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Ergonomic requirements for office work with visual display terminals (VDTs) —

Part 620: The role of sound for users of interactive systems

~~WD~~FDIS stage

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Foreword

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This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

A list of all parts in the ISO 9241 series can be found on the ISO website.

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

In physics, sound is a vibration that propagates as an acoustic wave, through a transmission medium such as a gas, liquid or solid. In human physiology and psychology, sound is the reception of such waves and their perception by the brain. Unwanted sound is referred to as noise and is often perceived as the most serious disturbance factor at office workstations. In many industrial environments, sound can be a serious threat to health in general, not limited to auditory effects alone.

While sound is a measurable physical reality, acoustic noise is a psychoacoustical concept. The main goal of this document is minimizing the impact of noise while operating interactive systems, ~~e.g.~~for example on the behaviour of users, their well-being and/or performance. This can be accomplished by technical measures, organizational means, interventions at the personal level and any combinations thereof. ~~The overall concept T-O-P (**T**echnical – **O**rganizational – **P**ersonal) indicates the reasonable order in which efficient measures can be taken.~~

The overall concept T-O-P (technical – organizational – personal) indicates the reasonable order of measures that can be taken to control the impact of the acoustic environment on human work. In this context, technical solutions have priority over organizational measures and personal protective equipment (PPE).

Psychoacoustics is the branch of psychophysics involving the scientific study of sound perception and audiology – how humans perceive various sounds. More specifically, it is the branch of science studying the psychological responses associated with sound (including noise, speech~~,~~ and music). This document deals with the undesired effects of sound~~. Undesired effects of sound~~, which can be classified as follows:

— ~~Impaired~~impaired hearing;

— ~~Undesired~~undesired responses of the central and autonomic nervous system;

— ~~Hindrance~~hindrance of verbal and other communication;

— ~~Reduced~~reduced performance and cognitive functioning;

~~— Annoyance~~

— ~~Acoustical~~annoyance.

Acoustic satisfaction of a space cannot be guaranteed without consideration of each of the three principle parameters of architectural ~~acoustical~~acoustic design, formalized and established in the early 1900s by Sabine.[28]~~Sabin (Reference [15]).~~ The three principle parameters are known as the 'ABCs' of architectural acoustics: ~~—~~A for ~~Absorption~~absorption – Sufficient absorption in the built environment~~.—~~; B for ~~Blocking~~blocking – Sufficient isolation of the built environment~~.—~~; and C for ~~Control~~control – Control of sound levels in the built environment. For a given space, various measures in combinations can be taken to control the acoustic environment to achieve satisfaction. In ISO 9241-6~~:1999~~ such measures ~~were~~are briefly listed and partly explained. ~~The experience since than is~~Experience now suggests that a more thorough consideration of the acoustic environment is required because of the changes ~~in the~~to work organization and ~~the~~ tasks.

Controlling the acoustic environment is considered part of the T-O-P concept. It can comprise ~~e.g.~~ for example:

— reducing the rating level

  — insulation in structural components;

  — reducing noise emission from equipment;

  — increasing sound absorption;

- reducing the ambient noise level;

- optimizing the signal-to-noise ratio
  - reducing the sound level in speech frequencies;

- sound reduction within use environments
  - sound-absorbing ceilings;
  - partitions;
  - adequate distances between workstations;
  - reducing reverberation.

While all these measures are of a technical nature (T of the T-O-P principle, Figure 1),), the impact of sound events on persons and work can require ~~organisational~~organizational measures ~~like~~, such as holding small meetings ~~outside the workspace~~ dedicated to certain tasks. outside the workspace. The ~~ultimo ratio, the measure of last resort,~~final argument comprises measures ~~in~~at a personal level, including training to cope with adverse environments.

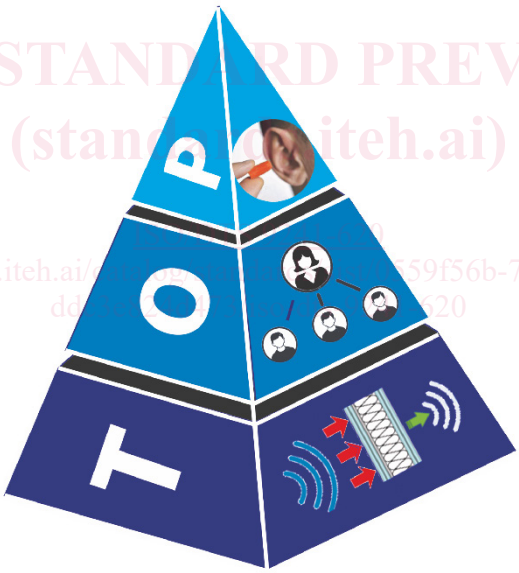

Figure 1 — T-O-P principle for controlling the impact of the acoustic environment on human work

The acronym T-O-P (Technical – Organisational – Personal) stands for the reasonable order of measures that can be taken to control the impact of the acoustic environment on human work. In this context, technical solutions have priority over organisational measures and PPE (Personal Protective Equipment).

Ergonomic requirements for office work with visual display terminals (VDTs) —

Part 620: The role of sound for users of interactive systems

1 Scope

This ~~Technical Specification~~document provides users with a summary of the existing knowledge about ergonomics considerations for the influence of sound in use environments on humans. It describes how unwanted effects of sound (noise) can be controlled. The main goals for controlling the acoustic use environment are reducing the rating level of sound in general, optimizing signal-to-noise ratio and sound reduction within the workspace.

This document also provides users with organizational measures that can be taken if and when~~where~~ technical measures do not help sufficiently. Also included are measures ~~in~~on a personal level.

This document deals with sound events that can cause extra-aural effects. Noise-induced hearing loss prevention and the ways to eliminate or reduce hazardous noise exposure are not covered by this document.

The intended users of this document include:

— developers of systems, products and services;

— public and corporate purchasers;

— occupational health and safety professionals;

— architects and interior designers;

— human resource professionals;

— usability~~/~~, ergonomics~~/~~ or human factors professionals;

— users of interactive systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
~~ISE~~ irrelevant speech effect
ISE
negative effect of verbal sound level

3.2
rating level
L_{AR}
equivalent continuous A-weighted sound pressure level during a specified time interval plus adjustment for tonal character and impulsiveness

[SOURCE: ISO 9241-6:1999]

Note 1 to entry: ΔLT = 0 dB or 5 dB according to subjective assessments.

where

- Δ is difference;
- L is level;
- T is tonal.

Note 2 to entry: Impulsiveness is specified only if $\Delta LI = L_{AIeq} - L_{Aeq}$ > the difference of the measured sound level with and without impulses exceeds 2 dB according.

[SOURCE: ISO 9241-6:1999, 3.19, modified — Notes to ISO 11690-1.entry replaced.]

3.3
background noise level
$L_{p,B}$
A-weighted sound pressure level present at the workstation during working hours with people absent

Note 1 to entry: The A-weighted background noise level $L_{p,B}$ is expressed in dB.

3.4
total noise sound pressure level
L_{NA}
sound pressure level that contains all noise components affecting the listener during use, such as noise generated by building systems, operating equipment or the audience, and which is determined at ear height for the area in which people are normally located

Note 1 to entry: The A-weighted total noise sound pressure level L_{NA} is expressed in decibels.

Note 2 to entry: If not otherwise specified, noise is determined according to DIN 45641 as the A-weighted equivalent continuous sound pressure level averaged over the time that is representative for the disturbance.

3.5
impulsive sound
any sound with a rapid rise and decay of sound pressure level, lasting less than one second and causing an increase in the sound level of at least 6 dB(A)

3.6
reverberation time
T
time required for the sound pressure level in a room to decay by 60 dB once sound excitation has stopped

Note 1 to entry: The reverberation time is expressed in seconds.

3.7
speech transmission index
STI
metric ranging between 0 and 1 representing the transmission quality of speech with respect to intelligibility by a speech transmission channel

[SOURCE: IEC 60268-16:2020, 3.3]

Note 1 to entry: Speech transmission channel can also be the use environment.

3.8
sound pressure level
SPL
logarithmic measure of the effective pressure of a sound relative to a reference value

4 Sound and noise

4.1 How sound and noise impact users

Hearing (audition, auditory sense) is one of the five basic senses used by humans to perceive the physical environment. Even if its sensor, the ear, seems to function independently from those of the other senses, , alongside sight (vision, visual sense), hearing (audition, auditory sense), taste (gustation, gustatory sense), smell (olfaction, olfactory sense),) and touch (somatosensation, somatosensory sense), they). Even if its sensor, the ear, seems to function independently from those of the other senses, they all function in concert. Sight and hearing, or those sensory aptitudes that maycan collect information from a distance (relatively speaking), are called far senses. Hearing is the only sense that can detect objects or events beyond the (optical) horizon.

Evolution has programmed human beings to be aware of sounds as possible sources of danger. The hearing as the far sense notifies usgives notice of things wethat cannot seebe seen but that maycould be important. It plays an alerting function. Even if this function is not needed in most use environments, it cannot be switched off or ignored. While the sense of sight is relatively inactive during sleep, hearing remains "on". The alert function requires that hearing is almost non-directional compared towith sight. We canIt is possible to look away or even close the eyelids, watch certain objects while ignoring others, but there is no mechanism to ignore acousticalacoustic events.

The directionality of the human auditory system is limited to sound localization. The brain utilizes subtle differences in intensity, spectral, and timing cues to allow us to localize sound sources. to be localized. Thus, even if onesomeone tries to ignore a certain acousticalacoustic event there will be a response. And althoughAlthough people tend to habituateget used to noise exposure, the degree of habituation differs for individuals and is rarely complete.

Adverse effects of sound events can be of a different nature. The simplest effect is characterized as annoyance without further consideration of the genesis and aftermaths. Other effects maycan be of a physiological and/or psychological nature (see Table 1.).

— A classificationTable 1 — Classification of the annoyance by noise in the order of their importance for thefactors that affect individual annoyance towith noise[15 (Reference [2])]

Factors that affect Individual Annoyance to Noiseaffect individual annoyance with noise	
Primary acoustic factors	Sound level
	Frequency
	Duration
Secondary acoustic factors	Spectral complexity
	Fluctuations in sound level