

Workplace Safety and Health Guidelines

Management and Removal of Asbestos



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1. Introduction

Asbestos had been widely used in buildings, plants and ships due to its excellent fire, heat and chemical resistance properties. However, exposure to asbestos, such as through inhalation of asbestos fibres, can lead to serious diseases. In response to these health risks, the use of asbestos in buildings was banned in Singapore in 1988 by the Building Control Division (now the Building and Construction Authority [BCA]).

Many old buildings in Singapore still contain asbestos or asbestos-containing materials (ACMs). These asbestos and ACMs can be released into the air when disturbed, affecting building occupants. It is therefore important to manage asbestos in buildings and workplaces to prevent harmful exposure. Precaution and care must be taken when conducting work activities involving ACMs. These activities include building structural works (e.g., repair, dismantling, demolition, renovation, maintenance and alteration) and other related operations (e.g., handling, sawing, cutting, grinding, drilling, lagging and delagging).

This set of guidelines was developed to provide guidance on the proper management of ACMs and how to work with them safely. It is primarily aimed at contractors, occupiers and building owners, especially those in the construction sector, shipyards and petrochemical facilities.

The guidelines will first discuss some health effects of asbestos exposure and list examples of ACMs. It will then elaborate on the management of ACMs and good industry practices. This is followed by a description of the various aspects of asbestos-removal work. Salient points on air monitoring, training and medical surveillance will also be covered.

After reading this guide, contractors, occupiers and building owners should be able to:

- identify ACMs in workplaces;
- understand the health risks of work involving asbestos; and
- manage the risk of ACMs through appropriate controls.

2. Asbestos and Asbestos-containing Materials

Asbestos

Asbestos is a naturally-occurring mineral. Asbestos fibres have excellent physical and chemical properties which made them popular as construction materials and useful for fireproofing, thermal, electrical or sound insulation and heat or chemical resistance.

There are six types of asbestos fibre and they are classified into two groups: amphibole and serpentine (see Table 1). Amphibole is generally more brittle and tends to be straighter, whereas serpentine, that is, chrysotile is more flexible and less likely to be friable. Crocidolite, amosite and chrysotile are the three most common types of asbestos. Crocidolite and amosite are known to be more hazardous than chrysotile.

Types of asbestos	
Amphibole <ul style="list-style-type: none">• Crocidolite (blue asbestos)• Amosite (brown asbestos)• Anthophyllite• Tremolite• Actinolite	Serpentine <ul style="list-style-type: none">• Chrysotile (white asbestos)

Table 1: Types of asbestos.

Asbestos-containing Materials

ACMs are any material, substance, product or article containing asbestos. ACMs are either friable or non-friable. The degree of friability of an ACM determines its classification and the potential that it will release respirable fibres. To classify whether the ACMs are friable or non-friable, the densities of the materials need to be determined. Established methods to determine density can be found in the *British Standards BS 4624: 1981* and *BS 3536 Part 2: 1974*.

A list of materials that may contain asbestos is provided in **Annex A**.

2.1 Non-friable Asbestos Materials

Generally, non-friable ACMs are less hazardous than friable ACMs. Non-friable asbestos materials are cementitious, resinated, plastic or bituminous. In their dry form, they cannot be crumbled, pulverised or reduced to fine particles by hand, thus it is harder for them to produce the asbestos fibres that constitute a serious health risk. In these materials, asbestos fibres are generally locked or embedded in the base material matrix. Therefore under normal usage conditions or in the course of normal handling, they usually do not release enough asbestos fibres to constitute a health risk.

In a dry state, non-friable asbestos materials usually have a density greater than 1 tonne per cubic metre (1000 kg/m³). They are hard, light grey and generally contain 10% to 15% asbestos fibres, but occasionally they can contain up to 40% asbestos fibres.

Examples of non-friable asbestos materials include:

- corrugated asbestos roof sheets;
- asbestos wall cladding;
- asbestos floor tiles;
- asbestos vinyl sheets;
- asbestos cement piping; and
- asbestos friction products.

2.2 Friable Asbestos Materials

Friable asbestos materials can be crumbled by hand, and their fibres are readily released into the air when disturbed. To completely contain airborne asbestos fibres, total enclosure for the work area and other strict control measures are necessary.

Any non-friable material in poor condition that has a high probability of being crumbled or pulverised during removal operations should be considered friable (e.g., roof sheets that are damaged or have been infested by mold or algae, and old gaskets that require scraping off during removal).

Examples of friable asbestos materials include:

- asbestos fibrous sprayed-on materials used for fire protection, anti-condensation and acoustic control purposes;
- asbestos thermal insulation on boilers and pipes;
- asbestos ceiling boards or wall panels; and
- cable penetrations.

3. Health Risks of Asbestos Exposure

Asbestos is a confirmed human carcinogen and all types of asbestos can cause cancer. Asbestos fibres can enter a body when inhaled as airborne dust or when contaminated materials are ingested. These fibres are retained in respiratory or digestive tissues, leading to diseases such as asbestosis, mesothelioma and lung cancer. These diseases often have a long latency period, and symptoms generally do not appear until 15 to 50 years after initial exposure.

Asbestosis

Asbestosis is a scarring of the lung tissue which leads to decreased lung volume and increased resistance in the airways. It is normally associated with high levels of exposure for many years. Symptoms include shortness of breath, persistent coughing, tiredness and nausea.

Mesothelioma

Mesothelioma is a cancer of the lining of the lungs (pleura) and abdominal organs (peritoneum). Persons diagnosed with this disease usually have a short survival span. It does not normally require a threshold of exposure before ill effects occur, however the risk of contracting mesothelioma generally increases with the frequency, duration and level of exposure to asbestos. Symptoms include weight loss, fever, night sweats, chest pain and breathlessness on exertion.

Lung Cancer

Lung cancer, which can be caused by a number of inhaled carcinogens, including asbestos, is a malignant tumour in the lungs' air passages. Like mesothelioma, lung cancer does not require a threshold of exposure before ill effects occur. The synergistic effect of asbestos exposure and smoking can increase the risk of lung cancer by at least 50 times. Symptoms include a chronic cough, breathlessness, chest pain, haemoptysis (coughing up blood), hoarseness of the voice and wheezing.

4. Risk Management of Asbestos-containing Materials

Proper risk management of ACMs in buildings and workplaces can protect the safety and health of both occupants and workers. Putting in place a proper asbestos management plan can help prevent exposure to airborne asbestos fibres (see Figure 1) for a flow chart for the managing of ACMs.)

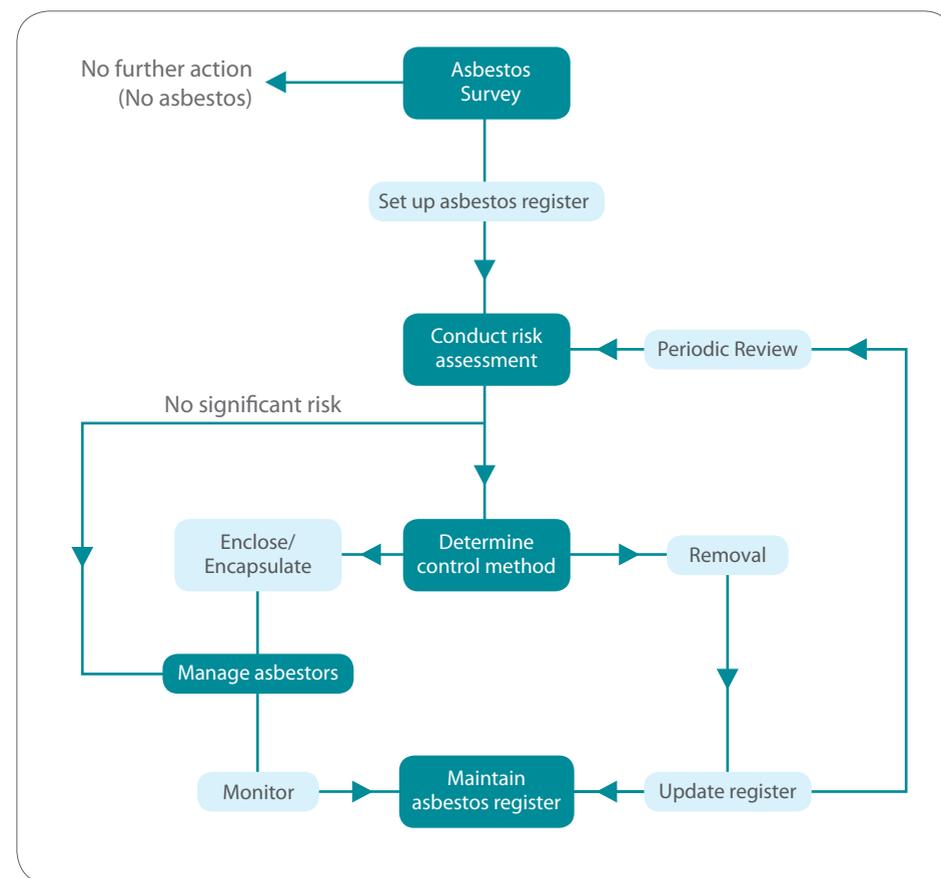


Figure 1: Flow chart for managing ACMs.

4.1 Identification of Asbestos-containing Materials

The first step in managing the risk of asbestos exposure is to determine the presence and location of all ACMs at the workplace, as well as the types and conditions of these ACMs.

Asbestos may be found in numerous building materials, typically for the purposes of fire protection, heat and sound insulation, such as partition walls, refuse chutes, roofing sheets and ceiling boards (see Figure 2).

The type of ACMs which may be found in a typical building include:

- corrugated roof sheets (e.g., roofing, wall cladding);
- insulation boards or tiles (e.g., wall partitions, ceiling boards, fire protection boards);
- flooring materials (e.g., vinyl floor tiles or sheets);
- insulation materials (e.g., fire doors, rubbish chute columns, brake linings); and
- asbestos cement products (e.g., gutters, water tanks, underground pipelines).

ACMs may also be found in ships and plant facilities. They include:

- asbestos sheets, ropes and cloths (e.g., gaskets, insulation, seals, fire blankets);
- spray-on thermal insulation (e.g., fire protection in ducts and structural steelwork, ceilings);
- lagging (e.g., thermal insulation of pipes and boilers; see Figure 3);
- insulation boards or tiles (e.g., wall panels, ceiling boards, fire protection boards, refractory linings); and
- electrical circuits (e.g., panels, wiring insulation, seals, cable penetrations; see Figure 4).

An asbestos survey can be carried out by a competent person to identify all the ACMs in the workplace. (See **Annex B** on how to conduct an asbestos survey.) The competent person must exercise care and diligence in conducting the survey to ascertain the presence of asbestos or ACMs. See below for general steps on how to identify asbestos in buildings.

Step 1: Check the age of the building.

If the building was constructed before 1991, it is likely to contain asbestos since the use of asbestos in building materials was banned in Singapore in 1988.



Figure 2: Asbestos used in building roof sheets and ceiling boards.

1. Roof sheets.
2. Ceiling panels.



Figure 3: Asbestos cloth wrapping with asbestos lagging of exhaust pipe.



Figure 4: Asbestos-containing cable penetrations used on ships.

Step 2: Check building plans.

Some building plans may indicate the use of ACMs. However, it should not be assumed that the buildings do not contain asbestos just because the building plans do not indicate the presence of ACMs.

Details of any extension, adaptation, renovation or refurbishment to the building in the building plans must be examined.

Step 3: Conduct an asbestos survey.

There are two types of asbestos survey, Asbestos Management Survey and Building Refurbishment or Demolition Survey.

- An Asbestos Management Survey is conducted to locate, as far as reasonably practicable, any materials suspected of containing asbestos and assess their condition. It enables proper management of ACMs by preventing ACMs from being disturbed during building maintenance. Any inaccessible structure or material which may contain asbestos should be clearly indicated in the report.
- A Building Refurbishment or Demolition Survey is required if major renovation (alteration, addition or repair work) or demolition of the building needs to be carried out. This may involve destructive inspections to ensure that all areas are accessed and thoroughly checked. Condition assessment of the ACMs may be unnecessary if ACMs are soon to be removed. The report may indicate areas of damage or locations where asbestos debris may be present.

An asbestos survey must be carried out for buildings due for demolition or renovation if the building was built before 1 Jan 1991 (based on its temporary occupation permit date). A competent person must be appointed to carry out the survey to ascertain the presence of asbestos or ACMs before commencement of the work.

See **Annex A** for examples of materials that may contain asbestos.

All identified ACMs must be removed by an Approved Asbestos-Removal Contractor (AARC) before demolition work is carried out (see Chapter 6 on Removal of Asbestos-containing Materials).

Step 4: Take samples for analysis where appropriate.

Samples of materials suspected to contain asbestos should be sent to an accredited laboratory for analysis. Sample taking must be performed by a competent person and necessary precautionary measures should be taken. Samples should be analysed using the NIOSH 9002 Polarised Light Microscopy (PLM) Method of asbestos fibre identification. The analysis result should report the type of asbestos present in the sample. If any asbestos fibres are found in the sample, the material is taken to contain asbestos.

4.2 Exposure and Risk Evaluation

After ACMs in the building are identified, the risk of exposure to the ACMs is evaluated. The risk of exposure is determined by the potential of release and likelihood of disturbance of the ACMs. Factors to consider when evaluating the exposure risk are illustrated in Figure 5 and further elaborated in the paragraphs that follow.

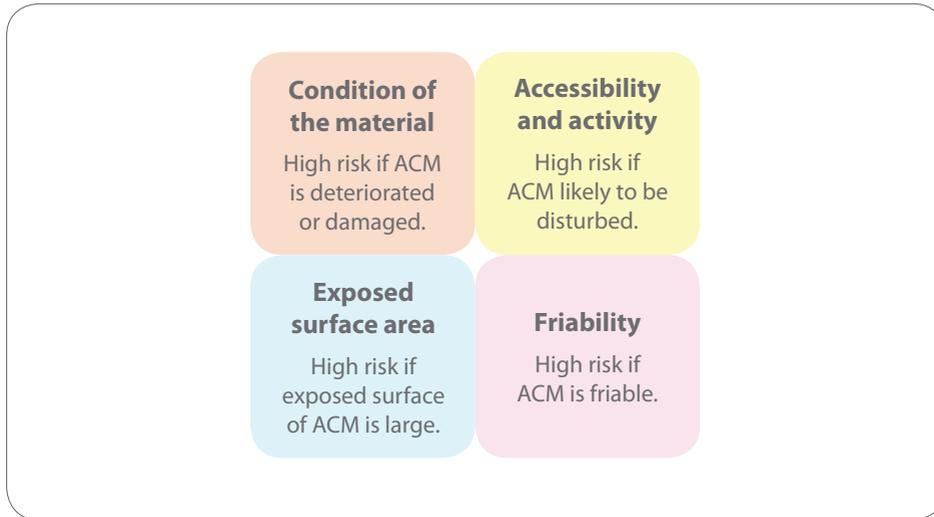


Figure 5: Factors affecting the risk of exposure to ACMs.

Condition of Material

The condition, extent of damage or deterioration of the ACM can influence how fast and how easily it releases asbestos fibres into the immediate environment. This factor is usually associated with the quality of the installation work, the adhesion of the friable material to the underlying surface, and the integrity of the material. Water can also affect the condition of the ACM by dislodging and disturbing the asbestos in the material. Asbestos fibres can be dislodged by water and deposited elsewhere after the water has evaporated.

Exposed Surface Area

The greater the exposed surface area of the friable material, the higher the potential for fibres to be dislodged or released. The release potential and risk of exposure are further increased if the friable material is exposed.

Accessibility and Activity

If a material can be accessed or reached easily, it may be subject to increased contact and hence possible damage. The amount and/ or type of activity or work happening in the vicinity of the ACM, such as vibration and air movement, can also result in potential damage and fibre release.

Friability and Content

Different ACMs have varying degrees of friability – the more friable the material, the greater the potential for asbestos fibres to be released. In addition, a higher asbestos content in a material also increases the likelihood of fibres being released.

4.3 Control Methods

Having evaluated the risk of exposure of ACMs, appropriate control measures need to be put in place. There are four methods of control.

Removal

Removal of ACMs should be considered if ACM damage is extensive and repair is not justifiable. Major changes or remodelling made to the building may also disturb ACMs present and warrant their removal. Asbestos-removal work poses a great risk of fibre release and should only be carried out by an AARC (see Chapter 6 on Removal of Asbestos-containing Materials).

Encapsulation

Encapsulation involves treating the ACM with a sealant that either binds the asbestos fibres together or coats the ACM so that fibres are not released. Encapsulation should be limited to areas where damage due to contact will not occur, so that the ACM will retain its bonding integrity. This method is usually used as an interim measure. It is necessary to ensure that the person carrying out the encapsulation work is adequately protected from exposure to asbestos fibres.

Enclosure

For the enclosure method, a barrier such as a suspended ceiling is usually constructed between the ACM and the building's environment. As the ACMs still remain, asbestos fibres and fallout can accumulate behind the enclosure. However, the accumulated fibres can be released into the building's environment if the enclosure is damaged. It is therefore important to include provision for access to the ACMs during the design and installation of enclosures so they can be inspected regularly.

Leave-in-place

ACMs that are in a good condition should be left undisturbed as they are less likely to release asbestos fibres into the surrounding air. The risk of exposure is normally low or negligible in such instances, and remedial action and assessment can be deferred to a later time when necessary.

The conditions of existing ACMs can change with time, making it necessary to periodically inspect and monitor ACMs. An inspection regime can be established to ensure that the risk of asbestos exposure does not endanger the health of building occupants. It can also indicate the need for further corrective actions such as ACM removal.

5. Good Practices in Managing Exposure to Asbestos-containing Materials

Asbestos Register

Based on the findings of the asbestos survey, an asbestos register can be maintained to keep a record of identified ACMs or those likely to be present.

The asbestos register should indicate the location, type and condition of the ACMs. It should also include inaccessible locations where materials may contain asbestos. The asbestos register has to be maintained, kept up to date, and made available to occupants and any other persons who may be exposed to ACM. The following should be done regularly to help maintain the asbestos register.

Information and Labelling

Wherever possible, ACMs in the workplace should be labelled with warning signs to warn workers or occupants of asbestos hazards. These help prevent people from disturbing the ACMs unknowingly and exposing themselves unnecessarily.

Training and Awareness

Training can be provided for workers or occupants to heighten their awareness of hazards caused by asbestos when working with or near ACMs. Persons who conduct activities in areas with ACMs or who are likely to be exposed to the asbestos in the building must also be informed and educated about the presence of ACMs and their potential hazards.

Isolate or Restrict Access

Restrict and control access to areas where ACMs may pose a risk. Only authorised persons wearing proper personal protective equipment (PPE) should be allowed access to these areas.

Asbestos Monitoring Programme

A programme can be implemented to inspect ACMs periodically (e.g., every six or 12 months depending on the condition of the ACMs) and monitor the concentration of asbestos in the air when necessary.

Reporting Procedures

Procedures can be established for workers or occupants to report any damage or deterioration of the ACMs so that timely and appropriate corrective actions can be implemented to minimise the risk of exposure.

Some Do's and Don'ts

- In areas with damaged ACMs, do keep activities to a minimum if unable to avoid the areas completely.
- Do wear appropriate PPE when working in areas where ACMs may be disturbed.
- Don't dust, sweep, or vacuum debris that may contain asbestos.
- Don't saw, sand, scrape, or drill holes in ACMs.

6. Removal of Asbestos-containing Materials

The Workplace Safety and Health (WSH) (Asbestos) Regulations define asbestos-removal work as any work that entails the removal of asbestos or ACMs that are fixed or installed in a building, plant, ship, machine, equipment or workplace, so that the asbestos or ACMs are no longer fixed or installed in that building, plant, ship, machine, equipment or workplace.

Asbestos-removal work is a high risk activity, and should only be carried out by AARCs. It is important to properly plan, effectively communicate and adequately prepare the site before starting asbestos-removal work.

Asbestos-removal work includes total or partial removal of any type of ACM. Examples of asbestos-removal work include:

- removing asbestos corrugated roof sheets or ceiling boards from buildings or factories;
- removing asbestos insulation or laggings from pipelines or boilers;
- removing asbestos gaskets from piping, flanges, boilers or heat exchangers;
- removing part of damaged asbestos roof sheets, ceiling boards or pipe insulations;
- cutting an opening in asbestos roof sheets or ceiling boards for installation of exhaust fans or pipelines; and
- cleaning up asbestos debris, including decontamination of the worksite or workplace.

6.1 Roles and Responsibilities

The occupier of a workplace should ensure that asbestos-removal work is carried out by an AARC.

An AARC should:

- Submit a notification of asbestos-removal work at least seven calendar days before commencement of the work;
- Appoint a competent person to supervise the asbestos-removal work;
- Ensure that the work is carried out under the immediate supervision of the competent person;
- Ensure that the asbestos-removal plan of work prepared by the competent person is implemented; and
- Ensure that asbestos-removal work is carried out in accordance with the requirements in the WSH (Asbestos) Regulations.

The competent person for asbestos-removal work should:

- Prepare an asbestos-removal plan of work and ensure that it is adequate, suitable and effective;
- Advise on all methods and measures related to asbestos-removal work;
- Ensure that the asbestos-removal work is carried out in accordance with the asbestos-removal plan of work;

- Coordinate or manage asbestos-removal work activities;
- Supervise the entire asbestos-removal work; and
- Ensure that only trained persons carry out asbestos-removal work.

6.2 Notification of Asbestos-removal Work

Under the WSH (Asbestos) Regulations, AARCs carrying out asbestos-removal work must notify the Commissioner for Workplace Safety and Health (WSH) at least seven calendar days prior to the commencement of work. This notification should be submitted through the e-service portal available on MOM's website.

AARCs have to update any change to the notification submitted. A copy of the notification should also be made available at the workplace and must be produced upon request by MOM inspectors.

6.3 WSH Risk Assessment

A proper and thorough WSH risk assessment (RA) must be conducted prior to the start of asbestos-removal work. The RA should identify all potential hazards, establish all the risks associated with asbestos-removal work (e.g., working at height, working in confined spaces), and propose measures to prevent or minimise these risks. Available asbestos registers and survey reports should be referred to when conducting the RA.

For more information about WSH risk assessment, see *Approved Code of Practice for WSH Risk Management*.

6.3.1 Other Hazards Associated with Asbestos-removal Work

Working at Heights

Contractors should avoid working on top of asbestos roofs or ceiling boards. As much as possible, asbestos-removal should be carried out from underneath the roof using suitable work platforms such as mobile elevated work platforms and scaffold platforms. Work platforms must be of safe design, sound material, good construction and adequate strength.

If working on a roof cannot be avoided, safety harnesses, lifelines and anchorage points have to be adequately provided to ensure that the work can be carried out safely. A proper fall prevention plan has to be developed and implemented for working at heights.

For more information on working at height, refer to the following:

- *WSH (Work at Heights) Regulations*;
- *Code of Practice for Working Safely at Heights*;
- *WSH guidelines: Working safely on roofs*;
- *WSH guidelines: Anchorage, lifelines and temporary edge protection*; and
- *Technical advisory for scaffolds*.

Working in Confined Spaces

For asbestos-removal work carried out in confined spaces, entry permits must be obtained prior to entry into the confined space(s). All requirements for work in confined spaces apply.

For more information on work in confined space, refer to the following:

- *WSH (Confined Spaces) Regulations*;
- *SS 568:2011 Code of Practice for confined spaces*; and
- *Technical advisory on working safely in confined spaces*.

Working in a Hot Environment

Outdoor asbestos work causes heat exhaustion due to the hot and humid environment, heavy physical work and non-breathable protective clothing. Heat-related hazards also result from working in enclosures and confined spaces.

However, heat-related disorders can be prevented by:

- ensuring workers are acclimatised;
- ensuring that workers drink plenty of water;
- ventilating the work area; and
- implementing a work-rest schedule.

Removal of asbestos from hot pipelines or machinery should be scheduled to take place during shutdowns, thus allowing sufficient time for the pipelines or machinery to cool. If this cannot be avoided, the plan of work has to take into consideration additional heat stress hazards arising from the pipelines or machinery. Appropriate PPE and control measures have to be put in place to ensure that the work can be carried out safely.

For more information on working in hot environment, refer to *WSH guidelines: Managing heat stress at the workplace*.

6.4 Plan of Work

Before undertaking any asbestos-removal work, it is important to develop a proper plan of work. A written plan of work will guide and establish details on how asbestos-removal work is to be carried out. The plan will vary according to the nature of the task, and the type, location, quantity and condition of the ACM to be removed. Other work activities in the vicinity should also be considered when developing the plan.

The plan of work must be readily available on site. A copy should be made available upon request by MOM inspectors and to others who may be affected by the work. Any change to the plan of work should be documented and updated.

The plan of work shall include, but should not be limited to, the following:

- a) Scope of work:
 - nature of work;
 - estimated duration of work;

- date of work commencement;
 - type(s) of asbestos fibres involved;
 - type of ACM(s) involved (attach photos if possible);
 - quantity of ACM(s) involved (estimated amount); and
 - the condition of the ACM(s).
- b) Location and address of asbestos-removal work.
- c) Particulars of person(s) involved in the work:
- stakeholders involved in the project (e.g., developer, main contractor, sub-contractors, consultants, AARCs);
 - competent person(s):
 - who advises on the establishment of the plan of work; and
 - who supervises the asbestos-removal work.
 - workers:
 - total number of workers involved in the project;
 - workers register;
 - summary reports for medical examinations;
 - fit testing records of respiratory protection devices; and
 - safety orientation course certificates of workers (in the relevant industries).
- d) Method(s) of removal and measures to minimise the release or spread of asbestos:
- method statement (see Chapter 6.6 on Removal Methods);
 - details of enclosures (see Chapter 6.5.3 on Enclosure):
 - size and dimensions;
 - structure and materials used for construction; and
 - calculations of air extraction flow rate requirements.
 - tools and equipment (including PPE) used:
 - specifications of equipment; and
 - checking and maintenance records of equipment.
- e) Decontamination facilities (see Chapter 6.5.4 on Decontamination Facilities):
- size, structure and material used (if it is to be constructed); and
 - manufacturer specifications (if the facility is a purchased unit).
- f) Site layout:
- demarcation of asbestos work area;
 - location of air extraction units;
 - location of the hygiene facility;
 - location of the asbestos waste storage area;
 - transit route; and
 - waste route.
- g) Decontamination procedures (where applicable, see Chapter 6.5.4 on Decontamination Facilities for more information) for:
- the workplace;
 - tools and equipment;
 - personnel; and
 - soil.
- h) Disposal arrangement (see Chapter 6.9 on Waste Disposal):
- procedures for waste handling;
 - National Environment Agency (NEA) approved asbestos disposal contractor; and
 - certificate of waste disposal receipt.
- i) Monitoring of asbestos levels (where applicable; see Chapter 6.10 on Air Monitoring):
- background level (before starting work);
 - workers' exposure level (during work);
 - check for spread of asbestos outside work area;
 - air clearance check (after completion of work); and
 - monitoring or test reports (where applicable).
- j) Emergency procedures (where applicable):
- breaches in integrity of enclosure during removal work;
 - unplanned ACM disturbance;
 - fire emergencies; and
 - rescue of personnel.
- k) Other hazards (where present, see Chapter 6.3 on WSH Risk Assessment).

6.5 Site Preparation

A visual inspection should be carried out to verify that the area is not contaminated before setting up the site for asbestos-removal work. If necessary, air monitoring can be conducted to establish the level of asbestos concentration in the air to determine if respiratory protection is necessary during site preparation.

Prior to covering the asbestos work area with a polyethylene sheet, the area should be pre-cleaned using a high efficiency particulate air (HEPA)-filtered vacuum cleaner or wet wiped. Dry sweeping must never be used to collect asbestos debris under any circumstances. All movable objects such as furniture should be removed from the work area to prevent them from being

contaminated with asbestos. Non-movable objects which are to remain within the work area such as circuit boxes and switch gears should be pre-cleaned thoroughly with an industrial vacuum cleaner equipped with a HEPA filter, or wet-wiped. They should then be sealed with two layers of polyethylene sheets and securely taped down to protect them from contamination. Any ventilation system serving or connected to the asbestos work area should be disabled and the ventilation ducts leading to and from the work area should be sealed for the whole duration of the asbestos-removal work.

6.5.1 Site Control and Arrangement

No person is allowed to enter the asbestos work area, except for those involved in the asbestos-removal work or authorised to enter the work area. The owner, occupants and employees in the workplace and anyone who may be affected by the asbestos-removal work should be advised to stay away from the asbestos work area during the period of work. Barriers or barricades should be erected to control the entry and exit of persons in the asbestos work area. Arrangement for alternate walking path is necessary to prevent unauthorised people or the public from going through or near the asbestos work area.

Signs should be put up at all entry and exit points of the work area to warn the occupants and public of the hazards of asbestos work (see Figure 6). The warning or hazard statements on the signs must be in languages that any person who may be exposed to the hazard can understand. The signs should also be weatherproof and secured in place until the asbestos-removal work is completed. Other signs should enforce site disciplinary rules such as mandatory PPE and no eating, drinking or smoking in the work area.

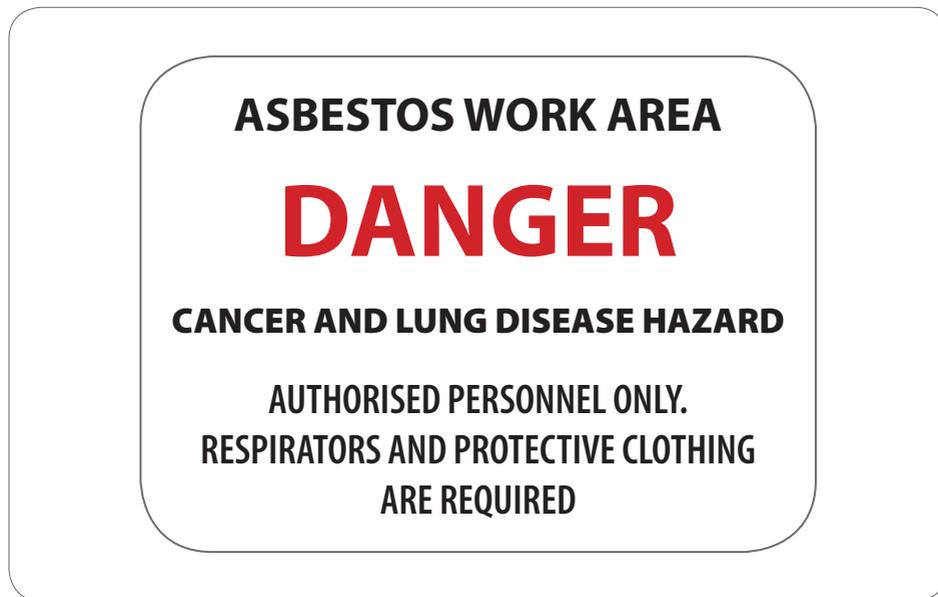


Figure 6: Example of a warning sign.

Scaffolds, lifelines and other work equipment required for asbestos-removal work have to be arranged and set up. During equipment installations, the ACMs should not be disturbed, to prevent unnecessary asbestos exposure. Workers performing the installations must wear appropriate PPE and be able to recognise work hazards such as falling through asbestos roofs or ceilings.

Arrangements should be made for other operations or work to stop during asbestos-removal work. Where possible, avoid work activity in the vicinity of the asbestos work area.

6.5.2 Tools, Materials and Equipment

The following are some tools, materials and equipment that may be required for asbestos-removal work:

- **Polyethylene Sheets**
Polyethylene sheets of 0.20 mm (or 8 mils) thickness should be used to enclose and seal the asbestos work area. These sheets are impermeable and impervious and can prevent asbestos dust and waste from spreading to the surrounding environment.
- **Wetting Agent**
ACMs need to be properly wetted with a suitable wetting agent to suppress asbestos fibres. Water can be used as the wetting agent for ACMs that contain hydrophilic chrysotile fibres, but is less effective for hydrophobic asbestos fibres such as amosite or crocidolite. For the latter, surfactants (e.g., detergent) will be a more effective wetting agent. Whenever possible, surfactants should be used for all types of asbestos-removal work. Surfactants used should be diluted to a specific concentration based on the manufacturer's instructions. For example, a wetting solution can be applied by an airless type portable water spray.
- **Water-based Polyvinyl Acetate Adhesives**
Water-based polyvinyl acetate (PVA) adhesives may be sprayed onto exposed surfaces to bind traces of asbestos that may still be around during the clean-up of the work area. The adhesives should be dyed to indicate where (and whether) they have been applied to facilitate cross-checking at a later stage. Such adhesives can also be used during decontamination work, by spraying them onto asbestos debris to minimise the release of asbestos fibres.
- **Industrial Vacuum Cleaner**
An industrial vacuum cleaner can collect asbestos dust and debris during the clean-up of the asbestos work area. The vacuum cleaner used should be of Type H or equivalent, fitted with a HEPA filter. Unless the vacuum cleaner is designed for wet application, it should not be used to vacuum wet materials as this will damage the HEPA filter. Domestic or general purpose vacuum cleaners should not be used as they do not meet the requirements needed to remove asbestos dust which is hazardous to health.

6.5.3 Enclosure

Depending on the type of ACMs to be removed, a partial or total enclosure needs to be provided.

Non-friable ACM Removal

Partial enclosures are required for non-friable ACMs removal. If the precautionary measures to suppress dust release during the removal work are found to be inadequate after assessment, total enclosures may be necessary. It is advisable to use polyethylene sheets to cover all openings to the asbestos work area as the sheets act as a barrier to prevent the spread of asbestos fibres to other areas in the workplace.

At the asbestos work area, the floor should be covered with polyethylene sheets extending up to at least 1.5m away from the work activity area. The edges of the polyethylene sheets should extend at least 30cm upwards, and should be sealed to the wall with adhesive tapes (see Figure 7). All wall openings such as windows should be covered and sealed with two layers of polyethylene sheets.

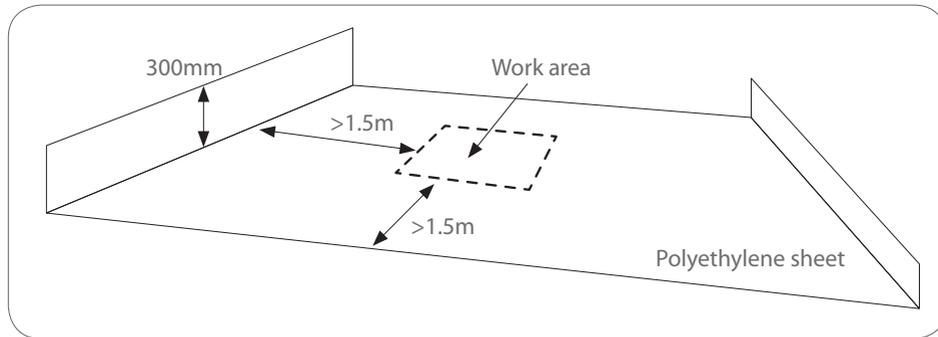


Figure 7: Flooring to be covered with polyethylene sheets at the asbestos work area.

For asbestos-removal work on roofs, a barricade at least 2m high should be erected 5m around the work area to prevent unauthorised entry (see Figure 8). If the minimal distance of 5m is not possible, the barricade should be high enough to prevent any ACMs or debris from falling out.

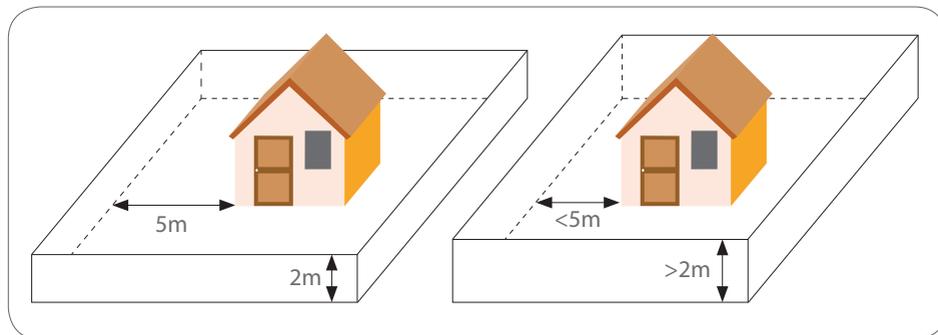


Figure 8: Example of how barricades for non-friable ACM removal work can be set up.

Friable ACM Removal

For removal of friable ACMs, the concentration of airborne asbestos fibres is expected to be high and total enclosure is necessary to prevent the spread of asbestos beyond the asbestos work area. Some factors to consider when designing the enclosure include location, size and shape of the work area, number of workers involved and the use of an air extraction unit to maintain sufficient negative pressure.

Enclosure Design

The enclosure should be of a suitable size based on the work requirements. (An oversized enclosure may not be practical as it increases the amount of ventilation required.) A common type of enclosure used is a self-supporting temporary unit built to accommodate the work area (see Figure 9). It consists of a frame to which polyethylene sheets are securely fixed.



Figure 9: Example of a self-supporting temporary enclosure.

The choice of materials for the construction of the enclosure is determined by a number of factors, including duration and location of the work. The sheets used must be thick enough to withstand wear and tear. In situations where fire hazards are a concern, fire-retardant polyethylene sheets must be used. Wherever possible, operating processes should not be enclosed as this may introduce additional hazards such as plant overheating, heat stress and fire hazards.

The construction of an enclosure may either make use of parts of the existing building structure or self-supporting temporary structures built around the asbestos working area. Where existing walls, ceilings and floors are used to form part of an enclosure, they should have smooth impervious surfaces that can be thoroughly cleaned after the asbestos-removal work. If any part of the surface is rough, damaged or friable, it should be lined with polyethylene sheets, after pre-cleaning has been done. Any openings (e.g., doors, vents, windows, holes) should be sealed using tape or proprietary sealing compounds and/or covered with two layers of polyethylene sheets. Care should also be taken to ensure that openings through which pipes or ducts pass are properly sealed. All the joints in the polyethylene sheeting need to be adequately sealed using adhesive tape.

The enclosure should be provided with a negative pressure unit (NPU) to prevent asbestos fibres from escaping. Airlocks should be constructed to allow a one-directional air flow between compartments (see Figure 10).

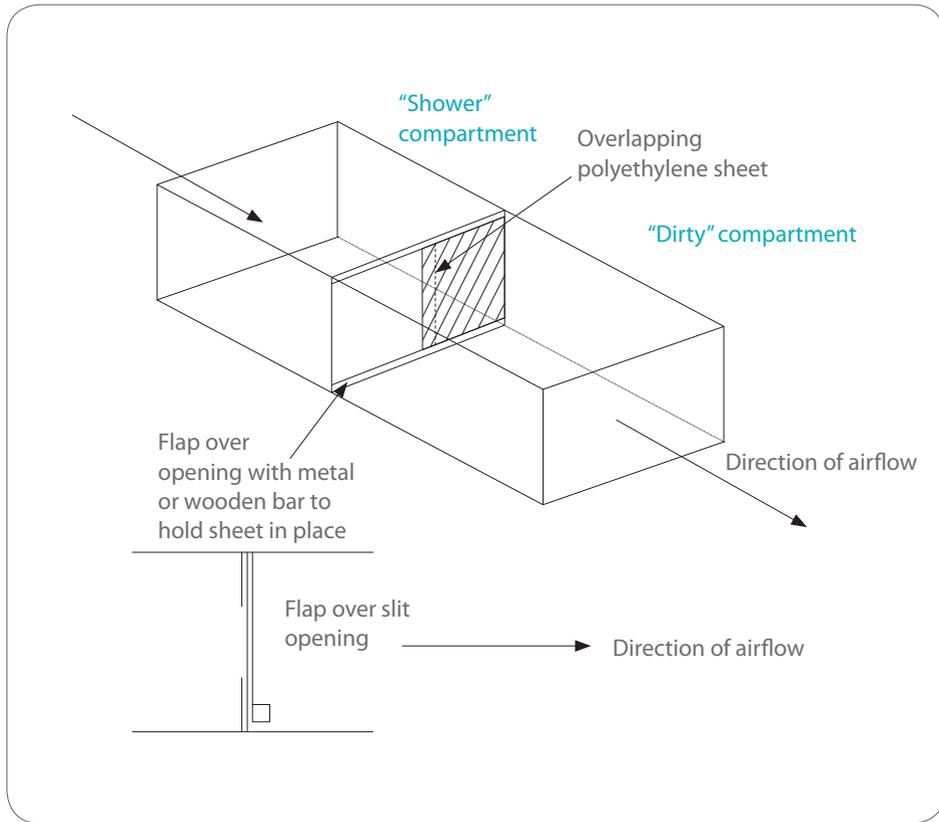


Figure 10: Air locks between compartments allow one-directional air flow.

Where a large plant such as a power station is to be stripped of asbestos, it is recommended that the whole area be compartmentalised into multiple smaller enclosed work areas for easier management of the asbestos-removal work. Suitable clear plastic “viewing panels” can be provided so that work activities can be supervised from outside the enclosure.

The enclosure must not obstruct any fire exits. (Where this is unavoidable, alternative arrangements should be made and clearly communicated to the occupants and workers in the premises.)

Air extraction equipment

Air extraction equipment such as an NPU is used to ensure that any asbestos released during the removal work is contained within the enclosure by maintaining the enclosure at negative pressure relative to the surrounding air (5 pascals or 0.5 mm water gauge). The integrity of the negative pressure system can be gauged from the effect of pressure on the plastic sheet. Negative pressure will pull the plastic sheet inwards. This indicates that air flow through any leaks is inwards rather than outwards, preventing asbestos fibres from spreading to the outside of the enclosure. This allows a supply of clean air to the enclosure.

The type of job, layout of the building, and enclosure size and volume need to be considered when determining ventilation requirements. The air extraction unit should be located where it can provide an effective airflow throughout the enclosure. The unit should be placed opposite of or furthest from the entrance to the enclosure so that air can be purged through the entire enclosure (see Figure 11). For large enclosures or those with complex shapes, more than one air extraction unit may be needed to achieve effective airflow.

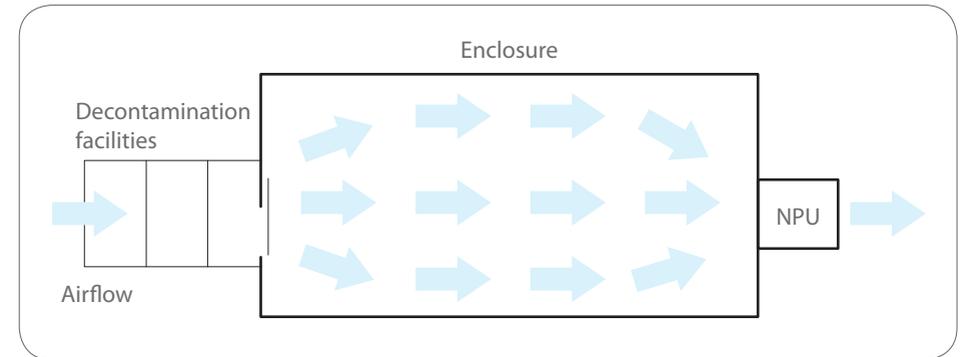


Figure 11: Illustration of an enclosure with an NPU.

It is recommended that the extraction flow rates should result in eight air changes per hour in the enclosure. The air extraction unit must be fitted with a HEPA filter of at least 99.97% efficiency. The air extraction unit should be located outside the enclosure where possible.

The following formula is used to determine the capacity of the NPU required:

(Required NPU capacity (m³/hr) = Volume of enclosure (m³) x no. of air changes per hour)

Example: For an enclosure that is 10m x 5m x 3m; the
 NPU capacity required = 10m x 5m x 3m x 8 air changes per hour
 = 1200 m³/hr

The air extraction unit must be correctly installed and checked by a competent person before use. Safe work procedures for changing of filters should be put in place where there is potential for exposure to asbestos. The air extraction unit should be examined and maintained at least once every six months to ensure that it is in good working condition and operating at its specified efficiency. The maintenance record must be kept updated and available for inspection.

- Inspection and Testing of Enclosure

A thorough visual inspection of the enclosure is required to check for any leakage prior to the start of each shift. Smoke testing by releasing smoke from a smoke generator inside the enclosure can be done to detect leakages. All air extraction units should be switched off during the smoke testing. Leakages can be detected by observing the smoke flow patterns from outside the enclosure. Any leakage detected must be rectified before work starts.

Additional testing can be performed externally using smoke tubes with the air extraction units running. Smoke tube testing should be carried out at around particular seals and joints to ensure they are effective. Smoke should be drawn into the enclosure during smoke tube testing.

The enclosure must also be maintained in negative pressure during work. Differential pressure monitors can be used to provide a continuous indication of whether or not the enclosure is in negative pressure. A pressure difference of about 5 pascals (0.5 mm water gauge) or above should be maintained. The pressure gauge on the air extraction unit should also be checked to ensure that sufficient airflow is maintained at all times during the work.

6.5.4 Decontamination Facilities

Decontamination or hygiene facilities should be provided to enable workers to:

- change into protective clothing and wear safety equipment such as respirators before entering the asbestos work area; and
- decontaminate themselves before leaving the work area.

The decontamination facility should be positioned adjacent to the work area as shown in Figure 12. Where it is not possible to provide the facilities adjacent to the work area, an alternative known as “transit facilities” should be provided. These transit facilities allow workers to decontaminate themselves partially before moving to the main decontamination facilities for complete decontamination. The route that connects the transit facilities to the decontamination facilities should not pass through occupied areas and allow public access.

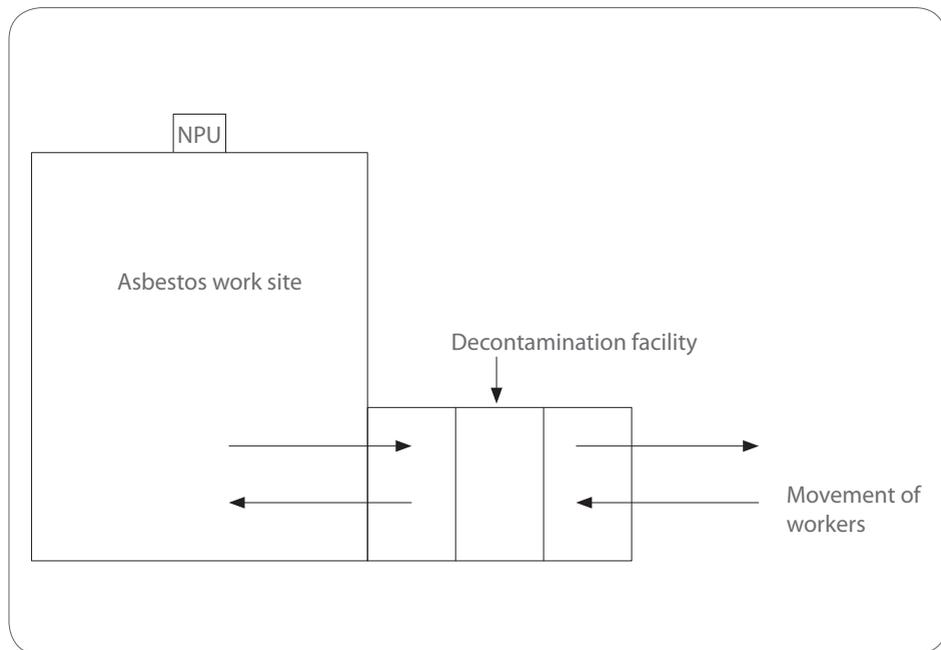


Figure 12: Illustration of a decontamination facility.

The size of the facilities is dependent on the number of workers who will be using them. These facilities should only be used by workers involved in asbestos work.

Design and Construction

Decontamination facilities consist of three separate compartments. They are clean, shower and dirty areas (see Figure 13). At minimum, each compartment should be 1m x 1m x 2m in dimension.

- **Clean Area**
There should be provisions for hanging workers' clothing and safe keeping their personal belongings. Decontaminated PPE are to be stored in the clean area. Battery charging points can also be provided in this area.
- **Shower Area**
Proper showers should be provided for friable asbestos-removal. The shower area should be between the clean and dirty areas.
- **Dirty Area**
There should be storage and disposal bags available in the dirty area for contaminated clothing and asbestos waste respectively. The disposal bags should be labelled to indicate that they contain asbestos waste.



Figure 13: A decontamination facility consisting of three separate compartments (clean, shower and dirty areas).

Decontamination facilities should be constructed such that the facilities can be easily cleaned and no accumulation of asbestos dust in inaccessible areas is possible. Some features and considerations for the facilities include:

- impervious surfaces for all internal walls and ceilings;
- floors completely covered with impervious floor coverings;
- avoiding ledges and grooves;
- covering all corners for easy cleaning;
- providing drainage holes on the floor; and
- capping all poles or tubing used for structure construction.

Two or more overlapping polyethylene sheets between the compartments should be used to ensure that an airlock is maintained as the worker passes through the decontamination facility or unit.

An air extraction unit is needed in the dirty compartment to ensure proper airflow and supply replacement air. Waste water from the decontamination facility should pass through a high efficiency particulate filter (less than 5 microns) before the water can be discharged into the sewer mains (see Figure 14).

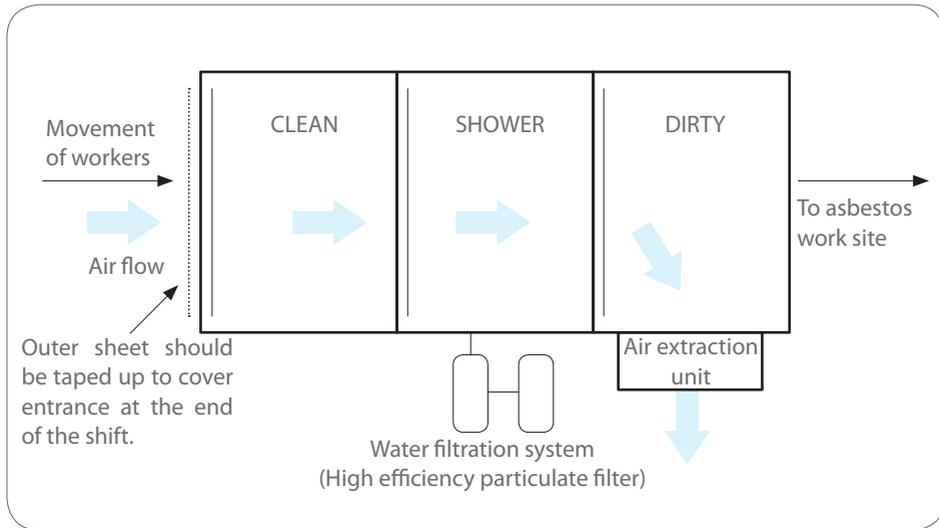


Figure 14: Illustration of a decontamination facility equipped with a high efficiency particulate filter and air extraction unit.

Cleaning and Maintenance

Decontamination facilities should be cleaned at the end of each working day. The daily cleaning regime should include the vacuuming of the entire facility followed by a thorough washing down of any exposed surfaces. The water filtration system should also be drained, and debris traps in the shower area emptied. Debris and asbestos waste collected should be put in labelled disposal bags for subsequent disposal. Maintenance workers cleaning the decontamination facilities should wear the appropriate respirator and PPE.

6.6 Removal Methods

The removal technique chosen for asbestos-removal work is usually determined by the nature of the ACMs and their location. Regardless of the technique chosen, the release of asbestos fibres during removal must always be kept to a minimum. Care must be exercised when handling ACMs to minimise breakage. Only non-powered hand tools should be used during the removal process, as the vibration from powered tools will cause more asbestos fibres to be released. Local exhaust ventilation or shadow vacuuming¹ may be used to control asbestos release.

The removal procedures for the different types of ACMs are provided in **Annex C**.

To select the appropriate asbestos-removal method, the following factors should be considered:

- the need to minimise the amount of asbestos fibres generated at the point where ACM is being stripped;
- the type of ACM present (e.g., impervious cement layer on pipe lagging resists wetting whereas lagging such as blankets is better wetted using sprays rather than injection);

¹ Shadow vacuuming applies local exhaust by placing the hose opening of a vacuum cleaner close to the task. The hose opening may be held by a second worker or directly attached to a tool.

- the presence of live electrical equipment that will prevent or restrict the use of controlled wet stripping (wet method);
- the presence of chemicals may present a direct risk to workers or prevent the use of controlled wet stripping methods; and
- the use of wetting agents can result in slips and falls. This is especially important when workers are working at heights.

6.6.1 Wet Method

The wet method refers to water or another wetting agent being used to minimise the release of asbestos. This method is suitable for ACMs that are not covered with other materials (e.g., metal cladding, coated with paint). The wetting agent is sprayed onto the ACM, and sufficient time is given to allow the agent to be absorbed into the material. Over-wetting would result in excess agent seeping out, causing a slip hazard and creating a runoff that may be difficult to handle. The wet ACMs should be removed and placed in a disposal bag, labelled and sealed.

6.6.2 Glove Bag Method

The glove bag is made of strong clear plastic material and can be used in the removal of asbestos-containing gaskets. Generally, the top of the glove bag fits around the material to be removed while the bottom keeps tools and asbestos waste (see Figure 15). The glove bag should have an entry port to allow a spray nozzle to wet the ACM before removal. The bag must not be reused. Procedures to remove the tools and asbestos waste from the glove bag after the removal work have to be established.



Figure 15: Glove bag containing asbestos waste.

6.6.3 Injection

Injection methods can be used when the outer surface of the ACM is sealed, covered or coated with impervious material. Where lagging is covered by a cement-like layer, holes can be drilled to allow access for injection heads. The holes should be 10 to 15 cm apart so that the wetting agent is able to reach all areas.

6.6.4 Other Methods

Asbestos can be found in vinyl floor tiles or mastic used to glue tiles to the floor. Hand tools such as scrapers should be used to remove such ACMs. Power tools or abrasive methods such as sanding must not be used during the removal process.

6.7 Personal Protective Equipment

Workers whose work involves asbestos should always put on the appropriate PPE such as disposable protective clothing and respirators.

6.7.1 Disposable Protective Clothing

Workers carrying out asbestos-removal work should use disposable protective clothing. The protective clothing should not have pockets, to prevent asbestos fibres from collecting in them. Also, it should not readily retain or allow the penetration of asbestos fibres. Clothing made of wool or other materials can attract fibrous dusts and must not be worn in the asbestos work area. A Type 5 (BS EN ISO 13982-121) disposable coverall is the appropriate clothing for asbestos work.

The disposable protective clothing must be removed upon leaving the work area (e.g., when the worker goes for meal breaks). It has to be stored in sealed labelled containers to prevent asbestos fibres from getting into the surrounding environment. The worker should refrain from blowing or shaking dust and debris off the clothing as this can dislodge the asbestos fibres. At the end of each shift, the clothing must be disposed of in sealed impermeable bags that are properly labelled.

6.7.2 Respirator

For friable ACM removal work where the exposure is likely to exceed the Permissible Exposure Level (PEL) of 0.1fibre/cc, workers should be provided with powered air-purifying respirators or other high performance equipment (self-contained breathing apparatus or airline respirators). Full-facepiece air-purifying respirators may be used if the exposure is not likely to be above the PEL. On the other hand, for non-friable ACMs removal work and low risk ancillary tasks (e.g., scaffold erection, site set-up, enclosure dismantling, waste handling outside enclosure), provisions should be made for half-facepiece air-purifying respirators equipped with HEPA filters.

Workers should be issued with personal respirators, and they have to ensure that their respirators are regularly cleaned and properly maintained. Fit tests for respirators must be conducted for all users to determine their suitability. Users should also be advised to have their faces clean-shaven to ensure a good fit.

The filter cartridges of the respirators should be replaced when damaged or clogged with dust (e.g., when breathing resistance increases). Workers are reminded to wash their faces and respirators when they leave the work area. The selection, use and maintenance of respiratory protective devices (RPDs), should be in accordance with *SS 548:2009*.

See **Annex D** for the selection and use of RPDs and filter cartridges, and fit test requirements.

6.8 Decontamination

Decontamination is an important step in minimising workers' exposure to residual asbestos fibres during asbestos-removal work processes. The asbestos work area, tools, equipment and PPE need to be decontaminated. Workers should carry out personal decontamination.

Work Area

Decontamination of the work area should be carried out after the asbestos-removal work. The wet-wiping method (e.g., using damp rags to clean the contaminated area[s]) can be used. This is followed by vacuuming to remove asbestos dust. The rags used must be disposed of properly after cleaning. Where wet-wiping is not feasible, sealing agents such as PVA may be used to bind asbestos fibres or dust. After decontamination, a visual inspection should be carried out to ensure that the area has been thoroughly cleaned.

Areas to be decontaminated should include the following, as asbestos debris or residue can be deposited in these areas:

- window sills, ledges, shelves;
- any rough or porous surface;
- support brackets, clamps and pipe hangers;
- nuts and bolts of flanges and hatches of vessels;
- backs of pipes and vessels;
- round conduits and inside cable trays, especially when they are made of metal mesh;
- holes in walls or partitions where pipes, cables or ducts pass through;
- undersides of boilers and tanks;
- folds or overlaps in the polyethylene sheets used to construct the enclosure; and
- electrical installations such as fuse and switch boxes and the inside of light-fitting enclosures.

After decontamination of the work area, an air clearance test should be carried out (see Section 6.10 Air Monitoring for details). The enclosure at the asbestos work area can be dismantled once satisfactory air sampling results are obtained. The sheeting materials used should be taken down, folded inwards, placed and sealed in appropriate disposal bags. The materials used in the construction of the enclosure may be contaminated and they may have to be disposed of as asbestos waste unless they can be effectively cleaned or sealed. All contaminated materials, including cleaning rags, plastic sheeting, timber scaffolds, and PPE must be disposed of properly as asbestos waste.

Tools and Equipment

All tools and equipment used during asbestos-removal work should be properly cleaned and decontaminated before they are removed from the asbestos work area. Otherwise, they would have to be disposed of as asbestos waste depending on the level of decontamination and ease of replacement. Tools and equipment can be cleaned by wet-wiping followed by vacuuming (where practicable) to ensure that all asbestos dust has been removed. Tools that cannot be completely decontaminated or are to be reused should be put in appropriate containers or bags, sealed and labelled.

Personnel

Workers have to carry out personal decontamination in the decontamination facilities at the asbestos work area. They must be trained in decontamination procedures, and adhere to the procedures for using the facilities to avoid contaminating the facilities and creating a health risk to themselves and others.

See **Annex E** for procedures for entering and leaving the asbestos work area.

Soil

In situations where the soil is contaminated with asbestos, for example, due to accidental breakage of ACMs or improper removal of ACMs, the contaminated area should be cordoned off and appropriate steps taken to mitigate the situation.

Decontamination can take the following steps:

- Wet the top layer of soil to minimise generating dust;
- Pick up all visible pieces of ACM debris;
- Remove contaminated topsoil to a depth that has no contamination or asbestos debris (a depth of 10cm is usually sufficient for most cases); and
- Dispose of the contaminated soil as asbestos waste.

6.9 Waste Disposal

Asbestos-containing waste, debris and contaminated clothing should be collected in sealed and impermeable bags or closed containers. The outer surface of these bags or containers should be wet-wiped or vacuumed before they are transported out of the asbestos work area. Bulky asbestos waste such as cement sheets, pipes or insulating boards should be wrapped twice in heavy duty plastic. All asbestos waste should be double-bagged, preferably using a coloured bag on the inside and a clear transparent bag outside. Asbestos waste must be sealed and affixed with labels that clearly indicate the presence of asbestos wastes.

All bags or containers used for asbestos-containing waste should be stored in a designated asbestos waste area. This area should be distinguished from other areas with warning signs. If waste bins or skips are used, wastes must be packed and sealed so that when bins and skips are emptied, there is no residual asbestos contamination.

All asbestos waste should be removed and disposed of accordingly by an approved asbestos disposal contractor regulated by NEA. An application for written permission to dispose of the asbestos waste should be made to NEA. A copy of the receipt issued by the NEA when asbestos waste is disposed off at a landfill should also be kept.

For more information on disposal of asbestos waste, visit www.nea.gov.sg

6.10 Air Monitoring

Air monitoring is conducted to ascertain:

- the airborne concentrations of asbestos fibres so that the correct choice of respirators has been made;
- that there is no measurable spread of airborne fibres to areas adjacent to the asbestos work area; and
- that the work area was adequately cleaned before it was returned to normal use.

Air monitoring is important when:

- large quantities of ACMs have been handled;
- work involves the use of abrasive power or pneumatic tools, and/ or breaking ACMs; and
- significant contamination has occurred.

Air samples collected should only be sent to accredited laboratories for analysis. See **Annex F** for information on air sampling.

6.10.1 Initial Exposure Assessment

To ascertain initial air exposure concentration, air monitoring can be done for friable asbestos before asbestos-removal work starts. The initial exposure assessment can help establish the condition of the work site and ensure that adequate preventive measures have been put in place to protect workers.

6.10.2 Exposure Assessment During Operation

For friable asbestos-removal work, contractors or employers must carry out exposure assessment for workers working in the asbestos work area unless there is:

- reliable data showing that the removal activity will not release airborne fibres in excess of the PEL; and
- historical data from prior monitoring for similar asbestos jobs conducted under similar conditions.

For non-friable asbestos-removal work conducted indoors, contractors or employers must carry out exposure assessment for workers working in the asbestos work area unless the contractor is using the control methods and removal methods recommended in the guidelines. If the contractor uses other control methods, the assessment must be carried out even when workers use supplied-air respirators.

The assessment can be terminated if the results show that the exposure is less than the PEL and there is no change in the conditions, for example, in the work method or equipment used.

6.10.3 Post-operation Assessment

Air or clearance monitoring is necessary after asbestos-removal work is completed for friable ACMs and non-friable ACMs indoors. The monitoring should only be carried out when the area has been cleaned and dried after a visual inspection of the work area.

When the results from the monitoring and visual inspection are satisfactory, the enclosure can then be removed. If any contamination is found during the dismantling of the enclosure, further cleaning must be carried out and the process of visual inspection and air monitoring repeated. For clearance monitoring, the concentration of airborne asbestos fibres in the air should not exceed 0.01 fibres/cc.

7. Training of Workers

Workers involved in asbestos work must be adequately trained not earlier than 12 months before they start any asbestos work and retrained once every 12 months after the completion of the last training.

The training programme must include instructions on the following:

- the harmful properties of asbestos and their hazardous effects on health;
- materials, substances, products and articles which contain or are likely to contain asbestos;
- work, processes or operations which may result in exposure to asbestos and preventive measures to minimise such exposure;
- safe work procedures and use of PPE;
- proper use, maintenance and limitations of respiratory protective equipment;
- asbestos decontamination procedures;
- asbestos waste handling procedures; and
- purpose and requirements of medical examinations as specified in the WSH (Medical Examinations) Regulations.

Training programmes must be reviewed periodically to take into account any significant changes in the type of work and/ or work methods used. The training record shall include information on the syllabus and content of the training programme and the start and end dates of the training programme. The training record must be updated, made readily available and kept for at least two years.

8. Medical Surveillance

Under the WSH (Medical Examinations) Regulations, workers involved in asbestos work must be sent for a pre-placement medical examination not later than three months after their employment commences, and every three years thereafter for regular medical examinations.

The medical examination includes a clinical examination and a large-size chest X-ray, and must be conducted by a designated workplace doctor. The contractor or employer is required to submit a register of all workers involved in asbestos work together with their medical summary reports to MOM. The contractor or employer is also required to update MOM if any asbestos worker has resigned or left employment.

The medical examination reports should be kept by the contractor or employer for at least five years, and should be made available upon request by MOM inspectors. It is recommended that these medical records should be retained as long as possible due to the long latency period of asbestos-related illnesses. Employees could also be given a copy of their medical report.

9. Annexes

Annex A – Materials That May Contain Asbestos

The following are materials that may contain asbestos. The list is not exhaustive.

- Bituminous adhesive or sealant
- Boiler insulation
- Brake disc pad
- Brake or clutch lining
- Caulking or putty
- Ceiling board or panel
- Cement board or panel
- Cement pipe
- Corrugated roof sheet
- Corrugated wall cladding
- Electric wiring insulation
- Electrical cloth
- Electrical panel partition
- Elevator brake shoes
- Fire blanket
- Fire curtain
- Fire door insulation
- Fire proofing cloth
- Fire proofing gloves
- Fire-rated wall
- Fire-resistant board
- Floor vinyl sheet
- Floor vinyl tile
- Gasket
- Gland packing
- Insulation block
- Joint sheet or compound
- Mastic
- Millboard
- Pipe cladding
- Pipe insulation
- Plaster (acoustical or decorative)
- Refractory lining or tile
- Roof gutter
- Roofing felt
- Rubbish or refuse chute
- Sprayed insulation
- Textured paint or coating
- Thermal insulation lining
- Thermal paper product
- Ventilation panel or pigeon hole ventilation block

Annex B – How to Conduct an Asbestos Survey

Below are general guidelines on asbestos surveys.

a. Survey Planning

Information you need before conducting an asbestos survey:

- number of buildings to be surveyed;
- description and use of building(s);
- age, type and construction details of building(s);
- details on any extension or refurbishment carried out after the building(s) was completed;
- building plans, floor layout or drawings of the site (to record location of samples taken and indications of ACM presence);
- safety and health hazards on site; and
- the location of heating and ventilation ducts, plant rooms, riser shafts, lift shafts, and so on.



Figure 17: A core sampler.

A list of equipment for asbestos survey work:

Equipment for taking samples	Other ancillary/auxiliary items	PPE
<ul style="list-style-type: none"> • Pliers • Screwdrivers • Hammer • Core samplers (see Figure 17) • Tapes • Penknife • Fillers • Hand-spray containing PVA or surfactant • Sampling bags 	<ul style="list-style-type: none"> • Site plan • Step ladder • Camera • Torch • Sampling labels • Type H vacuum cleaner • Asbestos waste bags • Wet wipes • Polythene sheeting 	<ul style="list-style-type: none"> • Disposable clothing • Disposable shoe covers • Disposable gloves • Respirators (where appropriate)

b. Bulk Sampling

Surveys should be carried out systematically to ensure that all areas are inspected and no ACMs are missed out. Each area and room should be thoroughly examined to identify the materials and locations to be selected for sampling.

Below are some good sampling practices:

- Materials should be inspected for apparent differences and variation in appearance;
- Samples of approximately 3 to 5 cm² surface area and covering the entire depth of the ACM should be taken;
- For homogenous materials, one or two samples will normally be sufficient. For non-homogenous materials, more samples may be required;
- Repaired or patched materials should be sampled in addition to the original material;
- Materials should be wetted with suitable wetting agent to control any release of airborne asbestos during sampling, and if necessary, shadow vacuuming² should be adopted;
- Sampling points, or locations where samples are taken, should be sealed with tapes or fillers to prevent the release of asbestos fibres after sampling; and
- The sampling area should be thoroughly clean, leaving no evidence of debris from the sampling operation.

c. Survey Report

The asbestos survey report should follow the format below:

- Executive summary:
 - brief description of scope and type of survey; and
 - summary of findings and conclusion.
- Introduction:
 - scope, purpose and objectives of survey;
 - type of survey (e.g., management, refurbishment or demolition survey);
 - number of buildings involved in survey; and
 - type and age of building(s).
- Site information:
 - details of surveyor (name of survey company, address, name of surveyor, contact email or number, etc.);
 - details of client (name of company, address, contact person, contact email or number, etc.);
 - name and address of premises surveyed;
 - date of survey;

² Shadow vacuuming applies local exhaust by placing the hose opening of a vacuum cleaner close to the task. The hose opening may be held by a second worker or directly attached to a tool.

- date of report;
 - areas accessed/ included in the survey;
 - inaccessible areas and the reasons why access is not permitted; and
 - survey method used.
- Survey results:
 - sample number;
 - location description;
 - product type;
 - photographs of ACM;
 - quantity;
 - test result (asbestos type);
 - condition³;
 - surface treatment⁴; and
 - building plans indicating the location of ACMs.
 - Conclusions and recommendations:
 - summary of findings (list samples that contain asbestos and type of asbestos found); and
 - recommendations and actions to be taken.
 - Appendix:
 - bulk analysis results of the samples tested (provided by the laboratory);
 - building plans or floor layout indicating sample locations and areas that contain ACMs; and
 - photographs of the site.

Examples of ACMs and their locations that could be provided in the survey report:

Sample no	Location	Product type	Quantity	Photo	Test result (asbestos type)
1.	Living room	Ceiling board	Whole ceiling		Amosite
2.	Roof	Corrugated roof sheets	Entire roof		Chrysotile
3.	Backyard roof	Corrugated roof sheets	50m ²		Chrysotile

³ not needed for Demolishment Survey.

⁴ not needed for Demolishment Survey.

Annex C – Removal Procedures for Asbestos-containing Materials

Removal Procedures of Non-friable ACMs

- **Manual Dismantling Method**

If asbestos cement sheets are in a good condition and it is reasonably practicable to provide safe access, they should be taken down in their entirety without breakage. It is best to:

- Remove them intact;
- Use wet methods where possible;
- Immediately vacuum all loose dust along the cut;
- Lower the roof sheets to the ground as soon as possible or by the end of the work shift;
- Wrap or bag the removed material before hoisting;
- Transfer unwrapped materials to a closed receptacle to prevent dispersion of the dust when lowered; and
- Isolate roof-level ventilation air intakes or shut down the ventilation system.

Roof sheets should preferably be removed from underneath with mobile elevating work platforms such as scissor lifts or cherry pickers. When using this method, the sheets should not be dropped or damaged. The equipment used should be thoroughly cleaned.

- **Remote Dismantling Method**

If the sheets are disintegrating or the risk of falls is too great, remote dismantling or demolition methods such as deliberate controlled collapse should be used. Remote demolition could expose equipment operators or waste disposal workers to asbestos fibres.

When the remote method is used, the work area must be continually sprayed with water to suppress the release of asbestos fibres. The roof sheets should be dismantled in a controlled manner, for example, using excavators fitted with suitable demolition attachments. The area should be cleared of other materials before work commences. The work should be designed to minimise breakage of sheets. Before and while loading the broken sheets onto lorries, keep the sheets damp by spraying them with water. Lorries should be securely covered to prevent the asbestos waste from drying out and dispersing during transportation.

In some cases, the public may be alarmed by the remote method of demolition as it can be noisy, dusty, or appear uncontrolled, and potentially spread dangerous fibres from asbestos roofing and/ or roof sheets. To alleviate these concerns, contractors can keep members of the public informed about the work and carry out background air sampling at the perimeters of the site.

- **Removal of Floor Tiles**

To remove asbestos-containing floor tiles, such as vinyl floor tiles, individual tiles should be lifted by scraping manually at their bases. As underlying mastic adhesives may also contain asbestos, any adhering remnant of tiles should be completely removed from the floor slab by manual scraping and wetting.

To remove asbestos floor coverings, a continuous 1 m high dust barrier sealed to the floor around the work area is required, and mechanical chipping should not be carried out unless in a negative pressure enclosure. Dry sweeping and sand flooring are not allowed.

- **Removal of Gaskets**

When removing asbestos-containing gaskets, contractors or employers must ensure the following are carried out:

- Enclose gaskets in glove bags before removal if they are visibly deteriorated and unlikely to be removed intact;
- Thoroughly wet the gaskets with wetting solutions or water prior to removal;
- Immediately place the wet gaskets in a disposal container; and
- Scrape using wet methods to remove residue.

- **Removal of Cement Pipes**

In most cases, asbestos-containing pipes are considered non-friable. They should not be shattered, crumbled, and/ or pulverised as they will release asbestos fibers. Asbestos-containing pipes should not be sanded, sawed, ground and/ or chipped under any circumstances, such as when using power tools.

When removing the asbestos containing pipes, contractors or employers must ensure the following are carried out:

- Excavate the soil to expose the pipes;
- Use manual tools to clear away the soil surrounding the pipes;
- Wet the material during removal using a water hose, garden sprayer, spray bottles, or any method that keeps the material wet;
- Cut the pipe using hand-operated blade cutters or snap cutters and pull the pipe up out of the ground in easy to handle lengths (1 to 1.5 m or 3 to 5 feet); and
- Do not use compressed air, dry sweep, or vacuum with a non-HEPA rated vacuum cleaner.

Removal Procedures for Friable Asbestos-containing Materials

- **Removal of Lagging and Sprayed Coating**

If the material is thick (greater than 1 cm), and covered with a coating which can be punctured by injection heads, low-pressure injection can be used.

If the material is unsealed and relatively thin (less than 1 cm), controlled low-pressure sprays can be used to wet the materials. If there is an impermeable layer which cannot be punctured by injection heads, such as a pipe lagging with a hard cement coating, injection holes can be made by drilling.

When pipework is redundant, wrap and cut can be applied.

- **Removal of Boards**

For surfaces which are painted and accessible, shadow vacuuming must be applied while unscrewing the board. Controlled low-pressure sprays should be used on unpainted surfaces, followed by surface vacuuming while unscrewing the boards.

- **Soaking Method (Controlled Wetting Using Injections)**

If the ACM is so thick that the spray method will not suppress the dust significantly, the soaking method should be used to ensure the material is completely saturated. First, the insulation is soaked in water or another wetting agent through an appropriate applicator which feeds the wetting agent to the insulation via numerous side holes or outlets. To facilitate rapid wetting of the insulation material, holes or cuts should be made in the outer covering to enable water or wetting agents to be injected. It is important to note that the ACM should be saturated with the wetting agent, not just washed out through a liquid passage.

Where access to ACM is obstructed by coating or cladding, the coating or cladding should be removed carefully to avoid dust generation. Before removal, the surfaces should be vacuum cleaned or where practicable, sprayed with water. The quantity of water or wetting agent and soaking time will depend on the thickness of material, access and location of holes. Water or wetting agent application should be controlled to prevent slurries and/ or surface run off. The saturated ACM should be removed in sections and placed in properly labelled and sealed containers before it is disposed of as asbestos waste.

The most useful technique for achieving good control of asbestos fibres at the point of removal is multi-point injections, using injection heads which penetrate the outer layer of ACM such as sprayed coatings or lagging. Injection heads with holes only at the tip allow thin layers (1 cm or less) of sealed sprayed coatings to be injected. Alternatively, angled injection heads which help the lateral movement of the wetting agent can be used. However, injection methods may not be appropriate for unsealed sprayed coatings where the injection heads can dislodge asbestos during application.

- **Spray Method**

The spray method should be used on ACM which is not covered or coated by other materials such as paint and/ or cladding which requires prior removal. The water spray should be applied so that the entire surface of ACM is wet while also minimising runoff. A manually controlled low-pressure water spray could be used. The spray should be both copious and fine so that the water droplets do not generate dust on the surface of the insulation material upon impact. The ACM should be wet through the entire cross section of the ACM.

The spray should be directed at the cutting-up operation in progress and the wet material removed. The wet ACM should be removed in sections and placed in labelled containers, then suitably sealed. All removed ACM should be properly wet and small sections which may be dislodged should be properly disposed of. Suitable respiratory protection is still necessary when using a water spray method because asbestos dust may not be fully suppressed or eliminated.

Annex D – Selection and Use of Respiratory Protective Devices

Respiratory Protective Devices must be adequate (i.e., provide the level of protection required) and suitable (i.e., matched to the user, job and working environment).

- **Selection**

The selection of RPD for asbestos work should take into consideration:

- Expected Level of Exposure

The expected level of exposure should be established during risk assessment. Results from pre-job or previous air monitoring may be used as a guide in determining expected exposure levels.

- Protection Factor

Protective factor determines the effectiveness of the respirator in reducing the concentration of asbestos particles in breathing air.

See *SS 548: 2009 Code of practice for selection, use and maintenance of respiratory protective devices* for more information on the protection factor of the different RPDs available.

- **Fitting**

Users must undergo fit testing to ensure they have been outfitted with the right respirator in the right size for their job. A good facial seal is important to ensure optimal respirator performance. Fit testing should be conducted by the manufacturer or manufacturer-accredited representatives.

A qualitative or quantitative fit test method may be employed to determine if a satisfactory fit has been achieved. A fit test shall not be conducted if there is any hair growth between the face and sealing surface of the respirator, such as a beard or moustache.

See *SS 548: 2009 Code of practice for selection, use and maintenance of respiratory protective devices* for more information on the fit test procedures.

A fit test must be conducted before the first use of a respirator and subsequently at least once every 12 months, or whenever there is a change in the user's facial characteristics. Records of fit testing must be kept for at least two years.

- **Maintenance and Storage**

All respirators must be inspected for defects before each use. Fit checks must be done every time a respirator is used to ensure that the respirator is in good condition and that it is a good fit. Both a negative and positive pressure check should be performed. Respirators must be placed in a clean, sealable plastic bag when not in use.

- **Filter Cartridge**

For asbestos-removal work, a HEPA filter should be used.

Under the AS/NZS 1715:2009 and BS EN 143:2000 classification, the Type P3 particulate filter should be selected as it has a 99.95% efficiency.

Under National Institute of Occupational Safety and Health (NIOSH) classification, a P100 particulate filter should be used where 99.97% filtering efficiency is expected.

Annex E – Procedures for Entering and Leaving Asbestos Work Area

i. Procedure for entering the work area with decontamination facility:

- Enter the “clean area” of the decontamination facility.



- Inspect the respirator to ensure that it is in good working condition.
- Replace filter if/ when necessary.
- For positive pressure powered respirators, ensure that a fully charged battery has been fitted.



- Remove all personal clothing.
- Put on clean protective clothing if provided⁵.
- Put on the respirator and carry out a fit check.



- Pass through the “shower area” (without showering) into the “dirty area”.



- Enter work area.

ii. Procedure for leaving the work area with a decontamination facility:

- Before entering the decontamination facility, while still in the work area, remove all visible dust and fibres from protective clothing, respirator and footwear using vacuum cleaning equipment fitted with a HEPA filter.
- A shoe bath can be provided where there is contamination by wet materials.



- Enter the “dirty area” of the decontamination facility.
- Remove protective clothing and place them in the storage region or plastic bags for disposal.
- Do not remove the respirator.



- Enter the “shower area”.
- Shower thoroughly while wearing the respirator.
- Remove the respirator and continue showering.



- Remove filter from respirator and place it into a plastic bag, then leave the bag in the “shower area” for disposal later.
- Ensure that the inside and outside of the respirator is clean.



- Enter the “clean area”.
- Dry and change into personal clothing.



- Leave the respirator in the “clean area”.
- Charge the battery (if necessary).



- Exit the decontamination facility.

⁵ If protective clothing was left in the “dirty area” from a previous shift, put it on there.

iii. Procedure for entering a work area that uses a transit facility:

- Put on protective clothing and respirator in the “clean area” of the decontamination facility.



- Pass through the “shower area” (without showering) into the “dirty area”.
- Wear transit coveralls and foot covers.



- Exit the “dirty area” and walk to the transit facility via designated route.



- Enter the transit facility.
- Remove transit coveralls and foot covers.
- Containers or hooks can be provided in the transit facility for coveralls and foot covers.



- Enter work area.

iv. Procedure for leaving the work area that uses a transit facility:

- While still in the work area, remove all visible dust and fibres from protective clothing, respirator and footwear using vacuum cleaning equipment fitted with a HEPA filter before entering the transit facility.
- A shoe bath can be provided where there is contamination by wet materials.



- Enter the transit facility.
- Remove protective clothing and place them in the storage region or plastic bags for disposal.
- Do not remove the respirator.



- Put on transit overalls and foot covers.



- Exit the transit facility and walk to the decontamination facility via designated route.



- Enter the “dirty area” of the decontamination facility.
- Remove transit overalls and foot covers and place them in plastic bags for disposal.
- Do not remove the respirator.
- Follow **Annex E**: Procedure for leaving work area (main decontamination facility) from showering onwards.

Annex F – Air Sampling

Air sampling involves collecting airborne particles, including asbestos fibers and other fibres by drawing air through a filter using a sampling pump operating at a known flow rate for a measured period of time.

Static sampling is undertaken with the filter holder positioned between one to two meters above ground. The points of measurement should cover likely sources of fibres and places where many people gather.

For personal sampling, the sampling pump should be light and portable so that the worker can wear it on his/ her belt. The filter holder should be positioned within the breathing zone. If the worker is wearing a respirator, he/ she should take care to position the filter holder facing away from the filtered air exhaust outlet of the respirator.

Application	Sampling flow rates (litres/min)	Sample volume (litres)	Graticule areas examined	Limit of quantification (fibres/cm ³)
Compliance sampling	1 – 4	240	100	0.04
Assessment of respiratory protection	1 – 4	240	100	0.04
Clearance sampling	2 – 16	480	200	0.01
Background	2 – 16	480	200	0.01
Leak and reassurance	2 – 16	480	200	0.01

Figure 18: Recommended flow rates, volumes and limits of quantification.

The sampling flow rate should be adjusted to produce a fibre density of 100 to 1300 f/mm² on the filter. For clearance or background leak sampling, the number of graticule areas inspected may be reduced if the collected air volume is increased. In relatively clean atmosphere where targeted fibre concentrations are much lower than 0.1fibre/cc, larger sample volumes are needed to achieve quantifiable loadings. A minimum sample volume of 1200 litres is recommended for air clearance sampling.

Details of the sampling should include the:

- date of sampling;
- type of sampling carried out (e.g., personal, leak, background);
- sampling location;
- details of the worker and type of work he/ she undertook at the time (only applicable for personal sampling);

- identification numbers of equipment used (e.g., sampling pumps, flow measurement devices, filters and sampling heads);
- individual sample details of each sample in the form of:
 - unique identifier;
 - specific sample position; and
 - start and finish time for each sample.

Analytical Methods

NIOSH 7400 Phase Contrast Microscopy Method

The air sample should be analysed using Phase Contrast Microscopy (PCM) to determine the asbestos fibre concentration in the air. However, PCM does not differentiate between asbestos and other types of fibres. All fibres are counted and assumed to be asbestos. Results are expressed in fibres per cubic centimeter (f/cc).

NIOSH 7402 Transmission Electron Microscopy Method

The air sample can be analysed using Transmission Electron Microscopy (TEM). TEM is able to distinguish asbestos from other fibres, expressing results as an asbestos fibre count with the type of asbestos present also reported. The air sample can be analysed using TEM if the analysis result using PCM method exceeds PEL. This method is intended to complement the results obtained by PCM.

10. Further Information

Workplace Safety and Health (WSH) Act

WSH (Asbestos) Regulations

WSH (General Provisions) Regulations

WSH (Risk Management) Regulations

WSH (Medical Examinations) Regulations

WSH Council Code of Practice for WSH Risk Management

WSH Council Code of Practice for Working Safely at Heights

Singapore Standard SS 548: 2009 – Code of Practice for selection, use and maintenance of respiratory protective devices

UK Health and Safety Executive (HSE). Asbestos health and safety.

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