2018

# WHY THE UK NEEDS TIGHTER ASBESTOS CONTROLS

By Charles Pickles
MSc, BSc CCP (asbestos)*

# Executive Summary

Concern about low level chronic exposure to asbestos is now justified due to the following reasons:

- Much of the asbestos installed in the last century remains in-situ, with no effective regime for measuring any resulting current exposure.
- Exposure is cumulative and there is little understanding of the level of the actual chronic exposure from asbestos left in-situ.
- Workers (e.g. teachers, caretakers, nurses) not associated with acute exposure (such as trades people and construction workers) are dying from previous asbestos exposure and shall die in the future as a result of current and future exposure.
- Generally, people are now living longer giving asbestos disease longer to manifest itself.
- Children in schools risk becoming exposed to asbestos at a younger age than adults, again increasing the lifetime available for asbestos disease to develop.

It is now argued that the UK ought to adopt those measures in force in other European nations, who already share the same overriding EU legislation Directive 2009/148/EC on the protection of workers from the risks related to exposure to asbestos, and:

- Amend and enhance the existing legislation, namely the “Duty to Manage” within the Control of Asbestos Regulations, (2012) to:-
  - Set an occupational exposure limit for buildings known to contain high risk asbestos (R1 and R2), of <0.0005 f/ml, to ensure that respirable asbestos fibre levels in occupied buildings, are below the level known to present an elevated risk of asbestos disease, namely mesothelioma.
  - Measure the asbestos fibre concentration, via air sampling at the time of the periodic re-inspection visit, thus fully ratifying and verifying compliance with the Duty to Manage, by reporting that asbestos exposure is either negligible or that management action is needed.

**Charles Pickles***
Chief Technical Officer, Lucion Services

Having co-founded and nurtured what is now the UK’s leading asbestos consultancy, Lucion Services, Charles has always taken a keen interest in analysing, identifying and delivering incremental change. Drawing on 19 years of practical experience and in his role as Chief Technical Officer, Charles has often written and spoken about his opinions on ongoing incremental improvements to asbestos consultancy. He has considered in detail the epidemiological, legislative and practical fundamentals of asbestos consultancy with one question in mind: ‘do they stop us breathing in asbestos fibres?’. This paper aims to elucidate UK asbestos management with international comparisons and concludes that practices could and should continue to evolve to better control the asbestos hazard within the UK. The opinions expressed in this paper are expressly those of Charles Pickles and not of Lucion Services.

E: Charles.pickles@lucionservices.com

# Introduction

A comparison of international trade statistics shows that historically, the UK has imported relatively more asbestos per capita than most other countries. In addition, much more of this tonnage was of the more dangerous fibre types, amosite (grunerite or brown asbestos) and crocidolite (blue asbestos), rather than chrysotile (white asbestos), in comparison to other countries.

During the 1950s to 1980s much of this asbestos was incorporated into building materials (Asbestos Containing Materials - ACMs) and installed in public buildings, where it remains in an increasingly aged state and often in a deteriorating condition.

The UK asbestos regulations broadly aim to locate asbestos within buildings and prevent acute disturbance to these materials by maintenance workers who would otherwise be unaware of their presence and the hazards presented. The regulations presume asbestos left in-situ and which is not subject to building/maintenance work is of little risk.

In comparison to historical exposures, caused during the milling, manufacturing and installation of asbestos products, present-day exposure is undoubtedly considerably lower. Earlier asbestos legislation has drastically reduced asbestos exposure and demonstrated that legislation is the most effective tool we have to control the asbestos risk.

Nevertheless, there is now serious and growing concern over current exposure levels from asbestos that remains in-situ because the materials themselves have either been damaged and/or are degrading, which increases the likelihood of fibres being released into the air and increasing the likelihood of exposure.

These arguments are reminiscent of the path of tobacco legislation. Smoking was not a concern until the evidence of its health impacts became overwhelming. Two to three decades later, concern mounted about the dangers of passive smoking. The dangers are much reduced but still significant and elevated. Legislation was then passed to ban smoking from all public buildings and workplaces.

Similarly, the dangers of acute asbestos exposure, although not first recognised, are now broadly accepted and have been effectively legislated against, thus controlling exposure from the direct handling of asbestos. Concern about low level chronic exposure to asbestos is now justified due to the following reasons:

- Much of the asbestos installed remains in-situ, with no effective regime for measuring any resulting current exposure.
- Exposure is cumulative and there is little understanding of the level of the actual chronic exposure from asbestos left in-situ.
- Workers (e.g. teachers, caretakers, nurses) not associated with acute exposure (such as trades people and construction workers) are dying from previous asbestos exposure and shall die in the future as a result of current and future exposure.
- Generally, people are now living longer giving asbestos disease longer to manifest itself.
- Children in schools risk becoming exposed to asbestos at a younger age, again increasing the years available for asbestos disease to develop.

Faced with these consequences it is argued that UK asbestos legislation should continue to evolve to better deal with the chronic low level risks presented by the high risk amosite (predominantly) and crocidolite that remains throughout so many of our public buildings.

All Health and Safety law in the UK is governed by the principles that emergent best practices and techniques are adopted as they become available. This is evidently the case, as asbestos legislation has evolved and should continue to do so. In 1985 the import and use of amosite and crocidolite asbestos was banned and later in 1999 chrysotile was banned.

In 2002, The Control of Asbestos At Work Regulations (CAWR, 2002) were established, introducing the “duty to manage” asbestos, requiring property managers and owners to locate and prevent exposure to asbestos. CAWR was amended in 2012 to bring the regulations into line with the EU Directive on exposure to asbestos (Directive 2009/148/EC).

It is asbestos fibres, not asbestos materials which are dangerous, yet currently for in-use buildings, it is the materials rather than the fibre concentrations which are routinely assessed. This practice should be modified to enable improved management of the both the fibre levels and the materials from which fibres originate.

It is now argued that the UK ought to adopt those measures in force in other European nations, who already share the same overriding EU legislation Directive 2009/148/EC on the protection of workers from the risks related to exposure to asbestos at work and:

- Amend and Enhance the “Duty to Manage” with the Control of Asbestos Regulations, (2012) to:
    - Set an occupational exposure limit for buildings known to contain high risk materials (R1 and R2), of <0.0005 f/ml, to ensure that respirable asbestos fibre levels in occupied buildings, known to contain high risk asbestos are below the level known to present an elevated risk of asbestos disease, namely mesothelioma.
    - Prove ongoing compliance at the time of the re-inspection visit, thus fully ratifying and verifying compliance with the Duty to Manage, by reporting that asbestos exposure is either negligible or that management action is planned / is being enacted.

The UK has more asbestos in-situ currently and a higher asbestos - related death rate than any other nation except Australia. Our legislative regime stipulates that asbestos exposure should be reduced as far as is reasonably practicable. This requirement is not fixed in time but dynamic, requiring updates to guidance as best practice evolves. Our current practice for measuring asbestos exposure (Phase Contrast Microscopy - PCM) is insufficiently sensitive to observe the vast majority of asbestos fibres in a given sample of air.

Other nations with much less of an asbestos problem have adopted sensitive air monitoring techniques and thus are able to monitor much lower exposures. In contrast here in the UK, we simply do not know what exposures people in our public buildings and workplaces are being exposed to, although techniques are available to measure these and it is written into law elsewhere as explained later.

Without sensitive air monitoring, we do not know if asbestos exposures are as low as is reasonably practicable and if our buildings are safe. Given that asbestos is very widespread and, as a result of historical exposures, is the number one occupational cause of death, it is argued that the UK ought to continue to adopt best practice as it evolves, particularly for testing air within buildings containing high risk asbestos, to be assured of their ongoing safety.

The versatility, tensile strength, heat and chemical resistance of asbestos led to it becoming known as the wonder mineral of the 1950s and 60s, with widespread use in building materials and products.

Although it has been illegal to use asbestos in the construction or refurbishment of any building since 1999, crocidolite (blue), amosite (brown) and chrysotile (white) asbestos were used extensively from the 1950s to the mid-1980s in building materials of all types and for a variety of purposes, including fireproofing and insulation.

# The tarnished reputation of a once 'wonder' material

As a result, asbestos was commonly used to improve the performance of everything from sprayed coatings, laggings and insulating board, used in ceiling tiles and wall panels, to decorative textured coatings and vinyl floor tiles.

Various forms of workplace and asbestos-specific regulations have progressively tightened asbestos controls in the UK. The Asbestos Licensing Regulations 1983 introduced licensing requirements from the Health and Safety Executive (HSE) for contractors working with asbestos insulation. In 1985, the UK banned the import and use of blue (crocidolite) and brown (amosite) asbestos. This rule was replaced in 1992 with a law that also banned some uses of white (chrysotile) asbestos, traditionally considered less lethal than the other forms of the mineral. In 1999, the UK government banned the use and import of chrysotile asbestos.

The UK's Control of Asbestos at Work Regulations were first introduced in 1987 and included the need to identify the type of asbestos present as well as providing information, instruction and training as part of adequate control measures to prevent the spread of debris.

Various amendments to the Control of Asbestos at Work Regulations were introduced culminating in the 2006 Regulations which brought together the Control of Asbestos at Work Regulations 2002, the Asbestos (Licensing) Regulations 1983 and the Asbestos (Prohibitions) Regulations 1992. The 2006 law prevented new uses of the mineral but allowed existing asbestos to remain intact if it remained in good condition and undisturbed. In this way the CAR 2006 legislation incorporated the 'duty to manage' requirement, set maximum exposure limits and demanded that anyone who was at risk of encountering asbestos on the job be trained in the proper handling of the material.

The following asbestos products and work activities relating to asbestos were banned in the UK by the Control of Asbestos Regulations, unless the products were manufactured prior to November 1999:

- Spraying of asbestos materials as a surface coating
- Use of low-density insulating or soundproofing materials made from asbestos
- Import of asbestos-containing products
- Use of asbestos cement
- Use of boards, panels or tiles covered in asbestos paint or plasters

The Control of Asbestos Regulations 2012 updated the previous regulations to comply with the European Commission's opinion that the UK had yet to completely implement the European Union Directive on asbestos exposure. This measure didn't change prior regulations, but it rather added more requirements to improve safety measures of non-licensed asbestos work including updates to deal with sporadic and low intensity exposure.

In addition, these updated measures included reporting non-licensed asbestos work to the relevant enforcing authority, keeping written records of the work and having workers under medical surveillance.

Limits for the concentration of airborne asbestos fibres were introduced soon after the Asbestos Regulations 1969 came into force (1). Initially the limits were focussed on the asbestos manufacturing industry to determine safety conditions for employers and employees, but the focus of control of later legislation switched to setting safe or acceptable levels of exposure, or control limits among asbestos removal workers.

However, rather than setting a safe or acceptable level of exposure, the control limits became a trigger for the implementation of certain additional control measures (such as the use of PPE) over and above measures to minimise the release of fibres at source.

The effect of the various asbestos-related regulatory introductions has been to progressively lower control limits, with the current limit of 0.1 f/ml being one thirtieth of the 3 f/ml limit that applied in 1970.

The history of occupational hygiene is generally a case of 'too little, too late' and this is exemplified by asbestos legislation. The current asbestos control limits were relevant to asbestos manufacturing and asbestos removal. They are in no way relevant or suitable to managing asbestos materials in-situ.

As it is government policy to measure asbestos in-situ, the legislation could be improved by introducing meaningful control limits for all buildings where high risk asbestos materials are present. Without this, fibre levels are benchmarked against historic, dangerously high concentrations.

There are strict Health and Safety Executive (HSE) (2) and legal duties on all workplaces aimed at reducing the risks to health that asbestos poses and there should no longer be any excuse for anyone being exposed to potentially dangerous levels of airborne asbestos fibres.

The Health and Safety At Work Act 1974 says, 'It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all employees'.

More specifically, the Control of Asbestos Regulations 2012, Regulation 4.8, (Duty to Manage) Asbestos (3), states that a determination of the risk from any asbestos known to be present is made, moreover, "the regulation is designed to make sure anyone who carries out any work in non-domestic premises and any occupants of the premises are not exposed to asbestos from ACMs that may be present".

This responsibility falls to the duty holder, which in many cases is the person or organisation that has clear responsibility for the maintenance or repair of the premises.

# Duty to manage asbestos

In particular, the duty holder is required to assess and manage the risks from asbestos to employees and others, and must ensure that anyone who is likely to work on, or disturb, asbestos is provided with information about its location and condition.

Government policy considers that asbestos that remains in good condition and is unlikely to be damaged or disturbed is not a significant risk to health as long as it is properly managed. Only when ACMs are disturbed or damaged is the risk of exposure increased through the release of airborne fibres.

Rigorous systems of asbestos management are therefore needed to prevent the disturbance of ACMs, which requires the careful monitoring and management of building materials and maintenance at all times. Regular inspections and checks by the duty holder of the condition of ACMs are essential and this should include details of any precautionary or safeguarding measures that are needed.

Specifically, an asbestos register and management plan is required that incorporates all relevant information about the existence and location of any known or presumed asbestos containing materials. The plan also needs to be updated regularly and to be made available to anyone visiting or working on a particular building or site.

As part of this requirement an assessment of the risk associated with each identified occurrence of asbestos is required. The assessment must take into account the type of building material present and the type of asbestos it contains and a priority assessment of the likelihood of someone disturbing the material based on a number of factors. These latter factors include occupant activity, the likelihood of disturbance, frequency of use of an area and most importantly the level of planned or unplanned maintenance activity in the area.

A total risk assessment is calculated by a combination of the material and priority assessments to provide a comparison of the risk presented by each item of ACM present so that priorities can be set and appropriate management plans developed.

Currently, there is no requirement to monitor the air in buildings to verify and provide assurance that the above measures are effective and that people are not exposed to chronic low level of asbestos fibres. The law requires duty holders to manage asbestos. If we do not measure the fibres we are exposed to we shall remain ignorant as to the level of, or hopefully absence of exposure. What is not measured cannot effectively be managed. Given the toxicity of asbestos and its widespread presence, it is argued that the UK ought to actively measure asbestos fibre concentrations in areas known to contain high risk asbestos.

The World Health Organization (WHO) estimates that 107,000 global annual deaths are caused by mesothelioma, asbestos related lung cancer and asbestosis. A descriptive analysis of data (4) in the WHO mortality database shows that 56% of all mesothelioma deaths and 41% of all asbestosis deaths recorded worldwide occurred in Europe, which accommodates 13% of the world's population. Combining these data with those from other sources showed that Europe accounted for 60% of the reported global deaths from asbestos-related diseases, excluding asbestos-induced lung cancer.

During the periods 1920–1970 and 1971–2000, Europe used 48% and 58%, respectively, of all asbestos traded throughout the world. Europe can thus be characterized as the historical global centre of asbestos use and the current global centre of reported asbestos-related diseases.

## International comparisons

Within Europe, during these periods the UK imported more asbestos per capita than any other country.

More significantly, in terms of the dangers associated with asbestos, the UK imported much more amosite (grunerite) fibre, commonly referred to as brown asbestos, than its peer nations, who imported proportionally more chrysotile. Amosite was then put inside buildings as insulation / insulative products, whereas much of the chrysotile was used in cement and clad to the outside of buildings. Thus the UK installed much high risk amosite into its building stock.

There are three main reasons for this:

- The British climate necessitates central heating and insulation to a greater extent than our neighbours in southern Europe and amosite was the main fibre type used for these purposes.
- In the 1950s, 60s and 70s there was a comparative building boom in the UK, particularly for larger public buildings.
- The UK's close trading links with those nations which produced amosite and crocidolite, significantly South Africa and Australia, allowed the UK to source and import more of these (then) highly desirable building materials.

**Table 1: A Comparison of European Asbestos Imports**

| Country | Average Per Capita Asbestos Use 1920-70 | Average Per Capita Asbestos Use 1971-2000 |
|---|---|---|
| **UK** | 1.92 | 1.03 |
| **Germany** | 1.17 | 2.18 |
| **France** | 1.08 | 1.44 |
| **Netherlands** | 0.84 | 0.87 |
| **Italy** | 0.82 | 1.61 |
| **Spain** | 0.51 | 1.35 |

*Reference: www.who.int/bulletin/volumes/92/11/BLT-13-132118-table-T1.html*

# The relative toxicity of the different asbestos fibre types

There are two factors to consider when evaluating the relative danger of the three main asbestos fibre types. The toxicity of the fibres and the dustiness, or likelihood of fibre release from the matrix.

**Toxicity:** Chrysotile (white asbestos), amosite (brown asbestos) and crocidolite (blue asbestos) have relative toxicities of 1: 100: 500. So brown asbestos is 100 times more dangerous than white asbestos and blue asbestos is 500 times more dangerous than white asbestos. (Hodgson J.T. and Darnton A. (2000), "Quantitative Risks of Mesothelioma and Lung Cancer in Relation to Asbestos Exposure", Annals of Occupational Hygiene, 44: p. 565-602.

**Dustiness:** Amosite (brown asbestos) and crocidolite (blue asbestos) are estimated to be ten times more dusty than chrysotile (white asbestos). This is due to the nature of the molecular structure which makes chrysotile fibres stick to themselves and other matrices. Amosite, by its morphology, is friable and due to its chemistry and crystalline structure, hydrophobic. The same properties which make amosite an effective insulator and fire retardant, also mean that is does not bond well to and with other components within building materials. Hence asbestos insulation board (AIB), looks and feels solid, but fibres are readily released from it upon disturbance.

Taking these two factors together, it is abundantly clear that crocidolite and amosite are very dangerous materials. The current UK HSE algorithm for estimating risks associated with asbestos materials, scores the relative risks for chrysotile, amosite and crocidolite as 1: 2: 3 respectively (HSE (2012), HSG 264, Asbestos: The Survey Guide, p.67, appendix 4). Although the differences between fibre types are recognised, the relative dangers posed by amosite and crocidolite appear suppressed, which may lead those managing asbestos to commission works to chrysotile materials, rather than amosite materials.

It is thought that the widespread historical usage of amosite explains the UK's notably high death rate from mesothelioma. Significantly, power tools became prevalent during the years amosite was being made and installed. Energetic, high speed power tools produce much more dust than hand tools.

**Table: 2 European Mesothelioma Death Rates / 1000 (1994-2008)**

| Country | Mesothelioma Death Rates / 1000 (1994-2008) |
|---|---|
| **UK** | 18.36 |
| **Italy** | 10.37 |
| **France** | 7.74 |
| **Germany** | 7.04 |
| **Netherlands** | 15.91 |
| **Spain** | 4.13 |

*Reference: www.who.int/bulletin/volumes/92/11/BLT-13-132118-table-T1.html*

As the table above shows, the UK's asbestos deaths compare most unfavourably to that experienced in other European countries and are between two and three times worse than in France and Germany. As Figure 1 illustrates, these historical factors have resulted in the UK having an asbestos created mesothelioma problem that is visibly separate and notably much worse than that experienced by other nations in Europe.

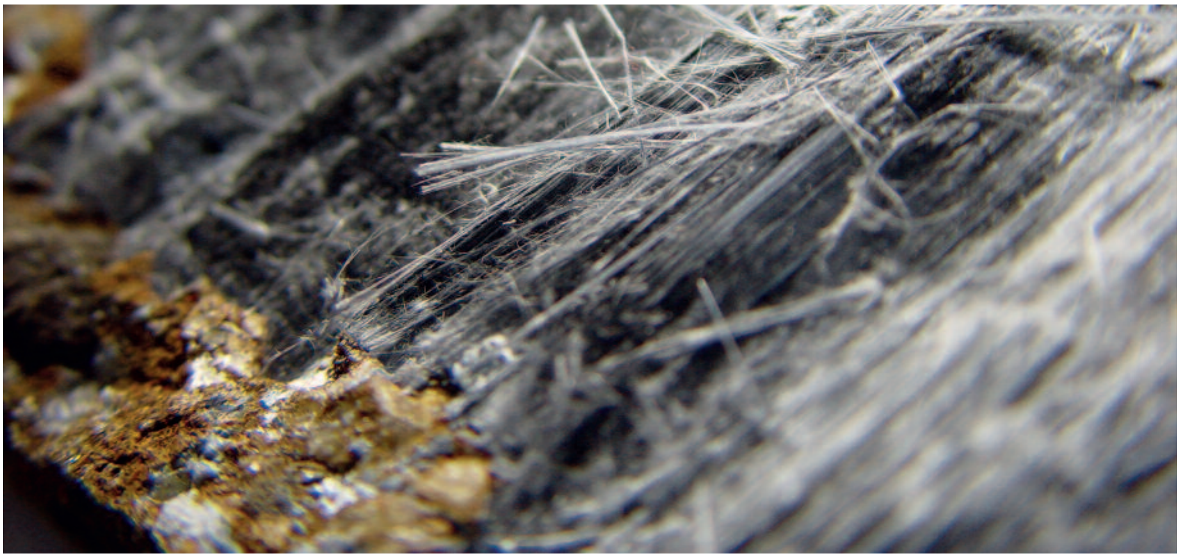
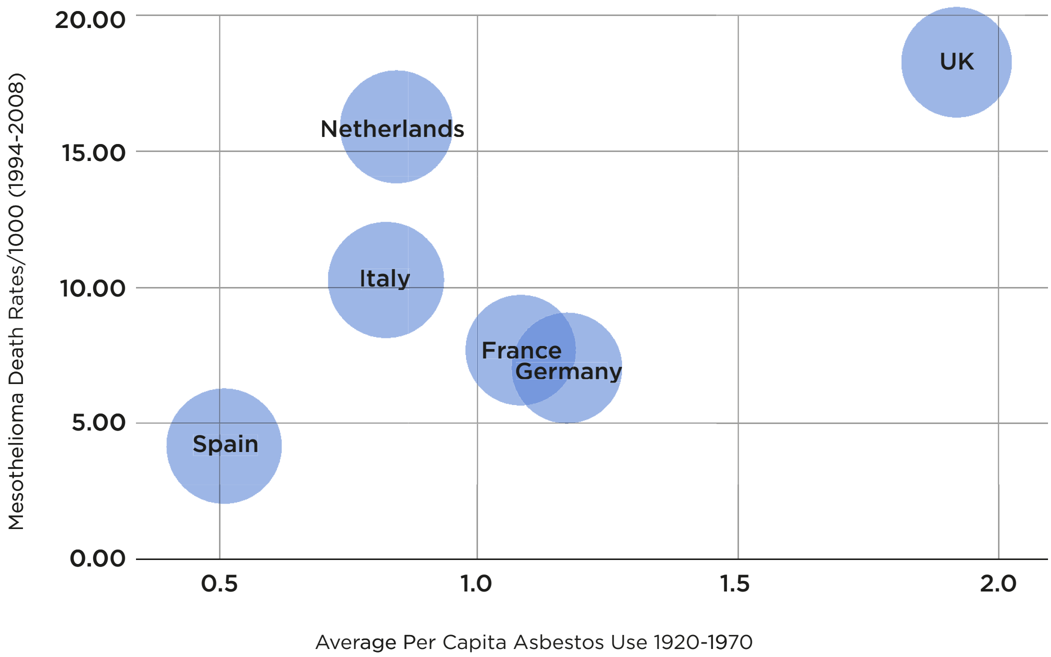


**Figure 1: International Comparison of Historical Asbestos Use and Current Mesothelioma Death Rate**




*Source: Charles Pickles with data from World Health Organisation (WHO) www.who.int/bulletin/volumes/92/11/BLT-13-132118-table-T1.html*

In this respect the UK's asbestos problem is in a league of its own. The Dutch, in recognition of their asbestos legacy, have enacted an "environmental control limit" to ensure current and future asbestos exposure is minimal. By contrast, little suitable air monitoring has been conducted within UK buildings containing asbestos.

## The current situation of asbestos in situ in the UK

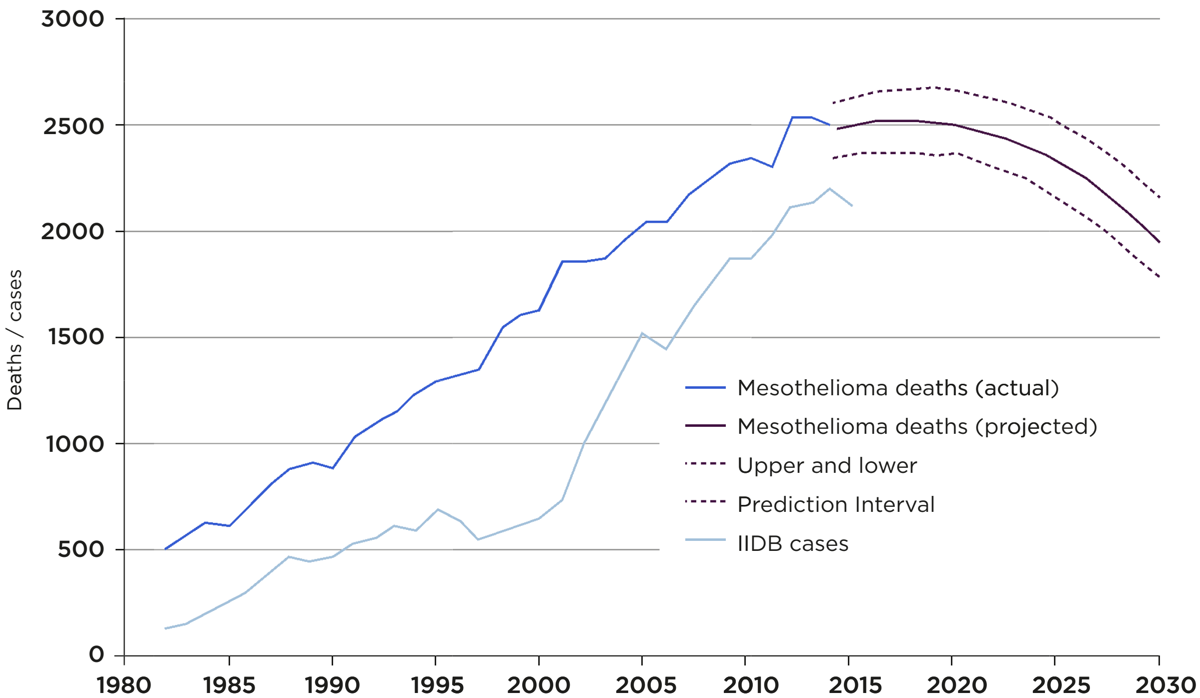
Much of the amosite and crocidolite installed in the UK during the postwar period went into larger public buildings where there was increased need for fire protection in the form of the widespread use of insulation board and sprayed insulation to structural steelwork. In addition, amosite was widely used as pipe insulation to central heating systems. Although large quantities of asbestos materials have since been removed, the majority still remains and is now in an aged state.

HSE policy is to identify and manage asbestos in-situ. Given that most UK public buildings contain asbestos, most notably in more than 70% of schools (5), it is clearly impractical to remove all of this material. The UK must therefore use the best techniques and tools available to better monitor and manage its asbestos.

In practice, managing asbestos typically involves the removal of high risk and accessible material whilst materials visibly assessed to be of lower risks are sealed and left in situ to be re-inspected periodically, usually annually. Building materials which are not easily visible are not re-inspected.

In the circumstances, as the actual risk to health is the inhalation of fibres, the measurement of airborne fibres present would enable the risk to be directly measured, rather than the current practice of inspecting the materials for damage. Air monitoring would also determine any risk being caused by the release of fibres from asbestos that is within the building but cannot be seen eg: insulation boards installed behind column liners.

**Figure 2: Mesothelioma in Great Britain: annual deaths, IIDB* cases and projected future deaths to 2030**




*Source: www.hse.gov.uk/statistics/causdis/mesothelioma/mesothelioma.pdf*
**IIDB - Industrial Injuries Disablement Benefit*

# The UK evidence of exposure levels in schools

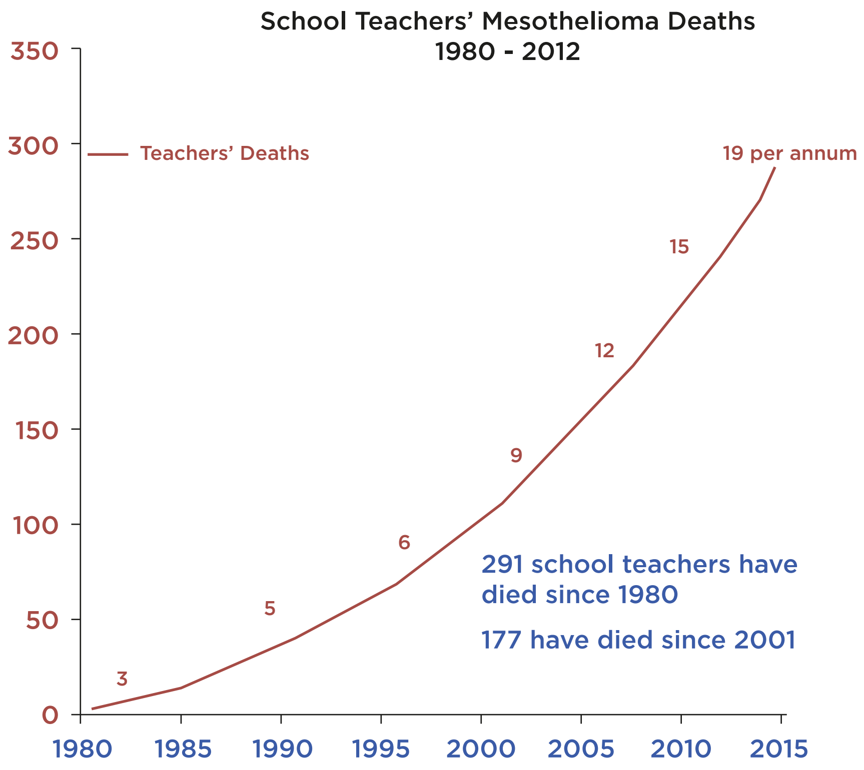
The UK HSE concludes that, "there are very few published studies of airborne asbestos concentrations in buildings since the Health Effects Institute - Asbestos Research (HEI-AR) review. What has been published suggests that there is no increase in the average occupant exposure in normally occupied buildings and the average concentrations may be even be lower than assessed by the HEI report and the earlier UK study. This reduction may be due to less maintenance work being carried out in the buildings during sampling in the later studies." (6)

However the HSE also acknowledge that in CLASP/system built schools, 'There is a significant amount of data that shows that amosite fibres can be released into the classroom air when some of the casings are struck or adjacent windows and doors are banged. After further field sampling work had confirmed the probable mechanisms for release (damaged and /or poor sealing) and that predominantly amosite asbestos fibres were being released.' (7)

As a 2012 report from the All-Party Parliamentary Group on Occupational Health and Safety on asbestos in schools noted (8), over 140 school teachers died from mesothelioma in the previous ten years. It was also reported that an unknown number of cleaners, admin staff and caretakers had also died.

Similarly, at a 2013 House of Commons Select Committee hearing (9), evidence was presented by mesothelioma widower Michael Lees of an increase in the number of school teachers dying from mesothelioma in Britain from 3 a year in the 1980s to a total of 243 in the period since 1980. In 2013, 2015 and 2017 there were 17, 22 and 22 "teacher deaths" from asbestos, continuing the rapidly rising trend for this occupational group as illustrated in the figure below.

**Figure 3: HSE: Male and female mesothelioma deaths aged 16- 74 for selected occupations in the education and medical sectors 2012**



# Current and future deaths from chronic low level exposure

The current abundance of aged amosite building materials in UK public building is of grave concern, as is expressed by a growing body of evidence to suggest that low level chronic exposure to these materials causes death by mesothelioma.

Hodgson and Darnton (2000), two HSE scientists, quantified the lung cancer and mesothelioma risks associated with occupational exposures to crocidolite, amosite and chrysotile (10). From their work, it is considered that the mesothelioma risk depends on the type of asbestos fibres, the cumulative exposure to airborne fibres and the exposed person's age at the time of exposure.

In addition, Doll and Peto (1985) calculated that the risk of developing mesothelioma increases as the time since exposure to the power of 3-4 (11). For example, the mesothelioma risk for someone first exposed at age 20 is a factor of 2.1 higher than for someone similarly exposed from age 30.

It is of particular relevance that affected teachers have not been subject to exposure through working with asbestos in the same way as construction or industrial workers have, but rather due to chronic low level exposure resulting from working in, and being taught in as pupils themselves, buildings containing asbestos. This is very much a current issue, rather than an historical one. Whereas Figure 2 describes a stabilising mesothelioma death rate, Figure 3 depicts an accelerating death rate. This is worrying as it implies that there will be many more deaths from groups not associated with handling asbestos materials at work.

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. It is therefore particularly worrying that, in addition to teaching staff, it is not known how many children have subsequently died from exposure to asbestos. However, because of the long latency period associated with the disease and the younger age of first exposure, in USA (12) it has been estimated that for every teacher's death nine former pupils will subsequently die from their asbestos exposure at school.

After years of essentially uncontrolled use, there are projections of up to 25,000 asbestos related deaths in Europe in the next 25 to 30 years (13). In a 1992 paper Peto (14) predicts that a UK peak of annual male mesothelioma deaths in about the year 2020 of between 2700 and 3300 deaths. With 2542 mesothelioma deaths in the UK in 2015, the latest projections from the HSE (15) suggest that there will continue to be around 2,500 deaths per year for the rest of the current decade before annual numbers begin to decline.

However these projections themselves are likely to be gross under estimates. For example, the HSE predictions are made on the assumption that exposure starts at the age of 20 and are based on an average life expectancy of 75. The reality, particularly for school children, is that exposure to asbestos fibres could start at a considerably younger age, with the disease having a much longer lifetime to manifest itself. As a result, death rates for those subject to passive or chronic low level exposure are likely to continue to increase.

A recent publication (16), states that, "teachers and nurses had about 5 and 3 times respectively more mesothelioma deaths than expected in populations not exposed to asbestos.'' The observed excess mesothelioma deaths suggest that both teachers and nurses were likely to have been exposed to airborne asbestos fibre concentrations significantly higher is typical in buildings containing asbestos-containing materials in good condition.

From Hodgson and Darnton (2000) the likely cumulative exposures over 30 years would need to have exceeded the equivalent of about 0.15 f/ml.years of amosite for teachers
or about 0.06 f/ml.years of amosite for nurses to cause the number of observed mesothelioma deaths in each profession during the period of interest." (16)

# Exposure limits and control levels

With the possibility that teachers and pupils could be inhaling raised levels of asbestos for six or seven hours a day, in 1983 the Department for Education considered a proposal for an 'environmental' limit to be created specifically for schools.

The proposal suggested that, because of the particular vulnerability of children, a level 1/100 of the workplace control levels would not be unreasonable in schools. However, an environmental level has never been introduced and workplace clearance limits are instead still applied to classrooms.

A more recent analysis of deaths (16) leads Howie to conclude that, 'airborne asbestos fibre concentrations in both schools and hospitals need to be substantially reduced and that programmes of high sensitivity sampling, in combination with the use of analytical Transmission Electron Microscopy used to count all asbestos fibres, not only fibres longer than 5 micrometres and fibres wider than 0.2 micrometres, as adopted by HSE's Health and Safety Laboratories, e.g. Burdett (2012), to identify where control actions are necessary.'

The clearance indicator (0.01 f/ml) is intended to indicate that a working environment is notionally safe following asbestos removal works and is used as part of an in-depth post work assessment process called the 'four stage clearance' procedure included in HSG248: Asbestos: The analysts' guide for sampling, analysis and clearance procedures (17). The clearance indicator is described as 'a transient indication of site cleanliness,... and not as an acceptable, permanent environmental level' (18).

In the UK, when working with asbestos containing materials without an enclosure, asbestos concentration should be kept below a 4- hour control limit of 0.1 f/ml and a peak level measured over 10 minutes of 0.6 f/ml. A 'disturbed air' test with a clearance indicator of 0.01 f/ml in air is used to assess whether it is safe to take down an enclosure after asbestos removal has been completed and the area thoroughly cleaned.

The clearance indicator has now remained the same for over 30 years and employers and duty holders often regard them as a true indication of safety, despite the HSE stressing that this should not be regarded as a 'safe' level and work activities involving asbestos should be designed to be as far below the control limit as possible.

In fact there are many that argue that, rather than a safe level, the clearance limit simply reflects the limits of quantification allowed by the measurement techniques available at the time it was introduced and does not take into account modern advances and improvements to sampling and analytical techniques.

This is supported in a 2014 article by the British Occupational Hygiene Society (BOHS) (19) that makes the point that, although no level can be regarded as safe, published studies say that school buildings with asbestos products in good condition have an airborne concentration up to about 0.0005f/ml (or 500 fibres per cubic metre).

On this subject, the Medical Research Council has also stated that exposure to airborne asbestos fibre concentrations above 0.0005 f/ml may increase the likelihood of contracting mesothelioma (20).

Further work on this matter has also been undertaken on both exposure limits and the HSE assertion that asbestos in good condition and which remains undisturbed does not pose a risk to health.

Leading occupational hygienist Robin Howie has tested these declarations to consider the overall health risks posed by cumulative exposure to asbestos fibres and age of first exposure to asbestos (21) for a number of different groups. In a series of assessments, Howie estimated that, taking into account exposure durations, the ambient exposure concentrations that should not be exceeded for pre-school children in the home and for children in schools. For crocidolite these concentrations are 0.000001 and 0.00003 f/ml respectively and for amosite are 0.00004 and 0.0001 f/ml respectively.

In summary, Howie concludes that asbestos induced death risks from undisturbed asbestos materials in good condition in buildings are significantly higher than those defined by HSE as being acceptable in buildings containing crocidolite or amosite, particularly for pre-school children in both school and home. He also says that the HSE should ensure, publish and enforce the airborne asbestos fibre concentrations in rented or leased residential properties and schools which should not be exceeded if asbestos-induced deaths in the relevant populations are to be restricted to 1 per million per year -a figure defined as an 'acceptable' risk by the HSE.

Against this background, the monitoring and analytical techniques needed to properly and effectively measure asbestos fibre levels present in the air are readily available in the UK. Indeed, in the interest of the safety of both staff and the general public some organisations have already been encouraged to monitor air samples in public buildings on a routine basis to ensure that where asbestos is known to be present it does not cause an elevated risk of exposure.

In these circumstances it is relevant that the Health and Safety at Work Act (1974) requires that UK guidance should be updated as and when technology and techniques develop, in order to ensure protection from hazards. Despite this requirement current HSE guidance does not require any routine air monitoring of asbestos.

Given the UK's significantly higher occurrence of asbestos, significantly higher use of amosite and growing evidence of deaths from asbestos exposure during normal occupation, it is strongly recommended that the UK adopts those measures currently in-place elsewhere in order to meet our greater current risks from asbestos. This would enable exposures to be identified earlier, enabling effective asbestos management, thus avoiding future deaths and curtailing the UK asbestos legacy.

## The situation in other countries

Some of the UK's closest neighbours have introduced much tighter asbestos controls and occupational exposure limits, despite not having the historically high levels of asbestos use compared to the UK.

For example, in the Netherlands the level of mesothelioma deaths due to environmental exposure to asbestos led to parliamentary concern that exposure guidelines were not strict enough. The Health Council of the Netherlands was subsequently asked for advice and its report noted the importance of evaluating quality of exposure in epidemiology, 'since poor quality of exposure data will lead to underestimated risk' (22).

As a result of the report, the Netherlands updated its occupational exposure limit to 0.002 f/ml for all asbestiforms, from 1st Jan 2014 with the intention of lowering the threshold for amphibole asbestos to 0.0003 f/ml somewhere in the future.

In contrast to the UK position, in the Netherlands when and where the condition of asbestos materials is found to have deteriorated during re-inspection surveys, under the auspices of the legislative instrument NEN2991, dust and air samples are taken and subject to scanning electron microscopy and should stringent thresholds be exceeded, immediate control measure and / or remediation is required (23). The combination of an occupational exposure limit and pragmatic mechanisms to implement it, are worthy of serious consideration.

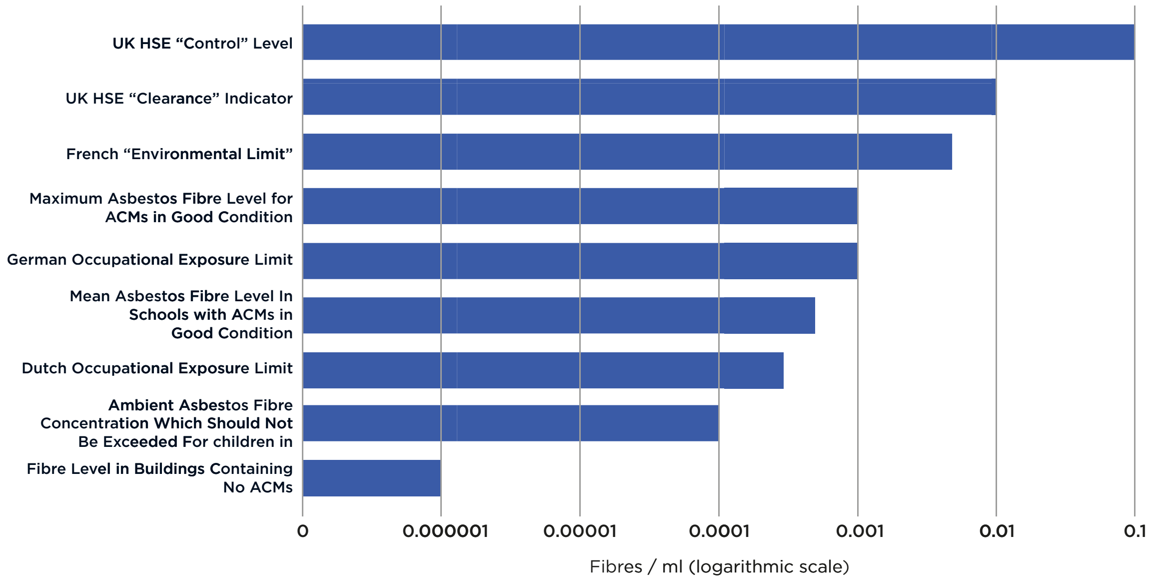
Similarly in France, there is an environmental level within buildings of 0.005 f/ml (ANSES. Asbestos. Presentation, health effects, exposure and regulatory framework. Updated 4 Apr 2013) and Germany has adopted a national enforceable occupational exposure limit of 1000 fibres per cubic metre (or 0.001 f/ml).

So it is apparent that our European neighbours who have much less of a problem with asbestos, have considerably tighter asbestos legislation and having reviewed the evidence have now enforced effective occupational exposure limits.

In summary therefore, not only is the UK currently exposing workers and the public to asbestos fibres, but there is no requirement to detect this and for measuring exposure. It follows that UK health and safety duty-holders remain unaware that those present in their buildings may be being exposed to potentially harmful levels of asbestos.

Clearly, what is not measured is seldom well managed and it is argued that UK public buildings, which contain high risk asbestos should have their ambient asbestos fibre levels measured, during normal use, to prove their on-going occupational safety.

**Figure 4: International Comparisons And Asbestos Fibre Concentration Thresholds**




References Used in Figure 4:

1. *"Maximum Asbestos Fibre Level for ACMs in Good Condition": Massey SW, Llewellyn JW and Brown RC (1997), Environmental Exposures To Fibrous Materials, published in Fibrous Materials In The Environment, Institute for Environment and Health, Leicester University, Leicester*
2. *"Mean Asbestos Fibre Level In Schools with ACMs in Good Condition" : Fibrous materials in the environment MRC Institute for Environment and Health p71*
3. *"Ambient Asbestos Fibre Concentration Which Should Not Be Exceeded For Children in School" : 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*
4. *"Fibre Level in Buildings Containing No ACMs" : Massey SW, Llewellyn JW and Brown RC (1997), Environmental Exposures To Fibrous Materials, published in Fibrous Materials In The Environment, Institute for Environment and Health, Leicester University, Leicester*

# The analysis of air samples

In recent years there have been calls for the complete removal of asbestos from all buildings to overcome the legacy of asbestos and to completely eradicate the risk posed by damage to and deterioration of ACMs. Of course, whilst it is commendable that these concerns are being voiced publicly, and that everyone continues to recognise the risks to health associated with asbestos, full consideration needs to be given to the practicalities and scale of work that would be required to meet these ambitions.

The design of many older education buildings means that the only way to completely remove any asbestos present would be to almost completely dismantle parts of them or demolish the entire building. Against this sort of measure, there are no projections on what the cost of this work would be to the UK economy or how any removal costs would compare to the costs of alternative forms of management and reassurance monitoring now available to duty holders and occupiers of buildings. Due to finite finance and resources, it is clearly not feasible to remove all asbestos in the short term.

As detailed earlier, the current regulations impose a ‘duty to manage’ responsibility, but in the interest of avoiding any complacency when it comes to the risks associated with asbestos, it is essential that the regulations should be reviewed regularly and that improvements in best practice are widely adopted in order to better manage asbestos in-situ.

Rather than resorting to full removal of asbestos, modern air monitoring and analytical techniques provide the means to accurately measure any risks to occupants that might be present and enable the appropriate remedial actions to be taken. In the short and medium term, following the example set by countries such as France, Germany and the Netherlands, the focus should therefore be on the improved management of asbestos in schools and other public buildings.

In this way, air analysis utilising powerful scanning electron microscopy can ratify the efficacy of existing asbestos management techniques and prove that asbestos fibres levels are not elevated. Crucially this will provide the reassurance needed that those present in affected buildings are not being exposed to harmful fibre levels.

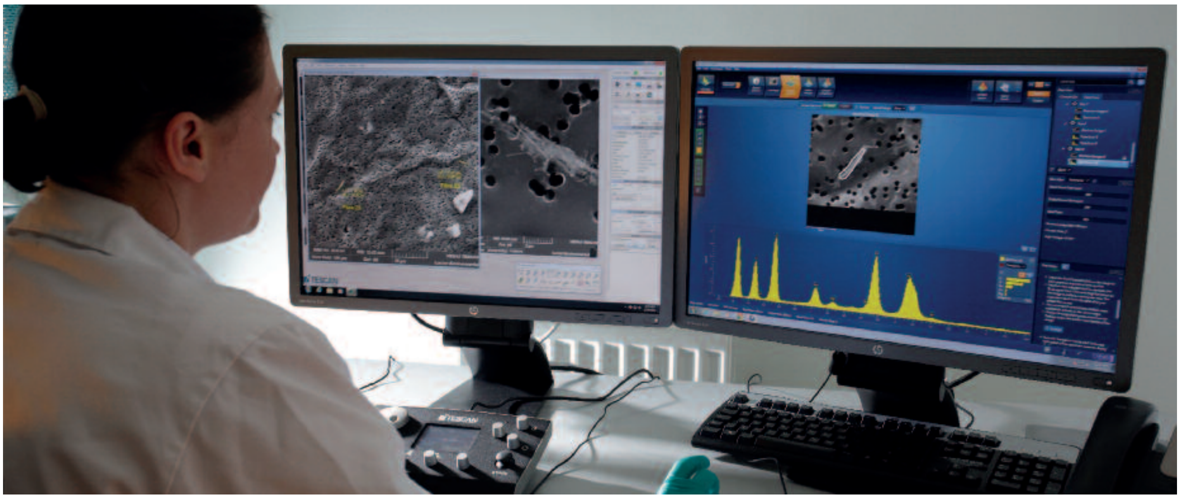
In the UK, air monitoring of airborne dust is currently only required as part of the post work asbestos clearance process and is designed to be used as part of a rigorous system to provide reassurance that a work environment has been properly cleaned. The recommended standard analysis of samples gathered from air monitoring provides quick results but it does not differentiate between asbestos fibres and other sorts of fibres that may be present such as clothing fibres.

This issue is particularly important in school premises where many different types of airborne fibres can be present but where most of them are also likely to originate from clothing or other potential sources (including organic fibres or so called MMMF/man-made mineral fibres) rather than ACMs.

In such circumstances, the analysis of air filter samples using scanning electron microscopy (SEM) can be undertaken in much greater detail than is possible with standard techniques. SEM’s ability to more accurately determine whether asbestos fibres are present means it can better identify the level of any risk that might be present.

In particular, SEM enables asbestos in air to be quantified to very low levels, typically achieving lower limits of detection to 0.0005 f/ml and below, compared to the 0.01 f/ml capability of standard phase contrast microscopy (PCM or PCOM). SEM can also distinguish between different asbestos fibre types and other non-organic fibres using energy dispersive x-ray analysis (EDXA).

As a result, SEM is invaluable for the detailed sampling of ambient or indoor air where the anticipated fibre levels are low or for periodic monitoring of areas to check the potential cumulative exposure on those using the premises. In particular its use would:



- Back up re-inspection surveys. Re-inspections are an exercise in assessing the condition of known hazards as a proxy for measuring the risk. SEM gives an actual risk level at the time of sampling
- Provide actual and direct asbestos risk measurement in locations
- Prioritise risk and target spending on abatement accordingly by avoiding areas that do not present a risk
- Provide longer term occupational exposure assessments
- Answer the question, 'is my room safe?' and identify where fibre levels are elevated before this question is asked
- Bolster any defence against a future claim by demonstrating that the best available practicable technique was used to enable a suitable and sufficient risk assessment to be made.

In this way SEM provides the means for duty holders to find out whether occupants of rooms are breathing in much lower concentrations of asbestos, thus greatly enhancing the ability to manage the asbestos risk present. With an emphasis on preventing potential exposure to asbestos fibres, the detailed forensic records and diagnostic testing provided by SEM analysis not only represents good safety management practice but can also provide proof of prevailing schoolroom conditions at any particular time.

With schools, colleges, local authorities and other owners of older properties increasingly facing health-related compensation claims, SEM can provide the evidence needed to demonstrate that buildings containing asbestos are being well maintained and that those present are not being exposed to dangerous levels of airborne fibres.

In contrast to many other nations, where air monitoring is undertaken as standard practice, the UK commonly uses PCM, rather than TEM or SEM to assess asbestos fibre concentration in the air. This technique was developed in the UK in the early 1960's by the asbestos industry / asbestosis research council (ARC) (see Addingley, 1964; Holmes, 1964 and Roach, 1964).

However, while suitable for those high level exposure environments associated with the handling of asbestos in factories, it is incapable of providing the depth of analysis required by those locations characterised by chronic low level exposure. For example, following damage to a amosite insulation board panel in a school, a PCM "reassurance air test" is typically commissioned. This technique is simply not sensitive enough to identify the asbestos in the air at anything other than a dangerous level.

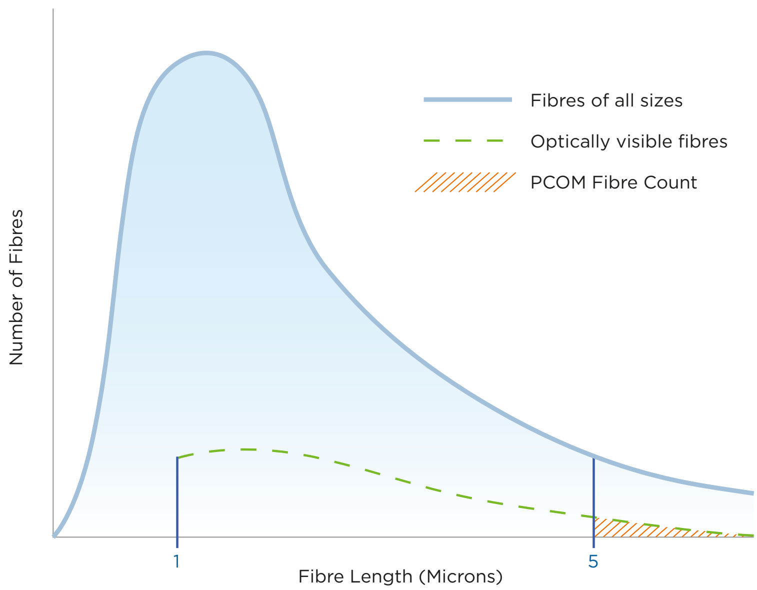
Results from PCM are only an index of exposure, rather than an accurate measurement of the fibres in the air sample, and it is notable that the PCM method can only see and record a small percentage of the total fibres, as Figure 5 suggests, with the red shaded area representing the proportion of the total fibre count recorded by PCM.

Reported fibre concentrations, commonly cited on air monitoring reports derived via PCM produced throughout the UK, of say 0.01 f/ml, are therefore roughly two orders of magnitude higher. This means that a PCM count of 0.01 f/ml actually means that 1 f/ml may be present. The figures are not directly comparable as PCM counts all fibres which are of a certain size, including non-asbestos fibres. However it is suggested that PCM results taken at face value grossly underestimate the number of asbestos fibres and thus the risk presented.

A secondary bias for the layman is arguably introduced through the terminology. In the UK the convention is to report to fibres / ml, rather than fibres / $m^3$. It is notable that the units of f/$m^3$ are used to measure just about every other airborne contaminant. One f/ml is equal to 10 million fibres / $m^3$. Would the public be reassured to know that an air test reporting asbestos fibre concentrations of <0.01 f/ml, could be rephrased to <10,000 f/$m^3$ measured by PCM or <100,000 f/$m^3$ measured by SEM?

The above might well confuse the public who have a legal right to know if they are safe or otherwise. The status quo of typically quoting asbestos fibre levels of <0.01 f/ml is a known unsafe level and is not suitable for providing ongoing reassurance.

**Figure 5: Relationship between total fibre distribution and optical fibre count**




*Source: Eric J. Chatfield, Measurement of Asbestos Fibre Concentrations in Ambient Atmospheres, Royal Comission on Asbestos Study Series, no. 10 (Toronto: Royal Comission on Asbestos, 1983), Figure 6, p.15*

Since the early 1960's fibre measurement techniques have of course developed, as has the need for sensitive and accurate measurement. As we do not have asbestos factories nor asbestos mines now, those techniques used to measure gross fibre concentrations then, through an index of exposure, are no longer suitable for measuring the thankfully much lower concentration but potentially chronic exposure originating from the asbestos within UK public buildings today.

It is therefore argued that within the UK, modern air monitoring techniques should be used to either prove that buildings known to contain amosite and crocidolite asbestos are safe for ongoing use, or elucidate chronic low level exposure so that those materials causing the problem may be safely managed or removed.

As depicted by Figure 5, PCM can only observe the shaded section on the total fibre count in the air. Current air monitoring practice (PCM in the UK) at best makes us "blind" to the problem and at worst, provides duty holders and the public with an unjustified assurance of safety.

# The Precautionary Principle

The Precautionary Principle (24) is a risk management concept that requires the development of a strategy to cope with possible risks where scientific understanding is yet incomplete. The principle aims at ensuring a higher level of protection through preventative decision-taking in the case of risk.

Although widely applied in a number of fields, the Precautionary Principle is particularly relevant for occupational safety matters and for dealing with the presence of asbestos in UK schools and other buildings, where the scale of the problem and the risk to occupants has not been properly assessed.

In the circumstances, until the scientific evidence is available, rigorous measures should be taken to prevent fibre release. In addition, with other EU member states already having effective "environmental control limits" for asbestos in place, it is argued that the UK should adopt similar measures urgently as the evidence strongly suggests that chronic low level exposure from in-situ asbestos is causing, and will continue to cause, excessive mesothelioma deaths.

# Conclusion

The UK was once the world's largest importer of asbestos and its incorporation in commonly used building materials throughout the 1950s and 1960s means that it remains in many shops, houses, hospitals, offices and schools that are still in use today.

The UK's historic record in the import and use of ACMs has contributed to our position as having the worst asbestos health-related problem in the world. The UK has more deaths from mesothelioma than any other country and we are currently in the midst of a mesothelioma epidemic as the long latency period of the disease begins to play out.

Even worse, the cumulative effects of chronic low level exposure to asbestos that remains embedded in our public buildings will continue to have an impact long into the future, with the younger age of first exposure and increased life expectancy of children making them particularly vulnerable to the deterioration of asbestos materials in schools.

Despite this situation, the UK's health and safety regulations and preventative measures remain weaker than in other countries with less of a problem.

As a result, despite the technology being available to better determine what exposure risks people who live, work and visit our public buildings are facing every day, in the vast majority of cases the duty holders and those responsible for ensuring safe working environments simply do not know what those risks are.

UK health and safety law is based on the commensurate adoption of best practice as and when it becomes available. Regrettably this has not been the case with asbestos analysis methods with the ability of modern air sampling techniques to accurately measure the risk present and prevent potentially dangerous exposures to fibres.

It is time for the UK to address this anomaly and adopt the much tighter measures and controls already in force in other European countries.

Campaign groups have long called for the introduction of a proactive programme of air sampling in schools and other buildings containing high risk asbestos and the establishment of more effective control limits to ensure that occupational exposure assessments are capable of proving that buildings are safe for continued use.

To respond to these calls the UK must now consider updating its health and safety guidance to ensure that actual asbestos health management techniques remain best practice and are equal to the task of effectively preventing ongoing exposure to potentially dangerous levels of asbestos fibres in the air.

Specifically, the "Duty to Manage" asbestos regulation (HSE, 2012, Control of Asbestos Regulations, Regulation 4) could be amended to measure fibre concentrations effectively during the normal occupation of these areas, where high risk asbestos is known to be present, particularly in buildings occupied by children.

This would ratify that in-situ asbestos is indeed safe or enable targeted and cost effective asbestos abatement. Regulation 4 stipulates a "Duty to Manage": however, what is not measured is seldom managed.

## Sources highlighted in text:


1 - Post Implementation Review of the Control of Asbestos Regulations 2012. Para 153. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/598574/post-implementation-review-of-the-control-of-asbestos-regulations-2012.pdf

2 - http://www.hse.gov.uk/services/education/asbestos.htm

3 - http://www.hse.gov.uk/asbestos/regulations.htm

4 - http://www.who.int/bulletin/volumes/92/11/13-132118/en/

5 - http://bc-legal.co.uk/images/pdf/asbestoslookingtothefuture.pdf

6 - http://www.hse.gov.uk/aboutus/meetings/iacs/acts/watch/271010/watch-asbestos-annex-4.pdf

7 - HSL Summary of fibre concentrations in CLASP construction schools containing asbestos HSL/2007/22 Introduction p1. para 3.6 p12 (http://docplayer.net/53451529-Asbestos-in-schools-the-scale-of-the-problem-and-the-implications.html

8 - https://www.ucu.org.uk/media/4999/Asbestos-in-schools---all-party-parliamentaryreport-Feb-2012/pdf/asbestos_in_schools_booklet_lo_res.pdf

9 - https://www.publications.parliament.uk/pa/cm201213/cmselect/cmeduc/writev/1056/ M2.htm

10 - https://www.ncbi.nlm.nih.gov/pubmed/11108782

11 - http://www.hse.gov.uk/asbestos/assets/docs/exposure.pdf

12 - https://www.ucu.org.uk/media/4999/Asbestos-in-schools---all-party-parliamentary-report-Feb-2012/pdf/asbestos_in_schools_booklet_lo_res.pdf

13 - http://www.actuaries.org/ASTIN/Colloquia/Berlin/Salvatori_Santoni_Michaels.pdf

14 - https://www.ncbi.nlm.nih.gov/pubmed/7776771

15 - http://www.hse.gov.uk/statistics/causdis/mesothelioma/mesothelioma.pdf

16 - Howie, R, (2018), Mesothelioma deaths in teachers and nurses in Great Britain, Environmental Health Scotland: 29(4): 35-37

17 - http://www.hse.gov.uk/pUbns/priced/hsg248.pdf

18 - http://www.hse.gov.uk/pubns/priced/l143.pdf (paragraph 453)

19 – Asbestos testing: up in the air. https://sm.britsafe.org/asbestos-testing-air

20 - http://www.iehconsulting.co.uk/IEH_Consulting/IEHCPubs/HumExpRiskAssess/sr2 exesum. pdf

(Medical Research Council - Institute for Environment and Health, 1997, “Fibrous Materials in the Environment - A Review of Asbestos and Man Made Mineral Fibres”, p4.”

21 - Robin Howie - https://www.healthandsafetyatwork.com/content/asbestos-buildings-risks

22 - https://academic.oup.com/annweh/article/55/6/565/175990

23 - Personal communication with J. Kosters, 2018, of Adamstars, The Netherlands

24 - EU Precautionary Principle http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2000:0001:FIN:EN:PDF