Te Whatu Ora
Health New Zealand

The Management of Asbestos in the Non-Occupational Environment

Guidelines for Public Health Officers

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Preface

The unique properties of asbestos have made it a valuable and, in some applications, an essential commercial material for which manufactured substitutes are still inadequate or very expensive.

Before the health risks were more completely appreciated, asbestos was regarded as a ‘miracle’ fibre of great versatility and usefulness.

Public concern regarding ambient levels of asbestos fibres in the air has arisen from an awareness that occupational airborne exposures to asbestos, especially in the extraction and manufacturing processes in the past, caused serious health problems, including asbestosis, lung cancer and mesothelioma.

In 1994, the Public Health Commission (PHC) released its policy advice to the Minister of Health on hazardous substances, which included the recommendation that ‘... the PHC, in consultation with the ... [other agencies] ... prepares recommendations on the control of asbestos outside the workplace for the purpose of avoiding or reducing unacceptable risks to health’ (PHC 1994). The Ministry of Health then published a guideline on *The Management of Asbestos in the Non-Occupational Environment* in 1997 as a result of this recommendation.

To protect the health of the public, the policy on the management of asbestos needs to be focused on the risks to individuals that asbestos may present and on sensible action that is related to the level of risk.

These guidelines are directed at non-workplace exposure to asbestos in air. The risk to health from workplace exposure is a matter for WorkSafe New Zealand (WorkSafe).

These guidelines are intended to assist public health officers address public concerns and give appropriate advice. In addition to drawing together background information, it suggests a protocol for a response related to the likely level of risk to health, and considers how risks may be evaluated and communicated.

This 2023 revised edition builds on the 1997, 2007, 2013, 2016, and 2017 editions. Changes in the 2023 the guidelines are predominately administrative to reflect the 2022 health sector reforms which saw Te Whatu Ora established, and other reforms (eg, establishment of Taumata Arowai as the drinking water regulator.

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Chapter 1: Risk assessment

1.1 Hazard identification

Asbestos

Asbestos is a common term describing a variety of naturally occurring hydrated silicate minerals which exhibit properties rendering them useful in manufactured products. Asbestos is composed of silicate chains bonded with magnesium, iron, calcium, aluminium, and sodium or trace elements to form long, thin, separable fibrils. These fibrils are arranged in parallel and a single microscopically-observed asbestos fibre can represent multiple fibrils that have not separated.

The morphology of the asbestos fibres differs between the groups. The most commonly mined forms of fibrous asbestos are:

- Serpentine: chrysotile, an iron–magnesium silicate white in colour
- Amphiboles: crocidolite, an iron–sodium silicate blue in colour; and amosite, an iron and magnesium silicate grey-brown in colour. Actinolite, tremolite and anthophyllite occur in both fibrous and non-fibrous forms and have rarely been mined as commercial asbestos. Amphiboles are distinguished readily only on basis of variation in chemical composition.

Both groups are naturally fibrous but the sizes (length and width) and the shapes of industrial fibres may differ. Figure 1 illustrates the different types of asbestos fibres and their theoretical formulae.

Chrysotile fibres are a bundle of thousands of agglomerated fibrils, which in section appear like a scroll of paper resulting in a vast surface area and possess elasticity, flexibility and good tensile strength. It is based on an infinite silica sheet (Si_2O_5) in which all the silica tetrahedra point one way. On one side of the sheet structure, and joining the silica tetrahedra, is a layer of brucite, $Mg(OH)_2$. Chrysotile fibres have a width of 0.1–1.0 μm (fibrils are less than 0.020 μm) and are thinner and curlier compared with those in the amphibole group (see Figure 2).

The amphibole group are straight, hard, sharp, needle-like structures with a double chain of silica tetrahedral which makes it very strong and durable. The external surface of the crystal structures of the amphiboles is quartz-like, and has the chemical resistance of quartz. The fibres may break longitudinally to form very fine fibrils. Crocidolite retains good flexibility and has high tensile strength. Fibres are 1–2 µm in width (fibrils 0.080µm) and up to 70 mm long. Amosite fibres are quite flexible and are weaker than the other forms. Fibre width is 1–2 µm (fibrils 0.100 µm) and length is up to 70 mm (see Figure 3).

Mechanisms of action

The exact mechanism responsible for the carcinogenicity of asbestos fibres is not known although available data indicates that both interaction between fibres and cellular components and cellular mediated pathways may be involved (ATSDR 2001a). For a given concentration of asbestos in air, the degree of exposure (magnitude or intensity, frequency and duration), fibre dimension (length and diameter), fibre durability or persistence in the lung and iron content are important determinants of asbestos toxicity (ATSDR 2001a). These fibre properties are briefly summarised below.

Fibre dimension (length and diameter)

Fibre dimension affects respirability (respiratory zone falls off above aerodynamic diameters of 5 µm) and clearance by alveolar macrophages (Donaldson and Tran 2004). These properties of asbestos fibres make them accessible to lung and other tissues through inhalation. It is believed that the dimensions of the asbestos fibre determines how far into the lungs it is likely to be deposited and how quickly it is cleared. Longer fibres induce a more vigorous acute and chronic inflammatory response than shorter fibres. Longer fibres are also more fibrogenic and carcinogenic than shorter fibres. The exact basis for these size-dependent differences is unclear (Goodglick and Kane 1990). Short fibres are cleared more efficiently than longer ones. Fibres >100 µm long are not respirable and hence do not pose a risk, unless they are first broken down into shorter fibres (enHEALTH 2005). Literature reviews of fibre sizes have concluded that the shorter fibres present low or no risk to human health (ATSDR 2003). However several studies (Dodson et al 2003; Dodson et al 2005; Suzuki et al 2005; Dodson et al 2007) report the presence of very short fibres in lung and pleural tissue from patients with malignant mesothelioma. Furthermore, some animal studies found that short, thin chrysotile fibres were contributing to the induction of malignant mesothelioma and concluded that asbestos fibres of all lengths induced pathological responses including the induction of experimental mesothelioma (Suzuki et al 2005). Wide fibres (diameter greater than 2 to 5 µm) tend to be deposited in the upper respiratory tract and cleared.

Fibre durability

Fibre durability is believed to be a major determinant of fibre-induced pathogenicity. Fibres whose chemical structure renders them wholly or partially soluble once deposited in the lung are likely to either dissolve completely, or dissolve until they are sufficiently weakened focally to undergo breakage into shorter fibres. The biopersistence of fibres may explain their ability to produce diseases with long latency periods (Broaddus 2001). The remaining short fibres can then be removed through phagocytosis and clearance. The largest size asbestos particles tend to deposit on the nasal mucosa or the oropharynx and are sneezed out or swallowed and never reach the lungs (NIOSH 2011). Durability seems to be greatest for amphiboles and less for chrysotile (Lippman 1984). For example acidic conditions (eg, in the stomach) and high temperatures will cause chrysotile fibres to dissolve rapidly while the amphibole fibres are degraded more slowly than serpentine fibres of the same dimensions (Schreir 1989).

Fibre type

There has long been considerable debate about the health risks associated with specific types of asbestos (McDonald and McDonald 1997). Although all forms of asbestos are considered hazardous, different types of asbestos fibres may be associated with different health risks. Results of several studies suggest that amphibole forms of asbestos may be more harmful than chrysotile, particularly for mesothelioma risk, because they tend to stay in the lungs for a longer period of time (ATSDR 2001a; IARC 2012a). Scientific reviews support that the difference in mesothelioma potency, that is, the estimated risk of mesothelioma associated with a unit increase (in fibre-years) in exposure to amphibole versus chrysotile asbestos fibres is considerable. However, estimates vary. For example, Hodgson and Darnton (2000) estimated that the potency differential between chrysotile and amphibole asbestos for lung cancer was between 1:10 and 1:50. Bardsley (2015) refers to one estimate suggesting the risk for mesothelioma according to fibre type was 1:100:500 for chrysotile, amosite, and crocidolite, respectively. In a 2010 analysis, which included more mesothelioma cases from updated cohorts, Hodgson and Darnton (2010) estimated that the ratio of potency for mesothelioma was smaller:1: 14 for chrysotile versus amosite and 1:54 for chrysotile versus crocidolite.

The risk of lung cancer associated with exposure to chrysotile compared with amphibole fibres is still highly contested. Hodgson and Darnton (2000) estimated the potency differential between chrysotile and amphiboles for lung cancer to be between 1:10 and 1:50. Berman and Crump (2008) reported similar findings ─ they estimated that chrysotile was less potent than amphiboles by a factor ranging between 6 and 60, depending on the fibre dimensions considered.

Iron content

The presence of iron in the fibres or the ability of the fibres to absorb and accumulate iron is a suggested mechanism for explaining the toxic and particularly carcinogenic effects of asbestos (Fubini and Mollo 1995). The presence of iron in the fibres (which may contain up to 30% of iron w/w) can act as a catalyst for the Fenton reaction that generates highly toxic hydroxyl radicals from hydrogen peroxide (Broaddus 2001). This seems to be also a key factor for asbestos toxicity and for the formation in the lung of the asbestos bodies that are the hallmarks of asbestos exposure (Ghio et al 2004). All types of asbestos contain iron cations, either as part of their crystalline lattice structure (crocidolite and amosite, and amounting to as much as 27% by weight in crocidolite) or as a surface impurity (chrysotile). Reactive oxygen species may be generated at the surface of asbestos fibres by chemical reactions that are catalysed by the iron component of the fibres. Or they may be the result of frustrated phagocytosis of asbestos fibres by alveolar macrophages or neutrophils (Shukla et al 2003).

Figure 1: Types of asbestos fibres and their theoretical formulae

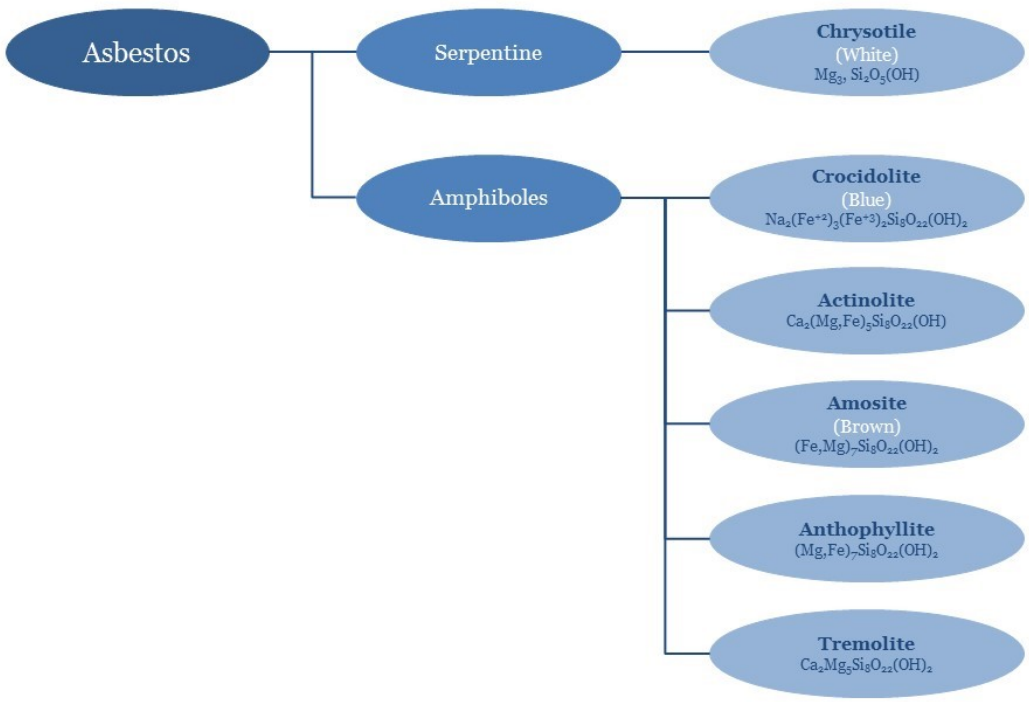

Figure 2: Serpentine asbestos

Source: **www.atsdr.cdc.gov**

Figure 3: Amphibole asbestos

Source: www.atsdr.cdc.gov

Kinetics

Health effects due to asbestos exposure have been clearly associated with inhalation where inhaled asbestos fibres are deposited in the upper and lower respiratory tracts. The relevance of the oral intake of asbestos fibres for human health is unclear. For this reason, only the deposition, retention and clearance of fibres from the human lungs are described.

Deposition

The degree of penetration in the lungs is determined by the fibre dimension (length and diameter), with thin fibres having the greatest potential for deep lung deposition (NTP 2014). In addition to the degree of exposure , the carcinogenic potential of asbestos fibres is associated with fibre durability in the lung and capacity to translocate across membranes (ATSDR 2001a). It is believed that the dimensions of the asbestos fibre determines how far into the lungs it is likely to be deposited and how quickly it is cleared. Wide fibres (diameter greater than 2 to 5 μm) tend to be deposited in the upper respiratory tract and cleared.

Clearance and retention

Fibres whose chemical structure renders them wholly or partially soluble once deposited in the lungs are likely to either dissolve completely, or dissolve until they are sufficiently weakened to undergo breakage into shorter fibres. Some of the smaller inhaled asbestos fibres are deposited on the surface of the larger airways where some of them are cleared by mucociliary transport and swallowing (Broaddus 2001). The remaining short fibres can then be removed through phagocytosis and clearance. Short fibres are cleared more efficiently than longer ones (enHEALTH 2005).

Several mechanisms are involved in the clearing of fibres from their site of deposition, ie mucociliary clearance, translocation of alveolar macrophages containing small fibres, and uptake by epithelial cells lining the airways. The most important physiological clearance mechanism is by alveolar macrophages with respect to phagocytosis. Short fibres are easily phagocytised, while the clearance for fibres longer than 20 μm is prolonged. Inflammatory conditions in the lung (for example, smokers) also contribute to impairment of alveolar macrophage-mediated mechanical clearance. One of the most effective clearance mechanisms (mucociliary clearance) is impaired by smoking. Co-exposure to tobacco smoke and asbestos fibres substantially increases the risk for lung cancer and the effect is at least additive and the heavier the smoking, the greater the risk (WHO 2014). Overall, the clearing mechanisms are very effective (95–98%) in non-smokers, although some fibres can remain in the alveolar regions.

Mechanisms of toxicity

The exact mechanisms by which asbestos causes disease are not fully clear (ATSDR 2001a; Barile 2010). In the IARC report, Kane (1999) proposed five mechanistic hypotheses involved for pathogenicity of asbestos:

1. Fibres generate free radicals that damage DNA (eg, see iron content above).
2. Fibres interfere physically with mitosis.
3. Fibres stimulate proliferation of target cells.
4. Fibres provoke a chronic inflammatory reaction leading to prolonged release of reactive oxygen/nitrogen species from macrophages.
5. Fibres act as co-carcinogens or carriers of chemical carcinogens to the target tissue.

Further research is needed to clarify evidence in favour of or against any of these proposed mechanisms.

Health effects

Asbestos is a proven human carcinogen (IARC Group 1). All forms of asbestos can cause cancer (WHO 2010). The inhalation of airborne asbestos in significant quantities causes mesothelioma (a cancer of the pleural and peritoneal linings), asbestosis (fibrosis of the lungs) (WHO 2014) and cancer of the lung, larynx and ovary (IARC 2012a; WHO 2014). Some scientists believe that the amphibole type is more potent in causing mesotheliomas than the serpentine type (chrysotile) (IARC 2012a).

Asbestosis

Asbestosis refers to diffuse or multi-focal fibrosis (scarring) in the lungs caused by the inhalation of asbestos fibres. It is considered that this disease only occurs in those who have been exposed to considerable concentrations of asbestos over a long time. The symptoms do not usually appear until about 20 to 30 years after the first exposure to asbestos. The person develops an insidious onset of shortness of breath and dull chest pains. Fibres penetrating to the peripheral air spaces initiate alveolitis, which, if chronic, results in scarring and fibrosis. The extent of lung inflammation and destruction is related to the amount of asbestos retained in the lungs, the fibre type and length, and individual susceptibility. Some evidence suggests that more retained asbestos is required to produce asbestosis than to produce asbestos pleural plaques.

The risk of asbestosis is insignificant for those who do not work with asbestos. The disease is rarely caused by neighbourhood or family exposure (US EPA 2007). High fibre doses (25–100 f/mL/yr) are generally required to produce clinically significant asbestosis within an individual's lifetime, with milder fibrosis at lower dose levels (Smartt 2004). Asbestosis is a marker of high asbestos exposure in individuals and its prevalence is a potential indication of high exposure in populations.

Non-malignant pleural conditions

Pleural plaques, and the less common diffuse pleural fibrosis, have been correlated with higher lung burdens of amosite, crocidolite and probably chrysotile than those of the general population. Cases are asymptomatic. They tend to develop after long latency periods, usually more than 20 years after exposure. Prevalence is related to duration of exposure and possibly to peaks of exposure. Although pleural plaques are not precursors to lung cancers, evidence suggests that people with pleural disease caused by asbestos exposure may be at increased risk of lung cancer (ATSDR 2001a).

Benign diseases of the pleura may be the only manifestations of exposure to asbestos (occupationally and even non-occupationally). They are considered to be important as they are likely to be the most common way in which those who may be affected by asbestos exposure can be identified (HEI – Asbestos Research 1991).

Carcinoma of the lung

The most common form of cancer caused by asbestos is bronchogenic carcinoma or lung cancer. Epidemiological studies in the occupational setting have confirmed an association between asbestos exposure and lung cancer, even in non-smokers. This association is considered causal, although the rates in various studies have differed. The latency period is measured in years and appears to be directly related to cumulative exposure. Exposure to asbestos in combination with cigarette smoke results in more than additive risk of lung cancer. Asbestos workers who smoke are about 90 times more likely to develop lung cancer than people who neither smoke nor have been exposed to asbestos (US EPA 2007).

Mesothelioma

Mesothelioma is a rare cancer of the cells lining body cavities. It is the classic tumour associated with asbestos exposure, and is unrelated to smoking (Muscat and Wynder 1991). Epidemiological evidence shows that approximately 70 to 90 percent of mesothelioma cases can be related to asbestos exposure (Youakim 2005). It is reasonable to assume that virtually all cases of mesothelioma are linked with asbestos exposure (US EPA 2007).

Cases of death from mesothelioma have been reported in studies of workers or of people exposed environmentally to each of the main types of asbestos, predominantly chrysotile, amosite, crocidolite and tremolite. There are several studies that suggest that amphibole asbestos (tremolite, amosite and crocidolite) may be more potent than chrysotile (IARC 2012a). The latency period is usually 35 to 40 years or more from the time of first exposure, although shorter periods have been recorded. The initial symptom is likely to be chest pain. Most cases have been associated with occupational exposure to asbestos or contact with contaminated clothing of asbestos workers (IARC 1987).

Asbestos-containing materials

Because of their exceptional insulating, fire-resistant and reinforcing properties, asbestos-containing materials have been utilised widely: in buildings in surface-applied finishes (for acoustical, decorative and fire-retardant purposes); in asbestos-cement products in sheet and other moulded forms; as thermal insulation in the construction of buildings; as well as in equipment used in buildings.

After about 1960, chrysotile was predominantly used in asbestos-containing materials in buildings such as asbestos-cement products, decorative coatings, vinyl sheet floor covering (Lino) and tile flooring. Crocidolite and amosite are also likely to be present, though in smaller amounts, in products prior to about 1960.

Over the last 50 years the removal of sprayed-on asbestos insulation materials from public buildings has increased and now few buildings still have this material. Decorative coatings in buildings and homes have also been largely removed as redecorating becomes necessary. Much asbestos-backed floor covering has been removed as well but, due to the difficult nature of this activity, some floor coverings have been overlaid with new coverings. By far the largest quantity of asbestos-containing materials around today is textured ceilings and wall cladding followed by cement sheet. These materials usually do not present a high risk unless they are disturbed. To a considerable extent, they are also gradually being removed as upgrading or demolition takes place.

The presence of asbestos in materials cannot be determined definitively by visual inspection. Actual determinations can only be made by instrumental analysis (polarised light microscopy (PLM), scanning electron microscopy (SEM), or transmission electron microscopy (TEM)). It is best to assume that the product contains asbestos until laboratory analysis proves otherwise.

In the home the primary asbestos-containing materials are:

- surfacing materials (such as asbestos-cement products used for cladding and roofing, and decorative/textured internal coatings on ceilings)
- thermal and fire insulation
- moulded materials (such as asbestos-cement products for gutters and down-pipes)
- electrical backboards
- backings to vinyl sheet floor coverings, and in the matrix of vinyl tiles.

Much less common asbestos-containing material may occur in the home as:

- lagging or insulation in old heating appliances, or around pipes and older hot water cylinders
- some external textured coatings
- plastic products, caulkings and other composites
- a woven sheath around old vulcanised India rubber insulated wiring
- built-up roofing felts.

Old household items with asbestos-containing material may include: asbestos simmer mats for stoves, oven gloves, mats on ironing boards, fire blankets and other asbestos textiles, electric heaters, hair dryers and older model toasters. All these items are unlikely to be in common use today.

Other sources of asbestos dust in the home may include dust from automotive friction materials or take-home dust from occupational exposure to asbestos.

In public buildings used as workplaces, asbestos-containing material may occur as:

- surfacing materials (eg, sprayed or trowelled asbestos-containing material on surfaces such as decorative finishes on ceilings, fireproofing materials on structural members, acoustical asbestos-containing material on the underside of concrete slabs or decking, and fire- and heat-resistant linings to boiler rooms)
- thermal system insulation (lagging and moulded insulation of heating and cooling service pipes, ducts, boilers and tanks to prevent heat loss, gain or condensation, and thermal insulation coatings or layers in the structure)
- miscellaneous asbestos-containing material such as asbestos-cement panels, cladding, roofing, pipes and other mouldings, asbestos-containing ceiling or floor coverings, and incidental uses in packings, friction materials, textiles, plastics reinforcement, gaskets and filters.

Asbestos-cement products

Composite materials containing Portland cement, sand and some form of fibrous reinforcement may generically be called 'fibre-cement' products. These products occur in housing and public buildings.

Chrysotile, in particular, is resistant to alkaline cement, which gives it an advantage over other reinforcing fibres. From 1982 to the present day, cellulose fibres have replaced asbestos in the make-up of a proprietary product called *New Hardiflex*.

In asbestos-cement products, the asbestos fibres are bound in the cement/sand matrix, often in small bundles just visible to the naked eye (usually about 10–12 percent asbestos). The material tends to become more brittle with age. Surface deterioration can occur due to acid rain, abrasion, or persistent damp conditions aided by organic growths.

Asbestos containing products typically used in housing included *Fibrolite* (from 1972 to 1982), *Durock* (up to 1974), *Coverline* or *Highline* profiled sheets (1972 to 1982), *Hardiflex* or *Hardiplank* (up to 1982), *Harditherm* (1972 to 1982) and *Durotherm* (up to 1974).

The *Fibrolite*, *Durock and Polite* mix was similar and contained chrysotile and a small amount of amosite. The mix was mouldable into corrugated and other forms such as gutters. Early products, up to the 1950s, probably contained crocidolite and the percentage of asbestos was higher, reputedly up to 50 percent. *Hardiflex* was not a mouldable material but was more flexible. (Fletchers produced an equivalent product, some of which was in the form of siding.) Sheet material may be found internally as linings in wet areas such as bathrooms, or in storage areas, occasionally as bench tops. *Harditherm* and *Durotherm* (22 percent asbestos) were used for fire protection and insulation. They were softer and easily nailed; they may become friable at the edges.

Summary of uses

1. Roofing: bold roll corrugated sheet (super 6); narrow roll corrugated sheet, shingles.
2. Walls: shingles, flat sheet (generally 9 mm), profiled sheet (eg, Coverline and Hiline).
3. Ancillary: guttering and down-pipes in various sizes, other moulded items (eg, garden troughs), roofing components (eg, verge and ridge trim).

Decorative coatings

Decorative internal coatings produced between 1964 and 1983 generally contained 5–9 percent chrysotile asbestos, and were applied as textured ceilings in housing and public buildings. The coating was able to mask imperfections in a substrate otherwise unsuitable for paint finishes. In public buildings, similar coatings were applied for decorative and/or acoustic purposes on ceilings and other surfaces out of reach. Also textured external/internal paint finishes and fake brick overlays were introduced. Use of product containing asbestos probably ceased around 1984.

The asbestos fibres and other fillers (such as expanded vermiculite and polystyrene) were bound together with adhesives to form the product. Portland cement was not included. Trade names of decorative coatings include *Glamortex* and *Whispar*. Licensed contractors were generally used by the producers of the products. Nuplex Industries, for example, are able to identify from their records particular jobs, their dates and the contractors used.

The products up to the late 1970s may be beige in colour (those containing vermiculite or perlite); those from 1980 to 1983 may be white (containing expanded polystyrene granules). The coatings are rather soft, because of the expanded materials in them, and could be damaged by impact or abrasion. Despite the soft nature of the coating, the fibres are generally well bound in a matrix of adhesive and filler-binders unless damaged or disturbed, when the material can become friable. The coating may be softened by water, and any areas that have become damp could suffer deterioration and poor adhesion to substrates; after drying out the material may be friable.

External decorative textured coatings were also made, using resin binders. Use is likely to have ceased around 1984.

Vinyl tile and sheet

There are two categories of resilient floor coverings containing asbestos: sheet material, consisting of a polyvinyl chloride layer with a chrysotile paper backing, and floor tiles, in which chrysotile is uniformly dispersed throughout the material. Vinyl-asbestos floor tile is made of 15 percent polyvinyl chloride (and sometimes asphalt) as the thermoplastic binder, with 10 to 20 percent asbestos and other mineral additives and pigments. The products may have been installed up to 1989. When sheet material is removed, the backing tends to remain adhered to the floor by the glue layer, presenting problems for safe removal. Vinyl sheet floor covering may be referred to as *Lino*.

The vinyl-asbestos floor tile must be regarded as a special type of asbestos-containing material in that abrasion in normal use can release dust if not properly maintained. Properly waxed, these floor coverings can be considered as encapsulated. However, buffing, wax stripping and other abrasive treatments can cause the release of fibres. Unique analytical problems arise in examining dust from such floors, and most fibres are less than 3 µm in length (HEI – Asbestos Research 1991).

Asbestos-containing material generally only in larger buildings

The following are types of asbestos-containing material that are largely found only in larger buildings.

- **Acoustic plaster soundproofing** is a firm, open-pored, plaster-like material, applied by trowel. The soundproofing material is usually exposed and not painted.
- Asbestos-containing material used in **insulation used for thermal system insulation** (TSI) – air-conditioning ducts, hot and cold water pipes, hot water reservoirs, pressure tanks, and boilers – is generally covered with a fabric or metal jacket. Fire doors often contain laminates of asbestos materials covered by wood or metal. The asbestos-containing material enclosed by the outer coverings is likely to be friable. These are old techniques and unlikely to be found today.
- A number of methods of **lagging** have been used on boilers, condensate tanks and steam headers; and pipes carrying steam, hot and chilled water and condensate, including:
  - raw asbestos/water mixture (or pre-formed asbestos blocks attached to the underlying surface) with an outer layer of wire-netting reinforcement finished with a cement of fine clay/asbestos
  - pre-formed pipe lagging of asbestos-containing material, usually in two halves wrapped in calico and traditionally painted red or white
  - asbestos paste to finish lagging around valves and bends, and as repair to damaged areas.

These are older techniques that are not likely to be used today.

Typical concentrations of fibres in various environments

The outdoor environment

Typical concentrations of asbestos fibres in the outdoor environment provide a useful yardstick for comparison with indoor environments. Examples of reported values are 0.1 f/L (fibres per litre), with more than 0.1 f/L downwind of local sources, such as vehicle braking (ATSDR 2001a). Fibre concentrations (fibres >5 μm in length) in outdoor air ranged between 0.1 and about 10 f/L, levels in most samples being less than 1 f/L based on surveys conducted in Austria, Canada, Germany, South Africa and the USA before 1986 (WHO 1998). A later survey carried out in Canada, Italy, Japan, the Slovak Republic, Switzerland, the United Kingdom and the USA showed means and medians of between 0.05 and 20 f/L (WHO 1998). The usual concentrations are 0.01 f/L in rural areas and up to 0.1 f/L in urban areas (ATSDR 2001a).

Public and residential buildings

Airborne asbestos concentrations in residences containing asbestos-containing material (ACM) are often reported combined with those for schools and other buildings as the number of sampled residences reported in the literature is small.

Reported concentrations in residential buildings all relate to building with asbestos-containing materials, which were, or were suspected of being, friable or were being damaged. The concentrations ranged from ‘not detected’ to 2.0 f/L but were generally in the range of 0.2 f/L to 0.4 f/L (Bignon et al 1989; CPSC 1983; HEI – Asbestos Research 1991; WHO 1986). ATSDR (2001a) suggests that the background indoor air levels average around 0.20 f/L.

Typical concentrations of asbestos fibres in public buildings, even those with friable asbestos-containing materials, are within the range of those measured in ambient air. Fibre concentrations (fibres >5 μm in length) in buildings in Germany and Canada reported before 1986 were generally less than 2.0 f/L. Mean values reported in surveys in Belgium, Canada, the Slovak Republic, the United Kingdom and the USA were between 0.05 and 4.5 f/L. Only 0.67 percent of chrysotile fibres were longer than 5 μm (WHO 1998).

Campopiano et al (2004) found a maximum level of 2.2 f/L in 59 Italian schools with ACM. The concentration exceeded the acceptable level of 2 f/L for re-occupancy following removal only in areas in which the ACM was undergoing continuing disturbance or seriously damaged.

Lee and Van Orden (2008) evaluated the results from 752 US buildings (only five were residences) with ACM sampled for defendants involved in asbestos in buildings litigation.

Airborne asbestos was not found in 64 percent of indoor samples and no airborne asbestos ≥5 μm long was found in 97 percent. The mean indoor concentration of fibres ≥5 μm was 0.12 f/L.

The ATSDR's toxicological profile on asbestos reports indoor concentrations ranging from about 0.03 to 6 f/L. However concentrations depend on the amount, type and condition of ACM used in the building, eg, asbestos in floor tiles is less friable than that in sprayed coatings and release of fibres from ACM is sporadic and episodic (ATSDR 2001a).

Caretaker, maintenance, and renovation personnel may disturb or damage ACM during their work resulting in brief, relatively high exposure episodes. Such episodes have been poorly characterized. However there is no evidence that episodic peaks in exposure affect disease risk other than affecting cumulative exposure (ATSDR 2001a).

Release of asbestos fibres from asbestos-containing material

Intact asbestos-containing material is not a risk merely by its presence. Potential health problems only occur if asbestos fibres become airborne. Fibres are released when physical actions (deliberate or accidental) disturb the surface. Asbestos-cement materials will release fibres when sawed, drilled or otherwise worked or damaged. Materials such as asbestos-cement pipe can release asbestos fibres if broken or crushed when buildings are demolished. Other asbestos-containing material, such as decorative coatings, acoustic insulation and thermal system insulation, is vulnerable to damage during building maintenance operations, from vandalism and accidental damage. The use of power tools to drill and cut through asbestos-cement material can generate a significant number of airborne fibres.

In a small study undertaken for claimants in litigation against the manufacturer of amphibole asbestos-contaminated attic insulation[4] three US homes were sampled over three to four days during various activities. Background air samples were below the limit of detection or very low. Activities included cleaning in the attic, removing the insulation, and cutting a hole in the ceiling of a living space below insulation. The average depth of insulation above the ceiling was 10 cm and the hole was of a size that might be needed to install a recessed light (Ewing et al 2010).

Release of asbestos fibres during removal

During the disturbance and removal of friable spray-on asbestos in multi-storey buildings, high concentrations of asbestos fibres have been reported outside the enclosures where work was taking place (IPCS 1989). In the examples given, before work commenced, the

[4] Vermiculite attic insulation is contaminated with amphibole asbestos (mainly tremolite, winchite and richterite) at concentrations of less than 1 percent.

background average concentration was less than 0.2 f/L. During the removal phase, concentrations outside the enclosures increased to between 14 and 290 f/L (generally around 70 f/L) then they declined over 16 to 35 weeks to between 1.0 f/L and 0.4 f/L. During a simulated maintenance activity on sprayed asbestos, a local concentration of around 30 f/L was observed. Such levels are unlikely to be reached during careful removal of asbestos-cement materials from the home. However, using electrical sanders to remove the backing material of vinyl sheet covering or Lino will produce significant airborne fibres.

Release of asbestos fibres during normal wear and weathering

Fibres can also be released naturally through corrosion and weathering of asbestos-cement products. The measurement of fibres released from corroded and weathered asbestos-cement products has been attempted by Spurney (Bignon et al 1989). Investigations measured the release of fibres in simulated wind speeds between 1 and 5 metres/sec. The results showed that:

- Asbestos-cement surfaces corrode and weather as a result of aggressive atmospheric pollution (eg, sulphur dioxide, aerosols and acid rain) in proportion to the acidity of the rain and concentration of pollutants
- The surface cement matrix is destroyed and a layer approximately 0.1–0.3 mm of free fibres is built up and bundles of fibres are visible to the naked eye
- Wind can disperse the fibres into the ambient air with emissions in the range 106 to 109 fibres per square metre per hour (with rates affected by pollution intensity and weather)
- About 20 percent of fibres are dispersed in the air and 80 percent washed out by rain
- There were crystallographic changes in the corroded chrysotile fibres, and pollutants (metal and organic substances) were deposited on the free fibres
- Fibre concentrations in the vicinity of buildings with corroded and weathered asbestos-cement products (fibres greater than 5 μm) were from 0.2 to 1.2 f/L.

A study on asbestos-cement products in Western Australia found that deteriorating asbestos-cement roofs were common and that asbestos was present in the gutters and run-off water. The highest concentration of asbestos was from roofs 10–17 years old; younger and older roofs produced lower concentrations. Air monitoring at nine sites suggested that the air concentrations are likely to be less than 2.0 f/L and more likely to be less than 0.2 f/L (Western Australian Advisory Committee on Hazardous Substances 1990).

Elevated levels of fibres have been detected following the use of high pressure jets for cleaning asbestos-cement roof surfaces. These fibres may be deposited on soil and other surfaces around the home and create an increased risk of airborne fibres when dry.

Release of asbestos fibres from a fire

Asbestos was widely used because of its fire resistance properties, however it is not thermally stable when exposed to high temperatures. Chrysotile decomposes at 800–850°C and the amphiboles at 800–1000°C. Asbestos fibres will readily be converted to dust at prolonged exposure to such temperatures.

In sheet form asbestos does not offer any fire resistance and it cracks in building fires. In a fire, asbestos cement sheeting will disintegrate and can explode, releasing fibres over a wide area, mostly in the direction of prevailing wind. Further information is provided in Appendix 2.

Drinking-water and aerosolisation

There is a theoretical possibility of exposure to airborne asbestos from drinking-water aerosols and dried asbestos deposits. Where significant fibre concentrations were found in water supplies, the fibre length median was generally between 0.5 and 1.0 µm, although fibres greater than 5 µm were present in the distributions (HEI – Asbestos Research 1991). Hence, the aerosolisation of water from faucets and showers or secondary resuspension of deposits remaining after evaporation of water, may give rise to indoor air concentration of asbestos fibres. In another study (Webber et al 1988) air measurements were made in some homes using water containing 24 million f/L and in other homes containing 1.1 million f/L. Mean values from a combination of background, showering and vacuuming activities showed that homes with the more polluted supply gave fibre and mass concentrations about four times higher than the ones with the less polluted supply. No data on exposure from this source have been found.

Most asbestos fibres in water are chrysotile and are <5 µm in length (ATSDR 2001a). Available data on effects of exposure to chrysotile asbestos specifically in the general environment, including data from ecological studies of populations in Connecticut, Florida, California, Utah and Quebec and from a case-control study in Puget Sound, Washington State, are restricted to those in populations exposed to relatively high concentrations of chrysotile asbestos in drinking-water, particularly from serpentine deposits or asbestos-cement pipe. Limited data indicates that exposure to airborne asbestos released from tap water during showers or humidification is negligible (WHO 2013, 2017).

Chapter 2: Risk assessment

2.1 Dose response, exposure assessment and risk characterisation

Dose–response

Dose refers to the amount of material potentially available for deposition in the respiratory tract (ie, the number of fibres in the air inhaled by the exposed person), while response is defined as the cumulative risk of developing an abnormality. Asbestos causes cancer in a dose-dependent manner (WHO 2000a). The greater the exposure, and the longer the time of exposure, the greater the risk of contracting an asbestos-related disease. The relative risk of lung cancer increases with cumulative dose of asbestos (Gustavsson et al 2002). Although no increased incidence of cancer has been observed in some exposed populations, no threshold has been identified below which no carcinogenic effect will occur (WHO 2014; IARC 2012). Exposure should therefore be kept as low as possible (WHO 2000a).

The International Agency for Research on Cancer (IARC) reviewed available data on the carcinogenicity of asbestos (IARC 1987). Overall, there was sufficient evidence for carcinogenicity and asbestos was classified as group 1, namely carcinogenic to humans. Although not entirely established, asbestos may be considered a genotoxic carcinogen hence is thought not to exhibit a threshold under which adverse effects are not seen. There is evidence that chrysotile is less potent than the amphiboles, but as a precaution chrysotile has been attributed the same risk estimates.

The total burden of residual fibres in the lungs depends not only on the size of the fibres but the amount of fibres inhaled from the environment (Dodson et al 2003). A clear dose-response relationship between cumulative exposure to asbestos and pleural mesothelioma in a population-based case control study in five regions in France with retrospective assessment of exposure was reported by Iwasatubo et al (1998). Current non-occupational exposure levels are considered to be too low to cause asbestosis. Mesothelioma (a highly specific outcome of asbestos exposure) occurs at lower exposure levels than asbestosis or lung cancer. It is the disease most likely to occur in relation to non-occupational exposures (Bardsley 2015). Inhalation exposure to asbestos is now known to be a serious public health risk, with consequential disease liable to develop after a long latency period – the risk of which is influenced by the intensity (dose), the frequency, and the duration of the exposure (ie cumulative amount breathed in) (Bardsley 2015).

Potential for non-occupational human exposure

The primary route by which the general population might be exposed is inhalation of air that contains asbestos fibres. Asbestos can also enter the body through ingestion but is a less common exposure pathway. Significant skin contact is unusual, but asbestos fibres may penetrate into the skin and can lead to calluses or corns (NTP 2014). However, asbestos fibres that penetrate the skin do not appear to pass through the skin into the blood (ATSDR 2001a).

Small quantities of asbestos fibres are ubiquitous in air, arising from natural sources (weathering of building asbestos-containing, wind-blown soil from hazardous waste sites, deterioration of automobile clutches and brakes, or breakdown of asbestos-containing materials). The levels of asbestos in dust and wind-blown soil may be higher for those living close to a site for mining or processing asbestos and certain other ores, or a building containing asbestos products that is being demolished or renovated, or a waste site where asbestos is not properly covered. In studies of asbestos concentrations in outdoor air, chrysotile is the predominant fibre detected (IARC 2012b).

In non-occupational exposure, the typical exposure is a low or very low, almost unmeasurable, background concentration, but occasional high exposure when there is a disturbance of some kind (Hillerdal 1999). A simulation study carried out by Goswani et al (2013) showed that the results for domestic exposures are lower than workers' exposures and are proportionate to background concentrations. The highest risk of exposure to asbestos in the home is through home maintenance, renovating, repair, and remodeling, where home occupants can potentially be exposed to higher levels of airborne asbestos than levels in general ambient air (ATSDR 2001b), for instance by cutting or drilling through asbestos-cement sheeting or sanding down asbestos-containing Lino or tiles. Left undisturbed, such materials pose a negligible risk; therefore it is recommended that asbestos-containing material in good condition be left alone.

There is an ongoing, although low, risk of exposure to asbestos fibres in a home from damaged or deteriorating asbestos-containing insulation, walls, ceiling or floor tiles. Friable asbestos (which would crumble easily if handled) is more likely to generate airborne fibre, hence increasing the risk of exposure to asbestos. The risk of generating airborne asbestos fibres can be reduced by appropriate management measures (eg, removing the friable material or sealing the surface).

There remains the possibility that individuals engaged in asbestos-related activities – such as renovating or demolishing buildings with damaged or deteriorating asbestos – could bring asbestos into the home. Workers' families and other household contacts may be exposed by breathing asbestos dust: from workers' skin, hair and clothing, and during laundering of contaminated clothes (Goswani et al 2013).

Exposure assessment

A knowledge of exposure is essential for environmental epidemiology and hazard control. Asbestos exposure affects not only asbestos workers but also their families, users of asbestos products, and members of the public who are exposed to building materials and asbestos in heating and ventilating systems (LaDou 2004).

Routes of exposure

Inhalation

Inhalation is the primary route by which the general population might be exposed to asbestos. Small quantities of asbestos fibres are ubiquitous in air, arising from natural sources (weathering of asbestos-containing materials), wind-blown soil from hazardous waste sites, deterioration of automobile clutches and brakes, or breakdown of building asbestos-containing materials. Indoor air in buildings with asbestos-containing materials can be a major source for non-occupational asbestos exposure (HEI – Asbestos Research 1991).

Non-occupational exposures may also occur by way of para-occupational exposure. In some of these cases, workers' families may inhale asbestos fibres released by clothes that have been in contact with asbestos-containing material. People who live or work near asbestos-related activities may also inhale asbestos fibres that have been released into the air by the activities.

Oral

Drinking-water

The general population can be exposed to asbestos in drinking-water. Asbestos can enter potable water supplies through the erosion of natural deposits or the leaching from waste asbestos in landfills, from the deterioration of asbestos-containing cement pipes used to carry drinking-water or from the filtering of water supplies through asbestos-containing filters (IARC 2012b).

The adverse effects following ingestion of asbestos have not been clearly documented. ATSDR (2001a) considers few fibres are able to penetrate the gastrointestinal tract. This means non-gastrointestinal effects from oral exposure to asbestos are unlikely. There is considerable controversy as to whether ingested asbestos fibres can penetrate and pass through the walls of the gastrointestinal tract in sufficient numbers to cause adverse effects. There is inconsistent evidence of carcinogenicity of ingested asbestos in epidemiological studies of populations with drinking-water supplies containing high concentrations of asbestos. Moreover, in extensive studies in experimental animal species, asbestos has not consistently increased the incidence of tumours of the gastrointestinal tract. There is therefore no consistent evidence that ingested asbestos is hazardous to health. The primary issue surrounding asbestos-cement pipes is for people working on the outside of the pipes (eg cutting pipes) because of the risk of inhalation of asbestos dust (WHO 2003, 2017).

The World Health Organization (WHO 2003, 2017) concluded that there was little evidence that ingested asbestos is hazardous to health and therefore did not feel it necessary to establish a health-based guideline value for drinking water.

Soil

Soil may be contaminated with asbestos by the weathering of natural asbestos deposits, or by land-based disposal of waste asbestos materials.

Food and other sources

The use of asbestos filters in food or pharmaceutical preparations has been discontinued in the US since 1976, and intake of asbestos through foods or drugs is now unlikely. However, asbestos has been found in art supplies such as crayons, probably as a contaminant of the talc used to strengthen the crayons (IARC 1977). Asbestos was detected in crayons in New Zealand in 2015. **https://www.sciencemediacentre.co.nz/2015/09/18/testing-reveals-asbestos-in-crayons/**

Dermal exposure

Asbestos fibres can penetrate into the skin, producing asbestos warts. However, asbestos fibres that penetrate the skin do not appear to pass through the skin into the blood (ATSDR 2001a).

Measurement of exposure

Exposure to asbestos cannot be measured by absorbed dose or other biological measurement (at least not until after death) – unlike, for example, lead exposure. The options available, therefore, may be ranked as:

- direct estimation by personal air sampling (in the breathing zone)
- indirect estimation by stationary air sampling of personal environments

- qualitative exposure categorisation on the basis of questionnaires, interviews, inspections, historical records and/or exposure simulations
- categorisation into ‘exposed’ and ‘unexposed’ populations.

For all measures of exposures there are ethical, practical, and cost limitations. Logistical issues, quality control, sampling methods, sensitivity and specificity all need to be considered, and expert laboratory advice is generally needed before exposure measurement is undertaken. Appendix 1 details the procedures and issues around asbestos sampling and analysis.

Risk characterisation

Underlying asbestos risk assessment, and hence its health impact, are assumptions that are difficult to make. Extrapolation from observations of asbestos workers to predict the cancer risk caused by exposure in non-occupational situations involves estimating exposure and establishing a formula for the relationship between exposure and risk. While there may be difficulty in estimating the excess risk, provided that the excess is substantial and suitable comparison rates are available for the local population, measuring exposure and choosing an appropriate dose–response model are substantially more difficult.

Risk characterisation involves integrating the outcomes of the previous steps in the risk assessment: hazard identification, dose response assessment and exposure assessment. Achieving this integration requires making a number of assumptions in cases where empirical information is not available. These assumptions result in a number of uncertainties associated with the risk assessment, which need to be acknowledged and discussed.

In assessing the risks of asbestos in the non-occupational environment, it is necessary to consider a number of uncertainties, ranging from indirect estimates of exposure to the use of mathematical equations derived by the application of mathematical models to observations in workers. The following are some of these uncertainties:

- It can be difficult to identify and characterise the hazards.
- Risk estimation for non-occupational exposure relies on extrapolation from much higher levels of exposure in industry.
- Assessment of risk at low concentrations of asbestos fibres can be only indirect.
- The concentrations of asbestos fibres to which people may be exposed are far below the levels at which adverse effects have been reported for workers in the past.
- Reported cases of mesothelioma from non-occupational exposure to asbestos have been associated with para-occupational exposure, domestic exposure, and/or neighbourhood exposure near asbestos mines or asbestos-using industries.

- For lung cancer, there are data to support increased incidence related to cumulative dose at high and moderate levels, but there are no real grounds that a linear relationship for lung cancer can be extrapolated back to the dose in non-occupational settings.
- There may also have been a low incidence of lung cancer as a consequence of para-occupational exposure to asbestos but it has not been possible to demonstrate this epidemiologically (because of the high background incidence of this disease). Alternatively, the inability to measure an effect of low levels of asbestos on lung cancer may be because this disease is not caused by low levels of exposure to asbestos.

Table 1 illustrates a basic flowchart table for homeowners to make an initial assessment about whether they should be concerned about asbestos exposure, based on the age of their house and the presence of ACMs. The materials should be assumed to be ACMs if there is uncertainty.

Table 1: Residential risk assessment based on age of home, presence of ACMs, and activities that could increase or decrease risk to bystanders/occupiers

The table should be read left to right to follow the possible presence of ACMs toward an estimation of risk. The yellow colour indicates possible presence of a hazard but probable low risk, green indicates minimised risk, and orange indicates ongoing presence of the hazard and higher risk.

Building age	Possible ACMs present	Status of ACMs if present	Activities impacting ACMs and exposure	Risk level
Pre-1940 unrenovated	None likely			None or negligible risk
Pre-1940, renovations performed 1950–1985	Exterior – corrugated cement roofing, Fibrolite or Hardiplank cladding, Fibrolite eaves	Cracks, chips or breaks in roofing or exterior cement sheeting (walls and eaves)	Materials wet during removal, not sanded or drilled, OR materials sealed/encapsulated	Extremely low risk
			Present when damaged materials were sanded or drilled	Possible short-term exposure – very low risk
		Materials undamaged and well-maintained (sealed and painted)		Extremely low risk
	Interior – textured ceilings, wall linings, vinyl flooring	Decorative ceiling crumbling or removed, vinyl flooring uplifted or old wall board crushed or drilled	Present during removal, but clean-up thorough	Possible short-term exposure – very low risk
			Home furnishings contaminated with dust, not cleaned or removed	Low risk but possible ongoing low-level exposure*
		Materials intact		Extremely low risk
1940 to 1990	Exterior – corrugated cement roofing, Fibrolite or Hardiplank cladding, Fibrolite eaves	Cracks, chips or breaks in roofing or exterior cement sheeting (walls and eaves)	Materials wet during removal, not sanded or drilled, OR materials sealed/encapsulated	Extremely low risk
			Present when damaged materials were sanded or drilled	Possible short-term exposure – very low risk
		Materials undamaged and well-maintained (sealed and painted)		Extremely low risk
	Interior – textured ceilings, wall linings, vinyl flooring	Decorative ceiling crumbling or removed, vinyl flooring uplifted or old wall board crushed or drilled	Present during removal, but clean-up thorough	Possible short-term exposure – very low risk
			Home furnishings contaminated with dust, not cleaned or removed	Low risk but possible ongoing low-level exposure*
		Materials intact		Extremely low risk
Post-1990	None likely			None or negligible risk

* Risk is dependent on amount of ACMs and extent of disturbance/works carried out. Although the risk is low in absolute terms, it will increase with time if steps are not taken to remove the asbestos fibres after work has been completed.

Source: Bardsley 2015

Public health risks from non-occupational exposure to asbestos-containing materials

There is little epidemiological evidence for health effects from inhalation exposure to ACM in buildings, and what evidence we have is weak (Goldberg and Luce 2012). This is not surprising given the difficulties of carrying out such an epidemiological study.

Despite several decades since public concerns about health risks from asbestos in buildings surfaced uncertainty about the cancer risk estimates remains high. Reasons include lack of satisfactory statistical power to detect effects at very low levels of exposure, issues relating to fibre measurement,[5] the representativeness of sampled buildings, possible insufficient latency period for pleural mesothelioma as use of ACM in buildings started in the 1960s, difficulty in evaluating individual cumulative exposure, and the lack of a truly unexposed population.

As the mechanism of action for asbestos-associated disease is unknown risk assessment models typically extrapolate from historical high occupational levels to low non-occupational levels using a linear no-threshold approach. The estimates are generally regarded as the upper limits of risk based on worst case assumptions such as amphibole or mixed amphibole and chrysotile exposure.

For 752 US buildings involved in litigation, using the US Environmental Protection Agency Integrated Risk Information System model, cancer risk estimates ranged from 2.1 per million for people working in schools to 1.1 per million for people working in public/commercial buildings. The cancer risk estimate for background outdoor exposure was 0.4 per million (Lee and Van Orden 2008). This compares to a previous lifetime asbestos-related cancer[6] risk estimate for building occupants based on results from buildings not involved in litigation by the US Health Effects Institute (HEI) of about 4 per million (HEI – Asbestos Research 1991).[7]

To better address the significant uncertainties more recent risk assessment often includes a range of exposure (or dose) – response models leading to a range of possible outcomes. For example, ATSDR derived risk estimates based on an exposure-response model for lifetime estimated risk of mesothelioma and lung cancer combined for exposure to naturally occurring asbestos in El Dorado County, California which ranged from 0.1 per 10,000[8] to 22 per 10,000 (Case et al 2011).

Typically epidemiological studies of non-occupational asbestos exposure and health effects include para-occupational exposure in the definition of ‘non-occupational’ and often do not include results without this exposure. For example, Bourdes et al (2000) carried out a meta-analysis of studies on domestic or neighbourhood exposure and pleural mesothelioma published from 1966 to 1998.[9] Only eight studies were identified. There was a range of study types and sources of asbestos exposure but not ACM in buildings. Domestic exposure included para-occupational exposure in all but one study.[10] Due to the

5 Issues include fibre size and type, analytical methods, and lack of or little measurement.
6 Mesothelioma and lung cancer.
7 The mean concentrations of the 198 US schools, residences and public and commercial buildings containing ACM on which the HEI’s risk estimate was based ranged from 0.04 to 2.43 f/L (95th percentile 1.4 f/L, n of air samples=1377). The mean concentration for 96 included residences (n of air samples=215) was 0.19 f/L (HEI – Asbestos Research 1991).
8 A risk of 1 in 100,000 (0.1 per 10,000) is defined as an acceptable risk.
9 The text says 1988, but the references indicate this is a typographical error.
10 In this study, domestic exposure was from natural asbestos-based materials used to whitewash floors and walls.

inclusion of para-occupational exposure and study location generally in areas with predominant or concomitant amphibole exposure the exposure characteristics, and hence summary relative risk, are not relevant to the New Zealand domestic context.

Some reports, published prior to 2000, of cases of mesothelioma were only due to known exposure to ACM in buildings. There have also been several earlier US studies of the prevalence of pleural and/or parenchymal radiological abnormalities in caretaker and maintenance staff in asbestos-insulated schools but none included a control group and confounding factors were not or only partially taken into account (Goldberg and Luce 2012).

Five mesothelioma cases (expected 0.2-0.7) were reported in 2001–02 among staff of a French university campus with asbestos-insulated buildings and no other known exposure. It was unclear whether the principal exposure was from proximity to construction of asbestos-insulated buildings or working in them (Buisson et al 2006[11] cited in Goldberg and Luce 2012).

A small European multi-centre case control study of mesothelioma suggests domestic exposure from handling ACM for maintenance or the presence of ACM susceptible to damage increases mesothelioma risk. Thirty-two[12] (32/215) cases in this study had domestic and/or environmental exposure only but for eight the only known source of exposure was some form of ACM in the home, in particular an asbestos roof (n=6). All six of these cases came from one city (Magnani et al 2000).

An Italian population-based case control study defined domestic exposure as ACM in the garden, courtyard, roof or inside the house. The estimated excess mesothelioma risk due to domestic exposure was 1.3 (95% CI 0.6–2.7).[13] This was similar with adjustment for residential distance from an asbestos cement plant (RR 1.3; 95% CI 0.8–2.3) (Maule et al 2007).

Analysis of cases from the Western Australian Mesothelioma register supports the need for health and safety guidelines in any renovation where asbestos exposure is possible. From 1960 to 1988 5.3 percent of cases were attributed to home renovation/maintenance or exposure as a bystander during these activities (n=87/1631). This compares to 4.6 percent of cases with no known exposure source. Western Australian incidence rates from non-occupational exposure have been increasing since the mid-1980s. Among developed countries Australia had the highest per capita use of asbestos-cement products and more than 60 percent of crocidolite mined in Australia was used in asbestos-cement product manufacture (Olsen et al 2011).

[11] This paper has not been seen, but the authors of the review (Goldberg and Luce 2012) were study co-authors.
[12] Of the 32 cases, 14 had domestic and environmental exposure, seven had environmental exposure only and 11 had domestic exposure only. Three of the cases with domestic exposure were para-occupational exposure and eight were ACM in the home.
[13] Adjusted for age, gender and occupational exposure.

A small US study found pleural radiological abnormalities from non-occupational community exposure to amphibole asbestos from the processing of vermiculite. The association was stronger for long-term lower exposure from background exposure to fugitive plant emissions than intermittent high exposure from activities such as playing on vermiculite waste piles (Alexander et al 2012).

Several studies suggest environmental exposure from a natural or industrial source increases mesothelioma risk even at a distance where exposure is likely to be very low. A case control California cancer registry-based study of several thousand mesothelioma cases found the odds of mesothelioma, adjusted for occupational exposure, age and gender, decreased 6.3 percent with every 10 km of residential distance from the nearest source of naturally occurring asbestos (95% CI 1.8–10.5%; p=0.006). Study limitations included use of residence at time of diagnosis (when causative exposure occurred decades earlier), the assumption that ultramafic rock location is a marker of asbestos exposure, incomplete information on asbestos exposure in occupations, lack of lifetime residential and occupational histories and no data on domestic asbestos exposure (Pan et al 2005).

A population-based case control study around Casale Monferrato, Italy, site of an asbestos cement plant found mesothelioma risk decreased rapidly with residential distance but at 10 km was still high (OR 5.8 95% CI 1.7–19.3 adjusted for age, gender, occupation in the asbestos cement industry, domestic exposure to ACM, and occupation in the asbestos cement industry of any relative). Lifetime residential and occupational histories were available in this study (Maule et al 2007).

A review of the health risks of non-occupational asbestos exposure by the Royal Society of New Zealand and the Office of the Prime Minister's Chief Science Advisor found asbestos exposure during the rebuild following the Canterbury 2010–11 earthquakes was unlikely to cause a significant increase in risk among residents, unless they were carrying out the work themselves, without taking proper precautions. Overall the risk was considered to be low if proper precautions were followed (Bardsley 2015).

Chapter 3: Risk communication

The general public does not base their perception of risk on technical risk assessment alone. Public recognition of risks, in contrast to risk assessment based on probabilities prepared by experts, includes intuitive risk perception. The characteristics of such perception appear to be related to concepts of fairness, familiarity, future and present ‘catastrophic potential’, and outrage at involuntary exposure to hazards not of one’s own making. When communicating risks it is important to show commitment, empathy and sound knowledge.

Asbestos hazards at home, where people expect to be safe, are among the hazards that the public will judge based on more than a scientific risk assessment. Comparisons of the level of risk with common risks, such as road traffic crashes, will generally not convince a person who feels that they – or their child – is at risk. Involuntary exposures that could cause a dreadful disease at some unknown future time, in a way that is still not understood, and for which there is little hope of cure, are particularly alarming. The level of alarm is compounded for asbestos due to its legacy of a high incidence of disease in the occupational setting and allegations of mismanagement by regulators in the mid-20th century.

Effective risk communication is more likely to be achieved if:

- A careful and sensitive explanation is given to assist and improve the level of understanding of the risk
- The feelings of dread towards asbestos-related disease are recognised, and efforts are made to assist a person to come to terms with those feelings before decisions are made
- The response to hazards that may affect a large number of people (especially children) is made with urgency and at an appropriate level.

Bear in mind that in general:

- Younger adults and better educated individuals tend to have more technical, scientific and medical knowledge about hazards
- The most concern about risks tends to be expressed by women, particularly those with young children, and by older people
- People tend to simplify complex and uncertain information into ‘rules of thumb’ (which, in the case of asbestos, may relate to the perception of occupational risk)
- People attempt to impose patterns on patternless events

- People overestimate the frequency of rare events and underestimate the frequency of common events
- Individuals taking voluntary risks tend to be overconfident and believe they are not subject to the same risk as other individuals
- Individuals forced to take involuntary risks overestimate the risk, and are unwilling to agree to ‘acceptable risk’ criteria set out by national and international agencies
- People tend to use past life experiences to relate to new situations, affecting their perception of the new situations (Health and Welfare Canada 1990).

Risk communication needs to be a two-way process, as described in some detail in *A Guide to Health Impact Assessment* (Ministry of Health 1998). It needs to be done in such a way that people are well informed and guided in the actions they can take, while knowing that the experts are taking account of, and acting on, their concerns.

To be effective communicators of the risks associated with asbestos in the non-occupational environment, public health officers need to build credibility and trust with the affected individual or communities. Thus in any interaction, they need to:

- Show that they are professionals committed to helping the affected people
- Be open and receptive to the concerns expressed by the affected people
- Establish their credentials to advise on the effects of asbestos
- Be empathic.

In many cases, difficulties in managing environmental issues or communicating risks arise because the regulator’s expectations differ from those of the affected people. Thus it is important to establish early in the process what the issues are, who is affected and what can be done about it and by whom. That is, the scope of the issue needs to be defined tightly (refer to Ministry of Health 1998).

For example, home owners who have put themselves at risk from asbestos eg, DIY renovation need to recognise that they are responsible for the problem and that they will need to manage it even though they can get advice from agencies. If contractors have caused the problem, then the issue should be referred to WorkSafe. This referral should be made in a way that cannot be interpreted as ‘passing the buck’.

Chapter 4: Risk management

Risk management

Priorities for managing risk should be based on the risk assessment, but should also consider public perception of risk. The range of risk reduction alternatives must be evaluated, including in relation to their social, economic and cultural implications.

This evaluation could be undertaken along two lines:

1. Control of actions and events that can translate an asbestos hazard into an asbestos risk
2. The removal or near-permanent containment of the asbestos hazard.

Asbestos exposures in non-occupational settings may vary greatly. A protocol for the management of such exposures should aim to provide a response that is graded according to the likely harm (exposures are likely to be very low).

Public health officers investigating complaints should assess the issue and proceed according to a graded response protocol, identifying and assigning responsibility for the issue to the appropriate agency.

Summary of the *Graded Response Protocol*

Note: This guide is essentially an operational document for public health officers to refer to when investigating complaints. The question ‘Is it a public health issue – that is, a non-workplace issue?’ needs to be spelt out first. If a member of the public has decided to engage a contractor then it becomes a workplace issue for the employer to manage, with WorkSafe enforcing the standards.

Step 1: Initial response and preliminary assessment

1.1 Gather and record information.

1.2 Identify and assess the hazard.

1.3 Decide whether to proceed to Step 2.

1.4 Identify and inform the agency most appropriate to take any further action.

1.5 If not proceeding to Step 2, provide support and precautionary advice.

Step 2: Inspection and hazard evaluation

2.1 Co-ordinate action/enforcement with the regulatory agency as appropriate and seek to carry out joint inspections.

2.2 Confirm initial information.

2.3 Obtain and record additional information to enable an adequate hazard evaluation.

2.4 Identify and characterise hazards.

2.5 Decide whether to proceed to Step 3.

2.6 Provide advice to manage hazards and potential exposure, and ensure action is taken.

Step 3: Exposure measurement, risk estimation and assessment

3.1 Co-ordinate action/enforcement with the regulatory agency as appropriate and encourage joint inspection visits.

3.2 Sample and analyse to determine presence and type of asbestos.

3.3 Measure the concentration of respirable asbestos fibres in air.

3.4 Estimate the exposure under normal conditions.

3.5 Estimate the excess risk from the exposure and assess its significance.

3.6 Communicate the risk.

3.7 Recommend actions to manage risk and ensure action is taken.

Background to the *Graded Response Protocol*

The guidelines and protocol aim to assist public health officers to identify asbestos hazards and risks using a combination of interviews, observations and laboratory testing. Risk communication and recommendations for the management of hazards and risk may then proceed.

The mere presence of asbestos does not always create a risk. The risk of developing asbestos-related disease depends on exposure to airborne fibres of respirable size. A graded response is based on the following three elements.

Hazard

|

Linking event or action causing exposure

|

Risk, and who is affected and in what way

More specifically, these elements are:

1. The nature and scale of the asbestos hazard and the corresponding potential to be a risk to human health

2. Mechanisms that may open pathways of exposure to create risk

3. The nature of the risk in terms of probability, likely consequences, people affected and the degree of risk each may face. The existing state of health of each person will influence likely consequences for that individual.

Approaches to assessing hazards and risks

A graded response requires some way of assessing likely or actual human exposure to airborne asbestos. There are two complementary approaches.

1. Inspect, identify and assess deterioration of the material and the potential for fibre release (ie, a hazard)

This approach identifies the **hazard**. It should be used in every situation before exposure measurement.

A close inspection and assessment of the material alleged to contain asbestos will allow future action to be identified. If the condition of the material could result in the release of asbestos fibres into the air, then corrective action is justified. In making this assessment, the following questions should be answered.

- What type of asbestos-containing material is involved?
- Where is the material located?
- Is the material friable and likely to release fibres?
- Is there a potential for future disturbances, which may release fibres?
- Are individuals likely to be exposed to airborne fibres?

The nature and scale of the hazard should be estimated.

Settled surface dust sampling and analysis indicate the presence of asbestos contamination and the hazard, but cannot reliably indicate airborne dust concentrations.

At the end of the inspection and assessment process, a judgement may be made as to whether asbestos is being released and thus causing some unquantified exposure. It can be said that a risk has been established (ie, hazard + exposure) but the significance of the risk is still uncertain and unquantified.

2. Measure the actual or potential exposure (respirable fibres in air) from which health risk may be estimated

Measurement of exposure over time is important in quantifying **risk**. Exposure measurement by air sampling provides a measure of exposure over the time of sampling. However, air sampling should not be carried out in isolation and it is important that consideration should be given to the circumstances that created the need for air sampling. The type and extent of damage to the ACM involved needs to be taken into account to enable a full assessment to be taken. This adds to the uncertainty of risk assessment and underscores the importance of inspection and assessment.

Measuring airborne fibres in a non-occupational environment is difficult due to the low levels of fibre likely to be found. An assessment of the level of risk will need to be made before sampling is undertaken. Sampling is warranted if public health risk is likely, eg when the asbestos-containing material is friable and the likelihood of exposure is high.

Graded Response Protocol

How to use the *Graded Response Protocol* and *Report Sheets*

The *Report Sheets* at the end of the guidelines have spaces for information and decisions corresponding to the *Graded Response Protocol*. They repeat the information required but, once users are familiar with the guidelines, the *Report Sheets* may be used in the field without the whole document.

The principle is to grade the response to the level of hazard

In practice, Step 1 will always be completed. If the situation involves a place of work then the person conducting a business or undertaking (PCBU)[14] has duties to manage the risk, including through identifying hazards and ensuring a safe place of work. Steps 2 and 3 will only apply if a private home is involved and no contractor was involved – that is, not a place of work.

Step 1: Initial response and preliminary assessment

The aims of Step 1 are to:

- Provide an initial response and support for the concerned person
- Identify the agency most appropriate for further action
- Identify the procedure to be followed for corrective action.

1.1 Gather and record information

Using the *Report Sheets* (Appendix 3), collect initial information from the informant by personal or telephone interview or possibly by a site visit.

Record informant details

- Contact person, their address and telephone number.
- Nature of concern.

Determine the location of potential asbestos hazard, type of building and building use

- Location (street address) of the suspected asbestos-containing material.
- Type of building(s) (eg, dwelling, school, public building).
- Building use(s).
- Other type of location (eg, a landfill, building or demolition site).

Assess the nature, condition, quantity and accessibility of potential asbestos hazard

- Description of the suspected asbestos-containing material.
- Information on the date that the suspected asbestos-containing material was installed (if known).
- Likelihood of being an asbestos-containing material (judging by the description and age).
- Likelihood of being a friable asbestos-containing material.
- Whether it is inside or outside the home or building.

[14] While a PCBU may be an individual person or an organisation, in most cases the PCBU will be an organisation (eg, a business entity such as a company).

- Level of accessibility of the suspected asbestos-containing material.
- Potential for future damage, disturbance or erosion of the suspected asbestos-containing material.
- Quantity of the suspected asbestos-containing material.
- Condition of the suspected asbestos-containing material (eg, deteriorating asbestos-cement product, damaged insulation).
- Whether the hazard is airborne (eg, visible dust or other assessment).

Identify actions that may translate the hazard into a risk to health

- Who is taking, or is proposing to take, or has taken the action.
- The nature of the action or disturbance affecting the suspected asbestos-containing material.
- Whether it appears likely that asbestos will be (or has been) released by the action.
- When the action or disturbance of asbestos-containing material is proposed, or when it happened.
- Whether a change in building use is proposed that may require interior modification and disturbance of surfaces that may use asbestos-containing material.
- Whether renovation or remodelling is proposed that may disturb asbestos-containing material.

Identify people at risk

- Who is at risk of exposure?
- How the people at risk of exposure could be exposed?
- The period over which the people may have been or will be at risk of exposure.
- The state of health of the people or population at risk of exposure.
- Who may be at greatest risk (eg, children, smokers)?

1.2 Identify and assess the hazard

Identify and assess:

- The possible presence of a friable asbestos-containing material,[15] its condition and accessibility
- Actions that may release asbestos fibres.

[15] Friable in relation to asbestos is defined in the HSW (Asbestos) Regulations 2016 as 'in a powder form or able to be crumbled, pulverised, or reduced to a powder by hand pressure when dry'.

1.3 Decide whether to proceed to Step 2: Inspection and hazard evaluation

Take into consideration the need to:

- Recommend action where it appears that work on asbestos-containing material may have released asbestos fibres already
- Support the informant by explaining the nature of the hazard and its management.

1.4 Identify the most appropriate action to take

Consider whether the identified asbestos hazard requires the attention of WorkSafe, the territorial authority or (less likely) the regional council.

- Asbestos contamination within a private home may be the responsibility of public health officers.
- Asbestos contamination arising in workplaces, including through the actions of contractors at private homes, may require the attention of WorkSafe.
- Nuisances and/or conditions injurious to health should be acted on by the territorial authority.
- The discharge of asbestos as a contaminant involves the regional council.

> Note: Under the HSW Act, the person conducting a business or undertaking (PCBU) is responsible for managing the place of work and ensuring that it is safe for workers and others affected by the work it carries out. This responsibility applies to all work activities and all places of work. This self-management approach does not require WorkSafe to be involved unless there is concern that safety is being compromised. The HSW Act does not apply to private homes unless a contractor is engaged to work in the home.

1.5 If not proceeding to Step 2, provide support and precautionary advice

Common sense actions to avoid unnecessary exposures or hazards are required to minimise risk.

- Provide copies of the resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home* published by the Te Whatu Ora (2023a, 2023b).[16]
- Emphasise the importance of seeking expert assistance if work with asbestos-containing materials is being considered.
- Confirm information given and remove all ambiguity. Make a site visit if you have not done so already. Be certain that information given is understood.

[16] Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

In all cases the capacity of the concerned person to understand the advice and take sensible action should be taken into account. Record the advice you have given in the *Report Sheets*.

> Note: The goal is to reduce the potential for exposure to airborne asbestos due to the release of fibres. A principle, therefore, is that exposure should be reduced as a result of the action recommended.

Step 2: Inspection and hazard evaluation

The aims of Step 2 are to:

- Identify and characterise hazard
- Achieve actions to manage hazard.

2.1 Co-ordinate action/enforcement with the regulatory agency as appropriate and seek to carry out joint inspections

2.2 Confirm initial information

Visit the site and, using the *Report Sheets*, clarify, confirm or amend the initial information.

- Clarify the nature and underlying factors of the concern, as an understanding of the way the risk is perceived is essential in framing advice.
- Inspect conditions at the site.
- Complete a new Report Sheet only if absolutely necessary. (Keep the first copy as a record of the initial step.)

2.3 Obtain and record additional information to enable an adequate hazard evaluation

Collect information to enable a proper assessment and characterisation of the hazard. Records of buildings held by the owners or the local authority may give some indication of asbestos-containing materials used in the construction of the building (and what asbestos-containing material may have been removed), but should not be relied on.

- Identify any further **suspected asbestos-containing material**.
- Determine **composition**, type and approximate amount of asbestos present in the suspected asbestos-containing material by sampling and analysis (see Appendix 1). Complete the asbestos sample record sheet(s), which also provides a space for results.
- Examine the **condition** of the suspected asbestos-containing material for deterioration.
- Note the **accessibility** of the suspected asbestos-containing material (eg, potential for damage, vandalism).

- Assess the **quantity** of asbestos-containing material.
- Obtain a clear description of the **actions** that could disturb asbestos-containing material and lead to the release of fibres (eg, drilling and cutting, removal, reuse, renovation, repair or redecoration).
- Identify **people at risk of exposure**.
- **Document** the information in the Report Sheets.

2.4 Identify and characterise hazards

From the complete information obtained, including the results of sample analysis, identify each opportunity for the release of asbestos fibres (including the likely potential release from further damage) and characterise each hazard with information about the:

- type of material – friable/not friable
- type of asbestos – chrysotile/amphibole
- degree to which asbestos may be released – significant/not significant.

Also rank the significance of the hazard (high/low), assuming that there is an open pathway for exposure to vulnerable people.

At this point of the inspection and assessment process a judgement may be made as to whether asbestos is being released and so whether a risk has been established (ie, a hazard and a pathway of exposure to a receptor exist). However, the significance of the risk may be still uncertain and unquantified.

2.5 Decide whether to proceed to Step 3: Exposure measurement, risk estimation and assessment

A decision on whether to proceed to Step 3 will depend on:

- the significance of the hazard identified in Step 2.4
- the likely pathways for exposure
- the presence of vulnerable people
- the number of people who may be exposed
- cost versus benefit of undertaking Step 3
- the degree of importance of quantifying the risk, as opposed to identifying the hazard, and whether such risk assessment will lead to a better decision on priorities and action.

In particular, consider the need to:

- show adequate support and understanding for serious concerns
- assist understanding and reduce uncertainty and/or suspicion

- provide ‘hard’ evidence to support the need for action and/or enforcement
- add to an understanding of environmental conditions and so assist in future situations.

> Note: The PCBU has responsibilities under the HSW Act if the site under consideration is a place of work. If a place of work is involved, they must make their own decisions about corrective action, in which they can be assisted by the information given above. A decision to proceed to Step 3 is not exclusive to providing advice as in Step 2.6 below. Advice should be offered at this stage regardless of whether exposure measurements and risk assessment will follow.

2.6 Provide advice to manage hazards and potential exposure, and ensure action is taken

Common sense actions to avoid unnecessary exposures or hazards are required to minimise risk.

- Provide copies of the resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home* (Te Whatu Ora 2023a, 2023b).[17]
- Emphasise the importance of seeking expert assistance if work with asbestos-containing materials is being considered.
- Confirm information given and remove all ambiguity. Make a site visit if you have not done so already. Be certain that information given is understood.

In all cases the capacity of the concerned person to understand the advice and take sensible action should be taken into account. Record the advice you have given in the *Report Sheets*.

Step 3: Exposure measurement, risk estimation and assessment

The aims of Step 3 are to:

- confirm the presence and type of asbestos in air
- estimate the exposure to respirable asbestos fibres
- communicate the risk
- recommend actions to manage risk.

[17] Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

3.1 Co-ordinate action/enforcement with the regulatory agency as appropriate and encourage joint inspection visits

3.2 Sample and analyse to determine presence and type of asbestos

Steps 1 and 2 cannot confirm the presence of asbestos fibres in the air, their type or their concentration. Sampling and qualitative analysis of suspected asbestos-containing materials will be relatively simple and quick as no quantification is sought. Air may be sampled or, following discussion with the laboratory, settled surface dust or bulk material may also be sampled.

Take into account the:

- person(s) and location(s) that are of interest
- factors considered in Appendix 1
- limitations of the information which will do little more than assist in the characterising of the hazards as considered in Step 2.4.

3.3 Measure the concentration of respirable asbestos fibres in air

Sampling and analysis of the air can indicate the number of fibres in air. This information can then be assessed for risk against recognised standards. Sampling should be undertaken only following consultation with the examining laboratory, using its methods and equipment. The laboratory will interpret the results.

3.4 Estimate the exposure

Sampling should reflect the spaces most used so that an integrated exposure may be derived. A sufficient number of samples should be undertaken so that variations are reflected. The duration of sampling airflow through the filter membrane will be a factor in the sensitivity of the results and needs to be discussed with the laboratory.

When reliable results have been obtained, the concentration will be expressed in f/mL of air.

3.5 Estimate the risk from the exposure and assess its significance

The risks may be estimated in the following way.

- Compare the fibre concentration to which a person may have been exposed with the typical exposures and lifetime risk estimates.
- Compare the significance of the estimated risk against criteria of acceptable risk, taking into account the person at risk.
- The estimate achieved by undertaking this risk assessment should then be categorised as ‘high’, ‘moderate’ or ‘low’ rather than provided to the exposed person as a number. A number may imply a degree of scientific accuracy that is not possible to achieve in risk assessment.

- Note that the acceptability of the risk to the individual exposed is for them to decide; the expert assists by providing information and improved understanding.

3.6 Communicate the risk

Risk estimates are **estimates** only, and may vary by several orders of magnitude. They are useful as a tool for putting the risk in context, making comparisons with risks estimated using similar methods and prioritising management options. The public perception and judgement of risk is based on many other factors, as discussed in Chapter 3.

Individual susceptibility, tobacco smoking, other exposures to asbestos, and exposures to other hazardous substances will impact on an individual's risk of adverse health effects from any given exposure to asbestos in the home.

Further guidance on risk communication is provided in:

- *A Guide to Health Impact Assessment* (Ministry of Health 1998)
- *Communicating in a Crisis: Risk Communication Guidelines for Public Officials* (US Department of Health and Human Services 2002)
- *Risk Communication in Action: The risk communication workbook* (Reckelhoff-Dangel and Petersen 2007).

3.7 Recommend actions to manage risk and ensure action is taken

Common sense actions to avoid unnecessary exposures or hazards are required to minimise risk. The assessment of risk (rather than hazard) may provide a sharper focus on what needs to be done.

- Provide copies of the health education resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home* published by the Te Whatu Ora (2023a, 2023b).[18]
- Emphasise the importance of seeking expert assistance if work with asbestos-containing materials is being considered.
- Confirm information given and remove all ambiguity. Be certain that information given is understood.

In all cases the capacity of the concerned person to understand the advice and take sensible action should be taken into account. Record the advice you have given in the *Report Sheets*.

[18] Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

Chapter 5: Roles and responsibilities

Individuals and agencies with roles and responsibilities in preventing or managing asbestos hazards in non-occupational settings include:

- Public health officers in the National Public Health Service, Te Whatu Ora
- Territorial authorities (city and district councils)
- Property owners, property managers and property occupiers.

Roles and responsibilities must be considered in three contexts:

1. The regulatory agency with statutory authority to bring about remedial action
2. The person or organisation responsible for taking remedial action
3. Agencies with statutory functions to ensure that the facts are established and the best advice is made available.

> Asbestos hazards need to be managed collaboratively to avoid duplicated effort, wasted resources and the perception of 'buck passing', and to ensure the most effective statutory response. Thus it is important to determine who has jurisdictional responsibility as a first step, then to ensure the issues are being addressed.

Role of the public health officers

Public health officers may often be the first to be made aware of a concern about asbestos. Preliminary investigations (as set out in the *Protocol* following) should establish the responsible person(s) and any need to pass on this information to the others. Particular roles for public health officers include:

- Providing specialist advice in epidemiology and toxicology where risk assessment is complex
- Preparing statements or advice about the risks to individuals or groups
- Providing scientific advice on whether sampling is likely to be useful
- Undertaking measurement and identification of asbestos
- Communicating risk to the public and the media

- Providing advice to other agencies on how to communicate statements about risk to the public and the media effectively
- Providing advice to lead agencies with statutory authority to effect remedies.

Role of the health protection officer

The skills of the health protection officer are necessary for the following activities.

1. Initial response and preliminary assessment

- Receive, record and interpret queries and concerns.
- Identify the cause of concern or complaint, the location and the associated parties.
- Provide initial response and support to concerned people.

2. Inspection, hazard evaluation and risk assessment

- Identify person(s)/groups at risk.
- Identify confounding factors (eg, smoking, occupational exposure to asbestos).
- Identify sources of asbestos, asbestos hazards, and open pathways of exposure.
- Collect environmental samples for laboratory analysis.
- Interpret laboratory results.
- Seek advice from the Medical Officer of Health and others if necessary (eg, epidemiologists, toxicologists).
- Assess the likely health risk from the information collected.

3. Information and risk communication

- Explain how risk should be managed to the lead regulatory agency.
- Consult with building owners, building managers and occupiers as necessary.
- Refer information to the lead regulatory agency to bring about remedial action.

4. Management plans

- As a first step, determine who has jurisdiction, engage the lead regulatory agency and make sure that the issues are addressed.
- Assist the lead regulatory agency to determine appropriate action including, if necessary, the design of abatement and exposure control strategies.
- Maintain communication and cooperation with the regulatory agency and other parties (recognising privacy).
- Evaluate the effectiveness of the management plan.

Health protection

Here the primary role of public health officers is to support enforcement by the lead regulatory agency by providing information and advice.

Public health officers may also consider health promotion initiatives aimed at increasing awareness of potential asbestos-containing materials and hazards associated with them. Health education resources are available to support such initiatives. A general information booklet, *All About Asbestos*, has been prepared targeting the general public. Although obtaining expert assistance should always be recommended if work with asbestos-containing materials is being considered, a further information booklet, *Removing Asbestos from the Home*, is available if required.[19]

Role of territorial authorities

In non-occupational settings, territorial authorities will normally be the lead regulatory agency with statutory authority to bring about a remedy. Territorial authority enforcement officers may collaborate with the other agencies, and public health officers should provide the territorial authority with information and advice. Since most issues to do with asbestos are likely to involve a workplace, territorial authorities should always co-ordinate action with WorkSafe to prevent duplication or confusion of roles.

Territorial authorities have duties and powers to prevent or control asbestos hazards under the following legislation.

Health Act 1956

The Health Act 1956 includes provision for territorial authorities to:

- Improve, promote and protect the public health
- Cause steps to be taken to abate nuisances or to remove conditions likely to be injurious to health or likely to be offensive
- Enforce regulations under the Act
- Make bylaws for the protection of public health
- Issue cleansing orders or obtain closing orders.

Section 29 of the Act defines health 'nuisances' and generally includes matters 'likely to be injurious to health'. Particularly relevant are references to:

[19] Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

- Accumulations or deposits
- Situation or state of premises
- Conduct of any trade, business, manufacture or other undertaking.

Enforcement is determined by the District Court if a nuisance is not abated voluntarily except where immediate action is necessary. Works undertaken by a territorial authority to abate a nuisance may result in costs being recovered from the owner or occupier. It should be noted, however, that any person can lay information regarding a nuisance. A nuisance has to exist before any action can be taken and, accordingly, is not an effective means of preventive action.

Under section 41 of the Act, the territorial authority may serve a Cleansing Order on the owner or occupier, specifying the work to be carried out and the time in which to complete it. A Closing Order made under section 42 or 44 can be issued as a last resort to protect the occupants, but such action will not, of course, resolve any external release of asbestos.

Building Act 2004

The Building Act 2004 includes provision for territorial authorities to:

- Require work to be done to prevent buildings from remaining or becoming dangerous or insanitary
- Take measures to avert danger or rectify insanitary conditions
- Issue project and land information memoranda revealing (inter alia) known hazardous contaminants.

A building consent will be required in most cases where demolition or structural alteration works are to occur. The ability to impose conditions on building consents appears to be limited to inspections or entering premises (section 222). Nevertheless, territorial authorities could, at their discretion, include a 'Hazardous Building Material Warning' on relevant consent documents.

Project Information Memoranda (PIMs) issued by territorial authorities must include information identifying special features of the land relating to the likely presence of hazardous contaminants where it is:

- Relevant to the design and construction or alteration
- Known to the territorial authority
- Not apparent from the operative district plan.

Section 44A of the Local Government Official Information and Meetings Act 1987 allows for an application for a LIM (Land Information Memorandum). Section 44A(2) states that the LIM must include information concerning the ‘likely presence of hazardous contaminants’.

A PIM is required for a Demolition (Building) Consent. The PIM will advise if any restriction on demolition, for example a Heritage listing, exists in the city or district plan.

Sections 121 to 124 and 129 to 130 of the Building Act 2004 deal with dangerous or insanitary buildings. It is possible that the presence of asbestos could lead to a building being considered ‘dangerous’ or ‘insanitary’ for the purpose of the Act. ‘Insanitary’ buildings include those of such construction that they are likely to be injurious to health. In determining whether a building is insanitary, consideration must be given to:

- Size of the building
- Complexity of the building
- Location of the building in relation to other buildings, public places and natural hazards
- Intended use of the building, including any special traditional and cultural aspects of the intended use
- Expected useful life of the building and any prolongation of that life
- Reasonable practicality of any work concerned
- In the case of an existing building, any special historical or cultural value of that building
- Aany matter that the territorial authority considers to be relevant
- Provisions of the building code.

Enforcement action is taken by way of formal notice requiring a remedy. An application for a Court Order authorising the council to do required work at the owner’s expense may be made on default.

An offence is committed if a building is used for a purpose for which it is not safe or sanitary.

Cases relating to sections 64 and 65 of the earlier Building Act 1991 may be useful references. These cases include *Hyslop v Dunedin City Council* (21.6.93) AP 35/93 (J Doogue, HC, Dunedin), which deals with asbestos on a building site, and *Marlborough District Council v Chaytor* (1995) DCR 382.

Resource Management Act 1991

In the Resource Management Act 1991:

- Section 15 prohibits the discharge of contaminants into the environment except where some form of authority or consent exists
- Section 17 requires every person to avoid, remedy or mitigate adverse effects on the environment.

Enforcement orders (Environment Court) or abatement notices (enforcement officer) may be issued requiring a person to cease, or prohibiting a person from commencing, anything that is already or is likely to be:

- Noxious
- Dangerous
- Offensive
- Objectionable.

Similar action may require a person to take certain actions to avoid, remedy or mitigate adverse environmental effects.

The Resource Management Act 1991 also includes provision for territorial authorities to make plans and rules that deal with hazardous substances. The health protection officer should be aware of the appropriate provisions of plans, as advice given without such knowledge could create difficulties.

Waste Minimisation Act 2008

The Waste Minimisation Act 2008 includes the following provisions.

- Part 4 provides for territorial authority refuse collection and disposal of waste services.
- Disposal must be undertaken so as not to be a nuisance or injurious to health. Work generally must be to the satisfaction of the territorial authority but a Health Protection Officer may serve notice on a territorial authority for causing a nuisance.
- The Medical Officer of Health may collect and dispose of the waste concerned, and may recover the reasonable costs of doing so from a territorial authority if the territorial authority, or any person collecting the waste on its behalf, failed to comply with the notice.
- Bylaws may also be made prohibiting or regulating the deposit of refuse of any specified kind.

Demolition material containing asbestos will almost certainly arrive at council disposal sites. Service managers will need to determine strategies to deal with this issue to ensure environmental risk and council liability are minimised. Asbestos waste may only be disposed of at a place approved for the purposes by the territorial authority under the Resource Management Act 1991.

Role of property owners

Property owners and their agents should inform occupiers of the presence of asbestos-containing materials and must also act to remedy any asbestos hazards. Property owners should seek expert advice from recognised and certified contractors if work with asbestos-containing materials is required.

Statutory obligations

Property owners must:

- Meet statutory obligations (eg, under the Health Act 1956, the Building Act 2004)
- Obtain necessary building consents and any other necessary consents including those for the disposal of asbestos waste.

Role of WorkSafe New Zealand

WorkSafe is responsible for the administration and enforcement of provisions under the Health and Safety at Work Act 2015 (HSWA). A guiding principle of HSWA is that workers and other persons should be given the highest reasonable level of protection against harm to their health, safety, and welfare from work risks.

WorkSafe may conduct investigations to ascertain whether the HSWA has been complied with. WorkSafe staff have considerable experience and expertise in investigation of hazards or incidents arising from incorrect or negligent use of hazardous substances in the workplace. Under provisions in the HSWA, WorkSafe may be required to investigate an asbestos incident. This may be at the request of a public health officer or a member of the public.

In general, WorkSafe will take the lead in corrective action involving asbestos contamination if contractors are involved in the home. Most circumstances where the release of asbestos fibres would be an issue will involve public buildings or a place of work. However, complaints about asbestos are likely to be received through the Ministry of Health or the National Public Health Service. Thus, public health officers will have an important role in responding and co-ordinating subsequent action. It is advisable that the local public health services establish a procedure to cover the roles and responsibilities between them and WorkSafe through, eg, a memorandum of understanding.

Health and Safety at Work Act 2015

The HSWA is administered by WorkSafe. Section 3(1a)of the HSWA provides for the protection of:

> *workers and other persons against harm to their health, safety, and welfare by eliminating or minimising risks arising from work or from prescribed high-risk plant.*

Section 3(2) requires that in furthering subsection 3(1a):

> *workers and other persons should be given the highest level of protection against harm to their health, safety, and welfare from hazards and risks arising from work or from specified types of plant as is reasonably practicable.*

Section 45 requires that workers, while at work, must:

> *(a) take reasonable care for his or her own health and safety; and*
>
> *(b) take reasonable care that his or her acts or omissions do not adversely affect the health and safety of other persons.*

Section 46 says:

> *a person at a workplace (whether or not the person has another duty under this Part) must—*
>
> *(a) take reasonable care for his or her own health and safety; and take reasonable care that his or her acts or omissions do not adversely affect the health and safety of other persons.*

Health and Safety at Work (Asbestos) Regulations 2016

The Health and Safety at Work (Asbestos) Regulations 2016:

- Impose general duties on persons conducting a business or undertaking (PCBUs) to ensure, so far as is reasonably practicable, that the workplace is without risks to the health and safety of any person
- Prohibit a PCBU from carrying out, or directing or allowing a worker to carry out, work involving asbestos, other than in circumstances expressly permitted
- Impose a general duty on PCBUs at a workplace to eliminate exposure to airborne asbestos at the workplace
- Require asbestos removal work to be licensed, and requires notification of that work to WorkSafe and other persons by the PCBU with management or control of the workplace and by licensed removalists

- Require licensed asbestos removalists to ensure asbestos removal workers have appropriate training, and to provide information about the health risks of exposure to asbestos and the need for health monitoring.

Implementation of management plans

Responsible property owners will:

- Administer and fund abatement work, environmental sampling and analysis
- Engage licensed contractors for abatement work
- Monitor the performance of contractors
- Ensure that routine maintenance work practices do not generate asbestos hazards
- Monitor the condition of the property and abatement work to ensure that asbestos hazards do not recur
- Inform contractors, occupiers and other building users of any asbestos hazards
- Advise occupiers on how to manage risks
- Inform purchasers of known or suspected asbestos hazards.

Role of property occupiers

Tenants should advise their landlord of the development of any asbestos hazard, minimise damage to asbestos-containing material, cooperate with the landlord in facilitating abatement work and act on advice from the health protection team regarding the avoidance of asbestos hazards.

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Appendix 1: Asbestos sampling and analysis

Main points

Air sampling

- Decide on the objective of sampling; generally the sample will be of ambient conditions in areas occupied by people at risk.
- Discuss the sampling objective and methodology with the laboratory.
- Schedule sampling to represent the cycle of activity considering the circumstances that created the need for sampling.
- Keep full records of the sample and of the methods used in its examination.
- Agree measurement criteria with the laboratory, including size and types of fibres to be measured, and sensitivity required.
- Agree sampling protocol with the laboratory, including sampling rate and duration.
- If you need to compare the results with other or earlier samples, make sure you are comparing samples using similar protocols.

Sampling asbestos-containing material

- If in doubt that a material contains asbestos, have it examined by the laboratory.
- Follow the advice on how to take a sample.
- Be clear what you need to know from the laboratory examination.
- Do not expose yourself to asbestos fibres.

Safety when handling asbestos-containing material

These guidelines do not cover the safety of public health officers when handling asbestos-containing materials as this matter should be covered by their health and safety practices and they need to consult WorkSafe.

Introduction

The aims of sampling and analysis of asbestos-containing materials are to:

- identify asbestos and its types in an asbestos-containing material or
- in air to measure the concentration of asbestos fibres in air.

Identifying asbestos fibres – involving either suspected asbestos in a material, or the presence of asbestos in a dust – requires sophisticated technology. The measurement of exposure to particles that are invisible to the naked eye and a hazard to health requires microscopic examination that identifies the size and types of asbestos fibres. The sampling strategies and methods of examination need to be selected for each particular circumstance, requiring close cooperation between the examining laboratory and the health protection team.

Air sampling

Air sampling strategies

Aspects of an air sampling strategy to consider are:

1. Objectives of air sampling
2. Sampler configuration and design
3. Personal versus area sampling
4. Scheduling of sample collection
5. Statistical design
6. Record keeping and quality assurance
7. Air sampling and measurement of asbestos.

1. Objectives

Once the presence of asbestos fibres in air has been established, several different objectives can be addressed in evaluating exposures to airborne asbestos, including the following.

1. Measure personal exposures of individuals at particular risk, or of those who serve as sentinels for groups having similar exposures.
2. Measure ambient concentrations in areas occupied by people at potential risk. These concentrations should be measured depending on the conditions of occupancy and

activity that created the need for sampling. More elaborately, time-weighted average exposures could be calculated by combining time-activity patterns of individuals or groups and the asbestos concentrations in the areas in which they spend their time.

3. Make source-related measurements. These measurements can indicate the potential for human exposure and may range from the measurement of actual fibre release from asbestos-containing material (whether disturbed or not) to estimates of the potential fibre release under specific simulated circumstances.

2. Sampler configuration and design

The aim of configuration and design is to obtain a uniform deposition of a representative sample of airborne asbestos onto the filter surface. The laboratory should be informed of the exact situation and objectives and be asked to advise on appropriate steps.

3. Personal versus area sampling

Building employees who disturb asbestos-containing material in the course of their work will be exposed to highly variable air concentrations of fibres. These are occupational situations (the responsibility of WorkSafe) requiring personal monitors drawing from the breathing zone. It is conceivable, however, that a home owner who insists on removing, or working on, asbestos-containing material in the home may require similar personal monitoring.

For building occupants not in contact with asbestos-containing material, samples collected from representative fixed locations should provide adequate estimates of personal exposure. Compared with personal sampling, area sampling is more practical and efficient and higher sampling air flow rates are possible.

The addition and removal of asbestos in air may be viewed in terms of sources and sinks. The primary source will be the asbestos-containing material that is releasing fibres; the secondary sources will be the re-suspension of fibres that have settled within the space. Sinks will be the removal and settling of fibres. The concentration of fibres measured will be the equilibrium concentration over the time of sampling. Activity and ventilation will therefore influence the concentration measured and should remain as close to the norm as possible.

4. Scheduling of sample collection

For general building occupants, air concentrations of asbestos fibres should be measured over relatively long time periods corresponding to occupancy cycles – that is, at least one full day or long enough to capture typical building activity patterns.

In buildings with air conditioning or ventilation systems, the pattern of exposure may vary with the seasons or even with individual days. Besides the indoor sampling, outdoor air samples should be collected near ventilation inlets to determine what the outdoor air may contribute to indoor fibre concentrations.

In the home, the variation of activity between weekdays and weekends should be reflected, as should changing activity patterns (particularly of children) due to the weather.

5. Statistical design

A statistical design should be discussed and agreed with the laboratory, taking into account:

1. The purpose of the study
2. The definition of the population under study
3. A statistical sampling strategy to obtain a representative sample of that population
4. The need for multiple (spatial) or repeated (temporal) sampling
5. Sample size, for example to estimate the mean exposure to a specified degree of confidence
6. The expected temporal and spatial variability in measurements.

Because of the analytical limitations for a single sample analysis when evaluating the concentration of fibres, many of the samples are generally below the analytical sensitivity. An appropriate statistical strategy may need to be considered by the examining laboratory when interpreting such data (Rao et al 1991).

6. Record keeping and quality assurance

Proper interpretation of air sampling data depends on full consideration of all data relevant to the sample. In addition to the objectives above, information will be needed to verify whether concentrations exceed some acceptable value; show a trend; correlate with building activities, maintenance or asbestos removal; or correlate with use of ventilation or air conditioning systems.

Accordingly, all sampling data should be related to factors that may influence the results or be of value in interpretation. Sample record sheets are provided in Appendix 3.

7. Air sampling and measurement of asbestos

Purpose of measurement

Measuring airborne asbestos evaluates the potential or extent of human exposure to airborne fibres. The measurement strategy needs to recognise the following (Johnson et al 1982).

1. Fibres within certain size ranges, if respired into the lung, can cause lung fibrosis, lung cancer and mesothelioma.
2. Health effects depend on where fibres are deposited (or migrate) and their physical–chemical properties. Important variables are length, width, composition, surface

chemistry, and durability. (At high exposures, which are exceedingly unlikely in the context of these guidelines, consider the rate at which inhaled particles of all types accumulate, and whether this alters normal particle clearance rates. In such circumstances, additional sampling to detect peaks is required.)

3. Other particles and fibres coexist in air, often in much greater concentration than asbestos, so the appropriate method should be used.

4. Methods to identify and count asbestos fibres need to reflect the very different conditions presented by environmental concentrations, where concentrations are generally very low, compared with occupational situations.

5. The sensitivity of measurement methods needs to satisfy either: (a) typical ambient air concentrations; or (b) levels commensurate with lifetime risks of the order acceptable to the public.

Sampling of suspected asbestos-containing materials

Objectives of sampling

The objective of sampling a suspected asbestos-containing material is to verify, or otherwise, the presence of asbestos and provide other information that will help in a risk assessment. Identification of asbestos can only be achieved by scientific examination. Any suspect material should always be sent for examination as asbestos has been found to occur when not expected. Fibre type and the condition of the asbestos-containing material are also important to determine as they may influence the risk assessment.

How to sample asbestos-containing material

- Discuss the purpose and approach to sampling with the laboratory.
- Note that asbestos in some materials may not be uniformly distributed and composite samples may be needed. Laboratory advice should always be obtained prior to sampling.
- Ensure your safety, from both asbestos fibres and accident, while taking a sample. Friable material, easily damaged by sampling, may release significant numbers of fibres. Wear at least a half-face respirator.
- Wet the material to be sampled with water.
- Take a representative quantity of about 10 grams, say the size of a 10-cent coin or a teaspoonful, disturbing the sample as little as possible. (A core sample may be

required for sprayed or trowelled insulation. Preferably use a single-use sampler that also acts as a container – such as an acrylic tube, about 12 mm wide and 100 mm long, bevelled to a cutting edge at one end fitted with caps.)

- Label with a unique number and place in a clean plastic bag; seal and protect from physical damage by packing.
- Clean debris with wet cloth and discard in a plastic bag; seal material with paint or core hole with a sealant.
- Complete relevant information in the sample record using a unique sample number.
- Send to the laboratory.

Information to be sought

The laboratory should provide information on the:

- Presence of asbestos
- Types of asbestos
- Methods used in examination.

The laboratory may also be able to offer an opinion as to the approximate portions of asbestos in the sample if requested. If asbestos is 1 percent or greater by mass, consider the material to be asbestos-containing material. This determination is likely to be necessary only if there is some doubt about the type of asbestos-containing material.

Appendix 2: Public health aspects arising from a fire involving asbestos containing materials: fact sheet for public health officers

The development of this fact sheet was prompted by the Taranaki Patea Freezing Works fire in 2008. Although the local public health staff managed the situation very well it became evident that very limited information is available with respect to the potential public health consequences when dealing with large scale fires involving asbestos containing materials (ACM).

Thermal stability of asbestos

Asbestos was widely used because of its fire resistance properties, however it is not thermally stable when exposed to high temperatures. Chrysotile decomposes at 800–850°C and the amphiboles at 800–1000°C. Asbestos fibres will readily be converted to dust at prolonged exposure to such temperatures.

In sheet form asbestos does not offer any fire resistance and it cracks in building fires. In a fire, asbestos cement sheeting will disintegrate and can explode, releasing fibres over a wide area, mostly in the direction of prevailing wind.

Effect of fire on asbestos fibre contamination

Fire can change the mineral structure and mechanical strength of asbestos, fixing the fibres and transforming it to a less hazardous state. The process will generally affect only the outer layers leaving most fibres intact within the material. Internal fibres in a fibre bundle will be unaffected due to the insulating quality of the mineral.

A study commissioned by the Victorian Department of Human Services (2006) examined the concentrations of respirable fibres away from the incident site, ie, fire location using a computational fluid dynamics programme designed to simulate fires of varying sizes. Fires within buildings comprising substantial quantities of ACM did not result in hazardous conditions with respect to respirable asbestos fibres either close to the building or away from the building. This was true of fires involving asbestos cement sheet only.

Friable asbestos within a fire does give off respirable sized fibres, such as the Broadcasting House fire.[20]

Sampling of the ash residue after a building test fire by the Centre for Environmental Safety and Risk Engineering in Australia did not find respirable asbestos fibres in the ash, however asbestos fibre bundles were present. These fibre bundles, while in their bundled form, are not respirable, however they could become respirable through the clean-up process if the bundles are exposed to further mechanical degradation. Therefore after a fire, the asbestos fibre bundles in the ash debris should be treated in the same manner as ACM during the clean-up process. Respirable fibre concentrations emitted by the fire were very low and appear to be lower than average background levels. Plume modelling was used in determining the dispersion of respirable asbestos fibres away from a fire location which demonstrated that in this particular test, respirable fibre concentrations close to the fire were extremely small. Concentrations reduce further away from the fire being, theoretically, orders of magnitude lower.

Exposure of the general population

People resident in the area, may be exposed following a fire involving materials containing asbestos. Sources of exposure include:

- Direct inhalation of asbestos in the original plume
- Inhalation of asbestos fibres resuspended into the air (eg, wind driven or a result of mechanical processes) following deposition on the ground or other surfaces
- Ingestion of local produce.

The degree of exposure of the general public will depend upon the concentration of asbestos in the air (directly from the plume during the fire or as a result of re-suspension following fire) and subsequent actions of the public and authorities. For example, rapid removal of significant fallout will reduce the potential for significant re-suspension exposures of the general public although it may result in exposures to staff involved in clean-up.

[20] Broadcasting House, a multi-purpose broadcasting centre on Bowen Street, Wellington, New Zealand, was caught by fire in 1997.

Mitigating factors against significant exposures of the general public following a fire involving ACM

- Not all the ACM present may be involved in the fire.
- Fibres may be entrapped in large pieces of material, etc.
- During a fire, most asbestos cement sheeting will be deposited as large pieces.
- Respirable fibres will be a fraction of the total released.
- Small proportion of fibres may be ‘denatured’ at prolonged exposure to high temperatures in large scale fires.
- Atmospheric dispersion and deposition (particularly as a result of rain) will reduce concentrations.21
- Duration of exposure will be short dependent on the type of ACM present.

Acute adverse health effects

Thermal injury or smoke inhalation is generally the most likely potential acute effect from large scale fires. Asbestos may produce irritation of the skin, eyes and respiratory tract due to mechanical action of the fibres. However this only occurs at very high air concentration levels well beyond those that members of the public would likely encounter from a fire.

Respiratory symptoms were reported by people who have been exposed in asbestos fire. However there is no hard evidence to suggest a severe acute health impact consequent on a fire incident associated with asbestos-containing fallout. Despite the lack of hard evidence of an acute health impact, it is important that health professionals are aware of the potential for patients to associate symptoms with such incidents.

[21] A survey was conducted by the Capital Environmental Services Ltd in Wellington on cement sheet roofing and fibre run-off with rainwater. This was conducted over a 12-month period using encapsulated asbestos roofs, a blank and un-encapsulated roof. Using Scanning Electron Microscope, the fibre run-off with rain water was found to be in the region of 13 million fibres per litre of water with little observed difference to the results between roof type. One blank of 12 indicated more fibre when compared with the samples after a particular month of exposure. The increase was found to be due to an asbestos cement roof further down the road being removed and replaced that particular month.

Long-term adverse health effects

There is no direct evidence of long-term health risks from fires involving ACM, although the literature in this area is limited. Considering the available evidence on asbestos exposures from fires involving ACM in the context of the results of epidemiological studies of occupational and environmental asbestos exposures, it is concluded that the risk of long-term health effects (mesothelioma and lung cancer) is low if appropriate clean-up procedures occur.

Evacuation

The usual first course of action is to 'shelter in place' unless directly threatened by fire in which case fire officers will direct evacuation. If evacuation has taken place for health reasons, the Medical Officer of Health and/or Health Protection Officer will determine when to advise residents that it is safe to return home.

Laboratory analysis

The presence of asbestos in materials cannot be determined definitively by visual inspection. Actual determination can only be made by instrumental analysis, eg, polarised light microscopy, transmission electron microscopy or scanning electron microscopy. It is best to assume that the material contains asbestos until laboratory analysis proves otherwise.

Collect and send samples to Capital Environmental Services Ltd (2–4 Bell Road South, Gracefield, Lower Hutt, phone 04-566 3311, fax 04-566 3312) for asbestos analyses to confirm the presence and type of asbestos. Laboratory staff are able to provide advice on how many samples should be collected for testing and how these should be collected. If necessary, a scientist from the laboratory may be sent to the affected area to provide assistance.

In general, air sampling carried out following asbestos fires will not reveal significant levels of asbestos fibres. Therefore in many cases it will not be necessary to carry out such monitoring. Monitoring may however be appropriate after large incidents for public reassurance purposes. This is a decision that should be made on a case by case basis.

At the earliest opportunity after results are known, they should be made public so that members of the public are fully aware of the situation and can make an informed decision.

Effect of watering

Dependent on water pressure, it is important to note that the addition of water will not result in the further degradation of any asbestos fibre bundle. In particular it has been shown that the application of water is very effective in reducing the likelihood of asbestos fibres from becoming respirable in soils and sands. Land contamination issues are possible as a result of water washing asbestos fibre bundles or pooling water in an area (as a result of a fire in the area). In case of asbestos cement products, it is unlikely that the asbestos bundles would be sufficient in terms of fibre size and form to generate respirable dust cloud particles, when the water has evaporated. It could be an issue for lagging and friable material as there can be incidences of rainwater puddles from asbestos cement roof leaks that contain significant amounts of friable asbestos (L Dwyer, personal communication, 29 July 2018).

Clean-up operations within the building should be performed in accordance with WorkSafe requirements. The application of water will further reduce any exposure risk to nearby personnel working in the area, since wetting down the debris after a fire reduces the risk of respirable asbestos becoming airborne. However it should be borne in mind that amosite repels water. So if large amounts of friable amosite are present watering will have little effect (L Dwyer, personal communication, 29 July 2008).

Handling asbestos materials is a specialist task requiring appropriate training and equipment, including personal protective equipment (PPE) as there is the potential for the workers involved to be exposed during the process.

Conclusions

The mere presence of asbestos in buildings or in ash/rubble does not necessarily pose a health risk to building occupants or the public. Asbestos fibres of respirable size must become airborne in sufficient concentration to pose a risk from inhalation.

Exposure of members of the public during and in the aftermath of a fire involving ACM is expected to be minimal if appropriate clean-up operations are undertaken. Thus the potential for long-term environmental exposure and the associated risk is likely to be low.

Some members of the public perceive a greater risk from large scale fires involving asbestos than is actually the case, and this should be taken into consideration when devising and issuing public warnings.

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Appendix 3: Report sheets

Copying and adapting the report sheets for your own use

Users may find it useful to copy parts of the text from the *Graded Response Protocol* and other material into the *Report Sheets*.

Step 1: Initial response and preliminary assessment

Reference number for this investigation:
Your name:

1.1 Gather and record information

Informant details

Date:
Contact person:
Address:
Phone:

Location of potential asbestos hazard, type of building and building use

The location (street address) of the suspected asbestos-containing material:
Person responsible at the site that is the subject of concern:
Address of this person:
Nature of concern:
Type of building – for example, dwelling:
Building use:
Other type of location – for example, a landfill, building or demolition site:
Spatial relationship to the site that is the subject of the concern – how far away, upwind, overlooking, etc. Use description from concerned person at Step 1.
Provide sketch and add information at Step 2. Consider photograph or video recording.

Nature, condition, quantity and accessibility of potential asbestos hazard

Description of the suspected material:

Information on the date that the asbestos-containing material was installed – may be known by the concerned person for their own home:

Is it likely to be an asbestos-containing material from the description in the last two items?

Yes **No** **Maybe**

Is it likely to be a friable asbestos-containing material?

Yes **No** **Maybe**

If 'Yes' or 'Maybe' proceed to Step 2.

Is asbestos-containing material inside the home or building?

Yes **No**

If 'Yes' proceed to Step 2 unless very minor and a simple recommendation can be made; if 'No' consider in conjunction with later questions.

Note location and other information.

Is the suspect material easily accessible to children? Note that accessibility is a measure of future damage, not exposure.

Yes **No** **Maybe**

If 'Yes' proceed to Step 2 unless very minor and a simple recommendation can be made.

What is the potential for future damage, disturbance or erosion of the suspect asbestos-containing material?

High **Low**

See table below which combines this factor with condition.

Quantity of the material: does it exceed about 15 square metres of surfacing material?

Yes **No**

If 'Yes' proceed to Step 2 unless very minor and a simple recommendation can be made.

Condition: is the suspect asbestos-containing material in good condition, a state of minor damage or deterioration, or poor condition?

Good **Minor damage/deterioration** **Poor**

See table below for recommendations on proceeding to Step 2.

Is the potential hazard airborne? (eg, visible dust or other assessment of the concerned person. May be from asbestos-containing material in the home or building, or from adjacent activity.)

Yes **No**

If 'Yes' evidence that it is asbestos needs to be confirmed. Proceed to Step 2.

Actions that may translate the potential hazard into a risk to health

Who is taking, proposing to take or has taken the action? This may be the home owner or a neighbour (residential or commercial), or it may be work being done or proposed in a public building or school.

Name (add description, eg, owner, neighbour):

Address:

What is the action or disturbance? Is it affecting the suspected asbestos-containing material? Add comment on scale, violence and duration.

Does it appear likely that asbestos will be (or has been) released by the actions?

Yes **No**

If 'Yes' proceed to Step 2 unless release can be managed by simple advice and person has good understanding of the hazard and precautions.

When is the action or disturbance of asbestos-containing material proposed, or when did it happen?

Date:

Time if relevant:

Is a change in building use proposed? Changes in use often require interior modification and disturbance of services and surfaces that may use asbestos-containing material. This would normally apply only to public or commercial buildings.

Yes **No**

If 'Yes' describe the change. Consider the need to proceed to Step 2 so that preventive action can be taken and make a note.

Is renovation or remodelling proposed? Alterations to the home of the concerned person, or of a neighbour, may require the disturbance/removal of asbestos-containing material.

Yes **No**

If 'Yes' describe the change. Consider the need to proceed to Step 2 so that preventive action can be taken and make a note.

Are there actions to do with an adjacent industry or business activity? There could be many other actions to asbestos-containing material, either in buildings or to do with processes or work. Note any other actions.

Yes **No**

People at risk

Who may be at greatest risk?

Name(s):

Relationship(s) to concerned person or other description:

How could the people at risk be exposed? For example, where are children's bedrooms or play areas relative to the site of disturbance of probable asbestos-containing material?

Over what period may the people have been, or will the people be at risk?

Who is clearly not at significant risk of exposure?

What is the state of health of the people or population at risk of exposure?

1.2 Identify and assess the potential hazard

Report Table 1.2: Actions or potential for damage, disturbance or erosion

Current condition of asbestos-containing material	Low	High
Good	Unnecessary to proceed to Step 2 unless other factors are significant	Proceed to Step 2
Minor damage or deterioration	Proceed to Step 2 unless simple advice can be safely given	Proceed to Step 2
Poor	Proceed to Step 2	Proceed to Step 2

1.3 Decide whether to proceed to Step 2: Inspection and hazard evaluation

Enter your decision and date here. Note the other factors referred to in the *Graded Response Protocol* for Step 1.3 before deciding.

Decision:

Date:

1.4 Identify and inform the agency most appropriate to take any further action

Does the asbestos hazard identified require the attention of WorkSafe, the territorial authority or (less likely) the regional council? **Yes** **No** **Maybe** Names of agencies: Date approached: Outcome: Should the health protection team continue to be involved with the regulatory agency? **Yes** **No** **Maybe** Roles agreed for each: What further inspections, assessments and action plans (which may follow a similar pattern to this Graded Response Protocol) would you recommend to any other authority?

1.5 If not proceeding to Step 2, provide support and precautionary advice

Advice based on a preliminary assessment of the hazard should be simple: take nothing for granted, and be precautionary.[22] Discourage do-it-yourself asbestos removal, and recommend that specialist firms are called in (WorkSafe has names and details).

Enter the advice given.

Date: Advice given to: Advice should be based on simple precautions, for example: • Do not attempt to do anything to, or handle, friable asbestos. • Avoid do-it-yourself asbestos removal. Call in specialist firms (WorkSafe has names and details). Provide copy of the Te Whatu Ora asbestos resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home*. Other advice given (include information on other agencies to be involved): Who else needs to be informed/involved (eg, landlord, property owners, other)?

[22] Air tests taken, in windy conditions, for a few weeks after the Broadcasting House fire in 1997 showed large amounts of airborne asbestos fibre. The fibre had been distributed over a very large area by the smoke plume. This included inside buildings with open windows and on far sides of high rise in the vicinity of the fire. Some of this fibre had been heat altered, but this was only a very small portion of what was collected by dust wipes.

Follow up on Step 1 if required

Date:
Result:
Follow-up, and/or action/enforcement by other agencies (including dates and action):

In all cases the capacity of the concerned person to understand the advice and take sensible action should be taken into account.

Step 2: Inspection and hazard evaluation

2.1 Co-ordinate action/enforcement with the regulatory agency as appropriate

Record dates and nature of contact and consultation with WorkSafe, territorial authority or other (eg, regional council).

2.2 Confirm initial information

Visit the site and confirm or amend all the initial information by working through all the points in Step 1.1 above. Complete a new *Report Sheet* only if absolutely necessary. (Keep the first copy as a record of the initial step.)

2.3 Obtain and record additional information to enable an adequate hazard evaluation

Identify any further **suspect asbestos-containing material** (see Step 2.3 in the Graded Response Protocol for further information). Examine the **condition** of the suspect asbestos-containing material for deterioration (seeking comment from the laboratory if the sample includes deteriorated material). Note main findings in words here. Sample for composition of the suspected asbestos-containing material. Test for friable asbestos-containing material (if not evident from a visual inspection) on site by rubbing and observe production of dust and particles; wear at least a half-face respirator. Complete sample record sheet (over) which also provides a space for results. Note: discuss with laboratory prior to sampling (refer Appendix 1).

2.3.1 Asbestos sample record

Sample unique number:

Reference number of investigation:

Reference of sample:

Relationship to other samples and their unique numbers:

Examining laboratory and contact name:

Where collected: address

When collected: date

Type of premises and use:

Owner:

Occupier:

Purpose of sample:

Type of sample: air, or asbestos-containing material (describe)

Location: description and sketch in plan and elevation of sampling position – use following sheet.

Site plan: show other potential sources of asbestos fibres (eg, adjoining structures, roads where vehicles brake) – use following sheet. Mark north point.

Sampler configuration and detail (eg, size selective inlet, membrane type, pore size (μm), area (cm^2))

Sampling duration: hours (from – to, using the 24-hour clock)

Air flow rate in l/minute:

Relevant activity at time of sample collection:

Describe ventilation in area sampled: natural (what) or mechanical or air conditioning.

Describe weather during sampling (especially for outdoor sample):

- wind direction
- approximate speed
- temperature
- precipitation
- comment (eg, fine, gusty, still).

2.3.2 Blank sheet for sketch of sample location and site plan

2.3.3 Results

Fibres per litre or presence of fibres in asbestos-containing material:

Type of fibres and proportions:

Method used in examination:

Sensitivity or detection limits:

Other results, comments or queries:

(Attach copy of laboratory report)

2.3.4 Sketch of building and location of asbestos-containing material

Make a sketch on the following sheet of locations, and note materials found and their condition. In the case of large buildings, try to obtain a copy of layout drawing from the territorial authority.

Note accessibility of the suspected asbestos-containing material on sketch on next page; assess as ‘easy’ or ‘difficult’ with children in mind. Note that accessibility is a measure of future damage, not exposure.

Assess the quantity of asbestos-containing material (see Step 2.2). Note areas of surfacing asbestos-containing material on sketch on next page and lengths of pipe or duct insulation in public areas.

2.3.5 Blank sheet for sketch of building and location of asbestos-containing material

2.3.6 Describe any disturbance of asbestos-containing material

Describe the **actions** proposed (or that have taken place) that could disturb asbestos-containing material and lead to the release of fibres. Write in words below and enter on sketch if helpful.

2.4 Identify and characterise hazards

From the complete information obtained, including the results of sample analysis, identify each opportunity for the release of asbestos fibres (including the likely potential release from further damage). It may be useful to mark the sketch with the main potential sources in colour. Describe below:

Report Table 2.4: Characterisation

Where	Friable (F) or Not Friable (NF)	Asbestos type: C, A or M*	Releasability: Significant (S) or Not Significant (NS)	Hazard: High (H) or Low (L)

* C = chrysotile; A = amphibole; M = mixed

Rank hazards as ‘high’ or ‘low’, assuming that there is an open pathway for exposure to vulnerable persons.

2.5 Decide whether to proceed to Step 3: Exposure measurement, risk estimation and assessment

Enter decision: proceed to Step 3

Yes **No**

Date:

Reasons for decision:

2.6 Provide advice to manage hazards and potential exposure, and ensure action is taken

Report Table 2.6: Potential for future damage, disturbance or erosion and suggested action

Current condition of asbestos-containing material	Low	High
Good	Take no further action now beyond operations and maintenance.	Undertake operations and maintenance measures to prevent damage. May require remediation to prevent further damage or deterioration.
Minor damage or deterioration	Operations and maintenance and local remediation are required. Prevent further damage.	Remediation is required as soon as possible to prevent further damage/deterioration. Operations and maintenance cleaning is required.
Poor	Remediation is required as soon as possible. Prevent access to minimise further damage. Operations and maintenance cleaning is required.	Remediation is required urgently. Evacuate people and isolate affected space from rest of building. Operations and maintenance cleaning is required.

Discourage do-it-yourself asbestos removal and recommend that specialist firms are called in (WorkSafe has names and details).

Enter the advice given.

Date:

Advice given to:

Provide copy of the Te Whatu Ora asbestos resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home*. Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

Other advice given (include information on other agencies to be involved):

Who else needs to be informed/involved? (eg, landlord, property owners, other)

Enter action/enforcement co-ordinated with other agencies from Step 2.1.

Note if asbestos waste generated and, if so, how, when and where waste was disposed of.

Follow up on Step 2

Date:

Result:

Follow-up, and/or action/enforcement by other agencies (including dates and action):

Step 3: Exposure measurement and risk assessment

3.1 Coordinate action/enforcement with the regulatory agency as appropriate

Record dates and nature of contact and consultation with WorkSafe, territorial authority or other (eg, regional council):

3.2 Sample and analyse to determine presence and type of asbestos

Discussed with laboratory:

Date:

With whom:

Decision:

Yes **No**

If 'Yes' record method proposed.

Enter sample details and results on the sample record sheet(s) (see Step 2.3).

3.3 Measure the concentration of respirable asbestos fibres in air

Discussed with laboratory:

Date:

With whom:

Decision:

Yes **No**

If 'Yes' record ...

Strategy:

Personal (special circumstances) **Ambient (usually)** **Source (rarely)**

Why will the results be useful?

Enter sample details and results on the sample record sheet(s) (see Step 2.3).

3.4 Estimate the exposure under normal conditions

(See *Graded Response Protocol* Steps 3.3 and 3.4 for note on adjustments.)

Report Table 3.4: Exposure estimation

Name of exposed	Age	Date(s) of exposure	f/mL	Adjusted exposure f/mL if appropriate

Note: Tables 5.1 and 5.2 make their own allowance for durations of exposure.

3.5 Estimate the risk

Consider the estimation of excess risk in Step 3.5 of the Graded Response Protocol.

Low **Moderate** **High**

3.6 Communicate the risk

Consider the factors in risk communication in Chapter 1 (and in the other references) and summarise below the key points you will make:

To whom:

Date:

What further response is required?

3.7 Recommend actions to manage risk and ensure action is taken

Reconsider the advice entered at Step 2.6 in the Report Sheets, taking into account the risk estimates now available.

Recommend actions to manage risk:

Date:

To whom:

Provide a copy of the Te Whatu Ora asbestos resource *All About Asbestos* and, if appropriate, *Removing Asbestos from the Home*. Both resources are available at: **https://www.tewhatuora.govt.nz/our-health-system/environmental-health/hazardous-substances/asbestos/**

Other advice given (include information on other agencies to be involved):

Who else needs to be informed/involved (eg, landlord, property owners, other)?

Note if asbestos waste generated and, if so, how, when and where waste was disposed of.

Follow up on Step 3

Visit to confirm advice:

Date:

Comments:

Enter action/enforcement coordinated with other agencies from Step 3.1.

Glossary

ATSDR	Agency for Toxic Substance and Disease Registry (USA)
μm	Micron (ie, one millionth of a metre – ie, 10^{-6} metres)
Abatement	The removal or significant reduction of a source of hazard, and intervention to reduce exposure to a hazard
CPSC	Consumer Product Safety Commission (USA)
Domestic	In or of the home environment
Epidemiology	The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems
Exposure	A measure of a factor to which a population is exposed
f/L	Fibres per litre
f/mL	Fibres per millilitre
Fibre.year/mL	The product of fibres per millilitre multiplied by years of exposure
Friable	Defined in the Health and Safety at Work (Asbestos) Regulations 2016 as " in relation to asbestos or ACM, means in a powder form or able to be crumbled, pulverised, or reduced to a powder by hand pressure when dry"
Hazard	A source or situation of potential harm
HEI	Health Effects Institute (USA)
IARC	International Agency for Research on Cancer
incidence	The number of new cases or deaths that occur in a given period in a specified population
IPCS	International Programme on Chemical Safety
ISO	International Standards Organisation
L	litre, sometimes also written as *l*
LIM	Land Information Memorandum
Mean	The sum of all the values in a set of data divided by the number of values

Median	The central value in a set of data
MF/L	Million fibres per litre of water
NAS	National Academy of Sciences
NIOSH	National Institute of Occupational Safety and Health
NZPHD	New Zealand Public Health and Disability Act 2000
OSH	Occupational Safety and Health Service of the Department of Labour then the Ministry of Business Innovation and Employment (Health and Safety Group) and now called WorkSafe New Zealand (WorkSafe)
Para-occupational exposure	Indirect exposure to a hazardous substance brought from the workplace to another place
PHC	Public Health Commission
PIM	Project Information Memorandum
PLM	Polarised light microscopy
Public building	Any building that the public may enter
Remediation	All measures to remedy the potential harm from a hazard, including abatement and operation and maintenance
Risk	The probability of harmful consequences arising from a hazard together with a measure of the scale or severity of the harmful consequence. In qualitative terms the risk may be said to have a probability that is 'high', 'moderate' or 'low' or another chosen term. In quantitative terms, the probability can range from zero (no possible harm) to unity (certainty that harm will occur). The scale and severity of the harm may be characterised by the number of people affected and the sort of harm (eg, death or serious injury).
Risk assessment	The systematic acquisition and evaluation of information that enables the probability, scale and severity of the risk to be described
Risk management	All actions of a management nature that are designed to minimise risk to levels acceptable to the person(s) exposed to the risk
RM Act	Resource Management Act 1991
SEM	Scanning electron microscopy
TEM	Transmission electron microscopy

TSI	Thermal system insulation (eg, lagging around boilers, pipes and ducts) to improve (hot or cold) thermal insulation
US EPA	United States Environmental Protection Agency
WES	Workplace Exposure Standards
WHO	World Health Organization