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ASSESSMENT OF THE SCIENTIFIC VALIDITY OF THE HEALTH AND SAFETY COMMISSION'S PROPOSAL TO EXCLUDE THE REMOVAL OF TEXTURED DECORATIVE COATINGS CONTAINING ASBESTOS FROM LICENSED ACTIVITIES

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EXECUTIVE SUMMARY

It is considered essential that any study undertaken to assess the risks associated with the removal of textured decorative coatings should address all groups of persons potentially at risk.

The HSL study failed to address the risks associated with exposures to asbestos which may have contaminated areas outside the asbestos enclosures.

It is considered that the measurement data from the HSL study should be assessed in terms of actual airborne fibre concentrations rather than in terms of time-weighted average airborne fibre concentrations.

As the proposed regulations specify that samples for airborne asbestos fibres shall be counted using the WHO rules, this author is puzzled that the HSL report assessed compliance of ERM counts against a Control Limit defined in terms of WHO counts.

About half of the measured personal airborne fibre concentrations, from the observed relationship between ERM and WHO counting rules, equalled or exceeded the proposed Control Limit concentration of 0.1 fibres/ml by WHO counting rules and about two thirds exceeded half the Control Limit concentration.

It is considered that the failure by HSL to address the effect of the study biasing the results "towards best practice" casts doubt on the validity of the measurement results obtained as being representative of likely real-world exposures.

From the HSL study report it is considered that the range of textured coatings removed during the study was too limited to permit a full assessment of the likely risks associated with textured coating removal. Any conclusions derived from the study results can therefore only be applied to the coating types and removal techniques observed.

No measurements were made during the HSL study to determine whether there had been spread of asbestos contamination to outside the enclosures and no measurements were made of airborne asbestos fibre concentrations at the location of demolished enclosures.

It is considered that the failure to address the potential for asbestos contamination generated by the removal of textured decorative coatings to spread into areas occupied by unprotected adults and/or children is a critical omission from the HSL study.

It is considered that estimating risk at the mean would result in a significant proportion of the exposed population being exposed to a higher risk than at the mean exposure.

It is considered that asbestos risk estimates should be based on protecting 85-95% of exposed persons.

It is considered that the HSL risk estimate is based on an inadequate assessment of asbestos operatives' personal exposures.

It is considered that the HSC (2005) data are likely to suggest a shorter service in the asbestos removal industry than is correct and that a risk estimate based on such assumption severely underestimates the mesothelioma risk to asbestos operatives.

It is considered that the mesothelioma risk estimate for asbestos operatives should be based on the assumption of an entry age into the asbestos removal industry of 20 and a likely service of at least 20 years. Such an age at first exposure and service combination would give a likely excess death risk of 146 per million exposed operatives.

It is considered that annual risk should be calculated by dividing total risk by the duration of exposure rather than by the survival period.

From the HSL exposure estimate of 0.08 fibres/ml and the calculation of annual risk on the basis of exposure duration the average risk is about 12 per million per annum during the first 5 years of exposure from age 20.

It is considered that criteria for both annual risk and total cumulative risk should be set. In terms of a "tolerable" annual risk of 10 per million per annum the limiting total cumulative risk over 20 years would be a risk of 200 per million.

It is considered than a risk of about 12 per million per annum is excessive and that such risk signals a requirement for more stringent controls of exposure than were observed during the HSL study.

It is considered that unless it can be demonstrated that exposures of residents to asbestos resulting from the removal of textured coating from domestic premises can be reliably maintained below a cumulative exposure of a cumulative exposure of 0.0002 fibres/ml.years over about 7,300 hours per year, the stringency of controls applied to the removal of textured coatings should be increased rather than decreased as proposed by HSC (2005).

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1 INTRODUCTION

The Health and Safety Commission (HSC) proposes to allow work with textured decorative coatings containing asbestos to be carried out by unlicensed contractors in enclosures not fitted with negative pressure units and without the requirement for clearance inspection and sampling before the enclosure is demolished, HSC (2005).

This proposal is nominally predicated on a study undertaken by the Health and Safety Laboratories (HSL) to determine the airborne asbestos fibre levels generated during such activities and on a risk assessment based the findings of this study, HSL (2005).

Robin Howie Associates has been instructed by the Asbestos Removal Contractors' Association (ARCA) to assess the scientific validity of the HSL study and of the risk assessment based on this study as the foundation of HSC's proposals for work with textured decorative coatings.

In any such assessment it is necessary to identify those who may be at risk from the process of concern and to assess the validity of the exposure data and risk assessment to ensure that the risk to all such individuals has been adequately identified and quantified.

This author's qualifications for undertaking such assessment are summarised in Section 6 of this report.

2 IDENTIFICATION OF THOSE WHO MAY BE AT RISK FROM THE REMOVAL OF TEXTURED COATINGS CONTAINING ASBESTOS

The removal of any asbestos-containing materials (ACM) may put two critical groups of individuals at risk: 1) removal contractors' operatives; and, 2) occupants of areas or buildings from which ACM has been removed.

It should be stressed that cleaning and maintenance personnel who work in areas, which may be contaminated with asbestos caused by the removal or disturbance of ACM, are also likely to be at risk. However, such risks will not be considered herein as, in many cases, those cleaning domestic premises will also be residents in the same premises.

Removal contractors' operatives should be protected by their methods of work, their respiratory protective equipment (RPE) and their personal decontamination procedures.

Occupants of areas or buildings from which ACM have been removed or who may occupy areas which may have been contaminated by asbestos from the removal process, e.g. by leakage from inadequate enclosures, by the passage of inadequately sealed debris containing asbestos or by the passage of asbestos contractors' operatives transiting from stripping enclosures, may be unaware that they are at risk of inhaling asbestos fibres and are unlikely to wear RPE. In addition, as occupants in residential properties, who may include young children, are likely to spend upwards of 12 hours a day, ~350 days a year in their homes, such persons may be at particular risk from the effects of age and/or extended duration of exposure – see Section 5.2.2 below.

It is considered essential that any study undertaken to assess the risks associated with the removal of textured decorative coatings should address all groups of persons potentially at risk.

In assessing whether the HSL study addressed the potential risks associated with the removal of textured decorative coatings for all three above groups, it is necessary to examine in outline the design of the study.

3 OUTLINE DESCRIPTION OF HSL STUDY

A full description of the HSL study is given in HSL Report No. HSL/2005/32, HSL (2005).

All removal work studied was undertaken by licensed contractors' operatives working in full asbestos enclosures fitted with negative pressure extraction units.

Airborne asbestos fibre concentrations were measured at 35 sites at which textured decorative coatings were being removed from domestic premises due to insurance claims having been made as a consequence of coatings having been damaged by water (23 sites), fire (1 site), subsidence (3 sites) or unspecified (8 sites).

At 30 sites the textured coatings were removed complete with the underlying surface. At 5 sites the textured coatings were scraped off leaving the underlying surface undamaged.

Many of the operations were dusty, and such dust could have included calcium sulphate fibres from underlying plaster surfaces, which would be counted using the normal fibre counting rules. However, as such fibres are not known to cause adverse health effects, the inclusion of such fibres in the analysis result would give an incorrect, exaggerated, measure of exposure.

HSL therefore developed a technique to remove the calcium sulphate fibres and applied such technique to the majority of the samples collected during the study.

HSL determined the relationship between the WHO and current European Reference Method (ERM) counting rules.

The HSL study measured only the exposure of asbestos operatives carrying out work with textured decorative coatings. That is, no measurements were made to assess whether there had been any release of asbestos contamination into any areas of the domestic premises studied which were subsequently likely to be occupied by residents.

The HSL study failed to address the risks associated with exposures to asbestos which may have contaminated areas outside the asbestos enclosures.

4 OUTLINE OF HSL STUDY RESULTS

As noted above HSL developed and applied a technique to exclude calcium sulphate fibre from the fibre analysis results. As the concern is about exposure to airborne chrysotile fibres rather than to calcium sulphate fibres, the following summary refers to the HSL results for "treated filters" only, i.e. results for filters treated to remove calcium sulphate fibres.

Results for treated samples were reported for 107 samples, of which 99 were from personal samplers worn by operatives and 8 were from static samplers. Statistically the static sampler counts were lower than the personal samplers. Consequently the results for the static samplers have been ignored herein.

All of the samples were analysed used the current ERM counting rules and a proportion were also analysed using the WHO counting rules. In an examination of the relationship between ERM and WHO results for the same filters, HSL concluded that application of the WHO rules on average doubled the number of fibres counted in this study counted using the ERM rules.

As the proposed regulations specify that samples for airborne asbestos fibres shall be counted using the WHO rules, this author is puzzled that the HSL report assessed compliance of ERM counts against a Control Limit defined in terms of WHO counts.

All subsequent analysis of the HSL results herein will be based on the assumption that WHO counts are twice those of the reported ERM counts.

HSL analysed 28 samples using a transmission electron microscope (TEM). This instrument permits asbestos fibres to be differentiated from non-asbestos fibres.

In assessing the acceptability, or otherwise, of airborne fibre concentrations it is necessary to appreciate that regulation 11 of the proposed Regulations requires that exposures to asbestos are reduced to "… the lowest level reasonably practicable by measures other than by the use of respiratory protective equipment …" That is, even if personal exposures to asbestos do not exceed the 0.1 fibres/ml Control Limit, the employer has not met his duty under either the current or proposed Regulations unless airborne fibre concentrations have been further reduced to as low as is reasonably practicable.

The above Control Limit relates to the time-weighted average concentration over a 4-hour reference period. However, most competent occupational hygienists tend to assess risk in terms of actual airborne concentrations over the measurement period rather than calculating the time-weighted average as this gives a better indication as to whether the process concerned is adequately controlled; particularly in the case of tasks lasting less than the relevant reference period. In addition, the actual airborne concentration over the measurement period allows the hygienist to assess the consequences of different exposure periods.

It is considered that the measurement data from the HSL study should be assessed in terms of actual airborne fibre concentrations rather than in terms of time-weighted average airborne fibre concentrations.

The HSL assumed WHO airborne fibre concentrations from personal samplers are summarised below:

	As observed with ERM counting rules	**As assumed with WHO counting rules**
Mean concentration (fibres/ml)	0.104	0.2
Standard deviation	0.18	0.2
No. results >0.1 fibres/ml	31	52
No. results >0.05 fibres/ml	52	66

From the above it can be seen that 52 (53%) of the measured airborne fibre concentrations equalled or exceeded the proposed Control Limit of 0.1 fibres/ml and that 66 (67%) exceeded or equalled 0.05 fibres/ml.

About half of the measured personal airborne fibre concentrations, from the observed relationship between ERM and WHO counting rules, equalled or exceeded the proposed Control Limit concentration of 0.1 fibres/ml by WHO counting rules and about two thirds exceeded half the Control Limit concentration.

5 ASSESSMENT OF ANY LIMITATIONS OF THE HSL STUDY

Possible limitations of the HSL study were assessed from three aspects:

1) Assessment of the scientific validity of the study design;

2) Assessment of the scientific validity of the study results;

3) Assessment of the scientific validity of HSL's risk assessment.

5.1 Assessment of the scientific validity of the study design

This author has three major concerns about the validity of the design of the HSL study:

1) Were the working conditions monitored representative of contemporary "real world" conditions?

2) Did the study cover the major likely types of textured coating removal activities?

3) The failure to address the potential for removal of textured coatings to expose persons other than removal operatives to asbestos.

These concerns are addressed below.

5.1.1 Were the working conditions monitored representative of contemporary "real world" conditions?

In assessing the risks likely to arise from the day-to-day removal of textured coatings containing asbestos it must be appreciated that the presence of investigators in a workplace could cause contractors and/or the contractors' operatives to modify their behaviour, particularly so, if the observers included HSL/HSE personnel or if HSE were to be made aware of the contractors whose employees were being studied.

Given HSE's role as the enforcer of the Control of Asbestos at Work Regulations etc. and the enforcement actions routinely instigated against asbestos removal contractors by the HSE, it can be anticipated that many contractors would be likely to ensure that the requirements and recommendations of the relevant Regulations, Approved Codes of Practice and Guidance were fully complied with. Recognition of such effect can be seen from paragraph A72 of HSC (2005) which comments regarding available exposure data for asbestos operatives that: "As it was likely the measurements were biased towards best practice, as HSE/HSL or other monitoring personnel were on site during the work … "

As an analogy, it must be wondered how many drivers would drive as they usually drive if they had an on-duty police sergeant in the passenger seat.

HSL (2005) identifies both the site occupiers and the licensed contractors who were undertaking the work studied. It is therefore evident that no attempt was made by HSL to minimise any such modification of behaviour, e.g. by giving the licensed contractors whose work was being monitored an undertaking that their identities, their clients' identities and the identity of the sites on which the study was undertaken would be withheld from the HSE.

It should be stressed that in the early 1990s this author designed and led a major HSE funded study into the performance of respirators during asbestos removal operations, Howie et al (1996). A secondary object of this study was to determine likely day-to-day working conditions during such operations. To ensure that any results obtained would be as little contaminated as possible by any “HSE observer effect” it was agreed with the HSE that site work would not be undertaken at any asbestos removal site recently visited by the HSE, that no HSE personnel would by present during any site work and that the identities of the contractors, clients and operatives would not be revealed to HSE. With the exception of a preliminary site at which methodology was developed, the above agreement was applied to all site work from which reported results were obtained. Although it cannot be proven that any observer effect was avoided, it was considered that, given the very high ambient airborne fibre levels observed, up to about 1,000 fibres/ml of crocidolite (“blue asbestos”) and amosite (brown asbestos”) and the poor working techniques observed, such as the application of power tools to dry and inadequately wetted crocidolite, any such effect was unlikely to have significantly affected the results obtained.

It is considered that the failure by HSL to address the effect of the study biasing the results “towards best practice” casts doubt on the validity of the measurement results obtained as being representative of likely real-world exposures.

5.1.2 Did the study cover the major likely types of textured coating removal activities?

Textured coatings containing asbestos were applied to a number of different underlying surfaces, such as plasterboard, lath and plaster, Asbestos Insulating Board (AIB) and cement, concrete, brickwork or stonework. In addition, the removal techniques can include removal of the underlying surfaces complete with the textured coatings, e.g. plasterboard with the textured coating still adhering, the careful removal of thoroughly wetted textured coating using manual methods and power sanding of dry coatings. From anecdotal information, some licensed contractors routinely apply the last removal method.

It is considered the HSL study should have ensured investigation of the removal of textured coatings from a range of likely underlying surfaces and using a range of likely removal techniques.

However the HSL study primarily monitored airborne asbestos fibre concentrations during the removal of textured coatings from plasterboard and lath and plaster with, at the majority of sites, (30 sites out of 35), the textured coating being removed with the complete underlying surface. No monitoring was carried out during the removal of textured coatings from cement, concrete or brickwork.

It is understood that textured coatings applied to hard surfaces, such as cement or brick, is common in commercial and industrial buildings.

It is important to put the importance of the underlying surfaces and the removal techniques adopted into the context of likely airborne asbestos fibre concentrations.

The volume of a 1 mm thickness of coating on 1 square metre of surface is 1 litre. Assuming a specific density of about 2, 1 litre of coating would weight about 2 kg. As the asbestos content of such coatings is generally about 1-5% by weight of chrysotile, each litre of coating would contain about 20-100 grams of chrysotile. Assuming a typical average textured coating thickness of about 3 mm, removing the textured coating from a 15-m2 surface will generate about 90 kg of debris (ignoring any wetting agent or other substance added to the coating to minimise dust generation) containing about 900-4,500 grams of chrysotile.

It will therefore be appreciated that removing decorative textured coatings from “hard” surfaces has the potential for generating significantly higher airborne asbestos fibre concentrations than removing a similar coating complete with the underlying surface, particularly so as the coating itself is difficult to wet and it is unlikely that sufficient water could seep through the hard surface to wet the coating from behind.

From the study report it is considered that the range of textured coatings removed during the study was too limited to permit a full assessment of the likely risks associated with textured coating removal. Any conclusions derived from the study results can therefore only be applied to the coating types and removal techniques observed.

5.2.3 The failure to address the potential for removal of textured coatings to expose persons other than removal operatives to asbestos

Unless an asbestos working area is thoroughly decontaminated before removal of its asbestos enclosure, any persons who subsequently enter such area may be exposed to asbestos. In addition, any asbestos fibres released from inadequately decontaminated operatives, materials or equipment leaving the enclosure can contaminate areas which may be occupied by unprotected persons. For example, Howie et al (1996) observed up to about 10 fibres/ml in a public area through which operatives had transited from an asbestos enclosure. It should be noted that the operatives concerned had carried out preliminary decontamination procedures before leaving the enclosure and had worn new hooded overalls when transiting.

There is therefore a potential for unprotected persons who spend time in the vicinity of an enclosure during work with asbestos, or who spend time in the vicinity of an area which previously contained an asbestos enclosure, to be exposed to airborne asbestos.

No measurements were made during the HSL study to determine whether there had been spread of asbestos contamination to outside the enclosures and no measurements were made of airborne asbestos fibre concentrations at the location of demolished enclosures.

HSC (2002) considered that about 2 million industrial or commercial buildings and about 2.4 million domestic premises in Great Britain still contain asbestos. Some proportion of such premises may contain textured decorative coatings containing asbestos. Those at risk from asbestos fibres released into buildings will therefore include adults who work in these about 2 million industrial and commercial buildings and adults and children who live these about 2.4 million domestic premises.

It is considered that the failure to address the potential for asbestos contamination generated by the removal of textured decorative coatings to spread into areas occupied by unprotected adults and/or children is a critical omission from the HSL study.

5.2 Assessment of the scientific validity of HSL's risk assessment.

Given the concerns about risks arising from the removal of textured coatings to asbestos removal operatives carrying out the removals and to residents in the buildings from which the coatings have been removed, it is necessary to assess the validity of the HSL risk assessment for these three groups.

5.2.1 Assessment of risk to asbestos removal operatives

From paragraph 28 of Annex E(ii) of HSC (2005) the risk assessment was based on:

1) The arithmetic mean exposure;
2) The age first exposed and survival;
3) The frequency and duration of exposure;
4) The type of asbestos released.

For the purposes of the risk assessment HSL assumed that the mean exposure to asbestos operatives during the removal of textured coatings was 0.08 fibres/ml over a 5-year period from age 30.

From the Hodgson and Darnton (2000) model these above inputs gave a total mesothelioma risk of 28 excess deaths per million assuming that no respiratory protective equipment was used.

HSL assessed the annual excess death by dividing the total excess death risk, 28 per million by the assumed survival period, 50 years, to give an excess death risk of 0.6 per million per annum.

This excess death risk was then compared with figure against the criterion of 1 excess death per million per annum which has been deemed by HSE to be the boundary between "acceptable" and tolerable" risk, HSE (2001).

It is necessary to assess the validity of some of the above assumptions.

Use of arithmetic mean exposure in risk estimates

Assuming that the figure of 0.08 fibres/ml is valid for operatives' annual mean exposure during the removal of textured coatings, it must be recognised that about half the operatives will have an exposure higher than the mean and about half lower than the mean.

It is considered that estimating risk at the mean would result in a significant proportion of the exposed population being exposed to a higher risk than at the mean exposure.

Although no definite figure is generally accepted as the basis for determining risk, it is useful to appreciate that respiratory protective equipment is selected on the basis of protecting 95% of wearers for the given use situation and that HSE guidance suggests selecting hearing protectors on the basis of protecting about 84% of wearers.

It is considered that asbestos risk estimates should be based on protecting 85-95% of exposed persons.

The statistical distribution of the HSL results from ERM analysis of treated filters from personal samplers gives a 95^{th} percentile of 0.32 fibres/ml, a 90^{th} percentile of 0.22 fibres/ml and an 85^{th} percentile of 0.19 fibres/ml. Assuming that WHO analysis would double the analysis results, the respective WHO results would be 0.64, 0.44 and 0.38 fibres/ml, as against an assumed long-term time-weighted average exposure of 0.08 fibres/ml based on ERM results.

It is considered that the HSL risk estimate is based on an inadequate assessment of asbestos operatives' personal exposures.

The age first exposed and duration of exposure

The HSL risk assessment is based an analysis of information on asbestos-related medical examinations which show that asbestos workers work in the industry for an average of 3.09 years, that 71.5% of such workers only have one medical, i.e. work for less than 2 years in the industry, and that the average age at the first medical is 32, (from paragraph 36 of Annex E(ii) of HSC (2005)).

For the purposes of the risk estimate HSL assumed that operatives would be exposed for 5 years from age 30.

To check the validity of the HSE data on age and service of operatives in the asbestos removal industry, ARCA contacted all of its member companies requesting the relevant information for all of their medically registered operatives.

Eighty-five member companies employing 1,060 operatives responded to the request. These responses represent 55% of member companies. Age data were available for 1,054 of the above operatives.

The age information for 1,054 operatives and service data for 1,060 operatives are summarised overleaf:

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Age data for 1,054 ARCA members' operatives in 2005

Age range	Mean age (sd)	Mean age at first medical (sd)	Age (years) and number [percentage] of operatives in defined age band					
			SB19	SB24	SB29	EC35	EC40	EC45
17 - 67	38 (8.1)	28.8 (8.3)	14 [1.3]	127 [12.0]	266 [25.2]	404 [38.3]	507 [48.1]	770 [73.1]

From the above age data, about 25% of ARCA members' medically examined asbestos operatives are aged under 30 and 12% are aged under 25.

Service in industry (years) data for 1,060 ARCA members' operatives in 2005

Service range	Mean [sd]	Number [percentage] of operatives in defined service band					
		EC2	EC5	EC10	EC15	EC20	EC25
0-40 years	8.0 [7.3]	879 (82.9)	594 (56.0)	363 (34.2)	229 (21.6)	117 (11.0)	39 (3.7)

From the above service data 56% of currently serving ARCA members' medically examined asbestos operatives have over 5 years service in the industry.

It is relevant to compare the HSL and ARCA members' operatives' data on duration of service in the asbestos removal industry. A summary comparison is shown below:

Comparison of HSL and ARCA data on operatives' duration of service in the asbestos removal industry

Data Source	Mean service (years)	Percentage of operatives with:	
		1 medical only	EC2 medicals
HSL	3.09	71.5	~10
ARCA	7.6	17.1	82.9

From the above comparison a substantial proportion of ARCA members' operatives have served for longer in the asbestos removal industry than is assumed in the HSL mesothelioma risk estimate, and, that although the mean ages at the time of the operatives' first medical were very similar in the HSE and ARCA data bases, a significant proportion of ARCA members' current operatives are aged below 30, ie. about 24% below age 30 and about 10% below age 25.

It is relevant to consider why these two data sources give such different results.

One possible source of difference is that the HSE data may be an analysis of the total number of operatives who have had medical examinations over the past 14 years whereas the ARCA data are a "snapshot" of the age distribution at present.

HSC (1998) considered that at that time about 5,500 asbestos operatives would require to have respirator face fit tests whereas HSC (2005) suggests that are currently about 9,000 asbestos operatives. If both figures are correct, that means that the difference between these two figures, about 3,500 operatives, have, by definition, less than about 6 years experience in the industry. HSC (1998) also considered that the annual turnover in the industry is about 20%.

It is considered that the HSC (2005) data are likely to suggest a shorter service in the asbestos removal industry than is correct and that a risk estimate based on such assumption severely underestimates the mesothelioma risk to asbestos operatives.

The effect of age and duration of exposure have a significant effect on the mesothelioma risk from a given cumulative exposure over 5-year periods. For example, for a 5-year exposure starting at ages 20 or 25 as against age 30, as assumed by HSL, the corresponding mesothelioma risks, from Hodgson and Darnton (2000) would be increased by factors of 2.1 and 1.5 respectively, i.e. the excess death risks would be 59 and 42 per million men respectively, as against 28 per million from the HSL risk estimate. If it is further assumed that a significant proportion of ARCA members' operatives work in the industry for 10 or more years, the total mesothelioma excess death risk will be higher than those noted above.

The table below gives mesothelioma risk estimates for a number of age and duration of exposure combinations taking age and duration multipliers from Table 9 of Hodgson and Darnton (2000) and Darnton (personal information 2005) and HSL (2005)'s figure of 28 mesothelioma cases per million resulting from a 5 year exposure from age 30.

Estimates of mesothelioma risk to age 85 for 5 to 25 year exposures from ages 20 to 30 at beginning of exposure, from Hodgson and Darnton (2000) and HSL (2005)

Age at Beginning of exposure	**Mesothelioma risk per million men exposed**				
	Duration of exposure (years)				
	5	**10**	**15**	**20**	**25**
20	59	101	129	146	157
25	42	70	87	98	106
30	**28**	45	56	64	70

As can be seen, the effects of first exposure at ages under 30 and exposure durations longer than 5 years have a major effect of the estimated mesothelioma death rate, e.g. for 20 years olds at entry who work for 25 years in the industry the total excess death risk is 157 per million as against 28 per million from the HSL risk estimate.

Given that the asbestos regulations do not prohibit operatives entering the asbestos removal industry at ages under 30 and do not prohibit operatives serving in the industry for longer than 5 years, it is considered that the age and duration of service factors in the risk estimate should include all legally acceptable combinations of age and service and should include 85-95% of asbestos operatives in any given year.

It is considered that the mesothelioma risk estimate for asbestos operatives should be based on the assumption of an entry age into the asbestos removal industry of 20 and a likely service of at least 20 years. Such an age at first exposure and service combination would give a likely excess death risk of 146 per million exposed operatives.

Estimation of annual excess death risk

The HSL estimate of the annual excess death risk is based on dividing the total risk by the survival period. In the HSL risk estimate the two figures taken were 28 per million and 50 years survival.

This author found division of the total by survival period surprising.

In the case of fatal accidents, annual excess risk is calculated by dividing total risk by the period over which the risk is accumulated, i.e. the duration of exposure.

HSE (2001) does not address how annual risk should be calculated. However, an earlier document on the subject of the tolerability of risk, HSE (1992), gives explicit guidance on the calculation of annual risk. Paragraph 167 of HSE (1992) states regarding estimating the risks from low-levels of radiation, where radiation-related deaths are essentially zero over the first 10-20 years and reach a peak 10-20 after cessation of exposure, that: “In order to permit comparison with conventional risks it is necessary to average the total radiation risk over the number of years of exposure”

As the development of mesothelioma in the 20 years after first exposure is relatively rare, it is considered that the situation described in HSE (1992) for low-level exposures to radiation is close to that of mesothelioma and the use of exposure period rather than survival period for the calculation of annual risk is valid.

It is considered that annual risk should be calculated by dividing total risk by the duration of exposure rather than by the survival period.

It is relevant to apply the above consideration to both the 28 mesotheliomas deaths per million from the HSL risk estimate for 5 years exposure and the above figure of 146 deaths from 20 years exposure from age 20. The respective risks are 28/5 = 5.6 deaths per million per annum and 146/20 = 7.3 deaths per million per annum.

It will be seen that these two annual risk estimates are similar, and are well within the experimental errors implicit in the exposure estimates. It is of interest that the group at highest annual risk are those who are exposed for 5 years from age 20, for whom the average annual risk is about 12 per million per annum. The apparent reduction in annual risk with increasing exposure duration is due to the mesothelioma risk declining rapidly with survival time.

From the HSL exposure estimate of 0.08 fibres/ml and the calculation of annual risk on the basis of exposure duration the average risk is about 12 per million per annum during the first 5 years of exposure from age 20.

The above annual risk estimates reveal a possible weakness in the way in which risk criteria have been set in documents such as HSC (2001), as, the annual risk for a given age at first exposure to asbestos decreases with increasing duration of exposure, although total continues to increase. It is therefore considered that it would be inequitable to ignore total cumulative risk and set criteria only for annual risk or to set criteria only for total cumulative risk and to ignore annual risk.

It is considered that criteria for both annual risk and total cumulative risk should be set. In terms of a "tolerable" annual risk of 10 per million per annum the limiting total cumulative risk over 20 years would be a risk of 200 per million.

Assessment of tolerability of a risk estimate of 12 per million per annum

HSL assessed its annual risk estimate against the Tolerability of Risk criteria in HSE (2001) and notes that this document defines an annual risk of 1 per million per annum as the divide between the "broadly acceptable" and the "tolerable".

It can therefore be considered that an annual risk of about 12 per million per annum is clearly well above the divide between the "broadly acceptable" and the "tolerable"

It is considered than a risk of about 12 per million per annum is excessive and that such risk signals a requirement for more stringent controls of exposure than were observed during the HSL study.

HSE (2001) defines risks of the order of 100-1,000 per million per annum as being "just tolerable" in some situations.

However, this author considers it morally repugnant for people not at risk themselves to adjudge risks of the order of 100-1,000 per million per annum as being "just tolerable" for others.

5.2.2 Assessment of risk to building occupants

The risk of developing mesothelioma, the main risk arising from exposure to asbestos at levels below about 0.1 fibres/ml, depends on two main factors: the total number of fibres inhaled, the "cumulative risk", and the age at which exposure occurs.

Cumulative exposure is given by the product of the average exposure concentration and the duration of exposure to that concentration, e.g. for a 5 year occupational exposure at 0.01 fibres/ml the cumulative exposure is 5 x 0.01 = 0.05 fibres/ml.years (f/ml.yr). In documents such as Hodgson and Darnton (2000) cumulative exposures are based on a working year of about 1,800 hours. However, for persons exposed for longer in the year that the nominal 1,800 hours, the effective cumulative exposure is greater at any given exposure level than for persons occupationally exposed, and the risk higher. For example, housebound persons exposed to asbestos for 20 hours/day throughout the year, i.e. for 7,300 hours/year, and will therefore have cumulative annul exposures over 5 years in 0.01 fibres/ml of 7300/1800 x 5 x 0.01 = 0.2 f/ml.yr.

The risk of developing mesothelioma increases as the time since exposure to the power 3-4, e.g. Doll and Peto (1985), HEI (1991). For example, the mesothelioma risk for someone first exposed at age 20 is a factor of 2.1 higher than for someone similarly first exposed from age 30. Age at the time of exposure is therefore particularly important for children as children have a higher probability than adults of living long enough to develop mesothelioma. The Hodgson and Darnton (2000) risk estimates assume that the mesothelioma risk levels off 60 years after first exposure. However, mesothelioma rates continue to increase in Scotland to ages 85, (personal communication from the Registrar General for Scotland). If mesothelioma patients aged over 85 were first exposed to asbestos when they left school, the mesothelioma risk must continue to increase for at least 70 years from first exposure. It is therefore assumed herein that the mesothelioma risk continues to rise for at least 80 years from first exposure. The Doll and Peto (1985) mesothelioma risk model has been applied to determine the additional risks for 5-year exposures starting at birth and age 5 as compared with first exposure at age 20. These correction factors are 2.4 and 2.0 respectively.

The persons at risk from asbestos contamination in their homes will include adults and children.

Adults in employment who are exposed to asbestos only in their homes are likely to be exposed for an average of about 10 hours per day for about 50 weeks per year, a total exposure duration of about 3,600 hours per year: twice as long as an occupational exposure. Adults not in employment, or who are housebound, may be exposed to asbestos in their homes for, say, 20 hours per day throughout the year, a total exposure duration of about 7,300 hours per year: 4 times longer than an occupational exposure. Children under school or nursery school age are likely to have similar exposures to adults not in employment or who are housebound: i.e. 4 times longer than an occupational exposure. School children are likely to be exposed to asbestos in the home for the same duration as adults in employment who are exposed to asbestos in their homes only, i.e. for about 3,600 hours per year: twice as long as an occupational exposure.

For the purposes of estimating risks in the home the figure of 0.01 fibres/ml of chrysotile has been taken for the purposes of calculation as HSE has defined such a concentration as being the criterion for sampling for the purposes of giving "reassurance" to building occupants, HSE (2005). Higher or lower exposure levels will result in higher or lower risk figures.

The table overleaf shows mesothelioma risk estimates based on Hodgson and Darnton (2000)' "highest arguable estimate" for chrysotile:

Mesothelioma risk estimates for 5-year exposures at 0.01 fibres/ml of chrysotile for residents in domestic properties

Exposure group	Age at first exposure	Cumulative Exposure (f/ml.yr)	Risk per million exposed persons to age 80
Working adults exposed in home only	20	0.1	84
Non-working adults exposed in home only	20	0.2	137
School children exposed in home only	5	0.1	168
Pre-school children exposed in home only	0	0.2	328

From the table it will be noted that the highest risk group is pre-school children exposed to asbestos in the home.

It is highly relevant to assess the "acceptability" of the above estimated risks. HSE (1992) defined an "acceptable" risk as an excess death risk of one/million/annum, HSE (2001, 1992). HSE (1992) commented that such risk: " …is of course not altogether negligible … but is a level of risk which, provided there is a benefit to be gained, and proper precautions are taken, does not worry us or cause us to alter our ordinary behaviour in any way."

A risk of 1 per million per year is a risk of 5 per million over 5 years. From the table it will be seen that, compared with the acceptable risk, the risks for pre-school children exposed in the home, school children exposed in the home only, non-working adults exposed in the home only and working adults exposed in the home only are respectively 66, 34, 27 and 17 times higher.

It is possible to estimate from Hodgson and Darnton (2000) the ambient chrysotile exposure concentrations which, taking account of exposure durations, should not be exceeded for pre-school children in the home. The limiting concentration over a 5-year period would be 0.00004 fibres/ml, i.e. a cumulative exposure of 0.0002 fibres/ml.years over about 7,300 hours per year.

It is important to appreciate that the estimate is based on a significant extrapolation from the original data on which the Hodgson and Darnton (2000) model was based. However, it considered that the assumption that such extrapolation can be made is to err on the side of caution rather than the reverse.

It should be noted that the above exposure level is below that found environmentally in some areas. However, such figure illustrates the critical importance of ensuring that the exposure to children to reduced to the lowest level technically feasible to ensure that any environmental exposures to asbestos are not exacerbated by further, avoidable, exposures in the home.

It is considered essential that residents, in particular pre-school children, should not be exposed to a cumulative exposure of 0.0002 fibres/ml.years of chrysotile in their home.

It is considered that unless it can be demonstrated that exposures of residents to asbestos resulting from the removal of textured coating from domestic premises can be reliably maintained below a cumulative exposure of a cumulative exposure of 0.0002 fibres/ml.years over about 7,300 hours per year, the stringency of controls applied to the removal of textured coatings should be increased rather than decreased as proposed by HSC (2005).

Robin Howie
19th December 2005

6 THE AUTHOR'S EXPERTISE

Robin Howie has been involved in occupational hygiene since 1974 and has held a BERBOH Diploma in Comprehensive Occupational Hygiene since 1982.

His main areas of interest are in the effects of asbestos on health, the control of asbestos-induced health risks, the reality of personal protective equipment performance in the workplace, in the relationship between noise exposure and noise induced hearing loss and heat stress/strain. He was an active member of the British Standards Institution Committees on Respirators between 1978 and about 2000. He has presented papers covering a wide range of occupational hygiene topics at conferences of the: American Society for Testing Materials; British Occupational Hygiene Society; Ergonomics Society; European Asbestos Removal Association; European Semiconductor Safety Association; International Occupational Hygiene Association; International Society for Respiratory Protection; Institute of Acoustics; Irish Chief Fire Officers Association; National Irish Safety Organisation; NOKOBETEF 6; Norwegian Occupational Hygiene Society; and, the Russian Association of Designers, Manufacturers and Suppliers of Personal Protective Equipment. He has published over one hundred occupational hygiene papers and articles: many on asbestos.

He was President of the British Occupational Hygiene Society in 1997/98.

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