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

Part 6:
Guidance on the work environment

Exigences ergonomiques pour travail de bureau avec terminaux à écrans de visualisation (TEV) —

Partie 6: Guide général relatif à l'environnement de travail

Reference number
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Contents

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 9241-6 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Sub-Committee SC 4, *Ergonomics of human-system interaction*, Working Group WG 3, *Control, workplace and environmental requirements*.

ISO 9241 consists of the following parts, under the general title *Ergonomic requirements for office work with visual display terminals (VDTs)*:

— *Part 1: General introduction*

— *Part 2: Guidance on task requirements*

— *Part 3: Visual display requirements*

— *Part 4: Keyboard requirements*

— *Part 5: Workstation layout and postural requirements*

— *Part 6: Guidance on the work environment*

— *Part 7: Requirements for display with reflections*

— *Part 8: Requirements for displayed colours*

— *Part 9: Requirements for non-keyboard input devices*

— *Part 10: Dialogue principles*

— *Part 11: Guidance on usability*

— *Part 12: Presentation of information*

— *Part 13: User guidance*

— *Part 14: Menu dialogues*

— *Part 15: Command dialogues*

— *Part 16: Direct manipulation dialogues*

— *Part 17: Form filling dialogues*

Annexes A to D of this part of ISO 9241 are for information only.

Introduction

This part of ISO 9241 applies to work systems as defined in ISO 6385 with visual display terminals (VDTs) as described in ISO 9241-1. Office work with VDTs can be performed in various environments. These environments can influence both the comfort and performance of the user. In addition, the work environment can be influenced by specific characteristics of the VDTs and related equipment (for example, printers, computers).

This part of ISO 9241 has been prepared to give guidance on the determination of environmental conditions which enhance user comfort and performance. Enhancing the interaction between users and environments often requires a well-balanced trade-off. For this reason, this part of ISO 9241 provides guiding principles as generic goals, basic aspects for each item (for example, lighting, noise) and gives guidance on developing integrated solutions under given circumstances (for example, methods of controlling the acoustic environment for a given task and a given environment).

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

Part 6:
Guidance on the work environment

1 Scope

This part of ISO 9241 provides guidance on basic principles for the ergonomic design of the work environment and the workstation, taking into account lighting, effects of noise and mechanical vibrations, electrical and magnetic fields and static electricity, thermal environment, space organization and workplace layout.

This part of ISO 9241 is applicable to the work environment and workstation in those work systems where a visual display terminal (VDT) is used for office work.

However, this part of ISO 9241 does not specify the technical characteristics of the equipment needed to satisfy those equipment-related guidelines associated with the work environment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9241. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9241 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1996-1, *Acoustics — Description and measurement of environmental noise — Part 1: Basic quantities and procedures.*

ISO 2631-1, *Evaluation of human exposure to whole-body vibration — Part 1: General requirements.*

ISO 2631-2, *Evaluation of human exposure to whole-body vibration — Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz).*

ISO 5349, *Mechanical vibration — Guidelines for the measurement and the assessment of human exposures to hand-transmitted vibration.*

ISO 6385, *Ergonomic principles in the design of work systems*.

ISO 7730:1994, *Moderate thermal environments — Determination of the PMV and PPD indices and specification of the conditions for thermal comfort*.

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

ISO 9241-3:1992, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 3: Visual display requirements*.

ISO 9241-7, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 7: Requirements for display with reflections*.

ISO 9612, *Acoustics — Guidelines for the measurement and assessment of exposure to noise in a working environment*.

ISO 11690-1:1996, *Acoustics — Recommended practice for the design of low-noise workplaces containing machinery — Part 1: Noise control strategies*.

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test*.

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 8, Power frequency magnetic field immunity test.*

3 Terms and definitions

For the purposes of this part of ISO 9241, the terms and definitions given in ISO 6385, ISO 1996-1, ISO 11690-1 and the following apply.

3.1
adaptation, visual
process by which the state of the visual system is modified by previous and present exposure to stimuli that may have various luminances, spectral distributions and angular subtenses

[IEC 60050(845):1987, IEC 845-02-07]

3.2
clothing insulation
resistance of a clothing ensemble to dry heat loss from the body (convection, radiation, conduction)

NOTE Adapted from ISO 9920:1995.

3.3
colour rendering
effect of an illuminant on the colour appearance of objects by conscious or subconscious comparison with the appearance under a reference illuminant

[IEC 60050(845):1987, IEC 845-02-59]

3.4
colour rendering index R_a
mean of the CIE 1974 special colour rendering indices for a specified set of eight test colour samples

[IEC 60050(845):1987, IEC 845-02-63]

3.5
colour temperature
the temperature of a Planckian radiator whose radiation has the same chromaticity as that of a given stimulus

[IEC 60050(845):1987, IEC 845-03-49]

3.6
draught rating
percentage of people predicted to be bothered with draught

[ISO 7730:1994]

3.7
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[IEC 60050(845):1987, IEC 845-02-49]

3.8
general lighting
substantially uniform lighting of an area without provision for special local requirements

[IEC 60050(845):1987, IEC 845-09-06]

NOTE General lighting can be thought of as the lighting of a room to achieve approximately the same visual conditions at all places in the room.

3.9
glare
condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or to extreme contrasts

[IEC 60050(845):1987, IEC 845-02-52]

3.10
glare by reflection
glare produced by reflections, particularly when reflected images appear in the same or nearly the same direction as the object viewed

[IEC 60050(845):1987, IEC 845-02-54]

3.11
illuminance
(at a point of a surface), the quotient of the luminous flux ($d\Phi_V$) incident on an element of the surface containing the point, by the area (dA) of that element

[IEC 60050(845):1987, IEC 845-01-38]

3.12
lighting, localized
lighting designed to illuminate an area with a higher illuminance at certain specified positions, for instance those at which work is carried out

[IEC 60050(845):1987, IEC 845-09-08]

3.13
luminance balance
ratio between the luminances of the displayed image and its adjacent surround, or sequentially viewed surfaces

NOTE Adapted from the definition of “luminance” given in IEC 60050(845):1987, IEC 845-01-35.

3.14
mean radiant temperature
uniform temperature of an imaginary enclosure in which radiant heat transfer from the human body is equal to the radiant heat transfer in the actual non-uniform enclosure

[ISO 7726:1998]

3.15
operative temperature
uniform temperature of a radiantly black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the natural non-uniform environment

NOTE Adapted from ISO 7726:1998.

3.16
predicted mean vote
PMV
index that predicts the mean value of the votes of a large group of persons on a 7-point thermal sensation scale

[ISO 7730:1994]

3.17
predicted percentage of dissatisfied
PPD
index that predicts the mean value of the thermal votes of a large group of people exposed to the same environment as a quantitative prediction of the number of thermally dissatisfied people

NOTE Adapted from ISO 7730:1994.

3.18
radiant temperature asymmetry
difference between the plane radiant temperature of the two opposite sides of a small plane element

[ISO 7726:1998]

3.19
rating level
LAR
equivalent continuous A-weighted sound pressure level during a specified time interval plus adjustment for tonal character and impulsiveness

NOTE Adjustment for tonal character DL_T = 0,5 dB according to subjective assessments. Impulsiveness is specified only if $DL_I = L_{IAeq} - L_{Aeq} > 2$ dB, both according to ISO 11690-1.

3.20
relative humidity
ratio between the partial pressure of water vapour in humid air and the water vapour saturation pressure at the same temperature and the same total pressure

[ISO 7726:1998]

3.21
reverberation
continuation of a sound in an enclosed space after the source has stopped; a result of reflections from the boundary surfaces of the room

3.22
turbulence intensity
ratio of the standard deviation of the local air velocity to the local mean air velocity

[ISO 7730:1994]

3.23
workplace
arrangement of workstations allocated to one person to complete a work task

[ISO 9241-5:1998]

3.24
workstation
assembly comprising display equipment with or without a central processing unit, which may be provided with a keyboard and/or input device and/or software determining the operator/machine-interface, optional accessories, peripherals and the immediate work environment

[ISO 9241-5:1998]

4 General guiding principles

Improving the ergonomic properties of the design of workstation, work equipment and work environment, will help to improve user performance, reduce errors and discomfort, and will help to improve their overall well-being.

Environmental design should incorporate adequate control by the individuals over their environmental conditions.

The interference of environmental factors with the relevant characteristics of the equipment should be kept as low as possible. The unwanted influence of the equipment on the work environment should also be minimized.

NOTE “Interference” in this sense means that the function of a given device is impaired by the influence of a specific environmental factor.

The characteristics of the work equipment and the work environment are considered under the following headings:

— natural and artificial lighting;

— sound and noise;

— mechanical vibrations;

— electromagnetic fields and static electricity;

— thermal environment;

— space organization and workplace layout.

NOTE This part of ISO 9241 does not address any potential health effects associated with electromagnetic radiation emissions from equipment and environment.

5 Guidance on natural and artificial lighting

5.1 General

Visual tasks associated with work with most visual displays differ primarily in three ways from the visual tasks related to traditional office work.

— The main visual object, the visual display unit, is in a vertically oriented position.

— The main visual object can be environment dependent (for example, because of reflections, loss of contrast and colour information caused by ambient light) to a high degree.

— The elevated line-of-sight increases the importance of the consideration of the characteristics of the visual environment.

5.2 Basic aspects

5.2.1 Visual tasks

In regard to the type of office work performed with a visual display terminal, a basic distinction should be made between two types of visual tasks:

a) assimilation of data presented on the display screen (for example, reading texts, viewing graphs, observing processes or perceiving and distinguishing symbols on the VDT screen);

b) assimilation of data presented on passive media (for example, reading texts or viewing graphs on paper or perceiving and distinguishing symbols on the VDT keyboard).

These different types of visual tasks, each considered on its own, indicate that the lighting should fulfil various user requirements. The lighting system should have sufficient flexibility to match the needs of users of display screens and passive media.

Correct lighting will not compensate for situations where a user's vision is not adequate or has not been adequately corrected for the task.

5.2.2 Basic design goals

A good lighting installation should be designed to fulfil its intended functions and should be compatible with the work environment. Relevant factors include the following:

— favourable distribution of the luminance and contrasts in the workroom;

— the illuminance in the horizontal and vertical planes;

— the ratio between the illuminance in the two planes.

In addition, it is important to consider that

— the lighting of many work environments is produced by a combination of natural and artificial light;

— windows perform a dual function that involves

  — visual contact with the outside, and

  — creating an adequate and acceptable level of luminance(s) on the inside;

— the quality criteria for artificial lighting are specified in the introduction of ISO 8995:1989 and include the following aims of visual ergonomics:

  — “to optimize the perception of visual information used during the course of work;

  — to maintain an appropriate level of performance;

  — to guarantee maximum safety;

  — to provide acceptable visual comfort.”

— the resulting quality can be affected by the presence of uncontrolled daylight.

In many situations, the installation of workstations and work equipment can be varied, based on the needs of work organization or users. Well designed lighting systems take into account frequent changes in workstation layout, equipment and work space layout.

5.3 Luminance distribution in the work space

The luminance distribution in the field of vision should be selected so that

— visual conditions are enhanced,

— glare is avoided,

— perception of relevant task objects is ensured,

— modelling of three-dimensional objects, for example faces, is enhanced,

— a well-balanced luminance distribution is achieved,

— visual communication is improved, and

— safety at work is not impaired.

For acceptable visual conditions, as well as for psycho-physical reasons, a balanced luminance distribution in the field of vision is beneficial.

Further information on lighting is given in annex A, together with a guide to selecting the type of lighting (see A.8).

5.4 Glare control

Glare should be avoided by suitable design and installation of the work equipment and the work environment.

In this connection, a distinction is made between

— direct glare,

— glare by reflection.

Direct glare refers to glare (see ISO 8995) from luminaires and other light-emitting surfaces (lamps, illuminated ceilings, sky, obstructions like adjacent buildings with reflecting glass surfaces). Glare can be caused by excessive, simultaneous local or successive differences in luminance in the field of vision. It relates both to large space-confining surfaces and to objects in the immediate and wider surroundings. The degree of impairment depends on the apparent size, luminance and position of the source of interference in the field of vision and on the state of adaptation of the viewer.

Glare by reflection is glare caused by reflected light (see ISO 8995). It can be caused by specular reflections resulting in a distinct image of the original object or by diffuse reflections resulting in high luminances. Glare by reflection can affect both task performance and comfort. Task performance can be affected if the reflected image of a visual object obscures the task on the display or on other visual objects. In addition, the contrast ratio of images can be lowered to an extent that readability or visibility is impaired. Comfort can be affected directly by luminance imbalance caused by the reflected image or indirectly by impairing visual functions.

To avoid glare by reflection, displays with a reflection-control treatment appropriate for the task and environment intended should be used (see ISO 9241-7). ISO 9241-7 specifies three classes of VDTs. Class I is considered suitable for general office use whereas Class II is suitable for most, but not all, office environments. Class III monitors require a specially controlled luminous environment for use. To achieve acceptable visual conditions, either the visual environment should be controlled according to the category of the display used or the appropriate category for the display should be selected considering the visual environment.

Methods for the restriction of glare are discussed in A.3. As a result of different characteristics of the work equipment or work environment, the appropriate method for a particular workstation can be different.

The selected methods for glare control should ensure that a comfortable posture can be maintained. This means that the glare control method should not impose any postural restrictions on the user. With respect to windows, adequate measures should be taken to control glare from windows. Such measures should be selected to allow user control and to maintain visual contact with the outside.

For avoiding or restricting glare by reflection on a VDT, different methods can be applied. The adequate combination should be selected with respect to the needs of the particular user and circumstances at the particular workstation (see annex A). These methods can be used in isolation or in combination with each other.

When applying the methods for avoiding glare by reflection, it should be remembered that an appropriate match between the VDT and the environment is not the product of a single factor, and that the methods given in Figure A.2 represent different approaches. Different types of display (for example, cathode ray tubes (CRTs) with curved surfaces or flat panel displays) may require different measures to achieve the same level of visual comfort. In general, positive polarity displays with adequate additional reflection control measures should be used as a preferred solution.

Glare control by artificial lighting (luminaire design, correct positioning of luminaires) should be taken into account when planning the work space. Shielding the glare source from the display position by movable partitions or similar techniques is a measure that should be applied if other lighting-related measures are not applicable in a given situation.

Glare control by correct location of the display and/or the workstation can be realized by applying one or more of the possibilities described in A.3.