

TECHNICAL NOTE

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SUMMARY

This Technical Note provides an introduction to the legislative background to respiratory protective equipment (RPE) and discusses the need for suitable RPE. The terminology used in respirator selection is described along with relevant details of the hazards that RPE can protect against. Emphasis is placed on selecting equipment that is suitable for each situation in which it will be used and for each person who may have to wear the RPE.

The range of available RPE is listed together with applications that are likely to be encountered in British forestry. General advice about selecting suitable equipment for each of these situations is provided, although selection must involve an evaluation of the circumstances of each individual situation. Sources of further information are provided.

INTRODUCTION

This Technical Note provides guidance for those who are exposed to substances that are hazardous to health in the workplace. It will help in choosing the correct type of respiratory protective equipment (RPE) and ensure that it provides protection for the wearer.

Substances such as dusts, mists, fumes, vapours and gases may be damaging to health. Frequently this damage occurs by inhalation of harmful levels of these substances. The purpose of RPE is to minimise their potential for harm.

Health and safety legislation requires that employers first try to prevent the exposure of employees and others to harmful substances. Where prevention is not practical, control measures must be put in place to prevent hazardous substances contaminating the workplace. These measures may include substitution of the harmful substance with others of lesser hazard or fitting engineering controls such as extraction units and filters into the workplace. Engineering controls are preferred as they protect everyone and do not rely on the individual to work in any special way. Personal protective equipment (PPE) is normally considered the 'last resort', to be used only after other options have been carefully considered and rejected as impracticable. However, the nature of certain types of work, such as spraying herbicides in the forest, may require the selection and use of suitable PPE since no suitable engineering controls are available.

LEGAL REQUIREMENTS RELATING TO RPE AND RPE STANDARDS

Health and Safety legislation has specific requirements for RPE. Legislation covering use, maintenance and record keeping for RPE can be found in:

- *Personal protective equipment at work regulations, 1992 (PPEWR).*
- *Control of substances hazardous to health, 2002 (COSHH).*
- *Control of asbestos at work regulations, 2002 (CAW).*

Other specific regulations apply for the use of RPE outside forestry, which are not described in this Technical Note.

Copies of the regulations and the Approved Codes of Practice (ACOP) associated with these regulations may be obtained from HSE Books (see References for contact details).

The law requires that whenever RPE is used, the following criteria must be met:

- For a filtering respirator the oxygen in the air must be sufficient to sustain life.
- The equipment used must be suitable for the intended purpose. This means it must provide

effective protection for each individual wearer for the defined operation in a specified environment.

- It should be capable of providing sufficient clean air for the wearer to breathe.
- It must fit the individual correctly, and be comfortable.
- It must be compatible with other PPE being used, such as hard hats or goggles.
- It must be CE marked or HSE approved (see section on Types of RPE, page 3).
- It must be maintained in an effective state.
- Facilities must be provided for storage in accordance with the manufacturer’s instructions.
- Those who have responsibility for the selection and maintenance of RPE must be suitably trained.
- Users must be given training and instruction in the safe use of RPE.

All RPE must be marked with the symbol CE (recognition of a product that has received approval for sale in the European Community). The Health & Safety Executive (HSE) previously approved RPE, although the system of approval ceased on 1 July 1995. If HSE-approved equipment is still being used then it must be suitable for its intended use and maintained to perform correctly. In addition to the CE mark, all respirators must have the European Standard and performance category markings, e.g. FFP2S (see section on Uses of RPE, page 6, for an explanation of these terms). Table 1 provides a list of the relevant European Standards, which are all available from the British Standards Institute. A number of other European Standards exist relating to RPE, but they do not apply to forestry operations.

Table 1 RPE European Standards

Number	Title
EN136	Full facepieces
EN140	Half-mask facepiece
EN141	Gas and vapour filters
EN149	Filtering facepiece particulate respirators
EN405	Valved filtering half-mask respirators for gases and particulates
EN12492	Powered respirator full-facemasks

RESPIRATOR TERMINOLOGY

The terms used in RPE can be confusing. The more common terms are described and explained below.

Occupational exposure limits (OEL)

Exposure to an airborne substance is determined by undertaking personal monitoring of the air in the immediate vicinity of the worker. The measured concentration of the substance, averaged over a working day (8 hours) or a short period within a day (15 min) may then be compared to a reference figure to determine whether actions are required to reduce exposure. The reference figure is usually the relevant OEL, and these are published by the HSE in their Guidance Note EH40 (see References for contact details).

If the measured exposure is above the OEL then control measures should be considered *before* selecting respiratory protective equipment. In the UK there are currently two types of OEL, as described below, however HSE are revising the framework for OELs to provide a single unified system of limits.

- Occupational Exposure Standards (OES) are concentrations of hazardous substances in air at which, according to current scientific knowledge, there is no evidence that they are likely to cause any ill-health. It is considered control measures would be adequate under the Control of Substances Hazardous to Health (COSHH) regulations if inhalation exposure is reduced to the OES.
- Maximum Exposure Limits (MEL) are maximum permissible concentrations of hazardous substances to which any employee can be exposed by inhalation under any circumstance. Employers have a legal duty under the COSHH regulations to ensure that exposure is kept as far below the MEL as is reasonably practicable.

Protection factors

The updated British Standard BS4275 *Guide to implementing an effective respiratory device programme* (see References for contact details) incorporates the latest information available on respirator usage and is regarded by the HSE as illustrating the current best practice in this area. This is a very important publication and should be read by anyone setting up an RPE programme.

Assigned performance factor (APF) is based on scientific evaluations of the effectiveness of RPE in the workplace as described in BS4275. An APF may be interpreted as the maximum number of times higher than an OEL a person may be exposed to the substance while wearing suitable RPE. The figure is used for selection calculations. Information on APFs for specific types of respirator is given in BS 4275. Further details may also be obtained from suppliers.

TYPES OF RPE

Two types of RPE are recognised:

- **Atmospheric respirators:** these are designed to filter or clean contaminated air before the hazardous material is inhaled by the operator.
- **Breathing apparatus:** this delivers an independent source of clean breathable air to the wearer, either through a hose or from tanks carried by the wearer.

Respirators and breathing apparatus are available in a range of facepieces.

Each type of RPE has specific limitations, which dictate the types of application for which it may be used and so it is important to initially select the correct device. RPE is tested to relevant European Standards, which determine the product performance.

Loose fitting facepieces such as powered hoods and helmets rely on sufficient air being provided from an external source. If the power fails then this type of RPE will not protect the user and it must not be worn in such circumstances.

Where there is insufficient oxygen in the air to enable the person to breathe or where there are very high concentrations of hazardous substances in the air, respirators must not be selected and the only safe way to enter such environments is while wearing breathing apparatus.

Atmospheric respirators

Atmospheric respirators for dusts or fumes

Dust respirators are only for use against airborne particles and are ineffective against oxygen deficient atmospheres or atmospheres where toxic gases are present. The contaminated air is drawn through a filter medium by the wearer's own inhalation. Except in the simplest types,

exhaled air passes through a valve back to the atmosphere. The life of the filter is dependent upon the concentration of contaminant and resistance to breathing increases with use due to gradual obstruction of the filter. All respirators should have a 'use by' date marked on the filter. The RPE should not be used after the date has expired, as the filter may not work properly.

These types of respirator may also be designed to provide protection against inhalation of mists, either water based or water/oil based. Types available include:

- disposable filtering facepieces (BS EN149), which consist of a moulded filter medium with a simple head harness that may be fitted with an exhalation valve;
- half-mask respirators (BS EN140) which generally consist of a rubber half-mask and dust filter or filters for protection against harmful dusts.

Atmospheric respirators for gases or vapours

These respirators are designed to protect against specific gases or vapours. They can take the form of a disposable moulded half-mask or a half-mask or full-facemask fitted with a cartridge or canister filter (i.e. a larger container and connected by flexible tube to the facepiece).

- **Disposable half-masks:** These masks are designed to cover the mouth, nose and chin and incorporate a particle and gas filter. Although they are designed to be disposable, as the filter elements cannot be changed, if used for more than 28 days they become subject to examination and record keeping under COSHH regulations (Regulation 9), which must subsequently be kept for 5 years. They must conform to EN405, which must be clearly marked on the respirator or the packaging, and include a CE mark.
- **Reusable half-masks with disposable filter cartridge:** These respirators give similar protection to masks meeting EN405 and are designed to protect against the same hazards. The main difference is that they can be fitted with a range of replaceable filter cartridges. The half-masks themselves are covered by EN140 and this, together with the compulsory CE marking, should be clearly marked on the respirator. The cartridges will be subject to discard criteria based upon the level of exposure to contaminants, the OEL and the protection factor that should be clearly marked on the body of the canister or cartridge. There will also be a 'use by' date on the canister.

- **Reusable full-facemasks:** These respirators are designed to cover the whole face and are fitted with a transparent visor. They should be used where a liquid can be splashed or where it can pass through bodily membranes such as the eye or when a greater level of respiratory protection is required. They are fitted with disposable cartridges for particles and gases and offer higher protection than half-masks with disposable cartridges. The masks should be clearly marked as conforming to EN136 together with the mandatory CE mark.
- **Power-assisted facemasks:** These are full or half-masks that have a low-pressure air supply via a small pump to assist in breathing. They are covered by prEN12942 with protection factors for disposable cartridges similar to those for full-facemask respirators.
- **Powered visors and helmets:** A wide range of this type of RPE is available from different suppliers with various combinations and protection factors for specific working environments. Generally, they consist of a hood or helmet, which has either an external pump or an integral fan-assisted air delivery, the air being drawn through a filter in both systems. They are useful in dust-laden atmospheres where the dust concentration does not exceed the OEL but where operator contamination by dust is a problem. Their construction is covered by EN12941.

Breathing apparatus

This type of device either supplies clean air or a mixture of air and oxygen. The supply can be via a flexible hose from a remote location or from self-contained breathing apparatus (SCBA). These types of devices are not normally used in forestry. They are mostly used where the highest level of protection is required or in oxygen-deficient atmospheres.

The degree of protection depends on the equipment selected, for example simpler forms of visor will give a lower protection than equipment using a hood as the ingress of contaminated air will be greater.

Within this class there are three sub-divisions of RPE, all generally using a full-facemask:

- **Simple compressed-air equipment:** Compressed air suitable for breathing is supplied through a flexible airline connected to a pressure-reducing valve of the demand, constant flow or positive pressure type. Filters may need to be included into the airline to remove

undesirable contaminants such as oil mist and moisture. Moving the airline can be difficult for the wearer and there is a risk of entanglement with obstructions.

- **Fresh-air hose equipment:** Air is drawn from an adjacent uncontaminated area along a large diameter hose by the breathing action of the wearer.
- **Breathing apparatus:** Air or oxygen suitable for breathing is supplied to the wearer, usually from cylinders, which are an integral part of the apparatus. The period of protection is limited by the amount of stored air or oxygen and by the work rate of the wearer. Air consumption increases dramatically with increasing work rate and hence the duration of protection decreases.

SELECTION OF RPE

RPE should only be used as a last resort as it only protects the wearer and, if used incorrectly or poorly maintained, may provide no protection.

The selection of correct RPE follows a four-step method to identify the hazards, assess the risk, choose the appropriate respirator and train in fitting and use:

Identification of hazards

Find out what contaminants are likely to be in the air. The selection of an appropriate filter will depend on this information. Decide what you want protection against:

- **Dusts** – produced when solid materials are broken down into finer particles, the longer the dust remains in the air the easier it is to inhale.
- **Mists** – tiny liquid droplets formed by atomisation and condensation processes such as spraying. Mists are often combinations of several hazardous ingredients.
- **Fumes** – occur when substances are vaporised under high heat. The vapour is cooled quickly and condenses into very fine particles that float in the air.
- **Gases** – airborne at room temperature. Able to diffuse or spread freely, can travel very far very quickly.
- **Vapours** – gaseous state of substances that are liquids or solids at room temperature. Formed when

substances evaporate in the way water vapour evaporates from water.

For gases and vapours it is most important to know exactly what chemicals are in the air as the selection of a suitable filter will depend on this information.

Assessment of risk

Measure or assess the hazard level and decide on other protection that may also be required, i.e. skin or eye protection. The use of RPE may be justified in the following situations:

- Exposure exceeds an occupational exposure limit and controls are being installed.
- Emergency maintenance work is to be undertaken.
- Exposure is of short duration or the work will be carried out in a situation where other control measures are not reasonably practicable.
- All other practicable controls are installed but there remains a residual inhalation risk.
- For escape purposes in the event of plant failure.
- Rescue work by trained personnel.

Selecting appropriate RPE

When selecting RPE, it must be remembered that **no** RPE provides 100% protection against exposure to a hazardous substance. In order to decide which RPE will fully meet the requirements for suitable protection the following questions must be asked:

- Will the atmosphere contain enough oxygen during the period of exposure? If you think that there may be insufficient oxygen then you must seek expert advice and the area must only be entered by someone wearing appropriate breathing apparatus.
- Which hazardous substances may be present, what are their properties and which forms do the air contaminants take?
- What effects may the substances have on the body?
- What are the probable atmospheric concentrations?

- What are the relevant occupational exposure limits?
- What other hazards exist?
- How long will RPE be worn?
- How simple is it to decontaminate and dispose of the used RPE?

Much of this information should be available in the relevant risk assessment records, e.g. an assessment made under the COSHH regulations. With regard to chemicals, the manufacturers should supply the necessary information about exposure risks and limits.

When deciding the type of RPE to use, the minimum protection required must be determined, i.e. the probable concentration divided by the relevant occupational exposure limit. RPE must provide suitable protection for all of those who need to wear it.

Fit testing

A mandatory requirement under the COSHH regulations 2002 is *fit testing*. This ensures that the selected equipment is tight fitting and provides an adequate seal to the wearer's face. It should be carried out during the initial selection process of RPE and it is mandatory for all wearers of RPE.

After the initial fit testing, it is important that re-testing should take place if the wearer's facial circumstances change e.g. through significant weight loss or major facial injury. Re-testing should always take place if a different size or model of RPE is specified for either a different operation or if reassessment of the COSHH/risk assessment indicates a higher specification.

As a minimum check, the fit testing of RPE should take place on an annual basis and records kept of the results and of any changes made. Advice on fit testing should be sought from manufacturers or suppliers of RPE.

It is important to consider all of the personal factors in relation to each individual who will wear RPE. The relevant factors include:

- The size and shape of the individual face: this will have a bearing on the type and size of RPE.
- Face-to-facepiece seal: tight fitting facepieces rely on a good seal between the wearer's face and the mask

to allow air to be drawn through the filter. Beards or facial hair do not allow a good seal and contaminated air will be drawn unfiltered as the wearer inhales. Even growth of facial hair for one or two days may interfere with the effectiveness of RPE and men should always be clean-shaven when wearing a tight fitting respirator. Men with a beard or moustache may require a loose fitting device such as a power-assisted visor or helmet. Conventional spectacles would seriously interfere with the seal of a full-facepiece mask and hence cannot be worn with this type of device.

- Medical fitness: RPE which has been approved by the HSE has passed basic performance tests, including tests and limits for resistance to breathing. These limits have been set for average healthy adults. People with respiratory disorders, such as asthma, may find breathing difficult with ‘lung-powered’ respirators and non-assisted fresh air hose breathing apparatus. In such cases medical advice should be sought before the person wears the RPE.
- Compatibility with other PPE such as safety spectacles or protective goggles: the other equipment must not interfere with the seal of the facepiece to the face.
- Work-related factors: physical work rate, mobility, visibility, other PPE, duration worn, communication, work environment, use of tools and other equipment. All of these factors may limit an individual’s ability to wear RPE for prolonged periods.

Training in fitting and use

To optimise respiratory protection, wearers should be trained in the theoretical and practical aspects of the various types of RPE to be used. These include:

- Why the RPE is needed and when it should be used.
- How it works and its limitations.
- How to use, put on and remove the equipment.
- Pre-use inspection/checks.
- Emergency procedures.
- Cleaning and inspection after use.
- Storage.

Emphasis must be given to the selection of RPE so that it is based on a risk assessment to be carried out under the appropriate regulations controlling the use of PPE, e.g. the COSHH regulations.

USES OF RPE

Each filtering device carries a mark denoting the type and class of device and the level of protection it provides. This section provides some general examples and aims to clarify the technical terms.

- Where the device is marked by ‘FF’, this denotes that it is a filtering facepiece.
- Each type of filtering device is available in three performance classifications and identified by a code consisting of a letter and a number which identifies the capacity. The three classifications are P1, P2 and P3. Where a filter is marked P3, it has a higher efficiency than a P2 or P1. Similarly, a P2 device has a medium efficiency and a P1 a low efficiency. This means that a P3 device will last longer than a P2, before the need to discard or clean it. If the operator finds that they are not obtaining an acceptable lifetime from the device, they should consider using one of the same type but of a higher class. The filters have been classified by performance according to the relevant BS EN standards.
- Some filters will be marked by an ‘S’, which denotes use against solid aerosols only. Where the filter is marked by ‘SL’, it can be used against solid and liquid aerosols.

The following two examples are typical forestry industry tasks. They indicate the kind of contaminant that can be expected from such an operation and provide general advice on the type of RPE that could be used as protection. Figures 1 and 2 show the type of mask required with an explanation of the code of that particular RPE.

Example 1: Sanding down wood

Protection is required against fine dust; a disposable half-mask marked EN149 FFP1S would be suitable.

Figure 1 FFP1S mask and explanation of code on RPE



Code	Description
EN149	Relevant standard EN149, <i>Filtering facepiece particulate respirators</i>
FF	Filter facepiece
P1	Low efficiency
S	Use against solid particles

Example 2: Applying liquid pesticide

Protection is required against water-based mist; a disposable half-mask marked EN149 FFP3SL would be suitable.

Figure 2 FFP3SL mask and explanation of code on RPE



Code	Description
EN149	Relevant standard EN149, <i>Filtering facepiece particulate respirators</i>
FF	Filter facepiece
P3	High efficiency
SL	Use against solid particles and liquid particles

MAINTENANCE OF RPE

Maintenance comprises all aspects of care which are required to keep the equipment in effective working order. It includes pre-use checks, cleaning, disinfecting, formal examinations, repair, testing and record keeping.

Proper maintenance is essential to make sure RPE continues to work correctly and provide the required level of protection. Maintenance of RPE should only be carried out by a competent person, in accordance with the manufacturer's instructions. Maintenance is required by specific legislation, such as the COSHH regulations and the Personal Protective Equipment at Work Regulations 1992. These requirements may include cleaning, disinfecting, examination, repair, testing and record keeping.

Pre-use checks and cleaning

Pre-use checks should be undertaken immediately before any use of the equipment to ensure it is not damaged, has not deteriorated since last used and still functions correctly. These checks are not normally recorded.

Re-useable RPE requires regular cleaning, and maintenance of the devices is essential. Disposable RPE should be dealt with in accordance with the manufacturer's guidelines. The type of contaminant collected on the device should be taken into account when carrying out disposal.

The manufacturer's instructions and recommendations for disassembling, cleaning and disinfecting using the appropriate cleaning agents should be closely followed.

Parts that are not re-useable should be disposed of in line with manufacturer's instructions. Devices should be stripped down and cleaned after each day's use. Uncleaned devices should be considered to be contaminated and dealt with accordingly.

Suitable storage conditions for new, partly used or cleaned and serviced devices should comply with the manufacturer's instructions, to prevent loss, damage or contamination. RPE should not be stored in dirty or contaminated areas or with other dirty work clothes. Many filters deteriorate quite quickly once opened.

Details of recommended maintenance for specific respirators can be obtained from the supplier.

Examination and testing

Examinations are the formal, defined list of checks undertaken at specific periods. They are recorded.

Testing is the formal functional testing undertaken to a defined procedure and is recorded. Some equipment may need to be tested by an authorised person or organisation.

The ACOP (L5) for COSHH sets out the requirements for examination and testing of RPE. Generally speaking, a thorough examination of all RPE (except disposable types) should be carried out at least once a month. In certain cases, if severe conditions apply, examination should be more frequent. Similarly, where devices such as quarter- or half-masks are used occasionally against dusts of low toxicity, longer inspection times may be allowed, but should not exceed 3 months.

The ACOP gives details of what a thorough examination should involve and the minimum information required to be recorded (see Record keeping below). The examination should include a thorough visual inspection of all parts of the device, in particular the straps, facepieces, filters and valves. BS4275 provides details of the types of tests that can be carried out to identify performance and fitting.

Record keeping

Records may be kept in any format. They should be readily available on request for inspection by employees or their representatives, or by inspectors appointed by the relevant enforcing authority or employment medical advisors. Records of thorough examinations should be kept for at least 5 years.

The records should include:

- Name and address of employer responsible for the device.
- Particulars of the device.
- Date of examination and clear identity of the person carrying out the examination.
- Condition of the device and any particulars of defects observed.
- Any comments made or received by wearers and supervisors.

CONCLUSIONS

- Harmful substances in the form of dusts, mists, fumes, vapours and gases can cause damage to health when they are inhaled. The purpose of RPE is to minimise the potential for harm from these substances by reducing the quantity inhaled. Two main types of RPE are available: air purifying respirators and breathing apparatus. The main difference between these is that respirators filter the air before it is inhaled, whereas breathing apparatus provides clean fresh air from either a cylinder or a remote location. Breathing apparatus is not widely used in British forestry.
- Respirators and breathing apparatus are available in a range of facepieces. Some shield the whole of the head in a hood or helmet, others cover the front of the face (full-face) and others just the nose and mouth (half-masks). RPE must be CE marked with the symbol plus the relevant European Standard and performance category markings.
- UK health and safety legislation contains specific requirements for RPE which is used to protect against exposure to hazardous atmospheres or substances.
- Care is needed to choose the type of RPE that is correct for the situation.
- Four steps are required to select suitable RPE: identify the hazards present in the work-place, assess the magnitude of the risk, select a proper respirator and provision of training for the users to ensure the equipment is properly fitted and used.
- To achieve adequate protection, equipment must be well maintained, fitted correctly and worn by appropriately trained persons.

- RPE should be used as a last resort as it only protects the wearer and, if used incorrectly or poorly maintained, may provide no protection.

REFERENCES

The following publications are updated at regular intervals; please check with supplier/distributor at the time of ordering.

BRITISH STANDARDS INSTITUTE.

Guide to implementing an effective respiratory protective device programme. BS 4275.

Available from BSI Customer Service, 389 Chiswick High Road, London, W4 4AL.

Tel. 020 8996 9001, Fax. 020 8996 7001.

HEALTH AND SAFETY EXECUTIVE.

The following are available from HSE Books, PO Box 1999, Sudbury Suffolk CO10 2WA.

Tel. 01787 881165, Fax. 01787 313995, www.hsebooks.co.uk.

- *A short guide to the personal protective equipment at work regulations, 1992.* INDG174.
- *COSHH in forestry.* AS30.
- *Control of asbestos at work regulations.* L27.
- *The approved code of practice for COSHH.* ACOP (L5).
- *Occupational exposure limits.* EH40/2001.
- *The selection, use and maintenance of respiratory protective equipment.* HSG53.

3M UNITED KINGDOM PLC.

3M personal protective equipment directory.

Available from 3M House, PO Box 1, Market Place, Bracknell, Berks. RG12 1JU

Tel: 0870 60 80060, e-mail: innovation.uk@mmm.com.

THE STATIONERY OFFICE (1999).

Control of substances hazardous to health regulations.

The Publications Office, PO Box 276, London SW8 5DT.

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