INTERNATIONAL STANDARD

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Safety of machinery — Anthropometric requirements for the design of workstations at machinery

Sécurité des machines — Prescriptions anthropométriques relatives à la conception des postes de travail sur les machines

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Foreword

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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 member bodies casting a vote.

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

International Standard ISO 14738 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

Annex A forms a normative part of this International Standard. Annex B is for information only.

For the purposes of this International Standard, the CEN annex regarding fulfilment of European Council Directives has been removed.

Contents

Foreword

This document (EN ISO 14738:2002) has been prepared by Technical Committee CEN/TC 122 "Ergonomics", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 159 "Ergonomics".

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of an identical text or by endorsement, at the latest by February 2003, and conflicting national standards shall be withdrawn at the latest by February 2003.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This International Standard is one of several ergonomics standards for the safety of machinery. EN 614-1 describes the principles designers should adopt in order to take account of ergonomic factors.

This International Standard describes how these principles should be applied by using anthropometric requirements for the design of workstations at machinery.

In addition it is recommended that the postures and movements that are imposed by the machinery design are evaluated as described in ISO 11226 and prEN 1005-4.

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

1 Scope

This International Standard establishes principles for deriving dimensions from anthropometric measurements and applying them to the design of workstations at non-mobile machinery. It is based on current ergonomic knowledge and anthropometric measurements.

This International Standard specifies the body's space requirements for equipment during normal operation in sitting and standing positions. This International Standard does not specifically include space demands for maintenance, repairing and cleaning work.

This International Standard does not give recommendations specifically for visual display terminal workstations at machinery. For this purpose ISO 9241-5 can be used in conjunction with this International Standard.

Situations where people are to be prevented from reaching a hazard are dealt with in ISO 13852.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

ISO 13852
Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs

ISO 15534-3
Ergonomic design for the safety of machinery - Part 3: Anthropometric data

ISO 7250 : 1996
Basic human body measurements for technological design

3 Task requirements

Design of workstations at machinery shall be based on an analysis of task requirements (see EN 614-1 and EN 614-2) including at least the following elements:

- time aspects e.g. duration of work at the machinery (see ISO 11226 and prEN 1005-4);
- size of working area;
- size of objects to be handled;
- force demands (see prEN 1005-2 and prEN 1005-3);
- action demands (e.g. for feeding and/or removing items from the machinery);

- dynamic body measurements (see Annex B);
- co-ordination demands;
- stability demands;
- visual demands;
- need for communication;
- frequency and duration of body, head and limb movements (see ISO 11226 and prEN 1005-4);
- need to move between workstations;
- the possibility for adopting different postures (see also ISO 11226 and prEN 1005-4).

Machinery and workstations shall be designed to ensure the best postures and movement patterns taking into account technical and economic constraints.

4 Determination of main work posture

Figure 1 shows an analysis method for determining the main work posture at a machine and shows how some of the different factors described in clause 3 should be used. The design of the machine, workstation, task and equipment shall encourage a certain amount of movement and shifting of posture. The design should also allow the operator to change freely between the sitting and standing posture during the working day. When the designer chooses the main work posture, sitting is generally to be preferred. The standing postures are less recommended. Kneeling, crowling and lying down should be avoided as working postures. Figure 1 also indicates how factors can be modified to allow a sitting posture.

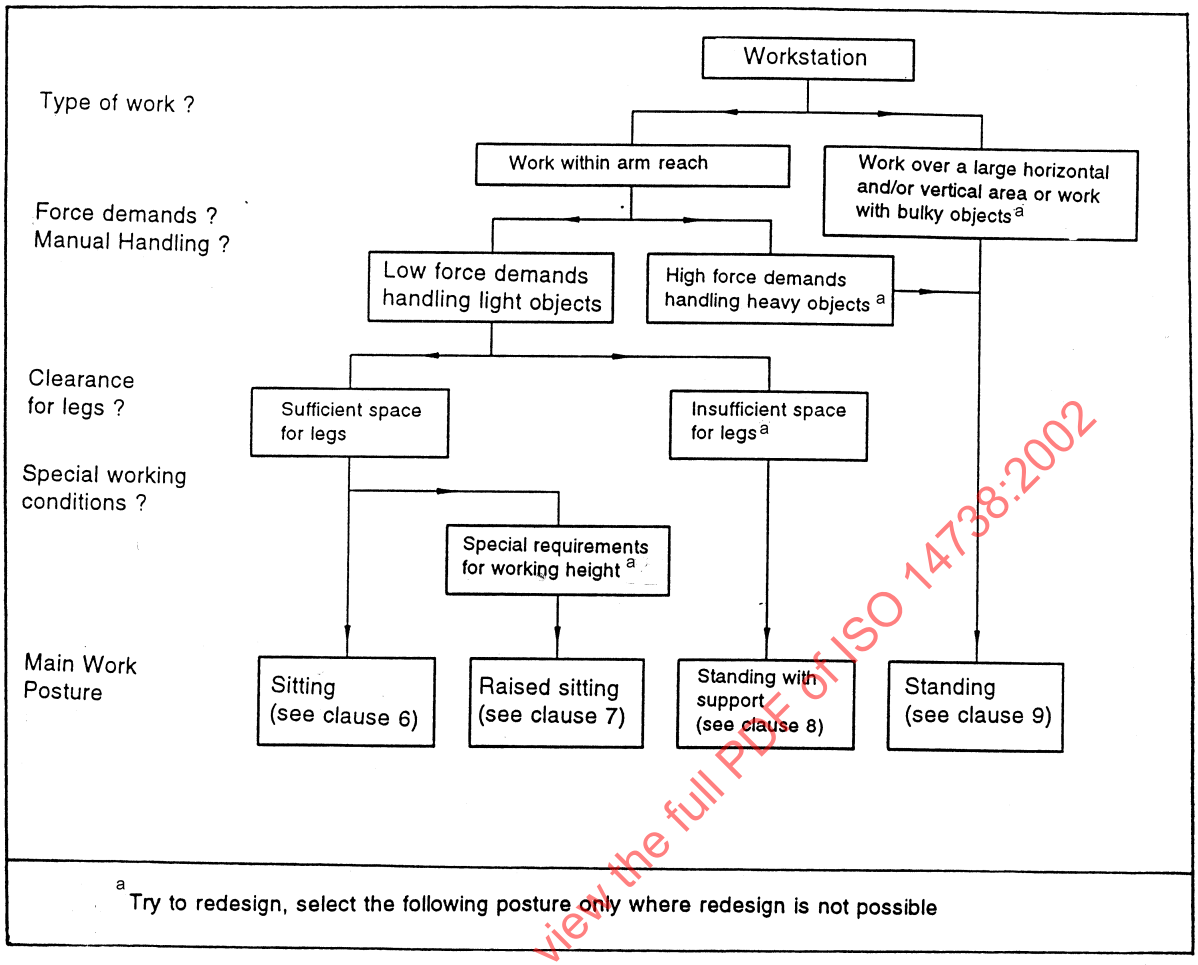


Figure 1 - Analysis method for determining main work posture

5 Dimensional data for workstation design

For each working posture described in this International Standard several dimensions for workstation design are given. These dimensions are based on anthropometric data. The anthropometric data originate from static measurements of nude persons and do not take into account body movements, clothing, equipment, machinery operating conditions or environmental conditions.

Annex A, table A.1, gives the human body measurements necessary to calculate the dimensions of workstations taking account of the known range of body sizes within Europe. Table A.2 is provided to allow the incorporation of anthropometric data from other regional areas of the world (for example from East Asia, South East Asia and North America). The notations used in this International Standard and its annexes are common to ISO 15534 Parts 1 to 3. Physical dimensions associated with the workstation are denoted by the capital letters A, B, C etc. in tables 4 to 8. These tables give dimensions calculated from human body measurements for European countries. Anthropometric measurements are denoted by lower case letters with indices. When a specific percentile of a body measurement is referred to, this is denoted by the actual percent figure preceeded by the letter 'P' within brackets after the index (e.g. a_2(P5) denotes the 5th percentile of body measurement a_2, shoulder breadth).

The dimensions given in table 1 are based on practical experience, and supplement the anthropometric measurements specified in Annex A. Together these data are used to specify the dimensions for the workstations at machinery.

The dimensions calculated will be the minimum for clearance dimensions and the maximum for reach dimensions. Wherever possible, the dimensions for clearance should be increased and the dimensions for reach should be decreased.

Table 1 - Allowances and additional dimensions

Height allowances (x)[1])	x_1- for shoes add 30 mm x_2- for shoes and foot movements add 130 mm x_3- for shoes and possibility to cross legs or for seat with forward sloping adjustment add 130 mm
Width allowances (y)	y - for movement of legs add at least 350 mm.
Depth allowances (z)	z_1- for movements at knee height add at least 50 mm z_2- for movements for the feet add at least 100 mm.
Other dimensions which are of importance:	- worksurface thickness as thin as possible, preferred maximum at front edge 30 mm (see clause 6.1) - width of footrest, preferred at least 700 mm - depth of footrest, preferred 700 mm.
[1]) For access to and use of pedal add pedal height plus sufficient space according to force demands see prEN 1005-3.	

Annex B provides additional information on body movements and associated space requirements.

6 Sitting

The advantages of the sitting posture include:

- the physiological energy cost and fatigue are reduced,
- it provides the body with a stable support,
- it allows precision work to be done.

The disadvantages include:

- the working area is limited,
- the possibilities for applying forces are limited,
- the possible risk of being constrained in a fixed posture for a long time.

Workstation dimensions shall accommodate the anthropometric variation in the user groups and the different work tasks, e.g. by being adjustable (see EN 614-1).

The best method of fitting the workstation to the user and the task is to make both the working surface and the seat easily adjustable.

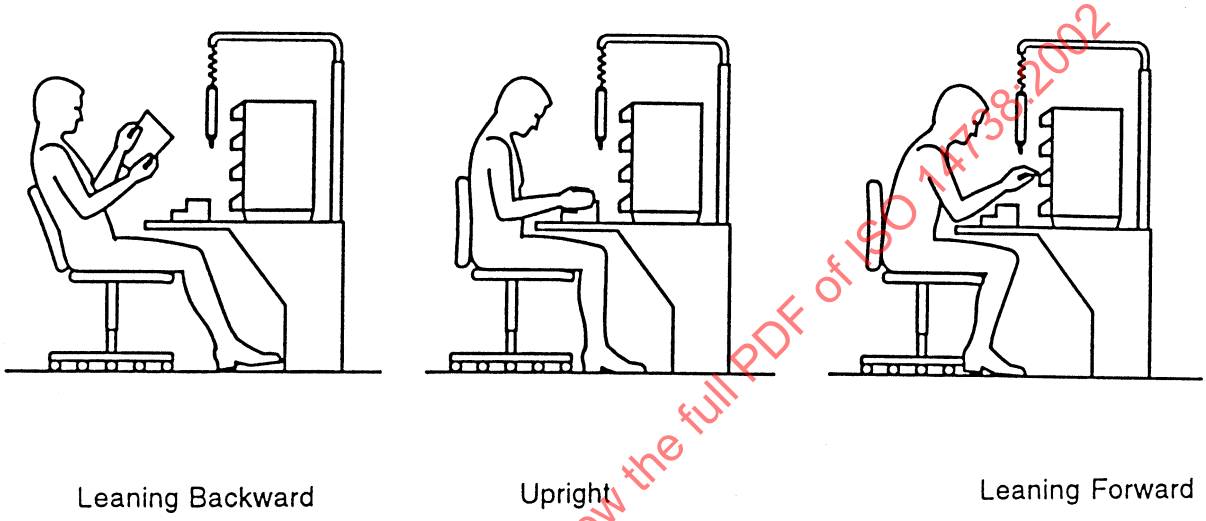


Figure 2 - Examples of variations in sitting posture

In order to avoid discomfort caused by sitting for a long time in a fixed position the workstation design shall allow variations in postures. This shall be done by adding sufficient allowances, as given in clause 5 (see also Annex B), to the relevant anthropometric dimensions when calculating the space requirements according to tables 4 and 5. Figure 2 shows variations in sitting postures ranging from slightly leaning backward to slightly leaning forward and illustrates how movements of the legs and upper body are interdependent.

In order to obtain appropriate sitting postures sufficient space for free body movements shall be provided, especially for the legs and feet. The working area for the arms shall be within appropriate distances according to the intended frequency and duration of movements of the body, head and limbs. For example, the placement of loading and unloading points on a machine shall be selected so that operation can be carried out in the preferred working area.

Account shall also be taken of the visual demands of the tasks which affect the position and movement of the head and body. The need for additional space for associated body movements should be assessed, tables 2 and 3 give information on the angles of movement of the head and body when seated. The influence of body movement on the effective field of vision is also shown (see also Annex B).

The angles α, β, γ and δ shown in tables 2 and 3 are guidelines for use in design. However, the actual values are highly variable and certain populations, e.g. younger or older people may have, respectively, much enlarged or restricted abilities to move parts of the body. Wearing spectacles or personal protective equipment, which restrict the field of vision, can increase the need for body movement. Factors, such as frequency and duration will also affect the acceptability of such movements (see also ISO 9355-2, ISO 11226 and prEN 1005-4).

Table 2 - Horizontal working areas taking account of eye, head and body movement

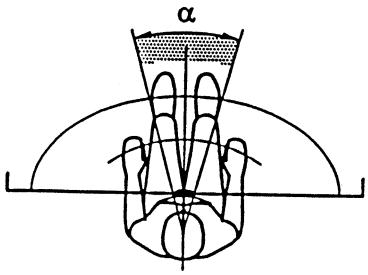
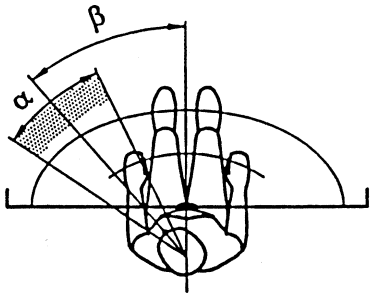
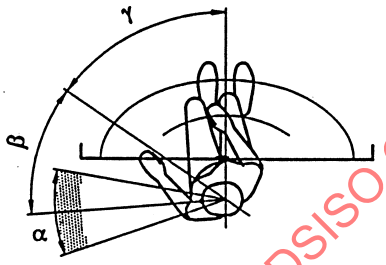
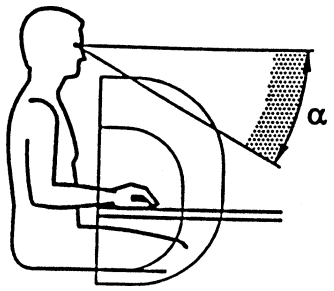
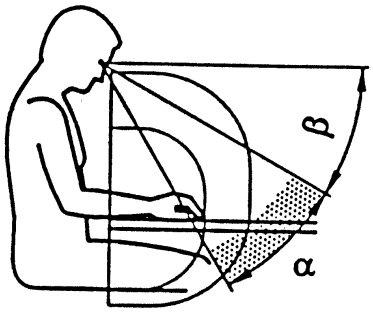
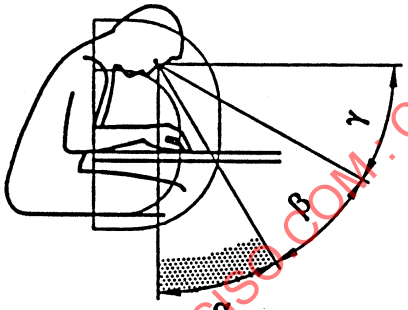
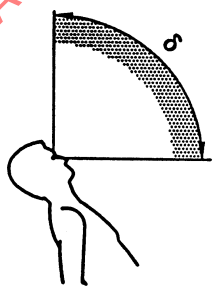
Posture	Notation	Value	Explanation of measurement
	α	30°	α = field of vision for frequent handling and observation without requiring head and body movement (see ISO 9355-2 for further information)
	α β	30° 40° 55°	α = field of vision (eye movements) β = head movement angle (left) α/2 + β = field of vision (left) for occasional handling and observation with head movement but without requiring body movement.
 Such postures should not be maintained for any length of time.	α β γ	30° 40° 55° 110°	α = field of vision (eye movements) β = head movement angle (left) γ = angle for extended head and body movement (left) α/2+β+γ = field of vision (left) only for occasional observation and light handling where turning the head and body is permissible.
NOTE 1: Only movement to the left is shown. Movements to the right are symmetrical. NOTE 2: According to table 4, the working areas are designated by curved lines.			

Table 3 - Vertical working areas taking account of eye, head and body movement

Posture	Notation	Value	Explanation of measurement
	α	30°	α = field of vision for frequent handling and observation without requiring head and body movement (see ISO 9355-2 for further information)
	α β	30° 30°	α = field of vision (eye movements) β = head movement angle without downward body movement
		60°	α+β = field of vision for handling and visual detection where downward head movement is permissible
	α β	30° 30°	α = field of vision (eye movements) β = head movement angle without downward body movement
	γ	30°	γ = angle for extended head movement or head and body movement (downwards)
		90°	α+β+γ = field of vision only for occasional handling and observation where downward head and body movement is permissible
 Such postures should not be maintained for any length of time.	δ	90°	δ = field of vision upwards, only for occasional handling and observation where head and body movement is permissible
NOTE: According to table 4, the working areas are designated by curved lines.			

6.1 Working height, working surface height and slope

When working on objects or on other devices there can be a certain difference between the working height and the working surface height. Working height in this standard means the height of the hands when working, while working surface height means the height of the supporting level. The working height should be chosen to provide an adequate posture for the body and at the same time fulfil visual needs. The choice is a compromise between demands on low load on the neck, arms, shoulders and back and demands on viewing distance for adequate visual control. The optimal working surface height and the slope depend on the work task. The figure 3 provides guidelines that can be used in most situations.

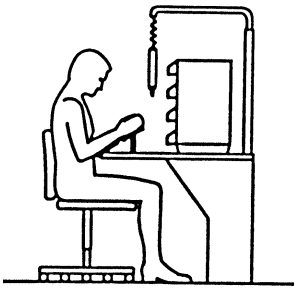
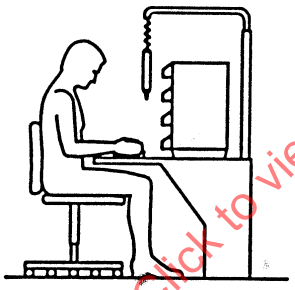
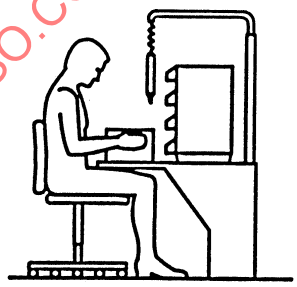
Task demands	Posture	Working height	Working surface height
Fine co-ordination of hand-work (arm supported) combined with visual monitoring in the same working area		higher than elbow height	high working surface possible
Active movements with arms, small objects		at elbow height	surface at elbow height
Handling of large, but not excessively bulky or heavy objects		variable, depending on the size of the object	surface below elbow height if compatible with space for legs; a forward sloping seat can provide more space

Figure 3 - Recommendations for working heights

In order to provide sufficient clearance for the thighs while allowing a good working height for the hands the working surface should be as thin as possible; this is a prerequisite for users to achieve good working postures. The minimum thickness of the surface will depend on the strength characteristics of the material used and other technical demands. In practice a 30 mm thick surface will often provide an acceptable compromise between the space needs and the strength characteristics.

The working surface may be sloping or horizontal. The most appropriate angle for a sloping surface is a compromise between the visual demands, the imposed loading on the neck, back and shoulders and an angle where the objects still remain on the surface. An angle of about 15° is recommended for many fine manipulative tasks with high visual demands.

Continuous work with raised upper arms should be avoided. If this is not possible, arm rests shall be provided.

Hand work should be arranged so that the hands are predominantly in the preferred working area (see table 4). Continuous work with unsupported arms should be avoided, even in this area. For occasional tasks with lightweight objects the maximal working area may be used.

6.2 Seat

The seat shall provide a stable support to the body in a posture which is physiologically satisfactory and appropriate to the task or activity which is to be performed and which remains comfortable over a period of time. Normally the seat should be rotatable.

The main physiological features of seated work are:

- the maintenance of a good posture requires minimal muscular effort;
- spinal loading is minimised by maintaining a moderate degree of lordosis with minimal muscular tension.

The seat shall be easily adjustable to the specific requirements of the individual user. The intended user population shall be accommodated by the range of adjustability and /or the sizes of seats available (see EN 614-1). A mechanism should be incorporated so that variations of posture between forward and backward leaning can be adopted. This mechanism shall be lockable.

In most work situations the optimum seat height for an individual will be close to their lower leg length (plus footwear). A forward sloping seat is recommended for work in a leaning forward position and may help when it is impossible to make the working surface and material thin enough to fit some individuals. To achieve adequate fit, the depth of the seat shall be a little shorter than the buttock to back of knee (popliteal) length of the intended user and/or be adjustable. The backrest shall provide good support for the back, especially the lower back, in all relevant postures. The backrest shall not restrict the necessary free movements of the arms.

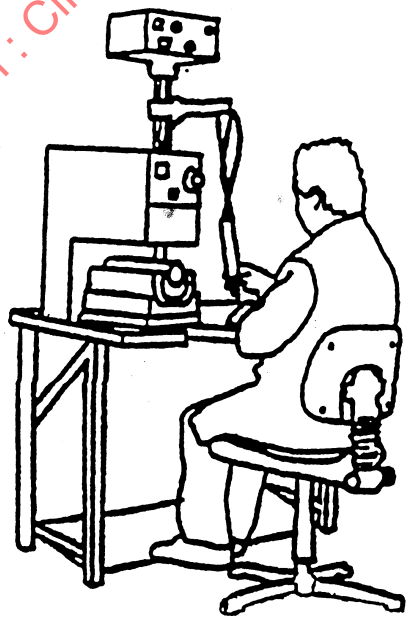
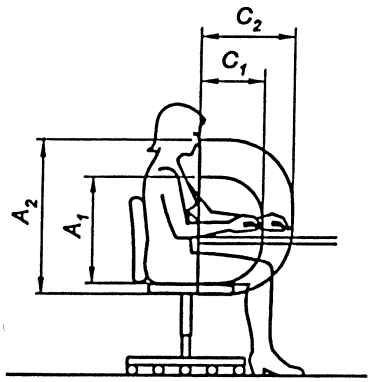
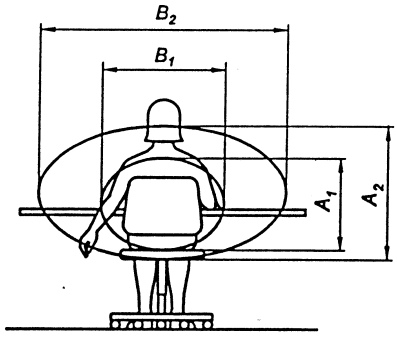
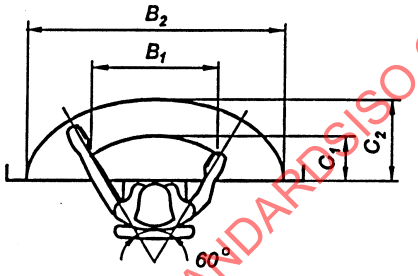


Figure 4 - Example of a seated work posture

6.3 Sitting - measurements

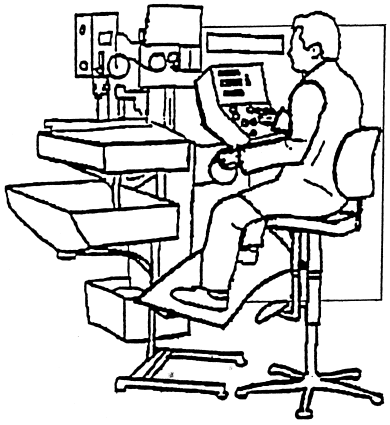
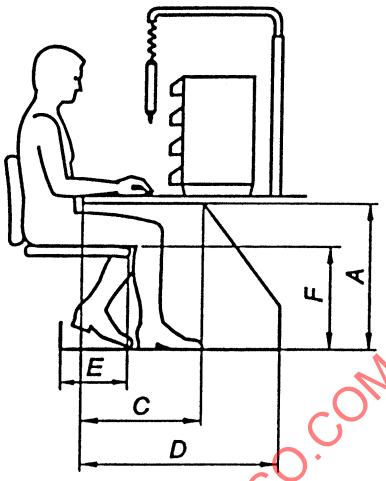
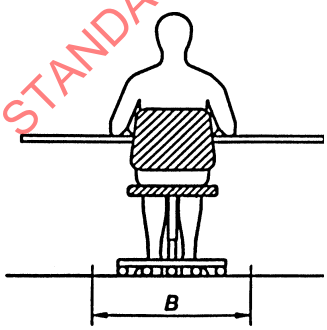
Table 4: Sitting, working area limits for arms

Posture	Notation	European Value (mm)[a]	Explanation of mesurements
	A_1	505	Preferred working area, height $A_1 = h_{13}$(P5) (from seat to shoulder height; centred around elbow height)
	A_2	730	Maximal working area, height $A_2 = h_{12}$(P5) + h_{17} (from 50 mm below seat to eye height)
	B_1	480	Preferred working area, width $B_1 = t_2$(P5) + a_2(P5), sides of area defined by the angle between the arms = 60°
	B_2	1170	Maximal working area, width B_2 = 2 t_3(P5) · sin 60° + a_2 (P5) (provision for body movement can extend this zone, see annex B)
	C_1	170 290	Preferred working area, depth $C_1 = t_2$(P5) for work with unsupported arms = up to t_2(P5) + 120 mm for work with supported arms
	C_2	415	Maximal working area, depth $C_2 = b_2$(P5) - 190 mm (fixed value, taking account of body movement)
			NOTE: Measurements are based on a horizontal seat surface

NOTE: For an explanation of notations see Annex A

[a] Value of other regional areas of the world (for example East Asia, South East Asia and North America) will be incorporated when available (see clause 5)

Table 5 - Sitting, space requirements for legs and feet

Posture	Notation	European Value (mm)[a]	Explanation of measurements
Working surface height, adjustable	*A*		Leg space height, sitting, adjustable:
		820 495	$A_{max}=h_{16}(P95)+b_{18}(P95)+x_3$ $A_{min}=h_{16}(P5)+b_{18}(P5)+x_1$
		720	not adjustable: $A=h_{16}(P95)+b_{18}(P95)+x_1$
	B		Foot and leg space, width
		790	$B=a_{17}(P95)+y$ (width for access to fixed seats see "B" in table 6)
	C		Leg space, depth at knee height
		547	$C=c_1(P95)-b_{15}(P5)+z_1$
	D		Leg space depth for feet
		882	$D=c_1(P95)-b_{15}(P5)+c_2(P95)+z_2$
Working surface height, not adjustable	*E*		Space for leg movement under seat
		285	$E=c_2(P95)$
	*F*		Seat height above foot support (adjustable) $F_{max}=h_{16}(P95)+x_1$
		535	$F_{min}=h_{16}(P5)+x_1$
		370	Footrest height (adjustable - only needed for non-adjustable working surface height)
	G		$G_{min}=0$ $G_{max}=h_{16}(P95)-h_{16}(P5)$
		0 165	For allowances, *x, y, z* see clause 5
			

NOTE: For an explanation of notations see Annex A

[a] see page 13

7 Raised sitting

For various reasons (e.g. maintaining the same eye level as standing persons; technical necessities; variable task requirements) there can be a need for using a high working surface where work can be done while sitting as well as standing.

The advantages of these raised sitting postures are the same as for sitting on a normal seat. It also allows changes in posture from sitting to standing.

The disadvantages include:

- difficulties in moving the chair in relation to the machine;
- risk of falling when getting onto or out of the chair;
- risk of tripping over the base when passing the chair;
- difficulties in adopting good sitting positions.

In order to provide for standing work, it is preferable to provide a means for adjusting the height of the main working area. Where this is not possible, a means for adjusting the height of the floor may be provided. Where it is necessary to use a fixed height working area this should be set so as to accommodate the majority of the expected user population. This should take account of:

- the task requirements, see clause 6.1 and table 8;
- the possibility for providing some individual adjustment to the working height (e.g. a removable and/or adjustable platform);
- the restrictions on possible working heights imposed by the range of tasks.

Fixed working heights and working surface heights should be selected between the appropriate maximum and minimum working heights given in table 8. These heights should then be used to calculate the space requirements given in table 6.

In order to obtain appropriate sitting postures an adjustable seat and sufficient space for the legs under the working surface shall be provided. In addition, a well designed foot rest shall be provided at the machinery. The adjustment ranges of the seat and foot rest shall be at least the same as for seated work (see clause 6).

The risk of the chair slipping away while using it, climbing onto it or climbing down shall be minimized. Support for the user whilst mounting the chair shall be provided.

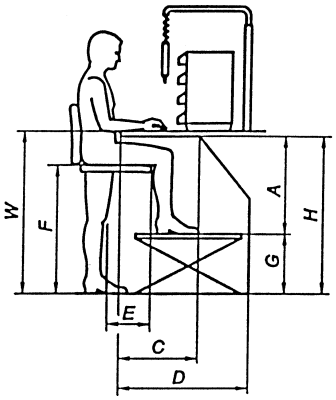
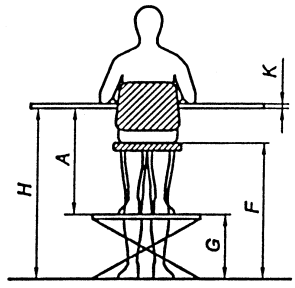
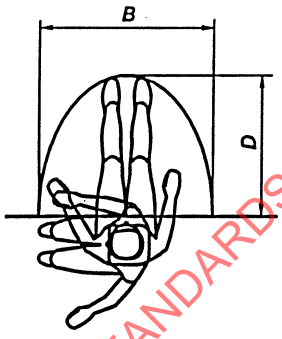
The advantages and disadvantages of an occasional standing posture are the same as those described in clause 9. To ensure unrestricted movement during standing, space for the unoccupied chair shall be provided beside the workstation.

The working area limits for the arms are as specified in table 4 for sitting. Standing increases the maximum working area.

Figure 5 - Example of raised sitting

7.1 Raised sitting - measurements

Table 6 - Raised sitting, space requirements for legs and feet

Posture	Notation	European Value (mm)[a]	Explanation of measurements
Working surface height not adjustable	*A*		Leg space height, sitting adjustable:
		820	$A_{max}=h_{16}(P95)+b_{18}(P95)+x_3$
		495	$A_{min}=h_{16}(P5)+b_{18}(P5)+x_1$
			not adjustable:
		720	$A=h_{16}(P95)+b_{18}(P95)+x_1$
	B		Foot and leg space, width (for access to seat)
		1094	$B=2C$
	C		Leg space, depth at knee height
		547	$C=c_1(P95)-b_{15}(P5)+z_1$
	D		Leg space depth for the feet
		882	$D=c_1(P95)-b_{15}(P5)+c_2(P95)+z_2$
	*E*		Space for leg movement under seat, in sitting position
		285	$E=c_2(P95)$
	F		Seat height (adjustable)
		905	$F_{max}=H-b_{18}(P5)$
		745	$F_{min}=H-(b_{18}(P95)+x_3-x_1)$
	G		Footrest height adjustable:
		535	$G_{max}=H-A_{min}$
		210	$G_{min}=H-A_{max}$
			not adjustable: (only in combination with an adjustable working surface height)
		375	$G=h_1(P95)-h_{11}(P95)-h_{16}(P95)$
	H		Leg space height from the floor
		1030	$H=W-K$
	K	≤30	work surface thickness (recommended maximum), see clause 6.1
	W		Working surface height
		1060	W=0,5 ($h_4(P95)+h_4(P5)$), or: $W = h_4$ (P50) For allowances *x, y, z* see clause 5
Working surface height adjustable Note: The working surface height should optimally be adjustable from the elbow height of a seated small person to the elbow height of a standing large person but this is not usually practicable at machinery. In practice a range of adjustability of at least W_{adj} should be provided.	W_{adj} *W*	265	Range of adjustability for work surface height $W_{adj}=h_4(P95)-h_4(P5)$ The level about which adjustability should be provided should be selected according to the task requirements, see table 8. For the adjustability of a footrest when standing, see table 8.
NOTE: For an explanation of notations see Annex A.			
[a] see page 13			

8 Standing with support

A sit/stand seat shall be provided only at workstations where it is impossible to use a fully seated or combined sitting and standing posture. It is better to provide a sit/stand seat than to require prolonged standing.

The advantages of using a sit/stand seat include:

– it supports up to 60% of the body weight;
– it is easy to transfer to a standing posture.

The disadvantages include:

– localised pressure and restriction of blood circulation;
– the legs tend to swell after a while;
– working postures are restricted.

Where the work requires extended arm reaching, sufficient knee and foot space shall be provided. Where knee and foot space is not provided then arm reach distances will be reduced in comparison to those available for normal standing.

A sit/stand seat should have a saddle-shaped form or a forward sloping seat pan with a relatively short seat depth. The sit/stand seat surface height shall be easily adjustable. Sit/stand seats of the pendulum type are not recommended due to safety reasons. The sit/stand seat shall be stable, and should be of low weight and easily stored when not in use.

Space requirements for legs and feet are given in table 7.

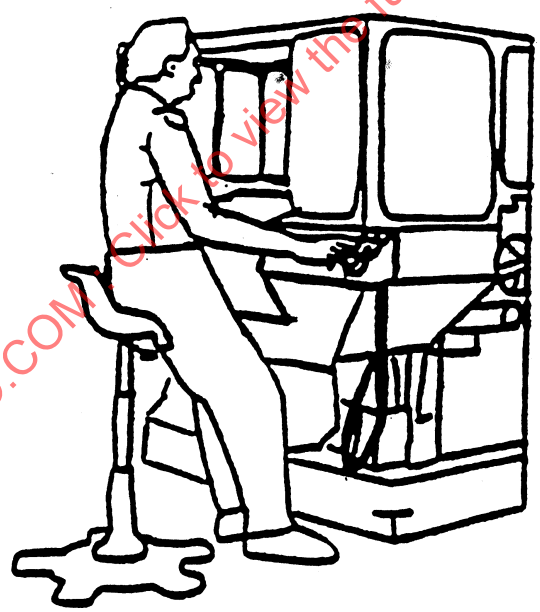
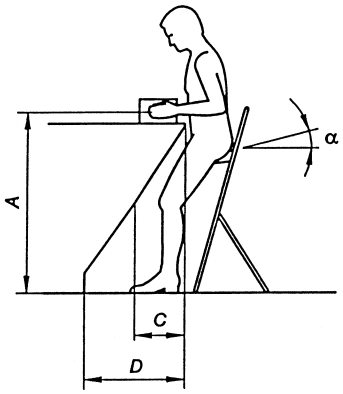
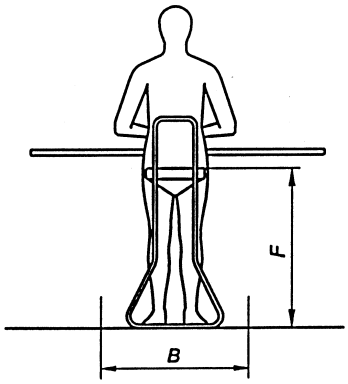


Figure 6 - Example of standing using a sit/stand seat

8.1 Standing with support - measurements

Table 7 - Standing with sit/stand seat, space requirements for legs and feet

Posture	Notation	European Value (mm)[a]	Explanation of measurements
	*A*		Working height *A*=see standing posture table 8: *A, B, C*
	B	790	Leg space width $B=a_{17}(P95)+y$
	C	285	Leg space depth at knee height $C=c_2(P95)$
	D	570	Leg space depth at ankle height $D=2c_2(P95)$
	*F*	840 630	Sit/stand seat height (adjustable) $F_{max}=0,9h_6(P95)+x_1$ $F_{min}=0,9h_6(P5)+x_1$
	α		Angle of seat pan for saddle shaped seat α = 0° to 15° for all other seats α ≈ 15°
			For allowances *x, y* see clause 5
NOTE: For an explanation of notations see Annex A			
[a] see page 13			

9 Standing

Standing workstations should only be designed when the task requirements do not allow the operator to sit or use a sit/stand seat.

The advantages of standing include:

– it allows free mobility of the person;
– it extends the available working area;
– greater physical forces can be applied when the feet provide good support and the weight of the body is utilized.

The disadvantages include:

– static loading of the leg muscles;
– foot controls are awkward to use;
– prolonged standing can cause back pain.

Height dimensions mainly depend on working requirements and user population dimensions. The working surface height should be adjustable wherever possible in order to accommodate the range of people's body dimensions, work pieces of various sizes and particular force demands. Adjustment shall be easy so that the operator can change the height of working surfaces according to different factors (e.g. tasks to perform, change of posture). If adjustable working surfaces cannot be implemented, an adjustable platform should be used to raise the operator to the appropriate working height, but this is less advisable from a safety standpoint (for instance, when walking from one workstation to another or when using a sit/stand seat). When an adjustable platform is used it shall be large enough to allow for the operator's movements, both those necessary to carry out the task and unintentional movements which might occur when someone slips etc. Special attention also needs to be paid to the surface finish, visibility of the edges and other safety aspects.

A fixed working surface height without an adjustable platform should be chosen only when the workstation is always occupied by the same operator and when the workpieces are the same size, or when it is used infrequently and for short periods of time.

Working heights and clearance requirements for the feet are given in table 8.

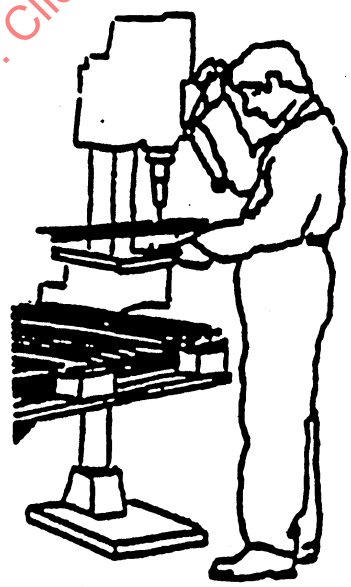
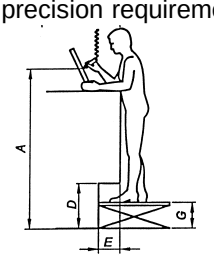
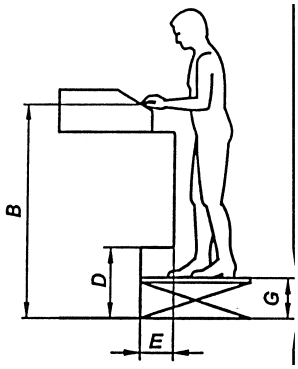
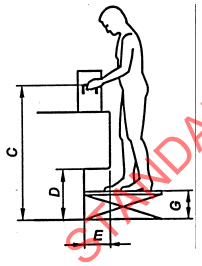


Figure 7 - Example of standing at the workplace

9.1 Standing - measurements

Table 8 - Standing, working heights and clearance requirements for feet

Posture	Notation	European Value (mm)[a]	Explanation of measurements
Working height for high visual and/or precision requirements 	*A*		Working height adjustable
		1584	$A_{max} = 1{,}3h_4(P95) + x_1$
		1053	$A_{min} = 1{,}1h_4(P5) + x_1$
			not adjustable
		1315 to1554	$A = k \cdot h_4(P95)$ factor k varying between 1,1 and 1,3 according to visual demands ($1{,}1 \le k \le 1{,}3$)
Working height for average visual requirements, medium precision 	B		Working height adjustable
		1225	$B_{max} = h_4(P95) + x_1$
		960	$B_{min} = h_4(P5) + x_1$
			not adjustable
		1195	$B = h_4(P95)$
	C		Working height adjustable
		1105	$C_{max} = 0{,}9h_4(P95) + x_1$
		867	$C_{min} = 0{,}9h_4(P5) + x_1$
			not adjustable
		1075	$C = 0{,}9h_4(P95)$
	D		Foot space, height
		226+*G*	$D = h_8(P95) + x_2 + G$ (where appropriate)
Working height to allow freedom of arm movements and handling of heavy objects where visual requirements are low 	*E*		Foot space, depth
		210	$E = 0{,}74c_2(P95)$
	G		Platform height (adjustable) where working height is not adjustable
		265	$G_{max} = h_4(P95) - h_4(P5)$
		0	$G_{min} = 0$
			For allowances *x* see clause 5

NOTE: For an explanation of notations see annex A

[a] see page 13

Annex A (normative)

Anthropometric data

A.1 European data

Table A.1 gives the human body measurements necessary to calculate the dimensions for workplaces taking account of the known range of body sizes within Europe. The data are based on information from anthropometric surveys representative of population groups, within Europe, comprising at least three million people. Both men and women are taken into account. The data are based on current information.

Table A.1 contains the appropriate definition and its corresponding value for the anthropometric measurements used in this International Standard. Wherever possible, definitions used in ISO 7250 are used. The column "Value P5 mm" contains the 5th percentile values for the relevant anthropometric measurements. The column "Value P95 mm" contains the 95th percentile values for the relevant anthropometric measurements.

Table A.1: Notations, explanations and European data for P5 and P95 measurements used in this International Standard

Notation	Explanation	Value P5 mm	Value P95 mm	Definition see	Use see
a_2	Shoulder (biacromial) breadth	310	430	ISO 7250 : 1996 4.2.8	table 4
a_{17}	Hip breadth, sitting		440	ISO 7250 : 1996 4.2.11	tables 5 and 7
b_2	Grip reach; forward reach	605		ISO 7250 : 1996 4.4.2	table 4
b_{15}	Buttock-abdomen depth sitting	190		ISO 7250 : 1996 4.2.17	tables 5 and 6
b_{18}	Thigh clearance	125	185	ISO 7250 : 1996 4.2.13	tables 5 and 6
c_1	Buttock-knee length		687	ISO 7250 : 1996 4.4.7	tables 5 and 6
c_2	Foot length		285	ISO 7250 : 1996 4.3.7	tables 5, 6, 7 and 8
d_1	Upper arm diameter, fixed value	121	121	ISO 15534-3	t_2 based on this
h_1	Stature (body height)		1881	ISO 7250 : 1996 4.1.2	table 6
h_4	Elbow height	930	1195	ISO 7250 : 1996 4.1.5	tables 6 and 8

(continued)

Table A.1 (concluded)

Notation	Explanation	Value P5 mm	Value P95 mm	Definition see	Use see
h_6	Crotch height	665	900	ISO 7250 : 1996 4.1.7	table 7
h_8	Ankle height, fixed value	96	96	ISO 15534-3	table 8
h_{11}	Sitting height (erect)	790	1000	ISO 7250 : 1996 4.2.1	fig. 6
h_{12}	Eye height, sitting	680	870	ISO 7250 : 1996 4.2.2	table 4
h_{13}	Shoulder height, sitting	505		ISO 7250 : 1996 4.2.4	table 4
h_{16}	Lower leg length (popliteal height)	340	505	ISO 7250 : 1996 4.2.12	tables 5 and 6
h_{17}	Fist height below seating surface, sitting - fixed value	50	50	-	table 4
t_2	Forearm reach, elbow-grip length minus upper arm diameter	170		ISO 7250 : 1996 4.4.3 ISO 15534-3	table 4
t_3	Arm reach to side	495		ISO 15534-3	table 4

A.2 Data for other regional areas

Table A.2 is provided to allow the incorporation of anthropometric data from other regional areas (see clause 5).

Table A.2: Notations, explanations and data from other regional areas for P5 and P95 measurements used in this standard

Notation	Explanation	Value P5 mm	Value P95 mm	Definition see	Use see
a_2	Shoulder (biacromial) breadth			ISO 7250 : 1996 4.2.8	table 4
a_{17}	Hip breadth, sitting			ISO 7250 : 1996 4.2.11	tables 5 and 7
b_2	Grip reach; forward reach			ISO 7250 : 1996 4.4.2	table 4
b_{15}	Buttock-abdomen depth sitting			ISO 7250 : 1996 4.2.17	tables 5 and 6
b_{18}	Thigh clearance			ISO 7250 : 1996 4.2.13	tables 5 and 6
c_1	Buttock-knee length			ISO 7250 : 1996 4.4.7	tables 5 and 6
c_2	Foot length			ISO 7250 : 1996 4.3.7	tables 5, 6, 7 and 8
d_1	Upper arm diameter, fixed value			ISO 15534-3	t_2 based on this
h_1	Stature (body height)			ISO 7250 : 1996 4.1.2	table 6
h_4	Elbow height			ISO 7250 : 1996 4.1.5	tables 6 and 8

(continued)