

# Fumigation

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



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This book is for employers in the fumigation industry and will also be useful to fumigation technicians and safety representatives. It replaces the old Approved Code of Practice, *Control of substances hazardous to health in fumigation operations* (L86), and the guidance note on fumigation (CS22). It incorporates changes to COSHH consolidated in the 2002 regulations (as amended) and also includes new controls on the production, supply and use of methyl bromide in the EU.

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# Introduction

1 Fumigation is a potentially hazardous process which involves the use of toxic gases to kill pests. This guidance explains what your duties are under the Control of Substances Hazardous to Health Regulations 2002<sup>1</sup> (COSHH) and what you have to do to comply with them. The guidance is intended for employers (including the self-employed) who undertake fumigation operations. It should also be useful to those employed as fumigation technicians and to safety representatives.

2 The guidance replaces the former HSC Approved Code of Practice (ACOP) *Control of substances hazardous to health in fumigation operations* (L86). It should be read alongside the HSC Approved Code of Practice and guidance *Control of substances hazardous to health*.<sup>2</sup> It updates and replaces the HSE Guidance Note on fumigation (CS22) by incorporating changes to COSHH consolidated in the 2002 Regulations (as amended). It also includes new controls on the production, supply and use of methyl bromide in the EU brought about by EC Regulation 2037/2000<sup>3</sup> on substances that deplete the ozone layer. Certain fumigation activities may involve work in confined spaces and will therefore attract the requirements of the Confined Spaces Regulations 1997.<sup>4</sup>

## Which operations are included?

3 All fumigation operations are included, whether undertaken in the open air, in temporarily created containment, in suitably prepared buildings or other structures, in ships or in purpose-built fumigation or sterilisation chambers or enclosures. All gases and vapours which may act as asphyxiants are now 'substances hazardous to health' for the purposes of COSHH. This guidance does not cover the use of fogs, mists or smokes. Any treatments involving non-gaseous pesticides approved under the Food and Environment Protection Act 1985<sup>5</sup> (FEPA) or the Control of Pesticides Regulations 1986<sup>6</sup> (COPR) should be in accordance with the ACOP *The safe use of pesticides for non-agricultural purposes*<sup>7</sup> and with the *Code of practice for the safe use of pesticides on farms and holdings*, also known as the Green Code.<sup>8</sup> Please note – The Plant Protection Products Regulations 1995<sup>9</sup> (PPPR) and the Biocidal Products Regulations 2001<sup>10</sup> (BPR) implement European Directives concerning the placing of agricultural and non-agricultural pesticides on the market. Under transitional arrangements, COPR and these regulations are running in parallel.

## Terms and definitions

4 Fumigation is defined in regulation 2(1) of COSHH as an operation in which a substance is released into the atmosphere so as to form a gas to control or kill pests or other undesirable organisms.

5 Other terms included in this guidance, which are not defined in COSHH include:

- 'fumigation operation': the entire procedure including the preparation for fumigation, the fumigation operation itself and the steps taken after fumigation, eg aeration and clearance;
- 'fumigation area': the whole of the area or space to which a fumigant will be applied;
- 'fumigant-generating material': a substance which is used for generating a fumigant gas;
- 'technician': a person who is engaged in a fumigation operation;
- 'technician in charge': a technician who directs the fumigation operation;
- 'risk area': 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 technicians and others, eg structures connected to the area or space which has been fumigated.

### What does COSHH require?

6 COSHH places duties on employers to:

- assess the risks from work likely to expose employees to hazardous substances;
- prevent or control the exposure of employees and others affected by the work;
- establish and maintain control measures as necessary;
- carry out health surveillance where appropriate; and
- inform and train employees.

7 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 technician in charge. The majority of the legal duties, however, remain with the employer. Where the employee of one employer works at another employer's premises, both employers will have duties under COSHH. Co-operation and co-ordination will be needed to make sure these duties are fulfilled.

8 If a fumigant is within the scope of COPR, it must have been approved under these regulations. The conditions of approval and consent should form the basis of the COSHH assessment.

### EC Regulation 2037/2000

9 This Regulation, on substances that deplete the ozone layer, replaces Council Regulation EC 3093/94 and introduces new controls on the production, supply and use of methyl bromide within the EU. The Regulation enforces within the European Community the commitments agreed by the Parties (currently over 170) to the Montreal Protocol. This is an international treaty developed to protect the Earth from the detrimental effects of ozone depletion. It controls the production and trade in ozone depleting substances worldwide. The EC Regulation is directly applicable in the UK without transposition into UK law. It reduces the levels of methyl bromide that can be manufactured and supplied and has, as at 1 January 2005, phased it out except for defined quarantine and pre-shipment critical uses and any uses subsequently agreed by the Parties to be critical. The latter are considered by the Montreal Protocol Technical and Economic Assessment Panel. More information is available in a leaflet produced by DEFRA, *Ban on methyl bromide: For the suppliers and users of methyl bromide*.<sup>11</sup> The regulation also requires all practical precautionary measures to be used during fumigations with methyl bromide,

including use of virtually impermeable films (VIF) or other similar methods for soil treatments. The procedures outlined in this guidance also serve to meet the requirements of the EC Regulation.

10 The phase out of methyl bromide means that users need to reduce their reliance on it as a fumigant and look to alternative methods of pest control. Any move to alternative methods that involve hazardous substances must be carried out in compliance with COSHH.

11 Where a reference is made to a workplace exposure limit (WEL), please note that these are amended from time to time. Ensure you keep up with such changes by referring to the latest edition of EH40/2005 *Workplace exposure limits*.<sup>12</sup> The previous system, setting occupational exposure limits (OELs) as maximum exposure limits (MELs) and occupational exposure standards (OESs) has been discontinued in favour of a single type of OEL, known as the WEL. Certain former OESs have not been converted to WELs because of doubts that the limit was not soundly based. These OESs have been removed. Where a fumigant does not have a WEL, this does not mean that the substance is safe. This guidance will help you control exposure to a level to which nearly all the population could be exposed daily, without adverse health effects.

## Qualifications and duties of technicians

12 Technicians should only be involved in a fumigation operation if they have been properly instructed and informed about the properties of the particular fumigant they are going to use and the safety precautions. They must be competent to undertake the operation and have received adequate training and certification.

### Instructions

13 Employers should ensure that sufficient and suitable instruction is given to technicians, so they will not endanger themselves or others through exposure to fumigants, fumigant-generating materials or residues. Technicians and technicians-in-charge engaged in fumigation should know:

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

## Training and certification

14 Employers should ensure that in relation to a particular fumigant, technicians are given training in the following:

- the hazards of the fumigant – which means the properties of the substance which have the potential to cause harm to health (see paragraphs 83-90);
- the operational control of the fumigant;
- the use, maintenance and limitations of Personal Protective Equipment (PPE);
- the use of application equipment in accordance with manufacturers' instructions on the label or otherwise;
- the use of calibrated equipment for the detection and measurement of that fumigant in the atmosphere;
- the action to be taken in an emergency;
- the signs and symptoms of poisoning by that fumigant;
- the action to be taken in the event of a poisoning; and
- the transport and storage of fumigants and fumigant-generating materials.

15 Because of the nature of risks involved in fumigation operations, it is recommended that employees initially be given basic training covering these areas. This may include limited practical experience such as observing fumigation from a place of safety (outside the risk area) or taking part in the preparation for fumigation. Until they have received and completed this basic training, trainees should be kept at a safe distance from the fumigant and not allowed to handle fumigants, fumigant-generating substances or articles that may have been contaminated.

16 After completion of the basic training, trainees may be allowed to take part in a fumigation under supervision. It is up to the employer to decide when the employee is competent to perform the duties of a technician and authorise the employee to carry out these duties. Evidence of competence is the Certificate of Proficiency issued by the British Pest Control Association (BPCA). **For fumigation using methyl bromide, certification is now mandatory under EC 2037/2000.** ProFume™ (sulfuryl fluoride) can only be used by Dow AgroSciences trained fumigators. The employer should issue a written authorisation, giving a full account of the training received and clearly stating the extent of the duties that the employee is considered capable of undertaking.

17 Employers need to keep the authorisation under review and revise it in the light of the holder's experience and the types of fumigation in which they are currently considered competent. When reviewing the authorisation, consider all known factors that may affect the technician's continuing competence to carry out fumigation operations of the types specified in the authorisation. Keep a record of each technician's authorisation.

18 Technicians and trainees (including the self employed) should be registered with the BPCA. They maintain a Register of Fumigation Technicians and Trainees in all fumigation companies, whether BPCA members or not, to control the supply and use of methyl bromide. They also produce codes of practice and arrange courses and certification examinations on fumigation practices. They can be contacted at: BPCA, Ground Floor, Gleneagles House, Vernongate, Derby DE1 1UP Tel: 01332 294288, Fax: 01132 295904, e-mail: enquiry@bpca.org.uk.

19 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 will usually be a judgement that at least two technicians will be needed for the fumigation. Make one of the technicians the technician in charge and give them responsibility for:

- the safe keeping, issue and release of the fumigant;
- observing all necessary safety precautions laid down by the employer, including the posting of warning notices and their removal after the issue of a certificate of clearance;
- confirming, at the end of the fumigation operation, that the fumigation and risk areas are safe for re-entry.

20 In the case of a large or complex fumigation, more technicians may be needed. In such circumstances the technician in charge may act as supervisor.

## The fumigation operation

### COSHH assessment

21 Under COSHH, you must carry out a risk assessment before a fumigation operation is started. Unless you are using a new product or substance, the job of drawing up the risk assessment should be largely routine, based on good practice and using standard procedures. If it is a new product, then you will need to go back to basics and examine the hazards and possible risk of exposure. The purpose of the risk assessment is to determine the likelihood of technicians and others suffering ill health through exposure to fumigants so that all steps can be taken to prevent that exposure as far as is reasonably practicable, or adequately control it. If you employ five or more technicians you must record the significant findings of the risk assessment as soon as you can after it has been completed. It is strongly advised that even if you have less than five employees you keep a written record of your assessment.

22 This guidance will help you to carry out a risk assessment for each fumigation operation and take account of the particular circumstances. This applies especially if you are planning to use a product or substance which you have not used before. The risk 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 gas being used (eg methods of application) and on the premises being fumigated. The following sections give guidance on the various aspects of fumigation you need to consider in the risk assessment.

# Procedures common to all fumigations

## Choice of fumigant

23 You have a duty under COSHH to assess whether there are safer alternatives to fumigation that would be reasonably practicable, in other words, as effective but less hazardous. Assuming, however, that fumigation is necessary, the choice of fumigant will be determined by the individual circumstances, eg the commodities or premises to be fumigated, availability of the fumigant, temperature, target pest, and available time to complete the fumigation. If a fumigant is within the scope of COPR, then it must have been approved under COPR. The conditions of approval will form the basis of the assessment.

24 Substances that are currently approved and in use in the UK include:

- methyl bromide;
- phosphine generating substances, eg magnesium phosphide and aluminium phosphide;
- sulfuryl fluoride;
- carbon dioxide;
- chloropicrin;
- methyl iso-thiocyanate generating substances, eg dazomet, metam sodium;
- 1-3 dichloropropene;
- formaldehyde.

25 With the phase out of methyl bromide, alternatives are being actively researched. Possible future replacements in the UK include:

- carbonyl sulphide;
- phosphine in liquid carbon dioxide;
- phosphine in pressurised nitrogen.

## Storage and transport

26 General guidance on storage of pesticides may be found in the *Code of practice for suppliers of pesticides to agriculture, horticulture and forestry*,<sup>13</sup> (the Yellow Code). HSE has also produced an information sheet called *Guidance on storing pesticides for farmers and other professional users*.<sup>14</sup> Anyone storing over 200 kg or 200 litres of pesticides must hold a BASIS Storekeeper's certificate of competence (see Further information section for details).

27 Fumigant gases kept under pressure, 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.



**Figure 1** Poison warning sign

28 Gassing powders, sachets and fumigation tablets such as aluminium or magnesium, phosphide and dazomet should be stored off the floor in a separate, moisture-proof, and fire-proof chest, bin or vault. The container should be marked 'Gassing compound: Do not use water' and should be kept locked.

29 Certain substances are subject to the provisions of the Poisons Act 1972.<sup>15</sup> This will be indicated on the product label. All Part 1 poisons, for example aluminium phosphide, must be kept under lock and key in a designated area of the store. See Figure 1 for an example of a poison warning sign.

30 Where fumigants and fumigant-generating materials are classified as dangerous for carriage, transport them in accordance with the requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004.<sup>16</sup>

31 Always carry gas cylinders, packages of fumigant and associated equipment outside the passenger compartment of transport vehicles. Where the risk assessment shows it to be necessary, keep these cargo areas well ventilated at all times and make respiratory protective equipment (RPE) available in the driver's cab in case of emergency, and train the driver in its use. Keep this RPE in a suitable container and do not use it during fumigation operations.

### Detection and other equipment (other than PPE)

32 Ensure that all equipment is examined before it is used in a fumigation operation and follow the instructions for maintenance issued by the manufacturers. Where appropriate, make arrangements for it to be examined and serviced regularly. In addition to routine examination by the technician-in-charge before carrying out fumigation, arrange for regular inspection and, where appropriate, calibration of detection equipment to ensure that all items are in effective working order.

33 Where appropriate, ensure that technicians have suitable fumigant detection equipment which they have been trained to use. Of the equipment described in paragraphs 35-37, at present only gas detector tubes are sufficiently accurate for confirming that levels of fumigant have fallen below the WEL or other appropriate level as indicated in paragraph 11, and that premises are safe for reoccupation. However, if technical advances make other methods available, these may be used, provided they are suitable for the purpose.

34 Methyl bromide cannot be detected by smell at low concentrations. For this reason, an indicator substance (eg amyl acetate) is sometimes added as a warning agent. Indicator substances, when present, give warning of leakage from cylinders and working spaces; but they are not indicators of safe working conditions. For this purpose use one of the methods described below.

### Portable electronic gas detectors

35 These have solid state diffusion type sensors which respond to the presence of vapours. They are extremely sensitive but will respond to other vapours, not only the fumigant. Some give a continuous audible warning with the frequency depending on the concentration of the gas, while others have a visual display of light-emitting diodes and trigger a warning bleep at concentrations above the WEL or other appropriate level as indicated in paragraph 11.

36 Other instrumental methods, based on electro-chemical cells, can also be used, especially for phosphine. For ProFume (sulfuryl fluoride) refer to the Dow AgroSciences approved electronic detection devices list. Take care, however, to ensure that other organic vapours do not interfere with the measurement of the fumigant.

### **Gas detector tubes**

37 Precise measurement of the concentration can be achieved using the simple method of a 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 the associated 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. Gas detector tubes can vary considerably in their accuracy and it is preferable to use tubes conforming to BS EN 1231:1997.<sup>17</sup> Use the tubes strictly in accordance with the manufacturers' instructions, particularly in relation to storage and expiry dates. A fresh tube is required for each determination. At present only gas detector tubes should be used that are capable of confirming that levels of fumigant have fallen below the WEL or other appropriate level indicated in paragraph 11, or that premises are safe for reoccupation. The HSE publication HSG173 *Monitoring strategies for toxic substances*<sup>18</sup> gives advice on sampling strategies and practical guidance on interpretation of the results. Gas detection tubes are not currently recommended for the detection of ProFume.

38 Advice on methods of detection can be obtained from the Central Science Laboratory, the Health and Safety Laboratory, the Laboratory of the Government Chemist or the Scottish Agricultural Science Agency. Please see Further information section for contact details.

### **PPE, including RPE**

39 Use the PPE indicated by the risk assessment and where directed, on the product label. PPE (including RPE) made or imported on or after 1 July 1995 must be 'CE'-marked in accordance with the requirements of the amended Personal Protective Equipment Regulations 2002.<sup>19</sup> Non-CE-marked PPE made or imported before 1 July 1995 may continue to be provided and used as long as it still offers adequate protection and is properly maintained.

40 Clothing, rubber gloves, surgical dressings etc can be penetrated by methyl bromide and may cause severe blistering of the skin. Do not wear gloves or rubber boots while working with methyl bromide in case liquid or concentrated vapour is trapped inside them. Do wear safety footwear when handling cylinders of methyl bromide. Rubber gloves and boots should not be worn when applying ProFume as these may trap liquid and prevent evaporation from the skin. Liquid sulfuryl fluoride, if in contact with the skin and eyes, can cause a freeze burn, whereas in its gaseous state it does not. You do not have to wear coveralls unless working with solid fumigants, but if you do, make sure they are light fitting and that air can pass through them.

41 When working with solid fumigants, you should wear light coveralls and appropriate footwear to avoid direct contact with the solid fumigant. Synthetic rubber or PVC gloves are needed.

42 RPE must be used when working with methyl bromide and sulfuryl fluoride. It is also recommended for phosphine. Either breathing apparatus or canister respirators may be used depending on the circumstances. If you are using a canister respirator, have spare unused canisters of the right type for the fumigant being applied to hand and ready to use. Follow the manufacturers' instructions on the life of the canister. For ProFume, canister respirators must not be used. Self-contained breathing apparatus is compulsory.

43 Always follow the manufacturers' instructions for testing and use. Arrange for RPE to be inspected and tested regularly to ensure it is working properly. It is recommended that this is at least once a month and more often when the conditions are particularly severe. Before each fumigation, ensure that technicians check their RPE is in sound condition. They should examine, for example the head harness, facepiece, exhalation valve, canister/air supply, breathing tube and testing for gas tightness (face fit). A simple test for good face fit is, after having put on the RPE and properly tensioned and adjusted the harness straps, to close the air inlet lightly with a card and inhale gently. The facepiece should then collapse slightly against the face. Do not make equipment uncomfortably tight to pass the test. If the facepiece does not collapse, this is a sign of excessive leakage; readjust the equipment and repeat the test. If the facepiece still does not collapse, replace it, since it is unlikely that it will give full protection. Technicians with facial hair or who wear glasses are unlikely to achieve a satisfactory face fit where a good seal is required. Further advice is given in the HSE publication *Respiratory protective equipment at work*.<sup>20</sup>

44 A record of all examinations and tests of engineering controls and RPE must be kept. Records must be kept for at least five years and should be readily available for inspection.

45 Wear RPE when opening cylinder valves, puncturing cans or changing pipe connections. At all other times during a fumigation carry RPE in such a way that it can be put on quickly if detection equipment indicates concentrations of fumigant at or above the WEL or other appropriate level, as indicated in paragraph 11.

### **Other measures to protect the skin**

46 Ensure that any recent cuts or abrasions are protected and the dressings changed immediately if they become contaminated or damp.

### **Defining the fumigation and risk areas**

47 The fumigation area is the whole area or space to which a fumigant is intended to be applied. It is always sealed from other areas and made as gas tight as possible. No one may enter it during a fumigation period, except in a serious emergency such as a fire and then only by agreement with the technician in charge of the fumigation. In such circumstances personal protective equipment, including RPE, will need to be worn.

48 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. The risk area may only be entered with the permission of the technician in charge and suitable PPE, including RPE will need to be worn.

# Preparing for fumigation

## Advance notification

49 Regulation 14 of COSHH says that if you are planning a fumigation using hydrogen cyanide, phosphine or methyl bromide, you must notify certain people such as the local council and fire brigade in advance. These are listed in Schedule 9 to COSHH (Part I), and the information that needs to be given is listed in Part II. There are some exceptions to this and these are listed in Schedule 8 to COSHH. Take this action as early as possible and at least 24 hours in advance, unless a shorter period has been agreed with those being notified. For example, aircraft arriving from abroad may need immediate fumigation. Consider also whether it may be appropriate to notify others – for example the ambulance authority. These procedures should also be followed for sulphuryl fluoride.

50 Take into account any particular precautions which may need to be taken regarding entry into confined spaces. These 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 the HSE guidance note *Safe work in confined spaces*<sup>21</sup>

51 As the employer, you will need to take the following precautions:

- evacuate the fumigation area (removing and securing any non-target animals, plants etc) and only allow fumigation technicians into the risk area;
- remove absorbent liquids and foodstuffs and, where possible, other absorbent solids (other than those intended to be fumigated) from the fumigation area;
- extinguish fires and naked lights including pilot lights, remove other sources of ignition (and allow hot elements to cool) in the fumigation and risk areas. When using Profume, glowing red electrical heating elements that may be directly exposed to the fumigant-laden air, must be turned off before introducing the fumigant;
- seal the fumigation area, checking for unusual escape routes for the gas, eg sumps, drains, holes around ducting, ducting shafts, pipe work, connections behind false ceilings etc;
- disconnect any unnecessary electrical supply to the fumigation area;
- secure the risk area against unauthorised entry; and
- place warning notices 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.<sup>22</sup> An example is given in Figure 2.



Figure 2 Warning sign

## During fumigation

52 You will need to:

- restrict the amount of the fumigant to the minimum necessary to carry out the fumigation both effectively and safely. This may be achieved by managing the temperature, improving the sealing and/or extending the duration of fumigation;
- check for and repair any leaks from the fumigation area or the application equipment and piping outside the fumigation area, especially at joints and couplings. Use an electronic detector or other detection device. If leaks are detected, they must be dealt with by a technician wearing RPE, before the fumigation continues. If it is not possible to seal a leak, extend the fumigation area and risk areas; and
- if atmospheric monitoring indicates that there is no leakage and the risk area can safely be reduced, consider 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 may need to be evacuated and warning notices erected.

## After application of fumigant

53 Remove equipment that is no longer required and surplus fumigant from the site:

- ensure that any cylinder valves are closed, and valve caps and cylinder caps are in position;
- ventilate all equipment and inspect it for residues while wearing appropriate RPE and PPE before loading it into transport or placing it in store; and
- remove any contaminated clothing and equipment (including RPE) and air it in a well-ventilated place for a minimum of two hours or until free of fumigant, whichever is the greater.

54 Skin and hair may become contaminated. Brush them free of residues in a well-ventilated place after work and before smoking, washing, eating or drinking or going outdoors in the rain.

## Venting

55 Ventilate the fumigation area and risk area at the end of the fumigation period. Where venting fumigated buildings, if possible start from the top of the structure to minimise the risk of the fumigant coming into contact with technicians or others. Where it is necessary to enter the fumigation area to effect the ventilation, eg to open doors or windows, then breathing apparatus should be used. The COSHH assessment should identify areas such as cellars, enclosed vessels and other similar confined spaces that may require 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. The technician in charge should ensure that all areas are safe for reoccupation by testing the atmosphere until the concentrations of fumigant have fallen below the WEL or other appropriate level. The technician in charge should wear suitable RPE. Take special account of materials in the fumigation area that may continue to desorb gas after the end of the fumigation operation.

## After venting

56 You will need to remove equipment from the site.

- Air gas-proof sheeting until it is free of fumigant before folding, rolling, transportation and storing it for future use. Similarly, air unwanted sheets before disposal.
- Dispose of empty tins or containers in accordance with the Green Code or after consultation with the Environment Agency (England and Wales) or the Scottish Environment Protection Agency (SEPA) – see the further information section for details.
- The residues remaining at the end of a fumigation with phosphine consist of inert metal hydroxide and a small amount of undecomposed metal phosphide, which will continue to decompose and generate phosphine very slowly. Remove residues which may contain unreacted phosphide from the fumigation and risk areas and render them safe for disposal, eg by total immersion in water containing 2% detergent by volume (to aid mixing) until gas is no longer generated. 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 the servicing company's premises. Dispose of the remaining residue of metal hydroxide after consultation with the Environment Agency or SEPA.
- Avoid heaping used packets or loose phosphide residues or closing them in any container or plastic bag as this might result in fire or an explosion.
- Remove and air any contaminated clothing and equipment.
- Brush hair and skin free of spent phosphide residues.

57 When all areas have been demonstrated to be safe for reoccupation, but before removing barriers and warning signs, issue a certificate of clearance 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 retain one copy for your records. The technician in charge signs the clearance certificate once the fumigation operation has been completed. It confirms that the fumigation site is safe for re-occupation and hands back the site to the owner/occupier.

58 Where confined spaces or enclosed vessels are involved, ensure that the certificate of clearance makes it plain that if the confined space or enclosed vessel is resealed, traces of gas may desorb slowly and accumulate. It may no longer be safe to enter without further ventilation.

59 After the certificate of clearance has been issued, remove any barriers and warning signs.

CLIENT NAME .....

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

The area(s)\* shown below has/have been fumigated with ..... at a dosage of .....g/m<sup>2</sup> 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.

<b>CONTRACTOR'S REPRESENTATIVE</b>	<b>GROWER'S AUTHORISED REPRESENTATIVE</b>
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<sup>3</sup> 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.

<b>CONTRACTOR'S REPRESENTATIVE</b>	<b>GROWER'S AUTHORISED REPRESENTATIVE</b>
NAME..... (CAPS)	NAME..... (CAPS)
SIGNED .....	SIGNED .....
POSITION .....	POSITION.....
DATE .....	DATE .....
TIME .....	TIME .....

**Figure 3** Soil and general fumigation clearance certificates

# Health records and health surveillance

60 Health surveillance includes keeping an individual health record and enquiries by a responsible person about any symptoms following self-reporting by employees (eg burns from fumigants). A responsible person is someone appointed by the employer who is competent to carry out the relevant investigation and report back to the employer on the outcome.

61 Keep health records for all those involved in fumigation operations containing the following information:

- surname;
- forenames;
- gender;
- date of birth;
- permanent address and post code;
- National Insurance number;
- medical practitioner;
- date when present employment 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.

The conclusions should relate only to the employee's fitness for work and should include, where appropriate, a record of the decisions of the medical inspector or appointed doctor, or conclusions of the medical practitioner, occupational health nurse or other suitably qualified or responsible person. 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.

## Health effects of methyl bromide, phosphine, chloropicrin and sulfuryl fluoride

62 Depending on the level of concentration and length of time, exposure can be fatal. Anyone poisoned by these substances will need immediate medical attention. Methyl bromide can penetrate clothing, shoes, rubber gloves, surgical dressings etc and the vapour, if in contact with the skin, can cause severe blistering. The blisters are usually large and surrounded by areas of redness and swelling. They may take a long time to heal. If in contact with skin or eyes liquid sulfuryl fluoride can cause freeze burns. In severe cases, freeze burn of eyes can cause blindness.

63 Methyl bromide is classified as toxic by inhalation and irritating to eyes, the respiratory system and skin. It may enter the body by inhalation causing respiratory irritation and later pulmonary oedema, or by absorption via the skin. Prolonged skin contact with liquid methyl bromide will cause severe skin burns. Poisoning can cause damage to the brain, nervous system, skin, lungs and kidneys.

64 Phosphine and phosphides are hazardous materials. They may enter the body by inhalation of phosphine gas or particles of phosphide dust or by swallowing phosphide preparations.

65 Sulfuryl fluoride is classified as toxic by inhalation. It may enter the body by inhalation as sulfuryl fluoride gas.

### *Symptoms*

#### *Methyl bromide*

66 The symptoms of methyl bromide poisoning following significant inhalation are:

- headache;
- dizziness;
- smarting of the eyes;
- cough;
- nausea;
- abdominal discomfort; and
- possible numbness of the feet.

67 The symptoms of higher or more prolonged exposure to methyl bromide are:

- unconsciousness;
- weakness of the legs;
- convulsions;
- possible delayed effects on vision, hearing and balance.

A rapid outpouring of fluid into the lung (pulmonary oedema) can occur up to 30 hours after exposure.

68 The symptoms of single or prolonged exposure to sulfuryl fluoride following inhalation are:

- nausea;
- difficulty in breathing;
- abdominal pain;
- slow and uncoordinated movements;
- slow or garbled speech;
- numbness in extremities;
- reduced awareness;
- lung irritation;
- pulmonary oedema.

#### *Phosphine*

69 The symptoms of phosphine poisoning following inhalation are:

- nausea;
- vomiting;
- headache;
- weakness;
- faintness;
- pain in the chest;
- cough;
- chest tightness; and
- difficulty in breathing.

Pulmonary oedema (fluid on the lungs) may also occur, usually within 24 hours of exposure, but it is occasionally delayed for a few days.

### *Chloropicrin*

70 The symptoms of poisoning following inhalation are:

- lachrymation (weeping from the eyes);
- coughing;
- difficulty in breathing;
- sore throat;
- dizziness;
- bluish skin;
- vomiting;
- possible pulmonary oedema.

71 Skin contact with chloropicrin can lead to chemical burns or dermatitis. Contact with the eyes can cause pain and redness and prolonged eye exposure can cause blindness.

### First aid

#### *People affected by fumigant*

72 Take the person into the fresh air at once and keep them quiet and warm. Rescuers must take care not to become poisoned themselves. Seek immediate medical attention and show the product label, Tremcard or safety data sheet to the doctor/paramedic. 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, administer artificial respiration using oxygen and a suitable mechanical device such as a bag and mask. **Do not use mouth-to-mouth resuscitation** (even with a resuscitator device).

### Methyl bromide

73 Remove any clothing that may have become contaminated and flood the contaminated part of the skin with water and wash it thoroughly. Keep a plentiful supply of clean water near fumigation areas for this purpose. If reddening of the skin or blistering occurs cover the affected parts loosely with sterile dressings.

74 One of the main dangers of methyl bromide is the delay between exposure and the onset of symptoms of poisoning. If any symptoms are observed, call an ambulance or take the person to hospital immediately.

### Sulfuryl fluoride

75 In all cases of overexposure seek medical attention **immediately**. Call medical emergency services immediately or take the person to a doctor or emergency treatment facility and show the label and the manufacturer's safety data sheet.

76 **If inhaled:** Remove the exposed person to fresh air. Keep warm and at rest. Make sure the person can breathe freely. If breathing has stopped, give artificial respiration. Do not put anything in the mouth of an unconscious person. Seek medical attention immediately.

77 **If liquid is on the skin or clothing:** Immediately apply water to the contaminated area of clothing before removing. Once the area has thawed, remove contaminated clothing, shoes, and other items covering the skin. Wash the contaminated area thoroughly or shower. Seek medical attention immediately.

78 **If liquid is in the eyes:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing the eye. Liquid sulfur dioxide in the eye may cause damage due to freezing. Seek medical attention immediately.

79 Sulfur dioxide is a gas that has no warning properties, such as odour or eye irritation. Repeated exposure to high concentrations can result in significant lung and kidney damage. Single exposures at high concentrations have resulted in death.

## Phosphine

80 People exposed to phosphine run the risk of pulmonary oedema even if they do not appear to be seriously affected. They should be kept under medical supervision for several days.

## Chloropicrin

81 If skin has been exposed remove contaminated clothing and decontaminate with running water. If eyes are affected flush with clean water. If gas has been inhaled, give oxygen if available or administer artificial respiration. Anyone who has been exposed to chloropicrin should be referred to hospital for observation and monitoring.

## Medical treatment

82 Ensure that notes on the treatment of poisoning for the guidance of medical practitioners are available at every fumigation and send them with the patient to the doctor or hospital. The manufacturer usually supplies such notes with the fumigant. The Department of Health issues guidance to medical practitioners in the handbook, *Pesticide poisoning*,<sup>23</sup> which includes advice on the toxic effects which may arise through misuse or accident with fumigants, and on their treatment. Advice on medical treatment may also be obtained from National Poisons Information Service Centres ([www.npis.org](http://www.npis.org)).

## Properties

### *Methyl bromide*

83 At normal temperatures, methyl bromide is a colourless gas 3.27 times heavier than air. It boils at +4°C and the pure gas has a faint, sweetish smell. At atmospheric pressure, methyl bromide has explosive limits at about 10% to 16% by volume in air but can be ignited only by a high energy source. Otherwise, for all practical purposes, mixtures of methyl bromide and air can be considered to be non-flammable.

84 Pure methyl bromide does not corrode most metals, but aluminium and its alloys may be attacked by prolonged contact with liquid methyl bromide. Natural rubber is attacked strongly by liquid methyl bromide but of the common plastics, polythene, polypropylene and nylon appear to be least affected. The pure gas may similarly affect those materials which are attacked strongly by the liquid, but the dilute concentrations of vapour in air (usually below 1% by volume) used in fumigation have little effect so that it is possible, in fumigation practice, to employ sheeting coated with a variety of synthetic rubbers and other plastics.

### ***Sulfuryl fluoride***

85 Sulfuryl fluoride is a gas fumigant product which contains 99.8% of inorganic chemical sulphuryl fluoride and 0.2% inert ingredients. The product is supplied in steel cylinders, as a liquefied gas under pressure. Sulfuryl fluoride is colourless and odourless and has a boiling point of  $-55^{\circ}\text{C}$ . It is approximately 3.5 heavier than air and has a gas solubility, at  $25^{\circ}\text{C}$  and 760 mm HG, of 750 ppm by weight. It is relatively non-reactive as a gas. It is not combustible.

### ***Phosphine***

86 Phosphine is a gas under normal conditions but can be liquefied at low temperatures and high pressures. The boiling point at atmospheric pressure is  $-87^{\circ}\text{C}$ . Its density is 1.2 (air = 1). As normally manufactured, it is colourless and odourless. Any 'fishy' or 'garlic-like' smell is due to impurities. It is generally held that very pure phosphine is not spontaneously flammable except at low pressures. Nevertheless, phosphine will ignite at a temperature of about  $100^{\circ}\text{C}$  and, with air, it will form an explosive mixture when the phosphine content exceeds about 1.8% by volume. The fire/explosion risk associated with phosphine is reduced by using the products specially formulated for fumigation purposes.

87 Phosphine is slightly soluble in cold water, has low solubility in most solvents and is not strongly absorbed onto wood, plastics or textiles. It reacts with certain metals, eg copper and its alloys, the reaction being more rapid in the presence of moisture and at high temperatures.

88 The short-term WEL (15-minute reference period) for phosphine is 0.3 ppm ( $0.4\text{ mg/m}^3$ ) and exposure should be reduced to this standard. There is no long-term WEL. Phosphine can sometimes be detected in the atmosphere at concentrations around the short-term WEL by the unpleasant odour of its impurities. However, do not rely on detecting phosphine in the atmosphere by smell, as people vary greatly in their sensitivity, which is reduced in the continuous presence of low concentrations of phosphine.

### ***Chloropicrin***

89 Chloropicrin is a soil fumigant used for its broad biocidal and fungal properties. It is a colourless to light green oily liquid with an intense and penetrating odour. It is not flammable, but could be a significant explosion hazard if involved in a fire. An alternative name is trichloronitromethane.

90 The short-term WEL (15-minute reference period) for trichloronitromethane is 0.3 ppm ( $2.1\text{ mg/m}^3$ ). The long-term exposure limit is 0.1 ppm ( $0.68\text{ mg/m}^3$ ).

# Extra precautions for different application methods

91 The following precautions are recommended for the application of methyl bromide or phosphine. However, the principles can also be applied to other fumigants.

## Methyl bromide

### *Release from cylinders as a liquid*

92 Locate cylinders outside the fumigation area, unless application is to be carried out by remote control. Apply the fumigant through piping terminating in symmetrically placed spray devices; never apply manually inside the fumigation area. If the pressure in the cylinder is below 10-15 bar and needs to be increased, use compressed nitrogen or other inert gas rather than compressed air, since oxygen and water vapour in the air will react with the methyl bromide causing corrosion.

93 Ensure that piping and fittings are compatible with the pressure of the methyl bromide in the cylinders.

94 Before disconnecting an empty cylinder and connecting a new one to the piping system, close the empty cylinder and purge the pipework with compressed air or inert gas before disconnecting the empty cylinder. Also do this at the end of the fumigation and seal the piping.

### *Release from cylinders using vaporisers*

95 Liquid fumigant may be passed through a vaporiser to form a gas which is then piped to the fumigation area. Paragraphs 92-93 apply here also. Do not allow liquid methyl bromide to pass into the distribution base. A liquid trap may be fitted on the outlet side of the vaporiser to prevent this.

96 Where the vaporiser design includes a liquid trap, take particular care when disconnecting the apparatus, as all the liquid may not have evaporated. By adjusting the flow of liquid from the cylinder, accumulation of liquid in the trap can be avoided.

97 Operate vaporisers inside the fumigation area only in exceptional circumstances (see paragraph 133).

## Sulfuryl fluoride

98 Sulfuryl fluoride cylinders should be placed outside the fumigation area. The cylinders are connected to leak-proof introduction tubes with a minimum burst pressure of 3440 kPa, which pass into the fumigation area and connect to a fan. The fumigant is dispersed by the air stream created by the fan. A fog-out (condensation of moisture caused by a drop in air temperature) is prevented by using fans of sufficient capacity. For building fumigation, application of sulfuryl fluoride should be into large open spaces and direct application to any surface should be avoided.

## Phosphine

99 Phosphine may be generated from solid aluminium or magnesium phosphide preparations. Fumigations typically last from 5-16 days and sometimes longer. High standards of proofing and the use of low permeability sheeting are very important.

### *Release from other preparations*

100 Metallic phosphide preparations generate phosphine at a rate dependent on temperature and relative humidity. This may take several days. Apply the preparations as quickly as possible and in a manner which allows easy removal of spent residues. Take particular care when handling magnesium phosphide preparations because they generate phosphine more rapidly than others. All types of phosphide preparations generate phosphine to a limited extent during storage. Because phosphine may form an explosive mixture with air, always point the mouth of the container away from the face when opening. Calculate the total dose to the nearest number of phosphide packages. Use the entire contents of a container, unless it is designed for airtight resealing. For safety, it is better to under-dose to a small extent if necessary.

101 Where possible, avoid direct contact with the commodity to be fumigated by placing tablets or pellets on trays or sheets of suitable material, eg plastic or metal, spacing them so that they do not touch each other. Residues may then be retrieved at the end of the fumigation. The BPCA with the Acheta partnership have produced guidance for the safe disposal of phosphine residues following commodity fumigations. Bags, bag-blankets and plates etc may be placed on the surface of bulk or packaged materials and retrieved later. However, in the fumigation of bulk foodstuffs such as grain, tablets, pellets or bags may be mixed intimately with the foodstuff and the residues subsequently removed by filtering processes at the end of the fumigation and subsequent ventilation.

## Extra precautions for different types of fumigation

### **Buildings**

102 Before any fumigant is released, check the building to make sure it is clear of people, non-target animals and plants and ensure that no unauthorised person can gain access until the building has been vented and declared safe by the technician in charge.

103 Make the building as gas tight as possible. If the fumigation area is part of several interconnected buildings, seal it off from the adjoining structures. Consider areas separated from the fumigation area only by a dividing wall to be part of the risk area and evacuate them during the period of fumigation. Seal all windows, doors and other openings from the building with masking tape or other suitable material, unless the building is to be enveloped completely by fumigation sheets of low permeability.

104 Carefully consider the number of technicians needed. They should work in pairs so that ventilation can be carried out safely. At the end of the fumigation period, the technicians, 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. Under instruction from the technician

in charge, and after testing the atmosphere, technicians may then enter the building and open the windows and other doors. In multi-storey or multi-section buildings, it may be necessary to leave the fumigation area 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. When working inside the building, wear RPE, unless tests with detection equipment show that concentrations of fumigant do not exceed the WEL or other appropriate level as indicated in paragraph 11. Pay particular attention to areas which are difficult to ventilate, including basements and stairwells where heavy gases such as methyl bromide and sulfuryl fluoride may accumulate. In the case of buildings to be occupied by people, do not allow reoccupation until suitable monitoring equipment shows that the area contains gas levels below the permissible exposure limit for that fumigant. Pay special attention to any absorbent materials which may continue to desorb gas for some time and may require additional ventilation.

105 At the end of the ventilation period, disconnect, dismantle and remove all piping and application equipment from the fumigation area and risk areas. Issue a certificate of clearance after the technician-in-charge has retested 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**

106 Use sheets of low permeability which are in sound condition.

107 Where it is not possible to stack the commodity on a concrete or other hard standing, it will be necessary to lay polythene sheeting on the ground.

108 If phosphine is used, new polyethylene sheeting, of at least 125 microns (500 gauge) thickness (or laminated sheeting of lower permeability) is recommended. Where more than one sheet is needed to cover a stack, seal the individual sheets one to another by rolling, use of spray-on adhesive or other suitable methods. Allow sufficient width of sheet on the floor to permit effective weighting down with sand snakes. Do not use water snakes, which can leak and could cause a fire if the water encounters the phosphide formulation. Where the stack is on pallets or dunnage, the phosphide preparations may be placed underneath the stack. Sachet or plate formulations can be carefully hung down the sides of the stack but not in contact with the sheet.

109 If fumigation is under gasproof sheets inside buildings, allow a ventilation period for the building before collecting sheets, piping or spent residues.

## **Ships**

### ***Coasters, barges and ocean-going ships***

110 Carry out fumigation in accordance with the recommendations of the International Maritime Organisation (IMO) who have produced a booklet<sup>24</sup> of recommended practice. The International Maritime Dangerous Goods (IMDG) Code<sup>25</sup> will also be applicable; some extracts are given in Appendix 1.

***At berth or at anchor***

111 Ensure the vessel is at a suitable location (check with the Port Authority), in good condition and capable of being sealed effectively. When the cargo space alone is to be fumigated, seal off any opening to other compartments. If this is impracticable, regard such compartments as part of the fumigation area and secure and seal them. Do not allow anyone to enter them during the fumigation and ventilation periods until tests show that fumigant levels are below the WEL or other appropriate level as indicated in paragraph 11. Where crew members are allowed entry, eg to facilitate ventilation (see paragraph 115), continue monitoring to ensure that the compartments remain safe before the final certificate of clearance is issued.

112 Once the fumigation contractors 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.

113 Do not apply the fumigant until the vessel has been thoroughly searched (including for stowaways) and all people not connected with the fumigation are ashore and have been accounted for.

114 Lock and seal the entrance to the crew's quarters (unless these are also being fumigated, when they may be left open). Give all keys to the technician-in-charge. It is recommended that the vessel is moored in a position which minimises the possibility of unauthorised access during the fumigation period, eg in midstream or at a wharf closed to the public. Leave a member of the fumigation team in attendance and place a warning notice at the shore end of the gangway. This should be illuminated at night.

115 Consider the number of technicians needed. They should work in pairs so that ventilation can be carried out safely. It is imperative that the ventilation of ships' holds for fumigants and the issue of the gas clearance certificate is undertaken by a qualified technician, such as a holder of the BPCA Module 5 (ships) certificate. At the end of the fumigation period, allow technicians wearing RPE to break seals and roll back sheets and tarpaulins, and lift hatchboards to assist ventilation and dispersal of the fumigant. Switch on forced ventilation if it is available, provided that it does not vent into the risk area, or areas where people may have access. Take care to test the atmosphere and to wear RPE when entering any part of the vessel. On some vessels, the crew or shore riggers open the hatches manually; it may be necessary to allow them on board to do so. Test the atmosphere 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. Do not allow them below decks unless tests have been made and have shown that fumigant levels are below the WEL or other appropriate level as indicated in paragraph 11. Do not allow them to remain on board before the final certificate of clearance has been issued.

116 In the case of loaded vessels, it may not always be possible to test the lower levels below the cargo until the cargo is being unloaded. Advice is given in the IMO publication mentioned in paragraph 110.

***Vessels in transit***

117 Fumigation with phosphine may take up to 2 weeks and it may be difficult to keep a vessel moored for so long. In appropriate vessels, fumigation sometimes takes place during a voyage. Before the ship sails, transfer responsibility for the fumigant to the ship's master and ensure they are trained to use and the vessel is equipped with RPE and detection equipment. Guidance is given in the IMO document cited in paragraph 110.

### **Aircraft**

118 Make sure that the aircraft is positioned in a safe place for the whole of the fumigation and ventilation periods. The risk area must be roped off and marked with warning notices to prevent access by anyone not directly concerned with the fumigation. Always consider the entire aircraft and an appropriate area around it as the risk area, even if only part of the aircraft is the fumigation area.

119 Consult the airline's agent on effective sealing of air inlets, vents to water tanks etc. Leave the doors to cabins and holds until last so that the technician-in-charge can make a final check that all unauthorised people have left the aircraft.

120 When the doors have been sealed and locked, place warning notices on them and at points of access to the risk area. Cargo holds may need to be fumigated separately.

121 Ensure that a technician remains where the risk area can be observed throughout the fumigation and ventilation periods. At the end of the fumigation period, technicians wearing RPE may open the doors and begin the ventilation process. Continue ventilation if there is any likelihood of an increase in fumigant concentration by desorption.

### **Freight containers (including cargo-carrying vehicles and trailers)**

122 Ensure that a freight container (and any other cargo-carrying vehicle or trailer) to be fumigated in port is in a designated area, separate from the normal container park or working areas.

123 Before fumigation, check the state of repair of the container and decide whether it is suitable for treatment, paying particular attention to the door gaskets. Seal any open ventilators. Report and repair any deficiencies, ensuring that the doors of the container are capable of being secured with a padlock or other device.

124 Some containers are fitted with one or more bulkhead fittings suitable for admission of the fumigant into the headspace near the roof. Where possible, apply the fumigant through such fittings, either from a cylinder or from cans. Gas sampling lines and temperature recording equipment may also, where appropriate, be fed in through these fittings.

125 Use detection equipment, paying particular attention to the sealing around the doors. When satisfied that effective sealing has been achieved, lock or otherwise secure the doors and give the keys to the technician-in-charge. Fix hazard warning notices identifying the fumigant and stating the time and date of the fumigant application, to the doors and at entry points to the risk area. Keep records of the time and date of application. Containers under fumigation are classified as Class 9 hazardous cargo and the mandatory requirements of the IMDG code (see paragraph 110) will apply. Do not apply fumigants to a container once it has been loaded aboard the ship.

126 Unless a container has been ventilated after fumigation to ensure that concentrations of gas are below the WEL or other appropriate level as indicated in paragraph 11, allow a period of time between the application of the fumigant and the loading of the container on board the ship. A period of 24–48 hours is normally adequate. Ensure the warning notice is fixed to the container door, stating the fumigant, date and time (using the 24 hour clock) of application. Ensure that all old notices are either removed or obliterated. Special precautions may be necessary on the ship. Guidance is available from the IMO.

127 The regulations on the transport of dangerous goods do not specifically prohibit the transport of containers under fumigation by road or rail, but it is strongly recommended that you do not do so before they have been ventilated and a clearance certificate has been issued. Containers transported under fumigation are subject to the requirements of the regulations indicated by paragraph 30.

128 The ventilation of shipping containers and the issue of a gas clearance certificate should be undertaken by a qualified technician such as a holder of the BPCA Diploma in fumigation and BPCA Certificate of Proficiency module 4 (containers).

129 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 into and must be re-sealed. Any person displaying symptoms of poisoning should seek immediate medical advice. Further monitoring, testing and ventilation will need to be carried out. Only once the fumigant levels are at or below the WEL or other appropriate level as indicated in paragraph 11, can the clearance certificate be issued.

### **Fumigation chambers**

130 When carrying out a fumigation in a chamber, ensure it is fitted with a ventilating system which either discharges the fumigant outside and well away from any work areas or other areas where people may be present, or which is designed to recover the used fumigant. Before allowing unloading, test (via the technician-in-charge) the inside of the chamber to ensure that the concentration of fumigant is below the WEL or other appropriate level as indicated in paragraph 11. Special care is needed where the nature of the fumigated commodities is such that desorption 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**

131 Soil and compost are often fumigated under sheets in glasshouses and plastic tunnels, usually with methyl bromide. Mushroom compost is fumigated without sheets in specially designed buildings. In such cases, the precautions recommended for the fumigation of buildings (paragraphs 102-105) apply. Make sure no people or non-target animals are in the structures before fumigation begins, and ensure that no unauthorised person can gain access until the structure has been vented and declared safe by the technician in charge.

132 **It is now mandatory to use virtually impermeable film (VIF) sheeting material in methyl bromide treatments.** After you have placed the sheets over the soil, bury the edges firmly to at least 10 cm depth or otherwise carefully seal them to minimise leakage.

133 Locate cylinders and application equipment outside and, as far as possible, plan piping runs 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, take the following precautions:

- carefully consider the number of technicians needed. It may be necessary for them to work in pairs so that ventilation can be carried out safely;
- before the fumigant is released, mark by warning notices the area of the glasshouse or tunnel designated as a risk area during the application of the fumigant;
- keep ventilators and doors fully open when the fumigant is being released beneath the sheeting as long as the cylinders and vaporising equipment remain inside the glasshouse or tunnel. Close them afterwards;
- for fumigants other than methyl bromide, a good quality low permeability sheet should be used and laid as soon after incorporation as possible.

134 At the end of the fumigation period, allow technicians wearing RPE to roll back the edges of the sheets to enable ventilation to proceed. When the concentration of residual fumigant has fallen below the WEL or other appropriate level as indicated in paragraph 11, the sheets and fumigation equipment may be removed. Check the fumigation area (via the technician-in-charge) and ensure that the soil may be worked safely before issuing the certificate of clearance.

### **Soil and compost outdoors (including fields)**

135 Outdoor fumigation of field soil or compost also takes place under sheets. It is now mandatory to use virtually impermeable film (VIF) sheeting material in methyl bromide treatments and it is considered good practice for VIF to be used with Chloropicrin. It may not be necessary to use RPE at all times, but have it available, so it can be used quickly when necessary. In addition to the precautions described in paragraphs 131-132, take into account:

- the proximity of buildings occupied by people or animals, together with the slope of the land and drains, when assessing the risk area. It is recommended that the risk area be at least 25 metres from occupied buildings and 10 metres from roads and public footpaths (it may be necessary to divert footpaths temporarily – consult the local Council);
- when laying barrier film on slopes, the risk of flooding on the areas below the sheeted area due to heavy rain. Check the weather forecast to prevent this. It may be necessary to postpone fumigation or to reduce the area to be sheeted and fumigated at any one time.

136 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. Assess these and take them into account before ventilation starts. At the end of the fumigation period allow technicians wearing RPE to 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 as indicated in paragraph 11, the sheets and fumigation equipment may be removed. Check the fumigation area (via the technician-in-charge) 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**

137 One method is to insert metal phosphide preparations directly into the grain with the aid of probes or tubes or probing into the grain with retrievable sleeves or bags; but other formulations may be used. Some preparations may also be placed on the surface of the grain and in aeration ducts underneath. Cover the surface of the grain with polyethylene sheet of low permeability or other equivalent gas-proof material.

138 Since phosphine may evolve more slowly during grain fumigation, ventilate adjacent risk areas at all times. Particular care is needed when only a dividing wall from the grain store separates living quarters or animal houses. Evacuate such areas during the whole period of fumigation and ventilation. Do not permit reoccupation until a certificate of clearance has been issued.

139 At the end of the fumigation period, uncover the grain and allow it to air. Remove fumigant residues manually or subsequently on filtering.

### **Grain in silos**

140 Fumigation is currently normally done with phosphine, although other active substances may be used. Seal the slides at the bottom of the silos and any other openings to prevent leakage of the gas. To prevent premature discharge of the grain, label the slides clearly and lock them into the closed position. Give as much ventilation as possible to working areas outside the silos being fumigated.

141 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 there may be some displacement of air containing phosphine from the silo; test regularly for the presence of phosphine.

142 When the fumigant has been applied, close and seal all the openings into the top of the silo and fix warning notices. Seal a fumigated silo completely before treating another.

143 Do not allow anyone to enter silos adjacent to those treated until they have been ventilated and tests show that fumigant concentrations are below the WEL or other appropriate level as indicated in paragraph 11.

144 Do not move treated grain until at least 5 days after fumigation is complete and not before tests (probing into the grain) show that the concentration of phosphine is below the WEL or other appropriate level as indicated in paragraph 11 and there is no further accumulation due to desorption. Although grain may not need to be moved for some weeks or months after fumigation, take care that people are not exposed to harmful concentrations of phosphine in conveyor tunnels or other spaces through which the grain moves. If tablets or pellets have been used, make an assessment as to whether it is necessary for people working near the moving grain to wear RPE. Operate silo ventilation fans to clear any gas which may be present in the ducting. Leave the empty silo open, top and bottom, for at least 24 hours before permitting anyone to enter. If the grain is turned into another bin, do not permit anyone to enter the space above the grain in the new bin unless tests have shown that levels of phosphine are below the WEL or other appropriate level as indicated in paragraph 11. If bags have been used, pick these out from the grain stream either manually (using RPE) or by a sieving device.

### **'In-bag' fumigation of individual packages**

145 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 phosphide preparation. Because of the small volume to be fumigated and the flammability of phosphine, take special care in calculating the appropriate amount. Take particular account of the permeability and portability of the plastic bag when defining the fumigation and risk areas.

## **Mammals underground**

146 Only carry out these fumigations in the open air, in dry weather. In addition to any relevant precautions described earlier, take the following action:

- check the wind direction;
- open the fumigant container out of doors;
- wear suitable PPE and have RPE available;
- use the entire contents of a fumigant container in one operation; and
- never fumigate burrows or runs within 3 metres of any building occupied by non-target animals or humans.

147 Give careful thought to defining the risk area. It may be necessary to provide warning signs and exclude people and non-target animals, eg when fumigating in urban areas.

# **Emergency measures**

## **Damaged or leaking fumigant canisters**

148 When carrying out the risk assessment before the start of the fumigation operation, include provisions for the disposal of damaged or leaking canisters:

- if the canisters can be moved safely, take them to a safe place in the open air and away from humans, animals and flammable materials. They may be vented by a technician wearing RPE;
- if the canisters cannot be moved safely, treat their current site as a fumigation area and take the appropriate precautions.

## **Major leakage**

149 In the event of an emergency during fumigation, eg if a delivery pipe breaks or becomes disconnected and leakage of fumigant occurs, wear RPE and close the main cylinder valve (if a cylinder is being used) and then withdraw from the risk area. After a period of ventilation, and wearing RPE, check the concentration of fumigant in the risk area. Do not allow unprotected people to enter the risk area until the concentration is below the WEL or other appropriate level as indicated in paragraph 11.

## **Fire**

150 If the fire brigade is called to a fire in or near a fumigation or risk area, explain which fumigant is being used and provide information on the hazards and precautions needed. Ensure this information is provided on site, together with an emergency contact number for use by the emergency services at times when fumigation technicians may be absent.

## Reporting incidents

151 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995<sup>26</sup> (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 given in the HSE leaflets *RIDDOR explained*<sup>27</sup> and *RIDDOR reporting: What the new incident contact centre can do for you*.<sup>28</sup> They are available on HSE's website: [www.hse.gov.uk](http://www.hse.gov.uk).

# Appendix 1

## Extracts from the International Maritime Dangerous Goods (IMDG) Code

### 5.5.2 Documentation and identification of fumigated units

5.5.2.1 Transport documents associated with the transport of units that have been fumigated shall show the date of fumigation and the type and amount of the fumigant used. In addition, instructions for disposal of any residual fumigant, including fumigation devices (if used), shall be provided.

5.5.2.2 A warning sign as specified in 5.5.2.3 shall be placed on each fumigated unit in a location where it will be easily seen by persons attempting to enter the interior of the unit. When the fumigated unit has been ventilated to remove harmful concentrations of fumigant gas, the warning sign shall be removed.

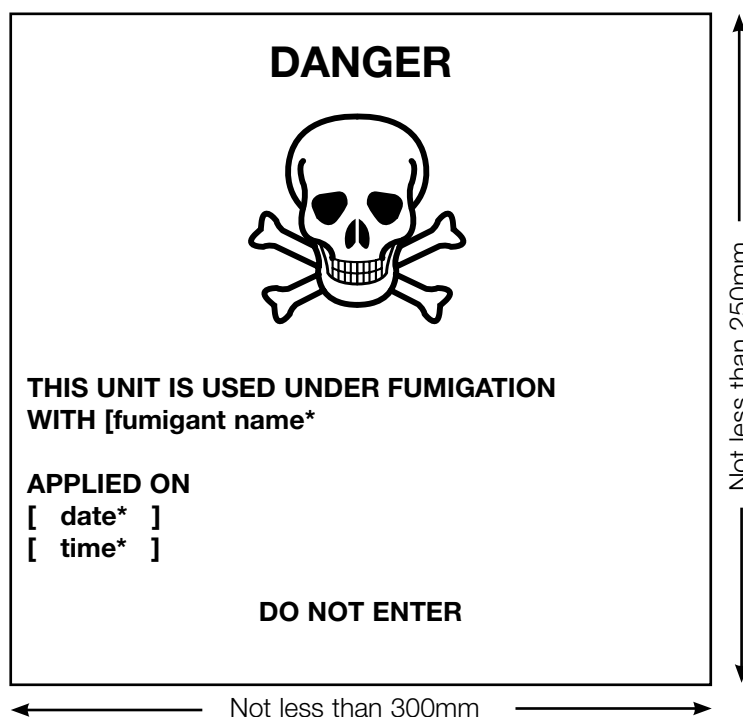


Figure 4 Fumigation warning sign

5.5.2.3 The fumigation warning sign shall be rectangular and shall not be less than 300 mm wide and 250 mm high. The markings shall be black print on a white background with lettering not less than 25 mm high. An illustration of this sign is given in Figure 4.

### **7.4.3 Cargo transport units transported under fumigation\***

7.4.3.1 Only a cargo transport unit that can be closed in such a way that the escape of gas is reduced to a minimum shall be used for the transport of cargo under fumigation.

7.4.3.2 A closed cargo transport unit containing cargo under fumigation shall not be allowed on board until sufficient time has elapsed to allow the attainment of a reasonable uniform gas concentration throughout the cargo. Because of variations due to types and amounts of fumigants and commodities and temperature levels, the period which shall elapse to attain the uniform gas concentration between fumigant application and loading of the cargo transport unit on board the ship shall be determined by the competent authority. Twenty-four hours is normally adequate for this purpose. Unless the cargo transport unit has been opened to allow the fumigant gas and its residue to be completely ventilated, the shipment shall be described as a FUMIGATED UNIT, Class 9, UN 3359 and conform to all the provisions of this Code.

7.4.3.4 The master shall be informed prior to loading of a cargo transport unit under fumigation.

7.4.3.5 When a cargo transport unit under fumigation is stowed under deck, equipment for detecting the fumigant gas or gases shall be carried on the ship, with the instructions for its use.

7.4.3.6 The provisions of this Code shall not apply to a closed cargo transport unit which has been completely ventilated after fumigation either by opening the doors of the unit or by mechanical ventilation to ensure that no harmful concentration of gas remains. When completely ventilated, the unit shall have the fumigation warning sign(s) removed.

7.4.3.7 Fumigants shall not be applied to the contents of a cargo transport unit once it has been loaded aboard a ship.

7.4.3.8 Cargo transport units under fumigation shall not be stowed under deck on a passenger vessel.

\* For cargo transport under fumigation, see 3.5 of the IMO publication *Recommendations on the safe use of pesticides in ships*. See also *Fumigated unit*, Chapter 3.2, Dangerous Goods List.

# References and further reading

## References

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Tel: 01904 455775 or it can be downloaded from [www.pesticides.gov.uk](http://www.pesticides.gov.uk))
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- 16 *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004* SI 2004/568 The Stationery Office 2004 ISBN 0 11 049063 0
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- 20 *Respiratory protective equipment at work: A practical guide* HSG53 HSE Books 2005 ISBN 0 7176 2904 X
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### **Further reading**

*The Personal Protective Equipment at Work Regulations 1992* SI 1992/2966 The Stationery Office 1992 ISBN 0 11025832 0

*The Environmental Protection (Controls on Ozone-Depleting Substances) Regulations 2002* SI 2002/528 The Stationery Office ISBN 0 11 039613 8

### **Further information**

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Website: [www.bsi-global.com](http://www.bsi-global.com)

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Health and Safety Laboratory  
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