

Control of diesel engine exhaust emissions in the workplace



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This guidance provides practical advice to employers and self-employed people on how to control exposure to diesel engine exhaust emissions (DEEEs) in the workplace, and so protect the health of employees and others who may be exposed. Managers, supervisors, employees, health and safety professionals, safety representatives and trade union representatives will also find this guidance useful.

The first part of the guidance shows how to assess the risk to health from exposure to DEEEs and gives a general approach to control. The second part provides examples of good working practices for controlling the engine exhaust emissions from diesel powered vehicles and also where there is likely to be an accumulation of DEEEs, such as warehouses, depots and bus garages.

This third edition has been updated, with minor amendments and clarifications, but the advice is broadly unchanged.

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

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Introduction

- 1 This guidance provides practical advice to employers and the self employed on how to control exposure to diesel engine exhaust emissions (DEEEs) in the workplace, and so protect the health of employees and others who may be exposed. Managers, supervisors, employees, health and safety professionals, safety representatives and trade union representatives will also find this guidance useful.
- 2 The guidance is in two parts. The first part shows how to assess the risk to health from exposure to DEEEs and gives a general approach to control. The second part provides examples of good working practices for controlling the engine exhaust emissions:
 - from diesel powered vehicles such as fork-lift trucks, railway locomotives, buses and lorries; and
 - where there is likely to be an accumulation of DEEEs such as in warehouses, locomotive depots, ro-ro ferries, bus garages, vehicle testing sites, fire stations etc.

Unless otherwise stated, the methods for controlling DEEEs also apply to emissions from petrol engines.

- 3 As there are special requirements for work in mines and offshore situations, this guidance does not apply to emissions from diesel powered vehicles or appliances in such situations. The guidance also does not apply to the control of engine exhaust emissions in confined spaces, as there is already guidance available.¹

Diesel engine exhaust emissions

Composition

- 4 DEEEs contain a complex mixture of gases, vapours, liquid aerosols and particulate substances. These substances are the products of combustion. Table 1 lists the major chemical constituents of DEEEs.

Table 1 The main chemical constituents of diesel engine exhaust emissions

Carbon (soot)
Water (H ₂ O)
Carbon monoxide (CO)
Carbon dioxide (CO ₂)
Nitrogen (N ₂)
Oxides of nitrogen (NO _x)
Oxides of sulphur, eg sulphur dioxide (SO ₂)
Alcohols
Aldehydes
Ketones
Various hydrocarbons (HC)
Polycyclic aromatic hydrocarbons (PAHs)

- 5 Exhaust emissions from diesel engines are usually more visible than those emitted from petrol engines because they contain over ten times more soot. In general, diesel engines produce less carbon monoxide than petrol engines but more oxides of nitrogen, sulphur oxides, aldehydes and particulate matter.

The soot particulates in DEEEs have hundreds of organic substances adsorbed onto their surface, some of which are potentially more harmful to health than others (see Figure 1). The soot content in the DEEEs varies from 60% to 80% depending on the fuel used and the type and condition of engine.

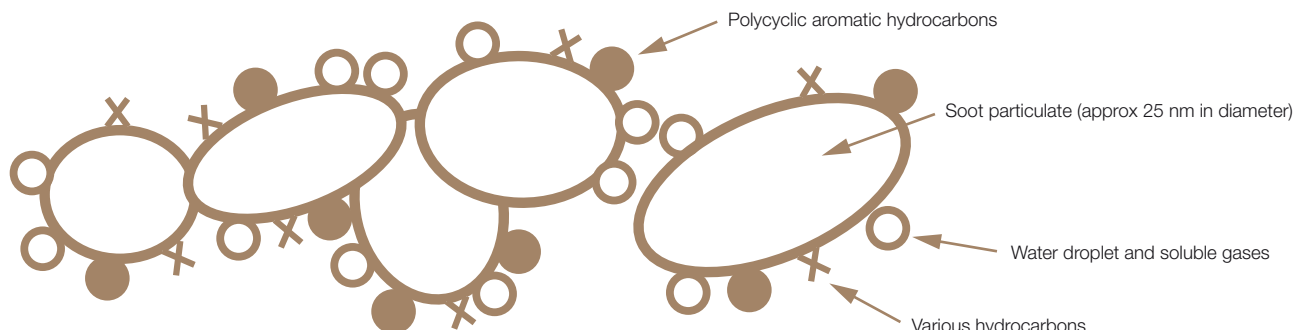


Figure 1 Soot particulates with adsorbed substances

6 The quantity and composition of DEEEs depend mainly on:

- the type of engine, eg non-turbocharged, turbocharged diesel engine;
- whether the engine has been regularly maintained and tuned;
- the specification of the fuel used;
- the workload demand on the engine, eg whether the engine is required to work near its capacity; and
- the engine temperature, eg starting from cold.

7 Three types of visible smoke may be produced during combustion. These are:

- blue smoke (mainly oil and unburnt fuel) which is caused by partly burnt fuel from badly worn engines which are poorly serviced and/or tuned;
- black smoke (soot, oil and unburnt fuel) which is produced if there is a mechanical fault with the engine, such as a defect in the fuel delivery system or if the engine is working near its maximum speed; and
- white smoke (water droplets and unburnt fuel) which is produced when **the engine is started from cold**, and disappears as the engine warms up. Where appropriate, the engine should be warmed up outside. If an engine is warmed up inside the garage, a suitable control should be used, such as an extraction system attached to the tailpipe. Improved engine maintenance will not reduce the quantity of white smoke produced. White smoke from older engines produces an acrid smell.

Workplace exposure

8 The major source of **workplace** exposure to DEEEs is from heavy vehicles that use diesel fuel such as buses, trains, lorries, and tractors, and also from fork-lift trucks. All motor vehicles that use diesel fuel generate DEEEs during garage repair or servicing, in car parks, in garages, when passing toll booths or in vehicle holds in ships and trains.

9 DEEEs are also generated from stationary power sources which may be used in tunnels, alongside railway lines during maintenance work and on construction sites.

10 Workers such as professional bus drivers, lorry drivers and taxi drivers, as well as police officers and traffic wardens, are occupationally exposed to DEEEs.

Health effects

11 It is not precisely known which components of combustion are responsible for ill health effects, but exposure to DEEEs is associated with irritation of the eyes and the respiratory tract. This is particularly noticeable when there are high levels of white smoke in the workplace such as in bus garages when the bus engines are started from cold in the morning with no controls. Irritation of the upper respiratory tract is the primary health effect following exposure to DEEEs.

12 Prolonged exposure to DEEEs, in particular to any blue or black smoke, could lead to coughing, increased sputum production and breathlessness.

13 Diesel engine exhaust emissions contain many known carcinogenic substances, for example Polycyclic Aromatic Hydrocarbons known as PAHs which are adsorbed onto the soot particulates. These particulates are easily inhaled into the respiratory tract and there is epidemiological evidence, which indicates that sustained occupational exposure to DEEEs may result in an increase in the risk of lung cancer.

Legislation

14 The law requires that a suitable and sufficient assessment of the risks to health which arise from exposure to hazardous substances is made, eg DEEEs.² This is covered by the Health and Safety at Work etc Act 1974³ and several other regulations, in particular the Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH)⁴ and the Management of Health and Safety at Work Regulations 1999⁵ (see Appendix 1). Having completed the assessment, there is a further duty to take the necessary steps to prevent or adequately control exposure to the hazard, and to use and maintain the relevant controls (see Appendix 2).

Risk assessment (COSHH regulation 6)

15 The health risk assessment will help you to assess the risks to health from exposure to hazardous substances and identify the necessary steps needed for controlling these risks. As workload, frequency of work, and work practices may change over a period, it is necessary to regularly review the assessment. In all but the simplest cases, you should record the assessment.

16 For DEEEs, the aim of the health risk assessment is to decide on the level of potential exposure, and then on the preventive measures or the level of control which you will need to apply. For example, if there is obvious blue or black smoke in the workplace, the controls need to be more stringent. In some circumstances, such as if there are visible exhaust emissions or complaints of irritancy, the assessment may necessitate carrying out monitoring to assess the effectiveness of the controls (see Table 2).

17 In order to carry out a suitable and sufficient risk assessment you need to ask a series of questions, find answers and then come to a conclusion. These questions include:

- How likely is it that exposure to DEEEs will happen?
- Who could be affected, to what extent and for how long? How many people are potentially exposed to the DEEEs? Can the exposures be avoided?

Table 2 Assessment of the level of exposure to DEEEs

Low	Medium	High
No visible haze in the workplace	Occasional white, blue or black smoke	Permanent white, blue or black smoke
No visible soot deposits	Visible soot deposits in certain areas	Heavy soot deposits especially near emission points
No complaints of irritancy	Some complaints of irritancy	All exposed workers complain of irritancy
CO ₂ levels much lower than 1000 ppm 8-hour TWA*	CO ₂ levels about 1000 ppm 8-hour TWA	CO ₂ levels greater than 1000 ppm 8-hour TWA
Controls likely to be adequate	Check adequacy of controls	Controls not adequate; decide on control strategy

* TWA: time-weighted average.

- Have there been any ill-health complaints from potentially exposed groups? If yes, what has been done about it?
- Is the engine being operated at full speed or left idling? What is the purpose of running at idling speed or full speed. Can it be avoided?
- What is the state of the engine, and how many miles or hours have been completed? Can the engine efficiency be improved, and can operating times and distances be reduced? Improving the efficiency of the engine will also bring financial benefits.
- What happens to the exhaust emissions: do they enter directly into the workplace, or are they piped away or processed through a treatment system? Could they trigger your fire detection system?
- Is there visible smoke near the exhaust point? What is the type of smoke, ie white, black or blue? How could it be avoided? Is there a visible haze in the workplace? Can it be avoided and how?
- What controls are in place to comply with COSHH? Are they satisfactory?
- Are there soot deposits in the workplace; how significant are they? What can be done to avoid them? What methods are in place for regularly cleaning the workplace?
- How many engines are running at any one time? Are they all necessary?
- Is it necessary to use diesel engines, or can alternative power sources be used?

Prevention and control of exposure (COSHH regulation 7)

18 The answers to the questions in paragraph 17 will guide you in deciding on the actions necessary to prevent or control exposure to DEEEs in the workplace. The control measures you choose need to be based on: the levels of risk and exposure; the type of workplace; present work practices; cost and benefit factors. Because of the variety of workplaces where exposure may occur, the potential exposure and the level of risk will be different. For example, there may be increased exposure where fork-lift trucks are being used in a warehouse all day for moving goods, whereas in a maintenance depot the exposure may be intermittent as the vehicles enter, stay there for maintenance, and then leave.

Prevention

19 Health and safety legislation requires you to prevent the exposure of employees and others to substances hazardous to health. You should be able to prevent exposure to DEEEs by adopting one or a combination of options, for example:

- changing the method of work;
- modifying the layout of the workplace;
- modifying the operations to eliminate exhaust emissions inside the workplace; or
- substituting diesel fuel with a safer fuel or alternative technology where practicable, eg compressed natural gas, battery powered vehicles.

20 Your risk assessment should take account of any other risks posed by these alternative fuels and technologies, for example the use of alcohols may generate greater quantities of aldehydes with possible accompanying irritancy.



Figure 2 Bus using a tailpipe exhaust extraction system to control emissions

Control

21 There will be situations where it may not be reasonably practicable for you to prevent exposure to DEEEs. In these situations, you should consider the circumstances individually and take the necessary control measures to reduce exposure. These may include:

Engineering controls

- the use of lower emission or more fuel-efficient engines where possible, eg higher engine injection pressures to reduce particulates, fitting exhaust gas recirculation systems to reduce gaseous oxide emissions;
- the use of cleaner fuels such as low sulphur diesel fuels;
- enclosing the exhaust tailpipe from which DEEEs are emitted, for example by using a fixed flexible hose with a tailpipe exhaust extraction system (see Figures 2 and 3);

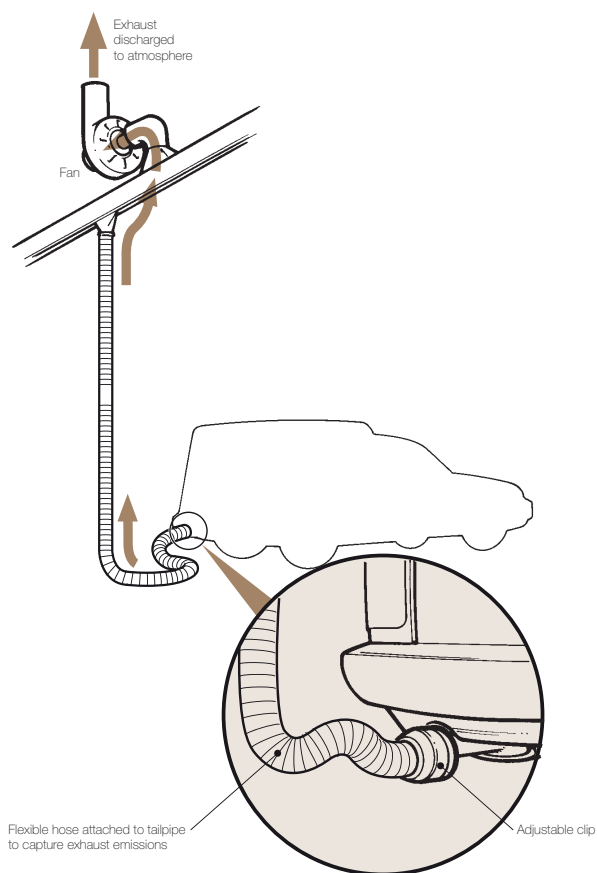


Figure 3 Fixed length flexible hose with tailpipe exhaust extraction system

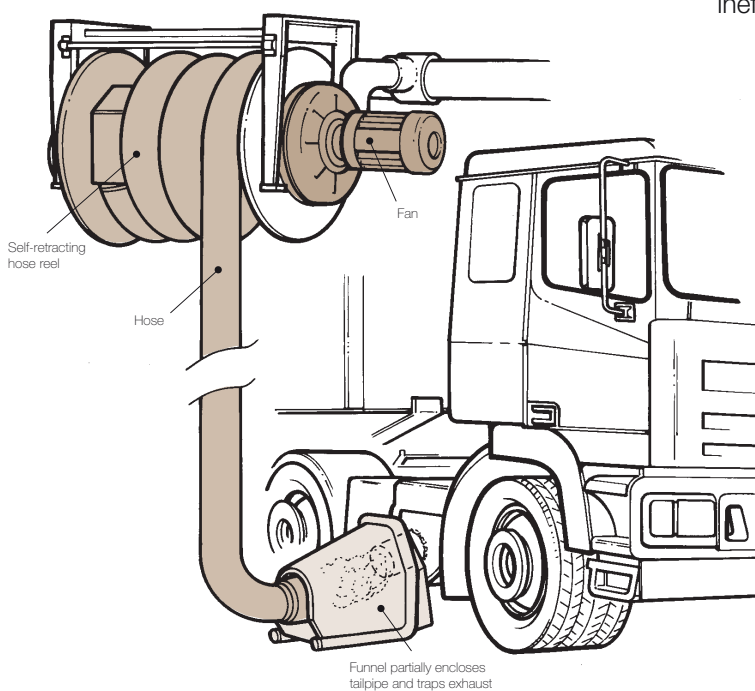


Figure 4 Fixed hose and funnel-type local exhaust extraction system

- using partial enclosure with local extraction ventilation (LEV) as shown in Figure 4;
- the use of diesel exhaust gas 'after-treatment' systems such as catalytic converters to oxidise organic substances and gases, and catalysed and non-catalysed particulate traps to remove particulate matter;
- using a combination of LEV and sufficient general ventilation, eg tailpipe exhausts with open doors or roof extraction;
- using sufficient general ventilation, eg manual or mechanical roof extraction;

Practice and administrative controls

- using processes or systems of work which will help you to reduce the generation of DEEEs, for example switching off engines when not required for a substantial period of time and adopting a programme of regular engine maintenance;
- where practicable, reducing the number of employees directly exposed and their period of exposure, eg ensuring that office staff working adjacent to DEEE areas are not exposed, job rotation; and

Respiratory protective equipment (RPE)

- as exposure to DEEEs is best controlled at source or by other means as described previously, RPE should only be used as a last resort. The RPE chosen should be suitable for protecting against the gaseous and particulate components. The use of nuisance dust masks as worn by cyclists are ineffective against DEEEs and, therefore, should not be used as a means of control in the workplace. Detailed information on RPE for use in the workplace can be found in the HSE guidance book HSG53 *Respiratory protective equipment at work: A practical guide*.⁶

Use of control measures (COSHH regulation 8)

22 You should ensure that any control measures are properly used or applied. Employees should make full and proper use of any control measure or personal protective equipment provided by the employer, and report any defects to management for immediate attention.

Maintenance, examination and the testing of control measures (COSHH regulation 9)

23 You should ensure that all the measures provided to control exposure to DEEEs in the workplace are maintained in an effective state, and kept in efficient working order and in good repair. Where engineering controls are used, they should be thoroughly examined and tested at suitable intervals.⁷ LEV, for example, should be thoroughly examined and tested at least once every 14 months.

24 With the exception of disposable filtering facepiece respirators intended for single shift use, RPE should not be used unless it has had a recent thorough examination and maintenance. The interval between thorough examination and maintenance should not be more than one month.

25 You should keep a record of such examinations and tests of LEV and RPE for at least five years from the date on which they were made. The record should be readily available for inspection by employees or their representatives, or by enforcement authorities.

Monitoring for exposure to DEEEs in the workplace (COSHH regulation 10)

26 Under regulation 10 of COSHH, monitoring at the workplace may be required for the following reasons:

- to determine if there is a failure or deterioration of the control measures which could result in an obvious health effect, eg irritancy from exposure to DEEEs;
- to determine whether any workplace exposure limit (WEL) or any in-house working standard has been exceeded; and
- when necessary to check the effectiveness of a control measure provided, eg particulate filter, LEV and/or general ventilation.

27 The health risk assessment will help you decide if it is necessary to carry out monitoring, for example, to judge the effectiveness of controls. A suitable monitoring strategy, as determined by a competent person such as an occupational hygienist, will indicate whether personal monitoring, fixed placed (static) monitoring, or both are required. It will show which site(s) require monitoring, when and how often, and which sampling and analytical methods would be appropriate.

Personal monitoring for exposure to DEEEs

28 You may need to carry out personal monitoring to determine the extent of inhalation exposure to DEEEs, and hence the level of risk. Personal monitoring samples should be collected in the breathing zone of the employees. Such samples should be collected where there is a significant potential for exposure during their working shift and include peak exposures, eg while repairing or testing/maintaining an engine, while driving a fork-lift truck or during lashing in ro-ro ferries.

29 The duration of sampling depends on the workplace situation, such as the nature of the work and the type of monitoring. However, to collect sufficient material from the workplace air and determine the time-weighted average (TWA) exposure, sampling periods will mainly be between six and eight hours. In some instances though, depending on the circumstances, short-term measurements may be all that is required to make decisions on the risk of exposure and level of control. The number of people you decide to sample at each location will depend on the nature of exposure and size of the exposed workforce, for example:

- processes or operations where exposures are likely to occur;
- the number, type and position of sources from which the DEEEs are released; and
- which groups of employees are most likely to be exposed.

Fixed place monitoring

30 Fixed place monitoring is appropriate in those areas of the workplace where it is impractical to collect personal samples, eg outside a toll booth. Such fixed sampling is useful for determining the effectiveness of your control measures and for measuring background concentrations of DEEEs.

What substances to monitor

31 Levels of carbon dioxide (CO₂) above 1000 ppm 8-hour TWA in the workplace, may indicate faulty, poorly maintained or inadequately designed control systems in particular LEV or roof extraction systems.⁹ **As measurement of the CO₂ level is easily carried out and because it is a useful indicator of the overall adequacy of control measures, it may be used as one of the steps in any assessment of the level of exposure to DEEEs (see Table 2).**

32 **Respirable dust levels** may be measured to help you assess the particulate exposure if, for example, the workload is particularly heavy.¹⁰ However, the levels measured will include particulates from all sources and not just the DEEEs.

33 In situations where personal exposure to carbon monoxide (CO) may be high (such as at toll booths and in car parks where the majority of vehicles are petrol driven) measurement of CO will provide an indication about the adequacy of controls.

Irritancy

34 As the definite causes of irritancy are unknown, if any of your workforce complain of this health effect, it is important to look for better means of control rather than to monitor for other gaseous constituents of DEEEs.

Health surveillance (COSHH regulation 11)

35 Under COSHH, no formal health surveillance is required by employers of those exposed to DEEEs or related emissions. However, if employees are concerned about the short or long-term health effects of exposure to DEEEs, they should discuss the problem with management. If still not satisfied with the outcome, they should voice their concerns with their union representative if available or the works safety representative. Furthermore, if management notices that employees are suffering irritancy effects following exposure to DEEEs, it may indicate that the controls have failed and prompt action is required.

36 Employers must provide information on health and related matters to employees or their representatives in accordance with the Safety Representatives and Safety Committees Regulations 1977 and the Health and Safety (Consultation with Employees) Regulations 1996. Such information allows employees or their representatives to help employers develop control measures.

Information, instruction and training (COSHH regulation 12)

37 Adequate information, instruction and training should be given to employees on the health hazards associated with occupational exposure to DEEEs and on the proper use of control measures. This information should also be made available to employee safety representatives or other appropriate people.

38 The information, training and instruction should enable employees to recognise obvious deterioration in the controls used (such as poor maintenance of engines, damage to extraction equipment or ineffective general ventilation), so they can report to employers who would then take the necessary action to rectify the situation.

Controlling exposure to DEEEs in specific situations

39 The second part of this guidance describes examples of good working practice for controlling exposure to DEEEs at the workplace. Before adopting these control measures, you need to compare these examples with the findings of your risk assessment and ensure that they are suitable for your work situation.

40 In all the situations described below, the use of alternative fuels or technologies, or the use of catalytic or non-catalytic particulate traps, should be considered where appropriate.

Garages and testing stations

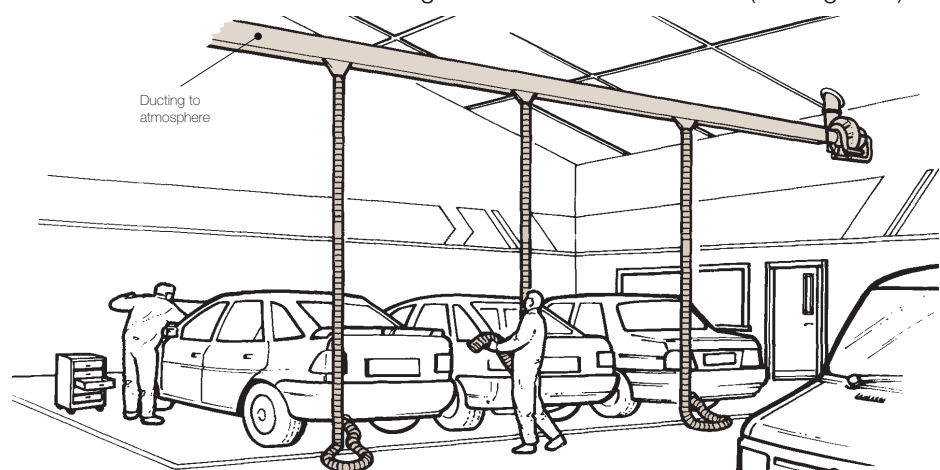
41 Vehicle engines should be started in the working area only when required, ie when essential to the job being carried out, and not part of the preparation such as warming up the engine oil before draining.

42 Where vehicles are being repaired or MOT tested, and where many vehicles are being handled, natural ventilation alone may not suffice. Several cars or lorries idling in a workshop may produce greater quantities of exhaust emissions than can be adequately controlled by natural air replacement.

43 The most effective method of control is to remove the exhaust at source using a flexible hose extraction system attached to the tailpipe and vented outside. An alternative method is to use a portable filter attached to the exhaust pipe outlet. However, when measuring or visually assessing the exhaust smoke as in a vehicle MOT, you should ensure that your exposure control measures do not interfere with the test.

44 A network of portable hose systems attached to vehicle exhaust pipes can be used where there are several cars being serviced at the same time (see Figure 5).

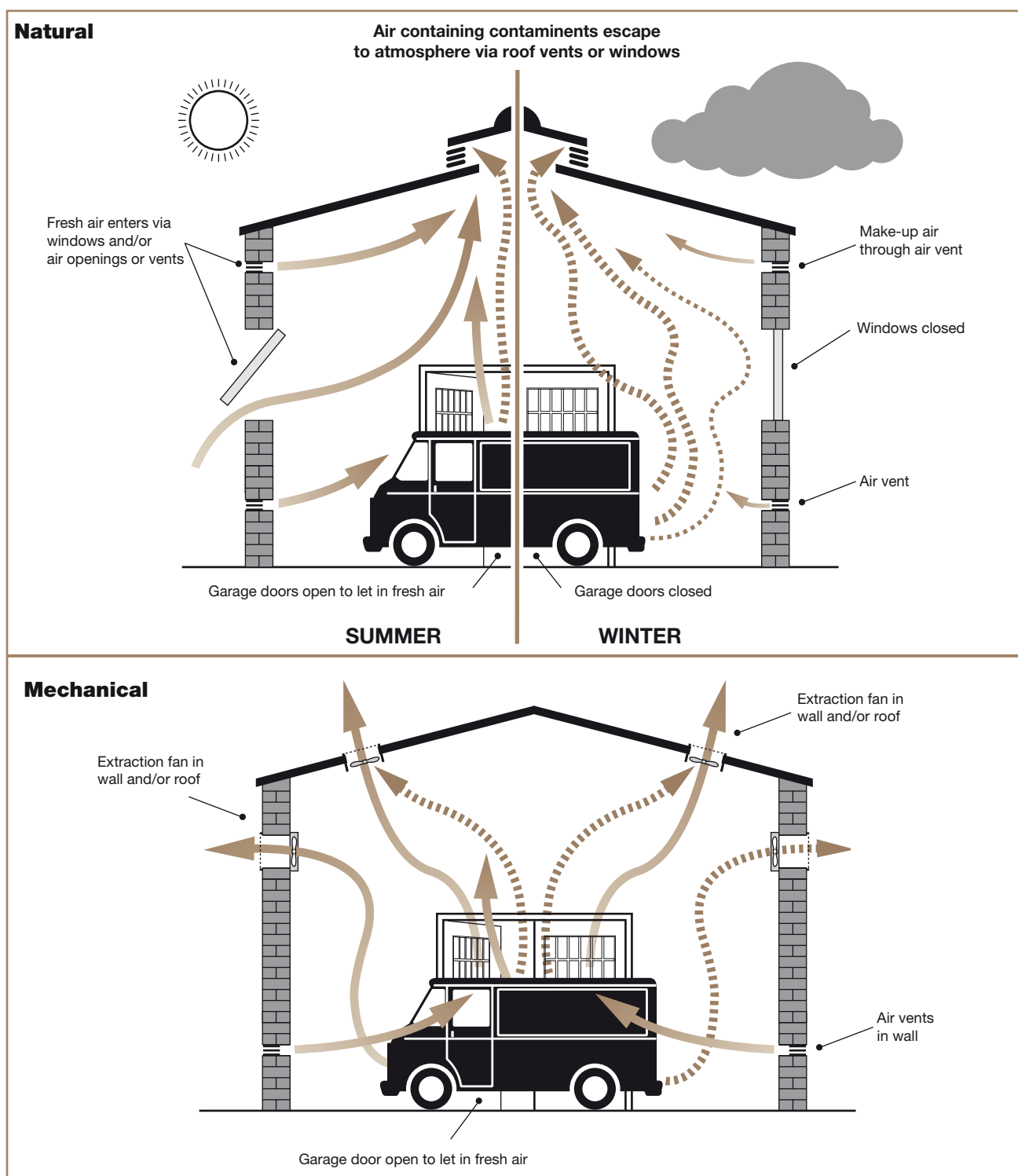
Figure 5 Multihose system attached to vehicle exhaust tailpipes in a specialist workshop



45 In smaller garages (ie those handling one or two vehicles at any one time), effective natural ventilation can be achieved by opening the outer doors or windows before starting the engine, and keeping them open during any work where the engine(s) are left running. If rear doors are present, these could be kept open to provide fresh air and help remove any exhaust emissions.

46 Air entering via an open door or air supply inlets may be vented using natural or mechanical roof extraction as illustrated in Figure 6. However, where open doors or windows provide the make-up air, in the winter they may be shut to conserve heat, leading to the potential build-up of engine emissions.

Figure 6 General ventilation in a garage, ie natural and mechanical



Bus garages

47 Bus drivers or conductors may only spend short periods of time in the garage whereas the fitters may spend a full working shift. The fitters are, therefore, likely to be more exposed to DEEEs, during repairs and when buses are moving in and out of the garage.

48 Most of the buses are usually driven out at the start of the day, ie 'run-out', and return in the early and late evening, ie 'run-in'. During these periods, bus engines must not be left idling so as to reduce emissions into the garage surroundings.

49 Roof extraction or wall vents can produce a steady flow of clean air throughout the garage. Where appropriate, the garage doors should remain open at all times during the working shift. Figure 7 shows a bus garage with the doors open to provide a steady flow of clean air. If it is not practicable to leave the doors open, then sufficient air supply should be provided to replace what is removed by extraction.

50 Engineering workshops ideally need to be in a separate building with their own system of general ventilation, eg open doors, air vents in the wall, roof extraction. Where it is not possible to site the workshop in a separate area, emissions can be controlled by using flexible ducting with local tailpipe extraction or particulate filters attached to the bus exhaust tailpipe.



Figure 7 Bus garage with doors open so as to provide a steady flow of clean air

Warehouses

51 Diesel operated fork-lift trucks tend to produce high quantities of DEEEs. The degree of exposure depends on the number of vehicles in use at any one time, the condition of the engines, the way they are driven, the site of operation within the warehouse etc.

52 When purchasing fork-lift trucks, you may consider the use of electrically driven or propane fuelled vehicles. Exposure to DEEEs can be reduced by keeping warehouse doors open to circulate the air and also by installing roof or wall mounted extraction. Furthermore, regular servicing of the trucks will improve the performance of the engines and hence reduce emissions. Engines should only be run when required.

53 Where it is unavoidable for a lorry to enter a warehouse for loading/unloading, or where a delivery van is in a loading bay in a despatch area, the engines of these vehicles need to be switched off unless required to drive hydraulic systems. When it is necessary to run the engine, other control measures should be used, such as an extraction system or a suitable filter system attached to the tailpipe.

Railways, railway repairs and rail tunnels

54 A large proportion of the railway system is served by diesel powered locomotives. Employees can be exposed to excess emissions at stations, maintenance and repair depots, and at work sites in tunnels.

55 At stations, diesel engines produce large amounts of emissions when starting up, idling or when under power after idling for long periods. Idling times of engines therefore need to be reduced. Regular maintenance of engines and rolling stock is also essential to keep emission levels to a minimum.

56 Natural ventilation at most stations may provide adequate control. However, in stations where the dispersal of emissions is restricted by the design, local extraction ventilation may be required at strategic positions.

57 Exposure to DEEEs occurs during repair or testing procedures, when the operators work adjacent to or underneath the locomotive and where engines are running for part of the operation. Roof extraction fans can produce adequate general ventilation together with open doors. A series of wall ducts, appropriately placed, can also transfer emissions to outside the building.

58 Workers in railway tunnels may be exposed to diesel emissions from locomotives carrying passengers or hauling a works train, or from small diesel-driven generators for lighting, etc. Such generators should be placed downwind of any workers so that any DEEEs are removed by natural ventilation. Otherwise, ventilation can be provided by the use of fans mounted on rail vehicles to extract air.

59 In short tunnels, it may be possible to site locomotives and plants outside the tunnel entrance where natural ventilation will disperse any emissions.

Ro-ro ferries

60 Ferry operations include the unloading and reloading of vehicles and freight. During unloading operations, the freight is unlashd from the decks by shacklers and then either taken by diesel powered tugs or by container lorries to dock. Reloading the freight involves marshalling vehicles into position on the decks, unloading the freight and lashing it securely.

61 Generally, unloading and subsequent reloading of goods and vehicles can take up to three hours. During these operations the shacklers and drivers, and others who may occupy their vehicles on the ferry, are exposed to DEEEs.

62 If the freight and vehicles are on open deck, any emissions will be removed by natural ventilation. On other decks, during the loading and unloading operations, the bow and/or stern doors are normally open. This will facilitate natural air circulation. Where this is not possible, exhaust ventilation may be needed at the stern end of the deck to extract any polluted air. But it may be of limited value if the decks are completely full.

63 Alternatively, adequate ventilation may be provided on the vehicle deck by situating a series of extraction fans along the side. Make-up air can be provided by a number of appropriately placed air vents and open doors such as those leading to the passenger accommodation.

64 Furthermore, drivers of container lorries need to be instructed that they must not start up their engines until all the freight loads are unlashd and they are ready to move.

Toll booths and car parks

65 Toll booths are situated at the entrances and exits of many bridges, tunnels and docks, while open air or multi-storey car parks often have pay booths. Workers in these booths can be exposed to diesel and petrol engine exhaust emissions. The level of exposure is dependent on the weather conditions, number of vehicles passing and control measures present.

66 Many booths may not have mechanical ventilation. In such instances these booths should be sited in areas with good natural ventilation and easy vehicular access at all times.

67 Ticket openings on pay and toll booths need to be as small as commercially possible, to limit the amount of polluted air entering the booth. During quiet periods (eg when there are few vehicles) windows and doors may be open to allow free movement of air.

68 However, where there is always a high accumulation of emissions, the booths need to be kept under positive pressure and provided with sufficient fresh air supplied from an uncontaminated source.

Fire stations

69 Because most fire stations are on call for 24 hours, and so fire engines may be kept running inside the station several times a day, emissions from these engines will accumulate in the building unless removed.

70 Before engines are started and the fire engines are ready to leave the fire station, the outer doors should be open. Engines should not be left idling before they leave the station for a call or when they return unless emission controls are in place.

71 Where appropriate, a fixed or portable hose linked to an exhaust extraction system needs to be attached to the engine tailpipe to remove exhaust at source. Some hoses can be fitted with a device which automatically disconnects the hose from the engine exhaust pipe as the vehicle moves away. Furthermore, specific filter systems can be connected to the exhaust pipe which disconnect automatically when the fire engine leaves the station.

72 It is important that vehicle engines are well maintained, regularly inspected and repaired when required. This will reduce the quantity of DEEEs produced.

Appendix 1

Legal requirements for the control of occupational exposure to DEEEs

The Health and Safety at Work etc Act 1974 (HSW Act) and several regulations are concerned with the control of exposure to engine exhaust emissions in the workplace. These regulations include:

- the Control of Substances Hazardous to Health Regulations 2002 (as amended);
- the Management of Health and Safety at Work Regulations 1999;
- the Workplace (Health, Safety and Welfare) Regulations 1992;¹¹ and
- the Provision and Use of Work Equipment Regulations 1998.¹²

The HSW Act is an umbrella Act which is concerned with securing the health, safety and welfare of people at work, and with protecting those who are not at work from the risks to their health and safety arising from work activities. This would include controlling, in the workplace and environment, the emissions of noxious or offensive substances such as engine exhaust emissions.

The COSHH Regulations 2002 (as amended), regulation 7 requires that exposure to all substances hazardous to health such as DEEEs be prevented or where this is not reasonably practicable, adequately controlled.

The Management of Health and Safety at Work Regulations 1999 require all employers and self-employed people to assess the health and safety risks to workers and any others who may be affected by their undertakings. Following the risk assessment it may be necessary to take action to control the risks from the hazard, eg reduce engine emissions in the workplace or use an alternative power source.

The Workplace (Health, Safety and Welfare) Regulations 1992 require that workplaces such as garages, bus depots etc meet the health, safety and welfare needs of each member of the work.

The Provision and Use of Work Equipment Regulations 1998 require equipment provided for use at work (including vehicles) to be selected appropriate to circumstances and to be adequately maintained. People who use the work equipment must have sufficient information, instruction and training.

Appendix 2

Carcinogenicity, workplace exposure limits (WELs) and skin contact

COSHH and carcinogenicity

As DEEEs contain substances hazardous to health (eg CO, formaldehyde, oxides of nitrogen NO_x) as defined in the COSHH Regulations 2002 (as amended), they are therefore subject to the general provisions of those Regulations. The Regulations require that exposure is prevented or, where this is not reasonably practicable, adequately controlled.

DEEEs are not listed in Table 3.2 of Part 3 of Annex VI of the CLP Regulation.¹³ Nor do they meet the criteria laid down in those Regulations for classification as a carcinogen in either Category 1 or 2. Therefore, COSHH regulation 7(5) concerning control of carcinogens does not apply.

Workplace exposure limits (WELs)¹⁴

No WEL has been set for DEEEs as a whole because there is insufficient data to establish a clear, reliable threshold for all potential health effects. Furthermore, there is no ideal candidate marker of exposure to DEEEs on which to base a WEL.

However, several of the major gaseous components of diesel exhaust have workplace exposure limits (WELs) under the COSHH Regulations. The particulate material itself has no set WEL but there are values which in themselves act as triggers for the application of the Regulations, ie 10 mg/m³ 8-hour TWA total inhalable dust or 4 mg/m³ 8-hour TWA respirable dust.

HSE experience indicates that the gaseous components of DEEEs are generally found at low levels in the workplace, ie below the WELs. However, your aims need to be focused on controlling exposure to DEEEs as a whole. This will reduce the potential for the irritancy effect and carcinogenic risk (even though it is very small). It is not known which component is responsible for causing irritancy.

The problem may result from a synergistic effect of one or more components. Therefore it is not feasible to control this health effect by reducing any particular component, so the control of exposure to DEEEs as a whole should be pursued.

Diesel fuel and skin contact

Disposable gloves of suitable material, such as nitrile, should be worn when handling cold diesel fuel as any spillage onto the skin may cause dermatitis. When hot fuel or oil is handled for short periods, you should use thermal protective gloves and a thin nitrile inner glove.

Appendix 3

Environmental DEEEs

DEEEs in the environment

Many airborne particulates (about 25% of total from all sources) originate from vehicle exhausts, especially those using diesel fuel. High environmental increases in levels of particulate matter less than 10 μm diameter (PM_{10}), in particular the sub 2.5 μm fraction ($\text{PM}_{2.5}$), have been associated with increased cardiovascular or respiratory disease particularly among the elderly and susceptible individuals. There is, however, no present evidence to suggest that these findings are of concern to workplace exposure.

Environmental PM_{10} levels and occupational exposure

Static sampling has been used for measuring PM_{10} levels to assess the quality of the air in the general environment, and this is averaged over a 24-hour running period (the recommended air quality standard (AQS) for PM_{10} in the UK can be found at www.airquality.co.uk). There is no simple method for measuring personal exposure. The AQS is not a workplace standard or WEL. Under COSHH, there is no need to measure PM_{10} to AQS level. In addition there is no relation between the AQS for PM_{10} and possible health effects arising from occupational exposure to DEEEs or other emissions.

Environmental health concerns

It is important for employers to differentiate between environmental and workplace health issues to prevent any unnecessary concern among employees. Health effects caused by exposure to DEEEs in the environment mainly affect the elderly and those with pre-existing illness. The Government has specific AQSs for environmental air which are not the same as WELs used in the workplace.

The contact point for air quality information, including DEEEs in the environment, is the Department for Environment, Food and Rural Affairs, see www.defra.gov.uk.

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