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Ergonomics of human-system interaction —

Part 306: Field assessment methods for electronic visual displays

Ergonomie de l'interaction homme-système —

Partie 306: Méthodes d'appréciation sur le terrain des écrans de visualisation électroniques

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Contents

Page

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 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9241-306 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

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 4: Keyboard requirements*

— *Part 5: Workstation layout and postural requirements*

— *Part 6: Guidance on the work environment*

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

— *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*

ISO 9241 also consists of the following parts, under the general title *Ergonomics of human-system interaction*:

— *Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services*

— *Part 110: Dialogue principles*

— *Part 151: Guidance on World Wide Web user interfaces*

— *Part 171: Guidance on software accessibility*

— *Part 300: Introduction to electronic visual display requirements*

— *Part 302: Terminology for electronic visual displays*

— *Part 303: Requirements for electronic visual displays*

— *Part 304: User performance test methods for electronic visual displays*

— *Part 305: Optical laboratory test methods for electronic visual displays*

— *Part 306: Field assessment methods for electronic visual displays*

— *Part 307: Analysis and compliance test methods for electronic visual displays*

— *Part 308: Surface-conduction electron-emitter displays (SED)* [Technical Report]

— *Part 309: Organic light-emitting diode (OLED) displays* [Technical Report]

— *Part 400: Principles and requirements for physical input devices*

— *Part 410: Design criteria for physical input devices*

— *Part 920: Guidance on tactile and haptic interactions*

For the other parts under preparation, see Annex A.

Introduction

This part of ISO 9241 is one of a group of standards in the ISO 9241 series that establish requirements for the ergonomic design of electronic visual displays. At the same time, this “300” subseries replaces either partially or fully certain previously published parts of ISO 9241 as well as several other International Standards (see the Forewords of the respective parts for the details).

— An introduction to the subseries is given by ISO 9241-300.

— Terms and definitions related to electronic visual displays have been transferred to, and collected in, ISO 9241-302.

— While the areas previously covered in ISO 9241 and by ISO 13406 remain essentially unchanged, test methods and requirements have been updated to account for advances in science and technology.

— All generic ergonomic requirements have been incorporated into ISO 9241-303.

— The application of those requirements to different display technologies, application areas and environmental conditions — including test methods and pass/fail criteria — are specified in ISO 9241-307.

— Methods for performing formal display measurements to determine display characteristics and verify technical specifications (tests that can be very costly and time-consuming and that are normally performed under rigorous test conditions with a new device) are given in ISO 9241-305 and ISO 9241-307.

— In addition, guidance on the design of SED (surface-conduction electron-emitter displays) and OLED (organic light-emitting diode) displays is given in ISO/TR 9241-308 and ISO/TR 9241-309.

The overall modular structure of the subseries will facilitate its revision and amendment, as ongoing technological development enables new forms of display interaction.

This part of ISO 9241 is concerned with ergonomic workplace assessment and is aimed at providing a means of assessing whether or not the visual ergonomic requirements specified in ISO 9241-303 are satisfied within a specified task setting. The intention is not necessarily to produce a perfect display with optimum visual characteristics, but rather to ensure that the needed qualities to perform the visual task satisfactorily are indeed present.

During the lifetime of a display, the context in which it is used can often vary; “ageing” normally takes place as the display is used and, as a result, the performance of the display may be reduced over time. The lighting conditions under which a display is used often also vary.

In actual VDT workstation use, the main ergonomic concerns are the visual task being performed and the input devices being used to accomplish the task.

There are several factors that make the performance of a visual task using a VDT different from that in many other non-VDT or paper tasks. These factors are related to the positioning of the various elements needed for performing the visual task.

The ergonomic goal is to be able to read the information on the display comfortably, easily, accurately and quickly (where necessary) — as when a paper “hardcopy” placed on the work desk is read.

One consideration is what might be called the *positional sensitivity* of the screen. If positioned poorly, displays are susceptible to external light sources: these can be reflected back to the viewer and can contribute to reduced legibility of the information on the screen. In more compelling environments, these light sources can give rise to glare. They can come from either natural light from windows or from artificial lighting systems such as overhead mounted luminaries in offices.

Given the size and dimensions of most displays, a display is typically oriented in a vertical rather than horizontal position. This orientation and position of the information to be read is considerably different than that when a book or paper placed on the desk is read. The line of sight from the eye to the visual task is raised up to 45°, giving rise to a quite different visual background, often with a varying luminous background arising from walls and other objects in the environment. These factors can affect the working posture of a user trying to compensate between the line of sight angle to the display needed to be maintained and the distance to the visual task.

These and other considerations demonstrate that the positioning of a display is much more important than the mere positioning of paper or other hardcopy reading materials. They gives rise to the need to be able to adjust the display for orientation and height and to have the flexibility to set up the workstation equipment so that the needs of a specific user can be realized. The combination of display, lighting environment and workstation equipment are the basics for an ergonomically well-designed workplace.

Unlike most visual task materials, displays are intended to be used for several years. Many other kinds of work materials are used only once or a few times, or are renewed or refreshed when visibility is too low or possibly too uncertain (e.g. safety instructions or warnings), or else simply remain unchanged over time.

The display assessment methods presented in this part of ISO 9241 do not, in most cases, require expensive measuring equipment and will in general be able to be carried out easily in a working field environment. In conducting these assessments, it ought to be possible to determine whether a problem is related to

a) the display itself (or the display in combination with the graphic adapter),

b) the application software, or

c) physical environmental conditions.

In cases involving a), the display, it is beneficial that the workstation set-up be reviewed to determine whether it meets the supplier's recommendations; if it does not, another assessment will need to be performed to determine how it can be made to meet them. In cases involving b), the application software, it might be necessary to contact the software developers of the application product in order to ascertain possible corrective action. In cases involving c), conditions in the physical environment, simple re-orientations or the repositioning of the workstation and/or display can be a satisfactory solution; whereas, in more complex situations, arrangements might need to be made with the relevant interested parties in order to ascertain appropriate actions and their feasibility. For details, see Annex B.

ISO 9241 was originally developed as a 17-part International Standard on the ergonomics requirements for office work with visual display terminals. As part of the standards review process, a major restructuring of ISO 9241 was agreed to broaden its scope, to incorporate other relevant standards and to make it more usable. The general title of the revised ISO 9241, *Ergonomics of human-system interaction*, reflects these changes and aligns the standard with the overall title and scope of Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*. The revised multipart standard is structured as a series of standards numbered in the "hundreds": the 100 series deals with software interfaces, the 200 series with human centred design, the 300 series with visual displays, the 400 series with physical input devices and so on.

See Annex A for an overview of the entire ISO 9241 series.

Ergonomics of human-system interaction —

Part 306:
Field assessment methods for electronic visual displays

1 Scope

This part of ISO 9241 establishes optical, geometrical and visual inspection methods for the assessment of a display in various contexts of use according to ISO 9241-303.

2 Normative references

The following referenced documents are indispensable for the application 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 9241-302, *Ergonomics of human-system interaction — Part 302: Terminology for electronic visual displays*

ISO 9241-303:2008, *Ergonomics of human-system interaction — Part 303: Requirements for electronic visual displays*

ISO 9241-305, *Ergonomics of human-system interaction — Part 305: Optical laboratory test methods for electronic visual displays*

ISO 9241-307, *Ergonomics of human-system interaction — Part 307: Analysis and compliance test methods for electronic visual displays*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9241-302 apply.

4 Preparation for assessment

4.1 Cathode ray tube (CRT) displays

4.1.1 Display warm-up

Allow sufficient time (at least 20 min) for the display luminance to stabilize.

4.1.2 Degaussing

If a monitor has a built-in degaussing device, activate it.

4.1.3 Cleaning

Ensure that the front glass of the display is clean; otherwise, clean it according to the manufacturer's instructions.

4.1.4 Contrast and brightness control settings

Adapt display contrast and brightness using contrast and brightness screen controllers according to the environmental lighting conditions, as follows:

— use a pattern that contains areas of different grey scale values from white to black;

— set both contrast and brightness to maximum (100 %);

— in a dark environment, reduce brightness until the darkest pattern area is displayed completely black — the difference between the darkest and the next lighter area should be distinguishable;

— set the contrast so that the brightness of the white area is at the maximum while the difference between the white and the next darker area is distinguishable;

— in a non-dark environment, set the brightness to a value where all grey levels are distinguishable.

4.1.5 Image size

Use factory or default setting if available. Otherwise, adjust to a specified size.

4.2 Liquid crystal displays (LCD)

The flat panel display shall be physically prepared for assessment.

4.2.1 Display warm-up

Allow sufficient time (at least 20 min) for the display luminance to stabilize. When indicated by the manufacturer, it shall be warmed up for the specified time.

4.2.2 Cleaning

Ensure that the display is clean; otherwise, clean it according to the manufacturer's instructions.

4.2.3 Contrast and brightness control settings

Adapt display brightness and contrast (if controllers are available) according to the environmental lighting conditions, as follows:

— use a pattern that contains areas of different grey scale values from white to black;

— set both contrast and brightness to maximum (100 %);

— set contrast to a value where all grey levels are distinguishable;

— display the content of a typical application and set brightness to a level appropriate to the lighting conditions.

4.2.4 Resolution

Use the factory-recommended (*physical*) resolution. Changing this native resolution to another can cause a degradation of the display image quality and character presentation, due to imperfect pixel interpolation (see Figure 1).

physical reduced

Figure 1 — Comparison of letters displayed with physical and reduced resolutions

5 Assessment methods

5.1 Viewing conditions

5.1.1 Design viewing distance

The optimum distance between the visual display and the user's eyes depends on various factors, and in particular character legibility (see Table 1) and the possibility of viewing a full application without head movement (see Table 2). The design viewing distance, i.e. the distance specified by the manufacturer of the display is set to $\geqslant$ 300 mm (see ISO 9241-303). The optimum viewing distance for office work in a seated position is 600 mm. However, individual users tend to prefer settings between 400 mm and 750 mm. Viewing distances in this range for most people require character heights that subtend between 20′ to 22′ of arc (see ISO 9241-303).

Check whether the display is used within the specified viewing distance, D. Measure the distance from the user's eyes to the centre of the screen with a ruler. For office work, the normal range is 400 mm to 750 mm: if the chosen distance is outside of this range, verify that there is not an underlying problem, such as bad image quality, incorrect font size or an uncorrected vision problem.

If the visual task requires that the entire application, i.e. its page or line width, is viewed at a glance, i.e. without head movements, the *minimum* viewing distances from Table 2 are recommended. They result from the maximum horizontal viewing angle of ± 15° with respect to the normal on the screen surface, which allows such viewing at a glance and depends on screen size. Figure 2 shows the relation between viewing angle, application width and viewing distance.

Table 1 — Maximum and optimum viewing distances for character legibility

Character height mm	**Maximum viewing distance for some users** cm	**Viewing distance of generally accepted legibility** cm
1,2	41	20
2	69	33
3	103	49
4	138	65
4,6	158	75

NOTE 1 The maximum viewing distance is based on character height of 10′ of arc and is usable only by a small number of users. Generally accepted legibility, i.e. one that is well accepted by most users, is calculated based on 21′ of arc. The optimum character height for task performance is a compromise between the legibility goal and the goal of "surveying at a glance" — presenting all information related to the same context on the same screen.

NOTE 2 The simplified rule of thumb for character legibility is: for optimum legibility, viewing distance ≈ 165 × character height:

— acceptable range ≈ ± 30 % for most users;

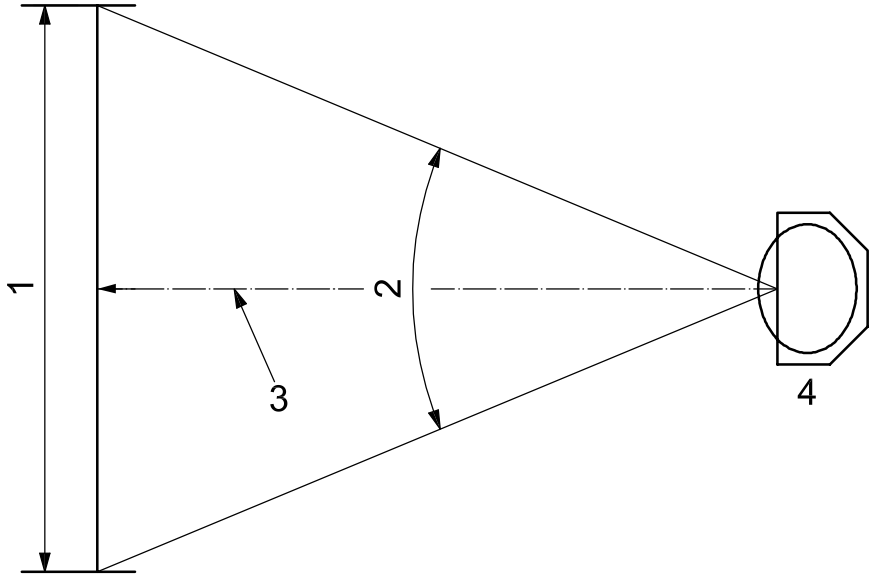
— acceptable range ≈ ± 100 % for some users.

Table 2 — The smallest viewing distance at which the full application width can be used without need for head movement

Width of the application (or page or line) mm	**Minimum viewing distance in order to avoid head movement** cm
215	40
250	47
300	56
350	65
400	75

NOTE 1 The relationship is based on the ± 15° requirement illustrated by Figure 2.

NOTE 2 In the field, it can be convenient to use the following approximation as a rule of thumb: viewing distance ⩾ 1,9 × application width.



Key

1 screen width
2 viewing angle (± 15°)
3 viewing distance
4 viewing location

Figure 2 — Viewing distance and viewing angle

5.1.2 Design viewing direction

If the display is a flat panel, check that it is used for the specified viewing direction class according to ISO 9241-303 and ISO 9241-307.

5.1.3 Gaze and head tilt angles

Verify that the work station and the visual display allow the user to view the screen with a gaze angle from 0° to 45° and a head tilt angle from 0° to 20°, using a device for measuring angles such as protractor or goniometer.

5.1.4 Virtual images

See ISO 9241-303:2008, Annex E.

5.2 Luminance

5.2.1 Illuminance

Measure the screen illuminance using a lux meter. Place the lux meter's sensor directly in the centre of the screen at the same tilt angle as applied by the user. Check that no shadows are falling onto the sensor.

Verify that the measured illuminance corresponds to the value specified by the supplier.

5.2.2 Display luminance

Measure the area luminance with a luminance meter: first, for white pattern on black background and, second, for black pattern on white background. Place the meter perpendicular to the display surface on the target. The target area shall be at least 100 % larger than the measurement area of the luminance meter.

For CRT, the luminance meter should be placed at measurement locations as shown in Figure 3. The pattern is the following:

— at the centre;

— at the locations on the diagonals that are 10 % of the diagonal length from the corners of the addressable area of the display.

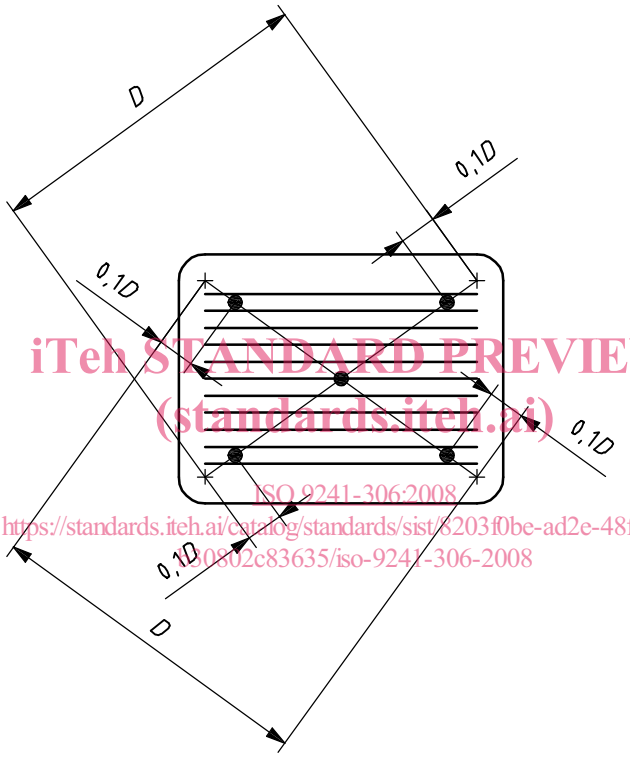
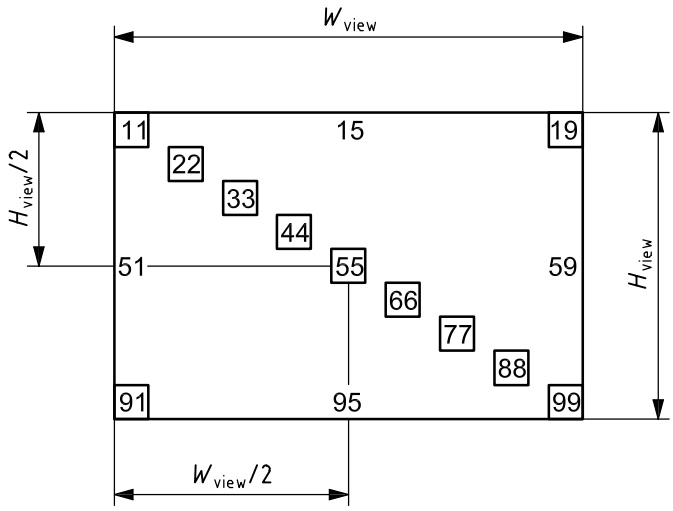


Figure 3 — Measurement locations — CRT

Verify that the measured luminance values are in accordance with ISO 9241-307.

For LCD, the measurement locations should be as shown in Figure 4. Determine the lowest and highest luminance.

Verify that the measured luminance values are in accordance with ISO 9241-307.



Key

H_{view} visible display height

W_{view} visible display width

Figure 4 — Measurement locations — LCD

5.2.3 Luminance balance and glare

Measure the luminance of the display (e.g. full screen white), of a frequently viewed task area (e.g. a document on the desk) and of a selected surround (e.g. a room wall). Calculate the luminance ratio between the screen and the frequently viewed area. Perform the same calculation for the luminance ratio between the screen and selected surround. Verify that the ratios are in accordance with the value range specified in ISO 9241-303.

A possible method of controlling the avoidance of glare is to check whether the surface of the housing is matte or glossy. Glossy surfaces may produce glare; the gloss value can be measured with a gloss meter or gloss reference samples.

5.2.4 Luminance adjustment

Verify that the luminance of the display and the contrast between characters and character background on the display are adjustable by the user to the ambient environmental conditions of the workplace.

5.3 Special physical environments

5.3.1 Vibration

See ISO 9241-303:2008, 5.3.2.

5.3.2 Wind and rain

See ISO 9241-303:2008, 5.3.3.

5.3.3 Excessive temperatures

See ISO 9241-303:2008, 5.3.4.