PERSONAL PROTECTIVE EQUIPMENT PROGRAMME

A GUIDE TO SELECTION, USE AND MAINTENANCE

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FOREWORD

The aim of this guide is to educate and provide information for both management and workers on the criteria necessary in the implementation of an effective personal protective equipment (PPE) programme and includes the selection, use and maintenance of PPE devices.

The goal of PPE is to prevent the transfer of hazardous material from patients or the environment to the susceptible worker. PPE refers to any equipment used to protect workers from exposure to physical, chemical and biological hazards, after all other control measures have been implemented and there is still significant exposure of the worker to the hazard.

It must be stressed that the use of PPE **does not eliminate** the hazard; rather it is an aid to prevent injury or adverse health effects to the worker concerned.

Different types of PPE may be used depending on the hazard present. However, it must be noted that PPE is unlikely to provide effective protection unless management implements a system of selection, use, maintenance and supervision of the PPE.

GLOSSARY

Aerosol
Particles (solid or liquid) suspended in air.

Air-Purifying Respirator
A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Atmosphere-Supplying Respirator
A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Attenuation-Real Ear Attenuation at Threshold (REAT)
A standardized procedure for conducting psychoacoustic tests on human subjects designed to measure sound protection features of hearing protective devices. Typically, these measures are obtained in a calibrated sound field, and represent the difference between subjects' hearing thresholds when wearing a hearing protector vs when not wearing the protector.

Attenuation-Real-World
Estimated sound protection provided by hearing protective devices as worn in "real-world" environments.

Auxiliary SCBA
An auxiliary unit means that the SAR unit includes a separate air bottle to provide a reserve source of air should the airline become damaged. The auxiliary unit shares the same mask and regulator, and enables the SAR to function as an SCBA if needed.

Canister/Cartridge
A container with either a filter, sorbent or catalyst, or a combination of these items, which removes specific contaminant(s) from the air passed through the container.

Contaminant
A toxic, irritating, or nuisance material

Demand Respirator
A respirator in which the pressure inside the face piece in relation to the immediate environment is positive during exhalation and negative during inhalation.

Disposable Respirators
A respirator that is discarded after the end of its recommended period of use, after excessive resistance or physical damage, or when odor breakthrough or other warning indicators render the respirator unsuitable for further use.

Degradation
The loss in physical properties of an item of protective clothing due to exposure to chemicals, use or ambient conditions (e.g. sunlight)

Dust
An aerosol consisting of solid particles derived from the breaking up of larger particles.

End-Of-Service-Life Indicator (ESLI)
A system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

Escape Gas Mask
A gas mask that consists of a half-mask face piece or mouthpiece, a canister, and associated connections, and that is designed for use during escape-only from hazardous atmospheres.

Face-shield
A device worn in front of the eyes and covering wholly or partially the face.

Filter or Air-Purifying Element
A component used in respirators to remove solid or liquid aerosols from the inspired air.

Filtering Facepiece
A particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Fit Factor
A quantitative measure of the fit of a specific respirator facepiece to a particular individual.

Fit Test
Means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)

Full facepiece respirator
A facepiece that covers the face from roughly the hairline to below the chin.

Fume
Solid aerosols of extremely small particle size, generated by condensation of a substance from a vapour state to a solid state. It is normally associated with molten metal where the metal is vaporized, followed by oxidation of the vapour and condensation of the oxide into fine solid particles.

Gas
A fluid that has neither shape nor volume.

Goggle
A device worn over the eyes and normally held in place by a headband.

Half facepiece
A facepiece that fits over the nose and under the chin.

Hearing loss
Hearing loss is often characterized by the area of the auditory system responsible for the loss. For example, when injury or a medical condition affects the outer ear or middle ear (i.e. from the pinna, ear canal, and ear drum to the cavity behind the ear drum - which includes the ossicles) the resulting hearing loss is referred to as a conductive loss. When an injury or medical condition affects the inner ear or the auditory nerve that connects the inner ear to the brain (i. e., the cochlea and the VIIIth cranial nerve) the resulting hearing loss is referred to as a sensorineural loss. Thus, a welder's spark which damaged the ear drum would cause a conductive hearing loss. Because noise can damage the tiny hair cells located in the cochlea, it causes a sensorineural hearing loss.

High-Efficiency Particulate Air (HEPA) Filter
A filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Hood or Helmet
A respirator component which covers the wearer's head and neck, or head, neck, and shoulders, and is supplied with incoming respirable air for the wearer to breathe. It may include a head harness and connection for a breathing tube.

Mist
An aerosol composed of liquid particles.

Negative Pressure Respirator
A tight-fitting respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Noise control-Administrative
Efforts, usually by management, to limit workers' noise exposure by modifying workers' schedule or location, or by modifying the operating schedule of noisy machinery.

Noise control-Engineering
Any use of engineering methods to reduce or control the sound level of a noise source by modifying or replacing equipment, making any physical changes at the noise source or along the transmission path (with the exception of hearing protectors).

Orinasal Respirator
A respirator that covers the nose and mouth and that generally consists of a quarter- or half-facepiece.

Permissible exposure level
The maximum time-weighted concentration of a contaminant in the air to which an individual may be exposed.

Penetration
The movement of chemical through zippers, stitched seams or imperfections (e.g. pinholes) in a protective clothing material.

Permeation
The process by which a chemical dissolves in and moves through a protective clothing material on a molecular scale.

Powered Air-Purifying Respirator (PAPR)
Means a device equipped with a facepiece, hood, or helmet, breathing tube, canister, cartridge, filter, canister with filter, or cartridge with filter, and a blower.

Pressure Demand Respirator
A respirator in which the pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.

Qualitative Fit Test (QLFT)
A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Quantitative Fit Test (QNFT)
Means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Required minimum protection factor
The protection factor required to reduce the exposure to an accepted level. It is expressed as a ratio of the measured ambient concentration of a contaminant to its permissible exposure level.

Respirator
A personal device designed to protect the user from the inhalation of hazardous atmosphere.
Risk

Respiratory Inlet Covering
The portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both. It may be a facepiece, a helmet, a hood, a suit, or a mouthpiece respirator with nose clamp.

Self-Contained Breathing Apparatus (SCBA)
An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Smoke
Particles of low vapour pressure suspended in the air. Smoke is made up of the solid and liquid products of combustion.

Sorbent
A material that is contained in a canister or cartridge and removes specific gases and vapours from the inhaled air.

Supplied-Air Respirator (SAR) or Airline Respirator
An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Tight-Fitting Facepiece
A respiratory inlet covering that forms a complete seal with the face.

Time weighted average (TWA)
The concentration of a contaminant in air determined by adding together the products of each concentration and the corresponding time over which that concentration was measured, and dividing the sum by the total time over which the measurements were taken.

Vapour
The gaseous phase of matter that normally exists in a liquid or solid state at room temperature.

CONTENTS

1. INTRODUCTION

1.1 The Personal Protective Equipment (PPE) Programme

The objective of this guide is to indicate the role of PPE in an overall control programme and to provide advice on setting up and implementing a PPE programme.

It is a tenet of good occupational hygiene practice that all possible action should be taken to prevent or reduce risks at source rather than relying on PPE to provide the only protection for the user. Management should take effective action to ensure that control measures are developed and applied in order to eliminate or minimise the risk to a level at which personal protection may not be required.

The use of PPE should not be regarded as an alternative to engineering or other suitable control measures but should be provided and maintained where such control measures cannot ensure protection. However, there will be work situations that where alternative means of controlling risks are not technically feasible and the use of PPE is unavoidable e.g. during incidents such as chemical spillages.

When PPE has to be used, it must provide adequate protection without itself leading to any risk or increased risk. To ensure that PPE provides effective ongoing protection, it is not sufficient to simply provide nominally adequate. Hence, it is necessary to set up a comprehensive programme to ensure that the PPE continues to be correctly used and if reusable, is maintained in efficient and hygienic condition.

1.2 Components of a PPE Programme

Management must ensure that a written PPE programme is in place to ensure that all workers are aware of their roles in the programme.

Essentially, the components of a PPE programme must include:

a. Selection

Selection and purchase of PPE specific and appropriate to the job must involve a suitably trained person as well as inputs by the end user (worker who is going to use the PPE).

b. Fitting

PPE fitting must be done on first issuance of selected PPE particularly in the use of respiratory protective equipment. Various sizes of each type of equipment will need to be available to fit each and individual worker.

c. Health aspects

PPE use may have an impact on the workers' health e.g. the use or rubber latex gloves may cause exacerbation or aggravation of a workers' atopy.

d. Compatibility

PPE use must be compatible to the different tasks involved in the job. The use of different types of PPE simultaneously in performing a task must also be evaluated.

e. Provision

It must be borne in mind that each PPE comes in several types i.e. specifications. The provision of PPE must be suited to each and individual workers' needs. Each specification may not be appropriate for the hazard and the use may instead lead to workers exposure rather than protection.

Wherever possible, PPE should be issued on an individual basis – a system of each worker signing up for each PPE they receive may encourage responsibility on the use and maintenance of the PPE issued.

f. Proper use

PPE is effective only when used correctly and appropriate for the tasks. PPE that can provide complete protection but if not properly used may provide no protection at all.Use of PPE by supervisory staff, employee encouragement and enforcement of use are important.

Employees should not be allowed from taking used PPE for domestic purposes.

g. Maintenance

With the exception of single use PPE, procedures for the cleaning and maintenance of PPE should be established according to manufacturer's guidelines.

PPE may be contaminated with toxic substances during its use; therefore, provisions should be made to avoid contamination of other areas of the workplace or of employees engaged in cleaning or maintenance of the used PPE.

h. Storage

As mentioned, PPE may be contaminated with toxic substances during its use - these must be placed in suitably labeled containers until sent for cleaning. Those PPE which are used intermittently should be stored in a clean container e.g. plastic bag and sealed off to avoid contamination. Provisions need to be made for proper storage of PPE when not in use.

i. Disposal

Disposal procedures need to be taken into consideration bearing in mind the contamination of the used PPE with toxic substances. The PPE may have to be treated as a toxic waste in certain circumstances.

j. Training

Employees must be given sufficient information and training about the hazards associated with their jobs to enable them to work safely and with minimal risk to health. Known limitation of using PPE includes discomfort and hinders the employee from doing his job properly. Employees who are fully aware of the hazards and the need for protection will be more ready to accept limitations associated with PPE use and use the equipment provided.

Any changes in the work procedure or requirements may need for a different type of PPE to be used and training and retraining may be needed.

k. Supervision

Supervisors must be knowledgeable and held accountable for effective use of the PPE which in turn ensures the success of the PPE programme. Supervisors must also set an example by wearing PPE as appropriate and ensure its use by others as required.

l. Evaluation

As with any other programme, evaluation on the procedures outlined should be done from time to time to confirm that it is appropriate, practicable and being followed. This can be done informally or through a specialist third party.

Please see **Appendix A** on issues to be considered in the implementation of the PPE programme.

1.3 Limitations on the Use of PPE

It must be borne in mind that the use of PPE does not provide complete protection against the hazard; rather, limitations to its use do exist:

1. The use of PPE does not reduce or eliminate the hazard.
2. Defective or ineffective PPE may cause the worker to be exposed to the hazard without the worker being aware of it.
3. PPE only provides protection to the worker using it - the exposure of other people (workers and general public) to the hazard must also be considered.
4. PPE use may not be suitable to the worker especially if the worker has underlying health problems.
5. PPE use may introduce additional hazards to the worker – using the PPE may hinder the worker to do the job properly or it may interfere with the workers senses e.g. use of full face mask may interfere with the workers' vision.
6. PPE use may transfer the hazard to another location e.g. toxic chemicals may be absorbed to PPE clothing and brought home by the worker resulting in exposure to the workers' family.
7. PPE may not be suitable for continuous use.
8. The worker may not be using the PPE correctly.

2. SELECTION AND TYPES OF PPE

2.1 Selection of PPE

The selection of PPE takes account of risks to health based on knowledge of the hazard and exposure assessment. Consideration is then required as to the degree of protection needed and the job tasks must be analysed to determine if there are any constraints on selection of equipment.

It is also wise to involve those who will wear the PPE in its selection. Equipment must be correctly fitted and adjusted for maximum comfort. Where possible, more than one model satisfying the appropriate safety performance and other criteria of suitability should be made available, thus providing individual choice and encouraging use.

Criteria for selection includes the following consideration:

- ✓ Nature of hazards-gases, vapour or liquid
- ✓ Severity of exposure
- ✓ Frequency and distribution of exposure-how often and for how long
- ✓ Parts of body exposed and manner of exposure
- ✓ Nature of work engaged in when exposed to the hazards
- ✓ Environmental condition, and
- ✓ Degree of protection which a particular PPE can provide

2.2 Types of PPE

PPE can be divided into two major classes:

- equipment providing protection from direct physical injuries caused by flying or falling objects, temperature extremes, abrasive and sharp edges

Nature of Threat	**Body Zone to be Protected**	**PPE examples**
Flying objects	Eyes	Spectacles/Safety glasses/Goggles Visor/Helmets
Falling objects	Head Feet	Helmets Safety Shoes/boots
Abrasion	Hands	Gloves-leather
Hot surfaces	Hands	Gloves-aluminium, glass fibre mixture, wool
Cold surfaces	Hands	Gloves-croygenic PVC, leather
Fire	Whole body	Gloves Helmet Fire approach suits/Close proximity suits

- equipment providing protection from chemical, physical and biological hazards, the effects of which are determined by the dose received.

Nature of Threat	Route to be Protected	PPE examples
Toxic, corrosive or irritant gas, vapour, mist, dust or fume	Airway Eyes	Full face respiratory protective equipment
Toxic, corrosive or irritant liquid	Eyes Skin	Visor/face shield Chemical goggles Chemical resistant gloves
Noise	Ears	Ear plugs/muffs

The specification of the PPE requirements is aimed at matching the protection to the risk.

Please see **Appendix B** on issues to be considered in the selection of PPE.

3. HEAD PROTECTION

The head, especially the brain, is the most susceptible to disabling injury from impact and injuries are potentially more dangerous with results of injury persisting over a long time.

There are four widely used types of head protection:
(a) crash helmets, cycling helmets, riding helmets and climbing helmets which are intended to protect the user in falls;

(b) industrial safety helmets which can protect against falling objects or impact with fixed objects;
(c) industrial scalp protectors (bump caps) which can protect against minor bumps and abrasions e.g. striking fixed obstacles, scalping or entanglement (not suitable for providing impact protection); and

(d) caps, hairnets etc. which can protect against scalping/entanglement.

The following guidance deals only with industrial safety helmets, scalp protectors and climbing helmets (i.e. it excludes caps and hairnets).

3.1 Process and activities

The following are examples of activities and processes involving risks of falling objects or impacts, which may require the provision of head protection; it is not an exhaustive list.

(a) Building work, particularly work on, underneath or in the vicinity of scaffolding and elevated workplaces, erection and stripping of formwork, assembly and installation work, work on scaffolding and demolition work.
(b) Construction work on bridges, buildings, masts, towers, hydraulic structures, blast furnaces, steel works and rolling mills, large containers, pipelines and other large plants, boiler plants and power stations.

(c) Work in pits, trenches, shafts and tunnels. Underground workings, quarries, opencast mining, minerals preparation and stocking.
(d) Work with bolt-driving tools.
(e) Blasting work.
(f) Work near hoists, lifting plant, cranes and conveyors.
(g) Work with blast furnaces, direct reduction plants, steelworks, rolling mills, metalworks, forging, drop forging and casting.
(h) Work with industrial furnaces, containers, machinery, silos, storage bunkers and pipelines.
(i) Building or repairing ships and offshore platforms.
(j) Railway shunting work, and other transport activities involving a risk of falling material.
(k) Slaughterhouses.
(l) Tree-falling and tree surgery.
(m) Work from suspended access system, bosun's chairs etc.

3.2 Construction

The standard protective helmet comprises of:

(a) A hard shell having a smoothly finished outer surface. The most common shell materials are high density polyethylene, polycarbonate, ABS (acrylonitrile-butadiene-styrene), polycarbonate/ABS blend, reinforced fiberglass and resin-impregnated textiles.
(b) A cradle or suspension system which encircles the head. It is usually of plastic construction and adjustable to a variety of sizes. This cradle is a major component in absorbing the energy from any impact.

(c) A headband which contacts the wearer's head at the forehead area.
(d) The helmet should be legibly and durably marked with the date of manufacture.

Standard accessories includes:

(a) A chin strap of fabric, leather or plastic-covered-elastic
(b) A nape strap usually of plastic material, sometimes containing a plastic foam pad
(c) Visors or faceshields
(d) Ear muffs
(e) Sweat bands

3.3 The selection of suitable head protection

To fit, head protection should:

(a) be of an appropriate shell size for the wearer; and
(b) have an easily adjustable headband, nape and chin strap.

Good head protection properties should include:
- (i) The outer shell must be strong and light in weight,
- (ii) Resistant to fire, water, oil, solvents and other chemicals,
- (iii) Composed of non-electrical conducting materials (especially if working with electricity), and
- (iv) Compatible with other PPE that is being used.

Cost is also a major factor when selecting the type of helmet to be procured; generally:
- (a) polyethylene helmet is cheaper than fiberglass or resin impregnated textile helmet
- (b) polyethylene helmets will deteriorate more rapidly in UV light exposure than will either fiberglass or resin impregnated textile helmets.

Head protection should be as comfortable as possible. Comfort is improved by the following:
- (a) a flexible headband of adequate width and contoured both vertically and horizontally to fit the forehead;
- (b) an absorbent, easily cleanable or replaceable sweat-band;
- (c) textile cradle straps;
- (d) chin straps (when fitted) which:
    - (i) do not cross the ears,
    - (ii) are fitted with smooth, quick-release buckles which do not dig into the skin,
    - (iii) are made from non-irritant materials,
    - (iv) can be stowed on the helmet when not in use.

Tight suspension fits are uncomfortable and the pressure can cause headaches. A loose harness, on the other hand, can also be uncomfortable. Thus, suspension condition is critical to the performance of the helmet. To avoid excessive heat, helmets should be smooth and shiny to reflect solar heat and to minimize heat load. Inclusion of a close-fitting compressible liner will act as an insulator.

3.3 Compatibility with the work to be done

Whenever possible, the head protection should not hinder the work being done. For example, an industrial safety helmet with little or no peak is useful for surveyor taking measurements using a theodolite or to allow unrestricted upward vision for a scaffold erector. If a job involves work in windy conditions, especially at heights, or repeated bending or constantly looking upwards, a secure retention system is required. Flexible headbands and Y-shaped chin straps can help to secure the helmet.

Head protection worn in the food industry may need to be easily cleaned and compatible with other hygiene requirements. Plastic or fiberglass shell will be more suitable for work involving exposure to chemicals and solvents. If other PPE such as ear defenders or eye protectors are required, the design must allow them to be worn safely and in comfort. Check manufacturer’s instructions regarding the compatibility of head protection with other types of PPE.

3.4 Maintenance

Head protection must be maintained in good condition. Head protection should:
- (a) be stored, when not in use, in a safe place, for example, on a peg or in a cupboard. It should not be stored in direct sunlight or in excessively hot, humid conditions;
- (b) be visually inspected regularly for signs of damage or deterioration;
- (c) have defective harness components replaced (if the design or make allows this). Harnesses from one design or make of helmet cannot normally be interchanged with those from another; and
- (d) have the sweat-band regularly cleaned or replaced.

Before head protection is reissued to another person, it should be inspected to ensure it is serviceable and thoroughly cleaned in accordance with the manufacturer's instructions. The shell and cradle can be scrubbed with a mild detergent to remove dirt and stains, rinsed thoroughly with warm water, wiped dry and then inspected for any signs of damage. They should be stored away from direct sunlight.

3.4.1 Damage to shell

Damage to the shell of a helmet can occur when

(a) objects fall onto it;
(b) it strikes against a fixed objects;
(c) it is dropped or thrown;

If the helmet has been subjected to a heavy blow, the shell and unit should be replaced immediately even though there is no visible damage.

3.4.2 Deterioration in shock absorption or penetration resistance

Deterioration in shock absorption or penetration resistance of the shell can occur from:

(a) exposure to certain chemical agents;
(b) exposure to heat or sunlight;and
(c) ageing due to heat, humidity, sunlight and rain.

Chemical agents which should be avoided include paint, adhesives or chemical cleaning agents. Where names or other markings need to be applied using adhesives, advice on how to do this safely should be sought from the helmet manufacturer. Exposure to heat or sunlight can make the shell go brittle. Head protection should never be stored therefore near a window, e.g. the rear window of a motor vehicle, because excessive heat may build up.

3.5 Replacement

The head protection should normally be replaced at intervals recommended by the manufacturer. It will also need replacing when the harness is damaged and cannot be replaced, or when the shell is damaged or it is suspected that its shock absorption or penetration resistance has deteriorated for example when:

(a) the shell has received a severe impact;
(b) deep scratches occur;
(c) the shell has any cracks visible to the naked eye.

The following is suggested for replacement periods:

(a) Polyethylene helmets:	3 years
(b) Polycarbonate helmets	6 years
(c) Resin impregnated textile and fiberglass helmets	10 years

4. EYE AND FACE PROTECTION

4.1 Types of eye and face protection

Eye and face protection serves to guard against the hazards of impact, splashes from chemicals or molten metal, liquid droplets (chemical mists and sprays), foreign bodies, dust, gases, welding arcs, non-ionising radiation and the light from lasers. These hazards can damage the three main areas of the eye which are the cornea and conjunctiva, lens and the retina.

Eye and face protectors include safety spectacles, goggles, welding filters, face-shields and hoods. Safety spectacles can be fitted with prescription lenses if required. Some types of eye protection can be worn over ordinary spectacles if necessary.

Please note that contact lenses are not PPE; lenses may be lost during emergency irrigation of the eye or damaged by chemical contact and accidental displacement can cause temporary loss of vision.

4.2 Process and activities

The following are examples of activities and processes involving a risk to the face and eyes for which eye and face protectors should be used. It is not an exhaustive list.

(a) handling or coming into contact with acids, alkalis and corrosive or irritant substances;
(b) working with power-driven tools where chippings are likely to fly or abrasive materials be propelled;
(c) working with molten metal or other molten substances;
(d) during any welding operations where intense light or other optical radiation is emitted at levels liable to cause risk of injury;
(e) working on any process using instruments that produce light amplification or radiation; and
(f) using any gas or vapour under pressure.

Eye protectors must be provided both for persons directly involved in the works and also for others not directly involved or employed but who may come into contact with the process and be at risk from the hazards.

4.3 Selecting suitable eye protection

The selection of eye protection depends primarily on the hazard. However, comfort, style and durability should also be considered.

No single type of eye protection may be suitable for all situations – the following serves as a checklist to assess for actual requirements:

(a) Type of risk	-hot or corrosive liquids, chemicals
	-gases and aerosols
	-radiation
	-impact
	-flying particles
	-hot metals
(b) Conditions of use	-temperature
	-humidity
	-wind velocity
	-cramped work area
	-degree of movement
	-clean or dirty surface

(c) Type of use	-continuous or intermittent -other protective equipment used
(d) Required field of vision	-wide -narrow

4.3.1 *Safety spectacles*

These are similar in appearance to prescription spectacles but may incorporate optional sideshields to give lateral protection to the eyes. Although not providing complete protection, they are useful against a number of hazards particularly flying particles.

To protect against impact, the lenses are made from tough optical quality plastic such as polycarbonate. Safety spectacles are generally light in weight and are available in several styles with either plastic or metal frames.

To ensure comfort and user acceptability, these should be tight, strong and properly adjusted to the user. They should fit so that the eyes look through the centre of the lenses and be as close to the eyes as possible (for the widest possible field of vision) without contacting the eyelashes. The nose bridge should fit comfortably.

Most manufacturers offer a range of prescription safety spectacles which are individually matched to the wearer.

4.3.2 *Safety goggles*

These are heavier and less convenient to use than spectacles. They are made with a flexible plastic frame and one-piece lens and have an elastic headband. They afford the eyes total protection from all angles as the whole periphery of the goggle is in contact with the face. They can be worn over corrective spectacles.

Goggles may have toughened glass lenses or have wide vision plastic lenses. The lenses are usually replaceable. Safety goggles are more prone to misting than spectacles. Double glazed goggles or those treated with an anti-fogging coating may be more effective where fogging is a problem.

Where strenuous work is done in hot conditions, ‘direct ventilation’ goggles may be more suitable. However these are unsuitable for protection against chemicals, gases and dust. ‘Indirect ventilation’ goggles are not perforated, but are fitted with baffled ventilators to prevent liquids and dust from entering. Indirect ventilation goggles however will not protect against gas or vapour.

4.3.3 *Faceshields*

These are heavier and bulkier than other types of eye protector but are comfortable if fitted with an adjustable head harness. The lift-up hinged type is preferred for intermittent use. Faceshields protect the face but do not fully enclose the eyes and therefore do not protect against dust, mist or gases. Visors on browguards or helmets are replaceable. They may be worn over standard prescription spectacles and are generally not prone to misting. They may also be hand-held. Faceshields with reflective metal screens permit good visibility while effectively deflecting heat and are useful in blast and open-hearth furnaces and other work involving radiant heat.

4.3.4 Hoods

Hoods are generally used with full protective suits or as part of respiratory protective equipment. Full face piece masks of respiratory protective equipment, provide both eye and face protection.

4.4 Maintenance

The lenses of eye protectors must be kept clean as dirty lenses restrict vision, which can cause eye fatigue and lead to accidents. There are two methods for cleaning eye protectors. Glass, polycarbonate and other plastic lenses can be cleaned by thoroughly wetting both sides of the lenses and drying them with a wet strength absorbent paper. Anti-static and anti-fog lens cleaning fluids may be used, daily if necessary, if static or misting is a problem. Alternatively lenses can be ‘dry’ cleaned by removing grit with a brush and using a silicone treated non-woven cloth. However plastic or polycarbonate lenses should not be ‘dry’ cleaned as the cloth used in this method can scratch them.

Eye protectors should be issued on a personal basis and used only by the person they are issued to. If eye protectors are re-issued they should be thoroughly cleaned and disinfected. Eye protectors should be protected by being placed in suitable cases when not in use. Eye protector headbands should be replaced when worn out or damaged. Lenses that are scratched or pitted must be replaced as they may impair vision and their resistance to impact may be impaired. Transparent face shields must be replaced when warped, scratched or have become brittle with age.

5. RESPIRATORY PROTECTION

5.1 Respiratory protection requirements

The purpose of respiratory protection is to ensure that workers are adequately protected from inhaling excessive airborne contaminants or air which is oxygen deficient. Workers should not be exposed to airborne contaminants in excess of their permissible exposure levels, where possible.

The amount of air-contaminant that penetrates into the respirator depends on:

(a) the efficiency of the filtering medium
(b) leakage through the seal between the facepiece and the face, and
(c) leakage through the exhalation valve.

For respirators to be effective, they must of the correct type for the hazard, be properly fitted to the workers face, be worn all the time in the presence of the hazard and be properly maintained.

5.2 Types of respiratory protection

Respirators can be classified according to the way breathing air is provided:

-air purifying respirators, and
-supplied air respirators.

Please see **Appendix C** on graphical illustration of different types of respirators and **Appendix D** on different types of respirator inlet covering.

The efficiency of respiratory protection in the removal of contaminants is expressed as the nominal protection factor (npf), which is defined as the ratio of the concentration of the contaminant present in the ambient atmosphere to the calculated concentration within the facepiece when the respiratory protection is being worn, i.e.

$$\text{npf} = \frac{\text{concentration of contaminant in the atmosphere}}{\text{concentration of contaminant in the facepiece}}$$

The npf is used to determine the degree of protection required, knowing the concentration of pollutant in the workplace and the required concentration inhaled by the worker. Actual protection factors are often much lower than npf.

5.2.1 Air purifying respirators

The inhaled air is drawn through filters or cartridges that remove the harmful airborne contaminant. This devices however, don not provide protection in oxygen deficient atmosphere (i.e. O_2 content less than 20%) or atmosphere where the level of harmful contaminant is excessive such as posing immediate danger to life or health (IDLH). There are two types:

(a) Non powered

The user inhales air through a filter or cartridge fitted onto a facepiece. The respirator may be:

- Disposable - suitable for respirable size dust,
- Half facepiece - covers nose and mouth; fitted with replaceable filter or cartridge and suitable for dust, vapour or gas; or
- Full facepiece – covers mouth, nose and eyes; fitted with replaceable filter or cartridge and suitable for dust, vapour or gas.

Disposable respirator


Half mask respirator
(npf=10)


Full facepiece respirator
(npf=50)

(b) Powered(PAPR)

The contaminated air is drawn through a filter or cartridge by means of a fan and delivered continuously to the enclosed space between the face and a tight/loose fitting inlet covering, generally under positive pressure. It may consist of a half or full facepiece or head covering (helmet, hood) with one or more replaceable filters or canisters/cartridges and an electrically operated (e.g. battery) blower unit. (npf = 500)

5.2.2 Supplied air respirators

Breathing air is provided from a source independent of the working environment. Uncontaminated air supply is from fresh air (delivered to the person through an airline) or compressed air (delivered from an apparatus carried by the person).

There are two types:

(a) Airline respirators

Breathing air is supplied through a hose from a compressor or compressed air cylinder. The hose is attached to the worker by a belt and can be detached immediately in an emergency. A flow control valve or orifice is provided to regulate the rate of air flow. Exhaled air passes to the ambient atmosphere through a valve or opening in the respirator inlet covering (half or full facepiece, helmet or hood). There are three types:

i) Continuous flow type (positive pressure)
A volume of air more than that required for breathing by the wearer is supplied continuously to the respirator inlet covering in positive pressure. (npf = 50)

ii) Demand type (negative pressure)
The demand valve allows flow of air only during inhalation when a negative pressure exists in the space between the inlet covering of a tight-fitting respirator and the face of the user.

iii) Pressure demand type (positive pressure)
A positive pressure is maintained in the tight fitting respirator with air flow when the pressure inside the facepiece is reduced below a pre-set (positive) value because of leakage or inhalation.

(b) Self contained breathing apparatus (SCBA)

The breathing air source is carried by the user. A full facepiece is most commonly used. This type of respirator permits the user to move without being restricted by an airline. The service life depends on the amount of oxygen carried and whether oxygen in the inhaled air is recirculated. It should be used in:

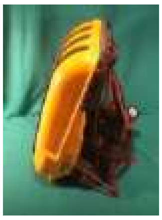
-atmosphere with unknown contaminants
-airborne contaminants with levels exceeding IDLH, and
-oxygen deficient atmospheres.

There are two types:

i) Open circuit SCBA

Compressed breathing air is carried in cylinders and is released through a pressure demand valve and breathing tube to a facepiece or head covering from which exhaled air passes through a non-return valve to the atmosphere. Lasts from 10-30 minutes. (npf = 2000)

ii) Closed circuit SCBA



Exhaled breath, containing 70% of the oxygen in inhaled air, is cleaned and recycled after removal of carbon dioxide and moisture. Make up oxygen is provided from cylinders of oxygen (compressed, liquid or oxygen-generating chemicals). Lasts up to 3 hours (npf = 2000)

Escape SCBA is a smaller and lighter version that provides breathing air for a shorter period of time for escape from IDLH or oxygen deficient environment. The facepiece or head covering is designed for quick donning.

The air quality for supplied air respirators must meet the following air quality requirements:

- ✓ Not less than 19.5% and not more than 23.5% by volume of oxygen
- ✓ Not more than 5 parts per million (ppm) carbon monoxide
- ✓ Not more than 500 ppm carbon dioxide
- ✓ Not more than 5 mg/m^3 of oil mist
- ✓ No objectionable or nauseous odour
- ✓ Temperature not exceeding 29 ^oC, and
- ✓ Relative humidity not exceeding 85%.

5.3 Health aspects of respiratory protection

Respirators impose physiological and psychological stress on the user. Although most workers would not have any difficulties using respirators, a few may have medical conditions that may preclude those using respirators. Carrying heavy respirators, for e.g. SCBA and other equipment in addition to heavy workload may impose stress on the cardiopulmonary system. Intense ambient heat e.g. firefighting could be an additional stress. Persons with severe lung disease may experience difficulty with breathing against the additional resistance of a respirator. Using a respirator especially with full body protection may give rise to feelings of anxiety and apprehension, making it difficult for them to work satisfactorily.

The following medical conditions may affect a user's capability to wear a respirator:
- Emphysema
- Chronic pulmonary disease
- Coronary artery disease (including angina, arrythmias)
- Post myocardial infarction
- Progressive hypertension
- Seizure disorders
- Breathing difficult when using respirator
- Claustrophobia or anxiety reaction when using respirator
- Bronchial asthma
- Evidence of reduced pulmonary function or history of pneumothorax
- Moderate or severe hypertension
- Anaemia
- Diabetes
- Cough(constant or recurring)
- Impaired sense of smell
- Weight lifting restrictions
- Pregnancy

5.4 Selection of respiratory protection

Selection depends on several factors:

i) hazard related
- including nature and permissible exposure level of the air-borne contaminant
- physical, chemical, and toxicological properties of the contaminant(s);
- expected concentration of each respiratory hazard;
- immediately dangerous to life or health (IDLH) concentration;
- oxygen concentration or expected oxygen concentration;
- eye irritation potential; and
- environmental factors, such as presence of oil aerosols

ii) task related
- including characteristic of work, length to be used and work requirements

iii) operator related
- including user physical features, medical conditions and training
- please note that respirators with tight-fitting facepieces should not be used when facial scars or deformities or facial hair interfere with the face seal.

Please see **Appendix E** on factors affecting respirator selection.

5.5 Respirator fit testing

The purpose is to select the right size and model of respirator for the user to ensure that good facial seal is achievable whenever the respirator is worn. After fit testing, each respirator issued to an individual must bear an identifying mark which may be the user's name, initial or badge number. This identification mark must not affect the performance of the respirator.

The user then shall proceed to conduct a fit check and if applicable, a fit test.

5.5.1 Fit check

The user can perform this test in the field. This will involve conducting a positive and/or negative fit check with all tight-fitting respirators to determine if the respirator is properly sealed to the user. This check should be performed by the user each time the respirator is worn and is a quick check of the face seal prior to entering a hostile atmosphere.

a) Negative pressure test

For respirator with valves:

- Close off the inlet opening of the filter(s) by covering with the palm of the hands or by squeezing the breathing tube so that air cannot pass through.
- Inhale gently so that the facepiece collapse slightly, and hold the breath for 10 seconds.
- Fit is satisfactory if the facepiece remains in a slightly collapsed condition and no inward leakage of air is detected.

For disposable respirator without valves:

- cover the filter with both hands and inhale sharply.
- An unsatisfactory face seal is indicated by the feel of an airstream channeling through the leak area.

b) Positive pressure test

For respirator with valves:

- Close off the exhalation valve and exhale gently into the facepiece.
- Fit is satisfactory if a slight positive–pressure can be built up inside the facepiece without the detection of any outward leakage of air at the seal.

For disposable respirator without valves:

- Cover the filter with both hands and exhale vigorously
- Unsatisfactory face seal is indicated by the feel of an airstream channeling through the leak area.

5.5.2 Fit test methods

A qualitative or quantitative respirator fit test method shall then be used to determine the ability of each individual user to obtain a satisfactory fit with a respirator. A fit test must not be conducted if there is any hair growth between the face and the sealing surface of the respirator such as stubble, moustache, beard or long side burns. Any safety equipment, such as goggles and safety glasses that is worn with the respirator in the normal course of the work should also be worn during fit testing.

Below is a very brief description of the fit test methods-it must be conducted by a trained person and according to certain protocols and in special laboratories.

a) Qualitative fit test methods (QLFT)
Banana oil (isoamyl acetate) testing agent can be used only for those respirators that can filter organic vapors. Saccharin and Bitrex test agents are used for testing particulate dust respirators not equipped with high efficiency filters. The latter is tested using an irritant smoke.

b) Quantitative fit test methods (QNFT)
Measures respirator leakage in a test environment and is the most exact method of checking respirator fit. It is expressed as percent penetration of test atmosphere or in terms of protection factor which is defined as the degree of protection provided by the respirator. If a quantitative fit test is used for a negative-pressure respirator, a fit factor that is at least 10 times greater than the assigned protection factor shall be obtained before the respirator is assigned to the user.

5.6 Maintenance

Respirator maintenance, inspection and proper storage must be an integral part of the respirator protection programme. Wearing a poorly maintained or malfunctioning respirator can give the user a false sense of security. Emergency escape and rescue devices are vulnerable to poor maintenance because they are used infrequently.

Respirators issued on an individual basis should preferably be maintained and inspected by the user. A programme for maintenance should include:

- Cleaning
  -after removal of filters/cartridges, the facepiece, straps and filter holders should be washed with detergent in warm water using a soft brush, thoroughly rinsed in clean water and air dried (not in direct sunlight) in a clean place. Note that some soaps or detergent may damage the respirator; manufacturer’s cleaning and disinfecting method may also be used.

- Inspection of defects
  -All equipment must be inspected before each use and during and after cleaning. Substitution of parts or filters from a different brand or type may affect the respirators performance.

- Replacement of filters/cartridges
  -The service life a filter depends on filter/sorbent characteristics, contaminant concentration, air flow rate and relative humidity. There are different types of sorbent used in canisters and cartridges.
  -For particulate filter, the breathing resistance will progressively increase as it traps particles- as a guide, the breathing resistance can be considered too high when there is a perceived increase in the resistance to breathing. For PAPR, clogging of the filters is signaled by a fall in the air flow rate.
  -Canisters or cartridges should be replaced when an odour or taste is perceived in the inhaled air or when the user experiences discomfort.

- Storage
  -should be stored in a convenient location, away from contaminated areas and placed in a clean, sealable plastic bag or container when not in use.

- Charging and replacement of batteries for PAPR

- Record keeping

5.7 Environmental surveillance

Any change in process, production capacity, engineering controls or deterioration in working conditions may affect the concentration of atmospheric contaminants and hence, periodic monitoring of the air contaminants level to which the worker is exposed should be carried to determine the need for continued respiratory protection or additional protection. Monitoring should be done at least annually or more frequently if levels are in excess of permissible exposure levels (PEL).

6. EAR PROTECTION

Excessive noise levels can cause hearing loss; short periods of exposure can produce a temporary hearing loss which may initially be reversible. Permanent damage, known as “noise induced hearing loss”, occurs when exposure to excessive noise continues over a longer period of time.

It is recommended that hearing protection should be used if the workplace noise levels cannot be reduced to below 85dbA. The degree of protection provided should be such that the level sat the workers ear is below 85dbA. Noisy workplaces as such require a hearing conservation program to be in place. Noise elimination or attenuation at its source is the most satisfactory method of hearing protection and noise control. If such measures are not practicable, personal hearing protection is then required.

6.1 Types of ear protection

(a) Expandable (mouldable) foam plugs

These plugs are made of a formable material e.g. plastic foam, glasswool or a mixture and designed to expand and conform to the shape of each person's ear canal. Disposable types of plug can provide excellent attenuation and will fit most ears. The formable types are generally introduced

(b) Re-usable, pre-molded plugs

Pre-molded plugs are made from silicone, plastic or rubber and are manufactured as either “one-size-fits-most” or are available in several sizes. Many pre-molded plugs are available in sizes for small, medium or large ear canals.

A critical tip about pre-molded plugs is that a person may need a different size plug for each ear. The plugs should seal the ear canal without being uncomfortable. This takes trial and error of the various sizes. Directions for fitting each model of pre-molded plug may differ slightly depending on how many flanges they have and how the tip is shaped. Insert this type of plug by reaching over your head with one hand to pull up on your ear. Then use your other hand to insert the plug with a gentle rocking motion until you have sealed the ear canal.

Advantages of pre-molded plugs are that they are relatively inexpensive, reusable, washable, convenient to carry, and come in a variety of sizes. Nearly everyone can find a plug that will be comfortable and effective. In dirty or dusty environments, you don't need to handle or roll the tips i.e. reducing the risk of dirt being transferred into the ear canal which can lead to infection.

(c) Individually molded ear plugs

These plugs are usually made from some form of silicone rubber and are actually moulded in a permanent from within the ear canal. The plugs may be removed and reinserted any number of times without affecting their performance. They combine good fit and good attenuation but are generally more expensive than the other types of earplug. Contamination of ear canal can occur as with disposable plugs.

(d) Canal caps

Canal caps often resemble earplugs on a flexible plastic or metal band. The earplug tips of a canal cap may be a formable or pre-molded material. Some have headbands that can be worn over the head, behind the neck or under the chin. Newer models have jointed bands increasing the ability to properly seal the earplug.

The main advantage canal caps offer is convenience. When it's quiet, employees can leave the band hanging around their necks. They can quickly insert the plug tips when hazardous noise starts again. Some people find the pressure from the bands uncomfortable. Not all canal caps have tips that adequately block all types of noise. Generally, the canal caps tips that resemble stand-alone earplugs seem to block the most noise.

(e) Earmuffs

Earmuffs come in many models designed to fit most people. They work to block out noise by completely covering the outer ear. They are held against the sides of the head by a spring head band, which is normally adjustable for length. The headband passes over the head, behind the neck or under the chin. Muffs can be "low profile" with small ear cups or large to hold extra materials for use in extreme noise. Some muffs also include electronic components to help users communicate or to block impulsive noises.

Workers who have heavy beards or sideburns or who wear glasses may find it difficult to get good protection from earmuffs. The hair and the temples of the glasses break the seal that the earmuff cushions make around the ear. For these workers, earplugs are best. Other potential drawbacks of earmuffs are that some people feel they can be hot and heavy in some environments. Sweat covers of moisture absorbent material are available which are placed over the seal.

6.2 Selecting suitable ear protection

Selection of the type of hearing protection depends on the conditions which the noise exposure occurs as well as the characteristics, duration and intensity of the noise.

In selection, in addition to attenuation, other factors to be considered include comfort, cost, storage, wear er acceptance and hygiene. Attenuation data for specific hearing protection devices can be obtained from manufacturers/suppliers.

It must also be assumed that hearing protectors are worn throughout the noise exposure period as the effective protection will be reduced if not worn all the time.

6.3 Problems in use

Re-usable ear plugs are not generally recommended because of the difficulty in maintaining cleanliness.

One problem with the usage of hearing protection is the perceived difficulty of understanding voice communication when wearing them. However, in practice, it is normally found that speech communication is easier in high levels of ambient noise when wearing hearing protection than when the ears are unprotected.

Another perceived difficulty is the hearing of other required sounds e.g. warning signals and machinery noises which require detection of minor changes in noise patterns. Although the noises sound different when wearing hearing protection, an adjustment period may be necessary for the wearer to get familiar with the new sound. Perspiration build up around the seals may also cause discomfort.

7. HAND AND ARM PROTECTION

7.1 Types of hand protection

Gloves of various designs provide protection against a range of chemical, physical and biological hazards, including:

(a) cuts and abrasion;

(b) extremes of temperature, hot and cold;

(c) skin irritation and dermatitis;

(d) contact with toxic or corrosive liquids.

The type and degree of protection depends on the glove material and the way in which it is constructed. There is no one glove that suits every purpose. Barrier creams may sometimes be used as an aid to skin hygiene in situations where the gloves cannot be used. Experience shows, however, that barrier creams are less reliable than suitable gloves as a means of chemical protection.

7.2 Process and activities

The following processes and activities involve risk of injury to the hands or hazards for which hand protection may be necessary. It is not an exhaustive list.

(a) *Manual handling:* Hands may be pierced by abrasive, sharp or pointed objects or damaged by impact when handling goods. However, gloves should not be worn when working near moving equipment and machinery parts as the glove may get caught in the equipment and draw the hand and arm of the worker into the moving machinery.

(b) *Vibration*: Gloves are essential to keep hands warm in cold weather when operating machines that cause vibrations such as pneumatic drills and chain-saws. Vibration White Finger occurs more frequently and more severely when the hands and fingers are cold as the blood supply to the fingers is reduced by the body in an attempt to conserve heat.

(c) *Constructions and outdoor work*: Keeping the hands warm and supple in cold weather is important when working on a building site handling scaffolding, bricks and timber. Manual dexterity is lost when the hands are cold, which can lead to accidents if articles are dropped. Gloves protect against hazards in site clearance such as previous contamination of soil which may contain disease spores that may seriously infect small cuts and abrasion.

(d) *Hot and cold materials*: Gloves will also protect against hazards from handling hot or cold materials and work involving contact with naked flames or welding.

(e) *Electricity:* Danger from electric shock.

(f) *Chemical:* There are many tasks where the hands may come into contact with toxic or corrosive substances. Examples include maintenance of machinery, cleaning up chemical spillages and mixing and dispensing pesticide formulations. If correctly selected and used, gloves provide a barrier between the wearer's skin and the harmful substance, preventing local damage, or in some cases absorption through the skin.

(g) *Radioactivity:* Danger from contamination when handling radioactive materials.

7.3 Selecting suitable hand protection

Gloves or other hand protection should be capable of giving protection from hazards, be comfortable and fit the wearer. The choice should be made on the basis of suitability for protection, compatibility with the work and the requirements of the user. You should consider the ability of protective gloves to resist abrasion and other industrial wear and tear. Always follow the manufacturer's instructions and marking for appropriate use and level of protection.

Gloves should be provided in a variety of sizes. When selecting gloves for chemical protection, reference should be made to chemical permeation and resistance data provided by manufacturers. Where penetration does occur, it may still be possible to recommend its use by also specifying procedures which include a maximum cumulative time period for wear. Please note that most gloves are not meant to provide protection during immersion in chemicals.

(a) *Penetration and abrasion*: Gloves made from chain-mail or leather protect against penetration and abrasion. Gloves knitted from special man-made fibres such as Kevlar will provide protection against cuts and gloves manufactured from e.g. Kevlar needlefelt give good puncture resistance.


chain-mail gloves

Gloves consisting of a fabric support coated with a chemical-resistant substance, such as PVC, have better resistance to tearing, cutting or puncturing than those made from the coating material alone. Unsupported gloves have better flexibility/sensitivity but lower tear, stretch and heat resistance.

(b) *Thermal protection*: Depending upon the weight and construction, terrycloth gloves will provide protection against heat and cold. Gloves made from neoprene are good for handling oils in low temperatures. Specially treated leather (thermo leather) has good resistance and has been found suitable for welding, cutting and burning applications. Gloves manufactured from other materials such as Kevlar, glass fibre and leather can be used to provide protection at higher temperatures e.g. high radiant heat.

Impervious gloves are necessary for the handling of cryogenic liquids with the vinyl coated cotton glove, foam backed with fleecy coating giving reasonable service. However, as with other gloves with thermoplastic coatings such as PVC, it may be unusable in cold conditions either from loss of flexibility or from cracking.

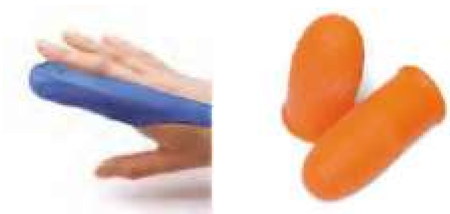
(c) *Fire resistance:* Chromed leather gloves are fire retardant.

(d) *Chemicals protection:* Chemical protective gloves are available in a range of materials including natural rubber, neoprene, nitrile, butyl, PVA, PVC and viton. The degree of protection against chemical permeation depends on the glove material, its thickness and method of construction. As a general rule, gloves for use in handling toxic liquids should be chosen on the basis of breakthrough time. This means that the duration of use should not exceed the breakthrough time quoted by the manufacturer of the glove for the chemical substance concerned. Laboratory testing may be required in order to establish adequacy in some applications.

When handling dry powders, any chemically resistant glove may be used. The durability of the gloves in the workplace should also be considered. Some glove materials may be adversely affected by abrasion.

(e) *General use gloves:* Rubber, plastic or knit fabric gloves are flexible, resist cuts and abrasions, repel liquids and offer a good grip. Rubber gloves allow a sensitive touch and give a firm grip in water or wet conditions. Leather, common knit or other general purpose gloves are suitable for most other jobs. General use gloves should only be used to protect against minimal risks to health and safety (e.g. for gardening and washing up and similar low risk tasks).

For small or delicate work requiring manual dexterity and tactile sensitivity the thinnest possible glove consistent with adequate protection should be selected. Finger stalls may be used if complete gloves are not necessary.



Finger stalls

7.4 Maintenance

Care should be taken in the donning, use, removal and storage of protective gloves. They should be maintained in good condition, checked regularly and discarded if worn or deteriorated. Gloves should be free of holes or cuts and foreign materials and their shape should not be distorted. Areas between the fingers and other flex points should be carefully examined. They may be tested for leaks by inflating with air and immersing in a water bath while still under pressure. They should fit the wearer properly leaving no gap between the glove and the wearer’s sleeve as ill fitting gloves are liable to premature wear.

Gloves should always be cleaned according to the manufacturer’s instructions as they may have particular finishes which may make the following general guidance inappropriate. For example, repeated washing may remove fungal and bacterial inhibitors from the lining of the glove which may ultimately lead to skin irritation. And there is also the risk of cross contamination as chemical residues can remain on the gloves even after washing.

Contact between the gloves and chemicals should be kept to a minimum as some chemicals can alter the physical characteristics of a glove and impair its protective properties. Gloves contaminated by chemicals should be washed as soon as possible and before their removal from the hands as the deleterious action of chemicals after contact continues until the gloves are cleaned. Grossly contaminated gloves, especially where highly toxic chemicals have been handled, should be discarded. Not all chemicals can be easily removed and immediate disposal of contaminated gloves without re-use may be required. Gloves contaminated on the inside can be dangerous as the chemical contamination will be absorbed by the skin. Wear armlets if there is a danger of chemicals entering the glove at the cuff.

When wearing protective gloves do not touch other exposed parts of the body, equipment or furniture as contamination can be transferred to them. Cotton liners can be worn if hands sweat profusely.

Discarded and contaminated gloves should be destroyed in order to prevent unauthorized retrieval and use. This is especially important for gloves that may have been in contact with very toxic substances.

Gloves should be stored at ambient temperatures away from light, moisture, solvents and chemicals. Each person should be issued gloves on a personal basis. Contagious skin infections, although rare, will not then be spread.

7.5 Care for the hands when handling chemicals.

Do not let chemicals come into contact with the skin. Wash hands frequently, dry them carefully and use a hand cream to keep the skin from becoming dry through loss of natural oils. Keep cuts and abrasions covered with waterproof plasters and change the dressing for a porous one after work. Handle and remove gloves carefully to avoid contamination of hands and the inside of the gloves.

8. FOOT AND LEG PROTECTION

8.1 Types of safety footwear

Protective footwear must protect against hazards ranging from dermatitis, extremes of hot and cold, slippery surfaces, punctures from nails to crushing injuries.

The following are examples of types of safety footwear:

(a) *The safety boot or shoe* is the most common type of safety footwear. These are normally have steel toe-caps. They may also have other safety features including slip resistant soles, steel midsoles and insulation against extremes of heat and cold.

(b) *Clogs* may also be used as safety footwear. They are traditionally made from beech wood which provides a good insulation against heat and absorbs shock. Clogs may be fitted with steel toe-caps and thin rubber soles for quieter tread and protection against slippage or chemicals.

(c) *Foundry boots* have steel toe-caps, are heat resistant and designed to keep out molten metal. They are without external features such as laces to avoid trapping molten metal blobs and should have Velcro fasteners or elasticated sides for quick release.

(d) *Wellington boots* protect against water and wet conditions and can be useful in jobs where the footwear needs to be washed and disinfected for hygienic reasons, such as in the food industry. They are usually made from rubber but are available in polyurethane and PVC which are both warmer and have greater chemical resistance. Wellington boots can be obtained with corrosion resistant steel toe-caps, rot-proof insoles, steel midsoles, ankle bone padding and cotton linings. They range from ankle boots to chest-high waders.

(e) *Anti-static footwear* prevents the build up of static electricity on the wearer. It reduces the danger of igniting a flammable atmosphere and gives some protection against electric shock.

(f) *Conductive footwear* also prevents the build up of static electricity. It is particularly suitable for handling sensitive components or substances (e.g. explosive detonators). It gives no protection against electric shock.

8.2 Process and activities

The following are examples of activities and processes involving risks to the feet. It is not an exhaustive list.

(a) *Construction:* Work on building and demolition sites will usually require safety footwear to protect the feet against a variety of hazards particularly objects falling on them, or sharp objects (e.g. nails) on the ground piercing the shoe and injuring the sole of the foot.

(b) *Mechanical and Manual Handling*: There may be a risk of objects falling on or crushing the front of the foot. There may be a risk of a fall through slipping which could result in damage to the heel on impact. There is also a danger of treading on pointed or sharp objects which can penetrate the shoe and injure the sole of the foot.

(c) *Electrical*: People who work where there are flammable atmospheres should wear anti-static footwear to help prevent ignitions due to static electricity. Such footwear is similar to conventional footwear in that the soles are sufficiently insulated to give some measure of protection against electric shock (please see 8.4).

(d) *Thermal:* Working in cold conditions requires footwear with thermal insulation. Work in hot conditions requires footwear with heat-resistant and insulating soles.

(e) *Chemical:* Footwear provided when working with hazardous chemicals should be both impermeable and resistant to attack by chemicals.

(f) *Forestry:* Forestry chain-saw boots are water resistant and are designed to offer protection against chain saw contact.

(g) *Molten substances*: Foundry boots that are easily removed should be provided where there is a danger of splashing by molten substances.

8.3 Selecting suitable foot protection

The selection of foot protection depends primarily on the hazard. However, comfort, style and durability should also be considered. The choice should be made on the basis of suitability for protection, compatibility with the work and the requirements of the user.

Generally, safety footwear should be flexible, wet resistant and absorb perspiration. Inflexible or unnecessarily bulky footwear will result in tired feet and legs. Boots and not shoes are required where ankles need protection. You should consider the ability of the footwear to resist corrosion, abrasion and industrial wear and tear. Always follow the manufacturer’s instructions and markings for appropriate use and level of protection.

(a) *Soles:* Work shoes and boots should have treaded soles for slip resistance. Soles can be heat and oil resistant, slip resistant, shock resistant, anti-static or conductive. Footwear intended to protect against oils, solvents or liquids need soles that are moulded or bonded to the upper. Soles that are stitched or glued may separate and expose the foot to hazard.

Footwear with steel insoles should be used where there is a risk that the sole could be pierced by nails and similar objects. Soles such as heavy duty polyurethane, PVC or wood can also provide effective protection.

(b) *Steel toe-caps:* They should be capable of providing protection from various degrees of impact and is essentially designed to protect the toes. Footwear complying with BS 4676 will offer this resistance.

(c) *Extreme temperature resistance:* Leather or other heat resistant materials can be used in safety footwear to offer protection against heat, sparks and molten metal. Heat resistant soles, such as expanded polyurethane, are available for moderately hot floors (contact temperature of 150°C while nitrile rubber boots are suitable for contact temperatures up to 300°C. Wooden soles are available for higher temperatures.

Cold conditions may require insulated footwear such as fleece-lined boots.

(d) *Waterproofing:* People working in wet or muddy places should wear safety footwear impervious to water. Boots are available in various leg lengths, from ankle boots, shin length, knee length to thigh length (waders). Rubber and PVC are suitable inexpensive water proofing materials for footwear but they are not permeable. There are 'breathable materials' e.g. man-made materials such as "CORFAM" which are water resistant, but which also allow air to get through and perspiration to get out, and may therefore be more comfortable and more hygienic. However, footwear manufactured form this type of material tends to be more expensive.

(e) *Chemical resistance:* Contact with chemicals may cause leather to crack and may also result in injury due to absorption of the chemical. Plastic and synthetic rubber (e.g. neoprene) soles are more resistant, as are shoe uppers made from man-made breathable materials. The use of footwear with an integral tongue construction is advised as it can prevent liquid and dust penetration through the lace holes reaching the skin. Once leather or synthetic shoes become contaminated it is usually not possible to clean them and they should be disposed of accordingly.

(f) *Electrical hazards:* No electrically insulating instrument should be introduced between the inner sole of the footwear and the foot of the wearer. Cotton and rayon socks have relatively high conductivity and can be worn usefully with anti-static footwear but wool, natural silk and nylon socks have low conductivities and act as insulators. The relative humidity of the atmosphere can affect the conductivity of clothing materials and the build up of static electric charges.

The following provide protection against electrical hazards:

i) Anti-static footwear: Anti-static footwear offers suitable protection against the hazard of static electricity and will give some protection against mains electric shock. Anti-static footwear must be worn where there is both a hazard from static build up and the possibility of contact with mains electricity. The soles must have a resistance low enough to allow static electricity to leak slowly away while maintaining enough resistance to protect against a 240 volt mains electric shock.

ii) Conductive footwear: Offers greater protection against static electricity and is used when the wearer handles very sensitive components or materials. *It must not be worn when there is a danger of electric shock.* The soles of conductive footwear must have an electrical resistance low enough to enable static electricity to be taken quickly away from the body to the earth. Such footwear must be free from nails, metal eyelets and lace tags, and must be sewn or bonded construction and worn in conjunction with other items of electrical protective clothing in dry conditions.

Where live electrical current above 250 volts is the hazard, conductive and antistatic footwear must **not** be used.

8.4 Leg protection

The following are examples of leg protection.

(a) People working around molten metal need protection for their lower legs. For example this can be achieved by the use of foundry boots and gaiters, or a high foundry boot worn inside molten metal protective trousers.

(b) Hard fibre or metal guards should be used to protect shins against impact. The top of the foot up to the ankle can be protected by added-on metatarsal guards.

8.5 Maintenance

Safety footwear should be maintained in good condition, checked regularly and discarded if worn or deteriorated. Laces should be checked and replaced if necessary. Materials lodged into the tread should be removed. The stitching should be checked for loose, worn or cut seams. Spraying the upper layer of new footwear with a silicone spray or applying a protective wax will give extra protection against wet conditions.

9. SAFETY BELTS, HARNESSES AND LINES

There are various types of safety belts; the construction of safety all types of belt should be such that if the wearer should fall, the risk of physical injury is minimized. At the same time, the belt should hamper the wearer as little as possible in his work.

9.1 Processes and activities

Safety belts are used in a wide range of activities:

a) work on construction projects and steel structures
b) climbing and working on towers, masts and similar structures
c) cleaning windows and buildings
d) working in confined spaces
e) working in trenches, pits, sewers etc
f) work on “monkey boards” during drilling operations.

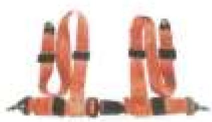
9.2 Types of safety belt

a) General purpose

Consists of a waist belt, a restraining line and the metal components. The purpose is to catch the wearer smoothly in the event of a fall and to limit the distance fallen.

Often fitted with shoulder and leg straps to keep the waist belt in place. The waist belt is normally fastened around the persons’s waist unless leg and shoulder straps are provided, in which case it can be worn chest high. The waist belt is fastened with a “D” ring to which one end of the restraining line is securely attached. The restraining line should be fastened with a hook of the self-closing type which can be secured against accidental opening.

b) Safety harnesses


Consist of a set of straps similar to those worn by parachutists and when worn, the forces exerted on the body during arrest of a fall will be absorbed not only by the trunk but also by the legs, thus reducing the chance of physical injury.

c) *Safety belts for use in confines spaces*
The purpose is to rescue the wearer from an enclosed space if he is unable to leave without assistance. The belt consists of a set of straps to which the rescue line is securely fastened.

9.3 Selecting suitable safety belts, harnesses and lines

These are usually made from artificial fibres which are strong, lightweight and adequately waterproof. Restraining lines made from man-made fibre have a considerable amount of stretch, which has a favourable effect on the size of forces exerted on the body during a fall. Care must be taken to prevent from damage from solvents e.g. during cleaning tank activities. If made partially or totally from leather, it must be borne in mind that it is susceptible to weathering and requires regular maintenance.

Metal components such as buckles, D-rings and hooks must be corrosion resistant. Buckles should have only one way of closure.

9.4 Maintenance

Safety belts, harnesses and lines should be cleaned and examined regularly, the frequency depending on conditions of use, but at not more than 3 monthly intervals. Manufacturers' advice should always be followed.

The equipment should be checked for damage before each occasion on which it is to be used. In the event that it has been used to arrest a person's fall, the equipment should be scrapped as its future integrity in similar circumstances cannot be guaranteed.

10. BODY PROTECTION

10.1 Types of protection

Types of clothing used for body protection include:

(a) coveralls, overalls and aprons to protect against chemicals and other hazardous substances;

(b) outfits to protect against cold, heat and bad weather;

(c) clothing to protect against machinery such as chain-saws.

Types of clothing worn on the body to protect the person include:

(a) high visibility clothing;

(b) life-jackets and buoyancy aids.

General work clothing offers no more direct body protection than ordinary street dress. Fabric uniforms or overalls are often supplied to protect against dirt, grease and oils. Effective laundering of reusable work clothing is an important aspect of exposure reduction.

10.2 Processes and activities

The following are examples of the sorts of processes and activities that require protective clothing for the body. It is not an exhaustive list.

(a) laboratory work or work with chemicals, dust or other hazardous substances;

(b) construction and outdoor work;

(c) work in cold stores;

(d) forestry work using chainsaws;

(e) highway and road works;

(f) work on inland and inshore waters;

(g) spraying pesticides;

(h) food processing;

(i) welding;

(j) foundry work and molten metal processes;

(k) fire-fighting.

10.3 Selection

10.3.1 Protection from chemicals and hazardous substances

(a) *Low risk chemicals* can be protected against by wearing chemical-resistant clothing, coveralls and laboratory coats made from uncoated cotton or synthetic material such as nylon or Terylene with a water repellant finish.

(b) *Strong solvents, oils and greases* require heavier protection afforded by coats, overalls and aprons made from neoprene or polyurethane coated nylon, or Terylene or rubber aprons.

(c) *Chemical suits* protect against more potent chemicals. They are totally encapsulating suits which are either vapour-proof or liquid-splash proof and are fed with breathable air. They must be washed in warm water and a mild soap whenever they have come into contact with chemicals. The suit should be hung up to dry before being stored in cases or hung on hangers. Chemical suits have a life expectancy of three to four years and should be inspected every three months even if not in use. This entails an air test and looking at all of the seams.

They may fail to provide protection because of: i) degradation (material failure on exposure to the chemical) ii) penetration (via pinholes, seams, zippers etc) or iii) permeation (chemical moving through the suit on a molecular level).

(d) *Vapour suits* protect against hazardous vapours and are made of butyl, polyvinyl chloride (PVC), viton, a combination of viton and butyl or Teflon. They should be air-tested with the manufacturer's test kit, before being stored in a protective case. Manufacturers of vapour proof suits generally provide a testing and repair service consisting of a visual inspection and air test.

(e) *Splash-resistant suits* are also made from the same polymers but may also be made of limited-use bonded olefin fabrics.

(f) *Fibres and dust*: Protection can be obtained by wearing suits made from bonded olefin that forms a dense shield which keeps out fibres and particles.

Keep in mind that suits can impose limitations on the amount of time the worker can wear it and the level of activity. Inefficient operation or heat stress may be a result.

10.3.2 Thermal and weather protection

(a) *Keeping dry*: Jackets, trousers and leggings made with PVC coated nylon or cotton will offer protection against rain. These materials are also resistant to abrasions, cracking and tearing and will protect against most oils, chemicals and acids. 'Breathable' water-proof fabrics will keep out water while allowing body perspiration to escape. Waxed cotton will also protect against rain.

(b) *Keeping warm:* Minus 25 and Minus 50 suits are available which are guaranteed to protect at these respective sub zero temperatures. More limited protection can be obtained from quilted and insulated coats and vests.

(c) Keeping cool:

Aluminium-asbestos clothing made of dust-suppressed material is heat resistant. The outside is made of aluminium and the inside lining is cotton. This type of clothing is suitable for hot work, for example in foundries. Welding and foundry clothing is flame retardant and is mainly of flame retardant cotton or wool materials. Cotton or cotton and polyester coveralls with flame-retardant finishes are available to protect against sparks and flame. Chrome leather is used for aprons etc.

Molten metal splash clothing is heat resistant and should resist molten metal splash up to 1600 degrees centigrade.

Water-cooled clothing are available but are only advantage when working at a relatively fixed workplace due to need for a piped water supply. Air-cooled clothing which distribute cooling air next to skin must have breathing quality air supplied and has limited mobility. Air fed suits incorporates positive pressure air fed with the air temperature able to be adjusted by use of a vortex cooler which is incorporated into the air supply. The use of such suits can seriously effect movement of the wearer and hence productivity. Ice pack vests are available with various numbers of ice packs the cooling of which will vary with time, contact pressure with the body, environmental temperature and any heating effects from clothing. Solid carbon-dioxide packs are available; however, such systems should not be used in confined spaces due to the build up of CO_2 gas and danger of asphyxiation.

10.3.3 Food processing

Food quality overalls and coveralls will protect against splashes from oils and fats. Butchers and slaughterhouse workers should wear lamex or chain-mail aprons if there is a risk of injury to the abdomen or chest, for example when using knives or choppers.

10.3.4 Chainsaw protective clothing

The front of the leg is most vulnerable to chainsaw accidents although the back of the leg is also at risk. Protective legwear incorporates layer of loosely woven long synthetic fibres. On contact with the chain saw, the fibres are drawn out and clog the chain saw sprocket causing the chain to stop. Legwear is available with all-round protection or with protection only for the front of the legs. The legwear with all round protection offers the greatest protection for users. Jackets and gloves are also available with inserts of chain saw resistant materials at vulnerable points.

10.4 Maintenance

Protective clothing should only be used for the purpose intended. It should be maintained in good condition and checked regularly. It should be repaired in accordance with the manufacturer’s instructions, or discarded if damaged. Any contamination should be washed or wiped off immediately. Water or soap and water is usually adequate but a chemical solution may be required to remove specified contaminants. They should be stored in hangars.

Generally, work clothing should not be taken home since clothing such clothing could become a hazard to persons handling it there. These should be laundered according to manufacturer’s instructions.

10.5 Personal protection worn on the body.

10.5.1 High visibility clothing

This is made from materials impregnated with fluorescent pigments, and will include some areas of retroreflective material. It is designed to make the use conspicuous under any light conditions in the day and under illumination by vehicle headlights in the dark. It will need to be worn by workers on roadsides and other places where it is important to be seen to be safe.

10.5.2 Personal buoyancy equipment

Life jackets or buoyancy aids should be worn where there is a foreseeable risk of drowning when working on or near water.

(a) *A life jacket* is a personal safety device which should be selected so that, when fully inflated (if inflatable), it provides sufficient buoyancy to turn and support even an unconscious person face upwards within five seconds (ten seconds if automatically inflated). The person’s head should be supported with the mouth and nose well clear of the water

Some people are reluctant to wear life jackets as they find them bulky and restrictive. However, either an automatically inflatable life jacket or a type which is inflated by a manual pull-cord should overcome these problems. These are usually compact and allow for a full range of movement. Automatically inflated life jackets need to be carefully maintained and regularly inspected, as the automatic inflation mechanism can fail to operate if subject to rough handling or incorrect storage.

(b) *Buoyancy aids* are worn to provide extra buoyancy to assist a conscious person in keeping afloat. However, they will not turn over an unconscious person from a face down position.

Appendix A

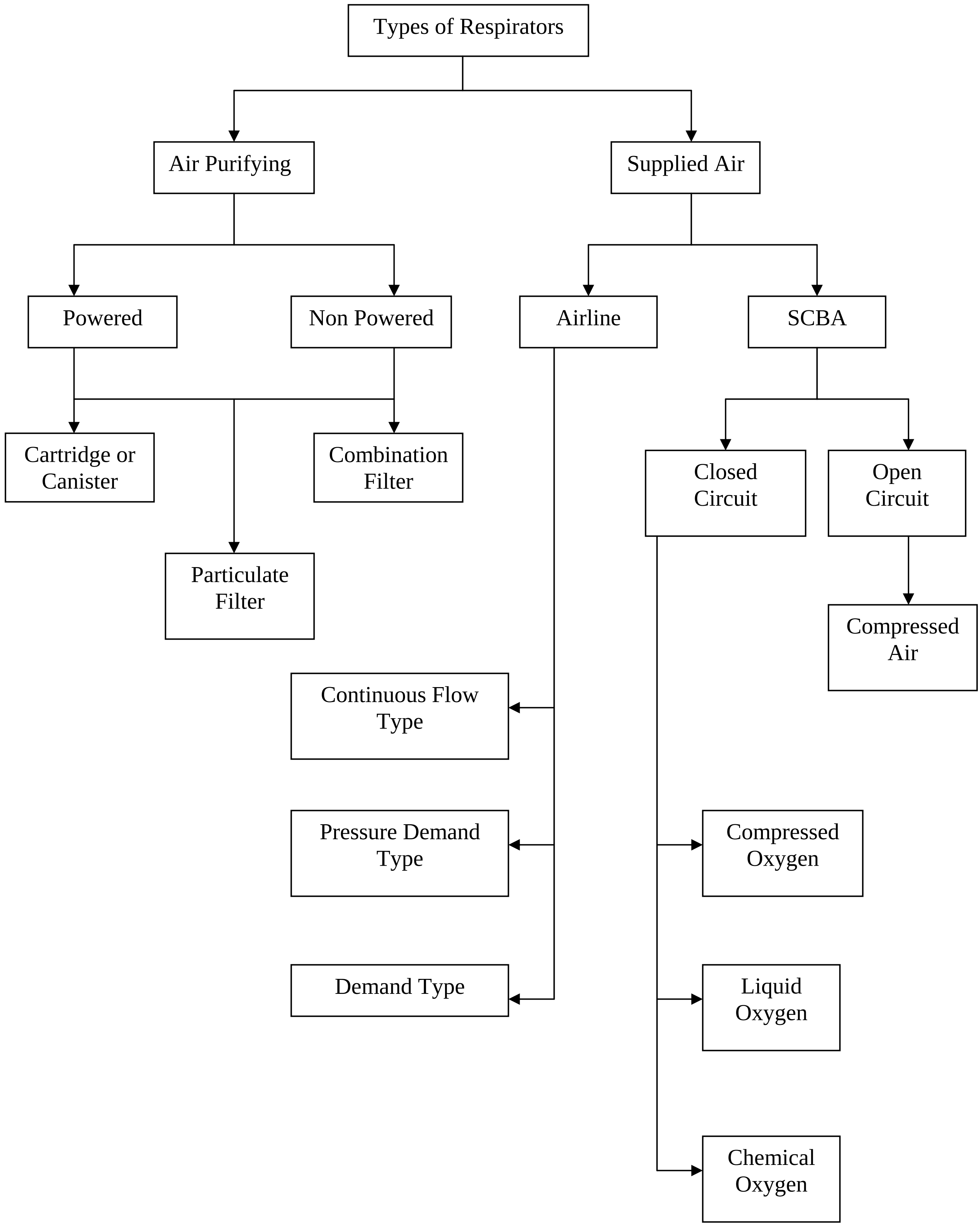
<u>Checklist on Issues to be Considered in Implementing the PPE Programme</u>

1. Which job tasks require the use of PPE
2. Which work areas require the use of PPE
3. Have other control measures been implemented e.g. engineering controls
4. Availability of information to employees on what and why PPE is needed
5. Availability of training to employees on using PPE
6. Does the PPE provide adequate and appropriate protection against the hazard
7. Existence of checking system to ensure that the PPE received from supplier is of the specification requested
8. Existence of PPE stock rotation system as well as system to ensure minimum stock availability
9. Existence of system responding to faulty PPE
10. Existence of system to respond to an emergency or problems in supply
11. Are there any up-to-date specification of the PPE
12. Does operating and maintenance instructions applicable to the available PPE
13. Are instructions reviewed and amended if there are changes in the task or production process
14. Are personnel issuing PPE aware of the specification and what circumstances the PPE is being used for
15. Are specific PPE items readily identifiable
16. Existence of systems to ensure proper cleaning and maintenance of used PPE
17. Reinspection of cleaned PPE is in place
18. Presence of proper storage area/facility of used PPE
19. Existence of system to ensure safe and proper disposal of used/contaminated/expired PPE
20. Monitoring system to ensure employees comply with using PPE and know how to put on PPE

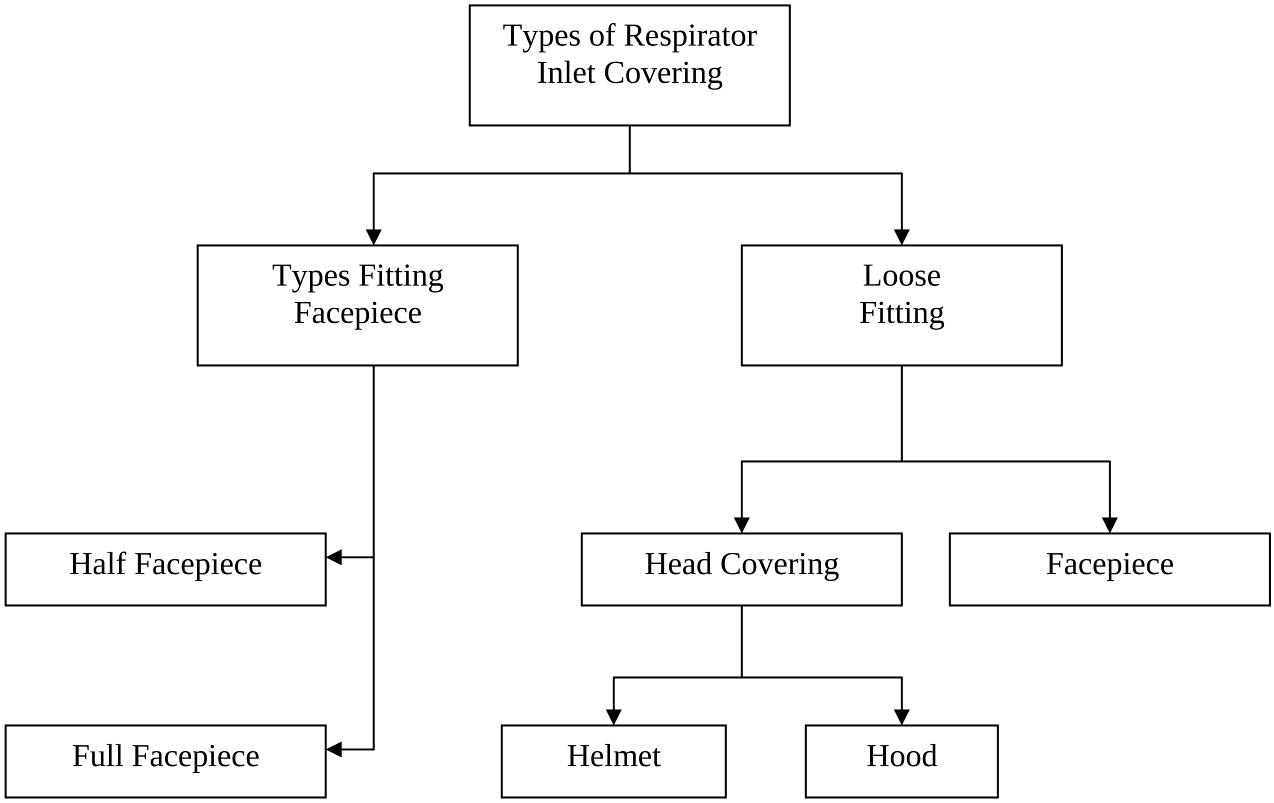
Checklist on Issues to be Considered in the Selection of PPE

	Type of PPE	Issues
1	Respirator	• Is the environment regularly monitored for hazardous substances • Are there other control measures in place to contain the hazard • What is the appropriate respirator specific to the hazard • Is respirator fit conducted • Respirator limitations considered • Training in the use, storage and maintenance of the respirators
2	Eye protection	• Does it offer adequate protection against the hazard • Does it distort the vision of the user • Does it limit peripheral vision • Are there gaps between the side shields and face which might allow particles to enter
3	Face protection	• Does it offer adequate protection against the hazard • Is eye protection also needed • Does it distort the vision of the user • Does it limit peripheral vision • Are there gaps between the side shields and face which might allow particles to enter
4	Head protection	• Does it offer protection against the hazard • Are liners, chin straps and sweatbands used to keep it in place • Will it fit properly • Does it affect movement of the head • Will it be too bulky
5	Hearing protection	• Does it offer adequate protection against noise • Are they comfortable to wear • Are ear muffs adjustable • Any associated medical conditions with wearing ear protectors • Does it create pressure to the chin, head or behind the ears • Are they any other system in place to alert wearer of any emergencies
6	Hand protection	• Is it of adequate length to protect against the hazard • Is it of the correct size • Does it offer adequate protection or is it suitable to be used against the hazard • Will it restrict hand movement or interfere with the task • Is it too slippery or too bulky
7	Leg and foot protection	• Does it offer adequate protection against the hazard • Is it too bulky • Is it comfortable to wear
8	Body protection	• Is the clothing of the right size • Does it offer adequate protection against the hazard • Is it comfortable to wear
9	Fall protection	• Is the harness suitable for the task at hand • Does it fit the user • Will it interfere with the task

Types of Respirators



Types of Respirator Inlet Coverings



APPENDIX E

Factors Affecting Respirator Selection

	Factor	Comments
1	Hazard Related	
	• -O_2 deficient -Unknown hazard -Unknown concentration -Concentration above IDLH	• -SCBA -Full face airline respirator (positive pressure) with escape SCBA -Helmet/hood continuous flow airline respirator with escape SCBA
	• Inadequate warning properties (absence of breakthrough noticeable odor, eye irritation or upper respiratory tract irritation)	• Supplied air respirators
	• Irritants and corrosives	• -Full facepiece, helmet or hood -Eye and skin protection must also be provided (e.g.chemical protective clothing)
	• Physical form of hazard	• Appropriate sorbent cartridge for gas or vapor
2	Task Related	
	• Working duration	• Service life of: SCBA limited by amount of breathing air carried Air purifying and PAPR by capacity of cartridges/canisters/battery
	• User activity	• -Unrestricted movement: SCBA/Air-purifying -Task location: Use cylinder air (length of air line may limit distance) -Heavy workload: Airline or PAPR
	• Communication	• Select facepiece with appropriate speech transmission facilities if communication important
	• Temperature extremes	• -High temp.: supplied air respirator with cool breathing air -High humidity:supplied air or PAPR (to avoid facepiece fogging)
	• Eye/head protection	• Full facepiece/helmet/hood protect eyes and heads from flying particles
3	Operator Related	
	• Facial hair growth e.g. beards, moustache, stubble	• Interferes with fit or proper sealing
	• Eye glasses	• Use full respirator with special corrective lenses mounted inside
	• Facial deformity e.g. scars, deep skin creases, prominent cheekbones, acne, lack of teeth	• Interferes with sealing

REFERENCES

1. *Personal Protective Equipment at Work-Guidance on Regulations*; HSE Document

2. *Personal Protective Equipment Guide*; Shell Safety Committee; June 1989

3. *Code of Practise for Selection, Use and Maintenance of Respiratory Protective Devices;* Singapore Standard CP 74:1998

4. *Personal Protection, Chapter 31;* Encyclopaedia of Occupational Health and Safety; International Labor Office Geneva