# Design of an Activity-Based Sampling Protocol for the Testing of Asbestos Fibre Release Potential from Residential Garden Soil

Introduction:

This protocol provides a draft outline of a potential activity-based sampling approach for the testing of asbestos fibre release potential from residential garden soil as part of a staged investigation strategy for land being investigated under Part 2A of the Environmental Protection Act 1990.

The protocol builds upon the US EPA Standard Operating Procedure 2084:2007 for activity-based sampling for asbestos, providing a pragmatic method to assist in determining whether asbestos in soil contamination poses an unacceptable risk to human health.

The primary objective of the Activity-Based Sampling (ABS) protocol is to provide a reasonable worst-case estimate of current and future fibre-release and subsequent localised airborne fibre concentrations that might be possible as a result of soil disturbance.

Background:

In the context of the CIRIA Guide on the Management of Asbestos in Soil (C733), and the on-going work of the Joint Industry Working Group on asbestos in soil, made ground and construction and demolition materials, activity-based sampling has the potential to be an important part of a staged approach to the assessment of health risk from the release of asbestos fibres resulting from the disturbance of asbestos-containing materials. In particular, it is capable of reducing the uncertainty in the estimation of fibre-release inherent in alternative theoretical approaches.

The procedure outlined in this proposal seeks to work within the practical and regulatory constraints of Part 2A, Control of Asbestos Regulations 2012 and residential garden investigations. In particular:

*"3.3 Local authorities should have regard to good practice guidance on risk assessment and they should ensure they undertake risk assessment in a way which delivers the results needed to make robust decisions in line with Part 2A and this Guidance.*

*3.4 Risk assessments should be based on information which is: (a) scientifically-based; (b) authoritative; (c) relevant to the assessment of risks arising from the presence of contaminants in soil; and (d) appropriate to inform regulatory decisions in accordance with Part 2A and this Guidance."*

Source: Defra (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance

*"11.—(1) Every employer must—*
*(a) prevent the exposure to asbestos of any employee employed by that employer so far as is reasonably practicable;*
*(b) where it is not reasonably practicable to prevent such exposure—*

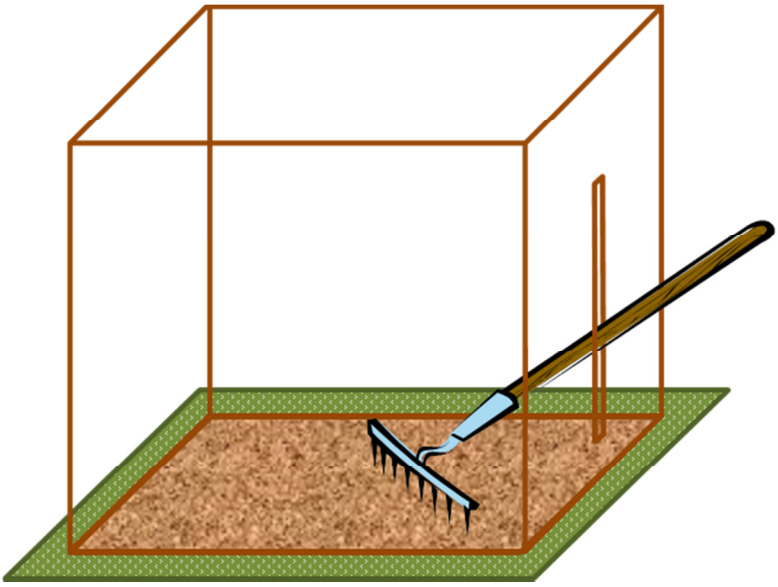
*(i) take the measures necessary to reduce exposure to asbestos of any such employee to the lowest level reasonably practicable by measures other than the use of respiratory protective equipment, and*
*(ii) ensure that the number of any such employees exposed to asbestos at any one time is as low as is reasonably practicable."*

*16. Every employer must prevent or, where this is not reasonably practicable, reduce to the lowest level reasonably practicable the spread of asbestos from any place where work under the employer's control is carried out."*

Source: Statutory Instrument 2012 No. 632. Health and Safety. The Control of Asbestos Regulations 2012

Procedure Outline:

The generic activity-based sampling involves the raking of a minimum 1m x 1m square of exposed bare soil using an ordinary garden rake within a temporary enclosure, as illustrated below:



The enclosure should be large enough to facilitate the manual raking of the enclosed soil by someone standing outside of that enclosure and large enough to house static air monitoring equipment. The enclosure should be capable of being secured to the ground thus providing a reasonable seal with the ground surface and mitigating against the risk of the enclosure being blown over, and should be capable of being dismantled such that the inner surface is not exposed prior to disposal.

The soil surface should be raked in a forwards/backwards fashion for sufficient duration to enable adequate air monitoring to take place. The duration will be dictated by the air sampling requirements i.e. method reporting limit and maximum sampling rate.

Protocol Elements:

The ABS might comprise the following elements:

- Identification of depth profile for asbestos contamination (based on visual inspection of the area and/or previous soil sampling results)
- Background air sampling to establish background ambient air dust and asbestos fibre concentrations
- Construction of a temporary ABS enclosure (for example a simple wooden frame wrapped with plastic sheeting)
- Use of static air samplers to record airborne dust and fibre concentrations generated within the ABS enclosure whilst the raking activity is undertaken
- Soil sampling for asbestos content within relevant soil layer tested
- Soil sampling for additional parameters such as particle size distribution, fraction of organic carbon and soil moisture content

Procedure Steps:

It is envisaged that the procedure could include the following steps:

1) Initiate background air sampling[1].
2) Identification of a suitable location for the ABS, based on visual inspection of the area of concern and/or existing soil sampling results if available.
3) Identification of depth to known asbestos contamination in proposed area[2].
4) Set up localised decontamination facilities for tools, footwear etc
5) Vegetation removal to reveal a bare soil surface area of at least 1 m x 1m.
6) In-situ testing of surface soil moisture content[3] if delay in laboratory results is impracticable, or if monitoring of drying of soil surface is necessary[4].

[1] Background air sampling requires a sample volume of 12500 litres to obtain a method reporting limit equal to the WHO AQG of 500 f/m$^3$. This will likely require a sampling duration of 12-24 hours using a high volume sampler. It is possible to achieve a detection limit of 0.0005f/ml by using SEM analysis and a sample volume of 2400 litres (4hrs @10 litres/min). Sampling and analysis should be in general accordance with Asbestos: The analysts' guide for sampling, analysis and clearance procedures (HSG 248) Appendix 1 and Determination of airborne fibre number concentrations: A recommended method, by phase-contrast optical microscopy (membrane filter method) World Health Organisation 1997.

[2] If asbestos contamination is known to be greatest below near surface (near surface considered to be <5 cm deep), ABS should be undertaken for the surface layer, and then repeated for the sub-surface layer where the greatest contamination is present. For the testing of contamination at depth it might be necessary to carefully excavate the soil from the required depth, and place in a disposable tray (envisaged to be 1 m x 1m with 0.1 m high sides) to a depth of 5 cm (i.e. 50 litres of soil), over which the temporary enclosure should be placed. Necessary precautions to prevent fibre release during excavation, (such as damping down) will likely require subsequent drying of the soil before commencement of the ABS.

[3] In-situ testing should be to recognised method, such as those outlined in Training Course Series No. 30, Field Estimation of Soil Water Content A Practical Guide to Methods, Instrumentation and Sensor Technology International Atomic Energy Agency, Vienna, 2008

[4] Soil layer being tested should be as dry as is reasonably practicable to achieve. The aim of the testing should be to test in the best conditions practicable and ensure that the soil moisture conditions the test was conducted under are known and recorded. It might be possible to install a greenhouse heater to dry out the soil surface for example. Or it might be possible to erect the temporary enclosure over the area to be tested, and leave the enclosure unsealed to protect the soil from further rainfall whilst the soil dries naturally, or erect a larger canopy to protect the soil. One specification option is a dry day period prior to sampling (for example the US EPA stipulates 3 dry days before sampling). This will lead to differing soil moisture levels being permissible dependent on soil type, air temperature, whether the soil is in sun or shade, and what the soil moisture content at day one is. An alternative specification is a

7) Set up the temporary enclosure over the soil test area[5].
8) Set up three clusters of static air sampling units within the test area (envisaged to be positioned either in three corners of the enclosure or along the three sides of the enclosure without the access slot for the rake handle)[6]. The three clusters of samplers are designed to provide air results in triplicate. Alternatively the samplers can be used in parallel to reduce sampling time.
9) Ensure that the seals around the penetrations (for rake and sampling heads) are adequate to prevent possible dust and fibre release.
10) Initiate dust and asbestos air sampling.
11) Undertake ABS using reasonably aggressive raking of the soil surface within the enclosure using a repetitive forwards and backwards motion across the entire test area to agitate and move the soil.
12) Continue ABS for required duration[7].
13) Stop air monitoring and store filters for subsequent laboratory analysis[8].
14) Sample soil layer that has been ABS tested – to determine soil concentration to correlate to measured air concentrations[9].

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maximum soil moisture level under which the testing can be carried out. This achieves year round repeatability of the test; however achieving such a level might not always be practicable. A detailed assessment of the influence of soil moisture on asbestos fibre release is limited to the evaluations of the Institute of Occupational Medicine (IOM) (Addison et al) and the Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Both IOM and RIVM conclude a substantial drop in airborne fibres at just 5-10% absolute soil moisture. Wind-blown fibres will be released from the surface (i.e. top 1 mm) of undisturbed soil and this surface could be dry at times. If soil is disturbed at any greater depth however, soil moisture might be expected to be more likely to be maintained at the 5-10% level or higher. Covering the soil for three days before sampling is a reasonable step when coupled with the aim of trying to undertake the testing when soil moisture is not already high (i.e. 3 days after heavy rain and/or a prolonged period of cool wet weather won't provide a dry soil for testing). The drying of the soil could potentially be assisted by the use of sun lamps or a dehumidifier. Ensuring that the soil surface is loose and the weather-protective cover well ventilated should also help.

[5] Enclosure should be at least 1m x 1m in plan, and will likely need to be a minimum of 1.5m in height to practically facilitate the racking activity.

[6] It is possible that the air sampling pumps could be housed outside of the enclosure, with only the sampling heads positioned within the enclosure. This would minimise sampling apparatus obstruction of the raking area. Sampling pumps should have an asbestos sampling head, an IOM filter head for inhalable dust, and a cyclone filter head for respirable dust. The sampling heads should be held 0.5 m above the ground surface to reflect potential breathing zone of young children playing with soil in garden. Dust sampling should be undertaken in general accordance with Methods for the Determination of Hazardous Substances: General methods for sampling and gravimetric analysis of respirable and inhalable dust (MDHS 14/3) but needs to be capable of detecting dusts levels to 10µg/m$^3$ if possible (certainly to 100 µg/m$^3$).

[7] The duration of ABS required will be a function of the dustiness of the soil and the reporting limit of the laboratory method employed to analyse the filters. A balance needs to be struck between the requirement for a sufficiently low detection limit and the need to avoid overloading the filters with dust. Sampling and analysis should be consistent with HSG 248 Appendix 1 where relevant. Obtaining a method reporting limit of 0.01f/ml requires an air sample volume of 480 litres. This can be achieved using a sample rate of 16 litres a minute and ABS duration of 30 minutes. Alternatively the Minimal Risk Level (MRL) could be halved by undertaking the ABS for 1 hour. If this is impractical, the analysis of the three samplers could be combined; a total sample volume of 1440 litres over the 30 minutes ABS providing a MRL of 0.003 f/ml, or if dust loading is a constraining factor, the three samplers could be run at a lower sampling rate for 15-30 minutes. Uncertainty over the analytical constraints of dust loading on the filters could be reduced by either repeating the ABS using a smaller air sample volume, or using multiple samplers set to differing sampling rates. Sampling to achieve an MRL equivalent to the WHO air quality guideline of 0.0005 f/ml would require a sample volume of 12500 litres, or the counting of over 5000 graticules, which is considered impracticable for ABS. It is possible to achieve a detection limit of 0.0005f/ml by using SEM analysis and a sample volume of 2400 litres (4hrs @10 litres/min). Similarly if this is not practical then the sample volume could be reduced and the number of fields analysed on the filter increased to achieve a similar limit of detection.

[8] Dust filters should be analysed by an appropriately accredited gravimetric method, in general accordance with MDHS 14/3. Asbestos filters should be analysed in general accordance with HSG 248 Appendix 1 and Determination of airborne fibre number concentrations: A recommended method, by phase-contrast optical microscopy (membrane filter method) World Health Organisation 1997. Fibre discrimination should be carried out as outlined in Methods for the Determination of Hazardous Substances: Guidance on the discrimination between fibre types in samples of airborne dust on filters using microscopy (MDHS 87).

15) Equivalent composite samples should be sent for laboratory testing for particle size distribution and soil moisture content.
16) Repeat ABS at a second (deeper) depth to target the soil layer with greatest asbestos contamination if it is suspected that surface layer is less contaminated than underlying soil.
17) Remove enclosure and decontaminate sampling equipment[10].
18) Arrange for disposal of enclosure materials as asbestos-contaminated material[11].
19) Restore test area to original condition, including importation of additional soil if required and replacement of original surface vegetation.
20) Repeat activity at next location if necessary. The number of locations tested will be dependent on the size of the affected area and the spatial heterogeneity of the asbestos contamination.

Quality Assurance and Control:

Appropriate levels of quality control and quality assurance should be maintained commensurate with the reliance on the ABS results.

The data quality objectives should be clearly defined as part of the sampling and quality plans for the specific ABS being undertaken.

Samples should be taken in duplicate or triplicate at a sufficient frequency to estimate sampling error.

Sample blanks should be analysed to determine the background fibre count on the filters. This is relevant to the estimation of the sensitivity of the laboratory analysis undertaken.

All instruments and equipment should be used in accordance with operating instructions, including calibration requirements.

Sample volumes and hence sampling duration and sampling rates can be determined by the formula in A1.35 of HSG248:

$$C(f/ml) = 1000.N.\frac{D^2}{V.n.d^2}$$

[9] Remove the 5 cm layer of soil tested by the ABS and place on a plastic sheet. Remove all visible fragments of Asbestos Containing Material (ACM) and place in a sealed container for subsequent laboratory analysis. Take three composite soil samples comprising 5 sub-samples each from the remaining ABS-tested soil. Each soil sample should be approximately 1 kg. This will provide a reasonable estimate of average asbestos concentration in the test area in triplicate. The samples should be analysed by an appropriately accredited laboratory to a method capable of a reporting limit of 0.001% wt/wt (for example a method based on Development and validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (HSE CRR83/1996).

[10] It is suggested that the inside of the enclosure could be sprayed with a dilute PVA solution to bind any asbestos fibres adhered to the inside of the plastic sheeting and hence prevent the potential release of asbestos fibres during the dismantling of the enclosure.

[11] The materials might be classified as '15 01 10* packaging containing residues of or contaminated by dangerous substances' (which is an absolute European Waste Catalogue entry), or '17 06 05* construction materials containing asbestos' (which is a mirror entry and the asbestos content of the bulk material would need to be 0.1%wt/wt or above for it to be classified as hazardous).

N = method sensitivity for minimum fibre count
$D^2$ = diameter of filter (mm)
V = sample volume (litres)
n = number of graticules inspected
d = graticule diameter (µm)

Health and Safety:

All work should comply with the Control of Asbestos Regulations (CAR) 2012. The requirements and specification for PPE and other protective measures should be detailed in the site-specific Health and Safety Plan developed for the ABS.

Limitations:

This protocol has been developed by the SoBRA asbestos in soil sub-group. It details an approach to activity-based sampling at residential sites where asbestos is a contaminant of concern that has been developed as a result of discussions between the group members. It is provided freely on the SoBRA website to help promote discussion on what should constitute good practice in investigating asbestos contaminated soil in the UK. Users of this protocol must satisfy themselves that the protocol is appropriate for the intended use and no guarantee of suitability is made.

Feedback:

Feedback on this protocol is welcomed and should be submitted to Simon Cole at simon.cole@aecom.com.
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