

*Robin Howie Associates*

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*12, Morningside Road,  
Edinburgh, EH10 4DB,  
Phone + Fax 0131 447 5161  
e-mail robin.howie@btconnect.com  
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**Our Ref:** RMH/03/324

**Mr. W.D. MacDonald,  
Head of Asbestos Policy Division,  
Health and Safety Executive,  
Rosecourt,  
2 Southwark Bridge,  
London, SE1 9HS**

Dear Mr. McDonald,

**Asbestos release from AIB**

Mr. Lees has passed to me copies of HSL Report MF2004/02 and Mark Piney's letter of 20<sup>th</sup> August 2004 regarding the HSL report.

Before discussing the HSL Report and Mark's comments, I think that it is important to consider the situation, as it is likely to arise in a real classroom.

Teachers' potential exposure to airborne amosite fibres from inserting drawing pints into, and removing drawing pins from, AIB could result from one or more of the following components of the process of interest:

***Placing a new drawing on a previously contaminated AIB surface:*** some proportion of any loose asbestos-containing material left on the AIB surface from previous activities could be disturbed and rendered airborne or displaced by either physical contact between the surface and the new drawing and/or the outward air movement caused by placing the new drawing against the contaminated AIB surface. Some such material could further contaminate the AIB surface and/or the back of the drawing.

***Inserting drawing pin into AIB through drawing:*** asbestos-containing material in the form of loose fibres and debris could be displaced from the AIB. Some proportion of such material could be trapped between the drawing and the AIB surface. Some such material could contaminate the AIB surface and/or the back of the drawing.

***Removing drawing pin from AIB:*** asbestos-containing material in the form of loose fibres and debris could again be released, particularly if the pin was allowed to rotate about its longitudinal axis during removal. This rotation will occur if a conventional drawing pin is removed by applying force asymmetrically to its head, as is usual when removing drawing pins. Some proportion of such material could again initially be

trapped between the drawing and the AIB surface. Some such material could contaminate the AIB surface and/or the back of the drawing.

***Removing drawing from AIB surface:*** some proportion of any asbestos-containing material initially trapped between the back of the drawing and the AIB surface could be rendered airborne by the inward rush of air as the drawing is pulled away from the AIB surface and/or allowed to fall during such removal. During such fall, fibres could be released from loose material.

***Handing removed drawing to helper:*** some proportion of any asbestos-containing material on the drawing could be dislodged and rendered airborne as the drawing is bent and moved relative to the ambient air as it is handed to the helper.

***Stacking removed drawings:*** if contaminated drawings are stacked on removal some proportion of any asbestos-containing materials adhering to the drawings could be disturbed and rendered airborne by the relative movement between sheets and air movement caused by sheets being placed together or separated.

It should be noted that a teacher could hand the removed contaminated drawings to a child who could stack the drawings and thus be exposed to any airborne fibres generated by the stacking process.

***Disposal or return of drawings to pupils:*** some proportion of any asbestos-containing material retained on the back of contaminated drawings may be rendered airborne by disposal of the drawings. If the drawings are returned to the pupils, possibly to be taken home and shown to the children's parents, the sorting of the drawings to identify the individual child could render some proportion of any asbestos-containing material on the drawings airborne.

***Disturbance of any asbestos-containing material which has fallen onto the floor or other surfaces:*** such material could be disturbed by the teacher or the children and thus some proportion of this material could be rendered airborne. Such debris could also be disturbed by cleaners or janitorial staff.

Teachers' personal exposures will depend on: the relative position of their breathing zones, faces, hair or clothing to any released asbestos-containing materials; whether gravitational effects are likely to cause released materials to move towards or away from the teachers' breathing zones, faces, hair or clothing; whether air movement is likely to cause released materials to move towards or away from the teachers' breathing zones, faces, hair or clothing; the severity of contamination of faces, hair or clothing; how long the teacher remains in the contaminated classroom; air movement patterns within the classroom; whether the classroom has deliberate extract ventilation or filtered recirculation ventilation etc.

It must be appreciated that any asbestos fibres released into the classroom could also impose a risk on pupils. In addition, further exposures could occur to a child helping the teacher by holding contaminated drawings which have been removed from AIB

surfaces and if contaminated drawings are returned to the children, possibly to be taken home. In the last situation any other items in the school bags could also become contaminated with amosite fibres.

From the above, it will be appreciated that exposure to airborne fibres resulting from the process of sticking drawings onto AIB surfaces could arise from both immediately released fibres and from fibres released from debris. Such exposures are likely to last significantly longer than the actual process of inserting or removing the drawing pins and could occur at any time drawings contaminated with asbestos-containing materials are disturbed or handled. This is particularly relevant in a classroom situation where the teacher and the children may remain in the classroom for an hour or longer after the last disturbance of AIB and where any loose asbestos-containing material which may have fallen onto surfaces could be disturbed by the teachers' or children's movements and circulated by either deliberate air movement, e.g. from fan-assisted heaters, and/or convective forces. In winter or cold or wet weather when windows are likely to be closed, airborne materials may remain in the classroom for extended periods unless the classroom is fitted with extract ventilation or filtered recirculation ventilation.

From the above, I consider that both immediate fibre release and some proportion of bulk debris are of concern and that any useful test must include collection of fibres from both possible sources of contamination.

I therefore repeated my own tests on AIB by using both my Higgins-Dewell cyclone in baby bottle sampler and a Nuclepore conducting plastic cowl with the inlet end cap still fitted and with a piece of 6 mm diameter rubber tube fitted to the inlet end cap.

I appreciate that Mark is concerned that the cyclone may cause debris to be broken up and thus give an overestimate of fibre numbers. However, the role of the baby bottle around the Higgins-Dewell cyclone is to function as a crude vertical elutriator to minimise the possibility of large pieces of debris being drawn into the cyclone and there blocking either the inlet or conical section or causing the debris to break-up in the cone. The baby bottle used gives a nominal cut at about 20 um unit density sphere (UDS). Note that the Higgins-Dewell cyclone in normal use is fitted with a sleeve which functions as a vertical elutriator with a cut at about 34 um UDS. The baby bottle was selected to give a smaller cut size to minimise the entry of large debris, such as carpet fluff from micro-vacuuming, into the cyclone. Oversize debris is collected in the bottle.

The tests were carried out on the top surface of a horizontal sample of unpainted AIB. I carried out five tests, three with the cyclone and two with the Nuclepore cowl.

Samples were taken as below:

- ML01/04, cyclone, 75 well separated holes
- ML02/04, cyclone, 25 holes within a 25 mm square
- ML03/04, cowl, 75 well separated holes

ML04/04, cowl, 25 holes within a 25 mm square

As previously, I used a poster pin rather than a drawing pin in these tests. The poster pin used is shown in Figure 1. As the poster pin is sharper than a drawing pin and easier to withdraw without rotation around its longitudinal axis, I therefore consider it likely that fewer fibres would have been released than if ordinary drawing pins had been used. The poster pin was inserted 7-8 mm into the AIB, equivalent to leaving the pin head about 1-2 mm proud of the surface to enable easier removal than if the pin was fully inserted.

I had originally intended to take two further samples, one each with the cyclone and the cowl but with both 75 well separated holes and 25 holes within a 25 mm square, but had access to sufficient clean undamaged AIB to permit only one further test. I had observed that the previous tests had generated significant amounts of debris which had not been collected by either the cyclone or cowl inlet tubes – see Figure 2. I therefore took one further sample only, ML05/04, using the cyclone in bottle sampler, with 75 well separated holes, 25 holes within a 25 mm square and debris from all tests.

The extensive quantity of oversize loose debris retained in the bottle is shown in Figure 3. This debris was very friable and easily broken up between the fingers.

The sampling filters were analysed by an accredited laboratory.

The results obtained are shown below:

Sample No.	Sampler	Activity	Total fibre release	Fibre release/hole
ML01/04	Cyclone	75 well separated holes	256,850	~3,400
ML02/04	Cyclone	25 holes within 25 mm square	198,900	~8,000
ML01 + ML02			455,650	~4,500
ML03/04	Cowl	75 well separated holes	96,219	~1,300
ML04/04	Cowl	25 holes within 25 mm square	92,243	~3,700
ML03 + ML04			188,462	~1,900
ML05/04*	Cyclone	75 well separated holes, 25 holes within 25 mm square and all debris from all tests	~2,500,000	

Note \*The laboratory was asked to give an estimate for this sample outwith its accreditation as the sample was too dense to count and had too much

obscuration by non-fibrous particulates. The laboratory estimated a density of about 50 fibres per graticule.

If you wish, I can let you have the mounted slides for the five above samples. The summations of ML01/04 and ML02/04 and ML03/04 and ML04/04 were calculated to permit comparison with the previous result. The summation ML01/04 and ML02/04 for the cyclone was about 2/3<sup>rds</sup> that previously obtained and the cowl summation gave about 1/3<sup>rd</sup> the count with the recent cyclone test.

The higher counts with the cyclone as against the cowl are expected, e.g. see Howie (1998).

If it is assumed for sample ML05/04 that the 100 holes formed gave about 500,000 fibres, i.e. the summation of ML01/04 and ML02/04, the overall result suggests that each set of 100 holes had formed debris from which about an additional 600,000 fibres could be released.

In my opinion, the above test results underline the critical importance of regarding the debris as a potent source of potential release of respirable amosite fibres.

I will now address the HSL report.

From HSL Table 1 there appears to be substantial differences between the HSL cyclone in bottle sampler results and my own initial result. This cannot immediately be explained, particularly as the HSL results with the same sampler in Table 2 is substantially higher for both the cyclone in bottle and cowl samples and in line with my own corresponding tests.

The Vacuuming test results from HSL Table 2 and myself are summarised below:

<b>Sampler</b>	<b>Result source</b>	<b>Hole spacing</b>	<b>Fibres/hole</b>
Cyclone in bottle	RHA	75 well spaced + 25 closely spaced	~6,500
	RHA	75 well spaced	~3,400
	RHA	25 closely spaced	~8,000
	HSL	100 well spaced	~5,900
Modified cowl	RHA	75 well spaced	~1,300
	RHA	25 closely spaced	~3,700
	HSL	100 well spaced	~1,300

It is considered that the above sets of results show adequate internal consistency to be acceptable, particularly when the effects of hole spacing are taken into account.

There are a number of aspects of the HSL report which cause me concern.

In attempting to interpret the results in HSL Table 2 covered by notes (c) and (d) it should be appreciated that there was a downward airflow of <0.1 m/sec throughout all of the tests. Any results obtained with samplers positioned about 50 centimetres from the board were therefore effectively in clean air as it is difficult to appreciate how fibres released from a low energy process could travel across a deliberately uniform airflow without being deflected by that airflow.

In attempting to interpret the result for sample 08417/03 it is necessary to appreciate that there was an airflow through the chamber of at least 0.05 m<sup>3</sup>/sec, from footnote on page 5. That is, an airflow of at least 3,000 litres/min. Clearly, some proportion of any fibres released from the underside of the board would not have been drawn into the cowl sampler. It is therefore not possible to interpret the result for this sample unless it is known what proportion of released fibres was collected by the sampler.

I question the relevance of carrying out tests on the upper surface of an AIB sample using a sampler which is unlikely to collect loose, friable debris – see below discussion on Mark's Section 3.1.2. Also, given my above assessment of the possible processes by which fibres may be released from the use of drawing pins on AIB and my assessment of the importance of ensuring that any tests take due account of the importance of debris as a potential source of further airborne respirable amosite fibres, I consider that none of the HSL tests, other than the vacuum tests, adequately address the potential hazard sources.

As an aside, Graham comments that the cyclone should have been operated at 2.2 litres/min rather than 1.9 litres/min.

I deliberately operate the cyclone at the original flow rate of 1.9 l/min to give a 50% cut at 5 µm UDS to minimise loss of the larger diameter amosite fibres in the cyclone. Theoretically, about 20% and 5% of 1 µm and 0.5 µm diameter amosite fibres respectively should fail to penetrate the cyclone at this flow rate. As these are likely sizes for amosite fibres from AIB, operating the cyclone at higher flow rates may cause even higher fibre losses than calculated for 1.9 litre/min.

Mark makes a number of comments in his letter with which I have concern.

In his Section 3.1.2 he comments that the air velocity through the modified cowl would be about 6 m/sec and about 0.6 m/sec at 2.5 centimetres in front of the cowl and would thus have about 100% efficiency at the point of the pin when 25 mm in front of the cowl.

From my understanding the first paragraph of Section 2.3 of the HSL report, all the results in HSL Table 3 were obtained at a flow rate of 11 litres/min, i.e. at a flow rate of about 183 ml/sec. Assuming that the effective internal diameter of the cowl was 22 mm, not 25 mm shown in HSL Figure 3, the velocity inside the cowl would have been about 0.48 m/sec. From ACGIH (1998), the flow rate at 50% of diameter in front of a plain pipe opening would be about 30% of that in the pipe and at 100% of diameter about 7.5%. In the case of the HSL tests, the velocity at 12.5 mm in front of the cowl

would have been about 0.14 m/sec and at 25 mm in front of the cowl about 0.036 m/sec.

I accept that with the point of the pin at 12.5 mm from the cowl entry, the efficiency for individual fibres released at low velocity may have been close to 100% but would expect efficiency for loose debris sitting on the surface of the AIB to be low. With the point of the pin 25 mm from the cowl entry, and a flow velocity of 0.036 m/sec at the point of the pin, I would expect the efficiency for individual fibres to be affected by the downward flow of air in the test chamber and to be well below 100%. I would also expect the efficiency for collecting loose debris 25 mm from the cowl inlet to be much lower than when 12.5 mm in front of the cowl inlet.

I therefore do not consider that the sampling efficiency would have been adequate in the HSL tests whose results are shown in Table 3 other than for individual fibres when the point of the pin was 12.5 mm in front of the cowl. I also consider that for all such tests the efficiency for loose debris on the surface of the AIB would have been inadequate to give useful results.

In his Section 4.2 Mark considers that the cyclone in bottle sampler would give unrealistic results.

Given the function of the bottle around the cyclone as a simple vertical elutriator, I do not accept that the vacuuming results obtained are an artefact of the sampling technique, particularly given HSL's results for vacuuming with a modified cowl, 1,284 fibres per well spaced hole, sample No 08387/03, and my own similar modified cowl results of about 1,300 fibres per well spaced hole, sample No. ML03/04.

As noted above, my own opinion is that the loose debris is a significant source of potential exposure in the real-world situation.

I therefore do not accept Mark's implied premise that fibres from debris can be ignored.

In his Section 6.0 Mark cites two headmistresses' comments and his own and his wife's recollection that classroom displays in primary schools are changed every term and in the case of infant classes every half term.

My wife was primary school teacher for about 7 years. Her schools had no display boards. Her displays were stuck onto the walls using sellotape. She reckons that while there were items on display for a full term, she would have put up other items on an about weekly basis.

My son is a senior primary school teacher. He generally has three display boards on two of which some material is changed about monthly. The displays on the other board are changed more often. He also puts work onto the walls. These displays are changed on a regular basis. He uses a staple gun to put displays onto the walls.

I would therefore expect a good teacher, particularly in an infant department or kindergarten, to change displays on at least a weekly basis.

In his discussion of risk from environmental fibres, Mark uses only the term “asbestos” although the topic being addressed herein is AIB, from which any fibres released are explicitly amosite. This is critically important as Hodgson and Darnton (2000) consider that for a given exposure, compared with chrysotile; amosite is 10-50 times more potent for causing asbestos-induced lung cancer and 100 times more potent for causing mesothelioma.

It would be more correct if Mark were to compare realistic amosite fibre levels in the classroom with general environmental amosite fibre levels.

Mark also discusses concentrations as if all fibres were uniformly dispersed into the classroom. However, the immediate concern is teachers’ exposures where the teachers are, by definition, within arms length of the source, may have their clothing or hair contaminated with debris containing amosite and are potentially handling materials which may have been contaminated with amosite fibres or friable debris containing such fibres.

From the above you will appreciate that I am critically concerned about both the validity of the experimental techniques adopted in the HSL study and Mark’s interpretation of the results from this study.

I consider that any risk assessments based on estimation of additional risks arising from exposure to asbestos in schools for teachers, other school personnel and children should be assessed against the “tolerable” and “acceptable” excess death rates respectively of 10 and 1 per million exposed persons per annum discussed in HSE (1992). My own preference is that the above risks should be assessed against the “acceptability” criterion.

I consider that this topic is too important to leave to abstract sniping about different test methods and interpretations and should be discussed around the table so that all opinions can be considered and a mutually acceptable way forward agreed: it helps non-one, particularly teachers and children, if this topic is not settled correctly and quickly.

I therefore suggest that it would be valuable to have a meeting to thoroughly discuss this subject, to agree the potential sources of hazards, to agree scientifically valid laboratory tests to attempt to quantify the potential consequences of AIB disturbance in classrooms taking account of all relevant potential sources of hazards and to agree how the results of such tests should be interpreted and presented.

I would be very happy to attend such a meeting at any mutually suitable venue and date.

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I further suggest that such a meeting should be organised as quickly as possible and that the HSL report should be embargoed from further distribution until the validity of its content has been clarified and agreed.

If have any queries regarding the above, please do not hesitate to contact me.

Yours truly,

Robin Howie

Copy: Mr. Michael Lees



*FIGURE 1: Poster pin used in fibre release experiments, on clean AIB surface*



*FIGURE 2: Debris on AIB around poster pin holes*



*FIGURE 3: Oversize AIB debris from 300 holes from bottle around cyclone*

**REFERENCES**

American Conference of Governmental Industrial Hygienists (1998) Industrial Ventilation. 23<sup>rd</sup> Edition (Metric Version). ACGIH: Cincinnati.

Health and Safety Executive (1992) The tolerability of risk from nuclear power stations. HMSO: London.

Hodgson JT and Darnton A (2000) Quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure. *Annals of Occupational Hygiene*, **44**: 565-602.

Howie RM (1998) Undersampling of airborne asbestos fibres by standard cowls. In: Abstracts of BOHS Conference 1998. BOHS: Derby.