

ENVIRONMENT AGENCY

**The determination of asbestos in soil and associated materials**

 **(June 2015) (v.10a)**

**DRAFT FOR CONSULTATION**

# ***Methods for the Examination of Waters and Associated Materials***

**Please forward any comments that you have on this version to Hazel Davidson at hazel.davidson@dets.co.uk by 31st July 2015.**

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**The determination of asbestos in soils and associated materials (2015)**

**DRAFT (June 2015)**

**(This draft is being developed by an SCA committee and is provided on the understanding that further development may still be required before publication is completed.)**

**Methods for the Examination of Waters and Associated Materials**

This booklet contains a method for identifying and quantifying asbestos containing materials and dispersed asbestos fibres in soils, construction and demolition materials and products, and other associated materials (see Appendix 1). All stages of this method involve identification of asbestos type. Furthermore, using the procedures described in this booklet should enable laboratories to satisfy the requirements of ISO 17025 for accreditation of the method, within the framework of a fully documented and maintained quality management system.

Use of this method will allow robust, reliable determination of asbestos in soils and associated materials, provide more accurate data for targeted remediation, and prevent inconsistent data or missed asbestos material leading to potential future litigation for consultants, developers, and landowners. The results will also inform the evaluation of potential human health risks and the waste classification of materials destined for recycling or disposal.

Whilst this booklet refers to equipment actually used, this does not endorse these products as being superior to other similar products. Equivalent equipment is available and it should be understood that resulting performance characteristics might differ when other products are used. It is left to users to evaluate these procedures in their own laboratories. Only limited performance data are presented.

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**The determination of asbestos in soil and associated materials**

The determination of asbestos containing materials and dispersed asbestos fibres in soils or construction and demolition materials and products, and other associated materials, using Polarised Light Microscopy (PLM) for identification, with a gravimetric method for ACM and fibre bundles, and dispersion and fibre counting for free fibres using Phase Contrast Microscopy.

### Note 1 Prior to using this method, it is necessary to perform the identification of asbestos fibres or asbestos containing material (ACM) in the relevant sample using Polarised Light Microscopy as per the method described in the HSE guidance document HSG 248: *The analysts’ guide for sampling, analysis and clearance procedures.* It is important to note that any laboratory offering asbestos identification must be accredited to ISO 17025.

**Note 2** It is important to note that Regulation 21 of the Control of Asbestos Regulations 2012 requires that every employer who requests an external organisation to analyse a sample of any material to determine whether it contains asbestos must ensure that the organisation is accredited by an appropriate body as competent to perform work in compliance with ISO 17025.

**Note 3** Prior to the implementation of this method, some laboratories offered a stand alone visual screen to determine if asbestos containing material was present in the sample, but this would only cover pieces of ACM and fibre bundles, and would not include small fragments or free fibres. UKAS state that ‘screening’ is now removed from accredited schedules, as it is not a method in itself, only part of the identification process. Samples should be inspected under a stereomicroscope to determine the presence of potential ACM and fibres, and if detected, quantitative analysis can then be performed according to this document, using gravimetric and fibre dispersion/counting as appropriate, to reliably identify and quantify asbestos in the sample.

**About this series**

|  |  |
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| IntroductionThis booklet is part of a series intended to provide authoritative guidance on methods of sampling and analysis for determining the quality of drinking water, ground water, river water and sea water, waste water and effluents as well as sewage sludges, sediments, soil (including contaminated soil) and biota. In addition, short reviews of the most important analytical techniques of interest to the water and sewage industries are included.Performance of methodsIdeally, all methods should be fully validated with results from performance tests. These methods should be capable of establishing, within specified or pre-determined and acceptable limits of deviation and detection, whether or not any sample contains concentrations of parameters above those of interest.For a method to be considered fully evaluated, individual results encompassing at least ten degrees of freedom from at least three laboratories should be reported. The specifications of performance generally relate to maximum tolerable values for total error (random and systematic errors) systematic error (bias) total standard deviation and limit of detection. Often, full evaluation is not possible and only limited performance data may be available. An indication of the status of methods is normally shown at the front of these publications on whether the method has undergone full performance testing.In addition, good laboratory practice and analytical quality control are essential if satisfactory results are to be achieved.Standing Committee of AnalystsThe preparation of booklets within the series “Methods for the Examination of Waters and | Materials” and their continuing revision is the responsibility of the Standing Committee of Analysts. This committee was established in 1972 by the Department of the Environment and is now managed by the Environment Agency. At present, there are nine working groups, each responsible for one section or aspect of water quality analysis. They are 1 General principles of sampling and accuracy of results2 Microbiological methods3 Empirical and physical methods4 Metals and metalloids5 General non-metallic substances6 Organic impurities7 Biological methods8 Biodegradability and inhibition methods9 Radiochemical methodsThe actual methods and reviews are produced by smaller panels of experts in the appropriate field, in co-operation with the working group and main committee. The names of those members principally associated with this booklet are listed at the back of this booklet.Publication of new or revised booklets will be notified to the technical press. If users wish to receive copies or advance notice of forthcoming publications, or obtain details of the index of methods then contact the Secretary on the Agency’s internet web-site ([www.environment-agency.gov.uk/nls](http://www.environment-agency.gov.uk/nls)) or by post. Every effort is made to avoid errors appearing in the published text. If, however, any are found, please notify the Secretary.Mark Gale*Secretary*June 2015 |

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#### Warning to users

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| The analytical procedures described in this booklet should only be carried out under the proper supervision of competent, trained analysts in properly equipped laboratories.All possible safety precautions should be followed and appropriate regulatory requirements complied with. This should include compliance with the Control of Asbestos Regulations (2012),Health and Safety at Work etc Act 1974 and all regulations made under the Act, and the Control of Substances Hazardous to Health Regulations 2002 (SI 2002/2677). Where particular hazards exist in carrying out the procedures described in this booklet, then specific attention is noted. | Numerous publications are available giving practical details on first aid and laboratory safety. These should be consulted and be readily accessible to all analysts. Amongst such publications are; “Safe Practices in Chemical Laboratories” and “Hazards in the Chemical Laboratory”, 1992, produced by the Royal Society of Chemistry; “Guidelines for Microbiological Safety”, 1986, Portland Press, Colchester, produced by Member Societies of the Microbiological Consultative Committee; and “Safety Precautions, Notes for Guidance” produced by the Public Health Laboratory Service. Another useful publication is “Good Laboratory Practice” produced by the Department of Health. |
| **Glossary** |  |
| Asbestos | Complex fibrous silicate minerals including:(a) asbestos actinolite, CAS No. 77536-66-4;(b) asbestos grunerite (amosite), CAS No. 12172-73-5;(c) asbestos anthophyllite, CAS No. 77536-67-5;(d) chrysotile, CAS No. 12001-29-5 or No. 132207-32-0;(e) crocidolite, CAS No. 12001-28-4; and(f) asbestos tremolite, CAS No. 77536-68-6 (CAR 2012) |
|  |  |
| Asbestos cement (AC)Asbestos-containingmaterial (ACM)Asbestos containing soils(ACS)Aspect ratioBulk sampleControl limit InterferencesMMMFPCMPLMRespirable fibresShort term exposure limit  Trace | Cement material which is a mixture of cement and chrysotile and which when in a dry state absorbs less than 30% water by weight (CAR 2012)  Any discrete fragment of material that contains asbestos above trace levels (see definition of trace)Soils, construction and demolition materials and products, plus other associated materials, that contain fragments of ACMs and/or dispersed asbestos fibres at or above the detection limit of this methodThe ratio of the length of a fibre to its diameter.(1) An as received sample containing soil, demolition and construction materials and products and/or associated materials (see Appendix 1)(2) Discrete fragments of materials such as spray coatings, pipe/thermal insulation, insulating boards/tiles, asbestos cement materials, other materials, dust and debris (HSG 248)A concentration of asbestos fibres in the atmosphere when measured in accordance with the 1997 WHO recommended method, or by a method giving equivalent results to that method approved by the HSE of 0.1 f/ml of air (100,000 fibres/m3) averaged over a continuous period of 4 hours.Fibrous substances which, if present, may interfere with asbestos analysis. Some common fibres are (HSG248 para A3.14): natural organic fibres (such as cotton and hair), synthetic organic fibres (such as aramid, polyester and rayon), man-made mineral fibres (for example, mineral wool and glass fibre), and naturally occurring mineral 'fibres' (such as wollastonite and diatom fragments) and according to OSHA: Fibreglass; Anhydrite; Plant Fibres; Perlite Veins; Gypsum; Membrane Structures; Sponge Spicules; Microorganisms.Man or Machine Made Mineral FibresPhase Contrast MicroscopyPolarised Light MicroscopyRespirable fibres are very small fibres (i.e. <3 um diameter, usually longer than 5 um and have aspect ratios of at least 3:1) that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.This is 0.6 fibres per cubic centimetre (f/ml) in the air measured over a ten-minute period. Any exposure which exceeds or is liable to exceed this is not sporadic and of low intensity. HSG 248 states ‘If, after careful searching of the sample under the stereo microscope for 10 minutes, and searching a minimum of two preparations mounted in suitable RI liquid at high magnification by PLM/PCM for a further 5 minutes, only 1 or 2 fibres are seen and identified as asbestos, the term ‘trace asbestos identified’ should be usedNote that this applies to bulk samples, typically fragments of suspected ACMs, in which no fibres have been seen using the stereo microscope, or no asbestos fibres have been identified by PLM. In such cased, tweezers or probes should be used to take random sub-samples after the bulk sample has undergone suitable treatment (Appendix 2 HSG 248).However, for soil, construction materials and products, and associated materials, where asbestos is quantified using this method, ‘trace’ will not be reported by laboratories. The equivalent of ‘trace’ in this instance, is linked to the reporting limitations of the method and therefore should quote only < 0.001%. |
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**The determination of asbestos in soil and associated materials**

1. Introduction

Asbestos is a known carcinogen and over 4000 deaths a year are attributed to asbestos related diseases. Most of the current legislation and guidance relates to workplace protection, clearance of buildings, demolition etc, and there is currently no specific legislation or guidance relating to guideline values for asbestos in soil, although CIRIA and CL:AIRE and AGS have published documents relating to the management of asbestos in soil (see references) . It is now apparent that many brownfield sites are contaminated with asbestos to some degree and this is a cause for concern, as asbestos analysis is not requested to be carried out on many samples of soils and construction/demolition materials submitted to laboratories.

Asbestos is not one compound, but consists of a group of naturally occurring fibrous mineral silicates: chrysotile (white), existing as a fibrous serpentine form, and the amphiboles such as crocidolite (blue), amosite (brown) and the asbestos forms of actinolite, anthophyllite and tremolite. Because of their excellent fire retardant properties, these materials were used extensively in the construction and manufacturing industries up until 1999, when chrysotile was finally banned. Chrysotile is the most common form, and is less carcinogenic than crocidolite, amosite (formerly banned in 1985), or any of the other amphiboles.

Asbestos-containing material (ACM) and/or free dispersed asbestos fibres are found on many sites where construction or demolition has taken place, and may not be visible to the naked eye on a preliminary site inspection. The presence of free dispersed asbestos fibres represents a much greater hazard and risk to human health than asbestos bound up in cement, tiles, bituminised products or other material. If the soil is wet, then there is less chance of airborne fibres being released, but when dry, there is an increased likelihood of the release of airborne asbestos fibres that present a risk to human health. A study performed by Addison *et al* in 1988 demonstrated that dried soils containing as little as 0.001% asbestos could release fibres at a concentration exceeding the current control limit of 0.1 fibres/ml, when compressed air was blown through the samples to produce respirable dust concentrations of > 5mg/m3. Soil can be tracked back into buildings on shoes and clothes, adhere to vehicles and tyres on site, and surface soil can be windblown.

When clients request asbestos analysis in soil and associated materials, it is important to determine the reason the client has requested the analysis and the end use of the data, and to ensure the laboratory can meet the requirements

The type of sample matrix is also important, and laboratories may be required to provide validation data for different types of soil, construction and demolition products, and associated materials, in order to receive accreditation for each matrix.

**Other information**

General comments on sampling, storage and subsampling:

This document will not comment on sampling procedures, other than to stress the importance of taking representative discrete samples of a suitable size from site, and to ensure samples are, wherever possible, in individually double sealed (e.g. 0.5 litre polythene tub in a plastic bag, or two plastic bags) and clearly labelled as potentially containing asbestos. It is also important that precautions to prevent cross contamination during the collection of the samples have been taken.

Samples do not require refrigeration.

**General comments on analysis**

**The laboratory should request from the sample supplier, wherever possible, at least 1 kg (approximate – a full 0.5 litre tub) of sample for the determination of asbestos (see section 2 of the method), and preferably these samples should not be used for any other analysis.**

General industry practice is based on three analytical stages:

Stage 1: The determination and identification of presence or absence of asbestos using stereomicroscopy, plus higher magnification PLM analysis for fine fibres (see HSG 248)

Stage 2: The removal of ACM and fibre bundles with identification and gravimetric analysis to determine percentage by weight

Stage 3: The dispersion and collection of free fibres followed by fibre identification, counting and measurement of fibres to determine percentage by weight

Prior to quantifying asbestos in soil, the whole as received sample should be examined visually to identify the presence of potential ACM and dispersed asbestos fibres/fibre bundles, with a dried subsample examined by stereomicroscopy (x 20) magnification), followed by higher magnification ( x 40) PLM or PCM on smaller subsamples for fine fibres. If none are detected, then the sample will be reported as ‘No asbestos detected’ (NAD) – this can only be used for identification, not quantification, where a ‘less than’ ( < ) numerical reporting value must be used.

**Note 1**: ‘No asbestos detected’ is not the same as ‘no asbestos present’. No analytical technique can report ‘zero’ for any determinand, as the constraints of the method, equipment, and competence of the analyst will all have their own limitations. Analysts can only ever work to a proven, validated detection limit, and for the identification part of the method, there may be very small fibres present which are not visible, even under stereomicroscopy. The opposite case is where a few fibres are seen at the identification stage, but when quantification is performed on the same sample, this is reported as < 0.001%\* due to the low density of the fibres providing insufficient mass to report above this limit.

\* It may be possible to reach a lower limit with additional method validation

**Note 2:** Staff must receive and complete an internal training module and obtain the P401

Identification of asbestos in bulk samples (PLM) certificate, and the P403 certification for

fibre counting, or other equivalent UKAS approved certification, before performing any

reportable analysis. The identification of asbestos fibres and asbestos type, and in

particular, the counting and measurement of free fibres on filters are extremely skilled

tasks. Analysts require extensive training and supervision before they can perform

analyses alone. Continuing competency checks are also required, plus analysis of

proficiency testing samples.

**Note 3:** Laboratories **must** obtain UKAS accreditation to ISO 17025 for the identification of asbestos.

**2 Contract Review**

It is of paramount importance for the client to confirm the end use of the data prior to the identification and quantification of asbestos, according to the JIWG Code of Practice, and to clarify that the method used by the laboratory is fit for purpose (such as this one).

As the laboratory only receives a small sample of the material, it can only state the classification of the sample with respect to its own waste disposal requirements – it is the responsibility of the waste producer to decide on the classification of the original material. Where material is being reused on site, waste classification is not appropriate.

In addition, the concentration and type of free fibres are important in determining in how waste should be handled, and whether it may be considered as a suitable feedstock for recycling/reuse processes, and therefore it is strongly recommended that free fibre concentration should always be determined.

For human health risk assessment, free fibres represent more of an immediate hazard and potential risk than asbestos fibres bound into an ACM, and the isolation and quantification of the free fibres is thus required. This will provide a Limit of Quantification (LoQ) of at least < 0.001% dry weight of soil.

It is crucial that clients are made aware of the limitations, accreditation status, and reporting limits of the method used by the laboratory.

3 Hazards and safety precautions

There is a risk of exposure to airborne asbestos fibres by inhalation, and skin contact of reagents used in the method.

Asbestos is a Class 1 carcinogen and great care should be taken to avoid inhalation of

fibres. All samples received in the laboratory should be handled in safety cabinets with

appropriate fume extraction and filtration. Internal asbestos air tests should be performed

monthly. It is important to note that other chemical hazards may be present in the soil,

which will not be removed by the HEPA filters (e.g. organic vapours), so laboratories must

ensure they comply with all relevant Health & Safety regulations such as the Health &

Safety at Work Act.

 **4 References**

Addison, J., et al. 1996. HSE Contract Research Report No. 83/1996, Development and validation of an analytical method to determine the amount of asbestos in soils and loose aggregates. IOM, Edinburgh

HSG 248 Asbestos: The Analysis Guide for Sampling, Analysis and Clearance Procedures. 2005.

HSG 264 Asbestos: The Survey Guide. 2012

McCrone W.C. Asbestos Identification (Second Edition), The McCrone Research Institute, 1987.

LAB 30 Application of ISO/IEC17025 for Asbestos Sampling and Testing, UKAS website for most recent version

MDHS 87 Guidance on the discrimination between fibre types in samples of airborne dust

 on filters using microscopy 1998

**The determination of asbestos in soils and associated materials**

**Scope**

This method describes the identification and quantification of asbestos in soil, construction materials and products, or associated materials,using a gravimetric method for ACM and fibre bundles, plus dispersion and fibre counting for free fibres using Phase Contrast Microscopy, including a calculation for the concentration of Potentially Respirable Fibres, as appropriate.

The asbestos, if present, may be in the form of different types of ACM, fibre bundles, or individual (free dispersed) fibres, and this method seeks to address as wide a range of materials as possible, initially by weighing the fragments of different ACMs and fibre bundles, and expressing their presumed asbestos content as a percentage by mass, and subsequently isolating the free fibres (dispersion) and then trapping these onto filters to be measured and counted. These can also be expressed as a percentage by mass of the sample. The sum of the two results provides a quantitative measure of the total mass of asbestos in the sample expressed on a dry weight basis. The results may also be broken down and presented in a more detailed form, depending up the requirements of the client, to include type of asbestos fibre, type of matrix, respirable fibres, and percentage by mass of each type/fraction.

**1 Performance Characteristics of the Method**

1.1 Substances determined Asbestos: chrysotile, crocidolite, amosite, and the

 asbestos forms of actinolite, anthophyllite and tremolite

1.2 Type of sample Ideally, approximately 1 kg of soil or associated

 Materials (full 0.5 litre tub)

1.3 Basis of method Visible fragments of ACM and fibre bundles are removed

 and determined gravimetrically, with free fibres

 dispersed, filtered, and measured and counted using

 PCM, if appropriate. The sum of the two results is

calculated as % by weight of the original dried sample, plus the detailed composition may be reported, when required.

1.4 Range of application Gravimetric: 100 - 0.001%

 Free fibres: 0.1- 0.001%

1.5 Calibration curve Not applicable

1.6 Standard deviation Gravimetric:

 Free fibres:

1.7 Limits of detection Gravimetric: 0.0001%

 Free fibres: 0.0001%

1.8 Limits of reporting Gravimetric: 0.001%

 Free fibres: 0.001%

1.8 Bias Gravimetric:

 Free fibres:

*The above values will be based on the group PT data*

**2 Principle**

**2.1 Stage 1 Identification of asbestos according to HSG 248**

The whole sample is carefully searched by eye to identify if any visible ACM is present, using the method stipulated in HSG 248. If no asbestos containing material is visible, a representative subsample is collected in a petri dish for examination by stereo microscopy (x20 - x40). If no asbestos is found during this analysis, several small representative subsamples are examined on a microscope slide in a suitable RI medium and analysed at a higher magnification (x80 – x500) using PLM/PCM techniques, according to HSG 248. If no asbestos fibres are identified, the sample can be reported as No Asbestos Detected (NAD). Asbestos fibres above trace level (see HSG 248) should be identified before continuing with Stages 2 and 3 of the quantitative analysis.

**2.2 Stage 2 Gravimetric analysis** – the whole as received sample is weighed and examined visually inside a safety cabinet. The oven dried weight of the sample is also determined.

 Any items and/or fragments that may potentially contain asbestos fibres are identified, and a representative sample of each ACM type is removed from the sample for further identification, where suspect ACMs and fibres/fibre bundles are examined using stereomicroscopy and Polarised Light Microscopy to confirm the presence and type of asbestos as described in HSG 248.

Materials confirmed as containing asbestos are removed, grouped according to material/asbestos type, weighed, and the mass percentage of ACM/fibre content of each material/asbestos type is calculated. The overall asbestos content of the sample is based on the maximum asbestos content of the specific ACMs found as per HSG 264 (See Appendix 5).

Once visible suspected ACMs are removed, a representative sub-sample (25 – 50g) of the remaining material should be selected by coning and quartering.This sub-sample is given a very detailed examination under stereo binocular microscope and any further smaller pieces of suspected ACM and or asbestos fibre bundles are removed for identification and weighing using a suitably sensitive balance. The mass percentage of each ACM/asbestos type in this fraction of the sample is calculated by expressing the weight of the recovered asbestos as a percentage of the dry weight of the sub-sample selected for detailed analysis. The overall asbestos content of the sample is then calculated.

If no ACMS or fibre bundles are detected, but free fibres are identified, then the Stage 3 dispersion/identification/counting method should be performed to ascertain the percentage of fibres present in the sample.

**2.3 Stage 3 Free fibre analysis** - following the gravimetric method, a representative subsample of the residue is weighed into a conical flask, and water added in the ratio of 1:200 solid to liquid (volume dependent on sample type). The sample/solution is mixed vigorously for a minimum of 30 seconds to ensure complete dispersion, allowed to settle for 10 seconds, and then a known quantity is filtered through a cellulose-ester filter paper. The filter is then placed onto a microscope slide, allowed to dry, and then cleared and fixed using the acetone/triacetin method described in HSG 248. The slides are then evaluated using PCM to identify and quantify (by a process of fibre discrimination) the asbestos fibres. From the number and size of the potential asbestos fibres observed on the slides the mass percentage of asbestos in the sample is estimated. The relative contribution to the overall mass percentage from presumed amphibole and serpentine asbestos may also be estimated.

The sum of both ACM/visible fibres and free fibres should also be reported as the % asbestos content in the original sample on a dry weight basis.

**3 Interferences and Limitations**

As only a sub-sample is used for detailed gravimetric analysis, and also for free dispersed fibre analysis, it is recognised that the original sample and further subsamples will decrease the representativeness of the sample to the area of site from which the sample was collected.

Non-asbestos fibres may be present in the sample and may cause misidentification in the PCM method. The non-asbestos fibres may be of mineral or organic origin and care must be taken to follow HSG 248 procedures for asbestos identification and avoid misidentification.

It is only possible to exclude some non-asbestos fibres and to assume the other fibres are asbestos. When counting free fibres, if it is not possible to determine the fibre as non-asbestos, the fibre is presumed to be either chrysotile or amphibole based on the morphology of the fibre. Fibres which are clearly identified as non-asbestos are not included in the count.

PLM identification of asbestos fibres is generally limited to fibres with widths > 0.8 microns. Many asbestos fibres will have widths below this and will be assumed to be asbestos.

The PCM method counts all particles of a certain size and shape as fibres, and will include some non-asbestos material, although the use of PCM with polariser/analyser and red tint plate will limit this misidentification (Ref: MDHS 87)

Clay matrices or oily samples may cause problems with the dispersion method (see Section 7.4.8).

**4 Sample handling**

All handling and examination of samples for asbestos, and the opening of all containers, should be conducted in a safety cabinet with appropriate extraction and HEPA filters. All staff must wear appropriate PPE. Care should be taken to avoid any risk of cross contamination, and the release of airborne fibres into the laboratory. This is particularly important once samples are dried, as dust is easily generated from these samples.

It may be preferable to perform the initial examination of the sample prior to drying (as in Stage 1), and results can then be corrected for the moisture content at a later stage.

Samples for quantification of asbestos should not be used for testing by other departments within the laboratory, as any removal of material will compromise the accuracy of the results. Therefore, the client should provide the laboratory with an individual asbestos sample whenever analysis for asbestos in soils and associated materials is required.

Clients should be encouraged to collect soil samples, typically 1 kg (wherever

possible) in 0.5 litre tubs, or heavy duty polythene bags, and preferably individually double

sealed (double bagged or a tub inside a bag) and labelled ‘ asbestos’.

No chemical preservation or refrigeration is required.

**5 Reagents**

5.1 Acetone

5.2 Triacetin

No reagents are required for the gravimetric section of the analysis.

**6 Apparatus**

**Gravimetric**

6.1 Balances capable of weighing to 2 and 5 decimal places, to achieve 0.001%

6.2 Disposable gloves

6.3 Metal spatula

6.4 Safety cabinet fitted with high efficiency HEPA filtered extraction units

 The cabinet extractor units and face velocities are checked regularly in line with current guidance (HSG 248) to ensure the linear velocity is > 0.5m/s and DOP tested every six months to check filter efficiency.

6.5 Sample bags

**Free fibres**

6.7 Balance capable of weighing to 2 decimal places

6.8 Analytical balance capable of weighing to 5 decimal places

6.9 Blunt nose forceps

6.10 Mixed cellulose-ester membrane filters, 25mm diameter, pore size of 0.8 or 1.2 µm

6.11 Straight-sided filter apparatus

6.12 Filtration collar

6.13 Vacuum pump

6.14 Auto pipette capable of pipetting 0.25ml

6.15 1ml Pasteur pipette

6.16 Acetone hot block/vaporiser

6.17 Microscope slides and coverslips – the slides should be 0.8 – 1.0 mm thick and the coverslips should be 0.16 – 0.19 mm thick

6.18 5 ml Syringe

6.19 1000 ml conical flask

6.20 Metal spatula

6.21 Phase Contrast Microscope with Polariser/Analyser and Red Tint Plate (without this addition, the fibre count could potentially be spuriously higher). The microscope should comply with the following specifications (HSG 248):

* a binocular stand with Köhler, or Köhler type illumination including a field iris. (The condenser (sub-stage assembly), objectives and eyepieces specified below must all be compatible with each other and with this stand.);
* a sub-stage assembly, incorporating an Abbe or an achromatic phase contrast, condenser in a centrable focusing mount, with phase annulus centring independent of the condenser centring mechanism;
* a built-in mechanical stage with slide clamps and x-y displacement;
* a low powered objective (e.g. X 10 or X 4 magnification), which is used for carrying out checks on the evenness of the dust deposit on the filter

6.22 NPL Test Slide

6.23 Stage Micrometer slide

6.24 G25 type Walton and Beckett Eyepiece Graticule, with an apparent diameter of 100 +/- 2 µm

6.25 Tally Counter

6.26 Coarse filters (for waste disposal)

6.27 47mm diameter 0.8 µm filters (for waste disposal)

6.28 Oven for drying to a temperature between 30oC and 110oC

**7 Analytical Procedure**

The following flow chart may be used to determine the stages of identification and quantitative analysis required on each sample, once the initial positive identification of the presence of asbestos is confirmed.

Identification and presence of asbestos confirmed by PLMas per HSG 248

Analysis complete

Identification and gravimetric quantification of any Asbestos Containing Materials (ACMs) present to 0.1%

Identification and quantification of small fibre bundles by detailed gravimetric analysis to 0.001%

Identification and quantification of free fibres by dispersion and PCOM to 0.001%

If no asbestos fibres are identified, report as NAD (no asbestos detected)

Stage 1 analysis

Stage 2 analysis (initial)

If asbestos is detected at > 0.1%, then the sample may be confirmed as hazardous waste without further analysis, but only if it is a waste sample

Stage 2 analysis (detailed)

**Note:** If Stage 3 is not performed, there is a risk that significant numbers of free fibres will not be included in the total result, and may give an underestimate. In addition, the type of asbestos fibre is also important for waste purposes.

Stage 3 analysis (dispersed fibres)

**7.1 Sample preparation**

7.1.1All preparations must take place within the Safety Cabinets under full extraction.

7.1.2The whole, as received, sample should be spread across a clean tray and evaluated visually for the presence of potential ACMs and fibre bundles/fibres. Suspect materials are removed and then examined using stereomicroscopy, in order to remove fibres for further examination using PLM according to HSG 248, for asbestos identification.

If asbestos is identified, the visible fragments and fibre bundles/ fibres removed for ID

should be quantified by gravimetric analysis as in 7.2.

**At this identification stage, before reporting NAD (no asbestos detected)**

**the time taken for the searching of asbestos in the initial tray and sub-samples**

**should be recorded, and that at least 15 minutes should elapse (HSG 248),**

**dependant on the sample type. This is designed to allow the analyst sufficient time**

**to examine the sample and not omit any visible ACM/fibre bundles. However, the**

**time taken will depend upon the experience of the analyst, the matrix of the sample,**

**and the form of ACM. If relatively clean, coarse grained samples (e.g. sandy) are**

**submitted, then the visual analysis can be much more rapid. If a shorter time**

**interval is recorded, this may require written justification.**

**NAD cannot be reported in the quantification part of the method, as a < numeric**

**reporting value must be used.**

**7.2 Gravimetric analysis**

7.2.1 Inside a safety cabinet, empty the sample into a suitable weighed tray, reweigh, and record the weight. Then dry the whole tray in an oven between 30oC and 110oC and record the weight after drying, to enable the results to be reported on a dry weight basis. The exact temperature is not critical, as asbestos is not volatile or lost on drying.

Note: If preferred, this step may be performed on a sub-sample rather than the whole sample.

7.2.2 From the samples, manually remove components such as brick, concrete or pebbles of > 10 mm (approximate) in size. Place these components in a weighed dish, re-weigh and record the weight. The analyst should ensure that no visible potential asbestos type material is adhering to the removed material (brushing or washing may be required).

For samples which contain < 20 g of residual (< 10 mm) material, this method is not suitable, as detection limits will be compromised – this should be dealt with under contract review to inform the client, who may still wish the analysis to proceed.

7.2.3 Examine the residual sample and remove any potential ACM and asbestos fibre bundles and transfer to a weighed dish for each type of visually similar ACM or fibre bundles (as per HSG 264).

Suspect ACM or fibres/fibre bundles should be identified as containing asbestos using PLM , as per HSG 248, and it may be advisable to photograph the material, if appropriate.

7.2.4 Re-weigh the dishes and use the weights to calculate the weights of each type of ACM. The approximate mass percentage of asbestos in the sample resulting from each type of ACM is given by the formula:

$$\sum\_{}^{}\left(\left(\frac{A}{S}×100\right)×\left(\frac{C}{100}\right)\right)$$

Where A = the dry weight of each type of ACM

 S = total dry sample weight (g) as derived from 7.2.1

 C = the asbestos content of each ACM based on the maximum value given in HSG 264

**Note:** Steps 7.2.1 – 7.2.3 may be performed at the same time as the identification process detailed in 7.1 Sample Preparation, to avoid double handling of the sample.

**7.3 Detailed gravimetric analysis**

A representative weighed portion (if possible 20 g +) of the residual sample produced in

7.2.3 should be selected for detailed examination under stereo binocular microscope.

During this examination, it should be possible to identify and handpick and weigh small

fragments of potential ACM and/or asbestos fibre bundles that were not identified during

the initial examination of the bulk material. If such materials are recovered these should

be transferred to suitable containers and weighed on a five place analytical balance. It is

necessary to use a more accurate balance for this stage of the analysis due to the small

weights, of material that are likely to be involved. Even using a relatively sensitive

balance, it is not practical to attempt to establish weights of asbestos below 1 mg,

recovered from a soil sample.

Suspect ACM or fibres/fibre bundles should be identified as ACM using PLM as per HSG

248, and it may be advisable to photograph the material.

Results for this stage of the analysis are calculated by expressing the weight of any

asbestos recovered as a percentage of the weight of the sub-sample selected for detailed

analysis. 1mg of asbestos recovered from 20g of fines represents 0.005%. This

percentage can then be applied to the total weight of the fines in order to estimate the

total mass of asbestos in this fraction of the sample, and then adjusted back to the original

sample.

If during detailed analysis of the sub-sample, asbestos fibres are identified, but these are

either too few and/or they are too fine to hand pick and weigh then these should be

quantified using the fibre counting/sizing method by PCM.

**7.4 Preparation of samples for free fibre analysis using PCM/PLM**

7.4.1 Weigh between 1 and 5 g of the residual material from 7.2.3 into a suitably sized conical flask, and record the weight to 2 decimal places.

7.4.2 Add water in a ratio 1:200 solid:liquid (depending upon the sample matrix).

7.4.3 Vigorously agitate the sample for a minimum of 30 seconds until the sample is completely dispersed.

7.4.4 Leave the sample to stand for 10 seconds to allow the denser material to settle.

7.4.5 Set up the filter assemblies with mixed cellulose-ester filters, 25 mm diameter with a pore size of 0.8 or 1.2 microns, using blunt nose forceps.

7.4.6 Label each slide with the appropriate sample identification.

7.4.7 Add approximately 5 ml of water to the filter to ensure even distribution of the aliquot on the filter.

7.4.8 After the 10 seconds settling period, using an autopipette, take a 1 ml aliquot from the mixture, from approximately 3 cm below the surface, and deposit this into the water on the filter. The volume removed may need to be less than 1 ml, depending on the quantity of suspended matter. Filter this suspension under vacuum.

Where prepared slides are found to be occluded and uncountable (for example, from samples with a high clay content) the suspension should be diluted by taking a 10 ml aliquot after shaking from the original suspension and making up to 100 ml. This diluted sample should then be processed as the original after further shaking/standing. The solution should be diluted further, if required, until an acceptable slide can be prepared. The limit of detection/reported results should be corrected for the dilution.

 (see Appendix 2 for examples)

7.4.9 Remove the filter from the filter assembly and place onto the labelled microscope slide.

7.4.10 Allow the filters to dry, ensuring the filters do not curl, before clearing and fixing using the acetone / triacetin method described in section 7.4.11.

**7.4.11 Clearing and fixing microscope slides**

**Acetone vapour is highly flammable and slightly toxic.** **Wear gloves for this stage to prevent acetone vapour coming into contact with skin**

7.4.11.1 Ensure the acetone vaporiser is on, checking that it is at the correct temperature.

7.4.11.2 Position the filter on the microscope slide underneath the outlet of the acetone vaporiser and inject acetone slowly into the hot block so that the acetone emerges in a steady stream over the filter.

7.4.11.3 Place the cleared filter onto the hot block for a few seconds to allow any excess acetone to evaporate.

7.4.11.4 Place a drop or two of triacetin onto a clean coverslip using a micropipette or other suitable dropper, invert the slide and lower the filter onto the coverslip.

7.4.11.5 Place the mounted slide onto the hot block until the triacetin has cleared, and then evaluate the filter using phase contrast optical microscopy (PCM).

**7.4.12 Microscope adjustment prior to identification and counting of fibres**

**Note: It is important to stress again the high level of skill and training required by the analyst when identifying, counting, and measuring fibres on the filters examined under the microscope. Extensive training is required, with close supervision, before the analyst can perform analyses unaided. This should not be underestimated.**

The following sequence is taken from HSG 248 – other sequences can be used provided

all the necessary adjustments and checks are made.

7.4.12.1 The microscope must be adjusted and used in accordance with the manufacturer’s instructions and HSG 248, and the analyst must check its performance at the beginning of each counting session (or more frequently if any adjustments have been made):

7.4.12.2 Place, centre and focus the working stage micrometer, preferably using bright- field illumination. If necessary use the low-powered objective to help locate the 0- 100 μm scale, then return to the X 40 objective;

7.4.12.3 Check and re-adjust the field iris and condenser height at the working magnification to obtain Kohler or Köhler type illumination.

7.4.12.4 Check (and adjust if necessary) that the inter-ocular distance is correct for the user, the image has sharp focus in both oculars and that the Walton-Beckett graticule is also in sharp focus;

7.4.12.5 Measure and record the diameter of the Walton Graticule against the stage micrometer - this should be 100 +/-2 um – the measured diameter should be used in calculations.

7.4.12.6 Remove the stage micrometer and replace it with the HSE test slide.

7.4.12.7 Centre and focus the test slide using phase contrast microscopy, (if necessary use dark field illumination and a low-powered objective to help locate the two sets of parallel grooves (tramlines) in which the test grating is located, before inserting the X 40 phase objective);

7.4.12.8 Check using the Bertrand lens that the phase rings are concentric and centred. Adjust if necessary.

7.4.12.9 Check and readjust the field iris and condenser height at the working magnification to obtain Köhler or Köhler type illumination

7.4.12.10 Record which of the seven bands on the test slide is just visible (lines only partly seen) by traversing from the most visible to the least visible;

7.4.12.11 The lines of block 5 of an HSE mark II test slide must be visible, while only parts of block 6 ridges may be visible and none of block 7 ridges should be visible at the working magnification. Mark III test slides issued with a red certificate require that block 4 must be visible while only parts of the block 5 ridges may be visible and none of the block 6 ridges should be visible.

7.4.12.12 The focus and condenser focus will need readjustment before each filter is evaluated.

7.4.12.13 200 graticule areas on the slide must be counted, although counting can stop if the analyst reaches 100 fibres, provided at least 20 fields have been evaluated, regardless of the number of graticules counted.

**Note 1: A maximum number of 8 slides per day per analyst is recommended, due to the difficulty in counting and sizing fibres over a long period, as this process is more onerous for soil samples than air samples.**

HSG 248: ‘ The number of graticule areas examined in any 8 hour period by one analyst should not normally exceed 2400, the equivalent of 12 samples if 200 graticule areas are examined on each (for air samples).

Analysts are recommended to take a break at least after every third or fourth slide identified/counted in succession, and if long shifts are worked, additional quality assurance (QA) measures may be necessary. The length and frequency of the fibre identifying/counting sessions will depend on the microscopist, the type of samples and the laboratory conditions. The number of samples evaluated in a day also differs from microscopist to microscopist: typically, analysts may take 10-25 minutes to evaluate a sample with a sparse dust deposit, but longer for greater numbers of fields and more difficult samples.’

**Note 2: If any of the slides are uncountable for any reason, for example if the analyst tried to clear the filter before it was fully dry, then extra aliquots should be taken from the mixture to replace the unusable slides.**

**Note 3: If the slides are uncountable due to excessive particle loading, then a new set of slides should be prepared.**

**7.4.13 PCM/PLM analysis for fibre discrimination and counting**

7.4.13.1 Place the slide to be evaluated onto the microscope stage, and scan the slide at x 10 magnification to check for even deposition across the slide. If not, or if the particulates cover > 10% of the slide, then the slide should be discarded.

Fibres on the filter should be counted using at least x 500 magnification.

7.4.13.2 Ensure all the appropriate information is recorded for the sample (mass of sample, volume of mixture, diameter of graticule and the weight of all the subsamples used and materials removed).

7.4.13.3 Graticule areas for counting must be chosen at random to avoid bias and to be representative of the exposed filter area. Fields lying within 4 mm of the filter edge should not be counted. Fields should be rejected if a filter grid line obstructs all or part of the field of view, or if more than half of the field is obscured by large particles. If more than 10% of fields are rejected, then the whole slide should be rejected (HSG 248).

7.4.13.4 Where possible, each fibre observed must be classified as amphibole, serpentine, or non-asbestos using the extinction and sign of elongation characteristics, as described in MDHS 87. Straight or gently curved fibres which cannot be confirmed as non-asbestos (e.g. because they are too fine) should be presumed to be amphibole asbestos, while curled fibres should be presumed to be chrysotile*.*

7.4.13.5 If an asbestos, or presumed asbestos, fibre is deemed ‘countable’, the fibre must be sized using the graticule, and the measurements recorded. Fibres should be counted regardless of their contact with other particles, and all suspected asbestos fibres should be counted.

7.4.13.6 Fibre dimensions for each fibre should be recorded to the nearest 5µm for length, and 0.5µm for diameter. Only those parts of the fibre which lie inside the graticule area should be counted. If one end of the fibre is in the field, but the other end is outside, record half the length of the fibre.

7.4.13.7 Analysts should keep track of the number of fields counted using a tally counter.

7.4.13.8 On completion of the sample, the total number of graticule areas evaluated (normally 200) should be recorded.

**For a full explanation of counting rules, and examples please see Appendix 5**

**7.4.14 Calculation of results**

The overall mass percentage of asbestos is given by the formula:

$$\left(\left.\frac{\left.A W \left(\sum\_{}^{}Vρ^{A }+ \sum\_{}^{}Vρ^{C}\right)\right.}{aNqS}\right.×100\right)×F$$

Where:

*ρA* = average density of amphibole fibres (3.3 x 10-6 µg µm-3)

*ρc* = density of chrysotile (2.5 x 10-6 µg µm-3) *V* = volume of fibre (µm3)

*W* = volume of mixture (ml) *A* = area of filter (mm2)

*S* = Weight of soil in suspension (µg) *a* = area of graticule (mm2)

*N* = number of graticules evaluated *q* = Vol aliquot on filter (ml)

*F =* Material removed correction factor

The material removed correction factor (*F*) is calculated using the following equation:

$$F=\frac{\left(T-g\right)}{T}$$

Where:

T = total dry weight of sample

g = mass of material removed fraction of sample

The purpose of this correction factor is to adjust the result to take into account large non-asbestos items within the sample such as stones which were too large to be analysed by PCM and which would therefore bias the result.

**7.4.15 Potentially respirable fibres (optional)**

To produce the result, each fibre counted during PCM/PLM identification and measurement is checked to see whether it conforms to the definition of a respirable fibre as defined in HSG 248, that is, greater than 5µm in length, narrower than 3 µm in width, and with an aspect ratio of greater than 3:1.

The number of potentially respirable fibres is calculated by first calculating the number of fibres per ml of the mixture using the following equation:

$$Fibres per ml=\frac{1000×N×F^{2}}{V×n ×G^{2}}$$

Where:

N = the number of respirable fibres counted

F= the filter diameter (mm)

V = the volume of the aliquot (ml)

n = the number of graticules counted

G = the graticule area (mm2)

The number of fibres per ml of mixture is then converted to the number of fibres per gram of original sample using the following equation:

$$Fibres per g=Fibres per ml×\left(\frac{V}{S}\right)$$

Where:

V = the volume of the mixture (ml)

S = the mass of the dried sample in the mixture (g)

**7.5 Reporting all quantitative data**

Reports may include the following information, with respect to each and all stages of the analysis, subject to customer contract review:

* Total dry mass of sample
* Total mass % of material removed (if applicable)
* Total mass % of asbestos
* Total gravimetric (ACM) mass %
* Total gravimetric (ACM) % of each ACM type
* Total mass % of free fibres
* Total mass % of each free fibre type
* Asbestos type (from PLM analysis) in each ACM type, if required
* Total mass % of respirable fibres, if required
* Any anomalies or problems, e.g. clay or chrysotile clumping

Any other options should be requested and discussed at contract review:

* Moisture content
* Mass or % of material analysed
* Photographs

**7.6 Quality Control**

QC schemes should comply with LAB 30 and HSG 248 – Technical Bulletin 1 from LAB 30 now incorporates asbestos in soils – refer to current UKAS publications.

Analysts performing identification and quantitative analysis should participate and maintain a satisfactory performance in their internal laboratory QC scheme.

Filters for fibre identification and counting must be checked by performing blank counts prior to use. Checked batches of filters will have the assigned batch number and the initials of the analyst performing the blank count on the base of each box of 25 filters.

**7.6.1 Gravimetric QC scheme**

The laboratory should retain a selection of asbestos containing materials of a known weight, which, on a monthly basis, will be used to spike two soil samples which will then be issued to the laboratory for analysis by each authorised analyst for identification and quantification.

The results should fall within the margin of error calculated for the method.

**7.6.2 PCM QC scheme**

The HSL operates a PT scheme for the identification and quantification of asbestos in soils, as per LAB 30, and the laboratory must participate, and maintain a satisfactory performance, in this scheme in order to gain UKAS accreditation for this method. This scheme is known as the Asbestos in Soils Scheme (AISS), and covers both identification and quantification.

In addition, the laboratory should establish a fibre identification and counting QC scheme based on the recommended internal QC scheme for asbestos air testing.

The laboratory should retain as selection of slides at a range of concentrations and fibre types.

**7.7 WASTE DISPOSAL**

7.7.1 After examination, the remaining subsamples should be double bagged within the safety cabinet.

7.7.3 Residual subsamples should be stored in a controlled area and retained for a minimum of six months before controlled disposal.

7.7.5 All waste samples, filter papers, slides, and Petri dishes should be placed in disposal bags inside the cabinets. Waste water from the PCM analysis should be filtered and the filter placed in the disposal bag. The filtrate should be disposed of by the laboratory’s standard disposal route.

7.7.6 All waste should be disposed of in a red bag clearly marked as ASBESTOS WASTE. This should be sealed and placed inside a clear bag similarly marked.

7.7.7 This bag should be transported to a suitable waste disposal site with the appropriate documentation and disposed of as asbestos waste.

When asbestos waste is removed from the laboratory, a hazardous waste consignment note must be completed or collected by a licensed transportation contractor with a copy retained by the laboratory.

**Address for correspondence**

However well procedures may be tested, there is always the possibility of discovering hitherto unknown problems. Analysts with such information are requested to contact the Secretary of the Standing Committee of Analysts at the address given below. In addition, if users wish to receive advanced notice of forthcoming publications, please contact the Secretary.

Secretary

Standing Committee of Analysts (National Laboratory Service)

Environment Agency

56 Town Green Street

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**Environment Agency**

**Standing Committee of Analysts**

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David Wood SAL

Colette Willoughby BOHS

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**Appendix 1**

List of associated material types

Soil types - sand, clay, loamy soil (top soil) are most common

Sediments – river, lake, canal, estuary derived, dredging spoil

Slurries – effluents, discharge pipes, settling tanks

Track/railway ballast

Aggregate – hoggin (sand and gravel)

 Type 1 crushed rock (range of fragment sizes)

 recycled aggregate (RA)

 inert wastes used for aggregates (EA Aggregates from inert waste Appendix C):

* + - * wastes from physical and chemical processing of non-metalliferous minerals
			* wastes from manufacture of glass and glass products
			* construction and demolition waste – concrete, bricks, tiles, ceramics

 wood, glass, plastic

 bituminous mixtures (not coal tar)

 mechanical treatment of waste products

 municipal waste

Construction and demolition products - concrete

 insulation board

 insulation rope/string

 thermal insulation

 ceiling tiles

 bricks

 roof tiles

Made ground – can be highly variable and can contain any of the above

**Appendix 2**

**Comments re issues with the PCM dispersion method**

|  |  |
| --- | --- |
|  |  |
| **Picture 1** - Stage 3 water dispersion preparation showing the problems encountered with clay soil types. | **Picture 2** - An occluded filter (top) prepared from a clay soil sample. A non occluded filter is shown on the bottom for comparison. |



**Picture 3** - The chrysotile problem of clumping.

**Appendix 3**

**Round Robin Date from AISS PT scheme Round 5**

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 ***Report*** *Round 5* **October *2014*** Asbestos in Soils Scheme

Asbestos in Soils Scheme (AISS)

 *Round 5* 23 October *2014*

 **BACKGROUND**

This report covers Round 5 of the Asbestos in Soils Scheme (AISS). The scheme has two options; Qualitative and Quantitative. Six laboratories participated in the Qualitative round and eighteen laboratories participated in the Quantitative round (one laboratory did not submit any results, one laboratory submitted results for sample 009 only and one laboratory did not submit quantitative results).

**SAMPLES**

Two samples were circulated as follows:

Sample S009 – No asbestos was present in this sample. Sample contained wollastonite, diatomaceous earth, talc and MMMF.

Sample S010 – This sample contained amosite and chrysotile present in asbestos insulating board (AIB) fragments. Each sample contained 0.05% by weight of AIB, which was assumed to contain 40% amosite. The assigned asbestos % was calculated as 40% of 0.05% = 0.02% asbestos. Each sample was individually made by mixing known weights of AIB fragments and soil.

**INFORMATION SUBMITTED BY LABORATORIES**

Laboratories used the HSL web-based PT data entry system to submit their results for this round. Results were submitted as asbestos type(s) present and for the Quantitative option, the % asbestos in ACM’s, as loose fibres and the total % asbestos.

**RESULTS OVERVIEW**

**AISS Quantitative**

Sixteen of the nineteen enrolled laboratories submitted results for all samples. No results were submitted by one laboratory and partial results submitted by two laboratories.

Sample 009 - All laboratories that submitted results for this sample correctly identified that there was no asbestos present.

Sample 010 – Twelve laboratories correctly identified amosite and chrysotile in this sample. Five laboratories reported only amosite present.

Sixteen laboratories submitted quantitative results; two laboratories reported results with ± 10% of the target value (0.02%) and a further thirteen were within ± 100% of the target value.

Three laboratories did not submit quantitative results.

**AISS Qualitative**

All enrolled laboratories submitted results. All laboratories correctly reported no asbestos present in Sample 009 and all laboratories correctly identified amosite and chrysotile in Sample 010. Page **2** o f **2** *Round 5* 23 October *2014*

|  |  |  |
| --- | --- | --- |
| **AISS Quantitative Scheme** HSL PT  | **Sample 009** Assigned Result **No Asbestos**  | **Sample 010**Assigned result**0.02% asbestos (amosite****& chrysotile)**  |
| Lab No. Sample 009  |  Quantitative Result %Sample 010  |
| 7  | No asbestos  | Amosite & chrysotile  | 0.014  |
| 803  | No asbestos  | Amosite & chrysotile  | 0.037  |
| 807  | No asbestos  | Amosite & chrysotile  | 0.057  |
| 831  | NRS  | NRS  | NRS  |
| 835  | No asbestos  | NRS  | NRS  |
| 1096  | No asbestos  | Amosite  | 0.026  |
| 1161  | No asbestos  | Amosite  | 0.024  |
| 1258  | No asbestos  | Amosite & chrysotile  | 0.009  |
| 1277  | No asbestos  | Amosite & chrysotile  | 0.012  |
| 1308  | No asbestos  | Amosite & chrysotile  | 0.021  |
| 1329  | No asbestos  | Amosite & chrysotile  | 0.021  |
| 1407  | No asbestos  | Amosite & chrysotile  | 0.011  |
| 1457  | No asbestos  | Amosite  | 0.040  |
| 1495  | No asbestos  | Amosite & chrysotile  | 0.017  |
| 1583  | No asbestos  | Amosite & chrysotile  | 0.010  |
| 1633  | No asbestos  | Amosite  | 0.140  |
| 1670  | No asbestos  | Amosite & chrysotile  | NRS  |
| 1711  | No asbestos  | Amosite  | 0.018  |
| 1753  | No asbestos  | Amosite & chrysotile  | 0.035  |

**Appendix 4**

**Percentage of asbestos in different ACMs (taken from HSG 264)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Material** | **% min** | **% max** | **%** |
| Loose Insulation | 100 | 100 | 100 |
| Blanket, tape, cloth, rope and string | 100 | 100 | 100 |
| Paper, Felt\* excludes any non-asbestos composite component | 100 | 100 | 100 |
| Millboard | 37 | 97 | 97 |
| Compressed Fibre Gaskets | 90 | 90 | 90 |
| Sprayed Coating | 85 | 85 | 85 |
| Thermal Insulation - Composite | 6 | 85 | 85 |
| Thermal Insulation - Caposil/Caposite | 8 | 85 | 85 |
| Brake Pads, Clutch Plates | 30 | 70 | 70 |
| Cement  | 10 | 50 | 50 |
| Insulating Board\* excludes any non-asbestos composite component | 15 | 40 | 40 |
| Cement - 'Asbestos Wood' | 10 | 25 | 25 |
| Thermoplastic Floor Tiles | 25 | 25 | 25 |
| Thermal Insulation - Sectional | 15 | 15 | 15 |
| Reinforced Plastic and Resin Composites | 1 | 10 | 10 |
| Bitumen Felt, DPC etc. | 8 | 8 | 8 |
| PVC Vinyl Floor Tiles | 7 | 7 | 7 |
| Textured Coatings | 3 | 5 | 5 |

Higlighted lines indicate where asbestos content is assumed as a worst case scenario, and maximum value of asbestos should be used in relevant calculations.

**Appendix 5**

**Fibre Counting Rules**

**Selecting fields for evaluation**

Graticule areas for counting must be chosen at random to avoid bias and to representative of the exposed filter area. Fields lying within 4mm of the filter edge should not be counted. Fields should be rejected if a filter grid line obstructs all or part of the field of view, or if more than half of the field is obscured by large particles.

To help prevent re-counting fibres, it is helpful to use the mechanical stage to move across the stage in straight lines.

When evaluating each field, it may be helpful to examine each quarter graticule area individually, focusing up and down to ensure that all fibres are observed.

**Counting fibres**

A respirable fibre is as a fibre which is 5µm or more in length, and has an aspect ratio of greater than 3:1. Fibres should be counted regardless of their contact with other particles.

Where possible, each countable fibre observed must be classified as amphibole, chrysotile, or non-asbestos using the extinction and sign of elongation characteristics, as described in HSG 248. Straight or gently curved fibres which cannot be confirmed as non-asbestos should be assumed to be amphibole asbestos, while curled fibres should be assumed to be chrysotile.

If a fibre is deemed ‘countable’, and it is decided that the fibre should be classed as asbestos, then the fibre must be sized using the graticule and rotating stage, and the measurements entered directly onto the excel spreadsheet.

Fibre dimensions for each fibre should be recorded to the nearest 5µm for length, and 0.5µm for diameter.

Analysts should keep track of the number of fields counted using a tally counter.

Counting can stop if the analyst reaches 100 fibres, provided at least 20 fields have been evaluated, or on reaching 200 fibres, regardless of the number of graticules counted.

On completion of the sample, the total number of graticule areas evaluated should be entered onto the spreadsheet.

A fibre which is split should be sized according to the length of longest individual branch.

The width of split fibres should be recorded as the narrowest width where all of the fibres are together (i.e. a place along the length of the fibre before it began to split), even if this point of measurement is outside of the graticule area.

Chrysotile fibres are very difficult to measure, especially lengthways. They should be estimated using any straight sections of fibre available.

Individual branches of split fibres should not be counted individually as this will tend to greatly overestimate the mass of fibres present, split fibres should be assessed as one fibre.

Very fine fibres, which are clearly finer than 0.5µm, should still be recorded as 0.5µm wide.

Examples of measuring fibres and fibre counting rules are shown below:

**Fibre definitions**

 5µm 3µm

 1 countable fibre

 Not countable (too short)

1 Countable fibre (length measured along curve)

 1 Countable fibre

 5µm 3µm

 Not countable (aspect ratio <3:1)

 1 countable fibre (particle ignored)

Not countable (visible parts of fibre too short)

1 Countable fibre, width assessed where all fibres are together

 1 countable fibre (particle ignored)

2 countable fibres

No countable fibres distinguishable, and whole clump >5µm wide

**Measuring fibres**

Two large fibres can be seen in this field. In order to assess their size, they should be compared to the measurements on the graticule.

The graticule has two guides, one with increments of 5µm and one with increments of 3µm

The 5µm guide should be used to measure the length, and the 3µm guide used to measure the width.

By rotating the stage, fibres can be lined up with the rulers, as in this diagram, making it easier to measure the dimensions.

After measuring the first fibre, the stage should be rotated again to measure the second fibre.

This fibre does not lie directly on the guide, but by aligning it parallel to the guide the length can be estimated with reasonable accuracy.

Measure curved fibres by assessing the lengths of the straighter parts of the fibre

Measure the length of split fibres as the length of the longest part, and the width as the narrowest part of the fibre where all the branches are still attached to the main fibre, even is this point is outside of the graticule area, and record as half the length of the fibre.

Curved fibres passing right through the graticule should not be counted

Both the fibres in this field are less than 0.5 µm in width, and they should both be recorded as 0.5µm, despite one fibre being obviously much finer than the other.

If more than half of the field is obscured by particles then the field should not be counted