Fumigation

Health and safety guidance for employers and technicians carrying out fumigation operations

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The guidance is primarily for employers and fumigators/fumigation technicians (including the self-employed) to help them comply with the Control of Substances Hazardous to Health Regulations 2002 (COSHH) when carrying out fumigation activities, both traditional pest control (invertebrate fumigation) and within the laboratory and biosecurity sectors. It will also be useful to their safety representatives.

It outlines the real risks and describes the law that applies to fumigation operations. There is specific advice on procedures common to all fumigation operations, including the use of monitoring equipment, personal protective equipment and respiratory protective equipment, health surveillance and first aid.

In addition, there is advice on precautions for specific fumigation environments, alternative fumigation technologies, the health effects associated with certain fumigants and other legislation which applies to fumigation.

This edition updates references to legislation and links to further guidance. It also gives a clearer explanation of what action to take and why.

Contents

About this guidance

1 The guidance gives advice to employers and fumigators/fumigation technicians (including the self-employed) to help them comply with the Control of Substances Hazardous to Health Regulations 2002[1] (COSHH) when carrying out fumigation activities; both traditional invertebrate fumigation and in the laboratory and biosecurity sectors. It will also be useful for safety representatives.

2 This guidance should be read in conjunction with COSHH, the Approved Code of Practice for COSHH,[2] The Plant Protection Products (Sustainable Use) Regulations 2012[3] (EU PPPR) and other relevant HSE publications which give guidance and advice relevant to the work being undertaken (there is a list of relevant publications in the References section).

3 In the guidance you will find:

- information on general health and safety law;
- the requirements of COSHH;
- the responsibilities and required competencies of fumigators/fumigation technicians;
- procedures common to all fumigation operations, including defining fumigation areas, application and venting of fumigants, the use of monitoring equipment and personal protective equipment (PPE), including respiratory protective equipment (RPE);
- health surveillance;
- first aid;
- emergency measures.

4 In addition, in the appendices you will find information on:

- precautions for specific fumigations including within laboratories, hospitals, buildings, under gas-proof sheeting, on ships, coasters, barges, freight containers, fumigation chambers, soil and compost – both indoors and outdoors, and for grain in silos and mammals underground;
- alternative fumigation technologies;
- health effects associated with certain fumigants;
- notifications needed when using hydrogen cyanide or phosphine; and
- other legislation which applies to fumigation.

5 There is also a References section and a Useful contacts section which signpost other sources of information.

6 Employers and fumigators should familiarise themselves with both the general information and the information specific to the fumigation they are undertaking.

Fumigation

7 Fumigation is a method of pest control using gaseous pesticides or biocides (fumigants) to suffocate or poison pests or undesirable organisms. Fumigants act either as poisons when they are breathed in, or through suffocation by removing or replacing the oxygen in air, or by the lethal biocidal effect of the fumigant on the surface of the target organism. Consequently, fumigation is a hazardous process, with potentially serious, even fatal, consequences to those applying the fumigants or to others in the vicinity, if not used correctly and safely.

8 Fumigation operations can occur in a variety of situations, including in purpose-built fumigation or sterilisation chambers, outside, in temporarily created containment, in suitably prepared buildings, on ships or other structures. This list is not exhaustive. Information specific to the risks these different locations/situations present can be found in Appendix 1.

9 The choice of fumigant will be determined by the individual circumstances, eg the commodities or locations to be fumigated, availability of the fumigant, temperature, target organism or pest, and available time to complete the fumigation.

10 All gases and vapours which may act as asphyxiants are classified as 'substances hazardous to health' for the purposes of COSHH. This guidance is relevant when fumigants are used in gas or vapour form. It is also relevant when fumigants are applied in the form of fogs, mists or smokes, which are additional terms used to describe various forms of airborne fumigants.

11 Fumigants and their use are regulated under several pieces of legislation. Employers should check the product's authorisation or approval conditions to ensure that the product's approval is in line with their proposed application. The authorised list is continuously updated so employers should check the list regularly. Further information can be found on HSE's website at www.hse.gov.uk/biocides/index.htm and www.pesticides.gov.uk/guidance/industries/pesticides.

12 Fumigators carrying out work in cargos arriving into the UK from outside the EU may encounter products which have previously been fumigated, sometimes with chemicals not permitted in the EU, and so they will need to be aware of the health effects associated with such chemicals and the necessary precautions.

13 Within the laboratory environment and biosecurity sector, various alternative forms of fumigant have been tested and are used regularly. These include:

- hydrogen peroxide, as a vapour and as an aerosol; some aerosol products also contain added silver ions or peracetic acid;
- chlorine dioxide;
- ozone.

14 Further detail on these fumigation technologies, including their use and associated hazards, can be found in Appendix 2 and detailed guidance is provided by the Advisory Committee on Dangerous Pathogens (ACDP), see www.hse.gov.uk/aboutus/meetings/committees/acdp.

Health and safety law

15 Under the Health and Safety at Work etc Act 1974[4] (the HSW Act) employers have to ensure, so far as reasonably practicable, the health and safety of themselves and others who may be affected by what they do or do not do. The HSW Act applies to all work activities and premises and everyone at work has responsibilities under it, including the self-employed.

16 Employees must take care of their own health and safety and that of others who may be affected by their actions at work. They must also cooperate with employers and co-workers to help everyone meet their legal requirements.

17 The Management of Health and Safety at Work Regulations 1999[5] (the Management Regulations) also apply to every work activity and workplace and all

risks must be assessed and, where necessary, controlled. Other regulations supporting the HSW Act set out more detailed legal duties for specific activities or industries.

18 Guidance to help employers comply with the law and prevent workplace accidents and ill health can be found in HSE's publication *The health and safety toolbox: How to control risks at work*.[6]

What does COSHH require?

19 COSHH sets out a generic system for managing risks to health, it does not set out detailed requirements for specific circumstances. The first step is to find out **what the situation is**, and secondly decide **what to do about it**.

20 COSHH provides a framework which will help employers control the risks; this is underpinned by a risk assessment. Only authorised products should be used for fumigation and they should only be used in accordance with their approval or authorisation conditions. The Safety Data Sheet, product label and authorisation conditions will provide the starting point for the risk assessment.

21 If alternatives to a hazardous substance have been considered and ruled out, the employer should then:

- find out what health hazards are associated with the proposed substance;
- decide how to prevent harm to health;
- provide control measures to reduce harm to health;
- make sure those control measures are used;
- keep all control measures in good working order;
- provide information, instruction and training for employees and others;
- provide monitoring and health surveillance in appropriate cases;
- plan for emergencies.

22 The underlying principles of risk management are the same for COSHH as those required by other health and safety law. The COSHH risk assessment and the resulting strategy for managing exposure to substances hazardous to health, can be made as part of, or as an extension of, the more general risk assessment requirements of the Management Regulations. The HSE publication *Managing for health and safety*[7] sets out a framework for the management of all workplace health, safety and welfare.

23 All parts of the fumigation operation should be considered to be within the scope of COSHH – ie the preparation for fumigation, the fumigation operation itself and the steps taken after fumigation, including, eg aeration and clearance. This is because exposure to toxic chemicals can occur at any point in the process, if effective controls are not in place.

24 As fumigation tends to be carried out on a third party's premises, many of the steps necessary to meet the requirements of COSHH during a fumigation operation will often be taken by the fumigator-in-charge. Most legal duties, however, remain with the employer. Where the employee of one employer works at another employer's premises, both employers should co-operate and collaborate to ensure that all the duties imposed by COSHH are fulfilled.

25 More information on COSHH relating to specific aspects of the fumigation process follows. Additional information on COSHH, including an assessment tool, can be found on HSE's website at www.hse.gov.uk/coshh/index.htm.

Responsibilities and competencies of fumigators-in-charge and fumigators

26 A fumigator (or fumigation technician) is the person involved in the fumigation operation and a fumigator-in-charge is the person who directs the fumigation operation.

27 Fumigators and fumigators-in-charge should only be involved in a fumigation operation if they are competent and have been properly trained. This includes training in the safe use and disposal of the fumigant they are going to use, the required safety precautions and what to do if there is an emergency.

28 Professional users of pesticides products are required to hold a specified certificate of competence from 26 November 2015, currently known as a certificate of competence. Further information on this can be found on HSE's website (www.pesticides.gov.uk).

29 There is no requirement for a specified certificate of competence for those using a professional biocidal product, although everyone who uses biocides is responsible for using them correctly and safely. Further information is available at www.hse.gov.uk/biocides/using.htm.

30 Employers should ensure that fumigators and fumigators-in-charge engaged in fumigation know:

- what to do, what precautions are needed and when they should be taken, including:
  - general safe procedures to be followed;
  - precautions to be taken in organising a fumigation;
  - applying a fumigant and containing the gas in the fumigated area;
  - how to conduct a risk assessment;
  - ventilation procedures to be followed after the fumigation has been completed to make the fumigated area safe to re-enter;
- the cleaning, transport, storage and disposal procedures required for the equipment and fumigant-generating substances, why and when they are required;
- when and how to dispose of fumigated items or how to safely retain raw produce (eg flour) if required by the label;
- the procedures to be carried out in an emergency.

31 Employers should ensure that fumigators have received the required level of training and that they are capable of:

- assessing the hazards of the fumigant – ie the properties of the substance which have the potential to cause harm to health;
- assessing the hazards of the work area, eg working at height, working in a confined space etc;
- controlling and containing the fumigant;
- using, maintaining and the limitations of PPE;
- using the application equipment in accordance with manufacturers' instructions;
- using the calibrated equipment for the detection and measurement of that fumigant in the atmosphere, if methods exist;
- safe transportation and storage of fumigants and fumigant-generating materials. A fumigant-generating material is a substance which is used for generating fumigant gas.

32 Employers should ensure that the fumigator understands the emergency procedures and, if necessary, is able to intervene using the appropriate level of first aid, eg being able to recognise the signs and symptoms of fumigant poisoning and then be able to carry out the appropriate resuscitation techniques. Information on health effects of some commonly used fumigants can be found in Appendix 3 and greater detail on first aid requirements can be found in paragraphs 78–84.

33 Due to the risks involved in fumigations, employees should be given basic training before being allowed to handle fumigants, fumigant-generating substances or articles that may have been contaminated. The basic training may include limited practical experience such as observing fumigations from a place of safety (outside the risk area) or taking part in the preparation for fumigation with a qualified person. Until they have received and completed this basic training, trainees should be kept at a safe distance from the fumigant.

34 After completion of the basic training, fumigators under training may be allowed to take part in a fumigation operation under supervision. It is up to the employer to decide when the employee is competent to perform the duties of a fumigator and to authorise the employee to carry out these duties. The certificate of competence issued by one of the recognised training providers is evidence of the fumigator's ability to perform the duties. The recognised Certificate of Competence for the use of pesticides is issued by City and Guilds or City and Guilds Land-Based services (formerly the National Proficiency Tests Council).

35 Some fumigants can only be used by fumigators who have undertaken specific training, or who are working within the requirements of a specific stewardship scheme. Where this is the case, the employer should issue a written authorisation, giving a full account of the training the fumigator has received and clearly stating the extent of the duties that the employee is considered capable of undertaking.

36 Employers should keep the fumigator's authorisation under review and revise it in the light of the holder's experience, ongoing training and the types of fumigation in which they are currently considered competent. When reviewing the authorisation, all known fumigation competencies linked to activities specified in the authorisation should be considered. A record of each fumigator's authorisation should be kept.

37 Registration on a Continuing Professional Development scheme helps fumigators demonstrate their ongoing training and development.

38 Safety and staffing recommendations exist for some individual products. The fumigator should take this information into account before drawing up the risk assessment. The outcome of the risk assessment may suggest that at least two fumigators will be needed for the fumigation, eg where lone working should be avoided. Where this is the case, both fumigators should be competent first-aiders and should understand the first-aid requirements relevant to the application and venting of fumigants. One of the fumigators should be the fumigator-in-charge and have responsibility for:

- the safe-keeping, issue and release of the fumigant;
- assessing the work area for non-fumigant-related risks;
- observing all necessary safety precautions laid down by the employer, including the posting of warning notices and their removal only after a certificate of clearance has been issued;
- confirming at the end of the fumigation operation that the fumigation area and other risk areas are safe for re-entry.

39 In the case of a large or complex fumigation operation, more fumigators may be needed. In such circumstances, the team leader may act as a supervisor.

40 Further information on fumigation using pesticides can be found at www.pesticides.gov.uk.

The fumigation operation: Control measures common to all fumigations

COSHH assessment

41 As a starting point, employers should consider whether there are safer alternatives to fumigation that are as effective but less hazardous. Where the conclusion is that fumigation is necessary, a COSHH risk assessment should be carried out before any fumigation operation is started.

42 The purpose of the risk assessment is to determine the risk of fumigators and others suffering ill health through exposure to fumigants, so that steps can be taken to prevent or adequately control any exposure. The depth of assessment required depends on the complexity and degree of risk. Simple, low-risk situations may require little attention, but high-risk, complex situations need much more.

43 The conditions of authorisation for products and active substances and their known toxicity should guide the risk assessments as they stipulate conditions for use; this may include comprehensive training requirements for fumigators.

44 If the product or substance is one which has been previously used, the COSHH risk assessment will be based on standard operating procedures, previous knowledge and experience. However, it should be recognised that using a known product in a new environment may result in the fumigant behaving differently to the last time it was used. If the product is new, a new assessment must be done, based on the safety data sheet, examining the hazards and considering the possible risk of exposure.

45 The findings of the assessment will result in a set of procedures to follow during the fumigation operation. Some of those procedures will be common to all fumigations (eg the marking out of fumigation and risk areas). Others will depend on the type or form of fumigant being used (eg methods of application) and on the location being fumigated.

46 Where there are five or more employees, the employer should record the significant findings of the assessment. Where there are fewer than five employees, there is no legal duty to create a written record. However, since under the Plant Protection Products (Sustainable Use) Regulations 2012 professional users must keep records of the products they use, a COSHH risk assessment may form part of those records.

Workplace exposure limits

47 Legal exposure limits have been set on the amounts of many substances, including fumigants, which can be present in workplace air. These limits are known as workplace exposure limits (WELs). WELs refer to concentrations of hazardous substances in the air that people breathe, averaged over a specified period of time referred to as a time-weighted average (TWA). Two time periods are used: long term (eight hours), and short term (15 minutes).

48 The degree to which exposure is reduced below the WEL should be proportionate to the health risk. Where a WEL has been set for a fumigant, control measures should be taken to reduce exposure so far as is reasonably practicable, below the levels set. Where a fumigant does not have a WEL, this does not mean that the substance is safe; control measures may still be necessary and the COSHH assessment will help determine this.

49 Workplace exposure limits may be reviewed if scientific evidence demonstrates a new understanding of adverse health effects associated with the substance. For this reason, employers should always refer to the latest version of EH40.[8]

Detection and other equipment (other than PPE)

50 Where available, fumigators should have suitable fumigant detection equipment which they have been trained to use. Fumigation detection equipment should be used to monitor the perimeter of the enclosure being fumigated for leakage and, to ensure that the concentration of fumigant is below the WEL (or equivalent measure if a WEL has not been established) before re-entry of the space being fumigated.

51 All equipment should be maintained in line with the manufacturer's instructions and it should be examined each time before use in a fumigation operation. In addition, detection equipment should be regularly inspected and, where appropriate, calibrated to ensure that all items are in effective working order.

Portable electronic gas detectors

52 Gas meters can instantaneously measure substances in air and display this measurement to the operator.

53 These are useful in fumigant work for:

- leak detection;
- warning workers of dangerous levels (by way of alarms);
- measuring other gases of interest, eg oxygen, carbon dioxide.

54 Some gas meters are specific to a single substance, eg a detector exists specific to phosphine. However, other detectors are not specific and will respond to a broad range of volatile organic compounds; this potentially means substances other than that of interest can contribute to the signal, interfering with the measurement of the fumigant gas in question.

55 Direct Read Instruments are only useful if they are sensitive enough to detect the very low levels of fumigant that can be hazardous to people. Sensitivity is defined by the 'limit of detection' for the device, which is the lowest measurable level in air. For fumigants, the level may need to be below parts per million for the fumigant of interest.

56 Some meters sample the air diffusively (passive samplers) others can draw air in using an integral pump (active samplers). In this latter case, sample tubing can sometimes be used to enable remote sampling. However, caution should be applied when using lengths of tubing as gas can adsorb onto the inner wall of tubing, reducing the concentration of gas in the sampled air, potentially giving erroneously low readings. PTFE tubing limits such effects, due to its chemical inertness.

57 Some fumigant manufacturers recommend particular meters for detection of their product.

Gas detector tubes

58 Precise measurement of the concentration can be achieved using a simple method of the gas detector tube system. Such systems consist of a graduated, transparent tube containing a chemically impregnated solid through which a sample of the contaminated air is drawn by means of a hand pump. A stained zone is produced on the indicating portion of the tube, the length of which is a measure of the concentration of the contaminating gas. The hand pump must be checked periodically in accordance with the manufacturers' instructions.

59 Gas detector tubes can vary considerably in their accuracy, so only tubes conforming to BS EN 1231[9] should be used, in accordance with the manufacturers' instructions, particularly in relation to storage and expiry dates. A fresh tube is required each time concentration levels are tested.

60 Gas detector tubes should be used only where they are capable of confirming that levels of fumigant have fallen below the WEL, or that premises are safe for reoccupation. The HSE publication *Monitoring strategies for toxic substances*[10] gives advice on sampling strategies and practical guidance on interpretation of the results.

61 Advice on methods of detection can be obtained from the Food and Environment Research Agency, the Health and Safety Laboratory, the Government Chemist or the Science and Advice for Scottish Agriculture (SASA). Contact details for these organisations can be found in Useful contacts.

PPE, including RPE

62 PPE is equipment worn to protect workers against hazardous substances. This could be in the form of gloves to protect against skin contact with fumigants or RPE to protect against inhaling fumigants.

63 RPE is the collective name for respirators or breathing apparatus (BA) used to protect health in the workplace. Respirators filter the air to remove harmful substances; BA provides clean air for the worker to breathe.

64 PPE and RPE should be used during fumigation operations. However, consideration should also first be given to engineering controls, such as segregation or remote operation.

65 The COSHH risk assessment, together with the information given on the product label, will determine the nature and type of PPE which should be used. PPE should be selected so it is both adequate, suitable for the task and complies with the Personal Protective Equipment Regulations 2002.[11]

66 In the case of respiratory protection 'adequate' means that the RPE will protect against the specific hazardous substance, ie if filters are used they are the right type, or if no filters are available then BA is used. Additionally, the RPE must offer enough protection to reduce exposure to levels below a WEL or other appropriate level.

67 Assigned Protection Factors (APFs) are given to all classes of RPE to advise users of the level of protection they offer. The maximum anticipated concentration of fumigant in the air should be anticipated to select the most appropriate RPE.

68 RPE is suitable when it is matched to the wearer, task and environment. For example it should be:

- a good fit;
- compatible with other PPE and prescription spectacles;
- comfortable; and
- not hinder the task.

69 If the RPE facepiece is tight-fitting (ie a mask), the device should be face fit-tested. Users should be trained in the correct use of RPE, including:

- the importance of being clean shaven, when wearing tight-fitting facepieces to maintain a good seal where the mask meets the skin;
- visually checking RPE before each use (valves, seals, straps etc);
- correct donning procedures including fit checking; and
- when and how to conduct maintenance.

70 When not in use RPE should be stored in a dedicated container or area to prevent physical damage and contamination. A trained person should thoroughly examine the RPE in line with the manufacturer's instructions. This should be undertaken at least monthly. The quality of air supplied to BA should be checked every three months. Records of these RPE and air quality checks should be kept for five years.

71 More information on RPE can be found in *Respiratory protective equipment at work: A practical guide*.[12]

Measures to protect the skin

72 Many fumigants are hazardous to the skin and eyes, this can be due to their chemical properties or even the physical properties – eg there is a risk of frostbite when handling compressed gases in cylinders. Any personal protective clothing must guard against the specific hazards and must be suitable and sufficient.

73 Recent cuts or abrasions to the skin should be protected and the dressings changed immediately if they become contaminated or damp.

Health surveillance and health records

74 Health surveillance should be risk based and follow a suitable and sufficient risk assessment. Further information can be found on HSE's website at www.hse.gov.uk/health-surveillance/what/index.htm.

75 Health surveillance may include keeping an individual health record of enquiries by a responsible person about any symptoms following self-reporting by employees (eg burns from fumigants). A responsible person is an occupational health professional appointed by the employer who is competent to carry out the relevant investigation and report back to the employer on the outcome. A health record should be kept for each individual undertaking fumigation work.

76 Health records for all those involved in fumigation operations should contain the following information:

- surname;
- forenames;
- gender;
- date of birth;
- permanent address and post code;
- National Insurance number;
- medical practitioner;
- date when present employment involving the use of fumigants started;

- a historical record of jobs in this employment, involving exposure to identified substances requiring health surveillance;
- the results of all other health surveillance procedures and the date on which and by whom they were carried out;
- whether they were fit or unfit for work as determined by the health surveillance.

77 The conclusions should relate only to the employee's fitness for work and should include, where appropriate, a record of the decisions of the occupational health professional. The health record should not include confidential clinical data. Employers must keep the records for at least 40 years. As well as allowing employees to see their own individual record, employers may, with the employee's consent, also allow the employee's representatives to see them.

First aid

People affected by fumigant

78 Under the Health and Safety (First Aid) Regulations 1981,[13] a suitable and sufficient first-aid assessment must be in place. Employers are also responsible for ensuring that the appropriate number of fumigators carrying out the fumigation procedure have the necessary competencies to act as first-aiders and the necessary equipment readily to hand, ie oxygen and appropriate manual resuscitators (bag and mask) in an emergency.

79 The number of competent fumigation trained first-aiders required should reflect the size of the fumigation team.

80 First-aiders should have additional competencies in first aid than those provided in an emergency first aid or first aid at work course. For further advice on first aid, see the HSE's first-aid web pages at www.hse.gov.uk/firstaid/index.htm.

81 If a person is affected by fumigant, they should be taken into fresh air at once and kept quiet and warm. Rescuers must take care not to become poisoned themselves. Medical attention should be sought immediately and the product label, 'Instructions in Writing' or safety data sheet should be shown to the doctor/paramedic.

82 In general, the more seriously poisoned the victim, the more important it is to get them to hospital as quickly as possible. If breathing stops or shows signs of failing, artificial respiration should be administered using oxygen and a suitable mechanical device such as a bag and mask. Do not use mouth-to-mouth resuscitation (even with a resusci-aid device) because of the risks of secondary poisoning.

83 This advice is particularly important when cyanide poisoning is suspected. Resuscitation should be carried out using a bag and mask connected to oxygen. The employer should ensure that the first-aider is trained to use this equipment. Further advice on cyanide poisoning can be found on HSE's website at www.hse.gov.uk/pubs/misc076.htm.

84 Information on the health effects associated with some commonly used fumigants can be found in Appendix 3.

Medical treatment

85 Notes supplied by the manufacturer or supplier with the fumigant should be available at every fumigation to provide guidance to the medical practitioners. These notes should accompany the patient to the doctor or hospital.

86 Doctors can obtain advice on medical treatment from the National Poisons Information Service (www.toxbase.org). The National Poisons Information Service does not receive calls from the general public. In case of a medical emergency following exposure to a chemical, the public should contact NHS 111/NHS 24.

The fumigation operation: Procedures common to all fumigations

Defining the fumigation and risk areas

87 The fumigation area is the whole area or space into which a fumigant is delivered. The risk area is all areas or spaces where the fumigant gas has been applied and any other areas where the gas may move to, therefore posing a danger to fumigators and others. An example of this is where there are structures connected to the area or space which has been fumigated and where the fumigants may travel.

88 The fumigation area must always be sealed from other areas and made as gas tight as possible. No one should enter it during a fumigation period, except in a serious emergency, such as a fire, and then only by agreement with the fumigator-in-charge of the fumigation operation. In such circumstances PPE, including RPE, must be worn. Sealing an area may be made easier if it has been designed for fumigation, such as biosecurity Containment Level 3 or 4 facilities, but if the area is a normal room or other space, then plastic and gas impervious tape may be required around doors, windows etc.

89 The risk area comprises all adjacent spaces where it is considered that concentrations of the fumigant above the relevant WEL or other appropriate level could occur. Cavity roof spaces or false ceiling spaces above tiles are particularly susceptible and often difficult to seal off fully. The risk area may only be entered with the permission of the fumigator and suitable PPE, including RPE, should be worn.

Preparing for fumigation

90 When hydrogen cyanide or phosphine is used for the fumigation operation, there is a requirement in law for certain people to be notified in advance. This includes the local council, local police and Fire and Rescue Service – see Useful contacts.

91 Notification should be given as early as possible and at least 24 hours ahead of the fumigation operation, unless a shorter period has been agreed with those being notified. Consideration should also be given to notifying others, such the ambulance authority, where appropriate.

92 When hydrogen cyanide is used, the employer should ensure that competent fumigation trained first-aiders are present before any fumigation takes place.

93 Any particular precautions which should be taken regarding entry into confined spaces should be addressed. The confined space may be the whole or part of the intended fumigation area, risk area and/or other work area and there may be hazards other than those associated with release of fumigant. Further information is provided in HSE's leaflet *Confined spaces: A brief guide to working safely*.[14]

94 Before fumigation begins, the fumigator must ensure that the following precautions are taken:

- the fumigation area should be evacuated (removing and securing any non-target animals, plants etc) with only the fumigator allowed into the risk area;

- absorbent liquids and foodstuffs should be removed and, where possible, other absorbent solids (other than those intended to be fumigated) should also be removed from the fumigation area;
- fires and naked lights including pilot lights should be extinguished, other sources of ignition should be removed (hot elements should be allowed to cool) from the fumigation and risk areas;
- the fumigation area should be sealed, checking for unusual escape routes for the gas, eg sumps, drains, holes around ducting, ducting shafts, pipe work, connections behind false ceilings etc;
- any unnecessary electrical supply should be disconnected from the fumigation area;
- the risk area should be secured against unauthorised entry; and
- warning notices should be placed at the fumigation area and all points of access to the risk area. These must be in accordance with The Health and Safety (Safety Signs and Signals) Regulations 1996.[15] An example is given in Figure 1.

Figure 1 Pictogram of new International Symbols

During fumigation

95 Employers should ensure that:

- only the minimum amount of fumigant carry out the fumigation both effectively and safely should be used. This may be achieved by managing the temperature, improving the sealing and/or extending the duration of fumigation;
- a check of and, if necessary, repair of any leaks from the fumigation area or the application equipment and piping outside the fumigation area is carried out, especially at joints and couplings. An electronic detector or other detection

device should be used. If leaks are detected, they must be dealt with by a fumigator wearing RPE, before the fumigation can continue. If it is not possible to seal a leak, the fumigation and risk areas should be extended; and

- if atmospheric monitoring indicates that there is no leakage and the risk area can safely be reduced, consideration should be given to allowing normal work to resume in parts of a building previously evacuated and absent of fumigant. Or, if the risk area has to be extended, additional areas should be evacuated and warning notices erected.

After application of fumigant

96 Once the fumigant has been applied, application equipment and surplus fumigant that is no longer required should be removed from the site:

- where applicable, cylinder valves should be closed, and valve caps and cylinder caps placed in position;
- all equipment should be ventilated and inspected for solid residues by the fumigator wearing appropriate RPE and PPE, before it is loaded into transport or placed in store; and
- any contaminated clothing and equipment (including RPE) should be removed and aired in a well-ventilated place for a minimum of two hours or until free of fumigant, whichever is the greater.

97 If skin and hair become contaminated, they should be brushed free of any solid residues in a well-ventilated place after work and before smoking, washing, eating or drinking or going outdoors in the rain.

Venting (aeration)

98 The fumigation area and risk area should be ventilated at the end of the fumigation period. Fumigation gases and solid fumigation particles are heavier than air. Where possible, when venting fumigated buildings, the starting point should be the top of the structure to minimise the risk of the fumigant coming into contact with fumigators or others. Where it is necessary to enter the fumigation area to carry out the ventilation, eg to open doors or windows, RPE appropriate to the fumigant must be used.

99 The COSHH risk assessment should identify areas such as cellars, enclosed vessels and other similar confined spaces that should use forced ventilation to remove the fumigant. The arrangements for clearing these areas should be carefully planned in advance and the necessary equipment installed before fumigation takes place.

100 The number of fumigators required to vent the fumigation area will depend on the type of fumigation taking place and the associated risks highlighted by the fumigator-in-charge in the risk assessment.

101 The fumigator-in-charge, wearing RPE, should test the atmosphere until the concentrations of fumigant have fallen below the WEL or other appropriate level, to ensure that all areas are safe for reoccupation.

102 Materials in the fumigation area may continue to release gas after the end of the fumigation operation and so should be considered. Where this is the case, regular testing may be necessary until the fumigator is satisfied that the concentrations are below the WEL or other appropriate level.

103 Neutralising chemicals may be used to bring the level down to the WEL or below. Some fumigation systems, eg those delivering hydrogen peroxide vapours,

have dedicated aeration units that sit inside the treated premises and are used to reduce the active fumigant levels at the end of the process.

After venting

104 After venting, the fumigation equipment should be removed from the site.

- Gas-proof sheeting should be aired until it is free of fumigant before being folded, rolled, transported and stored for future use. Similarly, unwanted sheets should be aired before disposal.
- Empty tins or containers should be disposed of in accordance with the Environment Agency (England and Wales) or the Scottish Environment Protection Agency (SEPA) guidance – see the Useful contacts section for details.
- At the end of some fumigation processes, such as when phosphine has been produced, the remaining residues may contain undecomposed metal phosphides, which will continue to decompose and generate fumigant. If this is the case, the residues should be removed from the fumigation and risk areas and rendered safe for disposal. If it is not possible to deactivate the residues on site, they can be carefully transported in a ventilated but rainproof container in an open vehicle (lorry or pick-up) and deactivated at suitable premises.
- Any remaining residues should be disposed of after consultation with the Environment Agency or SEPA.
- Used packets or loose phosphide residues should not be heaped together nor enclosed within a container or plastic bag as this might result in fire or an explosion.
- Any contaminated clothing and equipment should be removed and aired.

105 When all areas have been demonstrated to be safe for reoccupation, but before the barriers and warning signs are removed, a certificate of clearance should be issued. The fumigator-in-charge signs the clearance certificate once the fumigation operation has been completed. The certificate confirms that the fumigation site is safe for reoccupation and records the handing back of the site to the owner/occupier.

106 Where confined spaces or enclosed vessels are involved, the certificate of clearance should clarify that it may no longer be safe to enter without further ventilation if the confined space or enclosed vessel is resealed, as traces of gas may release slowly and accumulate.

107 The certificate of clearance should be issued in triplicate – one copy to the owner or their representative, one copy to a safety representative (if appointed) of people usually employed to work in these areas, and one copy retained for the fumigator's records.

108 After the certificate of clearance has been issued, any barriers and warning signs should be removed An example is given in Figure 2.

Storage and transport

109 Guidance on the storage of pesticides can be found in the Department for Environment, Food and Rural Affairs' *Code of Practice for Suppliers of Pesticides to Agriculture, Horticulture and Forestry.*[16] HSE has also produced an information sheet called *Guidance on storing pesticides for farmers and other professional users*.[17]

CLIENT NAME .....

ADDRESS.....
.....
.....

The area(s)* shown below has/have been fumigated with ..... at a dosage of .....g/m^2 over the period from (time and date) ..... to (time and date)..... ..... in accordance with the Control of Substances Hazardous to Health Regulations 2002.

Safety tests carried out at (time and date) .... using ..... detection apparatus have shown that the concentrations of gas in all areas are below the current 8-hour workplace exposure limit (WEL).

AREAS .....
.....
.....
.....

* Full details to be specified.

PLEASE NOTE: Traces of gas can remain in the soil for some time. Maintain full ventilation for a further period of at least 24 hours before the soil is cultivated. It is suggested that cultivation is followed by another airing period of at least 48 hours.

CONTRACTOR'S REPRESENTATIVE	**GROWER'S AUTHORISED REPRESENTATIVE**
NAME..... (CAPS)	NAME..... (CAPS)
SIGNED	SIGNED .....
POSITION	POSITION.....
DATE	DATE .....
TIME	TIME .....

CLIENT NAME.....

ADDRESS.....
.....
.....

The areas shown below have been fumigated with ..... at a dosage of.....g/m^3 over the period from (time and date) ..... to (time and date) .....
Treatment has been carried out in accordance with the Control of Substances Hazardous to Health Regulations 2002.

Safety tests carried out at (time and date) .... using ..... detection apparatus have shown that the concentrations of gas in all areas are below the current 8-hour/15 minute workplace exposure limit (WEL).

The risk area may safely be re-entered and goods loaded/discharged/removed forthwith provided the area is continuously ventilated.

THE FOLLOWING HAS/HAVE BEEN FUMIGATED:

.....
.....
.....
.....
* Full details of commodities, containers etc with quantities to be specified.

PLEASE NOTE: Traces of gas can remain within commodities for some time and these will air off slowly, presenting no risk. If commodities are sealed up again, for example in a freight container, this could lead to concentrations above the WEL and a further, though shorter, airing period may be necessary.

CONTRACTOR'S REPRESENTATIVE	**GROWER'S AUTHORISED REPRESENTATIVE**
NAME..... (CAPS)	NAME..... (CAPS)
SIGNED	SIGNED .....
POSITION	POSITION.....
DATE	DATE .....
TIME	TIME .....

Figure 2 Soil and general fumigation clearance certificates

110 Pressurised fumigant gases, including carbon dioxide, should be stored:

- in an area which is securely fenced off, well away from foodstuffs and human or animal habitation;
- in a dry, well-ventilated store, which should be regularly monitored for leakage of the fumigant.

111 Gassing powders, sachets and fumigation tablets should be stored in their original containers off the floor in a separate, moisture-proof and fire-proof chest, bin or vault with appropriate labelling, including a warning 'Gassing compound: Do not use water'. The fire-proof chest, bin or vault should be kept locked.

112 Certain substances are subject to the provisions of the Poisons Act 1972.[18] This will be indicated on the product label. Where a product label indicates that a substance is subject to the Poisons Act, employers must familiarise themselves with the requirements of the Act. Aluminium phosphide is an example of a substance subject to the provisions of the Poisons Act.

Figure 3 Poison warning symbol

113 Figure 3 shows the symbol which indicates a product is classified as a poison.

114 Where fumigants and fumigant-generating materials are packaged and classified as dangerous goods for transport, when transporting by road or rail they should be transported in accordance with the requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.[19] If transported as part of a sea journey, they should be transported in accordance with the International Maritime Organisation's Dangerous Goods code[20] which is given force of law through the Merchant Shipping (Dangerous Goods and Marine Pollutant) Regulations 1997.[21]

115 Gas cylinders, packages of fumigant and associated equipment should always be stored outside the passenger compartment of transport vehicles. Where the assessment requires it, the cargo areas should be kept well ventilated at all times and RPE should be available in the driver's cab in case of emergency, with the driver trained in its use. The emergency RPE should be kept in a suitable container and not used during fumigation operations.

116 If there is a leak while the gas cylinders or packages of fumigant are being transported, action should be taken in line with paragraph 117.

Emergency measures

Damaged or leaking fumigant containers

117 The risk assessment carried out before the start of the fumigation operation should include provisions for the disposal of damaged or leaking canisters:

- if the canisters can be moved safely, they should be taken to a safe place in the open air and away from people, animals and flammable materials by a fumigator wearing RPE, where they may be safely vented;
- if the canisters cannot be moved safely, their current site should be treated as a fumigation area and appropriate precautions taken in line with this guidance.

Major leakage

118 In the event of an emergency during fumigation, eg if a delivery pipe breaks or becomes disconnected, or containment measures, such as sheeting, become damaged and leakage of fumigant occurs, the fumigator should wear RPE to immediately close the main cylinder valve (if a cylinder is being used) or repair the damage. The fumigator should then withdraw from the risk area. After a period of ventilation, and wearing RPE, the fumigator should check the concentration of fumigant in the risk area.

119 Unprotected people should not be allowed to enter the risk area until the concentration is confirmed as below the WEL or other appropriate level.

120 Consideration should be given to calling the fire and rescue service to resolve the matter if it cannot be effectively dealt with by an on-site fumigator.

Fire

121 If the Fire and Rescue Services and/or other emergency services are called to a fire or leak in or near a fumigation or risk area, the fumigator should explain which fumigant is being used and provide all available information to them on the hazards and precautions needed. This information, together with specific available detection equipment and an emergency contact number should be provided on site for use by the emergency services at times when fumigators may be absent.

Reporting

122 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013[22] (RIDDOR) place obligations on employers and other responsible people to report incidents to the appropriate enforcing authorities. Guidance on when and how to make such reports is available on HSE's website: www.hse.gov.uk/riddor/index.htm.

Other legislation which applies to fumigants

123 Other legislation, applicable to fumigants, which employers should be aware of includes:

- the EU Biocidal Products Regulation 528/2012 (EU BPR); [23]
- the Control of Pesticides Regulations 1986 (COPR);[24]
- REACH (see www.hse.gov.uk/reach/index.htm);
- The Plant Protection Products (Sustainable Use) Regulations 2012 (EU PPPR).

If a fumigant is within the scope of COPR, EU PPPR or EU BPR, it must be approved or authorised under that legislation. See Appendix 4 for further information on this legislation. Additionally, Codes of Practice giving further guidance on the use of plant protection products can be found on HSE's website at www.pesticides.gov.uk.

Appendix 1 Extra precautions for different types of fumigation

1 Fumigators should ensure that they have the appropriate training and are competent to carry out fumigation in the environment in which they are working.

Laboratories

2 Fumigation, particularly of laboratories, is potentially a high risk operation and should not be undertaken without adequate planning, consultation and preparation. Detailed guidance is provided by the ACDP publication *The management, design and operation of microbiological containment laboratories*.[25]

3 The Advisory Committee on Dangerous Pathogens (ACDP) guidance provides information and practical advice on managing the risks associated with whole-room laboratory fumigation. It is aimed principally at those with responsibility for the management and operation of facilities where deliberate work with biological agents is undertaken at Containment Levels 3 and 4. It should also be useful to those involved in providing Containment Level 3 or 4 maintenance, fumigation or sealability assessment services.

4 Information on the alternative fumigation technologies which are often used in laboratories can be found in Appendix 2.

Hospital rooms

5 Fumigation of hospital rooms is possible with alternative fumigation technologies (see Appendix 2).

6 Air vents, doors and other apertures should be sealed using adhesive tape or some other reliable method such as automatically dampered vents.

7 The presence of patients nearby means that hand-held detectors must be used to monitor the perimeter of the room or enclosure being fumigated. Hand-held detectors must also be used to ensure that the concentration of fumigant is below the WEL or other appropriate level before room re-entry.

Buildings

8 Before any fumigant is released, the building should be checked to ensure it is clear of people, non-target animals and plants and to ensure that no unauthorised person can gain access until the building has been vented and declared safe by the fumigator-in-charge.

9 When working inside the building, fumigators should wear RPE, unless tests with detection equipment show that concentrations of fumigant do not exceed the WEL or other appropriate level.

10 In multi-storey or multi-section buildings, the fumigation area should be left as each storey or section is opened, to ensure an adequate ventilation period before proceeding to the next floor. The duration of the ventilation period will vary according to the size and condition of the building and the weather conditions. Particular attention should be paid to areas which are difficult to ventilate, including basements and stairwells where heavy gases such as sulphuryl fluoride may accumulate.

11 The building should be made as gas tight as possible. If the fumigation area is part of several interconnected buildings, it should be sealed off from the adjoining

structures. Where areas are only separated from the fumigation area by a dividing wall, the area on the other side of the wall should also be considered to be part of the risk area and evacuated during the period of fumigation. All windows, doors and other openings from the building should be sealed with masking tape or other suitable material, unless the building is to be enveloped completely by fumigation sheets of low permeability.

12 At the end of the fumigation period, the fumigators, wearing RPE, may break the seals and open doors and other openings accessible from outside the fumigation area and then withdraw beyond the risk area for the ventilation period.

13 When buildings are to be occupied by people, they should not be allowed back into the building until suitable monitoring equipment shows that the area contains gas levels below the WEL or other appropriate level for that fumigant. Special attention should be paid to any absorbent materials which may continue to release gas for some time and may require additional ventilation.

14 At the end of the ventilation period, all piping and application equipment used for fumigation should be disconnected, dismantled and removed from the fumigation area and risk areas.

15 A certificate of clearance should be issued after the fumigator-in-charge has tested the atmosphere in all floors or sections and is satisfied that it is safe for people to enter without RPE.

Fumigation of stacks of commodities under gas-proof sheets

16 Where commodities are to be fumigated under gas-proof sheets, those sheets should be low permeability and in sound condition.

17 If it is not possible to stack the commodity to be fumigated on a concrete or other hardstanding, polythene sheeting should be laid beneath the stack on the ground.

18 Where more than one sheet is needed to cover a stack, the individual sheets should be sealed together by rolling, using spray-on adhesive or by other suitable methods.

19 If fumigation is under gas-proof sheets inside buildings, a period of ventilation for the building should be allowed before the sheets, piping or spent residues are collected.

20 If the fumigant being used under sheeting is phosphine, particular controls will apply. These include:

- using new polyethylene sheeting, of at least 125 microns (500 gauge) thickness (or laminated sheeting of lower permeability);
- sufficient width of sheet should be used on the floor to permit effective weighting down with sand snakes;
- water snakes should not be used to weight the sheets as they could cause a fire if they leaked and any water came into contact with the phosphide formulation;
- where the stack is on pallets or dunnage, phosphide preparations may be placed underneath the stack and sachet or plate formulations can be carefully hung down the sides of the stack, but should not be in contact with the sheet.

Ships, coasters, barges and ocean-going ships

21 Fumigation should be carried out in accordance with the recommendations of the International Maritime Organisation (IMO) guidance.

22 Methyl bromide is banned as a pesticide/fumigant within the EU because of its adverse effects on human health and the environment. However, fumigators and stevedores carrying out work within cargos arriving into the UK from outside the EU may encounter products which have been fumigated using methyl bromide and so should be aware of the health effects associated with it.

At berth or at anchor

23 Before fumigation starts, the employer should ensure the vessel is at a suitable location (check with the Port Authority), in good condition and capable of being sealed effectively.

24 When only the cargo space is to be fumigated, any opening to other compartments where fumigant may disperse to should be sealed off. No one should be allowed to enter the fumigation area during the fumigation and ventilation periods until tests show that fumigant levels are below the WEL or other appropriate level. Where crew members are allowed on board during fumigation, eg for carrying out other tasks on board or to facilitate ventilation, monitoring should continue to ensure that the compartments are and continue to remain safe before the final certificate of clearance is issued.

25 Once the fumigators have arrived on site, warning signs should be erected at the foot of the gangway, advising of the time and date of the fumigation being carried out.

26 The fumigant should not be applied until the vessel has been thoroughly searched (including for stowaways) and all people not connected with the fumigation are out and remain out of the fumigation area.

27 The vessel should be moored in a position which minimises the possibility of unauthorised access during the fumigation period, eg in midstream or at a wharf which is closed to the public. A member of the fumigation team should remain in attendance and a warning notice be placed at the shore end of the gangway. This warning notice should be illuminated at night.

28 At the end of the fumigation period, fumigators wearing RPE should break the seals and roll-back sheets and tarpaulins and lift the hatch-boards to assist ventilation and dispersal of the fumigant. The atmosphere should be tested before anyone enters the fumigation areas within the vessel to ensure that no one is exposed to concentrations above the WEL or other appropriate level during this period; anyone entering any part of the fumigation areas within the vessel should be wearing RPE.

29 Ventilation of ships' holds from fumigants and the issue of the gas clearance certificate should be undertaken by a qualified fumigator, such as a holder of the British Pest Control Council (BPCA) Module 5 (ships) certificate.

30 On some vessels, the crew or shore riggers open the hatches manually, so it may be necessary to allow them on board to do so. The atmosphere should be tested to ensure that no one is exposed to concentrations above the WEL during this period. After a preliminary period of ventilation, some of the crew may have to be allowed back on board to carry out necessary duties. However, they should not

be allowed below decks unless tests have shown that fumigant levels are below the WEL or other appropriate level. The crew should not be allowed to remain on board until the final certificate of clearance has been issued.

31 In the case of loaded vessels, it may not always be possible to test the lower decks below the cargo until the cargo is being unloaded.

Vessels in transit

32 Some fumigations may take up to two weeks, eg when phosphine is being used, and it may be difficult to keep a vessel moored for such a length of time.

33 In appropriate vessels, fumigation can sometimes take place during a voyage. In these cases, before the ship sails, responsibility for the fumigant should be transferred to the ship's master. The vessel should be equipped with suitable RPE and detection equipment and the ship's master should be trained to use it.

34 Additionally, 'in-transit' fumigation vessels arriving into the UK may not be marked with appropriate notices or even marked as 'degassed' when they are not. Where a vessel has been fumigated in transit, fumigators wearing RPE should break the seals, roll back sheets and tarpaulins and lift the hatchboards to assist ventilation and dispersal of the fumigant and the atmosphere should be tested before anyone enters the vessel to ensure no one is exposed to concentrations above the WEL or other appropriate level. Anyone entering any part of the vessel should be wearing RPE.

35 Containers being treated in transit are covered in paragraphs 37–47.

Aircraft

36 Fumigators should familiarise themselves with any airport operating procedures and the advice of the aircraft manufacturers should be sought before using any chemicals on board.

Freight containers (including cargo-carrying vehicles and trailers)

37 Freight containers may be treated at the port before onward transportation or they may arrive into the port already fumigated.

38 Containers may arrive into port without marking identifying that they have been fumigated. Anyone responsible for handling, opening or unloading containers must be aware of the risk of fumigants and consider the possibility that all containers may contain harmful concentrations of fumigant gases. If the presence of fumigants is suspected, the container should not be entered and must be re-sealed.

39 Any freight container (and any other cargo-carrying vehicle or trailer) which is being fumigated in port should be in a designated area, separate from the normal container park or working areas.

40 Before fumigation of a container begins, the container's state of repair should be checked to decide whether it is suitable for treatment; particular attention should be paid to the door gaskets. The doors of the container should be capable of being secured with a padlock or other device. Any open ventilators should be sealed.

41 Some containers are fitted with one or more bulkhead fitting suitable for admission of the fumigant into the headspace near the roof. Where possible, the fumigant should be applied through such fittings, either from a cylinder or from

cans. Where appropriate, gas sampling lines and temperature recording equipment should also be fed in through these fittings.

42 Detection equipment should be used, with particular attention being given to the seals around the doors. When the fumigator is satisfied that effective sealing has been achieved, the doors should be locked or otherwise secured and the keys given to the fumigator-in-charge. Hazard warning notices identifying the fumigant and stating the time and date of the fumigant application, should be fixed to the doors and at entry points to the risk area. Records of the time and date of application should be kept. Fumigants should not be applied to a container once it has been loaded aboard the ship.

43 A fumigator should stay where they are able to observe the risk area throughout the fumigation and ventilation periods. At the end of the fumigation period, fumigators wearing RPE should open the doors and begin the ventilation process. Ventilation should continue if there is any likelihood of an increase in fumigant concentration by desorption.

44 Ventilation of shipping containers and issuing of a gas clearance certificate should be undertaken by a suitably qualified fumigator.

45 Unless a container has been ventilated after fumigation to ensure that concentrations of gas are below the WEL or other appropriate level, a period of time should be allowed between the application of the fumigant and the loading of the container on board the ship – normally 24–48 hours is adequate. Special precautions may be necessary on the ship. Guidance is available from the International Maritime Organisation (IMO).

46 Containers under fumigation are classified as UN3359 Fumigated Cargo Transport Unit Class 9 for transport under the provisions of the International Maritime Dangerous Goods (IMDG) code or under regulations for the European Agreements Concerning the Carriage of Dangerous Goods by Road and Rail (ADR/RID).

47 Containers transported under fumigation are subject to the requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.

Fumigation chambers

48 When fumigation operations are to be carried out in chambers, the chambers should be fitted with a ventilating system which either discharges the fumigant outside, away from any areas where people may be present, or is designed to recover the used fumigant.

49 Before the fumigation chamber is unloaded, the fumigator-in-charge should test the inside of the chamber to ensure that the concentration of fumigant is below the WEL or other appropriate level. Special care must be taken where the nature of the fumigated commodities is such that desorption (release) of fumigant may continue for some time. If the chamber is closed after ventilation is completed, dangerous concentrations of the gas may accumulate and a further period of ventilation will be necessary before entering and unloading.

Soil and compost indoors

50 Soil and compost are often fumigated under sheets in glasshouses and plastic tunnels. Mushroom compost is fumigated without sheets in specially designed

buildings. In such cases, the precautions recommended for the fumigation of buildings should be applied. The structures should be checked to ensure that no people or non-target animals are within before fumigation begins, and that no unauthorised person can gain access until the structure has been ventilated and certified safe by the fumigator-in-charge.

51 The cylinders and application equipment should be located outside and, as far as possible, piping runs should be planned so that it is not necessary to enter the glasshouse or tunnel once fumigation has begun. In exceptional cases, where unusually long pipe runs are unavoidable and it is necessary to operate the application equipment inside the glasshouse, the following precautions should be taken:

- it may be necessary for fumigators to work in pairs so that ventilation can be carried out safely – carefully consider the number of fumigators needed;
- before the fumigant is released, the area of the glasshouse or tunnel designated as a risk area during the application of the fumigant should be clearly signed;
- ventilators and doors should be kept fully open while the fumigant is being released beneath the sheeting as long as the cylinders and vaporising equipment remain inside the glasshouse or tunnel, they should be closed afterwards;
- a good quality low permeability sheet should be used and laid as soon after incorporation as possible.

Soil and compost outdoors (including fields)

52 Outdoor fumigation of field soil or compost takes place under sheets. In addition to the precautions described in paragraphs 50–51, the following should also be considered:

- the proximity of buildings occupied by people or animals, together with the slope of the land and drains, when assessing the risk area. The risk area should be at least 25 metres from occupied buildings and 10 metres from roads and public footpaths. It may be necessary to divert footpaths temporarily, in which case, the local Council should be consulted; and
- the risk of flooding on the areas below the sheeted area due to heavy rain when laying barrier film on slopes. Fumigation should be postponed or the area to be sheeted and fumigated at any one time should be reduced if the weather forecast suggests that this will be an issue.

53 The speed and direction of the wind and the amount of gas to be ventilated will have a significant effect on the dispersion of gas emitted during ventilation. These factors should be assessed and factored in before ventilation starts. At the end of the fumigation period, fumigators wearing RPE should roll back the edges of the sheets to enable ventilation. When the concentration of residual fumigant has fallen below the WEL or other appropriate level, the sheets and fumigation equipment may be removed. The fumigator-in-charge should check the fumigation area and ensure that the soil may be worked safely before issuing the certificate of clearance.

Grain in small bins or in bulk on the floor

54 Where fumigation is taking place in small bins or on the floor, fumigation preparations may be inserted directly into the grain with the aid of probes or tubes or probing into the grain with retrievable sleeves or bags. Some preparations may also be placed on the surface of the grain and in aeration ducts underneath. The surface of the grain should then be covered with polyethylene sheets of low permeability or other equivalent gas-proof material.

55 Where retrievable devices are used, instructions relating to residual products should be made known to and followed by the grain store operators.

56 Some fumigants, such as phosphine, may evolve more slowly during grain fumigation, so adjacent risk areas should be ventilated at all times. Particular care should be taken when the grain store is only separated from living quarters or animal houses by a dividing wall. Where this is the case, such areas should be evacuated during the whole period of fumigation and ventilation and people should not be allowed back into the living quarters until a certificate of clearance has been issued.

57 At the end of the fumigation period, the grain should be uncovered and allowed to air. Fumigant residues should be either removed manually or subsequently when the grain is filtered.

Grain in silos

58 When grain is fumigated in silos, the slides at the bottom of the silos and any other openings should be sealed to prevent leakage of the fumigant gas. To prevent the grain being discharged prematurely, the slides should be clearly labelled and locked into the closed position. Areas outside the silos being fumigated should be ventilated as much as possible.

59 Normally the fumigant is applied to the grain stream near the point of entry into the silo. This may be done by means of an automatic applicator which dispenses pellets at predetermined intervals. It is possible that some air containing fumigant will be displaced from the silo, so regular tests for the fumigant should be carried out to ensure that people are not exposed to concentrations above the WEL or other appropriate level.

60 When the fumigant has been applied, all the openings into the top of the silo should be closed and sealed and warning notices fixed in place. A fumigated silo should be completely sealed before another is treated.

61 No one should enter silos adjacent to those already treated until they have been ventilated and tests show that fumigant concentrations are below the WEL or other appropriate level.

62 The treated grain should not be moved until at least five days after fumigation is complete and not before tests (probing into the grain) show that the concentration of fumigant is below the WEL or other appropriate level.

63 Although grain may not need to be moved for some weeks or months after fumigation, people must not be exposed to harmful concentrations of fumigant in conveyor tunnels or other spaces through which the grain moves. If tablets or pellet form fumigants are used, an assessment should be made to determine whether people working near the moving grain should wear RPE.

64 The silo ventilation fans should be operated to clear any gas which may be present in the ducting and the empty silo should be left open, top and bottom, for at least 24 hours before anyone is permitted to enter it. If the grain is to be turned into another bin, the risks of confined spaces should be considered and no one should enter the space above the grain in the new bin unless tests have shown that levels of fumigant are below the WEL or other appropriate level.

'In-bag' fumigation of individual packages

65 Individual sacks or other small items can be fumigated by placing them in a gas-proof enclosure such as a plastic bag and adding an appropriate amount of the fumigant preparation. Special care should be taken in calculating the appropriate amount of fumigant to be used. In addition, particular account should be taken of the permeability and portability of the plastic bag when defining the fumigation and risk areas.

Mammals underground

66 Fumigation of mammals underground should only be carried out in the open air and in dry weather by suitably trained and qualified fumigators. In addition to any relevant precautions described in relation to open-air fumigation, the following action should be taken:

- check the wind direction and, if it may affect the safety of the fumigation, take action;
- the fumigant container should be opened outside, standing sideways to the wind when handling compounds;
- PPE and RPE suitable to the fumigant being used should be worn;
- the entire contents of a fumigant container should be used in one operation; and
- burrows or runs should not be fumigated within ten metres of any building occupied by non-target animals or humans.

67 Warning signs and barriers should be used to mark the risk areas so that people and non-target animals are kept out. This must be done when fumigating in urban areas.

68 From 26 November 2015 anyone using metal phosphides to control rats, rabbits and moles must hold a certificate of competence approved by OfQual and the Chemicals Regulation Directorate of HSE. A list of approved qualifications and training bodies can be found at The Register of Accredited Metallic Phosphide Standards in the UK (RAMPS) (www.ramps-uk.org).

69 Further information on gassing rabbits and vertebrate pests can be found in HSE's information sheet *Gassing of rabbits and vertebrate pests*.[26]

Appendix 2 Alternative fumigation technologies

Detailed information on active substances, dosage and safe use

1 A summary of key fumigation active substances and their safety in use is given in Table 1.

Hydrogen peroxide vapour (H_2O_2) (from 30–35% hydrogen peroxide)

2 Hydrogen peroxide (H_2O_2) is a broad-spectrum anti-microbial fumigant which is produced from a solution of liquid H_2O_2 and water in generators specifically designed for the purpose. The vapour can be generated in a 'condensing' or a 'non-condensing' process. In the condensing process, the gas gives a high concentration of liquid hydrogen peroxide on surfaces, while, in the non-condensing process, the hydrogen peroxide does not condense.

Hydrogen peroxide (H_2O_2) as an aerosol (also called a fog or a dry mist) (usually from 5–6% hydrogen peroxide)

3 In aerosolised (fogging/misting) applications the fumigant is usually at a lower concentration than with vapour-based technologies.

Ozone gas (O_3)

4 Ozone is effective against a range of microorganisms at high humidity, including bacterial spores and some viruses, though it is generally regarded as less effective against spores compared to H_2O_2 and chlorine dioxide (ClO_2).

5 Ozone has to be generated at the point of use as its low stability means that it cannot be stored. It is usually generated from a bottle or piped supply of industrial oxygen or compressed air.

Chlorine dioxide gas (ClO_2)

6 Chlorine dioxide has been successfully used as an antimicrobial in liquids and has been widely used in the disinfection of drinking water and swimming pools since the 1950s. It is also used as an anti-microbial in the food industry, where it is effective against common bacterial food pathogens, including spore-forming bacteria. Chlorine dioxide can be used as a fumigant to treat air and surfaces.

Fogging with quaternary ammonium compounds

7 Quaternary ammonium compounds (quats) are available for fogging or mist-based room treatments – benzalkonium chloride is one of the best known. They disrupt the cell membrane of microorganisms and have wide application, meaning that they are used across many sectors, including food, healthcare, farming and laboratories.

Fogging with peracetic acid

8 Peracetic acid (also known as peroxyacetic acid or PAA) is an organic acid available for fogging or mist-based room treatments.

Table 1 Summary of key fumigation actives and their safety in use

Active fumigant	Commercially available?	Application	Associated hazards and EH40 WEL (if applicable)	Portable monitoring equipment available?
Formaldehyde as a vapour or gas	Yes – usually purchased from suppliers as a stock aqueous solution (37–40%) stabilised in 10–15% methanol. Can also be generated from heating paraformaldehyde pellets.	Liquid preparation is boiled off with added water to vaporise; paraformaldehyde pellets are heated dry in a heating block to release formaldehyde. Wide-spectrum antimicrobial activity; sporicidal; efficacy likely to improve with higher fumigant concentration.	Toxic if swallowed or in contact with skin; causes severe skin burns and eye damage and may cause an allergic skin reaction; toxic if inhaled and may cause respiratory irritation; long-term exposure linked with cancer. Refer to EH40 for the maximum WEL.	Yes. Hand-held measurement devices available commercially.
Hydrogen peroxide as a vapour (H_2O_2)	Yes – both active agent and delivery equipment. Usually uses H_2O_2 at 25–30% as a source for vapour generation.	Wide-spectrum antimicrobial activity; vegetative cells and spores are effectively killed by this gaseous fumigant.	Respiratory irritant; risk of chemical burns; harmful if swallowed; risk of eye damage from splash; Refer to EH40 for the maximum WEL. Breakdown products non-toxic.	Yes. Hand-held measurement devices available commercially.
Hydrogen peroxide as a dry mist or fog (H_2O_2)	Yes – both active agent and delivery equipment. Usually uses H_2O_2 at 5–10% as a source for fog generation.	Wide-spectrum antimicrobial activity; dry mist often delivered at a lower concentration range so less sporicidal.	Respiratory irritant; risk of chemical burns; harmful if swallowed; risk of eye damage from splash; Refer to EH40 for the maximum WEL. Breakdown products non–toxic.	Yes. Hand-held measurement devices available commercially.
Chlorine dioxide gas (ClO_2)	Yes – mobile commercial equipment generates ClO_2 gas from bottled gas source (98% nitrogen: 2% chlorine).	Wide-spectrum antimicrobial activity; vegetative cells and spores are effectively killed by this gaseous fumigant.	Severe respiratory irritant; may be toxic in contact with skin; severe eye irritant; Refer to EH40 for the maximum WEL.	Yes. Hand-held measurement devices available commercially.
Ozone gas (O_3)	Yes – commercial equipment generates O_3 gas from bottled air or oxygen source.	Wide-spectrum antimicrobial activity. Less effective than some other fumigants at killing spores. Requirement for high humidity.	Toxic if inhaled; causes eye and skin irritation; Refer to EH40 for the maximum WEL.	Yes. Hand-held measurement devices available commercially.
Quaternary ammonium compounds – delivered as a fog	Yes – Large-scale production for wet surface disinfection provides multiple options for fogging treatments. Can be delivered by compatible fogging devices.	Encompasses a range of disinfectants. Traditionally used as wet application but some have been used for fogging.	Toxic if ingested; harmful by inhalation or ingestion; corrosive and irritating to the skin and eyes. No WEL available for airborne exposure.	No. Many chemical variations in the group mean that measurement by hand-held instruments is currently not possible.

Table 1 Summary of key fumigation activities and their safety in use (continued)

Active fumigant	Commercially available?	Application	Associated hazards and EH40 WEL (if applicable)	Portable monitoring equipment available?
Peracetic acid (PAA) – delivered as a fogged agent	Yes – can be purchased in various concentrations as a relatively inexpensive stock chemical and can be delivered by compatible fogging devices.	An organic acid. Wide spectrum of antimicrobial activity against vegetative and spore-forming microorganisms.	This substance is a powerful oxidiser that can cause severe skin burns and eye damage. Toxic and acts as a respiratory irritant if inhaled. Breaks down rapidly into less harmful components; explosive risk at temperatures above 110^{o}C. Acute exposure guideline limit is 0.17 ppm for all exposure durations.	Organic acid monitors available but accuracy uncertain, eg could cross react if other airborne chemicals are present.
Hypochlorous acid – delivered as a fogged agent	Yes – can be purchased in various forms (branded and unbranded) and delivered by compatible fogging devices.	A chlorine oxyacid that is the active form of chlorine in water. Wide spectrum of antimicrobial activity.	A strong oxidizer that can form explosive mixtures. Can cause severe skin burns and eye damage. Toxic and acts as a respiratory irritant if inhaled.	Organic acid real-time monitors available but accuracy uncertain.
Mixed actives – delivered as a fog or dry mist	May include combinations such as hydrogen peroxide with peracetic acid; hydrogen peroxide and ozone.	Usually use existing active agents, but may be presented at lower concentrations due to enhanced effect claimed for mixed products. Broad applicability.	Depends on actives present. Most contain strong oxidising chemicals capable of causing chemical burns, eye damage etc. Breakdown product toxicity will depend on composition. WELs vary with composition.	Often at least one active can be measured and used as a real-time indicator of residual fumigant.

Appendix 3 Health effects associated with certain fumigants

Details of health effects of fumigants not listed in Table 2 will be found on the Safety Data Sheet and product label.

Table 2 Health effects associated with certain fumigants

Fumigant	Potentially fatal	Skin	Symptoms of poisoning
Phosphine Further information can be found in *Phosphine: Toxicological overview*[27]	Depending on the level of concentration and length of time, exposure can be fatal.	Causes severe blistering on skin contact.	■ Nausea ■ Vomiting ■ Headache ■ Weakness ■ Faintness ■ Pain in chest ■ Cough ■ Chest tightness ■ Difficulty breathing Pulmonary oedema may also occur usually with 24 hours of exposure, but occasionally it may be delayed for a few days.
Hydrogen cyanide Further information can be found in *Hydrogen cyanide: Toxicological overview*[28]	May be fatal.		■ Headache ■ Nausea ■ Dizziness ■ Difficulty breathing High concentrations may cause: ■ Unconsciousness ■ Irregular heartbeat ■ Coma ■ Death
Sulphuryl fluoride	Depending on the level of concentration and length of time, exposure can be fatal.	In contact with skin or eyes causes freeze burns. Extreme cases of freeze burn can cause blindness.	■ Nausea ■ Difficulty breathing ■ Abdominal pain ■ Slow and uncoordinated movements ■ Slow or garbled speech ■ Numbness in extremities ■ Reduced awareness ■ Lung irritation ■ Pulmonary oedema

Table 2 Health effects associated with certain fumigants (continued)

Aluminium phosphide/ magnesium phosphide		Contact with skin may cause sweating and irritation.	■ Irritation of nose, mouth, throat and respiratory tract ■ Chest pains ■ Coughing ■ Nausea ■ Vomiting ■ Diarrhoea ■ Muscle pain ■ Headache ■ Dizziness
Gluteraldehyde		At high concentrations causes burns.	■ Coughing ■ Wheezing ■ Nausea ■ Headaches ■ Drowsiness ■ Nosebleeds ■ Dizziness Prolonged exposure can cause: ■ Skin allergy ■ Chronic eczema Gluteraldehyde has been implicated as a possible cause of occupational asthma.
Hydrogen sulphide Further information can be found in *Hydrogen sulphide: Toxicological overview* [29]	High levels of exposure can be fatal.		■ Difficulty breathing ■ Coughing ■ Headaches ■ Eye irritation ■ Dizziness ■ Reduced awareness
Formaldehyde Further information can be found in *Formaldehyde: Toxicological overview* [30]		Skin irritation and skin sensitisation (allergic contact dermatitis).	■ Irritation and burning of nose, mouth and respiratory tract ■ Headache ■ Nausea ■ Vomiting ■ Pneumonia ■ Wheezing ■ Breathing difficulties ■ Coughing ■ Laryngeal and pulmonary oedema ■ Convulsions ■ Coma

Table 2 Health effects associated with certain fumigants (continued)

Methyl bromide* Further information can be found in *Methyl bromide: General information*[31]	Depending on the level of concentration and length of time, exposure can be fatal.	Causes severe blistering on skin contact.	■ Headache ■ Dizziness ■ Smarting of eyes ■ Cough ■ Nausea ■ Abdominal discomfort ■ Numbness of feet Higher or more prolonged exposure case: ■ Unconsciousness ■ Weakness of the legs ■ Convulsions ■ Delayed effects on vision, hearing and balance

** Methyl bromide is banned as a pesticide/fumigant within the EU because of its adverse effects on human health and the environment. However, fumigators carrying out work within cargos arriving into the UK from outside the EU may encounter products which have been fumigated using methyl bromide and should be aware of the health effects associated with it.*

Appendix 4 Other legislation which applies to fumigants

1 The EU Biocidal Products Regulation 528/2012 (EU BPR) covers a diverse range of products including disinfectants, pest control products and preservatives which are placed onto the market. Once an active substance has approval under the EU BPR, each member state must then authorise that product for use within its own country (or, where applicable, the European Commission must issue a Union authorisation).

2 The Control of Pesticides Regulations (COPR) is a UK national scheme, covering products which contain active substances that are not yet regulated under the Biocidal Products Regulation. This includes products such as wood preservatives, insecticides for public hygiene use, rodenticides and insect repellents, including those applied to animals. Under COPR, biocides are generally known as 'non-agricultural pesticides'.

3 REACH is a European regulation which applies to substances manufactured or imported into the EU in quantities of one tonne or more per year. Almost every business in the UK will have a duty under REACH as a manufacturer, importer, distributor, supplier or downstream user. However, the extent of the duties it imposes will vary significantly, depending on the dutyholder's activities. Responsibilities for users of chemicals are primarily to ensure that information gained with those chemicals is passed down the supply chain, and used to control risks.

4 The EU Directive 2009/128/EC on the sustainable use of pesticides, implemented in the UK via the Plant Protection Products (Sustainable Use) Regulations 2012, includes a number of provisions aimed at reducing the risks and impacts of pesticides. These include establishing National Action Plans; compulsory testing of application equipment; provision of training for, and arrangements for certification of, operators, advisors and distributors; provisions to protect water, public spaces and conservation areas; the minimisation of risks from handling, storage and disposal; and the promotion of low input regimes.

5 Plant protection products (pesticides to protect plant/crops) are regulated in the EU by Regulation (EC) No 1107/2009. The Regulation aims to harmonise, as far as possible, the overall arrangements for authorisation of plant protection products within the EU. Authorisation is given when products are assessed as meeting an agreed set of criteria.

6 More details can be found on HSE's website (www.hse.gov.uk/pesticides).

Appendix 5 Notification when using hydrogen cyanide or phosphine

(Required by COSHH, regulation 14)

1 When hydrogen cyanide or phosphine is used as a fumigant, the police and fire officer local to where the fumigation will take place should be notified 24 hours in advance.

2 When the fumigation is carried out within a harbour authority, notice should be given to the harbour authority in addition to the police and fire officer.

3 When fumigation using cyanide or phosphine is to be carried out on a ship in harbour, in addition to the above, notification should also be given to the officer in charge of Customs.

4 There are exceptions to the need to notify. These are listed in Table 3.

Table 3 Exceptions

Hydrogen cyanide	Fumigations carried out for research. Fumigations in fumigation chambers. Fumigations in the open air to control or kill mammal pests.
Phosphine	Fumigations carried out for research. Fumigations in fumigation chambers. Fumigations in the open air to control or kill mammal pests. Fumigations under gas-proof sheeting inside structures where not more than 1 kg of phosphine in each structure is used in any period of 24 hours. Fumigations in containers where not more than 0.5 kg of phosphine is used in any one fumigation in any period of 24 hours. Fumigations in individual impermeable packages.

5 The notice given should include the:

- name, address and telephone number of the fumigator;
- name of the person requiring the fumigation to be carried out;
- address and description of the premises where the fumigation is to be carried out;
- date on which the fumigation will be carried out and the estimated start and finish time;
- name of the operator in charge of the fumigation (if different from the fumigator); and
- fumigant to be used.

References

1 *The Control of Substances Hazardous to Health Regulations 2002* SI 2002/2677 The Stationery Office www.legislation.gov.uk

2 *Control of substances hazardous to health (COSHH). The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance* L5 (Sixth edition) HSE Books 2013 ISBN 978 0 7176 6582 2 www.hse.gov.uk/pubns/books/l5.htm

3 *The Plant Protection Products (Sustainable Use) Regulations 2012* SI 2012/1657 The Stationery Office www.legislation.gov.uk

4 *Health and Safety at Work etc Act 1974 (c.37)* The Stationery Office 1974 ISBN 978 0 10 543774 1 www.legislation.gov.uk

5 *The Management of Health and Safety at Work Regulations 1999* SI 1999/3242 The Stationery Office www.legislation.gov.uk

6 *The health and safety toolbox: How to control risks at work* HSG268 HSE Books 2013 ISBN 978 0 7176 6587 7 www.hse.gov.uk/pubns/books/hsg268.htm Microsite: www.hse.gov.uk/toolbox

7 *Managing for health and safety* HSG65 (Third edition) HSE Books 2013 ISBN 978 0 7176 6456 6 www.hse.gov.uk/pubns/books/hsg65.htm Microsite: www.hse.gov.uk/managing

8 *EH40/2005 Workplace exposure limits: Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations (as amended)* Environmental Hygiene Guidance Note EH40 (Second edition) HSE Books 2011 ISBN 978 0 7176 6446 7 www.hse.gov.uk/pubns/eh40.htm

9 BS EN 1231:1997 *Workplace atmospheres. Short term detector tube measurement systems. Requirements and test methods* British Standards Institution

10 *Monitoring strategies for toxic substances* HSG173 (Second edition) HSE Books 2006 www.hse.gov.uk/pubns/books/hsg173.htm

11 *Personal Protective Equipment at Work (Second edition). Personal Protective Equipment at Work Regulations 1992 (as amended). Guidance on Regulations* L25 (Second edition) HSE Books 2005 ISBN 978 0 7176 6139 8 www.hse.gov.uk/pubns/books/l25.htm

12 *Respiratory protective equipment at work: A practical guide* HSG53 (Fourth edition) HSE Books 2013 ISBN 978 0 7176 6454 2 www.hse.gov.uk/pubns/books/hsg53.htm

13 *First aid at work: The Health and Safety (First-Aid) Regulations 1981. Guidance on Regulations* L74 (Third edition) HSE Books 2013 ISBN 978 0 7176 6560 0 www.hse.gov.uk/pubns/books/l74.htm

14 *Confined spaces: A brief guide to working safely* Leaflet INDG258(rev1) HSE Books 2013 www.hse.gov.uk/pubns/indg258.htm

15 *Safety signs and signals. The Health and Safety (Safety Signs and Signals) Regulations 1996. Guidance on Regulations* L64 (Third edition) HSE Books 2015 ISBN 978 0 7176 6598 3 www.hse.gov.uk/pubns/books/l64.htm

16 *Code of Practice for Suppliers of Pesticides to Agriculture, Horticulture and Forestry* PB3529 (Yellow Code) Defra www.pesticides.gov.uk/Resourecs/CRD/Migrated-Resources/Documents/Y/yellow_code.pdf

17 *Guidance on storing pesticides for farmers and other professional users* AIS16(rev1) HSE 2012 www.hse.gov.uk/pubns/ais16.htm

18 *Poisons Act 1972 (c.66)* The Stationery Office ISBN 978 620163417 6 www.legislation.gov.uk

19 *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009* SI 2009/1348 The Stationery Office www.legislation.gov.uk

20 *Recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo transport units* MSC.1/Circ.1265 International Maritime Organization 2008 www.imo.org and *Revised recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo transport units* MSC.1/Circ.1361 2010 International Maritime Organization www.imo.org

21 *The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997* SI 1997/2367 The Stationery Office www.legislation.gov.uk

22 *The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013* SI 2013/1471 The Stationery Office www.legislation.gov.uk

23 *Biocides: Regulation* (EU) 528/2012 The Stationery Office ISBN 978 365667077 3

24 *The Control of Pesticides Regulations 1986* SI 1986/1510 The Stationery Office www.legislation.gov.uk

25 *The management, design and operation of microbiological containment laboratories* IAC HSE Books 2001 ISBN 978 0 7176 2034 0

26 *Gassing of rabbits and vertebrate pests* AIS22(rev1) HSE Books 2012 www.hse.gov.uk/pubns/ais22.htm

27 *Phosphine: Toxicological overview* Health Protection Agency 2007 www.gov.uk/government/uploads/system/uploads/attachment_data/file/338253/HPA_Phosphine_toxicological_overview_v1.pdf

28 *Hydrogen cyanide: Toxicological overview* Health Protection Agency 2007 https://www.gov.uk/government/publications/hydrogen-cyanide-properties-incident-management-and-toxicology

29 *Hydrogen sulphide: Toxicological overview* Health Protection Agency 2011 https://www.gov.uk/government/publications/hydrogen-sulphide-properties-incident-management-and-toxicology

30 *Formaldehyde:Toxicological overview* Health Protection Agency 2008 www.gov.uk/government/uploads/system/uploads/attachment_data/file/341379/hpa_formaldehyde_toxicological_overview_v1.pdf

31 *Methyl bromide: General information* Health Protection Agency 2010 www.gov.uk/government/uploads/system/uploads/attachment_data/file/317518/hpa_Methyl_Bromide__General_Information_v1.pdf

Useful contacts

1 City and Guilds www.cityandguilds.com Tel: 0844 543 0000

2 City and Guilds Land Based Services (formerly National Proficiency Tests Council) www.nptc.org.uk Tel: 02476 857300

3 The Food and Environment Research Agency www.fera.defra.gov.uk Tel: 01904 462000

4 The Health and Safety Laboratory www.hsl.gov.uk Tel: 01298 218000

5 The Government Chemist www.lgcgroup.com/lgc-science-and-technology/government-chemist/ Tel: 020 8943 7000

6 Science and Advice for Scottish Agriculture www.sasa.gov.uk Tel: 0131 244 8890

7 The Environment Agency www.gov.uk/government/organisations/environment-agency Tel: 03708 506 506

8 Scottish Environment Protection Agency www.sepa.org.uk Tel: 03000 99 66 99

9 National Poisons Information Service www.npis.org. NPIS does not provide clinical advice to members of the public. In case of a medical emergency following exposure to a chemical, the public should contact NHS 111/NHS 24.

10 BASIS Registration Ltd www.basis-reg.co.uk Tel: 01335 301205

11 British Pest Control Association (BPCA) www.bpca.org.uk Tel: 01332 294288

12 British Standards Institution www.bsi-global.com Tel: 0845 0869001

13 International Maritime Organisation www.imo.org Tel: 020 775 7611

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

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