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Ergonomics — Visual danger signals — General requirements, design and testing

Ergonomie — Signaux visuels de danger — Exigences générales, conception et essais

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Content

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11428 was prepared by Technical Committee ISO/TC 159, *Ergonomics,* Subcommittee SC 5, *Ergonomics of the physical environment.*

The technical content of ISO 11428 and European Standard EN 842, *Safety of machinery — Visual danger signals — General requirements, design and testing* is identical. However, the limits of applicability of the standards to other technical fields are different, thus direct transformation of the International Standard into a European standard is not possible. EN 842 was prepared in order to fulfil the Council Directive on essential health and safety requirements relating to the design and construction of machinery and therefore the applicability of the European standard is restricted to this Directive.

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Ergonomics — Visual danger signals — General requirements, design and testing

1 Scope

This International Standard describes criteria for the perception of visual danger signals in the area in which people are intended to perceive and to react to such a signal. It specifies the safety and ergonomic requirements and the corresponding physical measurements and subjective visual check. It also provides guidance for the design of the signals so that they can be clearly perceived and differentiated as described in ISO/TR 12100-2:1992, 5.3.

This International Standard does not apply to danger indicators:

— presented in either written or pictorial form;

— transmitted by data display units.

This International Standard does not apply to special regulations such as those for public disaster and public transport.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3864:1984, *Safety colours and safety signs.*

ISO/TR 12100-2:1992, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications.*

IEC 73:1991, *Coding of indicating devices and actuators by colours and supplementary means.*

IEC 1310-1:1995, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, auditory and tactile signals.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 visual danger signal: Visual signal indicating imminent onset or actual occurrence of a dangerous situation, involving risk of personal injury or equipment disaster, and requiring some human response to eliminate or control the danger or requiring other immediate action.

A distinction is made between two types of visual danger signal: visual warning signal and visual emergency signal.

3.1.1 visual warning signal: Visual signal indicating the imminent onset of a dangerous situation requiring appropriate measure for the elimination or control of the danger.

3.1.2 visual emergency signal: Visual signal indicating the beginning or the actual occurrence of a dangerous situation requiring immediate action.

3.2 signal reception area: Area in which the signal is intended to be perceived and reacted upon.

3.3 field of vision (visual field): Physical space visible to an eye in a given position (see also ISO 8995:1989, 3.1.10).

3.4 danger signal light: Light source intended to convey information about the existence of a dangerous situation by means of one or several characteristics, such as luminance[1], colour, shape, location and temporal pattern.

4 Safety and ergonomic requirements

4.1 General

The characteristics of the visual danger signal shall ensure that any person in the signal reception area can detect, discriminate and react to the signal as intended. Visual danger signals shall be:

— clearly seen under all possible lighting conditions;
— clearly discriminated from general lighting and other visual signals;
— allocated a specific meaning within the signal reception area.

Visual danger signals shall take precedence over all other visual signals.

Visual emergency signals shall take precedence over all visual warning signals.

Care shall be taken to review the effectiveness of the visual danger signals at regular intervals and whenever a new signal (whether a danger signal or not) is introduced in the signal reception area.

NOTES

1 A visual danger signal should, if not contradicted by special reasons, be associated with an auditory danger signal. When the danger signal is an emergency signal, auditory and visual signals should be presented together (see ISO 11429).

2 It could be advantageous for visual danger signals to have a relatively low intensity mode to indicate they are functional but not in a warning mode.

1) As defined in ISO 8995.

4.2 Detectability

4.2.1 Luminance[1], illuminance[1], and contrast[1]

4.2.1.1 General

Two types of light source need to be distinguished: luminous area sources and luminous point sources[2]. Luminous area sources have a visual angle greater than 1′ (minute) for daylight conditions or 10′ (minutes) for darkness; otherwise the light sources are luminous point sources.

4.2.1.2 Luminous area sources

In all cases when the light source is not to be regarded as small (point source), the criteria for detectability are the luminance of the surface, the luminance of the background and their ratio. This luminance ratio (contrast) is not affected by viewing distance (unless transmissivity is to be taken into account, see 4.5) so a specified luminance ratio can be considered adequate for a wide range of viewing conditions.

The luminance of a visual warning signal shall be at least five times the luminance of the background. The luminance of a visual emergency signal shall be at least twice that of a warning signal, i.e. at least ten times the luminance of the background.

4.2.1.3 Luminous point sources

For luminous point sources, the criterion for detectability is the illuminance produced by the luminous flux on the pupil of the observer's eye compared to the luminance of the background.

The relationship between the pupillary illuminance required for detectability and the background luminance is given in figure 1.

4.2.2 Flashing lights

Flashing lights shall be used for visual emergency signals.

By having a signal flash, i.e. continuously switching ON and OFF, the detectability (attention-attracting qualities) of the signal is usually increased, often accompanied by transmission of a feeling of urgency.

NOTES

1 It is recommended that the flash frequency be between 2 Hz and 3 Hz with approximately equal ON- and OFF-intervals.

2 Synchronism between light and sound is not generally required, but can improve perception.

3 Stroboscopic effects, e.g. from rotating machinery, can reduce the detectability of flashing light signals.

4.2.3 Location within the field of vision

Visual danger signals should be located where appropriate in the direct vicinity of the potential danger in order to allow its immediate detection by all persons within the signal reception area, or about to enter this area. Additional visual danger signals located outside the direct vicinity, such as in a control room or a control panel, are not excluded.

The signal reception area of a visual danger signal shall be explicitly stated in the design for every installation, indicating whether the signal reception area is, for example, just a single operator's console or parts of a factory or a whole plant.

For directly displayed danger signals, the signal lights shall be located within the field of vision inside the workplace being considered (signal reception area) (see figures 2 and 3 and prEN 894-2).

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1) As defined in ISO 8995.

2) As defined in IEC 50(845)

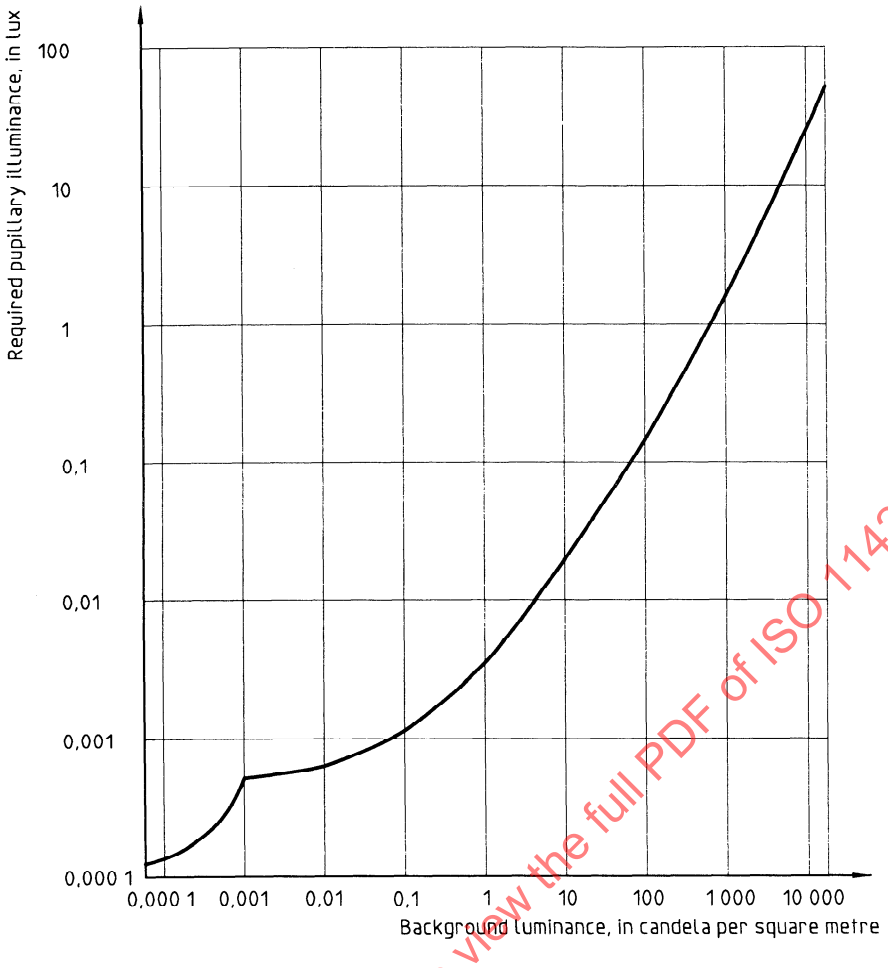
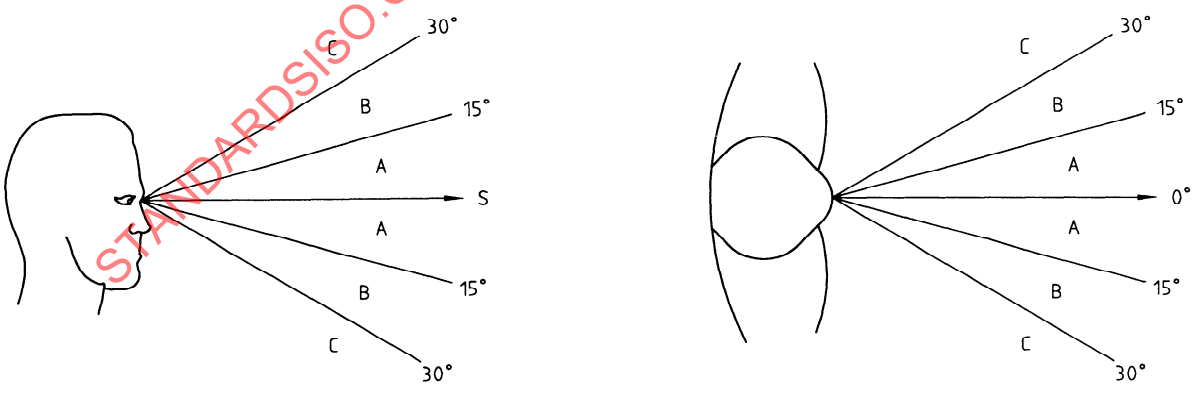


Figure 1 — Relationship between the required pupillary illuminance and the background luminance

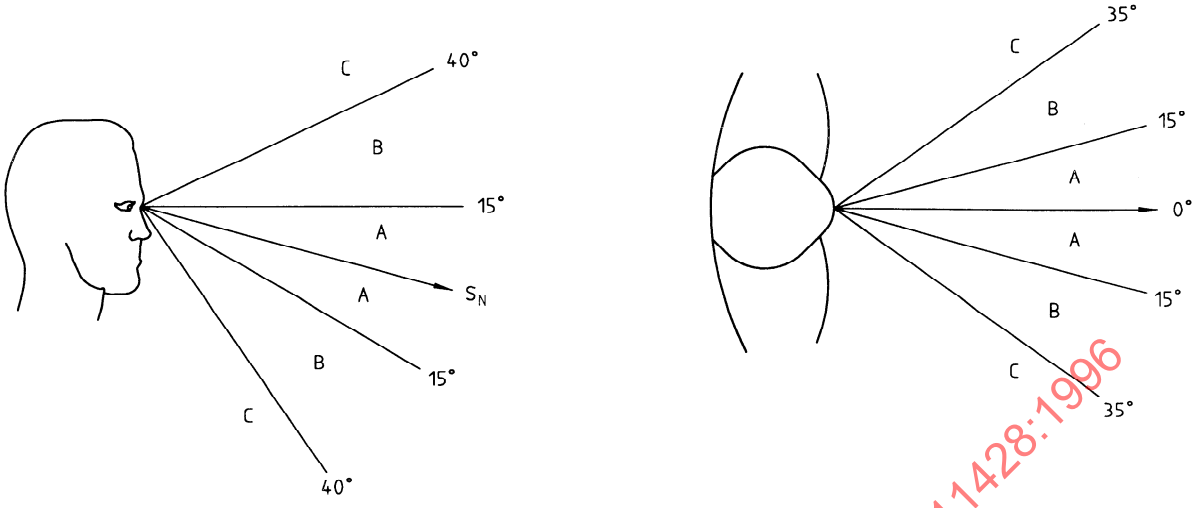


a) Vertical field of vision

b) Horizontal field of vision

Zone A: Recommended
Zone B: Acceptable
Zone C: Not suitable
Line S: Imposed line of sight

Figure 2 — Field of vision when line-of-sight direction is imposed by external task requirements



a) Vertical field of vision

b) Horizontal field of vision

Zone A: Recommended
Zone B: Acceptable
Zone C: Not suitable
Line S_N: Normal line-of-sight, 15° to 30° below the horizontal

Figure 3 — Field of vision when line-of-sight direction is not imposed by external task requirements

When the direction of the eye changes as a result of the work activity, or when the fields of vision of several people are non-overlapping, additional signal lights shall be installed. The signalling devices shall be positioned so that at least one danger signal is visible from any point within the signal reception area.

4.3 Discriminability

4.3.1 General

When a visual danger signal has been detected, it is of vital importance that the correct measures are taken; therefore the signal information needs to be transmitted unambiguously.

Discrimination between visual danger signals shall be accomplished using at least two of the following characteristics.

4.3.2 Colour of signal light

A visual warning signal shall be yellow or yellow-orange.

A visual emergency signal shall be red.

If visual warning and visual emergency signals are both used in a working area, and if despite the difference in colour the signals cannot be clearly discriminated, the emergency signal shall have at least twice the intensity of that of the warning signal.

Colours of signal lights and their meanings shall be in accordance with ISO 3864, IEC 73 and IEC 1310-1.

NOTE — For the choice of colours in a system of auditory and visual danger and information signals, see ISO 11429.

4.3.3 Location

Whenever possible, the visual danger signal should be placed so as to facilitate immediate and correct understanding of the nature of the danger and of the immediate measure to be taken.

4.3.4 Relative position of lights

If two or more signal lights are used in a signalling device, the red signal shall always be positioned above the yellow one. If two red lights are used, they shall be horizontally aligned.

4.3.5 Temporal pattern

Flashing lights shall be used for visual emergency signals. It is preferable to use more than one light in the same signalling device, to allow both a spatial and a temporal pattern of flashing.

4.4 Glare

The detection and discrimination of a visual danger signal as specified in 4.2 and 4.3 shall not be impaired by glare caused by other light sources, e.g. sunlight, in the signal reception area. A visual danger signal shall not be an unnecessary source of glare itself.

4.5 Distance

The distance between light source and observer should be kept as small as practicable in order to increase the pupillary illuminance or reduce the necessary light output.

NOTE — The distance between a light source and the observer's eye determines the amount of light reaching the eye, since the illuminance is inversely proportional to the square of this distance.

If there is fog, rain, snow, smoke, steam or dust between the light source and the observer, the luminous flux of the signal is additionally reduced by the lowered transmissivity of the medium. In some cases the transmissivity can be so low as to make light signals practically ineffective. In these situations auditory danger signals should be relied upon more heavily.

4.6 Duration

After the dangerous condition has been perceived and corrective action has been taken, the signal should be changed to a less urgent level. If the remaining hazard is negligible or controllable, the warning light should be switched off.

NOTE — When a visual danger signal is no longer required, an ALL CLEAR signal in accordance with ISO 11429 should be used.

5 Physical measurements

Measurements of illuminance and/or luminance (see 4.2.1) should be made as confirmations that the visual danger signals meet the requirements and recommendations of this International Standard. However, physical evidence shall not serve as exclusive confirmation of effective visual danger signal performance.

6 Subjective visual check

Considering the enormous complexity of the visual environment in many places and also considering the widely differing personalities and abilities of the possible observers, a system of visual danger signals should be checked with a representative sample of people.

In order to be representative, the group shall include also persons:

— more than 45 years old;

— with visual acuity less than 0,8;

— with colour vision defects (red-green colour blind);

— wearing eye protection (goggles), if appropriate.

To perform a subjective visual check, small groups of persons (five or less) are observed while the visual danger signal is presented without any previous notice. If the observed people react with spontaneous gestures or comments, the check can be terminated. If some persons do not display any overt reactions, they are asked immediately after the observation period about their visual perceptions during the last several minutes. Depending on the answers received, the outcome of the visual check can be taken as an indication of the effectiveness of the visual danger signal(s).

The subjective visual check should be repeated a number of times at various locations, with various persons and different lighting conditions, until a representative set of observations has been obtained.

The system of visual danger signals is considered adequate if all persons observed exhibited a reaction.

Annex A
(informative)

Bibliography

[1] ISO 8995:1989, *Principles of visual ergonomics — The lighting of indoor work systems.*

[2] ISO 11429:1996, *Ergonomics — System of auditory and visual danger and information signals.*

[3] IEC 50 (845):1987, *International electrotechnical vocabulary — Chapter 845: Lighting* (identical with CIE 17.4 *International lighting vocabulary,* 4th ed., 1987).

[4] EN 292-2:1991/A1:1995, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications* (equivalent to ISO 12100-2).

[5] prEN 894-2:1992, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays.*