

Appendix 01/23

**Minutes of the 40th meeting of the Asbestos Network Technical Working Group (ANTWG), 7<sup>th</sup> August 2023**

*Composition of TWG = ACAD, ARCA, BOHS-FAAM, HSE, NORAC, UKATA, Independent Industry Representative*

## **Personal Sampling, Employee Health and Exposure Records**

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Appendices are attached to Technical Working Group minutes when the nature and extent of discussions (or the complexity of the subject) warrants further explanation and clarification. This guidance is primarily aimed at Licensed Asbestos Removal Contractors (LARCs). However, it may also be useful for others who are involved in personal sampling for asbestos exposure and the compilation of employee health records to comply with the Control of Asbestos Regulations 2012 (CAR 2012). The following is a summary of the discussions and conclusions on the above topic.

### **Purpose**

LARCs are aware of the need to undertake personal sampling to maintain exposure records. However, Licence renewals have identified that some LARCs do not fully understand what information is required, how it should be recorded and used, and how the 'summary of air monitoring' links into the health record. HSE expects a more detailed and structured approach to personal sampling that drives a need for more accurate and useful records. This document explains the minimum level of detail expected from a LARC, it is also applicable to those undertaking Notifiable Non-Licensed Work (NNLW).

Employers may record information however they like, but must include the minimum information required by the respective Approved Code of Practice to Regulations 19 (Air Monitoring) and 22 (Health Records and Medical Surveillance) of CAR 2012.

### **Personal Monitoring Policy and Strategy**

HSE publication Asbestos: The Analysts' Guide HSG248 (2021) describes four types of personal sampling:

1. 4-hour Control Limit
2. Specific Short-Duration Activity (SSDA)
3. 10-minute Short-Term Exposure Limit (STEL)
4. Assessment of suitability of Respiratory Protective Equipment (RPE)

**Annex 1** provides further information on these types, including specific sampling requirements, and which requirements under the Regulations the results can be used to meet or support. The different types of personal sampling available make the **sampling strategy** important. Its design will be greatly influenced by the:

- aims of the monitoring; and
- conditions presented by the work.

The aims of the monitoring will derive from the regulatory requirement(s) to be met:

- To check employees' airborne exposure to asbestos is below the Control Limit **and** reduced to as low as is reasonably practicable; (**Regulation 11**)
- To confirm the adequacy of controls including RPE (i.e., whether the RPE chosen provides the appropriate degree of protection); (**Regulation 11**)
- To support current and future risk assessments; (**Regulation 6**)
- To establish employee exposure records. (**Regulation 19**)

One or more requirements can often be met from a single sampling exercise.

The conditions presented by the work could vary substantially and various approaches can be taken, however, it is important to consider the factors *most likely* to affect exposure, including:

- Asbestos product type e.g., Asbestos Insulating Board (AIB), sprayed coating, pipe insulation.
- Quantity e.g., small amounts, a single panel, large scale (requiring repetitive removal)
- Work environment e.g., small, or enclosed space, removal above head height, large volume space.
- Anticipated effectiveness of controls deployed, e.g., whether possible to spray full extent of AIB (sealed/unsealed), level of breakage.

Strategies for monitoring should be similar to strategies for targeting site visits / audits i.e., ensuring a representative range of work is sampled. The strategy should cover:

- A full range of work activities:
  - For routine jobs, carry out personal sampling during the actual removal activities where asbestos is most likely to be disturbed. Once removal activities have been monitored, personal sampling priority should broaden out to other stages of the project including set up, fine cleaning, waste runs and enclosure dismantling.
  - Resources should initially be directed at higher risk licensed activities, rather than sampling>NNLW activities.
  - Monitor all new activities and unusual projects that are anticipated to generate higher or unknown levels of fibre exposure.

- All workers, considering their levels of competence and previous results:
  - New or inexperienced workers, including temporary labour, should be prioritised for personal sampling. Given their lack of experience, it is important they are monitored on their initial activities.
  - A well experienced worker with consistently low readings will likely require less frequent monitoring.

The Regulations state that exposure monitoring should be carried out at regular intervals (regular is not defined) **and** when there is a change that might affect exposure. The ACOP, L143, states this is required for a representative range of jobs and work methods. Undertaking personal sampling for every worker on every job is not expected. The frequency of personal sampling across the company should be based on the results obtained, rather than simple percentages for each Asbestos-Containing Material (ACM). A minimum of one company personal monitoring sample per month is considered reasonable where workforces are small with low staff turnover, rare usage of temporary workers, repetitive work, and consistently low previous results. Should a company undertake no licensed or NNLW work in a month, then clearly there will be no monitoring required. More frequent monitoring would be required for variations in these elements or for other triggers detailed within this guidance.

A well-designed sampling strategy will look to maximise the validity of the data generated, so that conclusions reached about the risk to workers health are reliable, and the employer gets the most out of a sampling exercise (meeting multiple aims). This can be set out in a **Personal Monitoring Policy**.

The long-term aim of the policy will likely be to implement a strategy to undertake personal sampling on all employees undertaking all activities, with repeat measurements taken on higher risk activities or where an individual has a higher than company average result for a particular activity.

**Note:** All recorded values should be taken directly from the reported result, without application of the RPE Assigned Protection Factor (APF) which would reduce the reported result by a factor equivalent to the APF, typically 20 or 40. The only time the APF is applied is when checking that an employee's individual exposure has not breached the Control Limit (CL). This allows for work activities that by their nature are at levels that exceed the CL.

### **Personal Sampling**

Two types of personal monitoring will likely be undertaken: the **4-hour Control Limit** compliance check and the **Specific Short-Duration Activity (SSDA)**.

The **4-hour Control Limit** comparison is less about fibre levels for a particular activity, and more to do with the exposure over the course of a shift. Where more than a single activity is included, the result would usually be unsuitable for feeding into future anticipated values for similar work. It is usually used only to compare exposure against the Control Limit.

The **SSDA** is used to measure the fibre level for a specific activity with a defined set of conditions presented by the work. It is primarily used to feed into the LARCs database/library of anticipated fibre levels for similar work and to check the effectiveness of controls. It can also be used to confirm the suitability of the selected RPE, the suitability of methodologies, and, subject to meeting the WHO criteria (flow rate of 1-2 l/minute, minimum volume of 240 litres, which may be pooled from more than one sample), to calculate the exposure level for comparison with the Control Limit.

**Note:** Close supervision of the work and good liaison with the analyst is required from the supervisor so that when an activity ceases, so does the personal sample. The analyst should observe the activities of the person wearing the personal pump throughout its duration, **adhering to the details specified for the personal sample within the LARC's Plan of Work (PoW).**

An example template for completion by the analyst undertaking personal sampling is included in the second edition of HSG248. It has been created to assist analysts to record relevant information, including contextual details of the work activity, during the sampling period. A completed example is presented at **Annex 2**. This can be supported by standard air test certificates, a well-developed PoW and a detailed site diary.

#### **Engagement of Analysts and Liaison with Analysts where Client Appointed**

Client organisations should look to obtain PM data to support their management of contracts. Low fibre levels are usually an indication of good controls by the LARC; however, all fibre levels should be interpreted in the context of the removal activity being undertaken. Some will exceed the Control Limit, which is why there is an asbestos Licensing system in place.

To ensure the provision of meaningful personal sampling results, **it is important the LARC clearly specifies its requirements to the analytical company, irrespective of contractual arrangements.** These should include type of sampling, e.g. SSDA; when sampling is expected to occur; what activity is to be monitored; the anticipated duration and whom is to be monitored. These arrangements could be discussed with the analyst during the planning stage.

A site analyst is limited to checking 2400 microscope fields per day which limits the number of samples analysed, typically to 12 air tests per day based upon 200 fields counted, which is the recommended minimum for personal sampling to reach meaningful results. Further explanation is provided of the **4-hour Control Limit Calculation (Annex 3)** and **Limit of Quantification (Annex 4)**.

Analytical companies should ensure the analyst employed on a project has the required equipment and competence to undertake the requested activities, this should be established by the analytical company's accredited procedures.

**Note:** Whilst PM information is useful to a client, it is less important than the LARCs immediate requirement to monitor and manage its activities to ensure exposure to asbestos is reduced as far as is reasonably practicable. Therefore, irrespective of contractual/appointment arrangements, analysts **must always provide full PM results directly to the LARC as soon as possible after the collection of the sample via either hard copy or electronic means.** Failure to supply this information might be a breach of the analyst organisation’s duty under Section 3 of the Health & Safety at Work etc. Act 1974.

### Analysis and Review of Results

A LARC is expected to review all personal monitoring reports on site and extract management information from the data.

Results should be reviewed promptly by the LARC and checked against the anticipated fibre level for the activity. Elevated readings typically have two thresholds, each leading to a different action on site as described in the table below.

Threshold	Situation	Action
Exposure level above the APF of the RPE	The measured exposure level has exceeded the protection offered by the RPE, typically 2 f/ml for a half mask, and 4 f/ml for a full face (powered) respirator meaning the individual has potentially been exposed to asbestos, within their RPE, at a level above the Control Limit.	<p>Works must cease immediately, and the cause thoroughly investigated and rectified before work is allowed to continue.</p> <p>Management intervention is expected here, with close monitoring of the subsequent work, including additional personal monitoring.</p> <p>The employee should also be notified, and their health record annotated with details of the measured exposure level.</p>
Exposure level above that anticipated in the Plan of Work	The measured exposure level is above that expected and anticipated in the risk assessment or Plan of Work.	<p>The anticipated exposure levels in the PoW have a margin of error. Where the difference between the measured and anticipated exposure level is significant, e.g. 25% or more, the activity should be reviewed and suspended if necessary.</p> <p>If the Control Limit is exceeded, work should be suspended and an investigation conducted to determine the cause (assuming the level had not</p>

		<p>already been anticipated). Usually, management intervention occurs, with close monitoring of the subsequent work, including additional personal monitoring.</p> <p><b>Note:</b> If the Control Limit is exceeded during any Non-Licensed Work (NLW), work must stop immediately and the risk assessment reviewed, as this is likely to be licensed work with asbestos.</p>
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All PM results should be reviewed, including a comparison against employees undertaking the same task and against company average values. This illustrates the importance of observing and recording work activity during personal monitoring.

Where results are significantly higher or lower than expected, management should consider the reasons and act on the implications:

- Is there a difference between the dust-suppression techniques used?
- Are operatives carrying them out equally carefully?
- Does an operative have consistently high results creating a training need?
- Do operatives have different results simply by the nature of the work they are carrying out?

Management should look for trends over time, e.g., are experienced workers becoming complacent and PM levels gradually increasing?

Where PM results show the Control Limit has been unexpectedly exceeded, employers should tell employees, safety representatives and elected representatives of employee health and safety promptly, giving details of the reasons for what happened and the action taken or proposed.

**Estimation of exposure**

Exposure estimates can be used for:

- Risk assessment
- Producing daily employee exposure records.
- Producing the PoW, which specifically requires details of expected exposure levels to be included for each stage of the removal work e.g., pre-clean, set-up, removal, fine clean.

The following table shows what a PoW entry could look like for an AIB removal job with the expected exposure levels taken from average values of previous similar job conditions.

Activity	Expected Exposure Level (f/ml)
Pre-clean	0.2
Set-up	0.01
Removal	0.3
Fine Clean	0.15

Reliable estimates of workers' exposure can be sought from the results of personal sampling from:

- Others working alongside them; or
- Previous comparable jobs.

**Note:** Typical industry figures can be used as anticipated values for new activities, but they should be replaced by company task average results as soon as possible. Where novel techniques are to be used for the first time you should ensure that a "worse case" is presumed e.g. higher RPE selection to take into consideration training, familiarisation and experience in using the technique / equipment and the control measures needed.

### Employee Exposure Records

An employee exposure record is the written/digital record of the personal sampling/air monitoring required by Regulation 19. The information to be included is detailed in the associated ACOP (paragraph 482) and is reproduced here:

- employer's business name and address
- site address (where appropriate)
- date of air monitoring
- type of work being done and, where relevant, its exact location.
- type of sample, e.g., personal, static, clearance etc.
- location of any static sampler.
- date and time of sampling, the sample duration, and the flow rate.
- if a personal sample, the employee's name, the task being performed and the category of RPE being worn.
- the length of time individuals are exposed.
- the measured fibre concentration.
- the fibre type, if known.
- names and organisations of the sampler and analyst, and the sampling and analysis method used.

**Note:** The ACOP states that information from static sampling can form part of an employee exposure record. However, static monitoring is not a substitute for personal sampling. Static monitoring may underestimate personal exposures where the disturbance is close to the breathing zone of the person.

It is acceptable to have this information stored across more than a single system, providing that all the information is retrievable and securely stored in an accessible format for the minimum times specified.

**Note:** Regulation 19 gives an option of keeping a record of each air monitoring exercise **or** a suitable summary of each air monitoring record. Where employees are under medical surveillance, employers must keep the records or summary to supplement the health record for at least 40 years. The former could be the air monitoring report/certificate issued by the analyst. The ACOP at para 483 states that a 'suitable summary' must contain enough information to allow individual average exposures for distinct types of work to be estimated as accurately as possible.' A spreadsheet or database system is a sensible option.

### **Fibre Hours**

The ACOP requires the recording of duration and fibre levels for licence assessment purposes. There is no requirement for these to be multiplied together to provide a measure of dose in 'fibre hours'. However, this may be useful as an additional way of presenting exposure levels to employees in a meaningful way. By adding these dose levels over a chosen period, employees can readily be shown their weekly, monthly, annual, and total exposures during their employment and see how it compares against the company average for their role.

### **Health Records**

Where employees are under medical surveillance (i.e., those undertaking licensable or NNLW), employers must maintain a health record as required under Regulation 22 of CAR12. This requirement includes any **temporary workers** for whom the LARC has employer responsibility.

Employee Health Records include exposure records with additional requirements. For licensable work and NNLW, the health record should be kept in a suitable form, which will allow employees access, on request, to their own records. For licensable work it should contain the following:

- each employee's surname and first names, sex, date of birth, permanent address, post code and National Insurance number;
- a record of the types of work carried out involving asbestos, and, where relevant, its location, start and end dates, average duration of exposure in hours per week, exposure levels and details of any RPE used;
- a record of any work with asbestos before current employment, if the employer has been informed;
- dates of the medical examinations under the Regulations;
- a recording and planning system which brings forward the next required examination date for each individual.

For NNLW, the employer must:



- enter the employees carrying out the work in a register or record, indicating the nature and duration of the activity, and the exposure to which they have been subjected;
- have a recording and planning system which records the date of the last examination and brings forward the next required medical examination date for each individual.

Health records should be kept for 40 years after the date of last entry or until the employee concerned reaches the age of 80, **whichever is the longer period**. The records should be kept even if the employee leaves the employer.

For example, if you use a 22-year-old temporary worker for 1 week, you should keep the health records until the worker turns 80. If an employee retires at 55, you should keep the health records until the worker is 95.

Again, an electronic solution is likely to be the only sensible way to store this data.

## References

[L143 “Managing and working with asbestos”, CAR2012 Approved Code of Practice and Guidance.](#)

[HSG247 “Asbestos: The licensed contractors’ guide”](#)

[HSG248 Asbestos: The Analysts’ Guide](#)

**ANNEX 1 Application of the Different Personal Sampling Types described in HSG248 Table 5.2.**

Monitoring Type	Specific method requirements	What the result tells you	What part of CAR requires this	Application/Comments
<p><b>4-hour Control Limit (0.1 f/ml)</b></p>	<p>Must use the HSE approved method (HSG 248) which is based on the WHO method. This stipulates a specific airflow rate 1-2 l/min to obtain a minimum volume of 240 litres.</p> <p>Applies to a continuous period of 4 hours.</p> <p>Sampling should aim to cover the full shift or as near to it as practically possible.</p> <p>Sampling should be representative of the work activity or activities undertaken during that work period or shift and include the period when exposure is anticipated to be at its highest.</p>	<p>4-hour exposure of the employee averaged over a continuous period of 4 hours</p> <p>Whether the exposure is: (a) below the CL; and (b) how far below the CL it is</p>	<p><b>Regulation 11 Prevention or reduction of exposure to asbestos</b></p> <p><b>Reg 11(1)(b)</b> Every employer must, where it is not reasonably practicable to prevent such exposure, 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 RPE.</p> <p><b>Reg 11(5)</b> The employer must ensure that no employee is exposed to asbestos in a concentration in the air inhaled by that worker which exceeds the control limit.</p>	<p>There is a legal requirement to demonstrate that no employee is exposed above the control limit, taking into account the protection provided by RPE.</p> <p>Compared with other personal monitoring, the method requirements are specific in terms of flow rate and LOQ.</p> <p>This is the only type of sampling where exposure must be expressed as an average exposure over a period of 4 hours – this might require further calculation (if the sampling periods are longer or shorter than 4 hours) and account for varying exposure levels when completing different tasks.</p>
<p><b>Specific Short Duration Activities (SSDA)</b></p>	<p>The sampling duration should be at least 30 mins (HSG248 Table 5.2)</p> <p>The sampling strategy (volume of air sampled and graticules counted) must achieve a meaningful LOQ e.g., below 0.1</p>	<p>Exposure concentration for a particular person, ACM type and activity</p>	<p><b>Reg 6 Assessment of work which exposes employees to asbestos</b></p> <p>The RA must:</p> <ul style="list-style-type: none"> <li>consider the results of monitoring of exposure in accordance with regulation 19 (ACOP 158: Details of expected exposures should be recorded and include results already available from air monitoring in similar circumstances)</li> </ul>	<p>The objective of this type of sampling is to obtain accurate exposure levels for specific tasks undertaken which feeds into exposure record, e.g. removal of AIB, fine cleaning, bag run.</p> <p>This data will inform the current risk assessments and should</p>

Monitoring Type	Specific method requirements	What the result tells you	What part of CAR requires this	Application/Comments
	f/ml. This typically means higher flow rates for shorter durations.		<ul style="list-style-type: none"> <li>be reviewed regularly and immediately if the results of any monitoring carried out pursuant to regulation 19 show it to be necessary (ACOP 176 A specific review should take place if the results of air monitoring indicate the exposure levels to be higher than previously assessed)</li> </ul> <p>The results of the assessment feed into the Plan of Work (PoW).</p>	<p>prompt an immediate review where results are higher than previously assessed.</p> <p>A series of sequential samples can be taken to investigate several activities over a shift.</p> <p>It is important to record contextual information to allow the value to be used in future RAs and PoWs which have similar conditions. The site diary can be used for this.</p> <p><b>An SSDA test that meets the WHO criteria can also be used to compare against the Control Limit</b></p>
<b>10-minute Short Term Exposure Limit (0.6 f/ml)</b>	<p>Sampling duration should be around 10 minutes.</p> <p>Must achieve a LOQ of less than 0.6 f/ml to allow for meaningful comparison with the STEL.</p> <p>Sampling should therefore take place at the highest flow rate that a personal pump can operate – up to 4 l/min.</p>	<p>10-minute exposure of the employee which can be compared with the STEL</p>	<p><b>Regulation 2(4)</b> states that for exposure to be sporadic and of low intensity, the concentration of asbestos in the atmosphere should not exceed or be liable to exceed the concentration approved in relation to a specified reference period by the Health and Safety Executive.</p> <p>The <b>ACOP para 27</b> states that this concentration is 0.6 f/ml over a 10-minute period. Any <b>exposure which exceeds or is liable to exceed</b> this is <b>not</b> sporadic and of low intensity and the work meets the</p>	<p>The STEL can be used to:</p> <ul style="list-style-type: none"> <li>determine if work is licensable if there is doubt;</li> <li>establish the magnitude of peak exposures associated with an activity; and</li> <li>check that adequate control (through RPE/other measures) is achieved.</li> </ul> <p>On a practical level, sampling periods should be as close to 10-minutes as possible. Marginally different periods which are</p>

Monitoring Type	Specific method requirements	What the result tells you	What part of CAR requires this	Application/Comments
			<p>Regulation 2 definition of <b>licensable work</b> with asbestos.</p> <p><b>Regulation 11 Prevention or reduction of exposure to asbestos</b>  <b>ACOP para 283</b> states employers should reduce airborne levels of asbestos to as low a level as reasonably practicable and control exposure, so that any peak exposure is less than 0.6 fibres per cm<sup>3</sup> averaged over a maximum continuous period of ten minutes. This should be done by using appropriate RPE, if exposure cannot be reduced sufficiently by other means.</p>	<p>representative of the work activity can also be compared with the STEL.</p>
<p><b>Assessment of suitability of RPE</b></p>	<p>Flow rates between 0.2 and 4 l/min</p>	<p>The airborne fibre level measured outside the RPE. The measured result can be divided by the RPE Assigned Protection Factor (APF) to determine whether the RPE is adequate for the work (The result should be less than the Control Limit).</p>	<p><b>Regulation 11 Prevention or reduction of exposure to asbestos</b></p> <p><b>Reg 11 (3)</b> Where it is not reasonably practicable for the employer to reduce the exposure to asbestos of any such employee to below the control limit by the measures referred to in paragraph (1)(b)(i), then, in addition to taking those measures, the employer must provide that employee with suitable respiratory protective equipment which will reduce the concentration of asbestos in the air inhaled by that employee (after taking account of the effect of that respiratory protective equipment) to a concentration which is—  (a) below the control limit; and  (b) as low as is reasonably practicable.</p>	<p>The fibre level outside RPE is measured to check whether APF of respirator or breathing apparatus is sufficient to ensure exposure is below the CL and ALARP. This is particularly useful when using new removal or control techniques.</p> <p>The APF of the RPE worn at the time will need to be included in any record.</p> <p><b>SSDA and 10-min STEL sampling will also be suitable to assess suitability of RPE.</b></p>

**ANNEX 2 Completed Example of Personal Air Monitoring Template (from HSG248)**

<b>Type of Personal Monitoring</b>	4-hour Control Limit	
<b>Person's name</b>	A N Example	
<b>Job Title</b>	Licensed Asbestos Removal Operative	
<b>LARC</b>	A Company Name	
<b>Sampling start/finish time</b>	Start: 08:00	Finish: 12:00
<b>Sampling flow rate (l/min)</b>	2.0 l/min	
<b>Types of work carried out by individual during sampling period including duration of each type of work activity</b>	Initial lifting out of first ceiling tiles to expose void and bagging (15 mins) Spraying of unsealed side of tiles from above followed by lifting out and bagging (3 hours) Start of the fine cleaning of support frame (30 mins)	
<b>Type of asbestos product being removed</b>	Asbestos insulating board suspended ceiling tiles painted in a loose frame	
<b>Asbestos removal method (e.g. unscrewing, lift off, scrape)</b>	Cutting paint seal and lifting from support frame	
<b>Controls used (e.g. wet spraying)</b>	Wet spraying, careful removal and shadow vacuuming	
<b>Type of RPE worn</b>	Scott Vision 2 mask with P3 filters	
<b>Other factors which may affect the result (e.g. confined location, external, nailed AIB, significant visible debris, rubble)</b>	Another operative performing the same task at the other end of the enclosure.  Most tiles were easily lifted from frame, paint had slightly sealed but didn't result in significant breakage of tile but those along one side of wall were slightly awkward to get to.	

**Photos of work area (through viewing panel) Attach photos with date, time and caption**



07/08/23 08:15 Removal of initial tiles



07/08/23 11:30 Final tile that was awkward to remove.

### ANNEX 3 Control Limit 4-hour Compliance Sampling

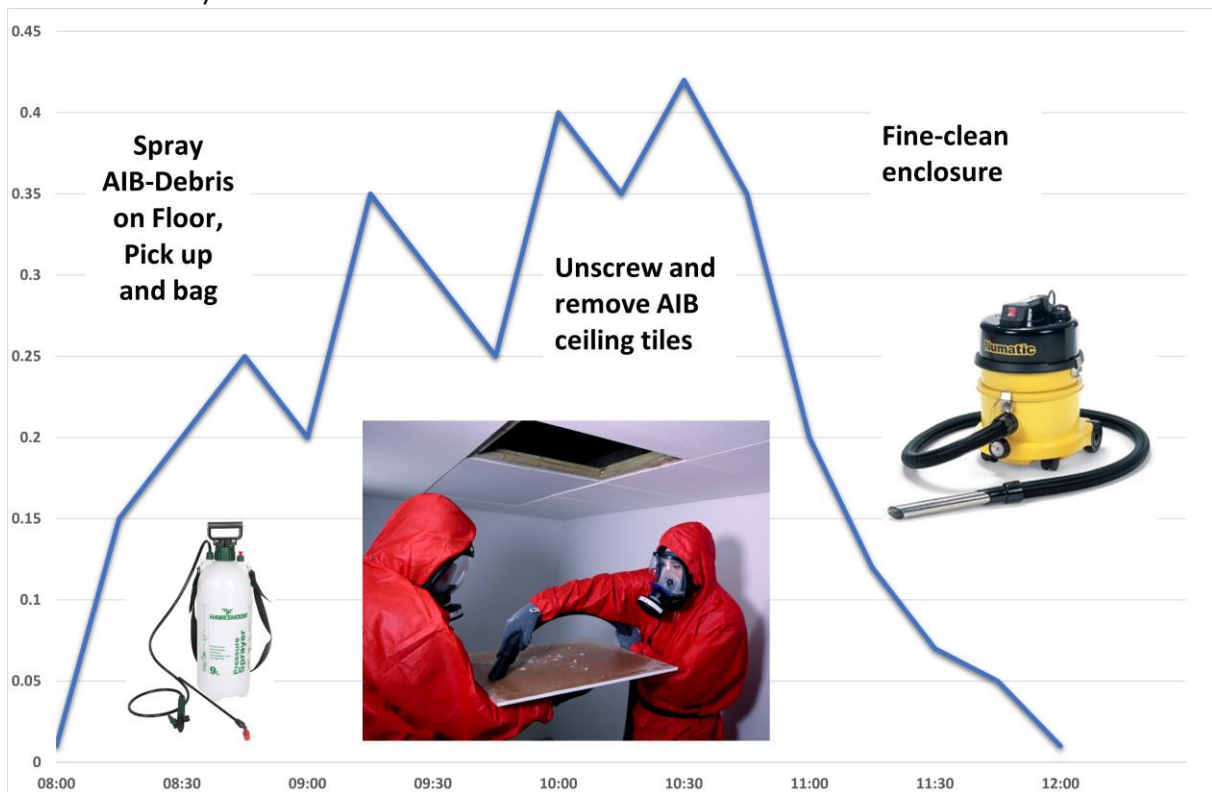
To check compliance with the Control Limit of 0.1 f/ml, measure personal exposure over a continuous 4-hour period.

An asbestos removal job is made up of different tasks and activities. Each present different exposure conditions at different times. **Figure 1** illustrates how levels could vary during a shift.

The LARC should anticipate the 4-hour period of the shift where fibre levels are likely to be highest. Ideally a personal sampler should be worn by the worker for a continuous 4-hour period, but there might be reasons why this is not possible: the work simply does not last this long, or a dusty work-area makes filters too dirty to count.

Options to ensure that the criteria are met:

- Select jobs large enough to ensure a minimum sampling period of at least 2 hours.
- Undertake sequential sampling of several activities over a continuous 4-hour period.
- Where airborne dust is the problem, a series of sequential samples may be taken for shorter times, and/or lower flow rates used to ensure countable samples.
- If further sampling is not possible, a realistic assumption about the likely exposure for the remaining time may be made. (e.g., that no further exposure took place after the shift ended)



**Figure 1. Illustration of an exposure pattern for a working shift.**

Figure 2 shows this shift, comprising three activities spray and pick-up of debris, removal of AIB, and fine cleaning. Four sequential personal samples were taken hourly.

The analyst calculated the 4-hour exposure of the individual worker using the durations and exposure-levels of these four samples.

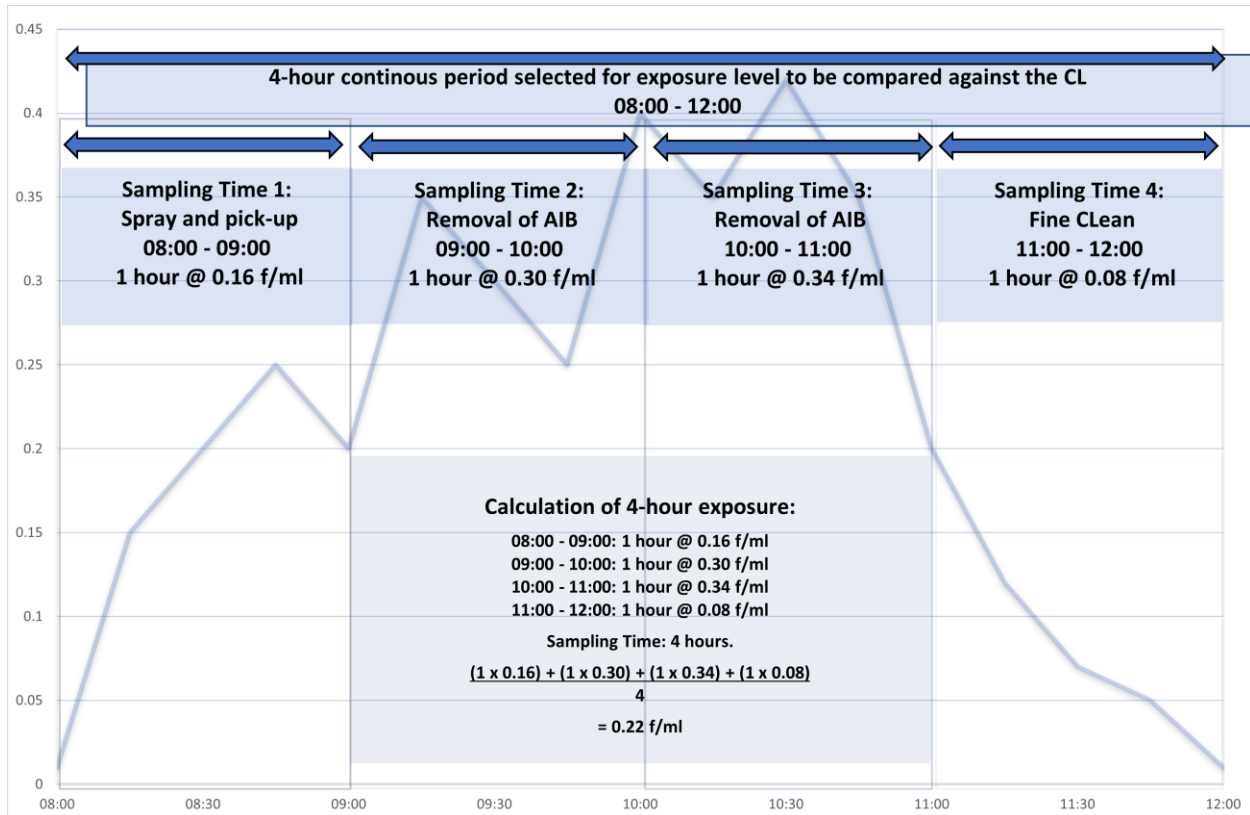
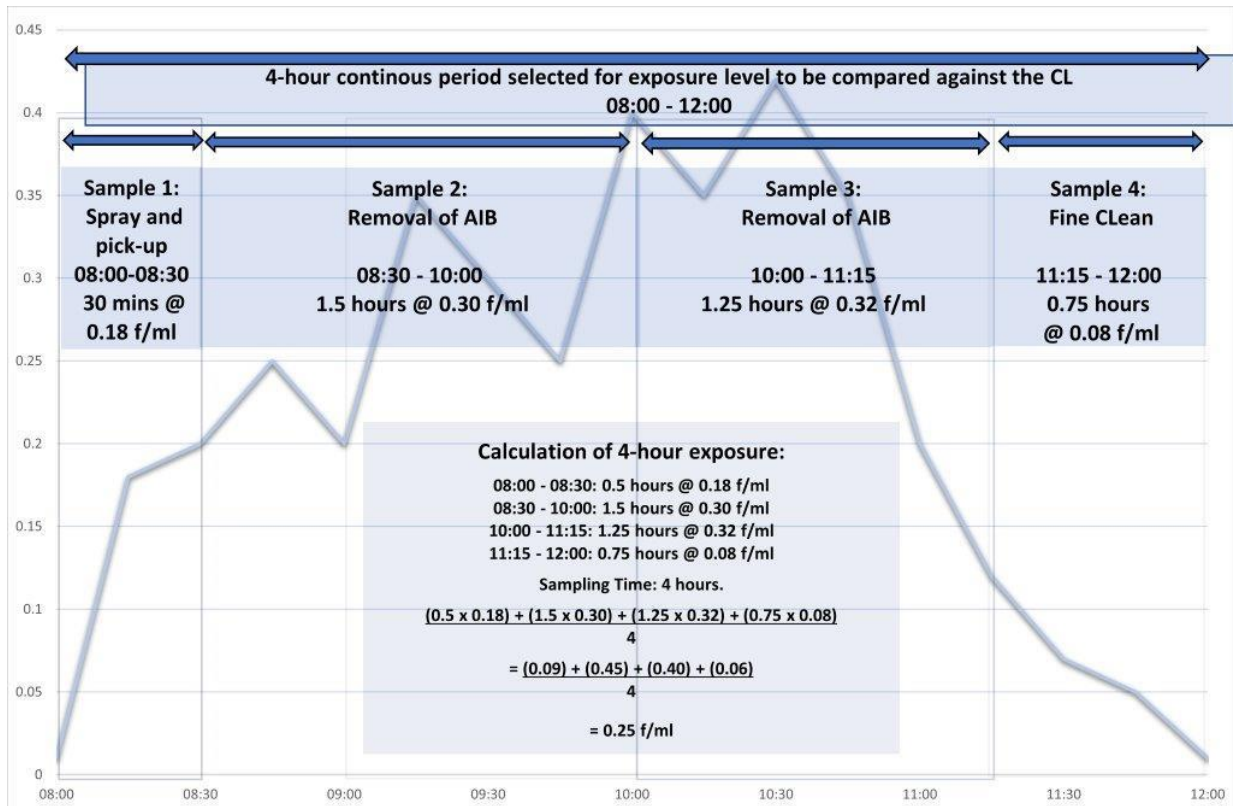


Figure 2: Illustration of sampling, exposure results and calculation of 4-hour exposure (sampling period split into 1 hour sampling periods for specific activities to give a simple illustration of how to calculate the 4-hour exposure).

**Figure 3** shows a similar shift, comprising different measurements of different lengths of time for the three activities: spray and pick-up of debris, removal of AIB, and fine cleaning. Four sequential personal samples were taken of different durations.

The analyst calculated the 4-hour exposure of the individual worker using the durations and exposure-levels of these four samples.



**Figure 3: Illustration of sampling, exposure results and calculation of 4-hour exposure. (sampling split into different time periods for activities to give a more complex illustration of how to calculate the 4-hour exposure).**



Figure 4 shows another example for a full working day, comprising three activities: asbestos removal, lunch break, and fine cleaning.

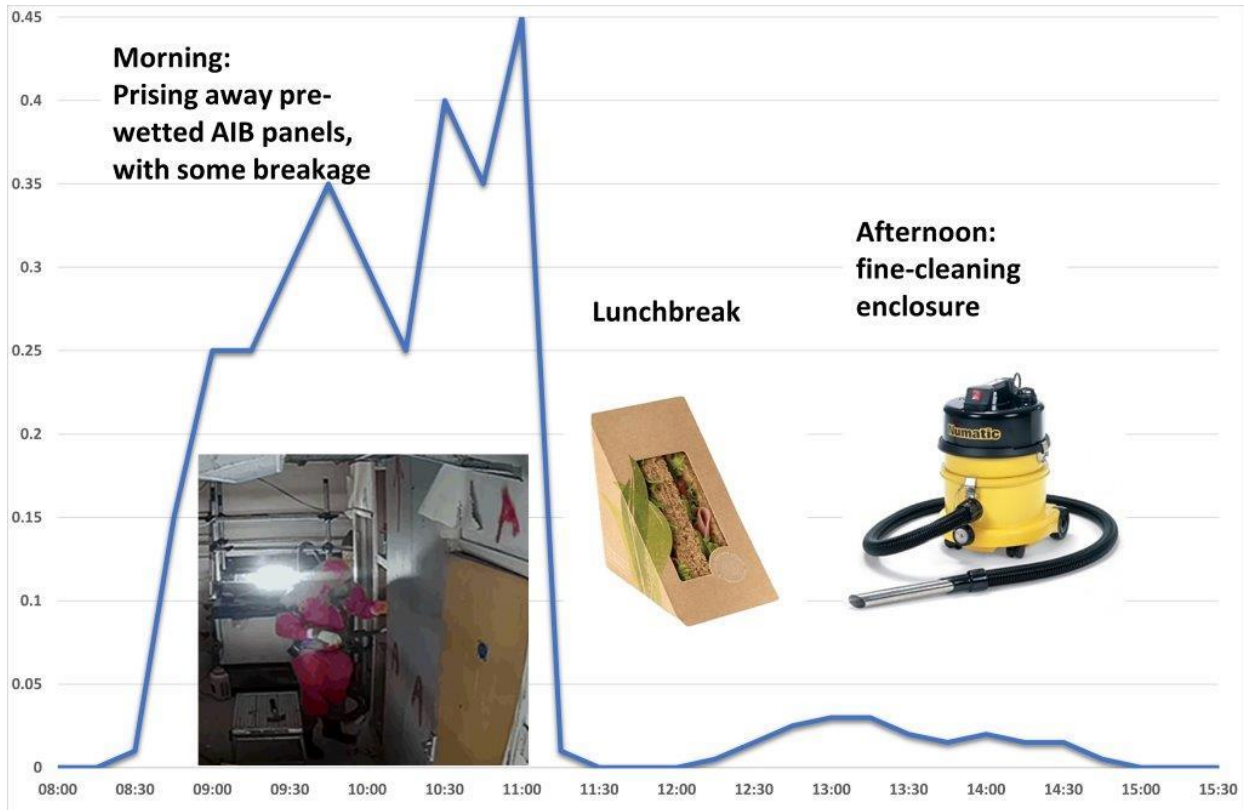
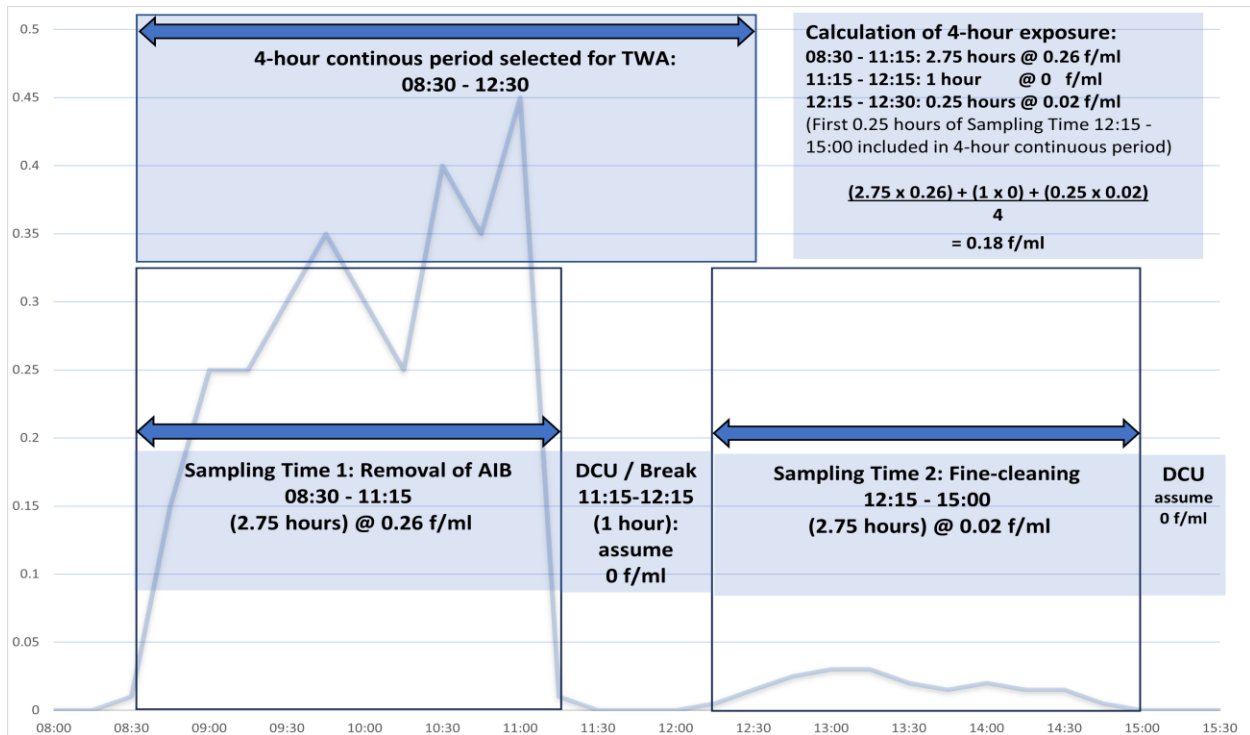


Figure 4: Illustration of sampling and exposure estimation where a break is taken.

**Figure 5** illustrates how anticipating the highest fibre-levels, the 4-hour continuous period started from asbestos removal at 08:30, just before entry to the enclosure to allow the analyst to put the sampling kit onto a worker. The workers exited for lunch at 11:15, and Sample 1 finished re-entering the enclosure at 12:15 to start fine-cleaning until 15:00, with personal sampling kit fitted to the same worker (Sample 2).

The analyst calculates the 4-hour exposure of the individual worker using the information relating to duration and levels of exposure for the three activities. Two separate personal samples were taken either side of the lunch break. No sample was taken during decontamination and lunch, instead exposure was assumed to be zero.



**Figure 5: Illustration of sampling, exposure results where a break is taken and calculation of 4-hour exposure.**

**Note:** In addition to checking compliance against the CL (0.18 f/ml continuous 4-hour period), the results from this sampling exercise can be used for:

- the **individual employee's exposure record** (2.75 hours at 0.26 f/ml and 2.75 hours at 0.02 f/ml);
- the **exposure record of the employees working alongside** (2.75 hours at 0.26 f/ml and 2.75 hours at 0.02 f/ml);
- the **database of anticipated exposure levels for planning** future, similar jobs - entry for AIB wall panel removal (0.26 f/ml) and fine cleaning (0.02 f/ml)

When undertaking personal sampling to demonstrate compliance with the Control Limit:

- Sampling must always include the work activity when exposure is likely to be highest i.e., representative of worst-case, which is likely to be removal of the asbestos.
- To meet the criteria set out in the WHO method (which is reflected in HSG248) a flow rate of between 1 and 2 l/min must be used.
- Sampling periods should normally be for the duration of the enclosure shift (e.g., 2–3 hours or more).
- HSG248 states that the minimum total volume required is 240 litres, this could be achieved by sampling for 2 hours at 2 litres per minute.
- When calculating the result, a continuous period of 4 hours must be used. The analyst should do this and record on the personal monitoring report. It is not up to the LARC but there should be communication between both parties to ensure a representative picture of exposure is gathered for that employee on that day.

**Note:** It is a legal requirement to demonstrate that exposures are reduced ALARP below the CL. Whilst account is made for the protection afforded by RPE worn, it may be argued workers are always going to be exposed below the CL. The results recorded in the exposure record will not account for protection afforded by RPE (although the make and model of RPE must also be recorded).

## ANNEX 4 What is the Limit of Quantification (LOQ) and why is it important?

All analytical techniques have their limitations on estimating countable fibre concentrations at or close to zero. Theoretically countable fibres must be present in a sufficient quantity that can be distinguished from fibres that might be present on blank unexposed filters.

The limit of quantification (LOQ) is the lowest concentration of countable fibres that can be quantified within defined limits of certainty. The statistical methods used require a minimum of 20 fibres counted to reduce uncertainty to an acceptable level. Where fewer than 20 fibres are counted, the result must be reported as “less than” the LOQ.

The LOQ is not fixed and can be reduced or increased depending on the volume of air sampled and number of graticule areas examined. The larger the volume of air sampled, or number of graticule areas examined, the lower the concentration of fibres in air that can be reported i.e., the lower the LOQ. However, there is a practical limit to this approach as too dense deposits of dust on the filter make examination of the filter difficult or impossible.

To assist analysts, LOQs based on this (i.e., minimum of 20 fibres) have been determined for a range of **minimum** sampling parameters and are presented at Table 5.2 in HSG248. However, there are other options to achieve a lower LOQ, e.g. increasing the volume of air sampled (increasing duration and/or flow rate) and analysing more graticule areas, as illustrated below. (**Note:** Counting a minimum of 200 graticule areas will ensure a more meaningful result as shown in the chart below).

LOQ Chart (f/ml)		Time (mins)			
Graticules	Flow Rate l/min	30	60	120	240
100	1	0.32	0.16	0.08	0.04
	2	0.16	0.08	0.04	0.02
	4	0.08	0.04	0.02	0.01
200	1	0.16	0.08	0.04	0.02
	2	0.08	0.04	0.02	0.01
	4	0.04	0.02	0.01	0.005

Analysts are expected to design a sampling strategy that will achieve a LOQ that allows reporting of a concentration which can:

- (a) be compared with relevant limit values; and/or
- (b) provide meaningful information about a particular task.

The following table details expected sampling parameters which would allow reporting of meaningful results for each personal sampling type.

<b>Personal Sampling Type</b>	<b>Expected Sampling Flow Rate (litres/min)</b>	<b>Expected Sampling Duration (mins)</b>	<b>Graticule areas to be examined</b>	<b>Calculated airborne calculation at the LOQ (20 fibres counted) (f/ml)</b>
4-hour control limit (0.1 f/ml)	1-2	240	200	0.01 – 0.02
10-minute short term exposure limit (0.6 f/ml)*	4	10	200	0.12
Specific short-duration activities	2-4	over 30	200	0.08 or below
Assessment of suitability of RPE	3-4	over 15	200	0.11 or below

\*The 10-min STEL is rarely undertaken in enclosures because it is not practical, it becomes more important for work where there is no enclosure e.g., NLW.