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Eye and face protection — Guidance on selection, use and maintenance

Protection des yeux et du visage — Lignes directrices pour le choix, l'utilisation et l'entretien

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94 *Personal safety — Personal protective equipment*, Subcommittee SC 6 *Eye and face protection*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 85, *Eye-protective equipment,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is intended to provide guidance on how to select, use and maintain eye and face protectors. A workplace eye and face safety programme should be introduced and a hierarchy of control followed where workers are exposed to a recognised risk of injury to the eyes and/or face. Examples of areas and processes where eye and/or face hazards may exist are shown in Tables 2, 4 and 5.

The aim of an eye and face safety programme is to protect the eyes and face of the worker through the process of elimination or control of hazards and, where necessary, the wearing of appropriate protection.

While responsibility for the successful implementation of an eye and face safety programme rests with senior management, every effort is required to secure the participation and involvement of employees or their representatives in all phases of the programme. Experience has shown that programmes lacking this involvement have less chance of success.

A critical examination of working conditions, particularly lighting, layout and planning of buildings and processes, form a necessary part of an eye and face safety programme.

Selection of a suitable programme may be assigned to safety personnel within the organisation or advice may be sought from outside sources. Elements that have been found in successful eye and face safety programmes include the following:

a) An assessment of hazards.

b) Determination of workplace hazard areas.

c) Elimination or confinement of hazards (where possible).

d) Vision screening.

e) Referral for optometric, ophthalmological examination or both, where necessary.

f) The universal wearing of suitable eye and face protectors for those persons at risk.

g) Educational campaigns on eye safety.

Eye and face protectors are items of personal protective equipment (PPE) intended to prevent the harmful effects that physical (e.g. flying particles, dust, splashing and molten materials), optical (e.g. solar and artificial radiation and high intensity radiation generated during operations such as welding and furnace work), chemical (e.g. pressurised materials, harmful gases, vapours and aerosols) and biological hazards may have to the eye and face.

For eye and face protectors to be effective they should be used at all times when the user is in a potentially hazardous environment. When selecting eye and face protectors, attention should be given to factors influencing comfort and user preference.

Those involved in selling eye and face protectors to the general public for use in non-workplace settings should adhere to the principles and guidance in this standard to ensure that users of personal protective equipment are fully informed about making the safest choice for a particular task and environment as well as how to use the protective equipment in the safest manner. This should also apply to those businesses that hire power equipment. Safety guidance based on this document should be provided to prospective customers to ensure they select and use the correct protective equipment to reduce the risk of eye and face injury.

Eye and face protection — Guidance on selection, use and maintenance

1 Scope

This document gives guidance to specifiers and users on the control of eye and face hazards including physical, mechanical, chemical, optical radiation and biological and the selection, use and maintenance of eye and face protectors.

This document applies to

— occupational use,

— tasks that are performed similarly to those in an occupation but not in the workplace, e.g. "do-it-yourself", and

— schools, educational and research establishments.

This document does not apply to eye and face protection for

— ionizing radiation,

— low frequency radio waves,

— microwaves,

— sports or vehicular usage, and

— sunglasses for general (not occupational) use – see ISO 12312-1.

NOTE The ISO 18527 (all parts) sets requirements for eye protectors for some sports.

Brief advice on protection when using lasers is included but for detailed advice, see IEC/TR 60825-14.

This document is neither a whole nor partial substitute for risk assessment, which is an essential part of any eye and face protection programme.

Although this document has been written to help specifiers and users, any recommendations in this document are to be interpreted as guidance only and not intended to replace any national regulatory requirements. Risk assessment is the sole responsibility of the employer and not the PPE manufacturer or its authorised representative.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4007, *Personal protective equipment — Eye and face protection — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4007[1)] and the following apply[2)].

1) The terms and definitions for risk and hazard have been included here for the reader's convenience.

2) The abbreviation PPE means personal protective equipment.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

NOTE ISO/IEC Guide 51:2014, Clause 4, states: The term “safe” is often understood by the general public as the state of being protected from all hazards. However, this is a misunderstanding: “safe” is rather the state of being protected from recognized hazards that are likely to cause harm. Some level of risk is inherent in products or systems. The use of the terms “safety” and “safe” as descriptive adjectives is avoided when they convey no useful extra information. In addition, they are likely to be misinterpreted as an assurance of freedom from risk. The recommended approach is to replace, wherever possible, the terms “safety” and “safe” with an indication of the objective – for example, the phrase “protective spectacles” should be used in preference to “safety spectacles”.

3.1
hazard
potential source of harm

[SOURCE: ISO/IEC Guide 51:2014, 3.2]

3.2
risk
combination of the probability of occurrence of harm and the severity of that harm

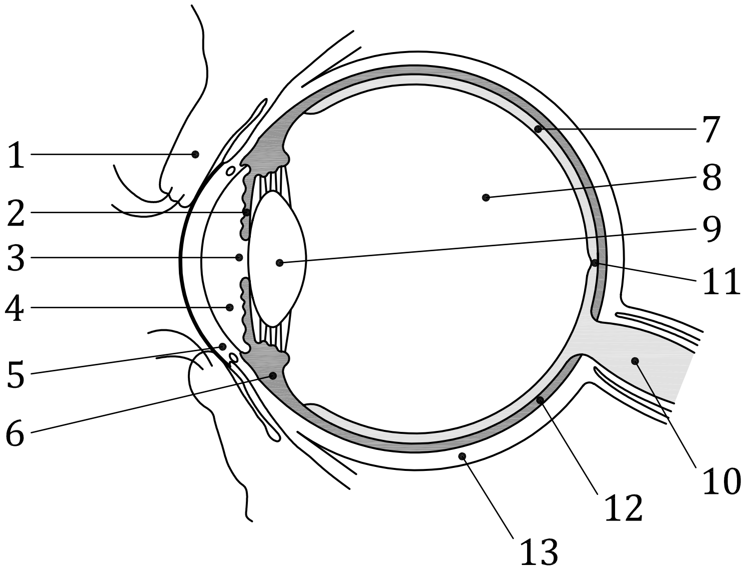
Note 1 to entry: Note 1 to entry: The probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event and the possibility to avoid or limit the harm.

[SOURCE: ISO/IEC Guide 51:2014, 3.9]

4 General

4.1 Structure of the human eye

See Figure 1.



Key

1 eyelid

2 iris

3 pupil

4 anterior Chamber (filled with aqueous humour)

5 cornea

6 ciliary muscle

7 retina

8 vitreous chamber (filled with vitreous humour)

9 crystalline lens

10 optic nerve

11 macular region of retina

12 pigment epithelium and choroid

13 sclera

Figure 1 — Outline of the human eye (cross section)

a) Light emitted, transmitted or reflected by an object in the field of vision travels toward the eyes.

b) Light passes through the CORNEA (transparent “front window” of the eye), which provides two-thirds of the focusing power of the eye.

c) The PUPIL (the opening at the centre of the pigmented IRIS) changes size to vary the amount of light that reaches the retina.

d) The CRYSTALLINE LENS provides the remaining focusing power of the eye.

e) The RETINA (rear inner lining of the eye that contains light-sensitive and image processing cells and nerve fibres) converts light into neural signals. The MACULAR region is located near the centre of the retina and is dense with photoreceptors; its function is to process central vision in fine detail.

f) The OPTIC NERVE is the collection of nerve fibres that carry these signals to the brain.

4.2 Hazards and risks to the eye and face

4.2.1 Surrounding structures of the eye

The structures surrounding the eye, including the eyelids, skin, muscles and the orbital bones are susceptible to permanent damage. Objects of sufficient energy can cause bone fracture, contusions, lacerations and penetration of these tissues. Damage to the muscles and bones around the eye can result in a temporary or permanent disruption to binocular vision.

4.2.2 Peri-orbital skin

The skin of the eyelids is thinner than the skin in the rest of the body and is therefore more susceptible to physical damage such as bruising and lacerations, while the geometry of the lower lid makes it more vulnerable to UV radiation damage, including some skin cancers.

4.2.3 Tears

The lacrimal gland, which is situated in the orbit above and temporal to the eye secrete the watery content of tears. Tiny glands in the conjunctiva secrete mucous. Meibomium glands in the upper (mainly) and lower lids secret an oily substance. These components combine into a structured layer of tears. Tears drain down to the nose through the naso-lacrimal ducts (often called simply the "tear ducts") that start as openings in the edges of the eyelids near the nose. The glands can be damaged directly by chemicals. Chemicals can also be absorbed into the body through the conjunctiva, the nasal mucosa or digestive system if washed through the tear ducts. Microorganisms may also enter the body by this route.

4.2.4 Cornea and conjunctiva

The cornea is about 0,6 mm thick at its centre and is composed of several layers. The outermost layer of the cornea, the epithelium, is highly sensitive to foreign bodies, including fine particles and dust, that can irritate and damage it. The resulting discomfort and soreness can last from a few minutes to several days. The epithelium regenerates very rapidly, so minor lesions heal quickly leaving no permanent damage. Minor ingress of foreign matter can be readily dispersed by the tears whereas larger amounts will require dispersal with a copious stream of water or other more intensive remedies conducted within a specialized medical environment. Even minor damage to the epithelium may facilitate infection which can result in clouding and permanent vision loss.

The main component of the cornea, about 90 % of its thickness, is the stroma. This relies on a very regular structure for its transparency so that any physical damage results in scar tissue that is irregular and, therefore, not transparent. Hence, more severe damage to the cornea that goes deeper than the epithelium such as lacerations, penetration, etc, will give opaque scar tissue which can result in clouded or permanent loss of vision.

Alkalis and strong acids will cause serious, often permanent, damage to the conjunctiva and cornea, which could lead to blindness. Alkalis are particularly damaging to the surface of the eye, rapidly causing irreversible damage. Conjunctivitis can also be caused by allergic reactions to many chemical substances, pollens, and biological agents. Even minor splashes or a fine aerosol spray of such substances can cause irritation.

The innermost layer of the cornea is a single layer of cells that form the endothelium. These cells do not regenerate after damage, the remaining cells enlarge to spread out over the surface. If this number falls below a threshold, the cornea becomes oedematous and is unable to maintain its transparency.

Exposure to sufficiently intense sources of infrared radiation from artificial sources can result in burns to the cornea (IR-B and C), retina and the lens (IR-A). Exposure to sufficiently high levels of UV radiation result in an acute painful inflammation of the epithelium of the cornea and conjunctiva. This acute effect is typically associated with exposure to electric arc welding and is commonly known as arc-eye or welder's flash. Long term exposure to UV can also result in chronic conditions such as pinguecula (a scar on the exposed conjunctival tissue nasally and temporally), pterygium (an abnormal mass of thickened conjunctiva and blood vessel growth into the cornea, most frequently on the nasal side), exposure keratitis (inflammation) and endothelial polymegethism (irregular cell sizes and shapes).

4.2.5 Iris and lens

Flying objects of sufficient mass and velocity can penetrate the cornea to injure the iris and the lens. Blunt trauma, e.g. walking into objects or falling onto furniture, impact from a large object such as a football or basketball, can result in damage to the iris, and can also cause cataract or subluxation (displacement) of the lens. Physical damage to the lens and its associated muscles can result in permanent loss of focus and increased susceptibility to certain diseases e.g. glaucoma. Damage to the iris can result in problems with light sensitivity (photophobia).

4.2.6 Retina

As well as being damaged by penetrating objects, the retina is also susceptible to blunt trauma to the exterior of the eye. This can result in retinal detachment and visual field loss. Acute damage, i.e. damage caused essentially immediately after an event rather than cumulatively, may be caused by high intensity optical radiation, e.g. lasers or viewing the sun. Visible light, especially bluelight, can cause photochemical damage within the light-sensitive cells of the retina. This painless loss of vision occurs several hours after the injurious exposure and may take several months to recover; permanent vision loss is possible. Some chemicals or medicines, e.g. drugs used to treat skin conditions, can photosensitize the retina so that less UV radiation or visible light is needed to cause damage.

4.2.7 Optic nerve

Blunt trauma to the eye can also result in damage to the optic nerve.

Though rare, intra-orbital penetration of objects, between the eye and the orbital bones, can occur and can result in damage to the optic nerve and the brain.

Exposure to certain chemicals can cause inflammation of the optic nerve, a condition known as optic neuritis. In the longer term, this can lead to degenerative changes known as optic atrophy. The resulting poor vision is often called “toxic amblyopia". This is more likely, however, to be caused by systemic absorption, e.g. drinking methanol or inhaling lead-contaminated dust, than resulting from chemical splashes in the eye.

4.2.8 Choroid and retinal pigment epithelium

The choroid lies between the retina and sclera; it has the functions of providing an absorbing layer for light passing through the retina, providing nutrients and oxygen to and removing carbon dioxide from the outer layers of the retina by being a highly vascular tissue. The outermost layer of the retina, the retinal pigment epithelium provides the major function of metabolising the waste products from the photosensitive tips of the rods and cones; it also acts as an intermediary, transporting nutrients, etc. between the choroid and outer layers of the retina. If there is a retinal detachment, which can occur following a blow to the eye, the retinal pigment epithelium stays attached to the choroid with the neural layers separating.

4.3 The eye's defence system

The natural defence mechanisms help limit the eyes exposure to some hazards. The eyelids, eyelashes and blink reflex provide a mechanical barrier. The blink reflex, particularly in response to a bright flash of light, will quickly reduce the amount of radiation entering the eye. The constriction of the pupil in response to the bright light will reduce the amount of radiation entering the eye in the longer term. The bony cavity containing the eyeball itself, as well as the brow and forehead, provide further protection as they protrude beyond the eye, particularly in children. The combination of lipids and oils in the tears, as well as the conjunctiva, provide a further barrier to injury. Natural mechanisms alone are insufficient, however, to prevent many injuries.

Table 1 gives an over-view of hazards to the various parts of the eye.

Table 1 — Some causes and consequences of damage to the eye

	Mechanical			Chemical			Optical radiation			Biological
Structure of the eye	Small	Medium	Large or fast	Acids	Alkalis	Other	UV	Visible	IR	
Cornea	Irritation. Epithelial damage. Repairable	Laceration. Scarring. Longer term damage	Rupture. Loss of contents Total loss of sight	Opacification Keratitis	Opacification. Very damaging, rapid penetration	Irritation, lacrimation	*Short term* Snow blindness. Welder's flash, arc-eye, photokeratitis *Long term.* Pterygium	None	Pain. Opacification from IR lasers	Infection
Iris		Laceration. Prolapse through corneal laceration. Detachment at the circumference (iridodialysis)							IR radiation incident on the iris will increase the temperature of the lens	
Crystalline lens		Traumatic cataract, Displacement of lens					*Long term* UV Radiation causing photo-degradation of the lens structure causing cataract		High ambient temperatures (e.g. above 38 °C) may accelerate aging of the lens (cataract)	
Vitreous		Intra-ocular foreign body. Siderosis (rusting)								
Retina		Haemorrhages. Commotio retina. Detachment				Optic neuritis	Lasers Photochemical damage, thermal damage, photoacoustic damage (pulse lasers)			
Adnexa (skin, eyelids, lacrimal system, orbital bones)	Laceration and contusion	Orbital fracture. Damage to lacrimal system, Epiphora (overflowing tears)		Chemical burns. Permanent scarring			Thermal burns			

4.4 Colour perception

The level of colour perception required to carry out work-related tasks will vary. Some tasks will only require the worker to detect the presence/absence of a coloured object, and so colour recognition is not important. Nevertheless, a coloured filter could make simple detection difficult because of the reduction in brightness contrast. Other tasks require the worker to recognize and identify the colour of objects. Examples could include identification of coloured wires, pipes, signal lights, or gas cylinders. In other tasks, the worker must be able to discriminate and identify accurately relatively small differences in colour, such as interpreting pH indicators, diagnostic strips, and the colour of different fuels.

Filters impair colour perception by selective absorption of wavelengths within the visible spectrum (i.e., coloured filters), lowering the light levels entering the eye to values equivalent to night-time levels (i.e., grey welding filters), or both (coloured welding filters). However, the filters also help with colour discrimination in limited and specific circumstances. Cobalt blue filters help in identifying the temperature of the molten metal by reducing the intensity of the light to below levels at which the visual system's discrimination ability saturates. Viewing the molten metal through the cobalt blue filter also accentuates the shift in its colour as the temperature of the metal changes.

Determining the effects of filter on colour vision can be challenging because the effects are dependent on the filter spectral transmittance characteristics, the spectral emittance of the signal light or light illuminating the object of regard, and the spectral reflective properties of the object(s).

Generally, filters that meet international guidelines for identifying traffic signal light colours would be appropriate to use when signal lights are used, since they are similar to traffic signals, or the coloured objects are similar in colour to roadway signage (red, blue, brown, green).

If colour detection and identification of signal lights similar to traffic signal lights is important, then the values of the relative visual attenuation coefficients (quotients) for traffic signal detection, Q_{red}, Q_{yellow}, Q_{green} and Q_{blue} should be met. All sunglare eye protectors for driving, marked GL0 to GL3, comply with a limit on these values as do UV filters marked "UL", IR filters marked "IL" and welding filters marked "WL" so these are indicated when colour detection of signals is an issue. However, these filters may not be suitable for other transportation modes such as the railways because the signal lights are different, and the viewing distances are longer.

If the task requires discrimination or identification of small differences in colour, then grey filters are recommended. The luminous transmittance should be greater than 10 % unless the average lighting in the area is very bright (equivalent to mid-day clear sky or brighter).

About 8 % of the male and 0,5 % of the female population suffer from colour vision deficiencies. These vary from being so little affected that they may never know and there may be no practical or occupational consequences to being unable to distinguish colours along the red-green colour axis. However, very few indeed are truly "colour-blind" as they can distinguish blueness and yellowness entirely normally. The issues of occupational consequences for these people are not a subject here except that they may be more affected by tinted lenses and filters than people with normal colour vision, so extra care may need to be exercised.

The first step in a risk assessment is to assess the need for colour detection and/or recognition in the workplace. Is there a need to detect or recognise colour accurately and quickly? What are the consequences of error, trivial though to dire? What is the likelihood of error, common through to rare? One indication would be if the medical standards already exclude some or all of the people with colour vision deficiencies.

There are then some engineering solutions that might be applied to reduce the risks. As well as colour coded, the signals, for instance, could be shape coded, they might vary in size, danger or warning signals could be larger, they could vary in number (two lights means danger or warning), the important light could flash and/or could be accompanied by an audible warning (bell or siren).

A short practical experiment may help to identify when the colour of the filter might be an issue.

a) Collect pieces of material/equipment (e.g. cables with the same cable colour coding that is used at the workplace).

b) Make sure that the person is in a safe area with illumination (type and intensity) consistent with their workplace.

c) Clean the eye protector and inspect it for damage (replace the eye protector if necessary, according to the user instructions).

d) Put the eye protector on according to user instructions.

e) Quickly sort the samples (e.g. cable pieces) by colour.

f) Assess the person's capacity to undertake the job is consistent with the requirements of the role.

g) Carry out a risk assessment of the specific factors in implementing the best solution. See also CIE S 017[27].

Control strategies where good colour detection and recognition appear important include to ensure that

— the colours used comply with the appropriate standards. See, for example CIE 39.2[28] and CIE S 004[29].

— the general colour rendering of the light sources, R_a is sufficiently high. A minimum R_a of 80 is recommended. In more demanding colour work a minimum R_a of 90 may be necessary. CIE 13.3[30].

— the illuminance levels meet the relevant requirements, see for instance, ISO 8995 (all parts).

5 Hazards and their consequences

5.1 General hazards

Table 2 gives a general classification of hazards but see Table 4 for additional details. These lists of hazards are examples only and are not exhaustive.

Table 2 — General classification of eye and face hazards, with some examples

Type of hazard	Examples of hazard
Mechanical	Flying objects, high pressure liquids
Chemical	Splashes, fine droplets, particles
Optical radiation	Sunlight, welding, UV curing, lasers
Ionizing radiation	X-rays (outside the scope; see IEC 61331-3)
Biological	Microorganisms (viruses, bacteria, fungi), bodily fluids
Heat and flame	Furnace work, gas welding, glass blowing

This document briefly addresses some elements of risk assessment and management relating to some specific elements of eye and face protection. Measures should be adopted that will avoid or minimise exposure to hazards. For detailed information, it is recommended that the reader consults appropriate guidance on the subject from other publications e.g. ISO 31000.

An adequate risk assessment should be conducted to assess the presence and severity of potential hazards to the eyes or face. The information detailed in this clause addresses some common workplace hazards and potential health effects that could be sustained as a result of workplace activities.

5.1.1 Mechanical hazards

5.1.1.1 Sources

Mechanical operations pose the most obvious sources of danger where damage to the eye can occur from flying debris, collision with static objects, ingress of fine particles, abrasion from fibrous materials or foliage, falls onto blunt objects. Burns from hot liquids and molten solids pose the dual danger of blunt injury and burns. Physical damage to the eye represents about 70 % of all eye injuries (Reference: Clin Exp Optom 2012;95: 129 -139). There is a range of mechanical hazards that can result in blunt or penetrating trauma to the eye, including from projectiles at speed or liquids under pressure. Workers at high risk of eye and face injuries include metal workers, miners, workers in medium to heavy manufacturing industries, commercial fishing, forestry and agriculture.

In quarrying work and the construction industry, there are obvious hazards from flying chippings and dust clouds. Similar hazards exist in mining operations, stone-masonry, sculpting and building repair. Forestry and landscaping operations present a range of potential hazards from sharp foliage, 'kick-back' from chain saws and flying fragments from broken power tools and machinery. Exploding flasks in laboratories, dust clouds generated during automobile sanding operations and grit generated by shot blast operations are other examples of mechanical hazards which are common causes of eye injury.

5.1.1.2 Health effects

The damage that can be caused to the eye by mechanical hazards ranges from mild irritation from ingress of fine dust to total loss of sight due to high velocity/high mass impacts or major direct encounter with molten metal. The cornea of the eye can easily be scratched by fine dust particles. This can result in discomfort or soreness lasting for a few minutes or several days depending on the severity of the abrasion. Minor damage to the cornea may provide a route for opportunistic infections by bacteria or acanthamoeba to occur. More severe damage to the cornea will result in clouded vision, or permanent loss of focus. Sharp flying objects of sufficient energy will lacerate the cornea and/or conjunctiva and may penetrate the cornea or sclera to injure the iris and the crystalline lens. Physical damage to the lens and its associated muscles can result in permanent loss of focus. Minor ingress of foreign matter can be readily dispersed by fluid secreted by the tear glands whereas larger amounts will require dispersal with a copious stream of water or other more intensive remedies conducted within a specialized medical environment.

5.1.2 Chemical hazards

5.1.2.1 Sources

As with mechanical hazards, there are many sources of chemical hazards which include very fine powders, aerosols, liquids, fumes, vapours and gases. Chemical hazards can be less immediately obvious than mechanical hazards; for example, fine cement dust entering the eye in small quantities may not present a serious mechanical hazard but the strong alkaline nature of such materials can cause severe corneal burns.

Alkalis continue to penetrate the tissues of the eye, especially the cornea, causing tissue destruction long after the initial exposure. Industrial processes that use potentially sight threatening alkaline or acidic chemicals include lime production, fertilizers, battery production and the processing of leather and food.

Many insecticides used in crop spraying are generated in aerosol form and can pose a hazard to agricultural workers. Paint spraying, varnishing and many other lacquering and treatment processes involve chemicals generated in aerosol form. Even if the base substance itself is harmless, it could be carried by a more damaging solvent or propellant.

The hazards associated with liquid chemicals are usually more obvious than from aerosols, fumes or gases and principally relate to splashes from containers during decanting and mixing, particularly where uncontrolled mixing leads to boiling by exothermic reaction.

Smoke and fumes generated by combustion are another potential cause of eye irritation and other more serious damage. A considerable number of vapours and gases can have a harmful effect on the eye. These include common industrial substances such as acetone, chlorine, formaldehyde, hydrogen sulphide, sulphur dioxide and toluene. Fume hazards are visible and warn of their presence whereas many harmful vapours and gases are invisible. Apart from leakages from containers and pipework, hazards also exist from vaporization of liquid chemicals during decanting, mixing and disposal. Readily

