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**Ergonomics — System of auditory and
visual danger and information signals**

*Ergonomie — Système de signaux auditifs et visuels de danger et
d'information*



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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 11429 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

The technical content of ISO 11429 and European Standard EN 981, *Safety of machinery — System of auditory and visual danger and information signals*, 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 981 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.

Annex A of this International Standard is for information only.

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Ergonomics — System of auditory and visual danger and information signals

1 Scope

To reduce risks associated with misinterpretation of visual and auditory danger signals, this International Standard specifies a system of danger and information signals taking into account the different degrees of urgency.

This International Standard is applicable to all danger and information signals which have to be clearly perceived and differentiated as specified in ISO/TR 12100-2:1992, 5.3, by other requirements or by the work situation, and to all degrees of urgency — from extreme urgency to an ALL CLEAR situation. Where visual signals are to be complementary to sound signals, the signal character is specified for both.

This International Standard does not apply to certain fields covered by specific standards or other conventions in force (international or national); in particular, fire alarms, medical alarms, alarms used in the field of public transport, navigation signals and signals for special fields of activity (for example, military). When new signals are being planned, however, this International Standard should be considered in order to avoid inconsistency.

For auditory signals, the system of signal character is a guideline for a signal language based on message categories which are classified according to urgency. Certain characters are specified for purposes which require safe and rapid recognition. Certain categories allow possibilities for variants, e.g. control and warning signals at workplaces where the signalling is intended for personnel with specific training.

For visual signals, the established meanings of the safety colours are not affected by this International Standard. For different needs, complementary meanings have been assigned to the signals by timed patterns, and in a very few cases by alternating colours.

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 7731:1986, *Danger signals for work places — Auditory danger signals*.

ISO 8201:1987, *Acoustics — Audible emergency evacuation signal*.

ISO 8995:1989, *Principles of visual ergonomics — The lighting of indoor danger signals*.

ISO 9921-1:1996, *Ergonomic assessment of speech communication — Part 1: Speech interference level and communication distances for persons with normal hearing capacity in direct communication (SIL method)*.

ISO 11428:1996, *Ergonomics — Visual danger signals — General requirements, design and testing*.

ISO/TR 12100-2:1982, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*.

3 Definitions

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

3.1 alternating sound [light]: Shifts between two or three acoustical [optical] spectra, with equal duration of the segments, at least 0,15 s each.

3.2 bursts of sound: Normally recurrent group of sound pulses with short but distinct interruptions, the pulse period, including interruption, being between 0,25 s and 0,125 s.

3.3 character of a signal: Combination of one or more auditory or visual components differentiating one signal from another.

3.4 flash: Light of duration less than 0,5 s.

3.5 quick-pulse: Sound of duration less than 0,5 s.

3.6 segment: One of a number of parts in a sound or light signal during which the signal character is constant.

3.7 spectrum of sound [light]: Intensity or sound pressure level of sound [light] represented as function of frequency or wavelength.

3.8 sweeping (sound): Continuously or discretely varying frequency.

4 Ergonomic principles for the design and application of auditory and visual signals

4.1 General

4.1.1 Auditory and visual signals shall be rapidly recognizable under all environmental conditions anticipated for their use. The recognition of a signal depends on many physical and psychophysical characteristics.

To ensure that signal effectiveness is not compromised by lack of reliability of signals, false alarm should be minimized or eliminated.

Signals shall be effective under all conditions of use, including conditions of environmental disturbance of the recognition process and in situations involving the highest degree of importance and urgency for action. Signal intensity shall be in accordance with ISO 11428 and ISO 7731.

4.1.2 The risk of panic caused by signalling is to be considered, but should not be overestimated. In principle two steps of panic reaction can be apparent:

The first sound impulse or flash of light can generate unintended fright. To avoid this shock-effect, the initial intensity of the sound should not be too high but should increase during the duration of the signal.

The sudden question: "What is happening?" can generate feelings of uncertainty and panic. Therefore, regular information is most essential.

4.2 Principles for distinctive characters

The primary requirement for a signal is some kind of typical pattern, which makes the signal message unambiguous and ensures recognition under different difficult environmental conditions. The necessary variations can be produced in several ways, but are basically achieved by variation in intensity or in spectrum of light or sound.

Although there is an analogy between the spectrum of light and sound, there are limitations to how this analogy can be used to make auditory and visual signals similar. For example, it is not wise to try to use sweeping colour like the sweeping pitch of sounds. For light, five colours are used which each carry a certain meaning, while for sound five analogous constant pitches are not used because pitch is a major tool which makes the signal audible with respect to the acoustical environment. In practice, any physical similarity between sound and light signals shall be based on temporal variation (i.e. variation in intensity over time) like characters from, for example, Morse Code.

Most people have the ability to remember and identify only very few different time patterns of signals. Echoes and acoustical delay can change the perceived character of a signal, especially when separate sound sources are used.

4.3 Qualities of auditory signals

The design of auditory signals shall be in accordance with ISO 7731. The use of speech signals shall be in accordance with ISO 9921-1.

A priority classification, of auditory signal character according to importance or urgency has been applied (see table 1). Signals with frequency variation — sweeping or alternating — are reserved for the most dangerous situations. Signals with constant frequency segments can be short grouped pulses (bursts), or sequences of equal or unequal segments. More than two different lengths of sound in each sequence shall not be used. The ratio of lengths should not be less than 1:3. Higher pitch is associated with greater urgency, but particular frequency distributions are not specified.

Variants in character (maintaining specified features) are available for numerous specific purposes within the two message categories DANGER and CAUTION. By applying the main scheme (see table 1) which specifies significant but not detailed character, a number of variants will be available.

4.4 Qualities of visual signals

The design of visual signals shall be in accordance with ISO 8995 and ISO 11428.

Certain special light sources for extremely short but high intensity flashes play an important role for warning, but the requirements of ISO 11428:1996, 4.2.2 shall be met.

NOTE — Very short light flashes have to be more intense in order to appear as bright as those of longer duration. This effect applies also to sound pulses lasting less than approximately 0,2 s. However, short light flashes and sound pulses are often preferred for technical reasons.

5 Systems of auditory and visual signals

5.1 Scheme of purpose and character

The principal requirements for systems of signals are summarized in tables 1 and 2. More detailed design parameters and remarks are listed in table 3 for sound coding and in table 4 for colour coding.

According to the degree of urgency, the message category as well as the appropriate signal character shall be chosen from table 1.

In case of emergency evacuation and public alarm, table 2 shall be applied.

5.2 Scheme of auditory signal character

Additional characters of auditory signals are given in table 3.

5.3 Scheme of visual signal colours

Additional characters for visual signals are given in table 4.

6 Testing

Regular routine tests according to ISO 11428:1996, clause 6 and ISO 7731:1986, clause 6 shall be carried out, including testing for detection of characters and understanding of their meaning.

Table 1 — Character of signals for general purpose, listed according to degree of urgency

Message category	Auditory signal		Visual signal colour
	Character available for ON phase	Temporal pattern	
DANGER Urgent action for rescue or protection	<ul style="list-style-type: none"> – Sweeping – Bursts – Alternating pitch (two or three frequency steps) <p>NOTE: Urgency can be implied by rapid rhythm, dissonance or high pitch</p>	<ul style="list-style-type: none"> – Continuous or alternating ON/OFF – Alternating ON/OFF – Continuous alternating ON/OFF <p>Any DANGER signal shall have a temporal pattern clearly differentiated from EMERGENCY EVACUATION (see table 2)</p>	RED
CAUTION Act when necessary	Only one sound with constant spectrum, minimum duration 0,3 s	<p>Alternating ON/OFF</p> <p>Clearly distinct from EMERGENCY EVACUATION</p> <p>At most two different lengths of ON segments in pattern, the first one long</p>	YELLOW
COMMAND Need for mandatory action	Two or three different sounds, each with constant spectrum	Continuous or alternating ON/OFF	BLUE (see IEC 73:1991)
ANNOUNCEMENT/ INFORMATION Public instruction	Two-tone chime	High-low non-recurrent (followed by instruction)	No light signal, normally. If needed: Yellow non-recurrent double flashes
ALL CLEAR Danger past	Sound with constant spectrum	<p>Continuous, at least 30 s</p> <p>Signal following a preceding warning signal</p>	GREEN
Note — Synchronism between sound and light is not generally required, but can improve perception.			

Table 2 — Character of signals for emergency evacuation and public alarm

Message category	Auditory signal		Visual signal	Remarks
	Character available for ON phase	Temporal pattern		
EMERGENCY EVACUATION ¹⁾ Leave the area immediately	Each sound segment 0,5 s. Can be constant, sweeping or split (see ISO 8201)	Three short segments in groups, repeated with 4 s cycle (see ISO 8201)	Red flashes synchronized with each triplet sound	Light signalling not standardized in ISO 8201
PUBLIC ALARM Important action required for personal safety	<ul style="list-style-type: none"> – Sweeping – Constant spectrum 	<ul style="list-style-type: none"> – Continuous – Alternating ON/OFF, period 4 s to 20 s 	Red intermittent light	<ul style="list-style-type: none"> – Standing instructions for indoor or shelter protection (gas), – Radio message follows

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

1) For existing equipment a continuous signal can be used for EMERGENCY EVACUATION. Such a continuous signal can consist of different characters and temporal patterns which are repeated very often.

Table 3 — Scheme for character of auditory signals

Sound	Light	Meaning	Remarks
SWEEPING Sliding increase or decrease in frequency at a rate of 5 Hz/s to 5 Hz/ms (variation permitted during cycle)	RED	Danger, act urgently	Highest sweeping rate principally for high tone frequencies, and vice versa. Lowest rate not to be used for sound segments shorter than 5 s, and not for tone frequencies above 400 Hz
BURSTS, quick-pulses When grouped, at least five pulses in each group. Pulse frequency 4 Hz to 8 Hz (pulse length 60 ms to 100 ms)	RED	Danger, act urgently	Reverberation can cause perceptual difficulty at pulse frequencies above 5 Hz. See ISO 7731
ALTERNATING Stepwise sequence of two or three distinct pitches, each segment 0,15 s to 1,5 s	RED	Danger, act urgently	Intensity as well as duration of the ON phase of sound segments equal
SHORT sound Constant spectrum, minimum duration 0,3 s	YELLOW	Caution, be alert	When different sound segment lengths are used, a ratio of 1:3 is recommended
SEQUENCE Two or three different sounds, each with constant spectrum	BLUE	Command, mandatory action	
PROLONGED sound Constant spectrum	GREEN	Normal condition All clear	Signal given after PUBLIC ALARM shall not be interrupted within 30 s