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Our Ref: **RMH/13/767**
Your Ref: **Cwmcarn High School**

Mrs. D Jones,
Health, Safety & Occupational Health Manager,
Health & Safety Division,
Caerphilly County Borough Council,
Penalita House,
Tredomen Park,
Ystrad Mynach,
Hengoed, CF82 7PG.

Dear Mrs. Jones,

Cwmcarn High School

As discussed at our meeting on 4th March I summarise below the critical data from my analysis of the information from the Santia Investigation Report of October 2012 and HSL Report AS/2012/14.

However before discussing these data it is relevant to outline the likely effects of building disturbance and wind/air infiltration effects on the validity of air monitoring results: see Appendices A and B to this letter.

From the Appendices it is considered likely that any air sample results obtained without recent occupation of the school or without significant representative deliberate disturbance are likely to be irrelevant as indicators of normal occupation of the school. In addition, any samples running longer than about 1 hour since last disturbance are likely to underestimate airborne fibre concentrations during normal occupation of a secondary school.

The Santia report confirmed the findings of the Enquin report of 2009 regarding the widespread contamination of the ceiling voids with debris containing amosite and provided results from Reassurance Samples taken in the 2-storey block of Building A and from Personal Monitoring samplers worn by CCBC personnel undertaking an environmental clean-up in ground floor Rooms 043, 045, 046, 048 and 049 of the same block.

It is understood that it was confirmation of the above contamination and its Reassurance and Personal Monitoring results that led Santia to recommend that the Council should consider immediate prohibition of access to the school and the Council's prudent adoption of Santia's recommendation.

The HSL report concluded that airborne concentrations in the School were "very low", that the airborne asbestos fibre concentrations in its report were significantly lower than the fibre concentrations previously reported by Santia and that provided that maintenance activities are carried out with appropriate precautions, the debris in the ceiling void is unlikely to result in quantifiable airborne asbestos exposures to occupants.

It is understood that it is the very substantial differences between the Santia and HSL reports that has caused differences of opinion between the Council, HSE, the Governors of the School and some parents of children at the school about whether the school is safe for reoccupation.

In my analysis of the various reports on asbestos in the School I have examined the Santia and HSL reports in detail.

HSL criticised the sample analysis data given in Appendix G of the Santia report on three grounds: the failure to analyse the Field Blank data; the failure to ensure that each of the individually reported data points from Appendix G was based on counts of sufficient fibres on the relevant filter; and, the fact that Phase Contrast Microscopy (PCM) cannot distinguish between asbestos fibres and non-asbestos fibres.

HSL is correct in the last comment, but quantitative differentiation between asbestos and non-asbestos fibres is not mandatory in guidance documents such as HSG 248, HSE (2005).

It should be noted that Santia collected one Field Blank in each of the three series of tests tabulated in Appendix G.

However, during the HSL study only one Field Blank was taken, which was not analysed, no Field Blanks were taken for any of its six Series of multiple samples and HSL failed to count sufficient TEM grids to permit adequate precision for any of the five non-zero count samples.

That is, HSL criticised Santia for the same shortcomings that HSL then repeated with in its own sampling and analysis.

In practice, where individual quantified results are to be reported the number of fields counted should be increased until a minimum of 20 fibres has been counted.

Assessment of the Santia and HSL data

In assessing the Santia and HSL reports it is necessary to consider the dates on which samples were collected and any changes in building conditions during September to October 2012.

The Santia samples were collected on Saturday 22nd September 2012, i.e. while the School was effectively unoccupied but within a day of a normal week of occupation. It is understood that no deliberate disturbance was induced during the Santia sampling.

The Santia report commented that, as the school was "almost empty" during their Reassurance sampling, it was likely that higher airborne fibre concentrations would have been observed if the school had been occupied.

I fully agree with Santia's above comment.

On Friday 28th September 2012 Council personnel sealed gaps between ceiling tiles and at service entries into the upper floor classrooms.

The school was closed on 12th October 2012.

The HSL samples were collected between the 26th and 28th November 2012. That is, the school had been unoccupied for about 6 weeks and the upper floor classroom ceilings had been sealed for 8 weeks before the HSL study commenced.

In interpreting the HSL results it is necessary to appreciate that sampling with deliberate disturbance was restricted to Series E samples only and that in this Series less disturbance was imposed in Room 184 than in the other rooms. This might account for the non-quantified fibre level in Room 184. Alternatively, the zero count might have reflected the limited number of grids counted.

The lack of significant disturbance in all HSL sampling series other than E suggests that only Series E data are likely to be relevant to normal occupation of Cwmcarn School.

Given that the duration of the HSL Series E samples was about 2 hours whereas the likely period between successive disturbances of the school during normal occupation would have been about 1 hour, the Series E measurements could have underestimated the actual airborne fibre concentrations that would have been present over a 1-hour period from first deliberate disturbance. Assuming an air infiltration rate of about 2-4 air changes per hour the Series E measurement results could range between about 25 and 50% of the actual fibre concentrations over about 1 hour.

It is relevant to assess whether the Santia Reassurance results differ significantly from the four non-zero HSL Series E results.

The data from Appendix G of the Santia report and the data for analysed samples from Table 2 of the HSL report are summarised in Tables 1 and 2 respectively. Table 1 also shows the Poisson 95% boundaries for each Santia sample fibre count, corresponding fibre concentrations and overall means.

Any comparison of these data has to take account of the wide error Confidence Limits (CL) of the individual data points.

From Table 1 the range between Poisson 95% CL for individual samples are substantially wider than for the means. For example, for Santia's Reassurance samples the CL for the sample with 10.5 fibres counted were 0.0025 to 0.0095 fibres/ml whereas the CL for the mean were 0.004 to 0.0065 fibres/ml.

The CL for the relevant Santia and HSL data points are shown in Table 3 and Figure 1.

As can be seen from Figure 1 the upper CL of the highest HSL Series E results lies above all the observed Santia Appendix G Reassurance results.

If the magnitude of the likely underestimates in the HSL Series E data are taken into account, the means of the HSL data do not differ significantly from the mean of the Santia Appendix G Santia Reassurance data.

CONCLUSIONS

It is considered that the non-zero Series E HSL results do not differ significantly from the Reassurance results from Appendix G of the Santia report and that consequently there is currently no basis upon which to reject Santia's recommendation to prohibit access to the school and the Council's decision to implement such recommendation.

In addition, it is considered highly likely that the results obtained for the HSL Series E samples would have underestimated the likely levels over the 60 minute period relevant to normal school disturbance due to pupil movement by factors of between about 2 and 4.

Before requiring reanalysis of the Santia Appendix G Reassurance results and the HSL Series E results it would be useful to ask if HSE agrees that only the HSL Series E results are relevant to the normal likely exposures of occupants of Cwmcarn School, and should not be "pooled" with the other HSL results, and that in the present relevant data there is no significant difference between the Santia and HSL results.

If HSE agrees that only the HSL Series E results are relevant and that the relevant Santia and HSL results do not differ significantly, reanalysis of the relevant filters will not be necessary.

If HSE insists all of the HSL results are relevant and that there is a significant difference between the Santia and HSL results it will be necessary to reanalyse all of the relevant filters to obtain at least 20 fibres counted on all of the Santia and HSL Series E filters.

In addition, it will be necessary to resample the HSL Series E data set with the same level of deliberate disturbance as previously but with all disturbance carried out during the first 5 minutes of a 60 minute sample; e.g. see HSL Report No. HSL/2001/11.

RECOMMENDATIONS

Given the concerns of the Council, the School Governors and some pupil's parents it is considered that the available samples should be reassessed to increase the precision of the fibre counts, and therefore the calculated airborne fibre concentrations.

The following recommendations are intended to generate reliable results upon which to address the areas of concern in the shortest possible time.

Recommendation 1

It is recommended that all of the Santia Reassurance samples reported in their Appendix G plus all Field Blanks plus five Reassurance samples reported in their Appendix E, (to act as controls), plus the samples taken by Santia during the HSL study be delivered to an independent laboratory which will renumber these samples and return the renumbered samples to Santia for reanalysis.

Recommendation 2

It is recommended that a minimum of 200 fields be counted on each filter and that filters that yield counts >10 fibres in 200 fields have sufficient additional fields counted until at least 20 fibres have been counted.

Recommendation 3

It is recommended that all of the HSL non-zero samples plus five zero count samples be delivered to an independent laboratory which will renumber these samples and return the renumbered samples to HSL for reanalysis.

If HSL TEM analysis involved photographing or recording images of the sample grids, the recorded images should be sealed until the re-analysis results have been reported or the samples should be analysed by an independent laboratory.

Recommendation 4

It is recommended that a minimum of 200 TEM grids be counted on each filter and that filters that yield counts >10 fibres in 200 grids have sufficient grids counted until at least 20 fibres have been counted.

I have no experience as to how many grids can be analysed on a single 2 mm x 2 mm grid as used by HSL but I note that sample 15B had 340 grid openings analysed. I also have no experience as to whether the TEM grid samples are robust enough to be transferred to other laboratories for renumbering or analysis.

On completion of the reanalyses the results will be returned to the independent laboratory that will match each result with the original filter number and report the data to the Council.

I consider that the above process should be able to be completed within about 20 working days.

Recommendation 5

As a control measure it is suggested that if the reanalysis results differ significantly from the initial results both the Santia and HSL samples should be reanalysed by a further independent laboratory that is completely unaware of the source of the samples.

As above, I consider that the above process should be able to be completed within a further about 20 working days.

Recommendation 6

If the above analyses indicate a statistically significant difference between the relevant Santia and HSL results it is considered that HSL Series E be re-sampled but a total sample duration of 1 hour with all deliberate disturbance, as described in the HSL report, carried out within the first 5 minutes of the sample period. If greater sensitivity is required, so requiring longer sample durations than 1 hour, the above disturbance regimen should be repeated at the start of every additional 1 hour sampling period.

Recommendation 7

As a scientific study that would provide valuable information on the relationship between Phase Contrast Microscopy (PCM), Polarised Light Microscopy (PLM) and TEM at the fibre levels observed in the School it would be very valuable if one unused quarter of each of HSL's Series E filters, plus two controls were mounted and analysed by PCM by both HSL and Santia and that one further quarter of each of HSL's Series E filters, plus two controls were prepared for, and analysed by, PLM. I understand that First Order Red of Bidworth is accredited for PLM.

I have spoken in confidence with Mr. Steve Sadley of ARCA to see if he would be willing for his laboratory to renumber the PCM samples. He agreed to do so. Mr. Steve Sadley is also seeking information as to an independent laboratory that could handle the TEM samples and/or reanalyse the TEM samples if necessary.

I have also spoken in confidence with Mr. Rob Blackburn to see if he would be willing to oversee the reanalysis procedures. He agreed to do so.

I trust that the above is clear and can act as an outline to obtain the necessary data to permit a scientifically valid conclusion as to the present situation regarding Cwmcarn High School.

I apologise that the above is longer than I would have wished but consider it necessary that all relevant background is available to all those involved.

If you have any queries please do not hesitate to contact me.

Yours truly,

Robin Howie

Fibre count	No of fields counted	Sample volume (l)	Concentration (f/ml)	95% Poisson boundary			
				Fibre count		Concentration (fibres/ml)	
5.5	152	630	0.0029	1.6	11.7	0.00083	0.0061
7	162	592	0.0036	2.8	14.4	0.0015	0.0075
8	630	630	0.0042	3.5	15.8	0.0018	0.0082
9.5	152	630	0.0049	4.1	17.1	0.0021	0.0089
10.5	162	592	0.0054	4.8	18.4	0.0025	0.0095
11	152	630	0.0057	5.5	19.7	0.0029	0.010
11.5	162	592	0.0060	5.5	19.7	0.0029	0.010
12	162	592	0.0062	6.2	21	0.0032	0.011
14	152	630	0.0073	7.7	23.5	0.0040	0.012
15.5	162	592	0.0080	8.4	24.7	0.0044	0.013
mean			0.0054			0.0044	0.0065

TABLE 1a: Santia Reassurance data, from Appendix G

Fibre count	No of fields counted	Sample volume (l)	Concentration (f/ml)	95% Poisson boundary			
				Fibre count		Concentration (fibres/ml)	
5.5	100	80	0.034	1.6	11.7	0.0099	0.073
9.5	100	80	0.059	4.1	17.1	0.025	0.106
11	100	80	0.068	5.5	19.7	0.034	0.122
mean			0.054			0.031	0.069

TABLE 1b: Santia Personal Monitoring data, from Appendix G

Sample No	Room	Sample Series	Fibre count	No grids counted	Sample volume (l)	Concentration (f/ml)
1	179	A	0	179	6691	<0.00019
10	184	C	0	187	2366	<0.00029
12	179	C	0	192	2904	<0.00023
13	201	C	0	281	1578	<0.00029
14	203	C/D	1	208	2192	<0.00045
15A	203	C	0	135	2052	<0.00030
15B	175	C	0	340	1292	<0.00029
16	47	H	0	190	2385	<0.00028
17	Library	G	0	166	1675	<0.00046
18	179	D	0	179	9736	<0.00007
19	201	D	0	150	3290	<0.00026
20	175	D	0	205	2083	<0.00030
21	184	D	0	80	6124	<0.00026
22	203	D	0	115	4091	<0.00027
23	175	E	3	105	992	<0.0032
24	184 (IT)	E	0	90	1210	<0.0012
25	179	E	3	85	1387	<0.0028
26	201	E	10	125	796	0.0047
27	203	E	4	106	954	0.0017

TABLE 2: HSL analysed samples

	Santia Appendix G data					HSL Table 2 data				
	Fibre count	No of fields counted	Nominal fibre concentration (fibres/ml)			Asbestos fibre count	No of grids counted	Nominal fibre concentration (fibres/ml)		
			Observed	95% Poisson boundaries				Observed	95% Poisson boundaries	
1	5.5	152	0.003	0.00083	0.0061	0	90	<0.0004	<0.0004	0.0015
2	7	162	0.003	0.0015	0.0075	3	105	0.0012	0.0002	0.0035
3	8	152	0.004	0.0018	0.0082	3	85	0.0011	0.0002	0.0032
4	9.5	152	0.005	0.0021	0.0089	4	106	0.0017	0.0005	0.0043
5	10.5	162	0.005	0.0025	0.0095	10	125	0.0042	0.0020	0.0077
6	11	152	0.006	0.0029	0.010					
7	11.5	162	0.006	0.0029	0.010					
8	12	162	0.006	0.0032	0.011					
9	14	152	0.007	0.0040	0.012					
10	15.5	162	0.008	0.0044	0.013					
11	mean		0.0053					0.0021*		

TABLE 3: Comparison of Santia Appendix G Reassurance results and HSL Series E results

Note: *zero count result excluded from HSL mean.

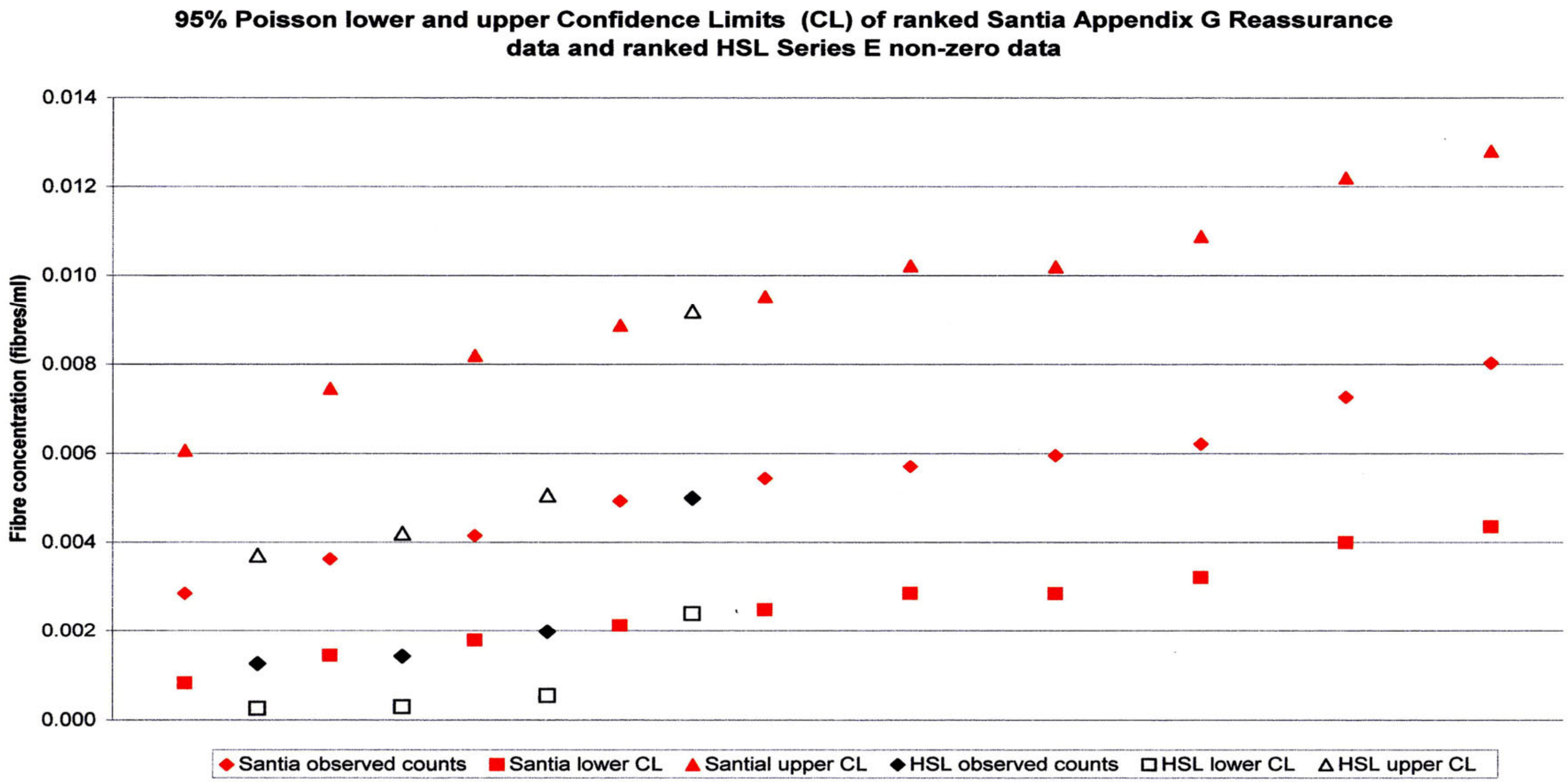

FIGURE 1: 95% Confidence Limits of Santia Appendix G Reassurance data and HSL Series E non-zero data.

Appendix A

<u>DUST DISTURBANCE MECHANISMS IN BUILDING STRUCTURES</u>

It should be appreciated that once dusts have settled onto dry surfaces the main mechanisms that can render some proportion of such dusts airborne is disturbance due to building vibration and the activities of occupants.

Such disturbance can contribute to the day-to-day exposures of building occupants.

Cwmcarn school has capacity for 900+ pupils aged 11-18.

From DES (1972) the average weight of a mixed gender population of 11 to 18 year-olds is about 52 kg. The movement of 900 such children therefore involves the movement of about 45 tonnes of children.

Movement of 45 tonnes of children in a series of short time periods is likely to cause vibration of the building structure.

Such disturbance is likely to be most significant in the two storey block in Building A as movement of children on the upper floor is likely to cause vibration that could potentially disturb the AIB debris in the ceiling voids on both the ground and upper floors.

As the about 1,000 m^2 of the upper storey of the 2-storey block accounts for about $1/6^{th}$ floor area of the school it can be assumed that about 7-8 tonnes of children will be in the upper storey at any time, and so potentially causing disturbance of AIB debris in the ceiling voids in the block at the start and end of each day and break and at period changeovers.

If each school day consists of six teaching periods with two breaks, one in the morning and one at lunchtime, there will be nine series of movements as pupils, enter, transfer between and leave classrooms. If each transfer movement takes about 5 minutes, the total duration of building disturbance will be about 45 minutes each day.

Guidance Note EH10, HSE (1995), states that: "Clearance sampling should be accompanied by activities designed to raise dust from the surfaces at least to a degree appropriate to any possible future activity in the area."

As the object of Reassurance sampling is to assess likely exposures during normal occupation of the building, it is considered that the above guidance from EH10 should be applied when carrying out such sampling.

In the context of settled dusts containing asbestos it is clearly not acceptable to cause or permit unprotected building occupants to deliberately disturb such dusts.

Investigators therefore effectively have three options: sample airborne dusts while the building is under normal occupation - acceptable only if airborne fibre levels are likely to be "low"; sample immediately after normal occupants have left the building; or, in buildings which have not been occupied for some time, cause deliberate disturbance. In the last situation, any deliberate disturbance should as closely as possible reproduce or mimic the disturbance likely during normal building occupation, i.e. as described above in EH10.

Collecting samples for the quantification of airborne concentrations of materials involves drawing air through suitable collection media. In general, the greater the volume of air sampled, the longer the sampling duration.

Air flows through the areas being sampled can dilute any airborne concentrations generated by short-term disturbance.

It is therefore necessary to address wind effects on buildings.

APPENDIX B

WIND EFFECTS ON BUILDINGS AND AIR INFLTRATION

When winds blow over buildings they causes slightly increased air pressures on the upwind sides of the building and slightly reduced air pressures on the down wind sides.

Daly (1978, 1990) provides information which enables the magnitude of the pressures generated by wind flows over buildings to be assessed: see Figure B1 below:

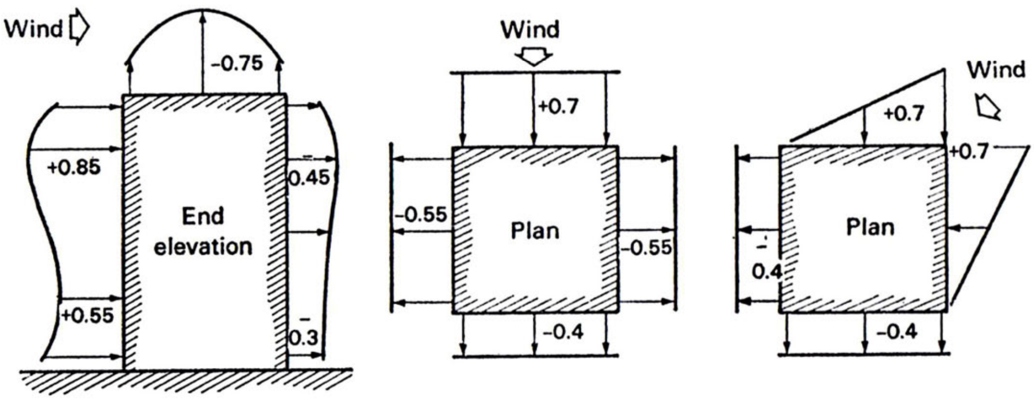

FIGURE B1: Effects of wind flow over buildings, Daly (1979, 1990)

The numbers in Figure B1 are expressed in terms of the Velocity Pressure, which is 0.5 x the density of air x the square of the wind speed at the top of the building, i.e. Velocity Pressure =~0.6 x velocity squared. "+" numbers indicate increased air pressures; "-" numbers indicate reduced air pressures.

The mean wind velocity is South Wales is 5-6 metres per second (m/sec) at 10 metres above ground levels, Lacey (1977). The Velocity pressure generated by such wind speeds is 15-20 Pascals and the maximum pressure difference across the building will be about 30% higher than the Velocity pressure, i.e. about 20-25 Pascals.

Anyone who has had plasterwork carried out in their home will be well aware that fine plaster dust can be carried throughout the house and can cause contamination of surfaces many days after the work has been completed. That is, the plaster dust migrates into areas where no plaster dust was disturbed or generated.

Such migration is driven by pressure differentials across buildings.

These pressure differences across a building can cause air infiltration:

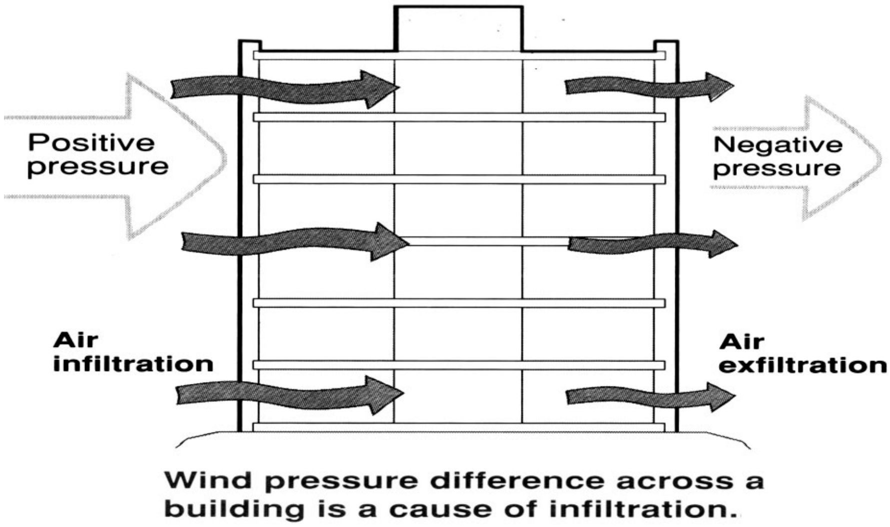

FIGURE B2: Air infiltration, BRE (1994)

BRE (1994) notes that an artificially induced pressure difference of 25 Pascals can induce an infiltration rate of 12 cubic metres per hour for each square metre of exposed wall surface in UK buildings of conventional construction.

The effect of air infiltration on the upwind side of a building and air exfiltration on the downwind side of the building can cause airborne contaminants in the upwind rooms to be spread through the building as air flows into the downwind rooms.

The same mechanism can cause airborne fibres to migrate throughout a building.

Daly (1978, 1990) gives typical infiltration data for common building spaces:

Building or room type	**Air changes per hour**
Large shops, swimming baths, small churches, assembly rooms	0.5
Small shops, restaurants, bars, living rooms, offices	1
Entrance halls, corridors, foyers	1.5
Bathrooms, hospital wards, classrooms	2

Massey et al (1997) comment that an average living room has about 2-4 air changes per hour.

From the above it can be assumed that an average classroom will have an average of about 2-4 air changes/hour.

Such air movements can cause airborne contaminant levels to decline so that airborne contaminant concentrations caused by short term activities can be difficult to measure if the necessary sampling measurement periods are appreciably longer than the duration of the activities which rendered the contaminant of concern airborne.

It is therefore critical to be aware of the magnitude of potential dilution rates when specifying sampling durations and interpreting sample results.

As a first approximation it can be assumed that each air change effectively halves the airborne concentration caused by any short-term process that emits contaminants.

If a situation is considered where 1000 units of airborne contaminant were released into a fixed volume and emission then ceased the airborne concentrations after 1 - 3 hours for various infiltration rates would be as shown below:

Time since cessation of emission (hours)	**Infiltration rate (air changes per hour)**			
	1	**2**	**3**	**4**
1	500	250	125	63
2	250	63	16	4
3	125	16	2	0.25

TABLE B1: Reduction in airborne contaminant concentrations due to air infiltration

The consequences of air infiltration on airborne contaminant concentrations is clear for classrooms with 2-4 air changers per hour: 1 hour after cessation of contaminant emission, airborne contaminant concentrations have declined to 1/4 to 1/16 of the concentrations at the time of emission. Samplers running longer than the duration of emission are therefore highly likely to underestimate the contaminant concentrations emitted - see HSL (2001) for discussion of the effects of fibre deposition and air exchange.

It is therefore essential that Reassurance Samples are taken in conjunction with disturbance representative of that caused by normal occupation.

In the context of a school where the disturbance causing emissions occurs every about 1 hour and the duration of disturbance is about 5 minutes, Reassurance Samples should be accompanied by representative disturbance. Each sample period should include at least one period of emission and sample duration should be restricted to about 1 hour. Longer duration samples should include sufficient full cycles of emission and dilution to achieve the desired sensitivity.

From this author's personal experience it is feasible to use mains powered pumps that achieve about 40 litres/minute through standard 22 mm diameter 1.2 um pore sized filters and so obtain sample volumes over each 1 hour period of about 2.4 m^3.

Such pumps are somewhat noisy but can be used in unoccupied rooms without causing disturbance in neighbouring rooms or be located in adjacent rooms and connected to the sampling heads by suitable tubing. To minimise the noise from the filters vibrating in the sampling heads air smoothers should be fitted into the tubing lines.

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