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Ergonomic design of control centres —

Part 4: Layout and dimensions of workstations

Conception ergonomique des centres de commande —

Partie 4: Agencement et dimensionnement du poste de travail

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This second edition cancels and replaces the first edition (ISO 11064-4:2004), which has been technically revised.

ISO 11064 consists of the following parts, under the general title *Ergonomic design of control centres*:

— *Part 1: Principles for the design of control centres*

— *Part 2: Principles for the arrangement of control suites*

— *Part 3: Control room layout*

— *Part 4: Layout and dimensions of workstations*

— *Part 5: Displays and controls*

— *Part 6: Environmental requirements for control centres*

— *Part 7: Principles for the evaluation of control centres*

Introduction

This part of ISO 11064 establishes ergonomic requirements, recommendations and guidelines for the design of workplaces in control centres.

All types of control centres are covered, including those for the process industry, transport and dispatching systems and emergency services. Although this part of ISO 11064 is primarily intended for non-mobile control centres, many of the principles are relevant to mobile centres such as those found on ships, locomotives and aircraft.

User requirements are a central theme of this part of ISO 11064 and the processes described are designed to take into account the needs of users at all design stages. The overall strategy for dealing with user requirements is presented in ISO 11064-1. ISO 11064-2 provides guidance on the design and planning of the control room in relation to its supporting areas. Requirements for the layout of the control room are covered by ISO 11064-3. Displays and controls, human computer interaction and the physical working environment are presented in ISO 11064-5 and ISO 11064-6. Evaluation principles are dealt with in ISO 11064-7.

The users of this standard are assumed to have some understanding of anthropometry, its use and limitations, and its application in the context of control rooms. Where this understanding is in doubt, it is recommended that the advice of an expert be sought.

The ultimate beneficiaries of this part of ISO 11064 will be the operator within the control room and other such users. It is the needs of these users that provide the ergonomic requirements that are addressed by the International Standards developers. Although it is unlikely that the end user will read this International Standard, or even know of its existence, its application should provide the user with interfaces that are more usable and a working environment which is more consistent with operational demands, and result in a solution which will improve system performance, minimize error and enhance productivity.

Ergonomic design of control centres —

Part 4:
Layout and dimensions of workstations

1 Scope

This part of ISO 11064 specifies ergonomic principles, recommendations and requirements for the design of workstations found in control centres. It covers control workstation design with particular emphasis on layout and dimensions. It is applicable primarily to seated, visual-display-based workstations, although control workstations at which operators stand are also addressed. These different types of control workstation are to be found in applications such as transportation control, process control and security installations. Most of these workstations now incorporate flat-display screens for the presentation of information.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7250-1:2008, *Basic human body measurements for technological design — Part 1: Body measurement definitions and landmarks*

ISO 9241-410:2008, *Ergonomics of human-system interaction — Part 410: Design criteria for physical input devices*

ISO 9241-5:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 5: Workstation layout and postural requirements*

ISO 11064-3:1999, *Ergonomic design of control centres — Part 3: Control room layout*

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

3 Terms and definitions

For the purposes of this part of ISO 11064, the following terms and definitions apply.

3.1
control workstation
single or multiple working position, including all equipment such as computers and communication terminals and furniture at which control and monitoring functions are conducted

[SOURCE: ISO 11064-3:1999, 3.7.]

3.2
cone of fixations
angular extent to which the line of sight can be swept by rotating the eyeball in the skull while the head rests

3.3
legibility
ability for unambiguous identification of single characters or symbols that may be presented in a non-contextual format

[SOURCE: ISO 9241-302:2008, 3.3.35.]

3.4
line-of-sight
line connecting the point of fixation and the centre of the pupil

Note 1 to entry: The line-of-sight with two eyes is the line connecting the point of fixation and the midpoint between the two pupils

[SOURCE: ISO 9241-302:2008, 3.3.36.]

3.5
nearpoint
nearest viewing distance to which the eye accommodates

3.6
normal line-of-sight
inclination of the line-of-sight with respect to the horizontal plane, when the muscles assigned for the orientation of the eyes are relaxed

3.7
percentile
value of a variable below which a certain percentage of observations fall

3.8
reach envelope
three-dimensional space in which an operator can comfortably reach and manipulate controls by either hand while assuming a posture normally anticipated for the task

3.9
task zone
space determined by the equipment and activities required for the conduct of a particular task

3.10
visual angle
angle subtended at the eye by the viewed object, e.g. a character or symbol

3.11
visual field, field of vision
physical space visible to an eye in a given position

[SOURCE: ISO 8995:1989, 3.1.10.]

Note 1 to entry: In this standard the use of both eyes is assumed for visual field considerations.

Note 2 to entry: The position of the visual field depends on the direction of the line-of-sight.

Note 3 to entry: Separate, distinct stimuli in the visual field will be detected even if they appear simultaneously.

Note 4 to entry: While the extent of the visual field is approximately ± 35° around the line-of-sight, only between 1° and 2° of these are for sharp vision.

3.12
work environment
physical, chemical, biological, organizational, social and cultural factors surrounding a worker

[SOURCE: ISO 6385:2004, 2.6.]

3.13
work space
volume allocated to one or more persons in the work system to complete the work task

[SOURCE: ISO 6385:2004, 2.15.]

3.14
workstation
combination of work equipment for a particular person in a work space

[SOURCE: ISO 11064-2:2000, 3.5.]

Note 1 to entry: It is possible that several persons may share a particular control workstation, or that several persons alternate several workstations within any period of time (i.e. on an hourly, daily, weekly basis).

3.15
work task
activity or set of activities required by the worker to achieve an intended outcome

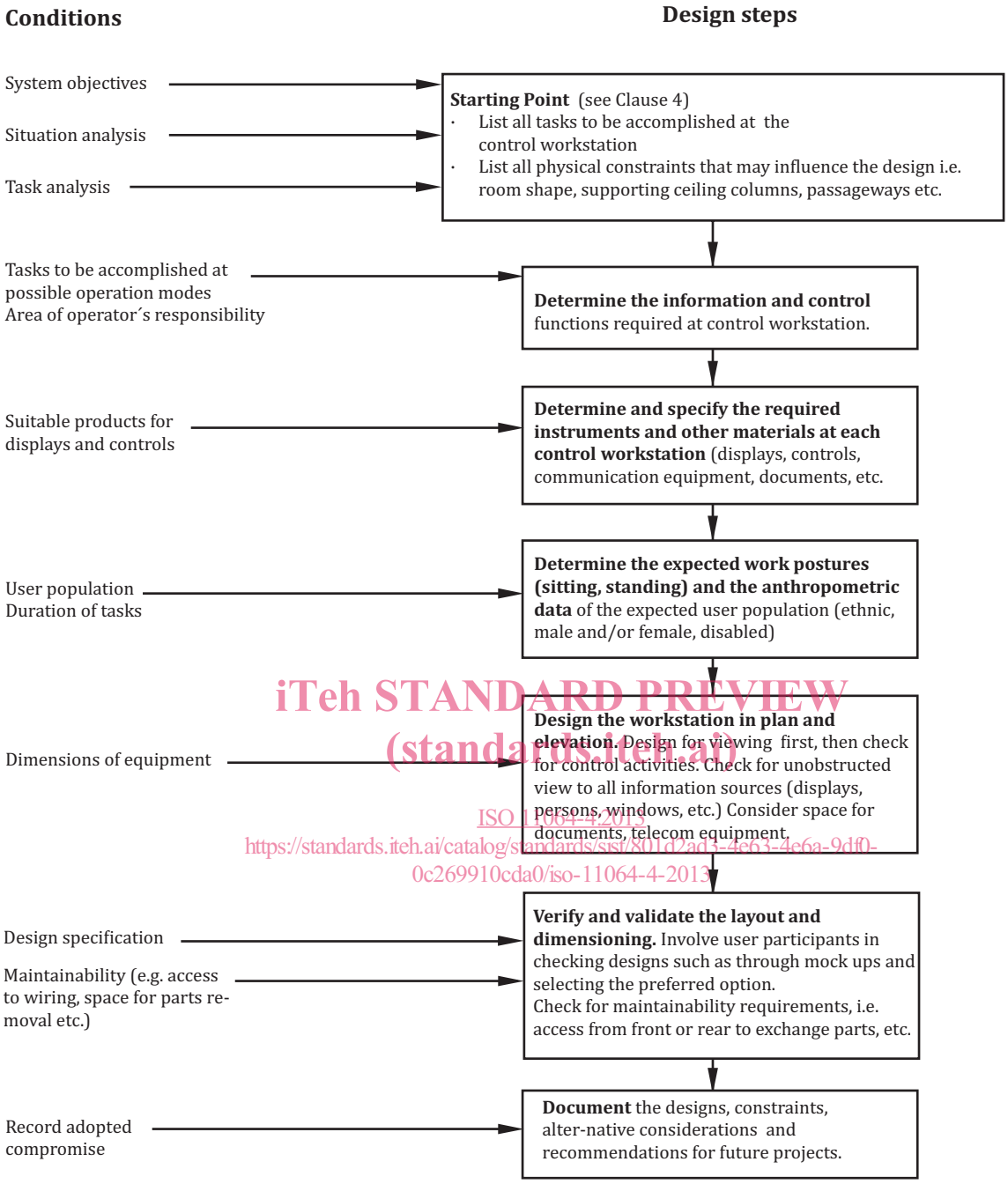
[SOURCE: ISO 6385:2004, 2.17.]

4 Initial control workstation layout considerations

The starting point for control workstation design (shape and dimensions) is a list of work tasks and related work characteristics. The human operator may need certain facilities, such as displays, input devices and communication equipment. Work space may also be required for special control-room-related tasks such as paper work. For each task, a compilation of the requirements of the associated devices is needed. By taking account of job designs, task zones are combined together into control workstation arrangements. The grouping of control workstations into control room layouts is discussed in ISO 11064-2 and ISO 11064-3.

Requirements identified for each task zone are inputs for the detailed engineering of control workstations.

A systematic approach to designing control workstations is presented in Figure 1. The sequence of stages involved in this process may vary as a result of iterations, and this may have an impact on the appropriate tasks which need to be undertaken at each stage.



NOTE Each design stage in the process may result in a feedback loop to one of the earlier steps.

Figure 1 — Control workstation design steps

5 Factors determining control workstation design

This clause is mainly concerned with control workstations with one or more visual displays, communication tools and space for administrative functions and documentation.

5.1 General user considerations

5.1.1 General requirements

Workstations shall be designed to accommodate from the 5th to the 95th percentiles of dimensions of the intended user population. When considering the user population, account shall be taken of the demographic characteristics of the intended users, including gender, age, ethnic background and disabilities.

Workstations shall be designed according to human capabilities, limitations and needs. Consequently, the design shall take into consideration the physical characteristics of the user population, including working postures, visual and aural needs, reach envelopes and their collective influences on control workstation layout and dimensions.

5.1.2 User requirements

The layout and dimensioning of control workstations shall be governed by the anthropometric dimensions of the user and any requirements for movement to accomplish his/her tasks. Anthropometric data are usually given in terms of percentiles.

General anthropometric requirements are the following.

a) The percentile values referred to in this part of ISO 11064 shall be computed from the set of anthropometric data of the expected user population.

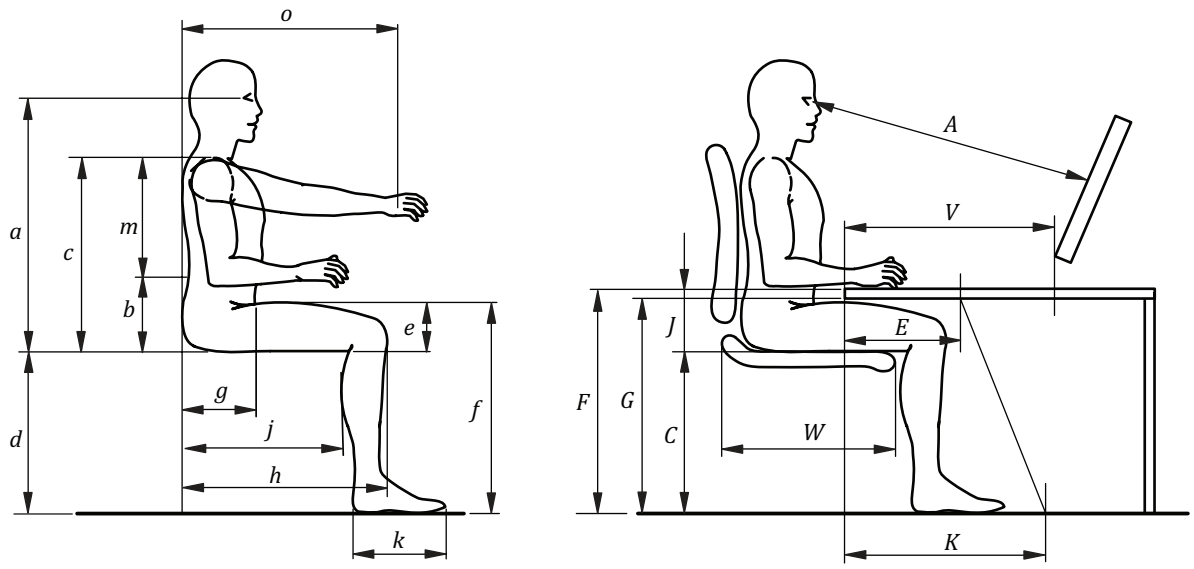
b) Control workstation dimensions shall accommodate at least a range from the 5th to the 95th percentile of the user population.

c) The following anthropometric data shall be used to primarily determine the control workstation dimensions:

   — reach envelope: 5th percentile of the user population, e.g. reach to critical equipment;

   — clearances: 95th percentile of the user population, e.g. clearances under work surfaces.

The key anthropometric dimensions for consideration of a seated operator (in elevation) are shown in Figure 2. Figure 3 shows the anthropometric dimensions (in elevation) for consideration for a standing operator, and Figure 4 shows the dimensions in plan view for seated and standing operators. Any design solution selected should not unnecessarily disadvantage members presenting extreme anthropometric dimensions of the user population. Design parameters proposed should be checked against the relevant characteristics of the user population.



Anthropometric measurements			Control workstation dimensions		
Symbol	**Description**	**ISO 7250-1:2008 subclause**	**Symbol**	**Description**	**Calculation**
a	Eye height, sitting	4.2.2	*A*	Viewing distance[a]	
b	Elbow height, sitting	4.2.5	*C*	Seat pan height range[b]	*C* = d plus shoe heel height minus comfort factor
c	Shoulder height, sitting	4.2.4	*E*	Horizontal clearance under[c] work surface at knee height	*E* = *h* minus *g*
d	Lower leg length (popliteal height)	4.2.12	*F*	Work surface height[d j]	*F* = *d* plus *e* plus shoe heel height plus seat cushion thickness plus work surface thickness
e	Thigh clearance	4.2.13	*G*	Vertical clearance under work surface[e j]	*G* = *d* plus *e* plus shoe heel height plus seat cushion thickness
f	Top of thigh height	4.2.14	*J*	Armrest height (from seat pan)[f]	*J* = *b* plus seat cushion thickness
g	Buttock abdomen depth sitting	4.2.17	*K*	Horizontal clearance at foot level[g k]	*K* = *j* minus *g* plus *k*
h	Buttock knee length	4.4.7	*V*	Usable work surface depth[h]	
j	Buttock popliteal length	4.4.6	*W*	Seat pan depth[i]	*W* = *j*
k	Foot length	4.3.7			
o	Grip reach	4.4.2			
m	Shoulder elbow length	4.2.6			

a Function of eye height, sitting and task requirements and equipment.
b Range — 5th percentile to 95th percentile.
c Use largest *h* minus smallest *g*.
d Fixed work surface height — use largest *d* plus largest *e*. Adjustable work surface height — range of *F* calculated using (smallest *d* and smallest *e*) and (largest *d* and largest *e*).
e Fixed work surface height — use largest *d* added to largest *e*. Adjustable work surface height — range of *G* calculated using (smallest *d* and smallest *e*) and (largest *d* and largest *e*).
f Range — use 5th percentile *b* to 95th percentile *b*.
g Use largest j minus smallest *g* plus largest *k*.
h *V* = derived from task and control equipment requirements.
i Use smallest *j*.
j Maximum recommended work surface thickness 40 mm.
k This calculation will give maximum values — see recommendation in 5.4.2 for leg and feet clearances.

Figure 2 — Illustration of key anthropometric and control workstation dimensions associated with *seated* control workstation in elevation

For standing vertical panels (see Figure 3), controls should not be so low that the standing-tall user must stoop to reach down to them.

Where no clothing allowances are specified in the anthropometric database, the dimensional effects of footwear and clothing shall be considered.

The effects of different postures shall be considered.

If it is impossible to cope with this range from the 5th percentile to the 95th with a fixed control workstation, an adjustable workstation shall be considered.

It may be necessary to combine anthropometric data, though caution should be exercised when doing this.

Usually, the native anthropometric data set is based on naked subjects. Some data sources, however, include clothing allowance on certain dimensions. The implications of wearing personal protective equipment should also be considered if a task analysis reveals that this is required.

The control workstation designers shall take account of the changes in eye position, relative to the location of equipment and the view over the workstation, when different postures are adopted by the operator (see Table 2).

NOTE Changing between the four postures of “bent forward”, “erect”, “reclined” and “relaxed” results in changes in the vertical position of the eyes and their relative position relative to the front edge of the workstation,

Another allowance concerns the so-called *slump factor* (a correction made to measurements taken from an erect posture), an attempt to simulate more natural and relaxed postures. In some sources, this factor is included; in others, not. Therefore, data sources should be checked carefully before being applied.

Typically, control workstations will be operated by multiple users who might exhibit a range of anthropometric features. Control workstation design and layout should take account of this variable user population.

Adjustable control workstations should be considered and accommodate at least a range from the 5th percentile to the 95th percentile of the determining body dimensions of the user population (see 7.2).

Adjustment devices should be easy and safe to use from a seated position.

NOTE Reliability is an important design feature when incorporating adjustability in workstations