



SLOVENSKI STANDARD

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Varnost strojev - Ergonomske zahteve za načrtovanje slikovnih zaslonov in krmilnih stikal - 4. del: Namestitvev in razvrstitvev slikovnih zaslonov in krmilnih stikal

Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 4: Location and arrangement of displays and control actuators

Sicherheit von Maschinen - Ergonomische Anforderungen an die Gestaltung von Anzeigen und Stellteilen - Teil 4: Lage und Anordnung von Anzeigen und Stellteilen
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Sécurité des machines - Spécifications ergonomiques pour la conception des dispositifs de signalisation et organes de service - Partie 4: Agencement et arrangement des dispositifs de signalisation et organes de service
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EUROPEAN STANDARD

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Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 4: Location and arrangement of displays and control actuators

Sécurité des machines - Spécifications ergonomiques pour la conception des dispositifs de signalisation et organes de service - Partie 4: Agencement et arrangement des dispositifs de signalisation et organes de service

Sicherheit von Maschinen - Ergonomische Anforderungen an die Gestaltung von Anzeigen und Stellteilen - Teil 4: Lage und Anordnung von Anzeigen und Stellteilen

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Foreword

This document (EN 894-4:2010) has been prepared by Technical Committee CEN/TC 122 “Ergonomics”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2010, and conflicting national standards shall be withdrawn at the latest by December 2010.

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For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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Introduction

This European Standard has been prepared to be a harmonized standard in the sense of the Machinery Directive and the associated EFTA regulations.

This document is a type B standard as stated in EN ISO 12100.

The provisions of this document can be supplemented or modified by a type C standard.

NOTE For machines which are covered by the scope of a type C standard and which have been designed and built according to the provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard.

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1 Scope

This European Standard contains ergonomic requirements for the location and arrangement of displays and control actuators in order to avoid hazards associated with their use.

This European Standard applies to displays and control actuators for machinery and other interactive equipment (e.g. devices and installations, instrument panels, control and monitoring consoles).

This European Standard is not applicable to the location and arrangement of displays and control actuators which are manufactured before the date of its publication as EN.

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.

EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 894-1:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators*

EN 894-2:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

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EN ISO 9241-11, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability (ISO 9241-11:1998)*

EN ISO 9241-110, *Ergonomics of the human-system interaction — Part 110: Dialogue principles (ISO 9241-110:2006)*

EN ISO 12100-1:2003 *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100-1:2003 and the following apply.

3.1

control/display ratio

C/D ratio

ratio of the movement of a control actuator to that of an associated element, display or controlled object

3.2

elements

generic term for displays and control actuators on consoles and panels

3.3

primary element

element frequently used for direct operation and monitoring of the system which includes safety and emergency related elements

EN 894-4:2010 (E)**3.4****secondary element**

element not frequently used for the direct operation of a system

EXAMPLE The time and duration of use can be freely selected.

3.5**grouping**

arrangement of several elements of a system in such a way that they appear to be associated functionally

3.6**coding**

procedure within the design process by which categories of information (e.g. form, colour, etc.) are allocated to elements for the purpose of reliable identification

3.7**arrangement**

way of combining or separating displays and control actuators relative to their function, task and/or location

3.8**surface**

surface on which elements are positioned and arranged, considering task priorities, information flows, and space constraints

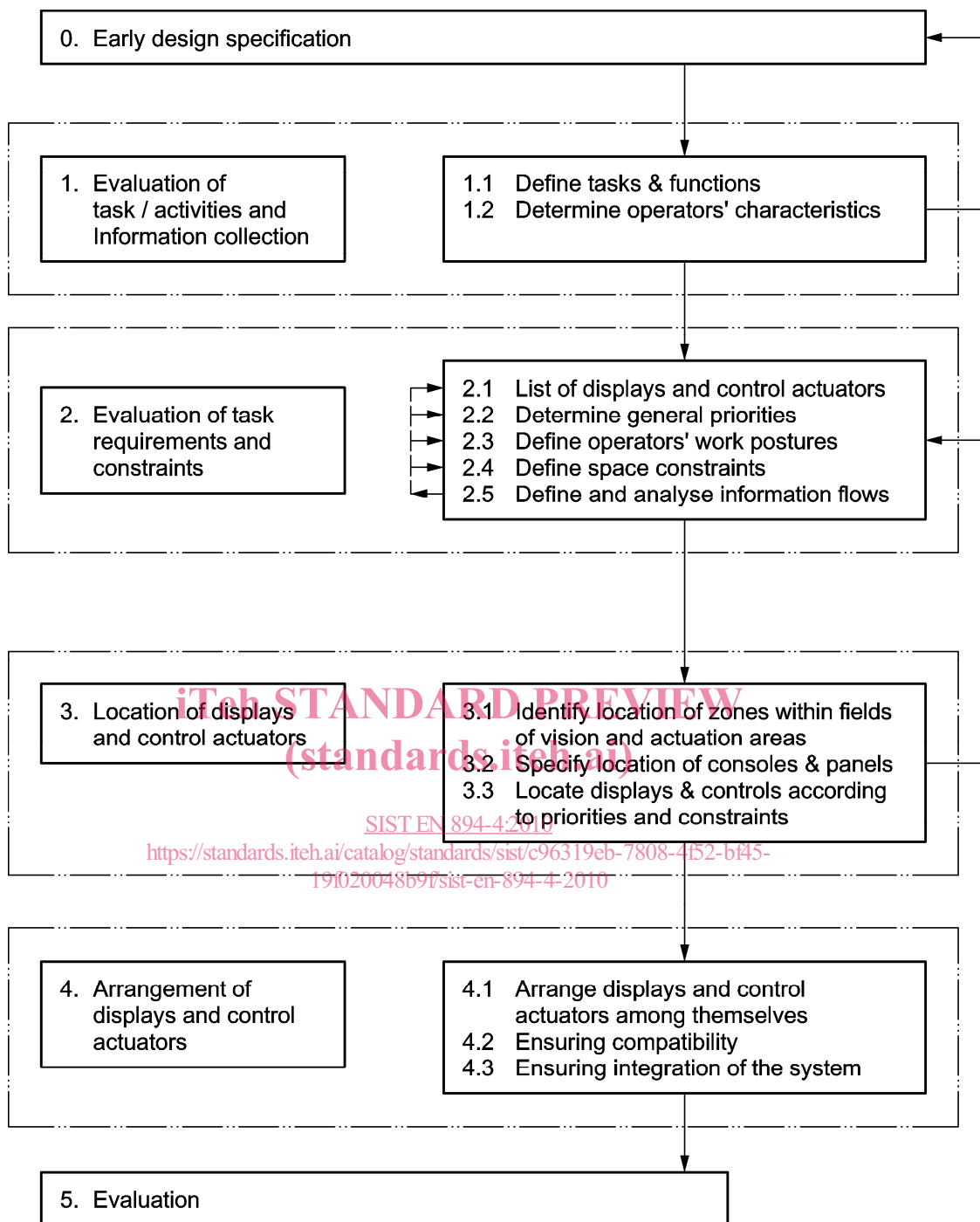
4 Principles for location and arrangement of displays and control actuators

The location and arrangement of displays and control actuators are intended to ensure the general reliability, safety and efficiency of the human-machine system. The most important tasks of the operator are to monitor, control and ensure continuous availability of the technical system and the interaction of its elements. This shall place the operator in a position to fulfil the following functions correctly and on time without becoming overtaxed:

- to perceive the current tasks;
- to control the operation;
- to select and/or develop suitable action strategies.

Basic principles for human machine interaction are given in EN 894-1.

The following describes a design procedure that will assist designers and manufacturers in complying with the requirements in this standard. It consists of six main phases, each of which contains several more detailed steps. These steps should be carried out iteratively until the requirements are met. The procedure is illustrated in Figure 1. In Phase 0 the initial information about the overall purpose, design goals and roles of the operators (see EN 894-1) is assembled.

**Key**

-----> Possible iteration

Figure 1 — Design procedure for location and arrangement

NOTE For details of each step see Clause 5 (e.g. step 1.1 is in 5.1.1; step 3.1 in 5.3.1).

EN 894-4:2010 (E)**5 Phases and steps for location and arrangement of displays and control actuators****5.1 Phase 1 – Evaluation of task/activities and information collection****5.1.1 Step 1.1 – Define tasks and functions**

Typical operator tasks are e.g. monitoring, error detection, diagnosis of faults and performing control actions; the following operating situations should be considered: start up, normal operation, troubleshooting, shutdown, emergency stop, etc., see EN 894-1, -2 and -3.

Task sequence and relevant information flows shall be recorded for each relevant operating situation.

If two or more operators may work at the same workplace the interactions between their tasks, control actions and information flows shall be specified to help avoid possible conflicts and improve overall safety.

5.1.2 Step 1.2 – Determine the operators' relevant physical and cognitive characteristics

The general principle as defined in EN 614-1, e.g. strength, body size, visual acuity, skills, experience and disabilities, shall be considered. Specific information on relevant physical characteristics for displays and control actuators is given in EN 894-2 and -3.

5.2 Phase 2 – Evaluation of task requirements and constraints**5.2.1 Step 2.1 – List of displays and control actuators**

Types of displays and control actuators which comply with the relevant requirements of EN 894-2 and EN 894-3 should be compiled in a list.

Technological features and/or constraints such as for multifunctional elements, e.g. touch screens, scroll balls, remote or handheld controllers need to be assessed.

5.2.2 Step 2.2 – Determine general priorities

The task requirements for each operational situation shall be specified and prioritized taking into account safety, performance and usability goals. Task requirements include accuracy, speed, force, frequency, importance, duration of use, sensitivity to error and sequence of use, etc.

Tasks should be assigned a level of priority, i.e. primary or secondary elements as defined in 3.3 and 3.4.

These priorities are used in Phase 3 to help locate displays and control actuators, and to exclude unnecessary elements.

The activities that make up the tasks should be identified, this helps to choose the most appropriate physical arrangements, e.g. which parts of the task can be done seated, which parts of the task require communication with other operators, which parts of the task require problem solving activities. There also needs to be consideration of the operator's action strategy in each operating situation.

The following constraints on activities shall be considered where appropriate:

- a) need for direct vision over the top of a console e.g. when monitoring supplementary information;
- b) need for continuous direct vision while controlling e.g. during a driving task, using a mobile machine;
- c) need for indirect vision (by e.g. camera systems) while controlling;
- d) need for direct vision and interaction with other people, e.g. crane operation;

e) need to use horizontal surfaces e.g. for writing, placing written material, work material, etc.

5.2.3 Step 2.3 – Define operators' work postures

5.2.3.1 General

The postures that have to be adopted when using displays and control actuators need to be specified as they strongly influence where the elements can be placed. Natural (not awkward) body postures should be selected which allow a balance between avoiding excessive movement and encouraging sufficient movement to allow a range of muscles to be used. Arrangements which allow changing of posture and do not continuously stress one part of the body should be selected. EN ISO 14738 provides additional information on how to select the main working postures.

5.2.3.2 Activities in seated position

The sitting position shall be selected particularly if the following demands are made:

- a high degree of body stability;
- high accuracy requirements.

For prolonged work periods it is important to allow for changes of posture and rest periods.

5.2.3.3 Activities in standing position

The standing position shall be selected for carrying out activities if:

- high mobility is required;
- extensive control movements are to be carried out;
- body weight is used in application of the force; and
- a large workplace is to be serviced.

5.2.3.4 Combination of activities in the sitting and standing positions

Control consoles where both standing and sitting is possible shall be set up when:

- a) a firm sitting support has to be assured for precise work;
- b) wide panels with displays and control actuators have to be monitored and actuation activities have to be carried out on them;
- c) there is an anticipated temporary increase in task demands where another operator has to help out.

Wherever possible, the operator should be able to sit and stand in order to have the benefits of both work postures. This helps to avoid the build up of musculoskeletal problems which can occur, particularly under conditions of psychological stress, when using one posture for a prolonged period of time.

5.2.4 Step 2.4 – Define space constraints

Any restrictions on the dimensions of the space available for positioning and moving displays and control actuators shall be fully recorded. This should include restrictions for direct vision of the process or objects where this is relevant to the performance of the tasks. Restrictions can arise from technological, environmental or task limitations.

EN 894-4:2010 (E)**5.2.5 Step 2.5 – Define and analyse information flows**

Collate information on the sequence of use of elements, their frequency of use and their relative importance. Identify any pre-existing stereotypes for the use of these elements.

Identify those elements which are used in combination, e.g. controls with their associated displays.

5.3 Phase 3 – Location of displays and control actuators**5.3.1 Step 3.1 – Identify location of zones within fields of vision and actuation areas for primary and secondary elements****5.3.1.1 General**

Displays and control actuators should be located in the appropriate zones taking account of requirements for frequency, importance, accuracy and order of operation, as well as operator's work postures and physical dimensions. Surfaces on which elements are positioned and arranged should then be determined within these zones considering task priorities, information flows and space constraints.

The field of vision (monitoring area) A, B, C is defined in EN 894-2:1997+A1:2008, Figure 2.

NOTE The information in EN 894-2:1997+A1:2008, Figure 2 applies to activities when sitting or standing.

In the same way, as shown in the following Figure 2, the actuation area A', B', C' are classified in three different zones, each with a different level of suitability.

The field of vision and the actuation area are classified as follows:

— A, A' : recommended;

— B, B' : acceptable;

— C, C' : not recommended.

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Thus for the various task priorities the following applies:

Elements used in primary tasks are located in recommended zones A and A'. They are used for the following:

- a) maximum priority for safe operation;
- b) quick and accurate reading (or actuation);
- c) important indicators (or control actuators) for operating the system;
- d) lengthy observation (and/or frequent actuation);
- e) elements for secondary and less important tasks, if space is left.

Elements used in secondary tasks are located in acceptable zones B and B'. They are used for the following:

- f) displays (or control actuators) of secondary importance that only have to be observed (or actuated) intermittently.

Elements used in less important tasks are located in the not recommended zones C and C'. They are used for the following:

- g) only suitable for displays (or control actuators) that are seldom used and are of low priority or importance such as for temperature regulation in a room.

5.3.1.2 Zones within fields of vision – seated

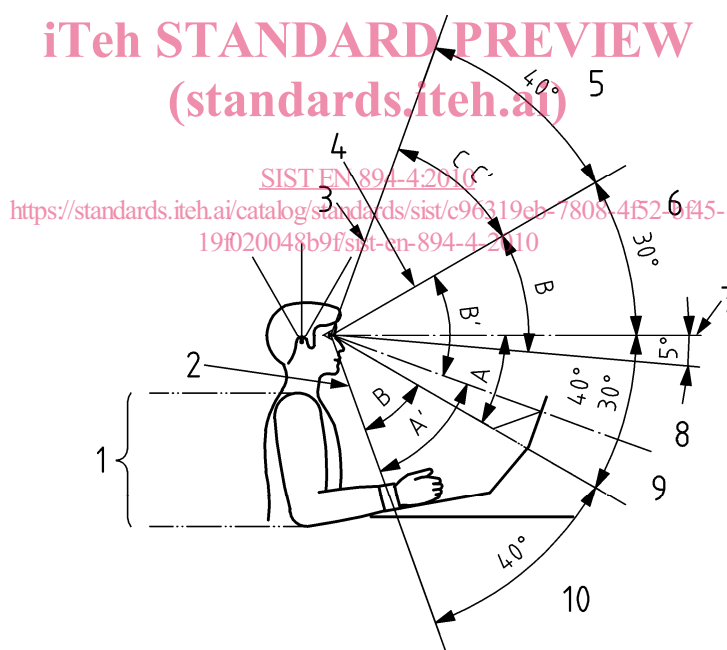
Figure 2 illustrates the display zones A, B, C. The eye height of the operators should be taken into account when calculating the position of displays using these angles. Annex A gives an example of console dimensions based on an average European sitting eye height of 1 250 mm. Further information on sight lines in different seated postures for control centre workstations can be found in EN ISO 11064-4, and for mobile machinery in EN ISO 6682. Typical distances for comfortably viewing displays such as video screens are 400 mm to 700 mm.

NOTE 1 A distinction should be made between leaning forwards, keeping vertical and leaning backwards in the sitting postures. When the posture is changed, the field of vision (or actuation) moves. For design purposes it is helpful to use the vertical (upright) position as a reference when calculating constraints on postures, for details see EN ISO 3411. Good design permits the adoption of other postures and easy accessibility.

The line of sight is located at 15° to the horizontal from the eye point. Zones (A, B, C) within the field of vision are derived from those given in EN 894-2.

It is important to ensure that discrimination of colours is not required towards the extremes of the field of vision. Figures 2 and 3 give some information about colour discrimination.

NOTE 2 The information about colour discrimination does not take account of head movement.



Key

- | | | | |
|---|--|------------|-------------------------------------|
| 1 | Optimum control zone between elbow and shoulder height | 7 | Horizontal |
| 2 | Lower visual limit 70° | 8 | Primary display & secondary control |
| 3 | Upper visual limit | 9 | Primary display & control |
| 4 | Limit for colour vision | 10 | Primary control, secondary display |
| 5 | Low priority display, control | A, B, C | Display zones (see 5.3.1.1) |
| 6 | Secondary display, control | A', B', C' | Control zones (see 5.3.1.1) |

Figure 2 — Location of Display Zones A, B, C and Control Zones A', B', C' (Vertical)