Consulting Ltd (2009). An assessment of the past exposure and estimation of consequent risks to health of pupils that may have arisen from asbestos-containing material in cupboards at a school by Andy Jones, Andy Stelling, I Levers and Hilary Cowie (Report – 626-00270)

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

Nicholson WJ, Swoszowski EJ Jr, Rohl AN, Todaro JD, Adams A . Asbestos contamination in United States schools from use of asbestos surfacing materials. Ann N Y Acad Sci. 1979;330:587-96.

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.

WATCH (2006) Assessment of potential exposure of teachers and others from the use of drawing pins on asbestos (amosite) insulating board in a school classroom setting http://www.hse.gov.uk/aboutus/meetings/iacs/acts/watch/010206/paper2.pdf

WHO (2000). Air quality Guidelines for Europe. WHO Regional Office for Europe, Copenhagen, Denmark.