

Monitoring strategies for toxic substances



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This guidance highlights procedures in how to investigate employee exposure to toxic substances through inhalation that may be hazardous to health and how to control the nature of and extent to this exposure.

It is aimed at all employers in general and at all health and safety professionals where it can be a useful introduction to the subject as well as ensuring that you are doing enough to comply with the law.

It also targets non-specialists in order to help with gaining an initial understanding in order to be able to ask questions and seek advice from consultants and others.

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This Code has been approved by the Health and Safety Executive, with the consent of the Secretary of State. It gives practical advice on how to comply with the law. If you follow the advice you will be doing enough to comply with the law in respect of those specific matters on which the Code gives advice. You may use alternative methods to those set out in the Code in order to comply with the law.

However, the Code has a special legal status. If you are prosecuted for breach of health and safety law, and it is proved that you did not follow the relevant provisions of the Code, you will need to show that you have complied with the law in some other way or a Court will find you at fault.

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Monitoring strategies for toxic substances

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Introduction

- 1 This guidance is addressed primarily to employers. First published as EH42, it was then revised to make it more accessible to non-specialists so that they can use it as an introduction to the design of inhalation exposure monitoring strategies.
- 2 You can use these procedures to investigate employee exposure, by inhalation, to substances hazardous to health. They will help you investigate the nature, extent and control of employee exposure.
- 3 The guidance will also help you to understand and ask questions about any information or advice that you may receive from consultants and others.
- 4 Health and safety professionals may also use this guidance as an introduction to the subject. For more detailed information on specific issues, see *References*.
- 5 The Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH),¹ regulation 2, states that substances and preparations (mixtures of two or more substances) hazardous to health include:
 - substances in Part 1 of the *Approved supply list*² as dangerous for supply within the meaning of the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP)³ and for which an indication of danger specified for the substance is very toxic, toxic, harmful, corrosive or irritant;
 - substances with a workplace exposure limit (WEL);
 - biological agents;
 - dusts of any kind in substantial concentrations; and
 - any substance that creates a risk to health because of chemical or toxicological properties.
- 6 The information in this guidance is not suitable for:
 - assessing exposure to micro-organisms;
 - assessing exposure from non-inhalation routes (ie skin absorption and ingestion);
 - assessing safety issues such as flammability, explosive hazards and asphyxiants; and
 - measuring emissions of volatile organic compounds (VOCs) under the Environmental Protection Act 1990.
- 7 You need to be aware that substances hazardous to health can enter the body by ingestion (ie swallowing the substance) and skin absorption (ie through the skin) as well as by inhalation. This means that in some situations you may also need to measure the total amount of a substance that has entered an employee's body.

This is done using a technique called biological monitoring.

8 Biological monitoring is outside the scope of this guidance. For further information about biological monitoring, see *Biological monitoring in the workplace: A guide to its practical application to chemical exposure*.⁴

9 There are specific legislative requirements for lead, asbestos and respirable dust in mines. The principles described in this guidance apply equally to monitoring inhalation exposure to these substances.

Legislative requirements

10 The principal regulations governing substances hazardous to health are the COSHH Regulations. The central requirements are:

- regulation 6(1) - you should carry out a suitable and sufficient assessment of the risks to the health of your employees and any other person who may be affected by your work, if they are exposed to substances hazardous to health;
- regulation 7(1) - you should ensure that exposure is prevented or, when this is not reasonably practicable, adequately controlled.

11 If you comply with COSHH regulation 6(1) you have fulfilled your duties under regulation 3 of the Management of Health and Safety at Work Regulations 1999.⁵ Remember, this only applies to substances hazardous to health, eg not physical hazards such as noise, radiation and machinery guarding. You will need to assess and control any physical hazards and risks separately.

12 The legal requirement for monitoring inhalation exposure is given in regulation 10 of the COSHH Regulations. It requires you to carry out monitoring if:

- it is not immediately obvious to you whether there is a risk to the health of your employees; and
- there is a suitable procedure which you can use to measure exposure.

13 Regulation 10 is clarified in detail in the COSHH *Approved Code of Practice*.⁶ This states that monitoring is required when:

- failure or deterioration of the control measures could result in a serious health effect;
- when measurement is needed to ensure a WEL or any self-imposed (in-house) working standard is not exceeded; or
- as an additional check on the effectiveness of any control measures provided in accordance with regulation 7, and always in the case of the substances or processes specified in Schedule 5 to the Regulations;
- when any change occurs in the conditions affecting employees' exposure which could mean that adequate control is no longer being maintained.

Exposure limits

14 A number of substances hazardous to health in the workplace have been assigned Workplace Exposure Limits (WELs). These are averaged over eight-hour or 15-minute reference periods.

15 A WEL is the maximum concentration of an airborne substance averaged over

a reference period, to which employees may be exposed by inhalation.

16 WELs should not be considered a hard and fast line between safe and unsafe. The principles of good control practice (COSHH 2002, Schedule 2A), if applied correctly, should ensure exposures are below any relevant WEL.

17 To comply with the requirements in COSHH regulation 7(7)(c) (exposure to asthmagens and carcinogens) to reduce exposure so far as is reasonably practicable, employers may need to carry out a programme of air monitoring in accordance with regulation 10. This will be generally necessary unless the risk assessment shows the exposure is unlikely to ever exceed the WEL.

18 The majority of substances used in industry have not been given WELs, but this does not mean that they are safe. In these circumstances you need to ensure that exposure is controlled to a level to which nearly all the working population could be exposed day after day, without adverse effects on their health.

19 To judge whether there is a risk to the health of your employees in these circumstances, you may be able to use limits produced by other bodies, such as *Guide to occupational exposure values 2005*⁸ from the American Conference of Governmental Industrial Hygienists. In all cases, the principles of good control practice should be applied in the first instance.

20 You can also use the information provided by your manufacturer or supplier, under the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002,⁹ to set in-house standards. For further information about setting in-house standards, see *References*.

Inhalation exposure monitoring

Why you should develop a monitoring strategy

21 As an employer, you may wish to develop a monitoring strategy. There are a number of good reasons to do this, including:

- health risk assessment;
- compliance with WELs;
- to help towards the design of exposure control measures;
- checking the effectiveness of your control measures;
- informing your employees of the pattern of exposure and level of risk;
- to indicate the need for health surveillance;
- establishing in-house exposure standards, where necessary;
- for insurance purposes; and
- to contribute to epidemiological studies.

Personal monitoring

22 Measuring your employees' personal exposure, by inhalation, to substances hazardous to health is not the same as measuring the amount at a particular fixed site in the workplace. Fixed sites can be either:

- at the source of emission of a substance hazardous to health; or
- at another area in the workplace, away from the source.

23 Personal monitoring is used to establish the concentration of an airborne substance within the employee's breathing zone. This is explained in more detail in Appendix 2, paragraphs 10-13. With the exception of vinyl chloride, WELs relate to personal exposure.

24 You will need to consider whether personal exposure monitoring will be useful when assessing the risks to your employees from working with substances hazardous to health.

25 Remember, exposure monitoring is not an alternative to the adequate control of exposure and programmes can be time-consuming, labour-intensive and expensive. Therefore, it is important that you establish:

- a clear need for monitoring;
- an understanding of the factors likely to influence the exposure; and
- a strategy which is fit for the purpose.

Fixed place monitoring

26 Most WELs refer to personal exposures. You can also use fixed place or static monitoring to obtain information on the likely sources contributing to the exposure. However, fixed place monitoring does not usually reflect the amount that one of your employees could breathe in, which determines the risk to health.

27 You may take fixed place samples:

- to check the effectiveness of your control measures;
- to identify emission sources;
- to determine background workplace contaminant concentrations;
- if there are no suitable personal monitoring methods available;
- when wearing personal monitoring equipment may introduce additional hazards;
- when continuous monitoring alarm systems are installed; and
- in the case of vinyl chloride.

Approaches to inhalation exposure assessment and monitoring

28 Because of variations in plant, process, work and other conditions it is difficult to draw conclusions about long-term exposure patterns on the basis of a single measurement of exposure at one point in time (see Appendices 1 and 2).

29 You will need to make sure that the monitoring strategy you devise and the way you interpret the results allows you to draw conclusions with confidence about the risk to the health of your employees.

30 Exposure monitoring can be time-consuming and expensive. But, if you follow the advice outlined in this guidance you will get the most out of a monitoring exercise, at a reasonable cost.

31 Each stage in the industrial manufacture and use of substances hazardous to health involves different tasks. Each of them can present different exposure conditions. Figures 1a - 1e show how exposure can vary, often over short periods of time, during a shift.

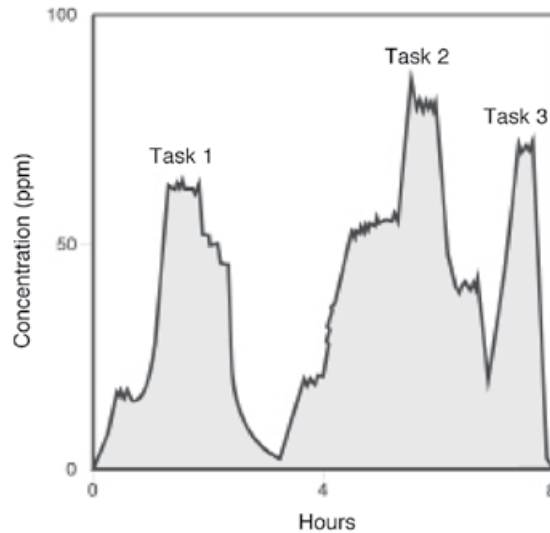


Figure 1a: An exposure pattern for a working shift (8 hours)

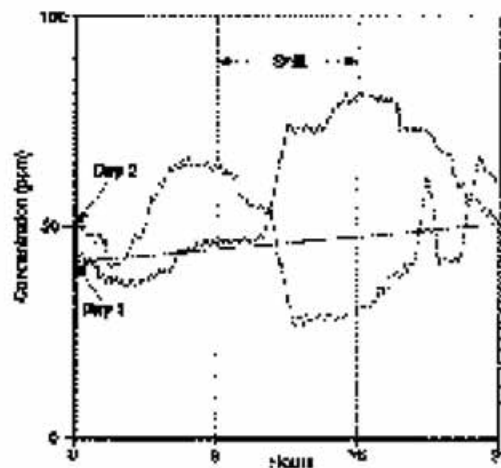


Figure 1b: Variations in exposure over a 24-hour period

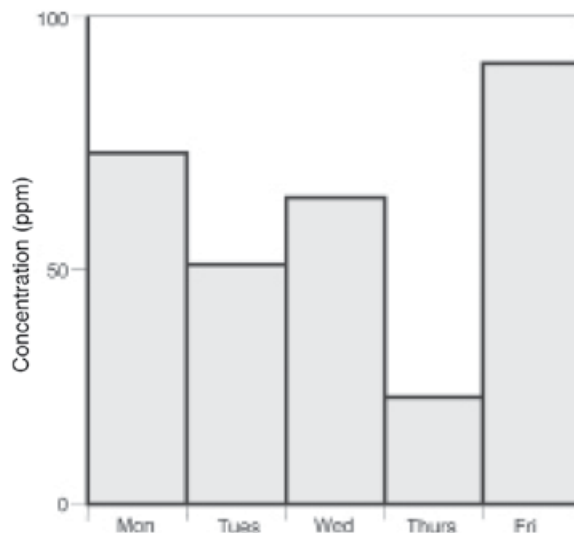


Figure 1c: Daily variations in shift averages (8-hour time-weighted averages)

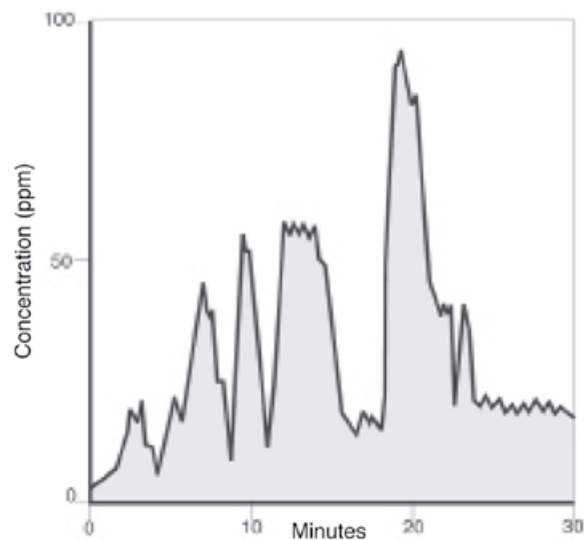


Figure 1d: Continuous monitoring trace (eg paint spraying showing intermittent nature of job)

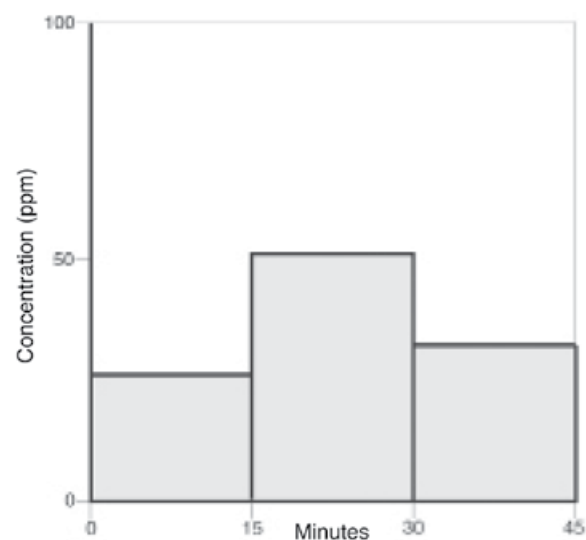


Figure 1e: 15-minute time-weighted average exposure

32 The design of a monitoring strategy will be greatly influenced by the:

- aims of the survey; and
- conditions presented by the process.

33 The scope of the exposure assessment will depend on how complicated the process is. However, in many situations it may be possible to determine the likely level of exposure without taking measurements. Figure 2 illustrates a structured approach for evaluating exposure by inhalation.

34 The following paragraphs outline this approach to monitoring inhalation exposure to substances hazardous to health.

35 Not every situation is complex enough to warrant such a structured approach, for example monitoring exposure to solvent vapours during hand painting in a well-ventilated room. In these situations you could select or combine different aspects of the structured approach.

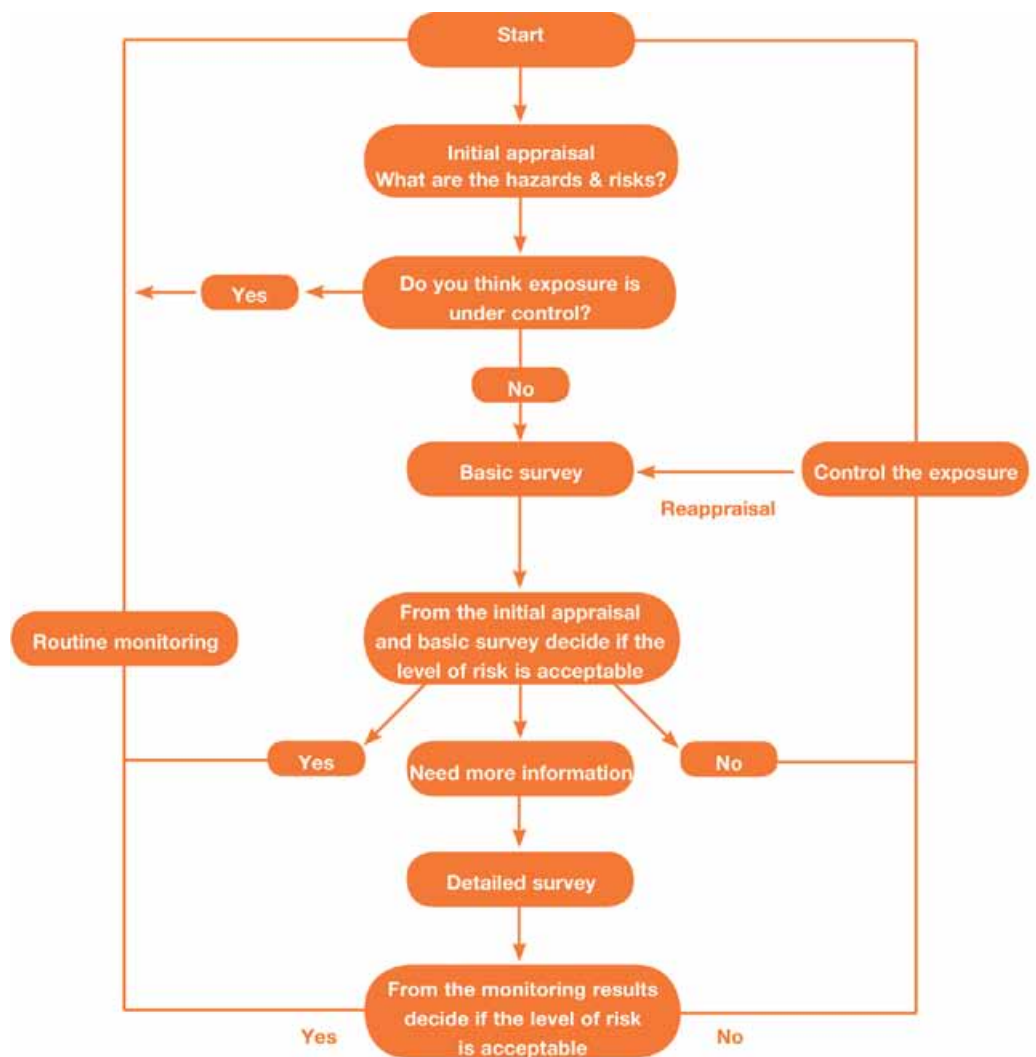


Figure 2: A structured approach for assessing exposure to substances hazardous to health by inhalation

36 You may consider combining aspects of the basic and detailed surveys. This may involve the simultaneous use of smoke tubes, air velocity meters, chemical indicator tubes and personal sampling equipment.

37 Standards for general performance requirements, for procedures to determine the concentration of substances hazardous to health in workplace air, can be found in BS EN 482, *Workplace atmospheres - general requirements for the performance of procedures for the measurement of chemical agents*.⁹

Initial appraisal

38 The initial appraisal is an important part of the strategy described in Figure 2. It helps you establish the need for, and the extent of, exposure monitoring. This will help you to decide on:

- the hazards;
- the potential risks; and
- whether more information is needed (eg do you need to carry out monitoring to obtain an estimate of the exposure of your employees to substances hazardous to health?).

39 The first stage of the initial appraisal requires you to find out information on a variety of factors, for example:

- the substance that your employees are exposed to;
- the hazardous and physical properties of the substance;
- the airborne forms of the substance;
- the processes or operations where exposures are likely to occur;
- the number, type and position of the sources from which the substance may be released;
- which groups of employees are most likely to be exposed;
- the pattern and duration of exposure;
- work practices;
- the means by which the release of the substance is controlled;
- whether respiratory protective equipment and/or other personal protective equipment are worn and their effectiveness; and
- what are the WELs, limits from other bodies or in-house standards for the substance involved.

40 You can obtain this information from a number of sources, for example:

- labels on containers and packages;
- manufacturers' and suppliers' safety data sheets;
- HSE publications;
- technical literature from trade associations; and
- past experience.

41 When you have this information, you can use simple qualitative tests to help you decide whether there may be a risk to the health of your employees, for example:

- smoke tubes can illustrate the movement of air under the influence of draughts, general and local exhaust ventilation systems, and show what the effects are;
- a dust lamp allows you to see very fine airborne particles which are invisible under normal light. This helps you identify emission sources and watch the movement of airborne dust. Further help on the use of dust lamps can be found in HSE's *The dust lamp: A simple tool for observing the presence of airborne particles*;¹⁰
- smell can also be used as an indicator of contamination. But remember this is an unreliable method.

42 Based on the information collected during the initial appraisal you may conclude that the level of exposure, by inhalation, is acceptable. If this is the case, it might not be necessary to carry out exposure monitoring.

43 Remember, the level of exposure of your employees to a substance hazardous to health can change. This means that your initial assessment may no longer be valid. You should always be aware of the need for exposure monitoring.

Basic survey

44 You will need to proceed to a basic survey when the initial appraisal suggests:

- there is an exposure risk but the extent of the risk is uncertain;
- major changes have been made to the process, procedures or control measures since the last assessment;
- unusual or periodic operations are planned;
- a new process is being commissioned; or

- a new WEL or in-house standard has been set.

45 The basic survey estimates your employees' personal exposure and provides an indication of the efficiency of process and engineering controls.

46 In the case of a basic survey it is best to look at worst-case situations, such as the 'dirtiest', or situations your employees make the most complaints about.

47 Before monitoring you need to identify those employees likely to be at significant risk of exposure along with the conditions giving rise to them. Appendix 1 sets out the factors that influence airborne concentrations and Appendix 2 outlines the variables which influence the design of monitoring strategies. This information will help you decide what needs to be done.

48 You can use semi-quantitative methods to estimate personal exposure. These give you a rough numerical estimate of exposure. Some semi-quantitative methods are comparatively inexpensive and easy to use.

49 Semi-quantitative methods range from simple techniques, such as chemical indicator tubes (where the absorbent granules in the tube change colour when a known amount of air, containing a chemical, is drawn through) to more complex methods which require specialist knowledge, including:

- computer exposure modelling; and
- organic vapour analysers such as photoionisation detectors, portable gas chromatographs and infra-red analysers.

50 Alternatively, validated laboratory-based sampling and analytical techniques can be used (see Appendix 2). If you are unsure how to use such techniques, you could consult a health and safety professional such as an occupational hygienist.

51 Air velocity meters can be used to assess local exhaust ventilation systems to ensure that they are performing in accordance with the design specification. Also, the qualitative methods used in the initial appraisal can be used here.

52 The basic survey may highlight defects and deficiencies in control strategies. Based on this and information gathered during the initial appraisal you may conclude that the control of inhalation exposure is acceptable. If the conclusion is not certain, you have two choices:

- carry out a detailed survey and take remedial action as necessary; or
- take direct action to control exposure.

Detailed survey

53 You can use this approach when:

- the extent and pattern of exposure cannot be confidently assessed by a basic survey;
- exposure is highly variable between employees doing similar tasks;
- carcinogenic substances (risk phrase R45 and R49), respiratory sensitisers (risk phrase R42 and R42/43) or mutagens (risk phrase R46) are involved;
- the initial appraisal and basic survey suggest that:
 - the time-weighted personal exposure may be very close to the WEL, limits from another body or in-house standard; and
 - the cost of additional control measures cannot be justified without evidence of the extent of exposure variability; and

- undertaking major maintenance and one-off jobs such as plant decommissioning.

54 A detailed survey is likely to involve techniques already mentioned for the initial appraisal and basic survey. This will be in conjunction with more detailed monitoring of your employees' potential exposure to substances hazardous to health.

55 A detailed survey is most suited to complex processes and will require an in-depth investigation of the process and its environment, for example:

- procedures involved in the process;
- work practices;
- maintenance procedures including the type and frequency;
- control measures in use and their suitability;
- protective equipment provided to your employees and its suitability;
- previous monitoring results;
- results of health surveillance programmes;
- information and instruction provided to your employees for carrying out the tasks involved; and
- the extent of the training provided to your employees.

56 A detailed survey usually requires more specialist knowledge than an initial appraisal or basic survey. It is beyond the scope of this guidance to describe such a procedure in full, especially as detailed surveys vary with the situation in each workplace.

57 For further information, see *References*. Additional information can also be found in other HSE publications or publications from your trade association. In addition, you could consult a health and safety professional. The British Institute of Occupational Hygienists holds a Directory of Consultancies.

58 For certain substances a detailed survey may need to include the use of biological monitoring. You can find out more about biological monitoring and how you go about it in *Biological monitoring in the workplace: A guide to its practical application to chemical exposure*.⁴

Reappraisal

59 Monitoring for the basic and detailed surveys may highlight deficiencies in control measures and poor work practices.

60 Once you have carried out remedial action you will need to see if the changes have had a positive effect. You can usually do this by a brief reappraisal of the situation.

61 If the risks to health are judged to be high, additional exposure monitoring may be advisable. For example, when:

- carcinogens are used; or
- there is a very variable pattern of exposure.

Routine monitoring

62 When you decide that the risk to your employees has been adequately controlled, you may decide that you need to set up a routine monitoring

programme to ensure that the control measures stay effective.

63 In particular, Schedule 5 of the COSHH Regulations requires continuous monitoring for vinyl chloride monomer and every 14 days for sprays given off from vessels during electroplating processes involving hexavalent chromium.

64 Routine monitoring can be time-consuming and expensive over the long term. Consequently, if you think that you may not be complying with a WEL it can be more cost-effective for you to invest in better control measures. This reduces the:

- need for expensive routine monitoring; and
- health risks for your workforce.

65 Remember, there are some simple and inexpensive instruments available which can provide information on the continued performance of your control methods, for example:

- pressure sensing devices fitted to ventilation systems;
- smoke tubes; or
- dust lamps.

66 For the results of a routine monitoring programme to be effective in protecting the health of your employees you need to be able to compare them with those obtained from previous monitoring exercises. This requires that the programme is well planned. You need to consider:

- the similarity of the processes and tasks monitored;
- where and at what stage of the process the monitoring was carried out; and
- the method of collecting and analysing the samples.

67 If a programme is not well planned it can produce a large volume of results and paperwork without being of any actual use in making sure that your employees' health is being protected.

68 The frequency of routine surveys will vary. The nearer the measured exposure is to the WEL the more frequently you will need to monitor.

69 One scheme for determining the frequency of routine monitoring is given in BS EN 689 *Workplace atmospheres: guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy*.¹¹

Interpretation of results

70 WELs are set down as eight-hour time-weighted averages (TWAs) and/or 15-minute TWAs. This means that you need to ensure that each result has been converted to the specified TWA reference period.

71 The approved methodology for calculating TWAs is given in EH40.⁷ When you are converting the results to TWAs, you need to give careful consideration to the accuracy and precision of the sampling and analytical methods. You can do this by consulting the manufacturer of the equipment or by seeking specialist advice, for example from the laboratory that carried out the analysis.

72 When comparing the results with WELs, limits from other bodies or in-house standards, you will need to take account of other relevant workplace information you have collected (see Appendix 3).

73 If you have used relatively unsophisticated techniques, such as chemical indicator tubes during an initial appraisal, do not place too much confidence in the level of compliance when an employee's exposure is within plus or minus 50% of the WEL.

74 In these circumstances you should conclude that the level of exposure is uncertain and a more detailed investigation is required.

75 When the exposure is outside this range you can be confident that no further action is necessary. As the strategies and techniques that you use become more refined, you can place greater confidence in the results.

76 In most situations you will not need to carry out a statistical treatment of the results. However, you may decide to apply a simple analysis such as a group average and range.

77 If you have taken a large number of samples, for example during representative (see Appendix 2) and routine monitoring, a more detailed statistical analysis may be carried out. This will require a knowledge of statistics.

78 Using statistics to analyse the results will give you a better indication of the variability in exposure and extent of compliance with WELs. Further information on statistics is given in *References* at the end of this guidance.

79 From the exposure monitoring results you may conclude that:

- the data are/are not adequate and/or representative of all those exposed;
- compliance with WELs, limits from other bodies or in-house standards has/has not been achieved;
- further actions are/are not necessary to prevent or reduce exposure; or
- more monitoring is/is not needed.

Compliance testing

80 Compliance testing means comparing your monitoring results with WELs, limits from other bodies or in-house standards to ensure that your control strategy will enable you to comply with COSHH regulation 7.

81 When interpreting the results and reaching your conclusion you need to remember that the COSHH Regulations require that protection is given to all employees. If you have carried out group-based, similarly exposed group (SEG) monitoring you need to show that the conclusion drawn for one employee is equally applicable to others in the same exposed group (see Appendix 2, Paragraph 5).

82 A number of schemes have been proposed for compliance testing. BS EN 689¹¹ describes some of these schemes.

83 Reducing exposure 'so far as reasonably practicable' means that:

'you must reduce exposure to the point where there is a big difference between, on the one hand, the sacrifice (in money, time or trouble) that would be involved in further measures and, on the other hand, the risks from exposure (which should be insignificant)'.

84 If you are comparing your results with limits from other bodies or in-house standards you need to consider the basis behind the number in order to decide whether there is a risk to the health of your employees.

Appendix 1: Factors influencing airborne contaminant concentrations

1 It is important to understand the variability of the workplace environment before designing a monitoring strategy. Factors which influence the release and airborne concentration of substances include:

- physical and chemical properties of the substance such as the vapour pressure, boiling point and particle size;
- the number of sources from which the substance is released;
- rate, duration and speed of release from each source;
- arrangement of the process, temperature and design of the control measures;
- variations in the process, job and tasks being carried out. These can be by the hour, day or even week;
- dispersion or mixing of the substance in the workplace air due to general or local ventilation; and
- ambient conditions (temperature, pressure and humidity).

2 These factors may produce rapid fluctuations in the concentrations of the substance over very small distances. Figure 3 shows a workplace where plant and process conditions, and local and general ventilation characteristics may vary from day to day or display a seasonal pattern.

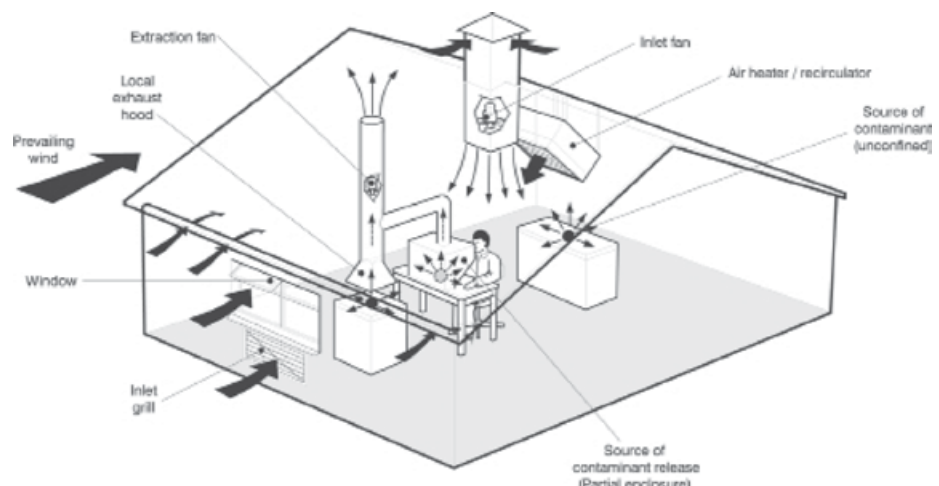


Figure 3: Factors influencing airborne contaminant concentrations

3 As well as the factors outlined in paragraph 1, your employees can also influence the level and pattern of exposure, for example:

- the type and position of each source relative to the employee;
- the length of time the employee spends in the vicinity of the source;
- whether the employee has:
 - direct control over the task or process; and
 - a poor appreciation of the risks involved leading to poor work practices.

Appendix 2: Variables influencing the design of monitoring strategies

1 This appendix outlines a number of variables which you will need to consider when designing a monitoring strategy. Further information can be found in *References*.

Health effect

2 The type of health effect that could be induced by the substance will influence the monitoring procedure. For a substance with acute effects such as eye irritation, the monitoring techniques need to be sensitive enough so that peak and short-term (15-minute TWA) measurements can be taken.

3 In the case of chronic effects the monitoring strategy will mainly focus on long-term (eight-hour TWA) exposures. This is because, in general, the development of health effects depends on exposure over a prolonged period of time.

4 You may need to consider substances which have the potential to induce both acute and chronic effects. The monitoring strategy will need to take this into account.

Grouping of individuals

5 The COSHH Regulations require that you protect the health of all your employees. While you may wish to have information on the exposure pattern of all your employees, in many workplaces the numbers involved may make the monitoring exercise prohibitively expensive. So monitoring strategies usually focus on groups of employees who do similar jobs in similar ways. These groups are described as similarly exposed groups (SEGs). The grouping of potentially exposed employees can be made by careful observation of such common factors as:

- similarity of the tasks performed (not necessarily the same job);
- exposure to the same range of airborne contaminants; and
- similarity of environment (process, exposure source and control measures).

6 If you have carried out group sampling, the results need to be carefully analysed to make certain that they are equally valid for all employees in the SEG. A wide difference in the results from different individuals indicates considerable variation within the SEG.

7 In these circumstances you need to further sub-divide the group or reassign employees to a more appropriate SEG. Repeated measurements from the same employee can help you decide whether that employee needs to be reassigned or a SEG further sub-divided.

8 As a useful guide: *when an individual's exposure is less than half or greater than twice the group average, then the individual needs to be reassigned to a more appropriate SEG.*

9 You can then focus your risk control strategies and further monitoring on those employees most at risk from excessive exposure.

Types of exposure measurement

10 As indicated in paragraphs 22 to 27 in the main text, there are two main types of monitoring, personal and fixed place (static). The purpose of personal monitoring is to establish the concentration of the airborne substance within the breathing zone of the employee.

11 The breathing zone is the space within 20-30 cm of the person's nose and mouth. This convention permits the placing of personal samplers on the employee's lapel. However, airflows and activities are variable. This means that the positioning of the sampler (right lapel, left lapel or helmet) may cause an over or under estimate of the average concentration inhaled by the employee. For example, the fume generated during soldering operations will rise straight upwards because of thermal currents. This may miss a sampler placed on the employee's lapel.

12 Therefore, you need to give careful consideration to the process, task and work practices before placing the sampler and during the monitoring exercise so that the results can be correctly interpreted.

13 There are two distinct types of personal measurement; *representative* and *worst-case*:

- *representative measurements* take into account all possible workplace influences including the variables described in Appendices 1 and 2.
- *worst-case measurements* can be taken where you can clearly identify employees who are subject to periods of high exposure. The monitoring period can then be selected to cover these events. For the purposes of determining the eight-hour TWA exposure, you can consider the exposures found in these circumstances as applying to the whole of the working period. This presumption will err on the side of safety once acted on.

Number of samples

14 Taking one or a few samples on one day will not provide you with sufficient information on which to base conclusions about long-term exposures. In reality the number of samples that you can take is usually constrained by the resources available to you. You need to use your judgement when deciding on sample size, especially when small groups are concerned.

15 For worst-case monitoring, as a rule of thumb, at least one employee in five needs to be monitored from a properly selected SEG, unless a smaller number can be justified.

16 For representative measurements:

- if there are less than ten employees in the SEG only five need to be included in the monitoring exercise;
- for complex situations involving more than ten employees in the SEG, see *References*.

Monitoring period and duration

17 If the process is continuous and has minimal variation, the choice of monitoring period is not of great importance. However, if the process is cyclic it is critical that you carry out the monitoring at the time your employees are being exposed.

18 The choice of the monitoring period is also closely linked to the type of health effect associated with the substance (see Appendix 2, paragraph 2). The duration of the monitoring has to be sufficient to:

- give results which are representative of the whole range of exposures, including peak exposures; and
- allow the relevant TWA exposure to be calculated.

19 You also need to ensure that start-up procedures at the beginning of shifts and end-of-shift tasks such as clean down operations are included.

20 In the case of continuous, well-controlled processes with minimal variability you can use a monitoring duration of less than the full shift (or eight-hour reference period). In such circumstances the monitoring period may cover at least 25% of the working shift and include periods of high exposure.

21 If there is considerable variation in the work pattern you may need to monitor on a number of days to cover all anticipated variations.

22 Remember, unsampled time represents a serious weakness in the credibility of any exposure measurement. Consequently, during this time, you need to make careful observation of work practices, etc.

Sampling and analysis equipment

23 The monitoring equipment and method of analysis that you choose has to fit the requirements of the strategy and not vice versa. However, the practicalities of the workplace may require you to make a compromise.

24 The sampling technique you choose needs to be appropriate for the given work situation and not significantly influence the employee's behaviour by being:

- too heavy;
- obstructive; or
- noisy.

25 The equipment needs to:

- be robust enough to cope with the demands of the work environment;
- have sufficient battery life; and
- be certified for use in flammable atmospheres, if necessary.

26 The errors in the sampling and analysis equipment need to be determined and supported when appropriate by quality control protocols.

27 Examples of national quality schemes include the:

- National Measurement Accreditation Scheme (NAMAS);
- Workplace Analysis Scheme for Proficiency (WASP).

28 Specific information on sampling and analytical techniques for many

substances and processes can be found in HSE's *Methods for the determination of hazardous substances* (MDHS) series. You can also get information from equipment manufacturers and analytical laboratories.

Appendix 3: Core information

1 A set of monitoring results in isolation is rarely sufficient to permit conclusions to be made with confidence on the level of exposure and the necessary control measures. Other essential information is often referred to as 'core information'.¹² Collecting core information at the time you carry out the monitoring will allow you to make reliable decisions about:

- the level of exposure; and
- the need or adequacy of controls.

2 Table 1 lists the information which you may need to collect when carrying out exposure monitoring.

Table 1: Core information

Key categories	Data element
Premises	This section includes details on the name of your premises, address and what type of work you do.
Workplace	This section gives information on the department, work area and process.
Worker activity	Details of the employee, eg name, ID number, male/female, profession, job title and tasks carried out are included in this section.
Product	This is the name of the product your employees are using.
Chemical agent	This is the substance which you are monitoring for. Chemical identification numbers can be noted if you know them (CAS or EINECS number). The current WEL or other standard can be noted.
Exposure modifiers	<p>These are important factors which will help you interpret the monitoring results. You can note the things which affect your employees' exposure, for example:</p> <ul style="list-style-type: none"> ■ is exposure continuous throughout the day or does it occur in occasional periods; ■ what type of controls do you use: <ul style="list-style-type: none"> - local/general ventilation; - maximising the distance of the employee from the process; - minimise the time spent at the process; - the use of respirators; ■ is the area where the employee works: <ul style="list-style-type: none"> - indoors or outdoors; - an open or enclosed space.
Measurement strategy	Note the strategy that you used in the survey in this section, eg was it a worst-case or representative situation.
Measuring procedure	Describe the procedure you used to carry out the monitoring, procedure, eg type of sample, duration of exposure and monitoring.
Result	Detail the sample result, the TWA result and units.
References	Note the report reference number and the name of the person who carried out the survey and date.

References

- 1 *Control of Substances Hazardous to Health Regulations 2002* SI 2002/2677
The Stationery Office 2002 ISBN 0 11 042919 2 (as amended)
- 2 *Approved supply list. Information approved for the classification and labelling of substances and preparations dangerous for supply. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002. Approved list L129* (Seventh edition)
HSE Books 2002 ISBN 0 7176 2368 8
- 3 *Chemicals (Hazard Information and Packaging for Supply) Regulations 2002*
SI 2002/1689 The Stationery Office 2002 ISBN 0 11 042419 0
- 4 *Biological monitoring in the workplace: A guide to its practical application to chemical exposure* HSG167 HSE Books 1997 ISBN 0 7176 1279 1
- 5 *Management of health and safety at work. Management of Health and Safety at Work Regulations 1999. Approved Code of Practice and guidance L21* (Second edition) HSE Books 2000 ISBN 0 7176 2488 9
- 6 *Control of substances hazardous to health (Fifth edition). The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance L5* (Fifth edition) HSE Books 2005 ISBN 0 7176 2981 3
- 7 *EH40/2005 Workplace exposure limits: Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended)* Environmental Hygiene Guidance Note EH40
HSE Books 2005 ISBN 0 7176 2977 5
- 8 *Guide to occupational exposure values 2005* American Conference of Governmental Industrial Hygienists 2005 ISBN 1 882417 59 3
- 9 BS EN 482: 1994 *Workplace atmospheres - general requirements for the performance of procedures for the measurement of chemical agents* British Standards Institution
- 10 *The dust lamp: A simple tool for observing the presence of airborne particles* MDHS82 HSE Books 1997 ISBN 0 7176 1362 3 (available free online at: <http://www.hse.gov.uk/pubns/mdhs/pdfs/mdhs82.pdf>)
- 11 BS EN 689: 1996 *Workplace atmospheres - guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy* British Standards Institution
- 12 *Occupational exposure databases: a proposal for core information for workplace exposure measurements on chemical agents* European Foundation for the Improvement of Living and Working Conditions 1996 ISBN 9 2827 7355 8

Further reading

- Sampling strategies for airborne contaminants in the workplace* British Occupational Hygiene Society (BOHS) Technical Guide No 11 H and H Scientific Consultants 1993 ISBN 09482 3714 7
- Harrington JM and Gardiner K *Occupational hygiene* Blackwell Science 1995 ISBN 06320 3734 2

Hawkins N, Norwood S et al *A strategy for occupational exposure assessment*
American Industrial Hygiene Association 1991 ISBN 09326 2746 3

Roach S *A most rational basis for air sampling programmes* Ann. Occ. Hyg. 1977
20 1-12

Dewell P *Some applications of statistics in occupational hygiene* British
Occupational Hygiene Society (BOHS) Technical Handbook No 1 H and H Scientific
Consultants 1989 ISBN 09059 2718 4

Whyllie D *Setting exposure limits: what to do when there's no standard*
Occupational Health and Safety Canada 1993 **9** (6) 58-60

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at www.opsi.gov.uk.