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Varovanje oči in obraza - Navodilo za izbiro, uporabo in vzdrževanje (ISO/DIS 19734:2020)

Eye and face protection - Guidance on selection, use and maintenance (ISO/DIS 19734:2020)

Protection des yeux et du visage - Lignes directrices pour le choix, l'utilisation et l'entretien (ISO/DIS 19734:2020)

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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

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For an explanation on 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 the following URL: 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.

Introduction

This document is intended to provide guidance on how to select, use and maintain eye and face protection. A workplace eye and face safety programme should be introduced 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 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 protection for those persons at risk.

g) Educational campaigns on eye safety.

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

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

1 Scope

This document gives guidance 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

— non-occupational use including around the home, leisure activities and hobbies

— 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.

NOTE See the ISO 18527 series for advice about application to sports.

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

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

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*

ISO 16321-1, *Occupational eye and face protection – Part 1: General requirements*

ISO 16321-2, *Occupational eye and face protection – Part 2: Additional requirements for welding protectors*

ISO 16321-3, *Occupational eye and face protection – Part 3: Additional requirements for mesh*

ISO 12312-1, *Eye and face protection — Sunglasses and related eyewear — Part 1: Sunglasses for general use*

ISO 18527 (series), *Eye and face protection – Eye protection for sports use*

AS/NZS 4174, *Knitted and woven shade fabrics*

3 Terms and definitions

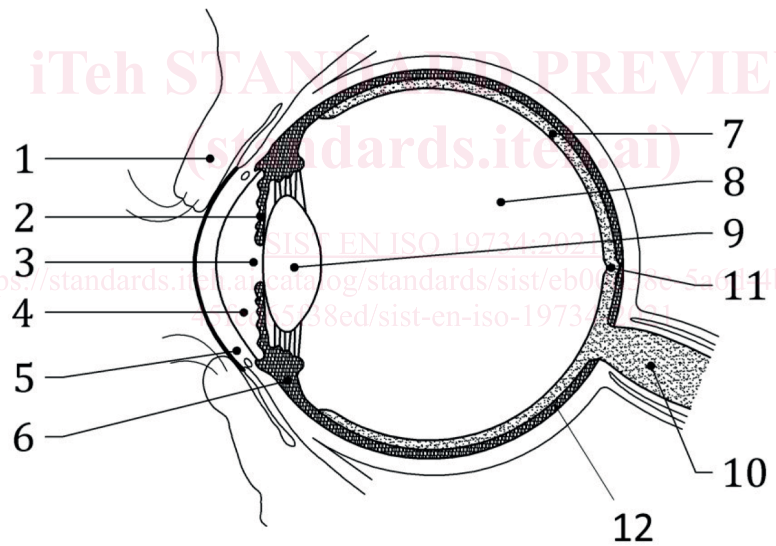
For the purposes of this document, the terms and definitions given in ISO 4007 apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE ISO 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 should be 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”

4 General

4.1 Structure of the human eye



Key

1	Eyelid	7	Retina
2	Iris	8	Vitreous chamber (filled with vitreous humour)
3	Pupil	9	Crystalline lens
4	Anterior Chamber (filled with aqueous humour)	10	Optic nerve
5	Cornea	11	Macular region
6	Ciliary muscle	12	Choroid

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

Explanation

a) Light is emitted by an object or strikes an object in the field of vision and is reflected or transmitted to the eyes. 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 entering the eye.

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) converts light into neural signals.

f) The OPTIC NERVE carries 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.

The lacrimal gland, which is situated in the orbit above and temporal to the eye, and tiny glands in the conjunctiva secrete tears. These 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, or the nasal mucosa if washed through the tear duct.

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.

The lacrimal gland, which is situated in the orbit above and temporal to the eye, and tiny glands in the conjunctiva secrete tears. These 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, or the nasal mucosa if washed through the tear duct.

4.2.3 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 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. 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.

Liquid splashes of alkalis and strong acids will cause serious, often permanent, damage to the conjunctiva and cornea, eventually 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 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. This does not regenerate after damage, the remaining cells enlarging 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 results in burns to the cornea (IR-B and C), retina and the lens (IR-A). Exposure to sufficiently high levels of UV radiation results in an acute effect with 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 pterygium (a scar on the exposed conjunctival tissue nasally and temporally), pannus (a nasal corneal growth), exposure keratitis (inflammation), endothelial polymegethism (irregular cell sizes and shapes).

4.2.4 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 or falling onto furniture, impact from a large object such as a football or basketball, can also result in damage to the iris, while it can cause cataract and 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 also result in problems with light sensitivity (photophobia).

4.2.5 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 blue light, 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 allowing even tiny amounts of UV radiation or visible light to cause severe damage.

4.2.6 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, or atrophy, mis-termed "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.

4.3 The eye defence system

The natural defence mechanisms help limit the eyes exposure to some hazards. The eyelids, eyelashes and blink reflex provide a mechanical barrier, and combined with the iris's ability to contract reduce visible light entering the eye. 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 potential results 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 on the iris may damage the crystalline lens	
Crystalline lens		Traumatic cataract, displacement of lens					*Long term* cataract			
Vitreous		Intra-ocular foreign body. Siderosis (rusting)								
Retina		Haemorrhages. Berlin's oedema (Commotio retina). Detachment								
Adnexa (skin, eyelids, lacrimal system, orbital bones)	Laceration and contusion	Orbital fracture. Damage to lacrimal system, epiphora		Chemical burns. Permanent scarring			Thermal burns			

4.4 Colour perception

In some work tasks there may be a need for accurate colour detection while in other tasks the ability to see that a coloured object (signal, sign, moving object) is present may be important. In other situations there may be a need for colour recognition, the ability to recognize the colour and its significance (red = stop or is mandatory or something not to do, yellow = caution or a warning, green = go or safety, blue = advisory or something to do or emergency vehicle, brown = tourist sign, colour coding of pipes and ducts, colours of gas cylinders etc). Furthermore, there may be a need to discriminate relatively subtle changes in colour (e.g. pH indicators, diagnostic strips, colours of different fuels, etc).

Colour perception when driving or operating machinery is critical but these tasks may not be the main reason a person is using eye protection in the workplace. Careful selection of appropriate eye protection should be undertaken in they may continue to be worn for driving and machinery operation.

For example, gas welding filters typically appear as a dark green, tint. For welding this might not matter and might even help to follow the weld-line, but such a tint changes colour perception.

In providing UV, IR or sun glare protective properties, an eye or face protector may also have selective transmittance properties in the visible region that will affect colour vision or colour perception.

Depending on the task, colour recognition should be distinguished from colour differentiation.

When a task requires colour recognition, the protector should change colour perception as little as possible. This may be the case with clear or neutral grey lenses. But grey lenses reduce the light passing through, i.e. may require additional illumination to allow precise colour recognition. The lower the light received by the human eye, the poorer the colour perception. In very dim light, colour vision ('day vision') turns to grey level vision ('night vision'), where colours can only be seen as different shades of grey.

The majority of workplaces, however, do not require precise colour recognition, but the ability to clearly differentiate between a well-known set of colours is important. In such situations, specific lens tinting could help to differentiate between these colour codes, despite the fact that the colours themselves may look slightly different compared with the colours seen with the naked eye.

Colour perception can be affected by workplace illumination (e.g. artificial illumination, especially illumination coming from fluorescent metal halide discharge or some LED lamps) and the transmittance properties of eye and face protection. Where colour perception is critical, colour recognition can be assessed prior to commencing work, e.g., by the following procedure.

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

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

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

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

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

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

7) Hazard and risk assessment of the specific factors in implementing the best solution.

5 Hazard 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	Welding, UV curing, lasers
Ionizing radiation	X-rays (outside the scope; see IEC 61331-3)
Biological	Pathological (microorganisms, bodily fluids)
Heat and flame	Furnace work and 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, *Risk Management*.

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 section 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 and burns from hot liquids and molten solids. 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 risks 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.