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Asthma at work

Part 3: good occupational hygiene – the pathway to prevention

In the third in a series of articles on asthma at work, Vince Sandys and Chris Keen explain how sound occupational hygiene principles can prevent or reduce exposure to hazardous agents to as low as reasonably practicable.

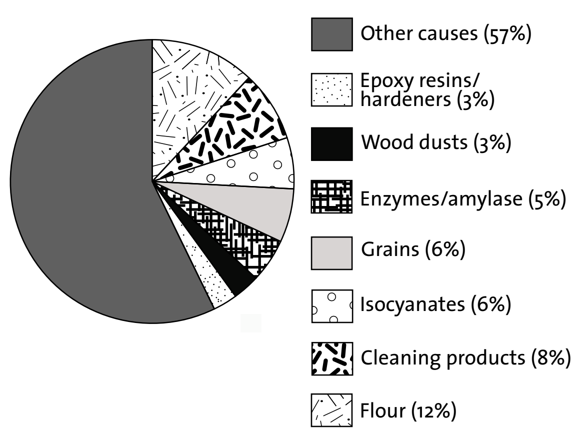
OCCUPATIONAL asthma is a serious and potentially irreversible condition that can have life-changing effects. There are many chemicals and products that can cause asthma, as well as process-generated airborne hazards where the risk of developing asthma resulting from exposure is often not fully appreciated – flour and wood dust are notable examples. Figure 1 shows the top seven substances reported between 2015 and 2017 as causing asthma at work[1,2] and illustrates the point that – with the exception of isocyanates – most are not materials that are widely perceived to be harmful.

For most asthmagens (substance causally related to asthma development) the absence of any obvious acute health effects before an allergy develops and a lack of awareness often mean that the realisation that exposure has occurred is when asthma has already developed, which is clearly too late. Therefore, a good knowledge of the hazards and risks from work processes and early intervention to prevent or adequately control exposures is vital. This is where a competent occupational hygienist comes in.

Occupational hygienists are specialists in assessing work processes and practices, identifying the health risks and devising strategies to prevent or adequately control exposure. It may not be necessary to employ an occupational hygienist in every case but where appropriate expertise is not available in-house, and/or the processes are complex, early consultation with an occupational hygienist will minimise the risk of ineffective control strategies being used. Applying ineffective controls can both increase the risk of illness – due to a false sense of security – and be very costly to rectify.

If good occupational hygiene practices are followed, then occupational asthma can be avoided.

Figure 1: occupational asthma – most commonly reported causal agents (2015–2017)



Source: HSE data 2015–2017[1].

Note: these figures only capture the most serious cases of occupational asthma, which have been referred to specialist physicians participating in The Health and Occupation Reporting (THOR) network, which underestimates the total burden of work-related ill health[2].

REGULATION

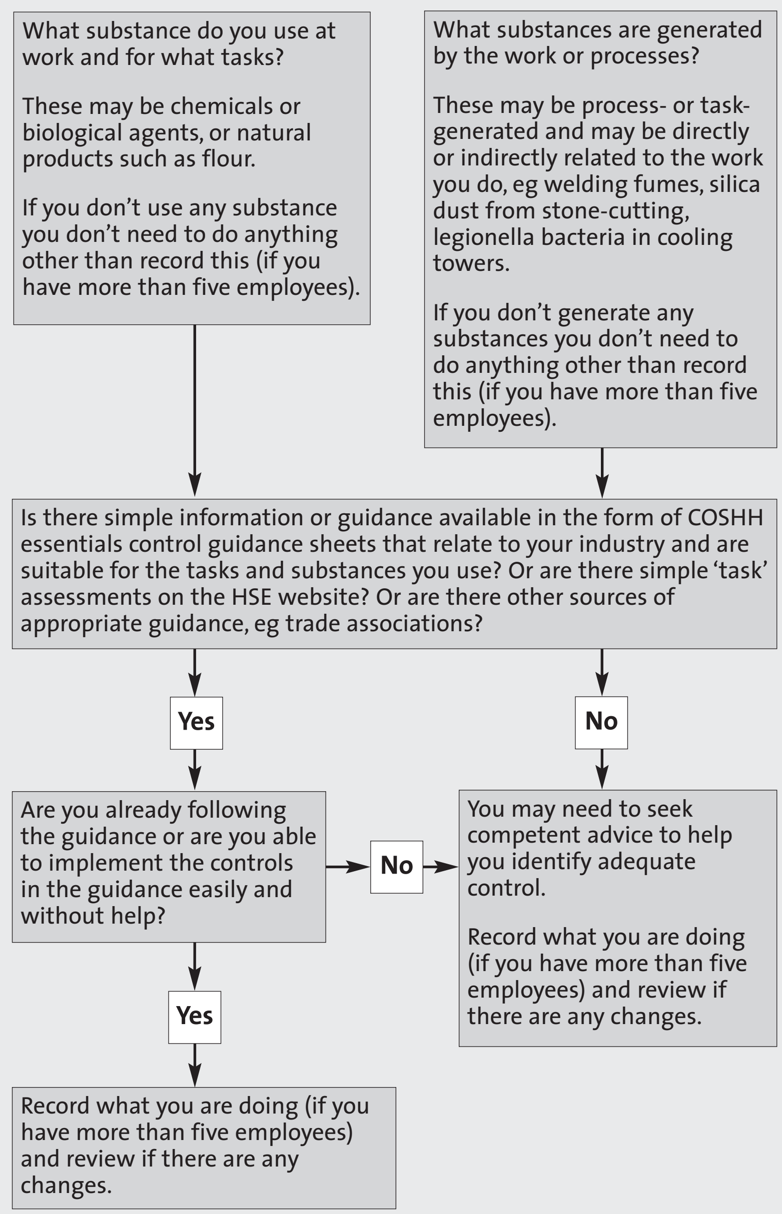
Much of what is covered in this article is enshrined in British law by the *Control of Substances Hazardous to Health Regulations 2002* (COSHH) (as amended), and by their equivalent Regulations in Northern Ireland. There is guidance freely available on the Health and Safety Executive (HSE) website to assist with controlling exposure to hazardous substances. This includes the COSHH Approved Code of Practice (ACoP)[3], COSHH essentials[4], HSE COSHH guidance[5], and other industry-specific information.

The duty to control asthmagens is a stringent one. Simply complying with the workplace exposure limit (WEL)[6], if one exists, is not considered adequate control if there are additional control measures available. And if no WEL exists this does not mean that a substance is inherently safe; exposure should still be controlled in accordance with the COSHH Regulations.

With asthmagens, the goal should be to prevent exposure (by elimination if possible) and where prevention is not possible exposure should be reduced to 'as low as is reasonably practicable' (ALARP). This puts far more emphasis on fully employing the principles of good control practice set down in schedule 2A of the COSHH Regulations.

The big question is: what does ALARP look like? The

Figure 2: route map to adequate control



Source: COSHH ACoP [3].

COSHH ACoP, at paragraph 143, states: 'Employers should continue to reduce exposure to ALARP. This means improving control until the cost of further reduction in exposure becomes grossly disproportionate when weighed against the benefit gained.'[3] This can only be determined by having a good understanding of the risks involved and how to control them effectively. In many cases, HSE guidance, such as *COSHH Essentials*, will specify a suite of exposure controls that if implemented effectively will meet the ALARP requirement.

Figure 2 (above) shows a 'route map' detailing the steps required when assessing and controlling exposure to hazardous substances.

RISK ASSESSMENT

To control exposure to hazardous substances successfully the first step is to fully assess the risks posed by exposure to them[7]. For the risk assessment process to succeed it will, in most cases, require input from competent occupational hygienists, safety professionals, people who fully understand the work processes and, crucially, the workers involved. Without worker buy-in, it is likely that exposure control will fail. The first stage is to learn about the process from as many sources as possible to fully understand how it works and what materials are used and potentially generated from the process (identify the hazards). Information on the health effects of the substances should then be collated using a variety of sources, including Safety Data Sheets (SDSs), internet searches, and the European Chemicals Agency (ECHA)[8]. Sole reliance on SDSs is not recommended as many do not contain adequate information and do not meet the requirements of the European Union REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) legislation[9].

The information collected should provide intelligence on the number of people who may be harmed and on the exposure routes for the various substances. It is also necessary to carry out an assessment of exposure for the tasks where exposure is possible. This needs to be combined with the previous information to determine exactly who is at risk, bearing in mind that this may include workers who are ancillary to the main process. At this point the extent of exposure will need to be assessed to inform the level of risk posed. With asthmagens, it is particularly important to identify and ultimately prevent high short-term peak exposures.

In most cases, this preliminary exposure assessment will not have to be too exhaustive as often a walk-through survey by a competent and experienced assessor using qualitative assessment tools – such as visual observation, dust lamp and smoke tubes – will be enough. Various exposure assessment methods are described later in this article.

SELECTING CONTROL MEASURES

The hierarchy of control (figure 3 on p.31) is a well-established method for preventing or minimising exposure; however, many employers choose to default to respiratory protective equipment (RPE) and other personal protective equipment (PPE) as the primary control, rather than first considering more effective control options.

The first step in the control strategy is to consider whether the process and the hazardous substances used or generated are necessary, or can be avoided altogether (**Elimination**). In many cases it is likely that elimination will not be practical; therefore, the next step is to consider if the process can be operated using materials that are less hazardous, or operated in a way that produces less hazardous emissions (**Substitution**).

Engineering control should be considered next, but this area should be entered into carefully. It is all too common at this stage to default to an off-the-shelf extraction system with little consideration given to what needs to be achieved and the best way to get effective control. Before installing ventilation controls, independent specialist advice is recommended, as it is critical that ventilation systems are capable of working (ie match the process). Engineering control should also consider process design with a goal of minimising the spread/emission of hazardous materials. Examples of this include: full enclosure, filtered vehicle cabs, water suppression of dusts, lids for containers, enclosed vessels, lower machine speeds and pressures used during spraying.

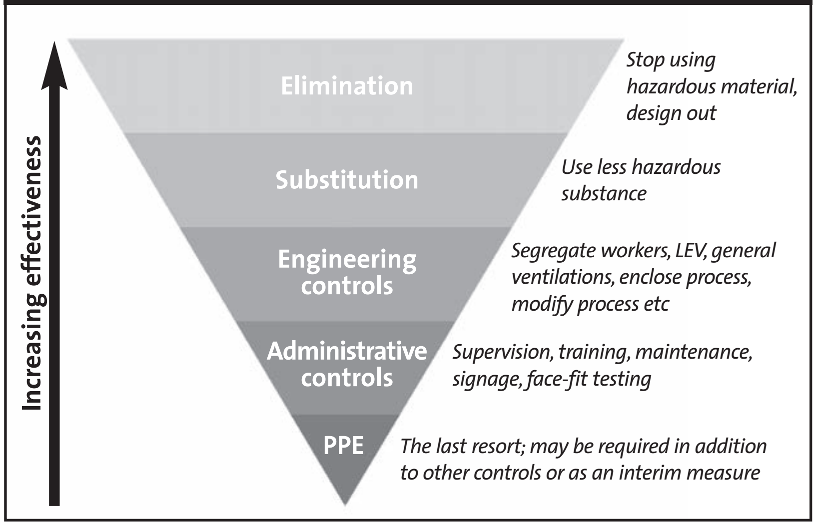
Before applying any engineering controls, it is important that people who are familiar with the process, such as operators and supervisors, are consulted on their usability. Operator resistance to change can be a barrier to achieving good control so gaining their confidence and buy-in is critical, ideally starting at the risk assessment phase. Improving operator buy-in and creating a good health culture is a challenge in every industry and can only be achieved with equal commitment from the shop floor, safety staff and managers.

Local exhaust ventilation (LEV) systems play a significant part in the control of exposure to substances[10]. These should be designed with a specific source of exposure in mind and require careful planning to work effectively. Appropriate specialist advice before purchasing LEV can help avoid making costly mistakes when selecting this equipment. With any LEV system, when purchased and installed there should be a commissioning process that includes testing to demonstrate that control has been achieved. Operating parameters (face velocities, duct velocities and system pressures) should be documented and any subsequent measurements taken as part of ongoing maintenance can be compared against these benchmarks to demonstrate that control is being maintained over time.

Maintenance of control measures should be regular, systematic and have some element of demonstrating that control is adequate. If an LEV system is neglected the control provided will be compromised over time – increasing the risk of asthma – and may well lead to a false sense of security.

An often-neglected part of the control strategy is the use of good personal hygiene facilities and standards to prevent spreading hazardous substances to non-production areas – such as offices and canteens – and secondary exposures occurring. Adequate washing facilities for workers and workwear must be available and workers should not wear contaminated workwear in non-production areas. Not removing overalls before entering canteens, or workers going home in contaminated clothing are examples of poor practice, and unfortunately this remains commonplace.

Figure 3: the hierarchy of control



Key practice points

- Thoroughly understand work processes and the risks posed by materials used or generated. If unsure, obtain competent occupational hygiene advice
- Do not forget ancillary tasks like cleaning and maintenance
- Implement controls following the hierarchy of control and the principles of good control practice
- The use of PPE and RPE should normally be a last resort; however, for asthmagens it will often be required in addition to other measures because control must be as low as reasonably practicable
- Maintaining a high level of exposure control requires inspection and maintenance of controls, good worker engagement, training and supervision

RESPIRATORY PROTECTIVE EQUIPMENT

The use of RPE is likely to be required *in addition* to engineering controls to reduce exposure to ALARP[11]. Unusually, however, RPE may occasionally be required as a primary control measure. But if this is the case, it needs to be justified by showing that more reliable controls are neither practical nor cost effective.

If RPE is required, its selection needs to be carefully considered, and again consultation with employees is essential. Figure 4 (see p.32) shows the steps required for an effective RPE programme, with each element rigorously applied. If any of the steps are missed it is most likely that RPE will not provide the protection required.

Selection of RPE needs to consider the substance, wear time, comfort in use, user requirements and work methods.

The most commonly used RPE is the type that relies on a good seal between the respirator and the user's face. Therefore, face-fit testing must be carried out on all users. In the UK, it is a legal requirement that workers using tight-fitting respiratory protective equipment must be fit-tested by a competent person, and it is recommended

Figure 4: RPE programme steps

Source: HSE.

that this is done by an accredited tester. The Fit2Fit website provides information on accredited face-fit testers as well as approved training courses[12].

It must be noted that a fit test is not sufficient on its own to ensure that the RPE is effective in practice. A high level of training and supervision of users is required to prevent failure. Common deficiencies in the use of RPE include: incorrect donning; storage of equipment in contaminated areas; users with beards or stubble using face-tight RPE; poor maintenance; out-of-date filters; using non-powered tight-fitting RPE for more than one hour; and incorrectly selected RPE.

ASSESSING CONTROL EFFECTIVENESS

Following the implementation of a control strategy, a method needs to be devised to show that control has been achieved. Given that the COSHH regulations require exposures to be reduced to ALARP, assessing control effectiveness should be carried out after all reasonably practicable control measures have been employed. Measurements and checks made at this stage should demonstrate that good control has been achieved. The results represent benchmarks against which ongoing assessment is compared. The tests for control effectiveness need to be relevant to the substance and the route of exposure. Although quantitative assessment of control (eg air monitoring) is seen as the highest standard, it may not always be necessary. Techniques for assessing control are discussed later in this article. Whichever techniques are used the results should be used to inform whether further control measures are required and/or as an indication of the residual risk.

Maintaining control

Even after a proper assessment and implementation of control measures it is not uncommon for their effectiveness to diminish with time. This is usually caused by an accumulation of small changes which go unnoticed or unreported, but which can ultimately add up to a significant change. This can occur for many reasons including, poor maintenance of control measures, unreported process changes, and staff turnover. To maintain adequate control there must be an effective inspection and maintenance regime for all the control measures, good supervision to ensure controls are being used, indicators that controls are failing, regular re-assessment of the risk, a fault reporting mechanism and regular training (eg 'toolbox talks') that discuss exposure to hazardous substances.

METHODS FOR ASSESSING EXPOSURE

Air monitoring can be used reliably to assess an individual's inhalation exposure[13]. Results from exposure monitoring should be used to test compliance with any applicable WELs and to benchmark what good control looks like once exposures have been reduced to ALARP. In some instances, the air-monitoring results can also be used to ensure that the right RPE is selected.

The key points are that the sampling is done within the worker's breathing zone (within 300 mm of the mouth), that the sample is representative of typical exposure and, importantly, that all tasks are captured by the sampling. Often tasks ancillary to the main work activity are missed, both during monitoring and during the risk assessment stage. Missing high-risk ancillary activities – such as cleaning – can lead to the measured exposures seriously underestimating the risk. Methods exist for a whole range of substances and many are freely available from the HSE[14] and the US National Institute for Occupational Safety and Health (NIOSH)[15]. The main downside to implementing an air-monitoring programme is that it requires specialist knowledge and equipment, and samples usually need to be analysed by a specialist laboratory. This means it can be a costly exercise.

Several direct reading instruments (DRIs) are available that can be used to measure airborne contamination in real time. These have a role in personal monitoring if they can be attached to the person, as well as in background measuring. They can also be used for leak detection, identifying exposure 'hotspots' and, in some circumstances, as an alarm for when airborne levels get too high. DRIs have, in recent years, significantly improved in terms of measurement accuracy and have come down in price. In addition, with modern data-logging communication methods (including Wi-Fi and Bluetooth) they can be useful tools for monitoring exposure.

Biological monitoring[16] using urine sampling is a quick and reliable way of assessing exposure to substances by all exposure routes. If a suitable method exists, collecting samples is straightforward and does not require any specialist equipment. Analysis of samples is relatively inexpensive when compared to other quantitative exposure measuring techniques. A good example of where biological monitoring is particularly effective is in monitoring isocyanate paint spraying inside a spray booth.

All biological monitoring sampling regimes need participants to provide consent and require the provision of information that covers what the sampling is and how the samples and results will be treated. This, and the proper interpretation of the monitoring results, requires medical expertise provided by a competent occupational health practitioner.

When air and/or biological monitoring has been carried out, it is important that the focus does not shift exclusively to the results – for example, assessing compliance with the WEL – at the expense of ensuring that good control practice has been followed.

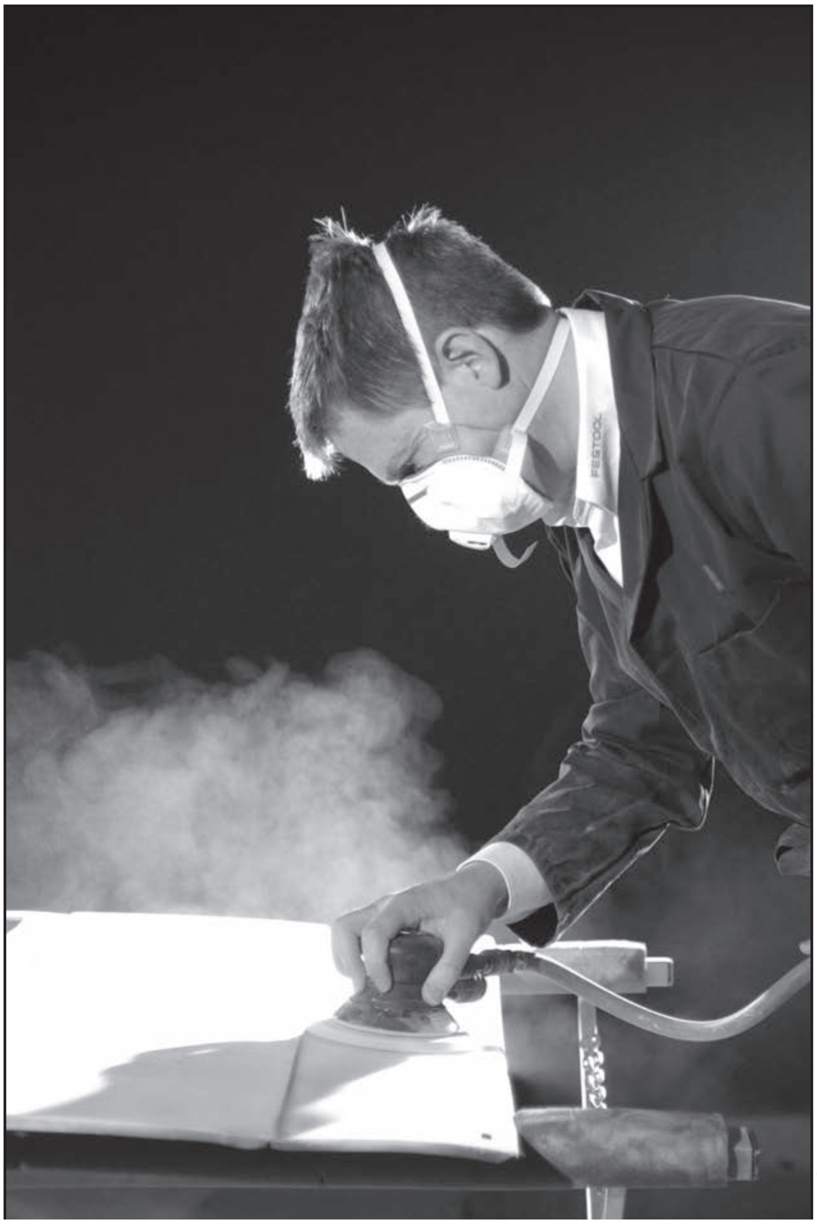
An experienced practitioner can use less-expensive methods as an indication of how well exposure is being controlled. A dust lamp (Tyndall beam)[17] can prove useful for dusts, fumes, mists and liquid aerosols. This is a backlighting technique using light-scattering effects that make dust clouds visible. The dust size fractions that we are interested in when looking at inhalation exposure with respect to occupational asthma are often not apparent to the naked eye under normal lighting conditions (see photograph on right).

The use of non-hazardous smoke is a good way to assess the effectiveness of LEV. If smoke is released in the working zone around an LEV hood it will show whether or not there is enough air pulling into the system and will highlight if there are any drafts that will have a detrimental effect on control. For high-energy processes – and provided it is safe to do so – it is important that the process is running when smoke testing LEV. Air current tubes (smoke tubes) are the most readily available and cost-effective option, though other types of smoke generator are available.

Dust lamps and smoke tubes can also be very powerful training aids for workers who use LEV, particularly as they often misjudge the range over which ventilation equipment is effective. For LEV to be fully effective the source of exposure needs to be very close to, or enclosed by, the hood.

Direct observation of the workplace can also provide an indication of how well emissions are being prevented. Examples of this are: being able to smell the chemical if it has an odour; the presence of visible dust or fume (such as in welding); checking if on-tool extraction is in use; build-up of dust on undisturbed surfaces; incorrect use of PPE/RPE; and workers with obviously contaminated clothing.

Health surveillance is a legal requirement where people are exposed, or likely to be exposed, to an asthmagen. The health surveillance programme should be designed to detect early signs of disease and should be



Operative using a palm sander without on-tool extraction. Backlighting reveals the dust that is not always visible under normal conditions.

carried out on a regular basis. The frequency and type of surveillance will depend on the extent of the risk remaining after all reasonable exposure controls have been applied.

Health surveillance is an important part of ongoing exposure monitoring; however, it is a lagging indicator (illness has already occurred) for where control has failed or is not adequate. Therefore, it should not be used in isolation, but as part of a monitoring programme that includes the other monitoring techniques discussed in this article.

To summarise, exposure to asthmagens should be controlled to ALARP. The prevention or control of exposure relies on a thorough assessment of risk and the implementation of an effective control strategy. This will

CONCLUSIONS

- **To minimise** the risk of developing occupational asthma, exposure to asthmagens should be prevented and, where this is not possible, reduced to as low as reasonably practicable (ALARP), considering the cost against benefit of removing the residual risk. If exposure is not prevented the remaining risk needs to be effectively managed
- **The journey** to preventing exposure starts with thoroughly assessing the activities where asthmagens are present, and then devising a control strategy following the hierarchy of control and employing good occupational hygiene practices. Effective control strategies are usually a suite of controls including administrative controls, engineering controls and personal protective equipment
- **Once** the exposure controls have been commissioned and implemented, there should be an ongoing programme that ensures that they are being used as intended, are effective, and that the risk is regularly re-assessed
- **As part** of assessing the risk and demonstrating adequate control, exposure assessment will be necessary. Many techniques exist and include air monitoring, biological monitoring and other qualitative and visual techniques. The method used needs to be proportionate to any residual risk posed
- **For exposure** controls to be effective and sustainable, they need to be regularly inspected and maintained. Neglecting this will mean that, over time, control effectiveness will decline and the risks of exposure and workers developing asthma will increase
- **Worker** engagement with all health-related work issues and the prevention of exposure to asthmagens (and all hazardous materials) is vital to minimise the risk of developing occupational asthma. In addition, all stakeholders should have appropriate training and competence to carry out their role, and those exposed to asthmagens at work should be supervised to ensure that control measures are being used
- **Any training** should include background information of the risks associated with working with asthmagens
- **Regular** health surveillance of workers is important as it can provide an early indication that illness is occurring; however, it is a lagging indicator (ie the illness has already occurred) and should not be used as the only method for demonstrating control effectiveness

most likely involve a range of measures from all levels of the hierarchy of control rather than a single solution.

Once these measures have been installed, adequate control needs to be demonstrated using appropriate exposure-monitoring techniques, including health surveillance. When adequate control has been achieved, ongoing monitoring should be carried out to sustain and demonstrate long-term control effectiveness. Everyone involved in the process should be competent to carry out their role and engaged with protecting health and improving working conditions. Worker training and supervision is essential. ■

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Previous articles in the series:

Fishwick D, Warren N. Asthma at work. Part 1: nature, extent and causes of occupational and work-related asthma. Occupational Health at Work 2018; 15(2): 25–30. ohaw.co/AsthmaAtWork1 (open access).

Bradshaw L, Barber C. Asthma at work. Part 2: diagnosis of occupational asthma. Occupational Health at Work 2018; 15(4): 27–32. ohaw.co/AsthmaAtWork2 (open access).

Notes

1 Work-related asthma in Great Britain, 2018. Bootle: Health and Safety Executive, 2018. ohaw.co/HSEasthma2018 (accessed 4.1.2019).

2 Data Sources. Bootle: Health and Safety Executive, 2018. ohaw.co/HSEdatasource

3 Control of substances hazardous to health. The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance L5 (sixth edition). Norwich: HSE Books, 2013. ohaw.co/L5HSE

4 HSE. COSHH essentials, ohaw.co/COSHHess

5 HSE. Control of substances hazardous to health, hse.gov.uk/coshh

6 EH40/2005 Workplace exposure limits. Third edition. Norwich: TSO, 2018. ohaw.co/2018EH40. Note: WELs are set in order to help protect the health of workers. They are expressed as concentrations of hazardous substances in the air, averaged over a specified period of time, referred to as a time-weighted average (TWA). Two time periods are generally used: long-term (8 hours) and short-term (15 minutes).

7 Risk assessment. A brief guide to controlling risks in the workplace. INDG163 (revision 4). Bootle: HSE, 2014. ohaw.co/INDG163

8 European Chemicals Agency, echa.europa.eu

9 Guidance on the compilation of safety data sheets. Version 3.1 November 2015. Helsinki: European Chemicals Agency, 2015. ohaw.co/SDSs

10 Controlling airborne contaminants at work. A guide to local exhaust ventilation (LEV) HSG258 (third edition). Norwich: TSO, 2017. ohaw.co/LEV

11 Respiratory protective equipment at work: a practical guide. HSG53 (fourth edition) Bootle: HSE, 2013. ohaw.co/HSG53RPE

12 fit2fit.org

13 Monitoring strategies for toxic substances. HSG173 (second edition). Bootle: HSE, 2006. ohaw.co/HSG173

14 HSE. Methods for the Determination of Hazardous Substances (MDHS) guidance. ohaw.co/MDHS

15 NIOSH Manual of Analytical Methods (NMAM) (fifth edition). Washington DC: National Institute for Occupational Safety and Health, 2017. ohaw.co/NMAM

16 Biological monitoring in the workplace: a guide to its practical application to chemical exposure. HSG167 (second edition). Bootle: HSE, 1997. ohaw.co/HSG167

17 The dust lamp: a simple tool for observing the presence of airborne particles. Bootle: HSE, 2015. ohaw.co/DustLamp