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Office furniture — Office chairs — Methods for the determination of dimensions

Mobilier de bureau — Sièges de travail pour bureau — Méthodes pour déterminer les dimensions

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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 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 136 *Furniture*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 24496:2017), which has been technically revised. The main changes compared to the previous edition are as follows:

— term 3.2 "Angle – Origin and sign convention" has been turned into a new Clause 4.5; numbering of terms and definitions was adapted accordingly, as well as numbering of Figures 2 to 27;

— symbols used in Figures 3 to 7, 9, 10, 13 to 15, 18 to 22, 24 to 26, 52 to 55, and 61 were revised;

— the definition of backrest width has been revised; 3.10, Figure 9 and 6.3.4.4 have been changed accordingly;

— in 6.3.1.1, a specification of the most prominent point has been given and the tolerances adapted;

— specification of the measurement has been described in 6.3.2.2;

— values given in 3.3 and Figure 3, 6.3.4.8 and Figure 61 have been corrected;

— Figure 56 has been revised;

— Annex C has been fully revised;

— Bibliography has been updated.

Introduction

A new office chair measurement method and a new chair measuring device (CMD) was developed in order to end the use of numerous sometimes conflicting chair measurement methods and CMDs with their particular weaknesses used in different countries around the world and make it easier to compare office chairs. The measurement methods and designs of CMDs considered during the development of this standard were from BIFMA CMD-1; BS 5940-1; DIN 4551; EN 1335–1; Sedometer according to 2 PfG 947; NF D 61040; SS 83 91 40 and UNI 7498.

The measurement method and the CMD developed in this standard used the strengths of the above mentioned measurement methods and CMDs.

The list of chair dimensions that can be measured using this standard are the dimensions measured in the standards listed above as well as additional ones which are based on the ergonomic factors listed in ISO 9241-5.

The test methods in this document are based on the manner in which anthropometric dimensions are measured.

Therefore, in order to be able to relate the dimensions of office seating to the anthropometric dimensions, a theoretical reference seating posture has been adopted. However, this posture does not automatically correspond to the ideal or optimum seating posture.

The reference seating posture is as follows:

— the sole of the foot placed on the floor;

— the foot forms an angle of approximately 90° with the lower leg;

— the lower leg is approximately vertical;

— the lower leg forms an angle of approximately 90° with the thigh;

— the thigh is almost horizontal;

— the thigh forms an angle of approximately 90° with the trunk;

— the trunk is erect.

Further information on the anthropometric dimensions can be found in ISO 7250-1, the ISO 20685 series and ISO 14738.

This document describes measurement methods. It can be used in conjunction with other relevant documents giving dimensional requirements.

For the rationale for the provisions contained in this document, see Annex C.

Office furniture — Office chairs — Methods for the determination of dimensions

1 Scope

This document specifies methods for the determination of the dimensions of office chairs.

This document does not contain dimensional specifications or requirements.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

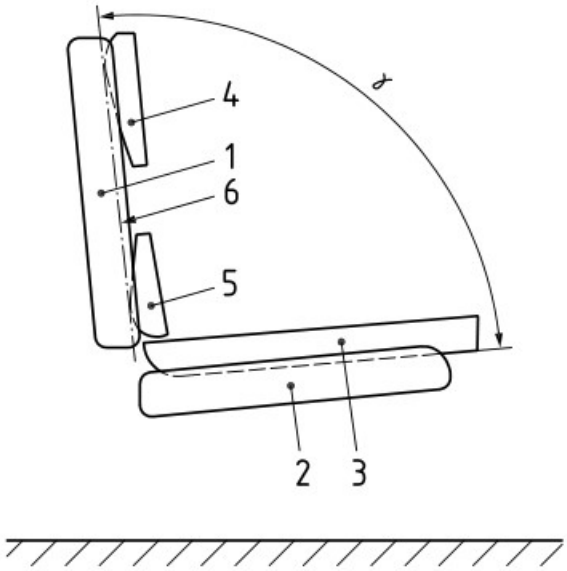
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

NOTE For the anthropometric equivalents of the terms and definitions, see Annex B.

3.1
angle between backrest and seat
γ
angle between the loaded backrest and the loaded seat

Note 1 to entry: See Figure 1.



Key

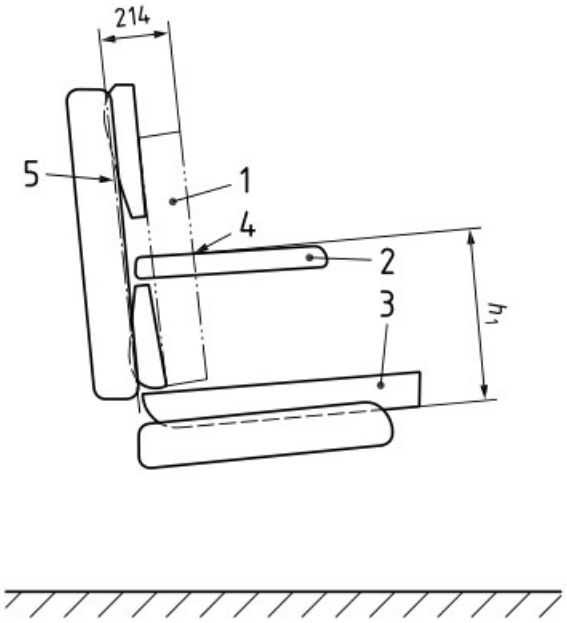
1 backrest
2 seat
3 chair measurement device (CMD) buttocks pad
4 CMD thoracic pad
5 CMD pelvic pad
6 backrest line
γ angle between backrest and seat

Figure 1 — Angle between backrest and seat

3.2
armrest height
distance from the top surface of the armrest to the bottom of the loaded CMD buttocks pad parallel to the backrest line at a distance of 214 mm from the backrest line

Note 1 to entry: See Figure 2.

Dimensions in millimetres



Key

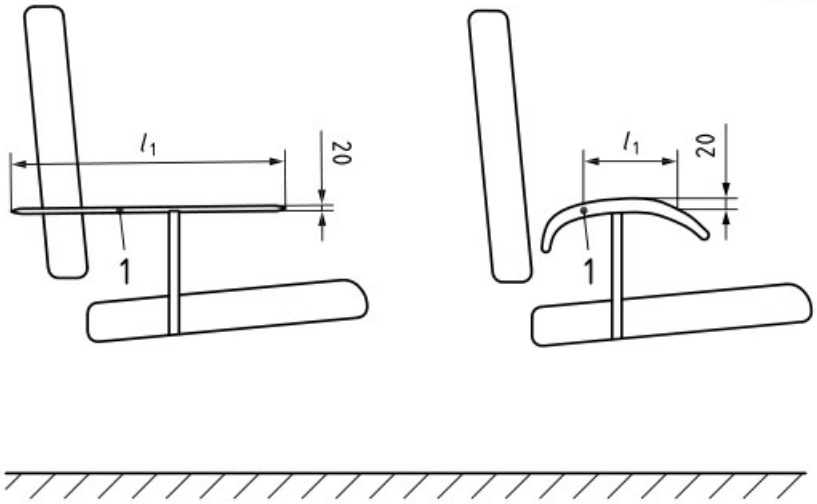
1 CMD vertical member
2 armrest
3 CMD buttocks pad
4 intersection of projection of vertical member front face and armrest
5 backrest line
h_1 armrest height

Figure 2 — Armrest height

3.3
armrest length
distance along the armrest within an envelope down from the top of the armrest that is 20 mm deep

Note 1 to entry: See Figure 3.

Dimensions in millimetres



Key

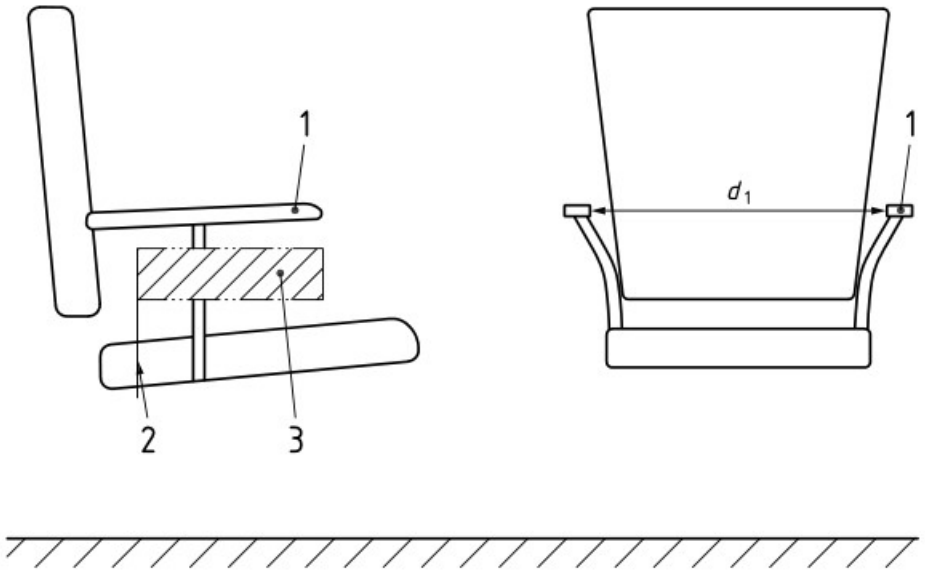
1 armrest

l_1 armrest length

Figure 3 — Armrest length

3.4
distance between armrests
horizontal distance between armrests from the rear of the seat surface width zone forward to the front edge of the seat within the measurement zone 5 mm down from the top of the armrest

Note 1 to entry: See Figure 4, Figure 6 and *seat surface width zone* (3.27).



Key

1 armrest

2 rear of seat width zone

3 armrest pad measurement zone

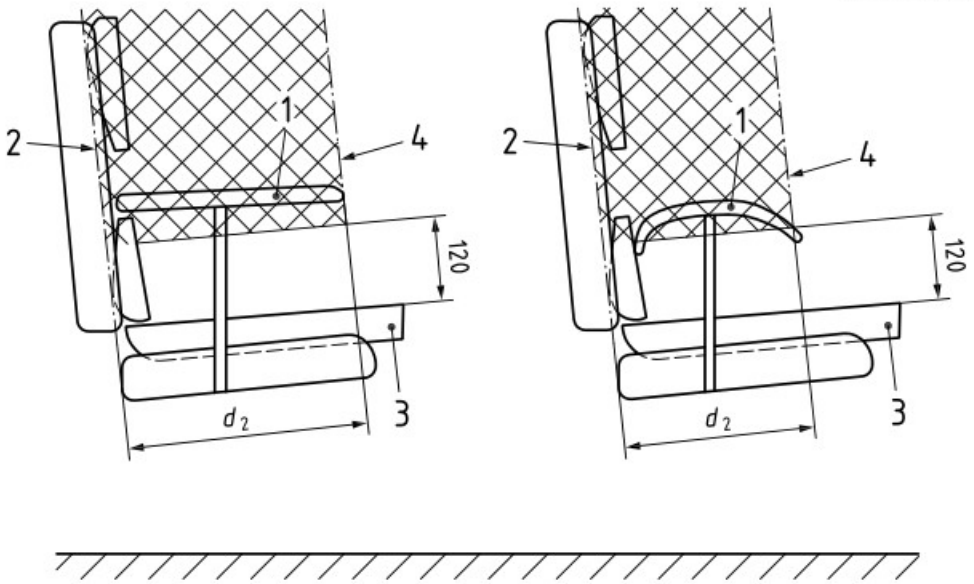
d_1 distance between armrests

Figure 4 — Distance between armrests

3.5
front of armrest position
perpendicular distance from the backrest line to the front of the armrest that is in the measurement zone 120 mm and greater above the top surface of the loaded CMD buttocks pad

Note 1 to entry: See Figure 5.

Dimensions in millimetres



Key

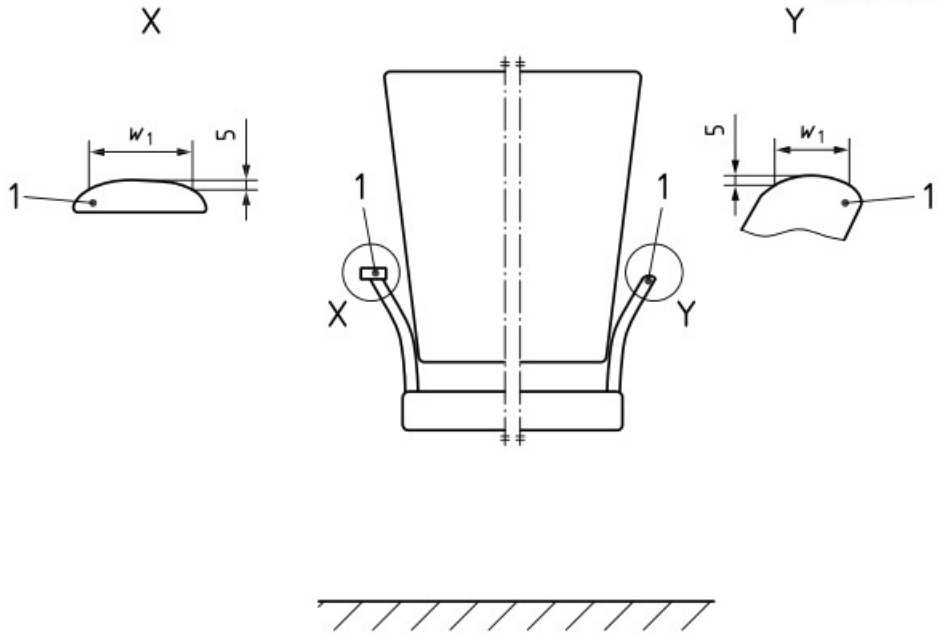
1 armrest
2 backrest line
3 CMD buttocks pad
4 measurement zone
d_2 front of armrest position

Figure 5 — Front of armrest position

3.6
armrest width
horizontal distance across the armrest within the measurement zone 5 mm down from the top of the armrest

Note 1 to entry: See Figure 6.

Dimensions in millimetres



Key

1 armrest

w_1 armrest width

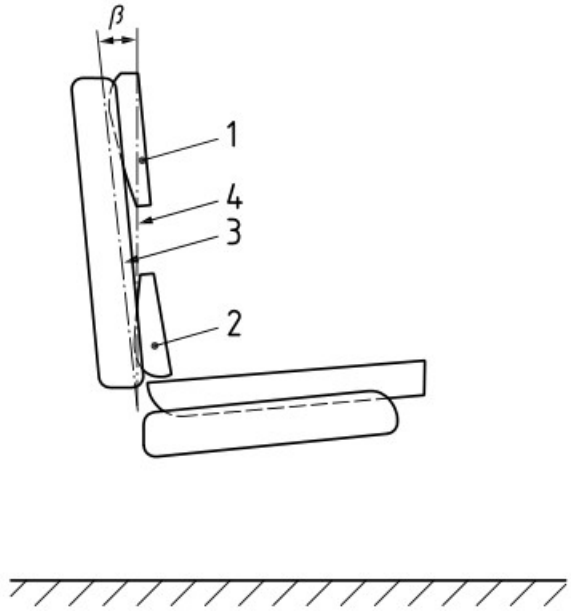
Figure 6 — Armrest width

3.7
backrest to seat movement ratio
ratio of change of the backrest angle relative to the change of angle of the seat that occurs when a seat and backrest move concurrently

Note 1 to entry: Does not apply to chairs with seat and/or back angles that only move independently.

3.8
backrest angle to vertical
β
angle between vertical and the loaded backrest

Note 1 to entry: See Figure 7.



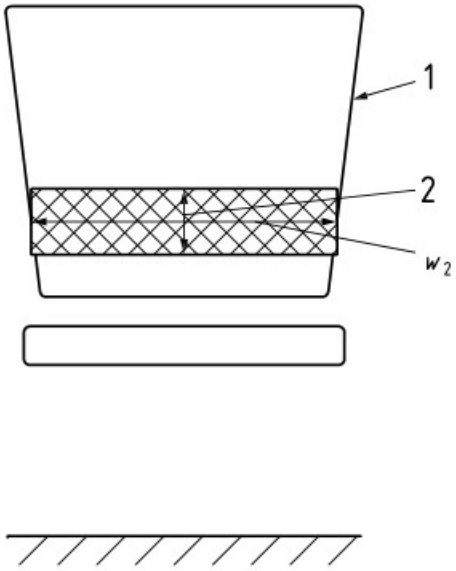
Key

1 CMD thoracic pad
2 CMD pelvic pad
3 backrest line
4 vertical
β backrest angle to vertical

Figure 7 — Backrest angle to vertical

3.9
backrest width
horizontal dimension of the backrest in the middle of the lumbar zone height

Note 1 to entry: See Figure 8 and *lumbar zone* (3.17).



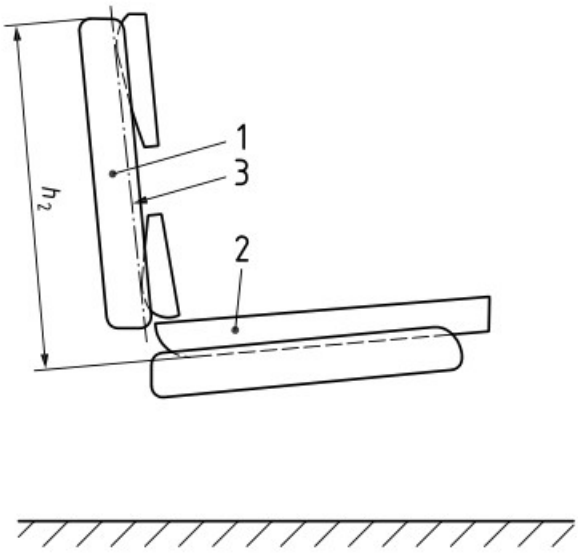
Key

1 backrest
2 lumbar zone
w_2 backrest width

Figure 8 — Backrest width

3.10
backrest height
distance from the loaded seat to the top of the backrest, measured parallel to the backrest line

Note 1 to entry: See Figure 9.



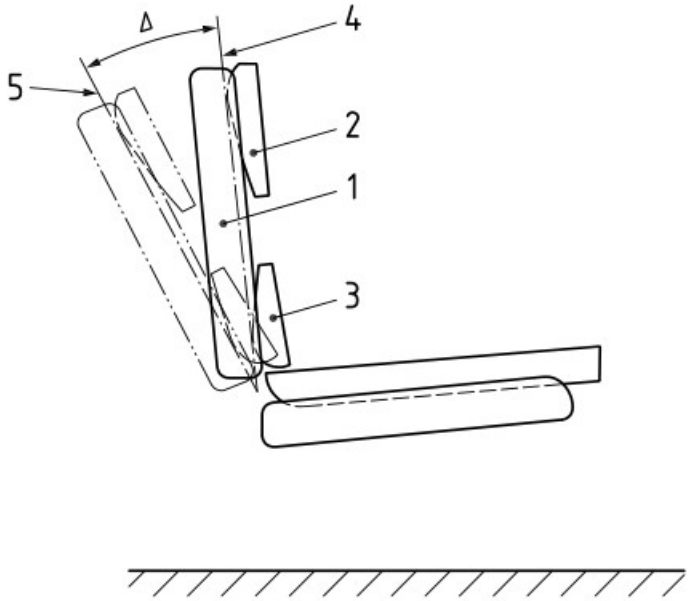
Key

1 backrest
2 CMD buttocks pad
3 backrest line
h_2 backrest height

Figure 9 — Backrest height

3.11
backrest inclination range
tilt range of the backrest from its foremost inclination to its most rearward inclination

Note 1 to entry: See Figure 10.



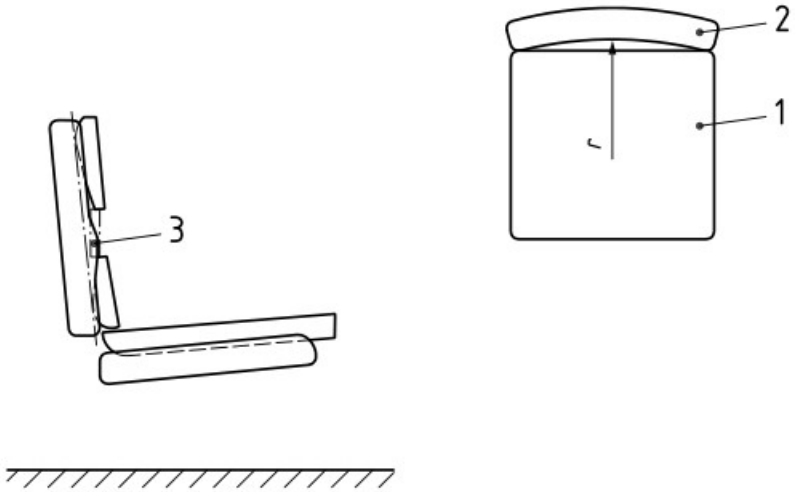
Key

1 backrest
2 CMD thoracic pad
3 CMD pelvic pad
4 forward most tilt backrest line
5 rearward most tilt backrest line
Δ range of backrest inclination

Figure 10 — Backrest inclination range

3.12
horizontal backrest radius
horizontal radius of the backrest measured within the lumbar zone

Note 1 to entry: See Figure 11 and *lumbar zone* (3.17).



Key

1 seat
2 backrest
3 lumbar zone
r horizontal radius of backrest

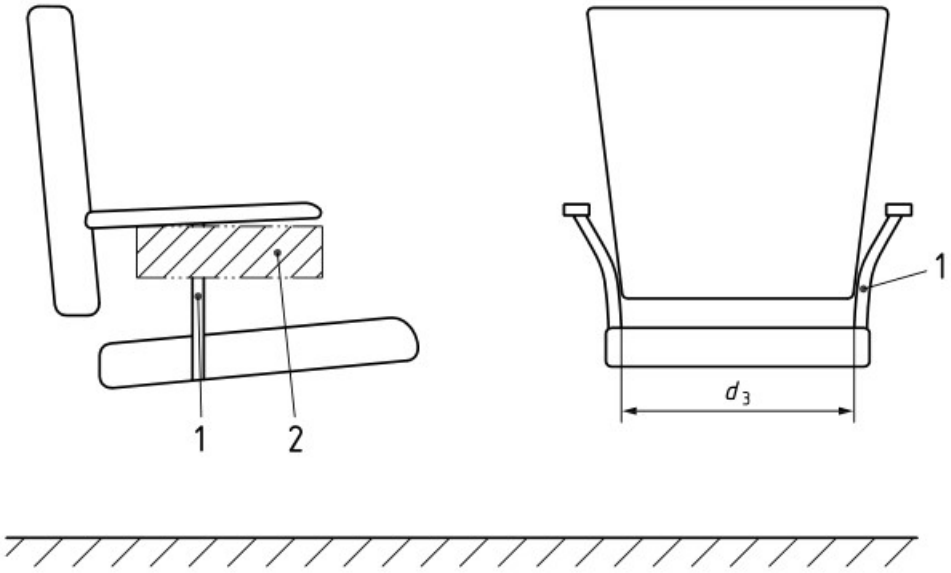
Figure 11 — Horizontal backrest radius

3.13
chair measuring device
CMD
instrument for measuring dimensions of chairs

Note 1 to entry: Specified in Annex A.

3.14
hip breadth clearance
minimum horizontal distance between armrest assembly from the rear of the seat surface width zone forward to the front edge of the armrest or armrest assembly as measured above the top of the seat surface

Note 1 to entry: See Figure 12 and *seat surface width zone* (3.27).



Key

1 armrest assembly

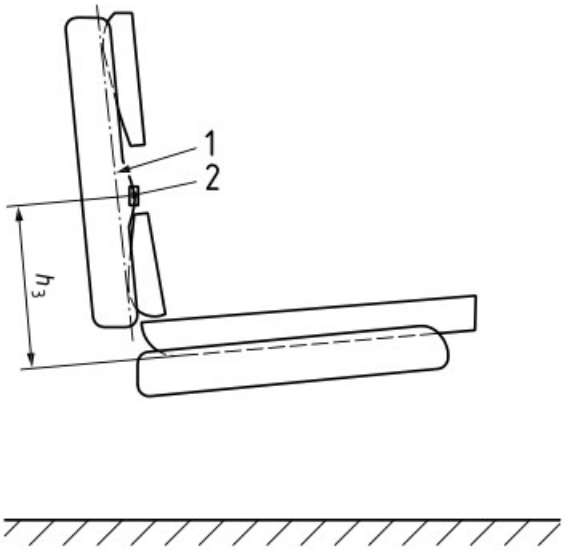
2 rear of seat surface width zone to front of armrest

d_3 hip breadth clearance

Figure 12 — Hip breadth clearance

3.15
lumbar support height
distance from the loaded seat to the most prominent segment (or segments) of the lumbar support as determined by the measuring indicators on the CMD, measured parallel to the backrest line

Note 1 to entry: See Figure 13 and Figure 35.



Key

1 backrest line

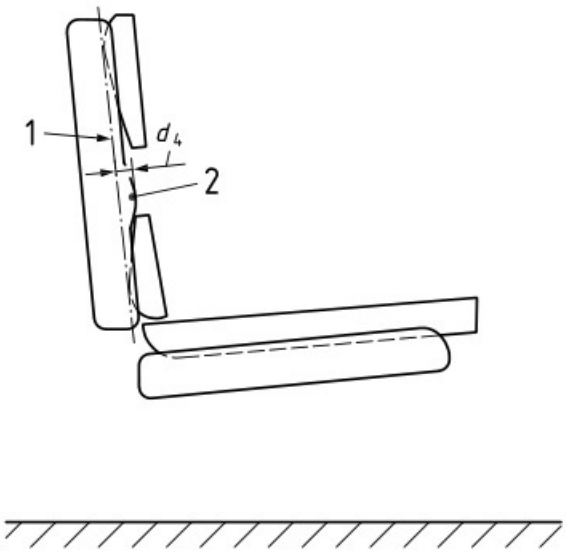
2 the most prominent segment (or segments) of the lumbar support

h_3 height of lumbar support

Figure 13 — Lumbar support height

3.16
lumbar support protrusion
distance from the backrest line to the most prominent segment (or segments) of the lumbar support as determined by the measuring indicators on the CMD, measured perpendicular to the backrest line

Note 1 to entry: See Figure 14 and Figure 35.



Key

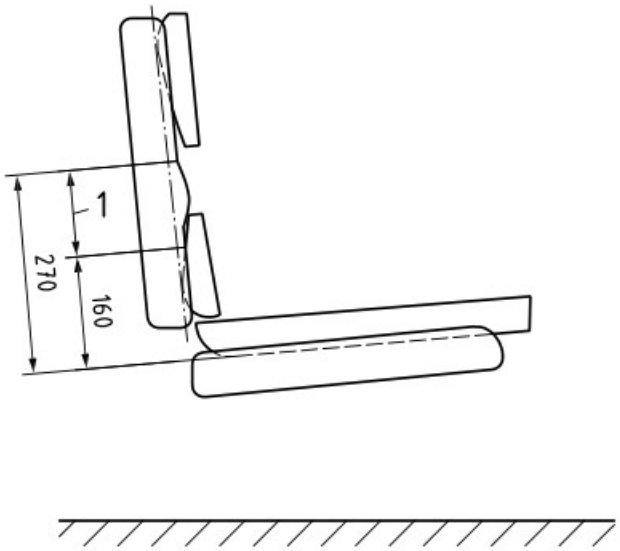
1 backrest line
2 most prominent segment (or segments) of the lumbar support
d_4 protrusion of lumbar support

Figure 14 — Lumbar support protrusion

3.17
lumbar zone
area that is parallel to the backrest line, 160 mm to 270 mm above the bottom of the loaded CMD buttocks pad

Note 1 to entry: See Figure 15.

Dimensions in millimetres



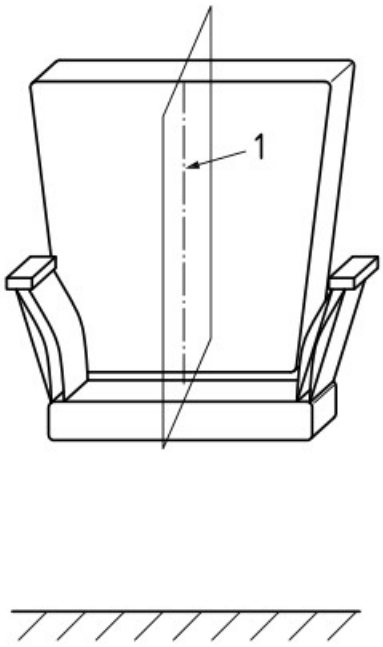
Key

1 lumbar zone

Figure 15 — Lumbar zone

3.18
median plane
vertical plane dividing the chair into two generally symmetrical parts (right and left)

Note 1 to entry: See Figure 16.



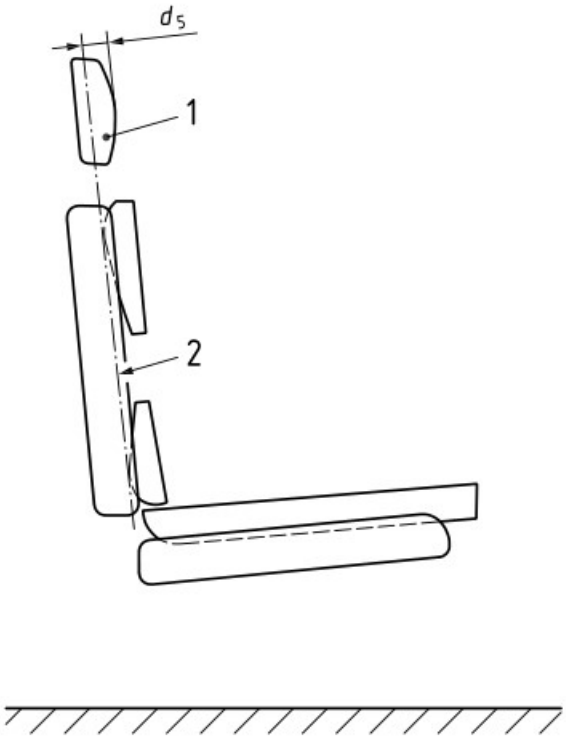
Key

1 median plane

Figure 16 — Median plane

3.19
neck/head rest protrusion
perpendicular distance from the backrest line to the foremost protrusion on the neck/head rest

Note 1 to entry: See Figure 17.



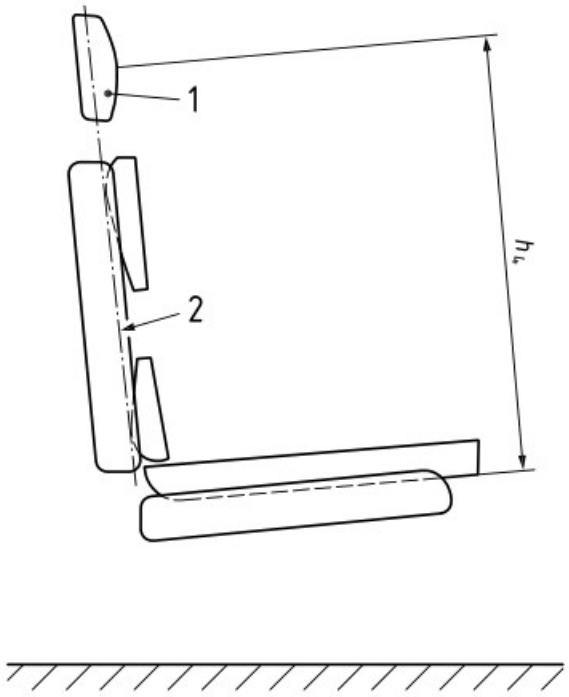
Key

1 neck/head rest
2 backrest line
d_5 neck/head rest protrusion

Figure 17 — Neck/head rest protrusion

3.20
neck/head rest height
distance from the loaded seat to the most prominent segment of the neck/head rest, measured parallel to the backrest line when the neck/head rest is in its most vertical position

Note 1 to entry: See Figure 18.



Key

1 neck/head rest

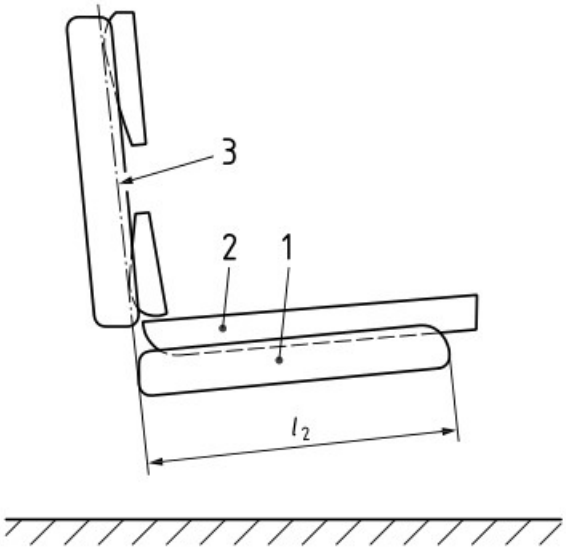
2 backrest line

h_4 neck/head rest height

Figure 18 — Neck/head rest height

3.21
seat depth
distance from the backrest line measured parallel to the CMD buttocks pad to the front of the seat

Note 1 to entry: See Figure 19.



Key

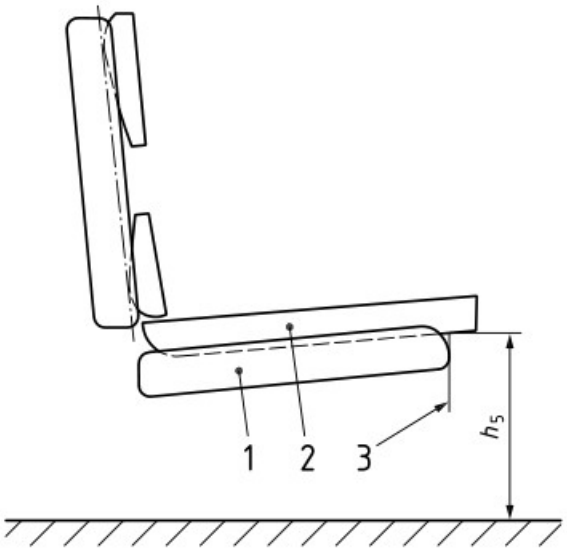
1 seat
2 CMD buttocks pad
3 backrest line
l_2 seat depth

Figure 19 — Seat depth

3.22
seat height
vertical distance, measured at the front of the seat, from the loaded seat to the floor

Note 1 to entry: See Figure 20.

Note 2 to entry: Adjustment of the seat inclination does not constitute a change in seat height.



Key

1 seat
2 CMD buttocks pad
3 front of seat
h_5 seat height

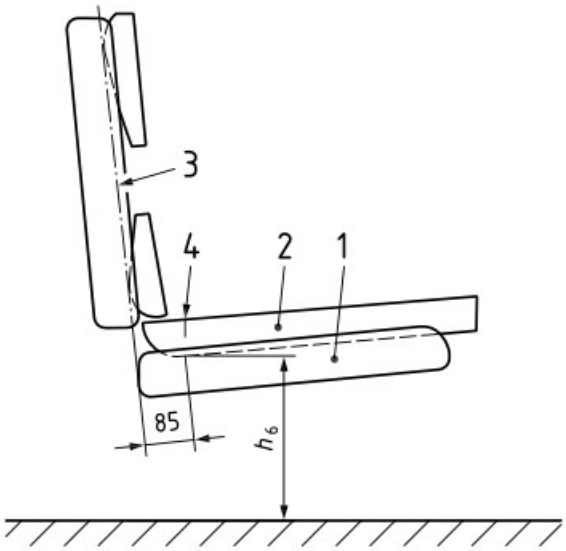
Figure 20 — Seat height

3.23
sitting height
vertical distance, measured 85 mm in front of the CMD backrest line, from bottom of the loaded CMD buttocks pad to the floor

Note 1 to entry: See Figure 21.

Note 2 to entry: Adjustment of the seat inclination does not constitute a change in sitting height.

Dimensions in millimetres



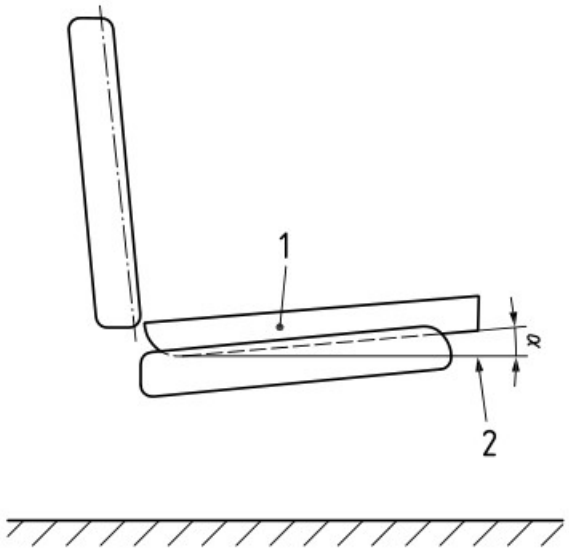
Key

1 seat
2 CMD buttocks pad
3 backrest line
4 sitting height line marked on the CMD
h_6 sitting height

Figure 21 — Sitting height

3.24
seat inclination
angle between the loaded CMD buttocks and the horizontal

Note 1 to entry: See Figure 22.



Key

1 CMD buttocks pad

2 horizontal

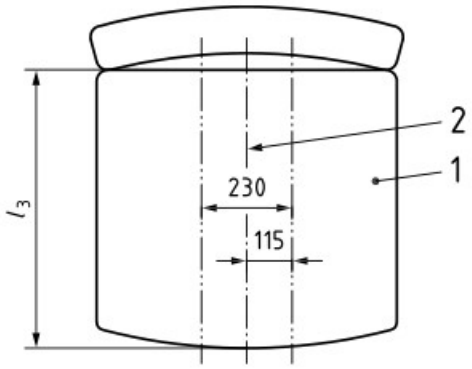
α seat inclination

Figure 22 — Seat inclination

3.25
seat surface depth
dimension of the least seat depth within the zone, 115 mm either side of the median plane

Note 1 to entry: See Figure 23.

Dimensions in millimetres



Key

1 seat

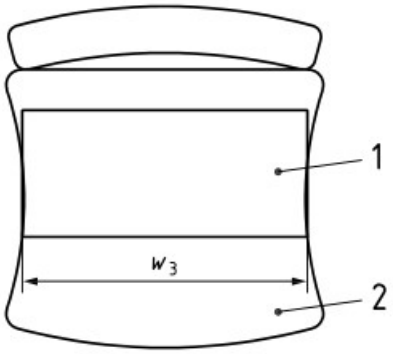
2 median plane

l_3 seat surface depth

Figure 23 — Seat surface depth

3.26
seat surface width
smallest dimension of the seat surface within the seat surface width zone marked on the CMD

Note 1 to entry: See Figure 24 and *seat surface width zone* (3.27).



Key

1 seat surface width zone

2 seat

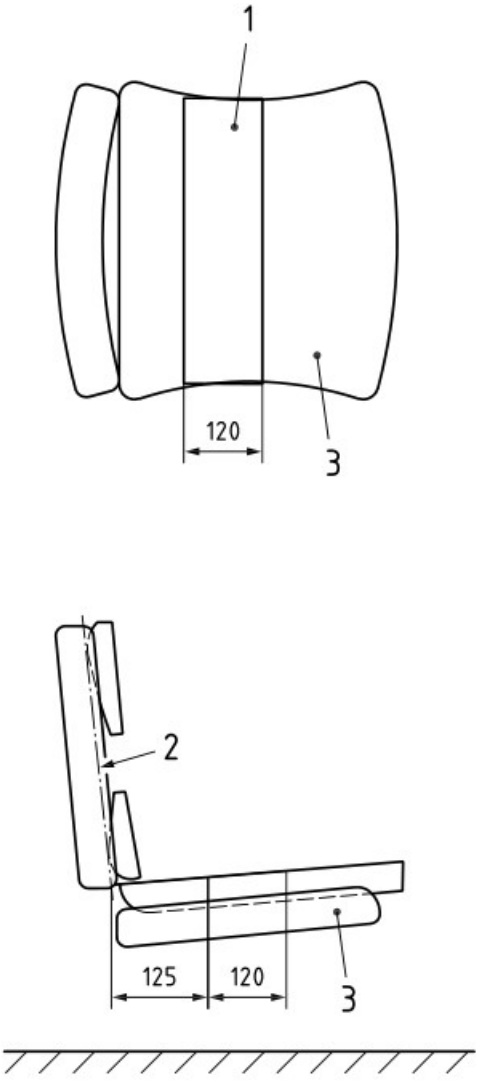
w_3 seat surface width

Figure 24 — Seat surface width

3.27
seat surface width zone
area along the seat surface, from 125 mm forward of the backrest line to 120 mm forward of the 125 mm line that supports the user's buttocks as marked on the CMD

Note 1 to entry: See Figure 25.

Dimensions in millimetres



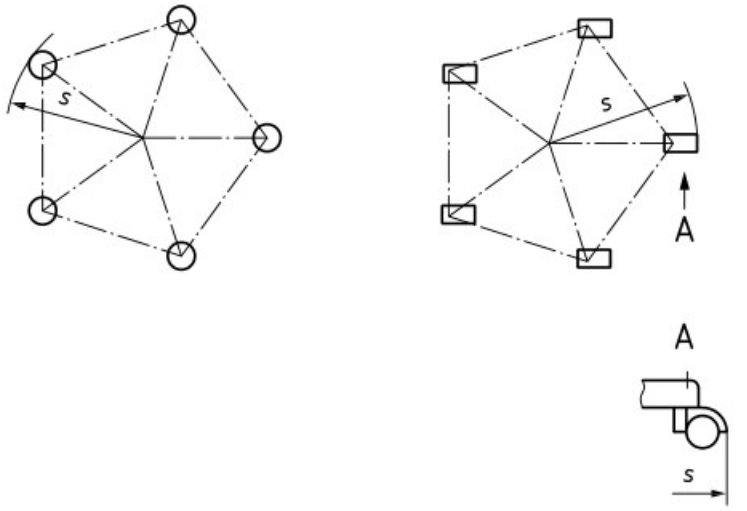
Key

1 seat surface width zone
2 backrest line
3 seat surface

Figure 25 — Seat surface width zone

3.28
maximum off-set of the underframe
maximum distance between the outermost point of the underframe including castors or glides and the axis of rotation

Note 1 to entry: See Figure 26.



a) Underframe without castors **b) Underframe with castors**

Key

s maximum off-set of underframe

Figure 26 — Underframe — Maximum off-set

4 General measurement conditions

4.1 General

Caution shall be used to ensure that any chair movement, adjustments and/or applied forces do not dislodge the CMD causing injury to the user or damage to the CMD.

4.2 Preliminary preparation

The chair shall be assembled and/or configured according to the instructions supplied with it. If mounting or assembly instructions are not supplied, the mounting or assembly method shall be recorded in the report.

All adjustments shall be operated through their range of adjustments at least one time before measurements are taken.

If a measurement cannot be taken as specified in the procedures due to the design of the product, it shall be carried out as far as possible as described, and deviations from the measurement procedure shall be recorded in the test report.

The test shall be carried out in indoor ambient conditions. If during a test, the temperature is outside of the range of 15 °C to 25 °C, the maximum and/or minimum temperature shall be recorded in the test report.

4.3 Tolerances

The following equipment tolerances shall be applicable unless otherwise specified:

— Forces: specified in the relevant clauses;

— Masses: ±1 % of the nominal mass;

— Dimensions: ±1 mm of the nominal dimension;

— Angles: ±1° of the nominal angle.

Test masses, forces, dimensions and angles shall be targeted at the nominal values specified.

4.4 Measurement uncertainty

The measurement uncertainties according to Table 1 shall be applicable unless otherwise specified.

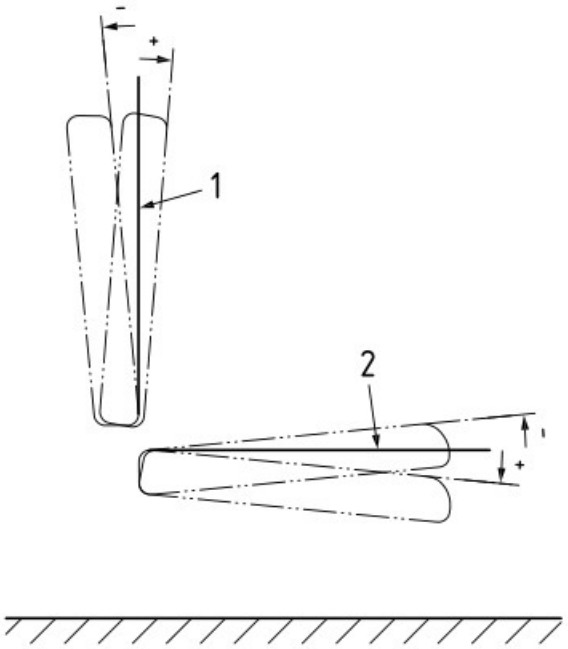
A rationale explaining the background of the measurement uncertainty is contained in C.6.

Table 1 — Measurement uncertainty

Subclause	Measurement description	Uncertainty at 95 % confidence level ($k = 2$)
6.3.1.1	Lumbar support horizontal protrusion	±15 mm
6.3.1.1	Lumbar support vertical height	±25 mm
6.3.1.2	Seat angles	±2°
6.3.1.2	Backrest angles	±4°
6.3.1.2	Backrest to seat angles	±4°
6.3.2.2 or 6.3.3.2	Seat height	±8 mm
6.3.2.2 or 6.3.3.2	Sitting height	±15 mm
6.3.2.3 or 6.3.3.3	Seat depth	±25 mm
6.3.2.4 or 6.3.3.4	Backrest height	±15 mm
6.3.2.5 or 6.3.3.5	Front of armrest position	±40 mm
6.3.2.7 or 6.3.3.6	Armrest height	±10 mm
6.3.4.2	Seat surface width	±10 mm
6.3.4.3	Seat surface depth	±25 mm
6.3.4.4	Backrest width	±10 mm
6.3.4.5	Backrest horizontal radius	Not applicable
6.3.4.6	Armrest length	±5 mm
6.3.4.7	Armrest width	±5 mm
6.3.4.8	Hip breadth clearance	±20 mm
6.3.4.9	Distance between armrests	±60 mm
6.3.4.10	Off-set of the underframe	±8 mm

4.5 Angle — Origin and sign convention

For all angle measurements the view shall be from the right side of the chair seen from the user seated in the chair. The origin is the horizontal reference line and the angle sign convention is clockwise when the angle rotation is positive (+) and counterclockwise when negative (–), see Figure 27.



Key

1 vertical (−90°)

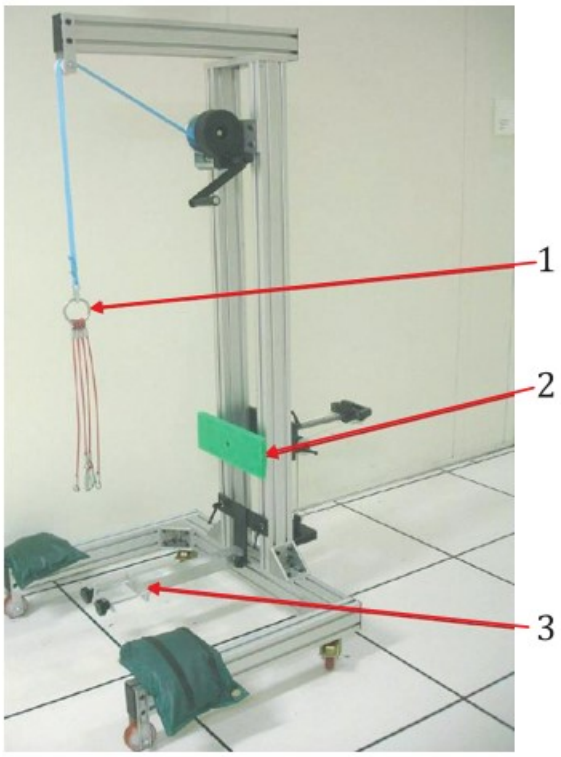
2 horizontal (0°)

Figure 27 — Angle — Origin and sign convention

5 Test equipment

5.1 Floor surface, rigid, horizontal and flat.

5.2 CMD placement fixture, which holds the chair in position while applying the horizontal force and lowering the CMD into the chair. This device shall not prevent adjustment of the chair. An example of the device (or devices) is shown in Figure 28 and Figure 29.



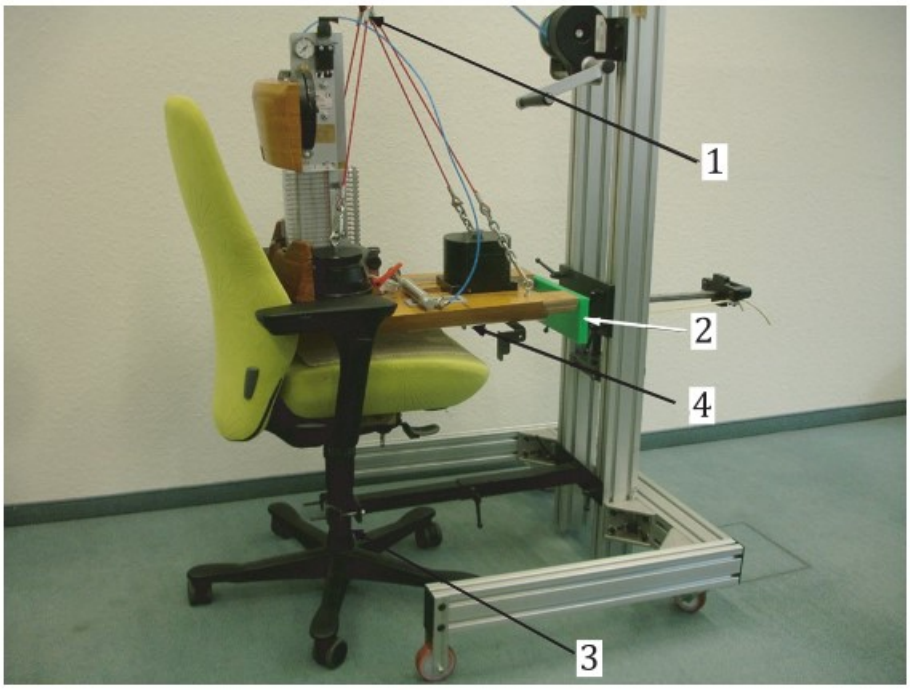
Key

1 CMD lowering crane

2 horizontal force loading device [see 6.2.2 e)]

3 chair base restraint mechanism

Figure 28 — Example of CMD placement fixture without chair



Key

1 CMD lowering crane

2 horizontal force loading device [see 6.2.2 e)]

3 chair base restraint mechanism

4 CMD

Figure 29 — Example of CMD placement fixture with chair and CMD

5.3 Chair measuring device (CMD), as specified in Annex A.

5.4 High friction material, (cloth) placed between the seat and the CMD in order to prevent the CMD from sliding on the seat during measurements. It can be, for example, an anti-slip material used underneath carpets. The thickness of the material, when compressed by the CMD, shall not exceed 1 mm.

6 Measurement methods and procedures

6.1 General

The measurements shall be taken to determine the dimensions and angles of the chair.

After the chair set-up and the CMD placement (see 6.2), the measurements shall be taken as specified in the measurement procedures (see 6.3).

6.2 Chair set-up and placement of CMD

6.2.1 Chair set-up

a) Position the chair on the floor surface (see 5.1) with the seat in the highest position.

b) Adjust all of the following to the mid-position of their range: seat depth, backrest tilt tension, backrest height, and lumbar devices. If an exact mid-position is not possible, then set the adjustable element to its next greater position. If there are independently adjustable lumbar device(s), adjust

the height to the approximate midpoint of the lumbar adjustment range, then adjust the protrusion to its mid-position, if that can be done without altering the height setting.

c) Adjust the seat so that it is in an approximately horizontal position that is counter-clockwise of the horizontal without forcing the functions of the chair. If the chair has no position counter-clockwise of the horizontal, set at most horizontal position without forcing the functions of the chair.

d) If independently adjustable, position the backrest so that the support surface is approximately vertical. If the adjustment of the backrest to a vertical position changes the seat inclination, the horizontal seat position shall take precedence.

e) Mark a line in the centre of the backrest so that the mark is visible from the top of the backrest. Place marks on either side of the seat 182 mm from the seat's centre near the front of the seat to assist in placing the CMD centrally in the chair.

6.2.2 Initial placement of CMD on chair

a) Load the CMD as illustrated in Annex A.

b) Place a layer of high friction material (5.4) between the CMD and the seat in order to ensure that the CMD does not slide on the seat.

c) The vertical member of the CMD shall be locked at 90° until step g) (see Figure 30).

Key

1 CMD vertical member to buttocks lock

Figure 30 — CMD vertical member locked

d) Place and attach the chair in the CMD placement fixture (see 5.2), so that CMD vertical member is close to, but not touching, the chair's backrest.

e) Ensure the CMD, chair and chair fixture are in alignment with the median plane. Ensure that the CMD buttocks pad is as horizontal as possible. Place the CMD seat depth indicator at a position that will be near, but not in contact with, the front edge of the seat as the CMD is lowered on to the chair. Lower the CMD until it is just above seat (no part of the CMD shall touch the seat) and just in front of the backrest (see Figure 31).

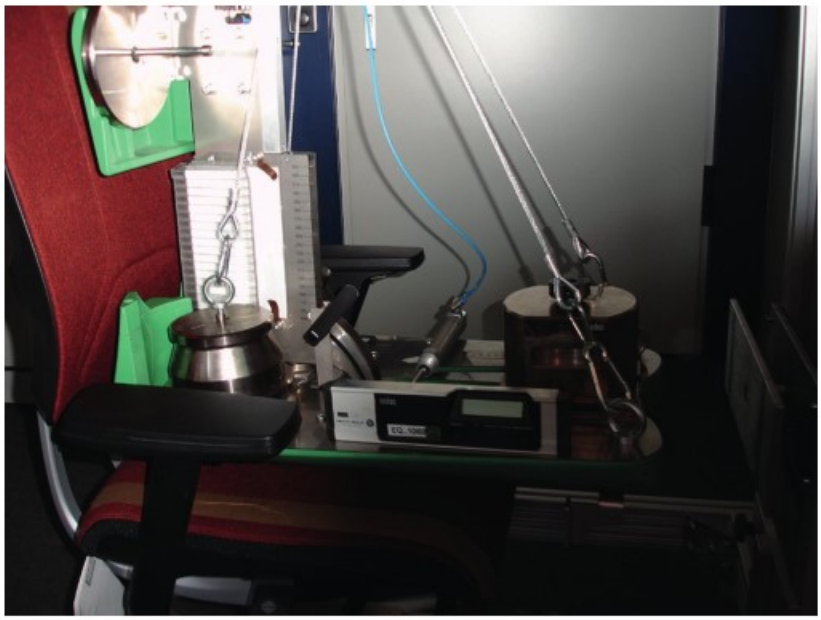
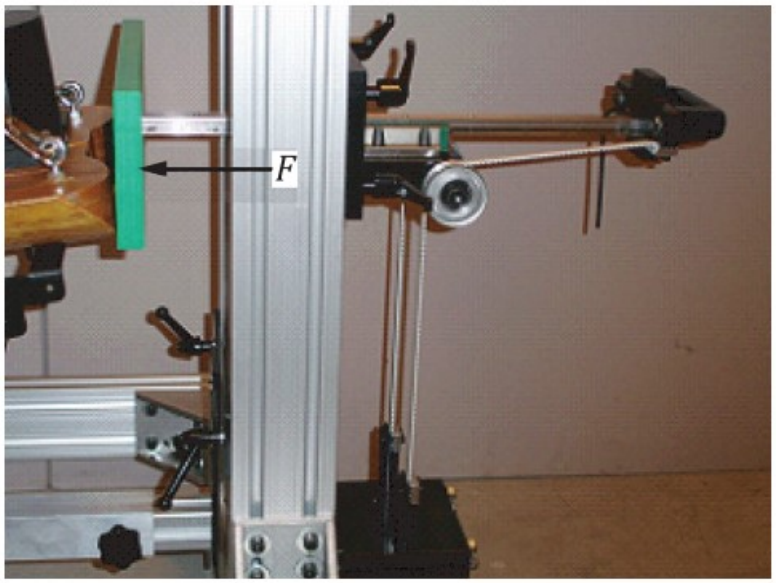


Figure 31 — CMD hovering above chair

f) Push the CMD towards the backrest with a force, *F*, of (40 ± 2) N (see Figure 32).



Key

F force of (40 ± 2) N

Figure 32 — Installation fixture force application

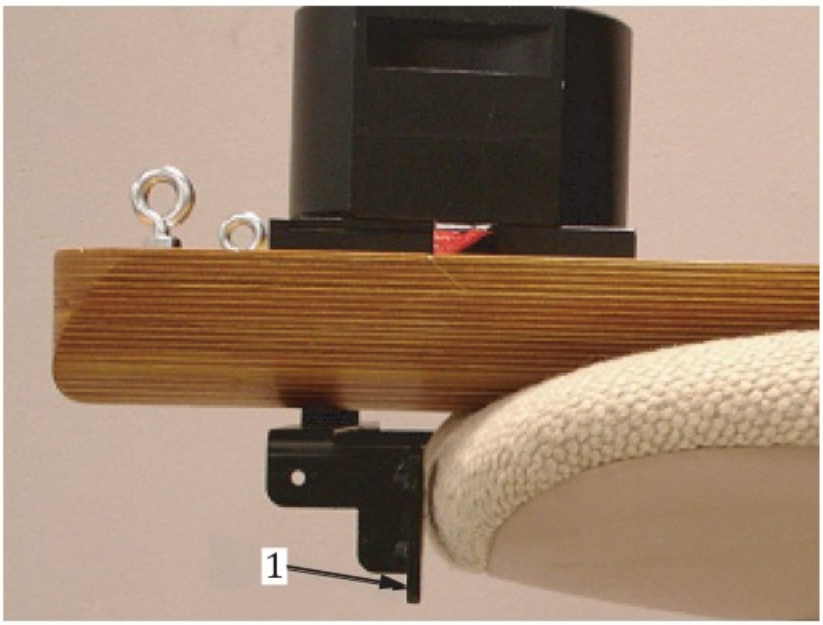
g) With this force acting, lower the CMD on to the seat while maintaining CMD alignment with the median plane. Use the previously located marks at the top of the backrest and the front of the seat to help keep the CMD aligned with the chair. Ensure that the seat depth indicator does not touch the chair during loading/placement.

NOTE It can be difficult to keep the CMD in the correct orientation as it is lowered into position. It can be helpful to have two people perform this operation.

h) Release the vertical member lock.

i) Remove the force, *F*.

j) Position the CMD seat depth indicator so that it is just touching the front edge of the seat (see Figure 33).



Key

1 seat depth indicator

Figure 33 — Location of the seat depth indicator

6.2.3 Final placement of CMD on chair

With the CMD fully resting on the seat, re-adjust the chair (typically by adjusting the seat inclination), if needed, so that the CMD buttocks pad is in the nearest horizontal position [see 6.2.1 c)]. After placing the CMD in the chair, lock the vertical member in its position.

NOTE This can require removal and re-placing of the CMD.

If any adjustments to the chair were made, relock the vertical member at 90°, remove the CMD and follow the procedure in 6.2.2 to reposition the CMD in the chair.

Mark the chair with the seat surface width zone identified on the CMD (3.27).

Mark the top of the lumbar zone (see 3.17) as defined.

6.3 Measuring procedures

6.3.1 Initial chair measurements

6.3.1.1 Lumbar support protrusion and height

When directed, apply a force perpendicular to the vertical member of the CMD simultaneously through each of 18 vertically stacked segments. The bottom of the lowest segment shall start at 150 mm from the base of the buttocks pad. Each segment shall apply a force of (3,5 ± 1,0) N against the backrest through a 10 mm high by 60 mm wide surface area. It is not necessary to maintain the 3,5 N force while the protrusion values are being recorded, unless movement of the segments is noted after the initial force application and before the values can be noted. The scale on the CMD shall be used to indicate the height and depth of the most prominent segment of the lumbar protrusion (see Figure 40 and Figure 41).

Most prominent segment: More than one segment may have the same or almost the same protrusion. If the difference is ≤1 mm (from the most protruded segment) the segments shall be considered to have the same protrusion.

The 3,5 N force is applied to the segments through air cylinders that are actuated by pressure from a hand pump. As an example, for a 6 mm cylinder, the 3,5 N force is typically achieved when 1,2 atmospheres pressure is applied. Other diameter cylinders can require a different pressure to achieve the 3,5 N force.

A Maximum horizontal protrusion

Make the various lumbar support protrusion depth adjustments available to cause the lumbar horizontal protrusion to be its greatest dimension. Apply the 3,5 N force to each segment. Record this dimension as the maximum lumbar horizontal protrusion. Record the lumbar support height at this setting. If the greatest lumbar horizontal protrusion is the same over more than one height indication, record all those heights (bottom of lowest segment to top of highest segment) with the same horizontal protrusion. Remove the force (pressure) and return the segments to their start position by pushing them back with your hand.

B Minimum horizontal protrusion

Without adjusting the height of the lumbar support, adjust the lumbar horizontal protrusion (horizontal adjustment), if any, to cause the lumbar support horizontal protrusion to be its least dimension. Reapply the force of (3,5 ± 1,0) N to the vertically stacked segments. Record this dimension as the minimum lumbar horizontal protrusion.

Calculate the difference between the maximum and minimum horizontal protrusion measurements and record the difference as the protrusion adjustment range.

Remove the force (pressure) on the vertically stacked segments and return them to their start position. Readjust the lumbar protrusion settings so that the lumbar protrusion depth is at its maximum.

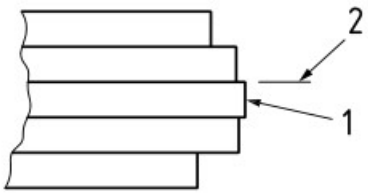
C Maximum vertical height

When available, make the various backrest and lumbar adjustments such that the lumbar support is at the greatest height that can be attained. If the backrest is to be adjusted, move the CMD vertical member to its 90° position and lock it. After the adjustments are complete, release the lock, let it settle into place, then relock it. Reapply the force of (3,5 ± 1,0) N to the vertically stacked segments.

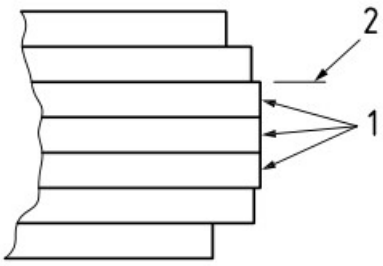
If only one segment is at a horizontal protrusion, record the dimension of the top of the segment as maximum lumbar height [see Figure 34 a)].

If more than one segment is at a maximum horizontal protrusion, record the dimension of the top of the highest segment as maximum lumbar height [see Figure 34 b)].

Remove the force on the vertically stacked segments and return them to their start position.



a) Maximum vertical height — One segment



b) Maximum vertical height — Multiple segments

Key

1 segment with maximum horizontal protrusion

2 maximum lumbar height

3 multiple segments with maximum horizontal protrusion

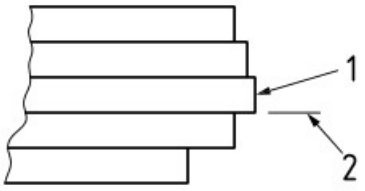
Figure 34 — Maximum vertical height

D Minimum vertical height

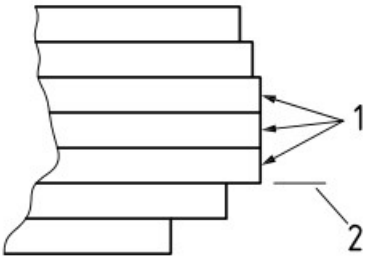
When available, make the various backrest and lumbar adjustment such that the lumbar support is at the least height that can be attained. If the backrest is to be adjusted, move the CMD vertical member to its 90° position and lock it. After the adjustments are complete, release the lock, let it settle into place, then relock it. Reapply the force of (3,5 ± 1,0) N to the vertically stacked segments.

If only one segment is at a maximum horizontal protrusion, record the dimension of the bottom of the segment as minimum lumbar height [see Figure 35 a)].

If more than one segment is at a maximum horizontal protrusion, record the dimension of the bottom of the lowest segment as minimum lumbar height [see Figure 35 b)].



a) Minimum vertical height — One segment



b) Minimum vertical height —Multiple segments

Key

1 segment with maximum horizontal protrusion

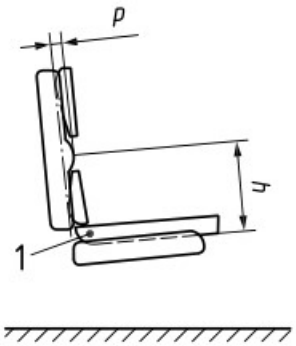
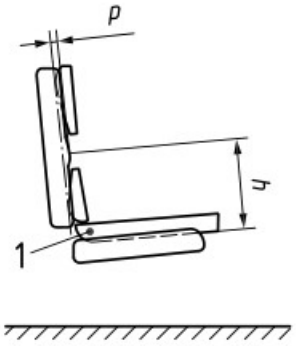
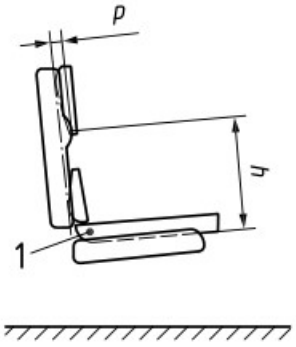
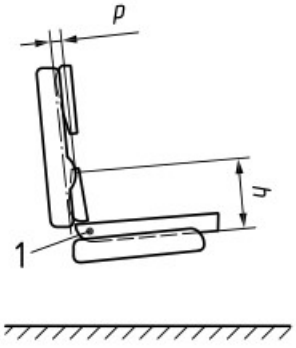
2 minimum lumbar height

3 multiple segments with maximum horizontal protrusion

Figure 35 — Minimum vertical height

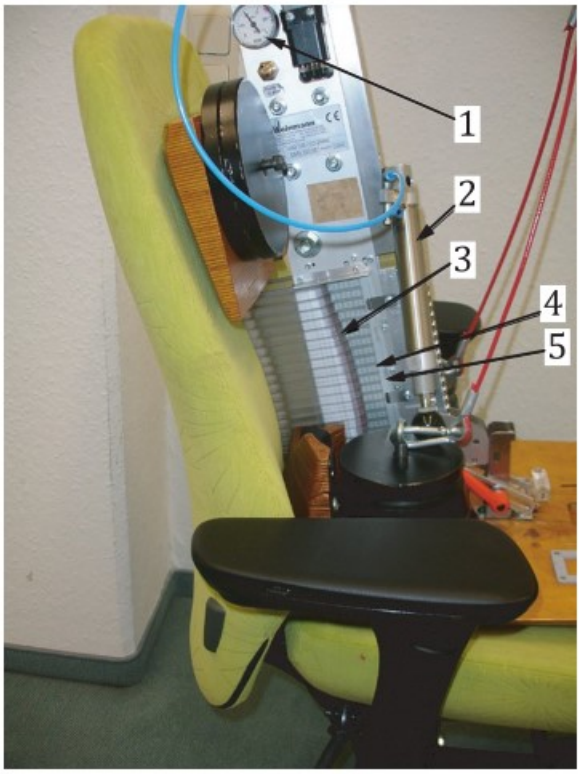
The measurement process (A through D) is illustrated in Table 2 (Figures 35 to 41).

Table 2 — Lumbar support measurement steps

Measurement step	Adjustment	Lumbar horizontal position	Measurement
A	Lumbar — height, as needed to achieve maximum protrusion — protrusion – maximum	 **Figure 36**	Lumbar — height (h) — protrusion (p) — backrest line (see Figure 1) — CMD buttocks pad (1)
B	Lumbar — height, as needed to achieve maximum protrusion — protrusion – minimum	 **Figure 37**	Lumbar — height (h) (same as A) — protrusion (p) — backrest line (see Figure 1) — CMD buttocks pad (1)
C	Lumbar — height – maximum — protrusion – maximum	 **Figure 38**	Lumbar — height (h) — protrusion (p) — backrest line (see Figure 1) — CMD buttocks pad (1)
D	Lumbar — height – minimum — protrusion – maximum	 **Figure 39**	Lumbar — height (h) — protrusion (p) — backrest line (see Figure 1) — CMD buttocks pad (1)

Calculate the difference between the maximum and minimum height measurements and record the difference as the lumbar support height adjustment range.

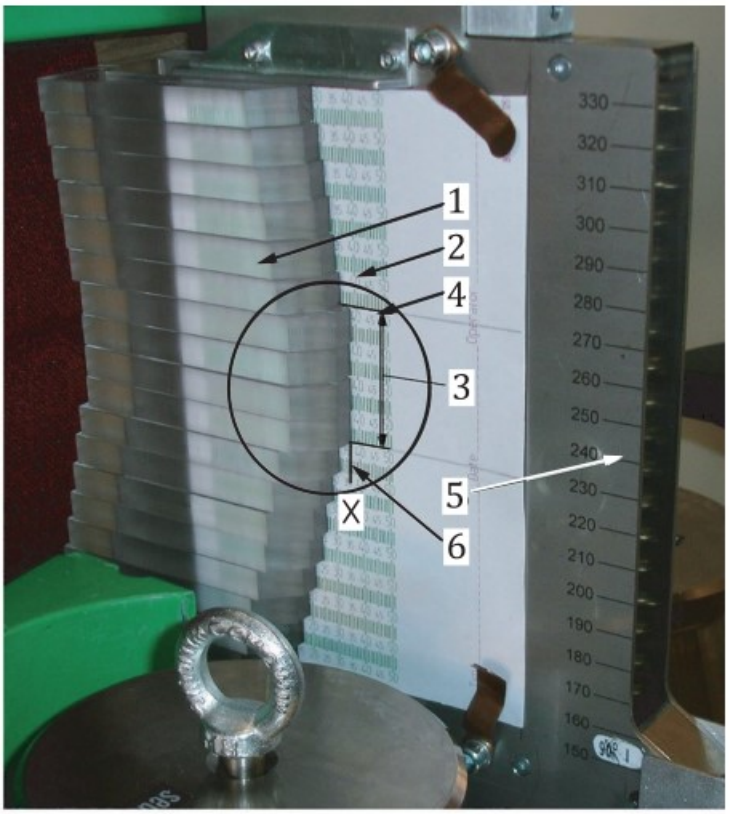
Remove the force on the vertically stacked segments and return them to their start position. If adjustments have been made during the execution of this clause, reposition the lumbar support adjustments to the position used in 6.2.1 b).



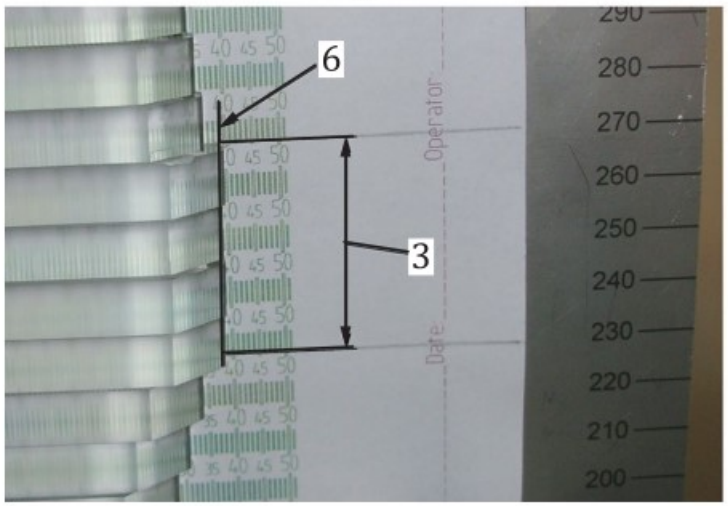
Key

1 pressure gauge
2 pressure pump
3 lumbar support protrusion and height measurement vertically stacked segments
4 lumbar support protrusion scale
5 lumbar support height scale

Figure 40 — Lumbar support protrusion and height measurement (overall view)



X



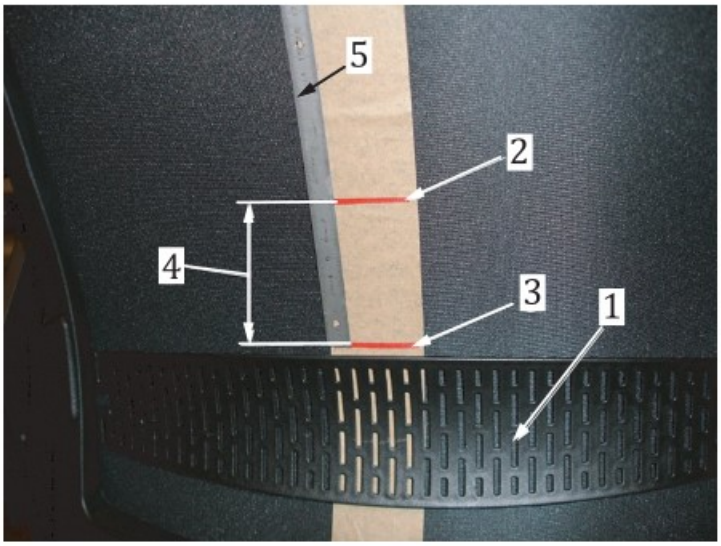
Key

1 lumbar support horizontal protrusion and height measurement vertically stacked segments
2 lumbar support horizontal protrusion scale
3 maximum lumbar support horizontal protrusion span
4 maximum lumbar support height range
5 lumbar support height scale
6 maximum lumbar support horizontal protrusion

Figure 41 — Lumbar support horizontal protrusion and height measurement (close-up view)

E Vertical lumbar adjustment mechanism travel

Where possible, measure the maximum physical vertical travel (see Figure 42) of the lumbar adjustment (may include movement of the backrest as well as the lumbar adjustment device) and record as vertical lumbar adjustment travel (see Figure 42).



Key

1 lumbar support adjustment mechanism (lower position)
2 mark on tape indicating top of mechanism in uppermost position
3 mark on tape indicating top of mechanism in lowermost position
4 lumbar adjustment mechanism travel
5 scale

Figure 42 — Vertical lumbar adjustment mechanism travel [example of a rear side of a backrest (part-view)]

Unlock the CMD vertical member from the CMD buttocks pad.

6.3.1.2 Inclination of seat, and backrest and angle between seat and backrest

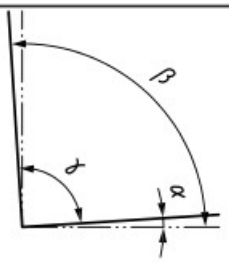
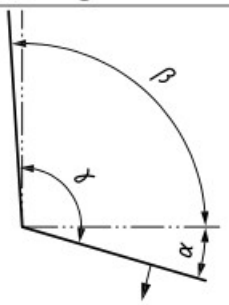
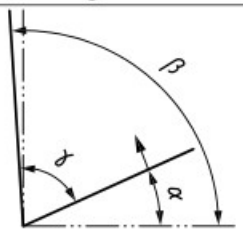
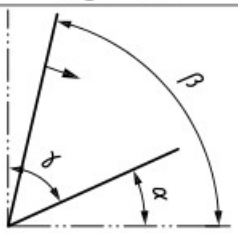
Measure the angle of inclination of the seat and backrest to the horizontal and angle between seat and backrest in the sequence given in Table 32 (Figures 43 to 51). Before carrying out the measurement, the chair shall be positioned according to 6.2.1 b). The vertical member of the CMD shall be unlocked. See Figure 27 for angle sign convention.

The chair shall be adjusted, by applying whatever force is necessary to bring the chair to its stop, in each of the positions given in Table 3, in sequence, to ensure appropriate positioning of the chair for each measurement. Record those measurements required in the applicable document. If the adjustment of a chair feature causes another feature measurement to change, that is acceptable.

NOTE 1 It can be impossible to take all of these measurements on some types of chairs. Record as "not applicable" (N/A).

NOTE 2 Prior to taking forward tilt measurements, the CMD can need to be secured to the chair to prevent dislodgement.

Table 3 — Angle measurement sequence

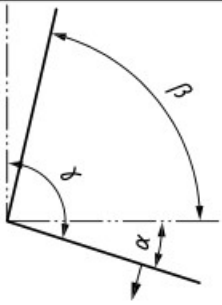
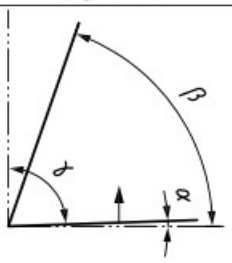
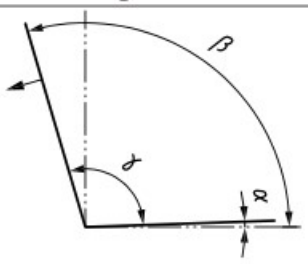
Measurement sequence	Graphical presentation of measurement	Settings	Inclination of seat α[a]	Backrest angle β[b]	Angle between backrest and seat γ[c]
1	 **Figure 43**	— Set seat as horizontal as possible — Set backrest as vertical as possible			
2	 **Figure 44**	— Set only the seat to its most forward tilt position — Backrest remains at the same adjustment as the prior step, but may move			
3	 **Figure 45**	— Set only the seat to its most rearward tilt position — Backrest remains at the same adjustment as the prior step, but may move			
4	 **Figure 46**	— Seat remains at the same adjustment as the prior step, but may move — Set backrest to its most forward position			

[a] α is read from the protractor positioned on the buttocks pad of the CMD.

[b] β is read from the protractor positioned on the front of the vertical member of the CMD.

[c] γ can be read directly from the angle indicator on the vertical member of the CMD or can be calculated from protractor readings.

Table 3 *(continued)*

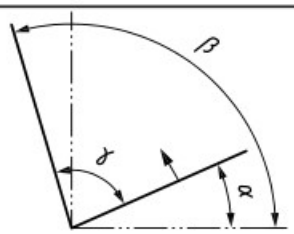
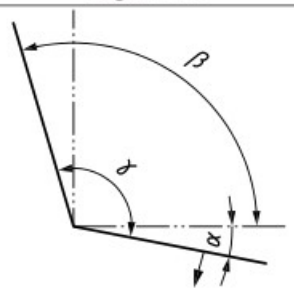
Measurement sequence	Graphical presentation of measurement	Settings	Inclination of seat α[a]	Backrest angle β[b]	Angle between backrest and seat γ[c]
5	 **Figure 47**	— Set seat to its most forward tilt position — Backrest remains at the same adjustment as the prior step, but may move			
6	 **Figure 48**	— Set seat as horizontal as possible — Backrest remains at the same adjustment as the prior step, but may move			
7	 **Figure 49**	— Seat remains at the same adjustment as the prior step, but may move. Set backrest recline resistance adjustments to their minimum. — Move the top section of the rear buttocks weights (2 × 6 kg) to the top of the backrest. If required to achieve full range of motion, apply an additional force to the vertical member of the CMD to ensure backrest is at its most rearward stop position.			

[a] α is read from the protractor positioned on the buttocks pad of the CMD.

[b] β is read from the protractor positioned on the front of the vertical member of the CMD.

[c] γ can be read directly from the angle indicator on the vertical member of the CMD or can be calculated from protractor readings.

Table 3 *(continued)*

Measurement sequence	Graphical presentation of measurement	Settings	Inclination of seat α[a]	Backrest angle β[b]	Angle between backrest and seat γ[c]
8	 **Figure 50**	— Set seat to its most rearward tilt position — Backrest remains at the same adjustment as the prior step, but may move			
9	 **Figure 51**	— Set seat to its most forward tilt position — Backrest remains at the same adjustment as the prior step, but may move			

[a] α is read from the protractor positioned on the buttocks pad of the CMD.

[b] β is read from the protractor positioned on the front of the vertical member of the CMD.

[c] γ can be read directly from the angle indicator on the vertical member of the CMD or can be calculated from protractor readings.

Replace the 6 kg weights to their place on the buttocks and restore the backrest tension spring to midpoint.

6.3.1.3 Backrest to seat movement ratio

This measurement applies only to chairs that have angles between the seat and back that vary as the chair tilts (e.g. "synchro-tilts") (see 3.7).

Calculate the back to seat movement ration with Formula (1):

$$R_{B/S} = [\beta_{mf(seq5)} - \beta_{mr(seq8)}] / [\alpha_{mf(seq5)} - \alpha_{mr(seq8)}] \quad (1)$$

where

$R_{B/S}$ is the back to seat movement ratio

$\alpha_{mf(seq5)}$ is the most forward inclination of seat; (sequence 5) as in Figure 47;

$\alpha_{mr(seq8)}$ is the most rearward inclination of seat; (sequence 8) as in Figure 50;

$\beta_{mf(seq5)}$ is the most forward seat backrest angle; (sequence 5) as in Figure 47;

$\beta_{mr(seq8)}$ is the most rearward seat backrest angle ; (sequence 8) as in Figure 50.

6.3.2 Measurements with the chair components adjusted to their minimum positions

6.3.2.1 General

Relock the vertical member at 90° in the CMD.

Remove the CMD from the chair.

If independently adjustable, the lumbar protrusion shall be set to its minimum depth. If independently adjustable, the lumbar height shall be set at the approximate midpoint of the lumbar zone. Adjust the seat and backrest so that they are in their most horizontal position, that is, not rotated clockwise of the horizontal and vertical position, respectively. All other components, including seat and backrest, except the lumbar height/depth, shall be set to their minimum position. Moving the backrest may move the lumbar away from the midpoint of the lumbar zone; this is acceptable.

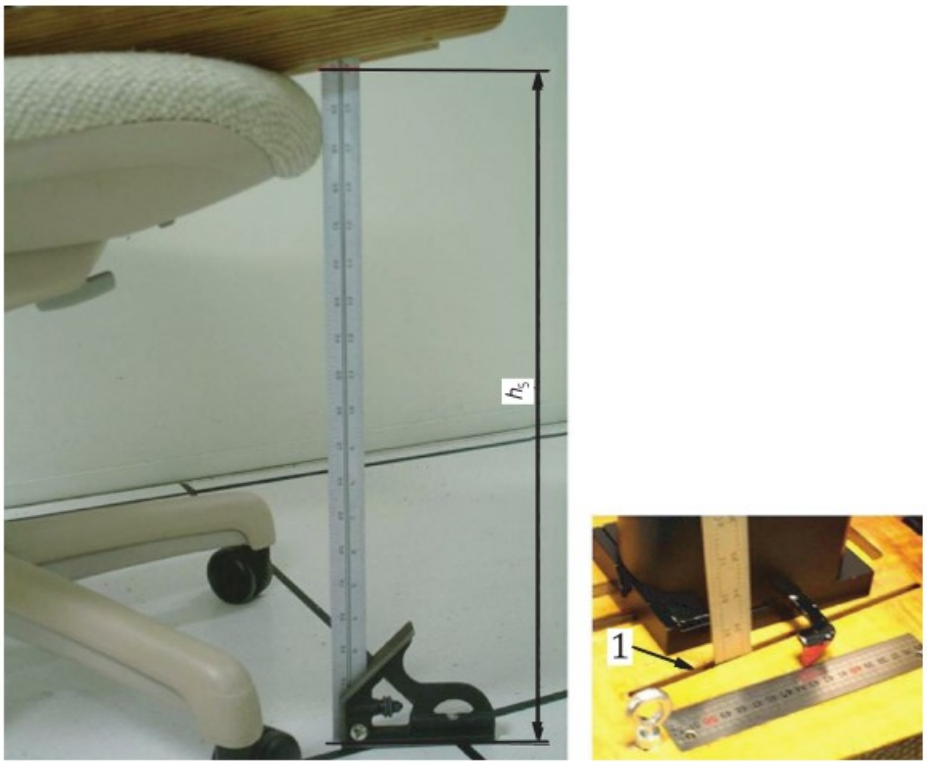
Position the CMD in the chair according to 6.2.2 and 6.2.3.

6.3.2.2 Seat height and sitting height

The seat height shall be measured with the seat in its most horizontal position that is not rotated clockwise of the horizontal.

If the seat is not in a horizontal position but can be moved to the horizontal position with little effort, then move the seat to horizontal position and secure it there. If the seat is secured in this manner, the technique shall be noted in the test report.

Measure the seat height (see 3.22) as the vertical distance from the underside of the CMD to the floor on a measuring scale placed through the seat height slot of the CMD at the front of the seat (see Figure 52).



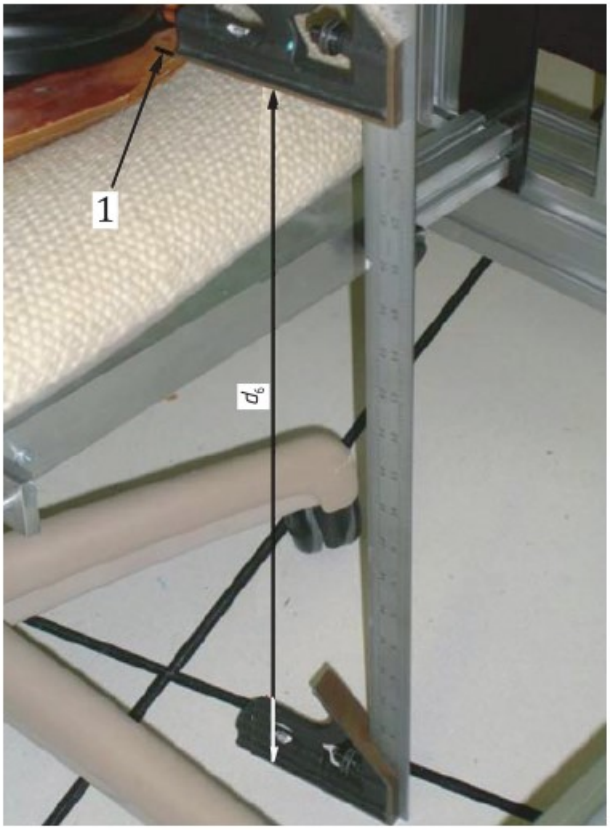
Key

1 seat height measurement slot

h_5 seat height

Figure 52 — Seat height measurement (two views)

Measure the sitting height (see 3.23) by measuring the height of the top of the CMD buttocks pad at the sitting height point marked on the buttocks pad to the floor, and then subtract 60 mm from the measurement to obtain the sitting height value (see Figure 53). Repeat the measurement on another side of the CMD (chair), then calculate the mean value. When a chair arm interferes with the direct measurement of the height, place a spacer on the buttocks pad that is high enough that its height is greater than the arm. Measure the height of that stack and subtract both the spacer thickness and 60 mm from the measurement.



Key

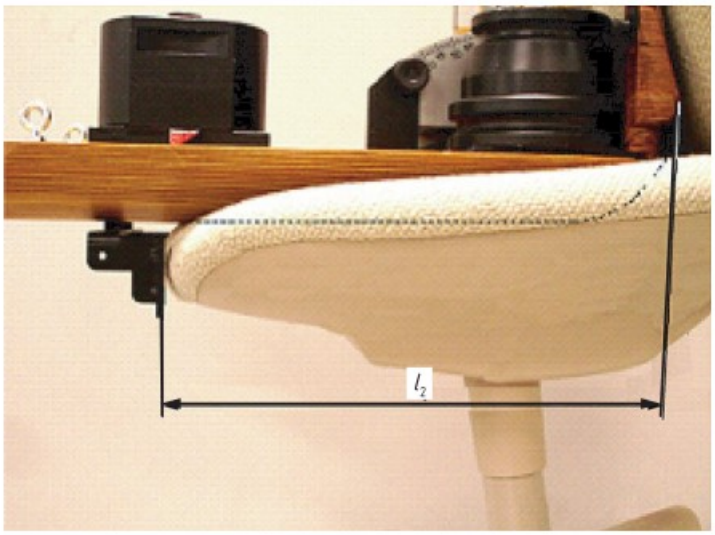
1 sitting height fore and aft position mark

d_6 sitting height plus the 60 mm of the buttock's plate thickness

Figure 53 — Sitting height measurement

6.3.2.3 Seat depth

Read the seat depth (see 3.21) from the measuring scale on the top of the buttocks pad. Adjusting the seat inclination or angle of backrest does not constitute seat depth adjustment (see Figure 54).



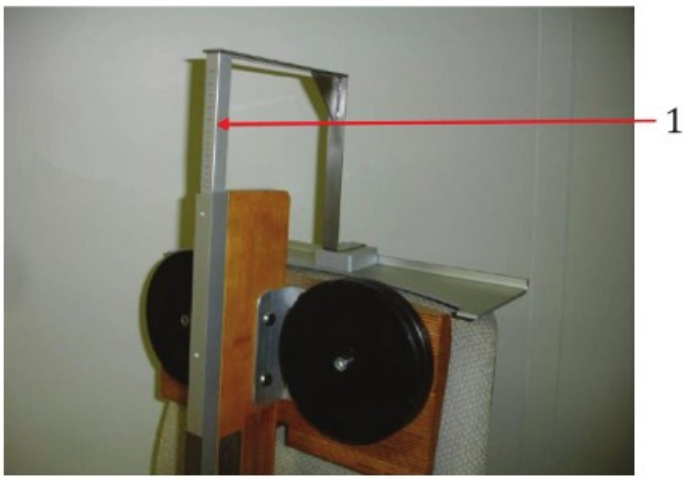
Key

l_2 seat depth

Figure 54 — Seat depth measurement

6.3.2.4 Backrest height

Slide the backrest height (see 3.10) gauge until it touches the top of the backrest. Read the height on the scale (see Figure 55).



Key

1 backrest height scale

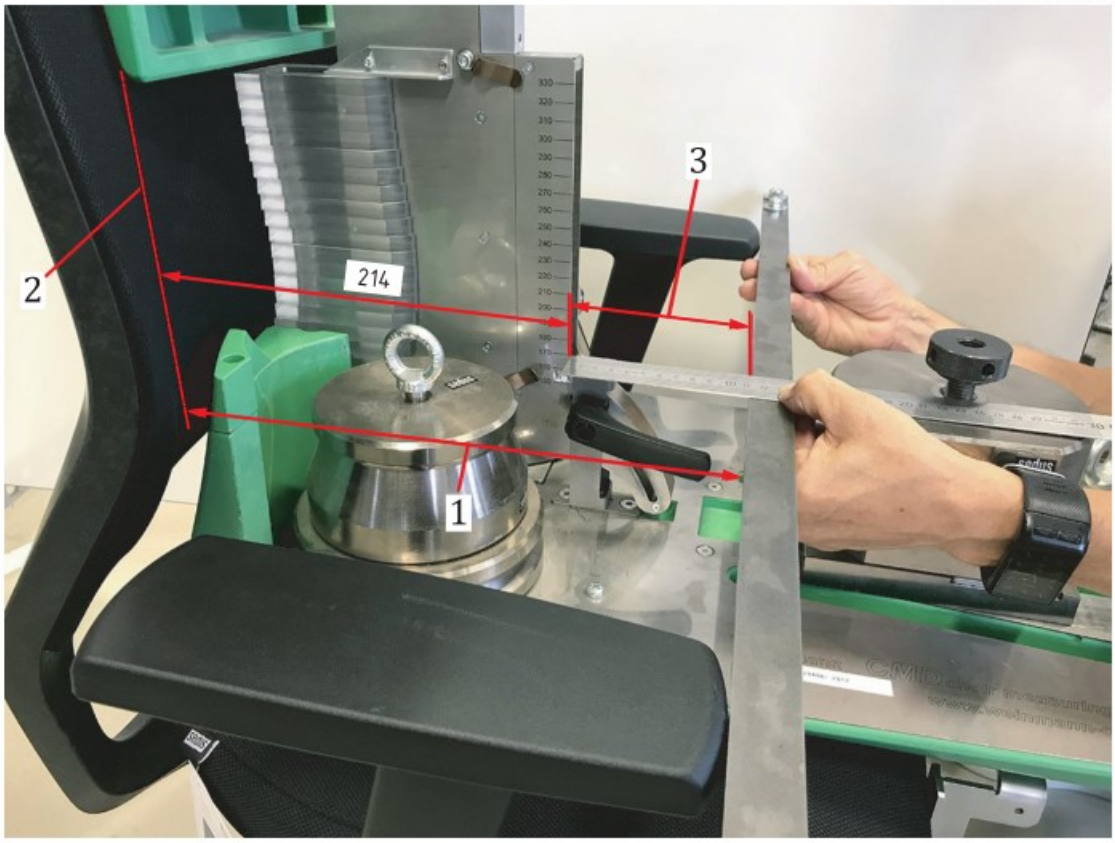
Figure 55 — Backrest height measurement

6.3.2.5 Front of armrest position

The armrest swivel, fore/aft movement and/or armrest clearance shall be adjusted as required to achieve the most rearward position within the armrest measurement zone (see 3.5).

Place a bar across the armrests at front edges. If the front edges of the armrest are less than 120 mm above the top surface of the loaded CMD buttocks pad, then place the bar at the front part of the armrest that is at the 120 mm high point. Measure the horizontal distance between the bar and the front part of vertical member of the CMD and add 214 mm (see Figure 56) (see 3.5 and Figure 5).

Dimensions in millimetres



Key

1 front of armrest position
2 backrest line
3 front of armrest to front of CMD vertical member

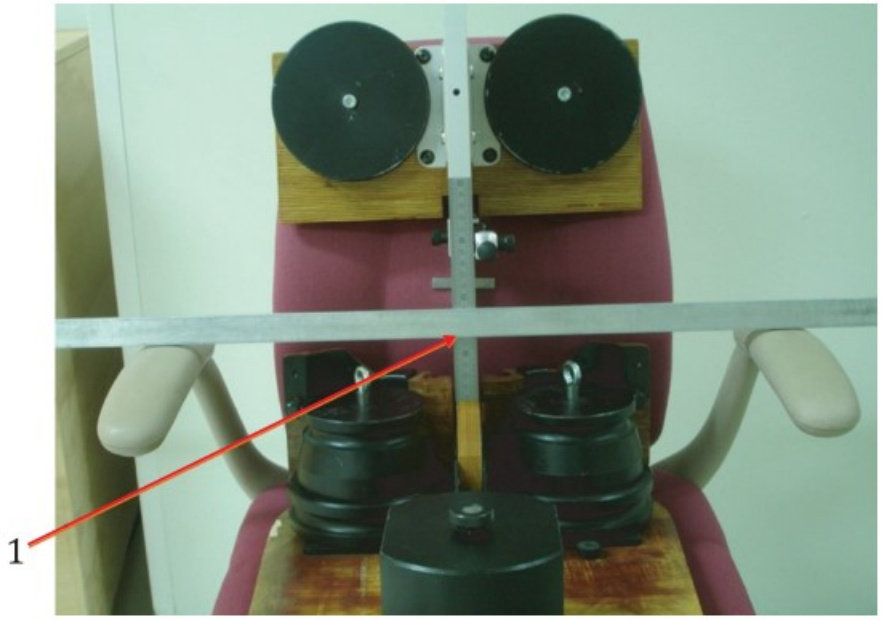
Figure 56 — Front of armrest position

6.3.2.6 Armrest set back

Calculate the armrest set by subtracting the front of armrest position value from the seat depth value.

6.3.2.7 Armrest height

Measure the armrest height (see 3.2) based on a straight line between the top of the armrests where it crosses the scale on the front of the vertical member of the CMD (see Figure 57).



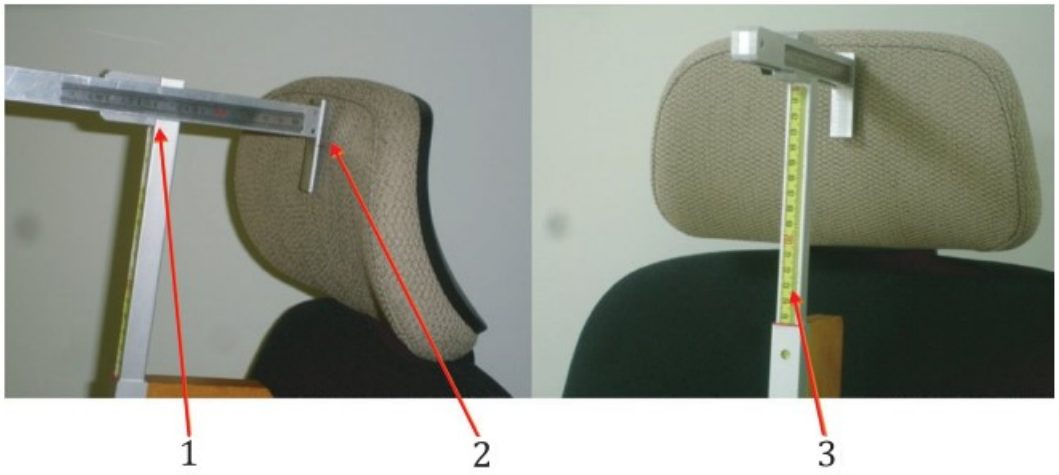
Key

1 armrest height reading position

Figure 57 — Armrest height

6.3.2.8 Neck/head rest height and protrusion

Align the marker on the neck/head rest measurement tool with the most forward point on the neck/head rest. Read the neck/head rest height (see 3.20) from the ruler at the front of the vertical height adjustment tube and the neck/head rest protrusion (see 3.19) from the ruler on the side of the horizontal adjustment tube (see Figure 58).



Key

1 neck/head rest protrusion

2 most forward point of neck/head rest

3 neck/head rest height

Figure 58 — Neck/head rest height and protrusion

6.3.3 Measurements with the chair components in their maximum positions

6.3.3.1 General

Relock the vertical member at 90° in the CMD. Remove the CMD from the chair. If independently adjustable, the lumbar protrusion shall be set to its minimum depth. If independently adjustable, the lumbar height shall be set at the approximate midpoint of the lumbar zone. Adjust the seat and backrest so that they are in their most horizontal position that is not rotated clockwise of the horizontal and vertical positions, respectively. All other components, including seat and backrest, except the lumbar height/depth, shall be set to their maximum positions. Moving the backrest may move the lumbar away from the midpoint of the lumbar zone; this is acceptable. Position the CMD in the chair according to 6.2.2 and 6.2.3.

6.3.3.2 Seat height and sitting height

Measure the seat height (see 3.22) and sitting height (see 3.23) according to 6.3.2.2.

6.3.3.3 Seat depth

Measure the seat depth (see 3.21) according to 6.3.2.3.

6.3.3.4 Backrest height

Measure the height to the top of the backrest (see 3.10) according to 6.3.2.4.

6.3.3.5 Front of armrest position

Measure the front of the armrest position (see 3.5) according to 6.3.2.5. Where applicable, the armrest swivel, fore/aft movement and/or armrest clearance shall be adjusted to achieve the most rearward position within the armrest measurement zone (see 3.5).

6.3.3.6 Armrest height

Measure the armrest height (see 3.2) according to 6.3.2.7.

6.3.3.7 Neck/head rest height and protrusion

Measure the neck/head rest height (see 3.20) and neck/head rest protrusion (see 3.19) according to 6.3.2.8.

6.3.4 Measurements without the CMD in the chair

6.3.4.1 General

Relock the vertical member at 90° in the CMD. Remove the CMD. Ensure that the chair adjustments are set to their maximum position according to 6.3.3 and carry out the measurements given in the following subclauses.

Mark the bottom of the lumbar zone by measuring down 110 mm from the previously marked top of the zone.

6.3.4.2 Seat surface width

Measure the narrowest seat surface width (see 3.26) within the seat surface plane width zone, as marked in 6.2.3.

6.3.4.3 Seat surface depth

Measure the least seat surface depth (see 3.25) within the span, 115 mm either side of the median plane (see Figure 23).

6.3.4.4 Backrest width

Measure the backrest width (see 3.9) in the middle of the vertical height of the lumbar zone.

6.3.4.5 Backrest horizontal radius

Measure the backrest radius of the chair at the lumbar zone. The radius shall be measured through a minimum width of 300 mm and minimum height of 10 mm. When measuring the radius, apply enough force to ensure that any textile coverings that cause bridging are formed to the backrest. For mesh materials, the radius measuring device or templates(s) may be narrower if necessary so it does not contact the side structures of the chair.

6.3.4.6 Armrest length

With the armrest pad surface in the most horizontal position, measure the greatest length in the fore and aft direction of the armrests horizontally within 20 mm below the top surface using callipers with jaws 20 mm long (see Figure 59).

Figure 59 — Armrest length callipers

6.3.4.7 Width of armrests

With the armrest pad surface in the most horizontal position, measure the greatest width in the side to side direction of the armrests horizontally within 5 mm below the top surface using callipers with jaws 5 mm long (see Figure 60).

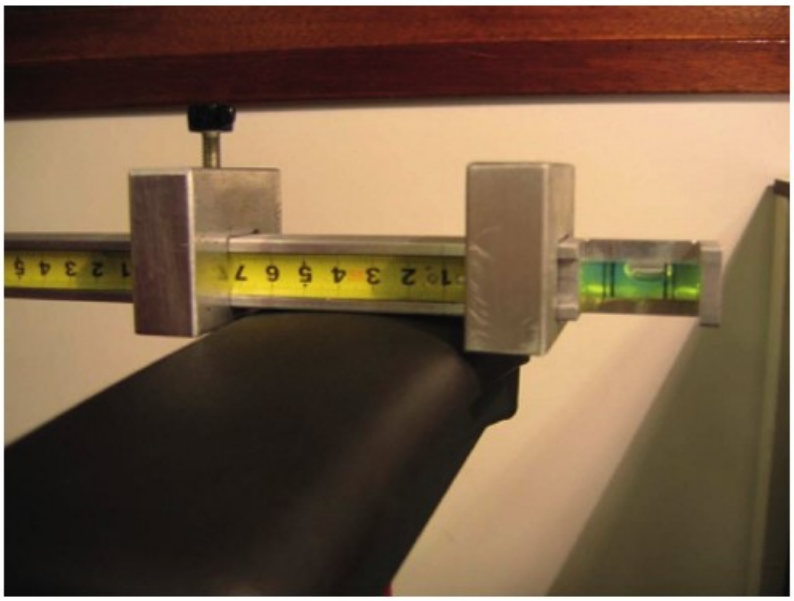
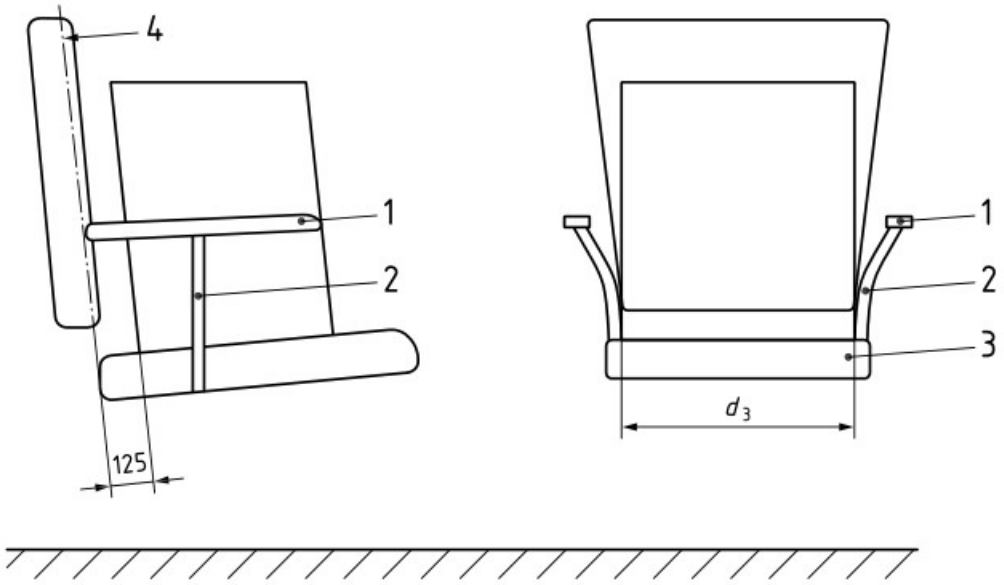


Figure 60 — Armrest width callipers

6.3.4.8 Hip breadth clearance

Adjust the armrests to their widest possible position. Measure the minimum width between the armrest assembly from 125 mm forward of the backrest line to the front edge of the armrest above the top of the seat surface (see Figure 61).

Dimensions in millimetres



Key

1 armrest
2 armrest assembly
3 seat
4 backrest line
d_3 hip breadth

Figure 61 — Hip breadth clearance

6.3.4.9 Distance between armrests

Adjust the armrests to their widest possible position and then to their narrowest possible position. Measure and record the smallest horizontal distance between the armrests (see Figure 4) in each position from the rear of the seat width zone forward to the front edge of the seat (see Figure 25) within the measurement zone 5 mm down from the top of the armrest (see Figure 6).

6.3.4.10 Maximum off-set of the underframe

Measure the maximum off-set of the underframe as the distance from the axis of chair rotation to the outermost point of the base/castor/glide (see Figure 26).

7 Test report

The test report shall include at least the following information:

a) a reference to this document, i.e. ISO 24496;

b) details of the chair tested and the name of the manufacturer;

c) manner of assembly/mounting, if applicable;

d) dimensions according to 6.3;

e) name and address of the test facility;

f) date of the tests.

Annex A
(normative)

Drawings and specifications, PDF files for CMD with 18 stacked segment lumbar support measurement method

The CMD shall be fabricated according to the drawings and specifications contained in the electronic PDF, .igs and .stp files, which are available at: https://standards.iso.org/iso/24496/ed-2/en/

Table A.1 lists the CMD drawings for the convenience of users.

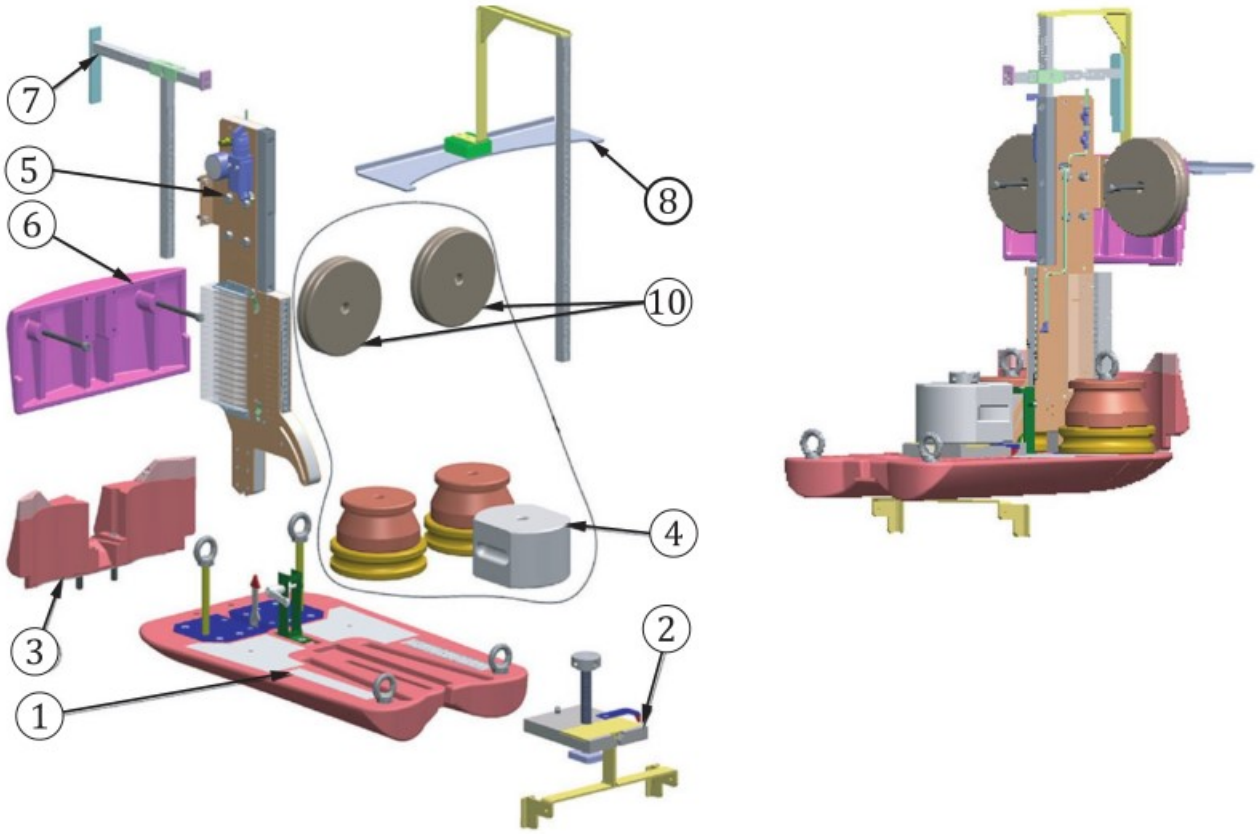
Table A.1 — CMD drawing list

Description		Drawing No.	Electronic file format	
			*.pdf	*.stp
ISO CMD		C001–24496–3	×	
1. Buttocks pad		A001–24496–2	×	
	buttocks form	P001–24496–2	×	×
	ruler seat depth	P002–24496–2	×	
	type plate	P003–24496–3	×	
	cover	P004–24496–3	×	
	rack	P005–24496–2	×	
	weight stand	A002–24496–2	×	
	weights stand left	P006–24496–2	×	
	weights stand right	P007–24496–2	×	
	weights axle	P008–24496–2	×	
	axle vertical member	P009–24496–2	×	
	stroke block	P010–24496–2	×	
	pointer for angle	P011–24496–3	×	
2. Front weight sliding support		A003–24496–2	×	
	support stand	P012–24496–3	×	
	clamp	P013–24496–2	×	
	pointer for seat depth	P014–24496–2	×	
	axle front weight	P015–24496–2	×	
	seat stop	P016–24496–3	×	
3. Pelvic element		A004–24496–3	×	
	pelvic form	P017–24496–2	×	×
	square	P018–24496–3	×	
	pelvic form add on l/r	P044–24496–2	×	×
4. Weights		A006–24496–3	×	
	front weight	P020–24496–3	×	
	thoracic weight	P021–24496–3	×	
	lower pelvic weight	P022–24496–3	×	
	higher pelvic weight	P023–24496–3	×	

Table A.1 *(continued)*

Description		Drawing No.	Electronic file format	
			*.pdf	*.stp
5. Vertical member assembly		A012–24496–2	×	
	side wall left and right	P034–24496–3	×	
	top plate middle	P035–24496–3	×	
	lower plate middle	P036–24496–3	×	
	angle top and bottom	P037–24496–2	×	
	glide tub middle	P038–24496–2	×	
	ruler	P039–24496–2	×	
	measuring box	A009–24496–3	×	
	valve connector	P040–24496–3	×	
	plate valve box	P041–24496–2	×	
	measuring pin	P042–24496–3	×	
	paper clamp	P043–24496–2	×	
	slotted pan head screw M 5x12, mod.	P048–24496–3	×	
	cylinder A CJ2B6–60R SMC – milling	A011–24496–2	×	
6. Thoracic element		A005–24496–2	×	
	thoracic form	P019–24496–2	×	×
7. Headrest measurement element		A007–24496–2	×	
	vertical glide	P024–24496–2	×	
	measuring slot	P025–24496–2	×	
	horizontal glide	P026–24496–2	×	
	measuring stop collar	P027–24496–2	×	
	block	P028–24496–2	×	
	ruler vertical	P029–24496–2	×	
	extension vertical glide headrest	P046–24496–2	×	
8. Back height measurement element		A008–24496–2	×	
	vertical glide	P030–24496–2	×	
	support plate	P031–24496–2	×	
	arm	P032–24496–2	×	
	flat	P033–24496–2	×	
	extension vertical glide back height	P045–24496–2	×	
9. Armrest measuring bar		A012–24496–3	×	
	bar	P047–24496–2	×	

Figure A.1 shows details of the CMD, including the designation of the components. Significant CMD details are given in Figure A.2.



Position number	Part number	Description	Quantity
1	A001–24496–2	buttocks plate	1
2	A003–24496–2	front weight sliding support	1
3	A004–24496–3	pelvic element	1
4	A006–24496–3	weights	1
5	A008–24496–2	back height measurement element	1
6	A012–24496–3	vertical member assembly	1
7	A005–24496–2	thoracic element	1
8	A007–24496–2	headrest measurement element	1
9	*blank*	*blank*	—
10[a]	P021–24496–3	thoracic weight	1

[a] Two weights each side.

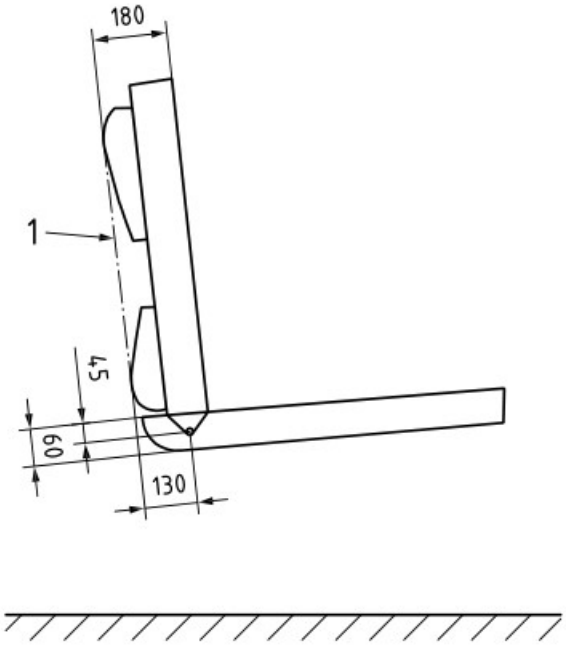
A manual air pump and air tube are also necessary to connect the pneumatic (not drawn)

Figure A.1 — CMD Dummy (C001-24496-3)

The weight of the complete CMD, excluding items 5, 8 and 9, shall be 64 kg.

Note that there are four eye bolts in the top of the buttocks provided so that the CMD is suspended by four cables as it is lowered into position during use. Turnbuckles or other adjustment mechanisms may be used as part of the suspension system to aid in levelling the buttocks pad as required in the document (see Figure 29).

Dimensions in millimetres



Key

1 backrest line

Figure A.2 — Significant CMD dimensions

Annex B
(informative)

Anthropometric equivalents of terms and definitions

B.1 General

In B.2 to B.28, the anthropometric equivalents of the terms and definitions listed in Clause 3 where they apply are described.

B.2 Angle between backrest and seat

See 3.1.

There is no direct anthropometric equivalent.

B.3 Armrest height

See 3.2 and Figure B.1.

Anthropometric equivalent: vertical distance from a horizontal sitting surface to the lowest bony point of the elbow bent at a right angle with the forearm horizontal. See ISO 7250-1:2017, 4.2.5 (elbow height, sitting).

Figure B.1 — Armrest height

B.4 Armrest length

See 3.3.

Anthropometric equivalent: there is no direct anthropometric equivalent; however, this dimension is related to the length of the forearm.

B.5 Distance between armrests

See 3.4.

Anthropometric equivalent: there is no direct anthropometric equivalent; however, this dimension is related to the hip breadth and shoulder breadth.

B.6 Front of armrest position

See 3.5.

Anthropometric equivalent: there is no anthropometric equivalent; however, this dimension is related to the lower abdominal depth (body thickness). See ISO 7250-1:2017, 4.2.15 (abdominal depth, sitting).

B.7 Armrest width

See 3.6.

Anthropometric equivalent: there is no direct anthropometric equivalent. However, this dimension is related to the forearm width.

B.8 Backrest angle to vertical

See 3.8.

There is no direct anthropometric equivalent.

B.9 Backrest width

See 3.9.

Anthropometric equivalent: the anthropometric equivalent is related to the essential lumbar support width, for which the waist width is used. The waist width is the horizontal width of the waist at the level of omphalion (see Figure B.2).

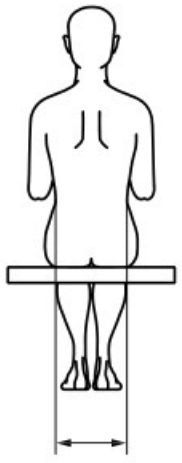


Figure B.2 — Backrest width

B.10 Backrest height

See 3.10.

Anthropometric equivalent: the anthropometric equivalent is related to the top of the pelvis height or the lowest point of the shoulder blades height or the shoulder height.

B.11 Backrest inclination — range

See 3.11.

There is no direct anthropometric equivalent.

B.12 Backrest radius — horizontal

See 3.12.

There is no anthropometric equivalent.

B.13 CMD (chair measuring device)

See 3.13.

Anthropometric equivalent: there is no direct anthropometric equivalent; however, the device is based on the 50th percentile person.

B.14 Hip breadth clearance

See 3.14.

Anthropometric equivalent: breadth of the body measured across the widest portion of the hips. See Figure B.3 and ISO 7250-1:2017, 4.2.11 (hip breadth, sitting).

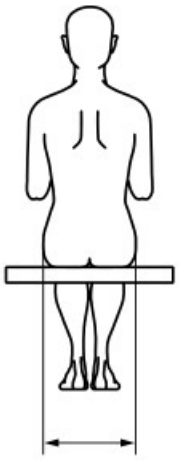


Figure B.3 — Hip breadth

B.15 Lumbar support — height

See 3.15.

Anthropometric equivalent: the anthropometric equivalent is the lumbar region of the spine where the L1 to L5 vertebras are located (see Figure B.4).

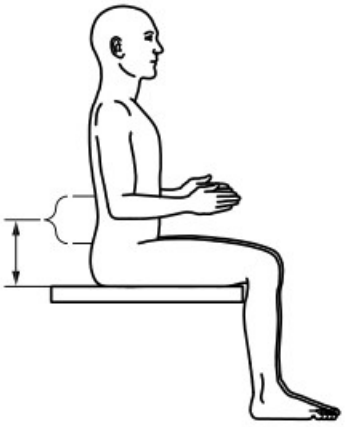


Figure B.4 — Lumbar Region

B.16 Lumbar support — protrusion

See 3.16.

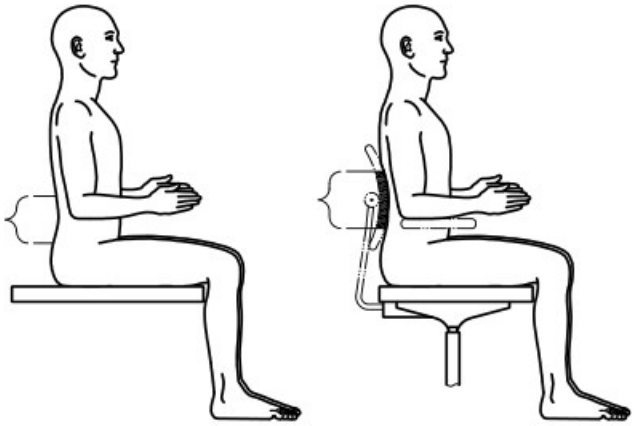
Anthropometric equivalent: the anthropometric equivalent is the lumbar region of the spine where the L1 to L5 vertebras are located (see Figure B.5).

Figure B.5 — Protrusion of lumbar

B.17 Lumbar zone

See 3.17.

Anthropometric equivalent: the anthropometric equivalent is the lumbar region of the spine where the L1 to L5 vertebras are located [see Figure B.6 a) and Figure B.6 b)].



a) Lumbar region b) Lumbar zone

Figure B.6 — Lumbar region and lumbar zone

B.18 Median plane

See 3.18.

There is no anthropometric equivalent.

B.19 Neck/head rest protrusion

See 3.19.

There is no direct anthropometric equivalent.

B.20 Neck/head rest height

See 3.20.

There is no direct anthropometric equivalent for head rest height. See ISO 7250-1:2017, 4.2.3 (cervical height, sitting).

The anthropometric equivalent for neck rest height is: vertical distance from a horizontal sitting surface to the cervical (see Figure B.7).

Figure B.7 — Neck rest height

B.21 Seat depth

See 3.21.

Anthropometric equivalent: horizontal distance from the hollow of the knee to the rearmost point of the buttock. See Figure B.8 and see ISO 7250-1:2017, 4.4.6 [buttock-popliteal length (seat depth)].

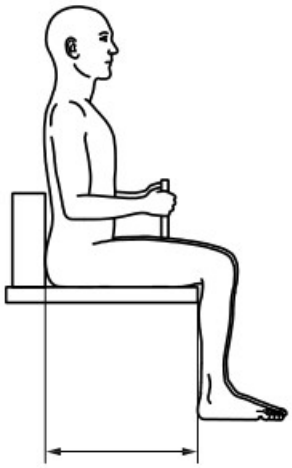


Figure B.8 — Seat depth

B.22 Seat height

See 3.22.

Anthropometric equivalent: vertical distance from the foot-rest surface to the lower surface of the thigh immediately behind the knee, bent at right angles. See Figure B.9 and ISO 7250-1:2017, 4.2.12 [lower leg length (popliteal height)].

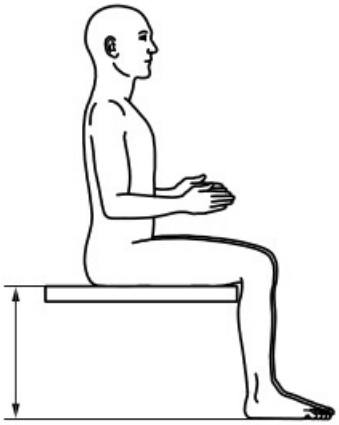


Figure B.9 — Seat height

B.23 Sitting height

See 3.23.

There is no direct anthropometric equivalent.

B.24 Seat inclination

See 3.24.

There is no anthropometric equivalent.

B.25 Seat surface depth

See 3.25.

There is no direct anthropometric equivalent.

B.26 Seat surface width

See 3.26.

Anthropometric equivalent: breadth of the body measured across the widest portion of the hips. See Figure B.10 and ISO 7250-1:2017, 4.2.11 (Hip breadth, sitting).

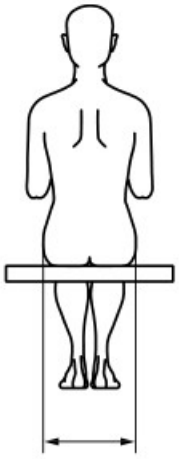


Figure B.10 — Seat width

B.27 Seat surface width zone

See 3.27.

There is no direct anthropometric equivalent.

B.28 Underframe — maximum off-set

See 3.28.

There is no direct anthropometric equivalent.

Annex C
(informative)

Rationale

C.1 Rationale for measurement method

Almost all measurements are performed with the adjustable features of the chair set into two states as many of the adjustment features of a chair affect the way the CMD installs onto the chair. The chair is first measured with all adjustments set to their smallest size and then measured again with all adjustments set to their largest size. The two exceptions to this are the measurement on backrest profile in the lumbar region and the measurement of seat and back inclinations.

During the measurement trials a number of difficulties were experienced when placing the CMD on the chair. For this reason, a gantry was developed which would lower the fully loaded CMD into place while a force of 40 N was applied to the front of CMD to push it against the backrest. This gantry also holds the CMD in a constant orientation.

C.2 Rationale for CMD design

The key design brief of the CMD was to ensure that it replicated as far as possible how a person would sit in an office chair. The use of multiple CMDs was considered to be overly complicated and unnecessary, as a system based on the 50th percentile person yields sufficiently accurate measurements.

The CMD consists of four key components; buttocks plate, pelvic element, thoracic element and a lumbar device which is an integral part of a pivoting back member. Pelvic support is shaped and is fixed to the rear of the buttocks plate which itself is shaped similar to the seat loading plate as defined in EN 1728:2010, Clause 5.4.

The buttocks plate and thoracic element are loaded with pre-determined weights to simulate a 64 kg person sitting on an office chair. The back of the buttocks plate is loaded to simulate the torso and the front part of the buttocks plate is loaded to simulate the legs. Weight distribution is based on extensive pressure mapping of people sitting on office chairs.

The CMD has a back member which incorporates a lumbar defining apparatus which consists of 18 square 10 x 10 mm segments which are pushed by a pre-defined air pressure onto the backrest to determine the shape and the height of the lumbar support area of the chair.

C.3 Rationale for measurement zones

C.3.1 The front of armrest position

The front of armrest position is important because it limits how close the chair occupant can pull up to her/his work surface and still have her/his back properly supported. This measurement is determined based on the first part of the chair arm that would touch the work surface when the chair is moved towards it. It is assumed that only those parts of an arm more than 120 mm above the seat could touch a work surface because it is assumed that the occupant would adjust the chair downward enough to be able to get her/his thighs below the work surface. The average person's thigh is 120 mm thick.

C.3.2 Seat depth

It is assumed that the area of concern of the depth of seat is that part that is to support the legs. The average person's legs spread out to a width of 230 mm about the centreline of the seat.

C.3.3 Seat width

It is assumed that the seat width zone of concern is the width of seat where the widest part of the body sits on the seat. Those are the ischial tuberosities of the buttocks. The majority of users' ischial tuberosities are located between 85 mm and 205 mm forward of one's back.

C.4 Areas of caution

It has been noted that the opening in the CMD back between the pelvic and thoracic elements is not always appropriate for every chair. On occasion, the pelvic element does not reach high enough to cause the element to bear against the bottom of the backrest as is normally needed for a realistic loading against the backrest during CMD installation. Typically, installation of the supplied pelvic extension corrects the condition. If not, the user will need to make her/his own adaptation to correct the condition. It is also possible that a given chair's backrest profile may have a protrusion that comes to bear against either the pelvic or thoracic elements in an unrealistic manner. If such a case occurs, the user is guided to make note of it in the report and make the CMD installation and measurements in a manner that best fits the intention and definition of the measurement being taken.

C.5 Uncertainty measurement

Measurement uncertainty is a fact of life long recognized by measurement practitioners. Another way of stating measurement uncertainty is that it is the observed variation in measurement results in repeated measurement observations. These variations can be explained, in part, by noting the following conditions:

— variation in placing the element to be measured in/on the measuring equipment;

— hysteresis in adjusting the measuring equipment to the size of the element to be measured;

— variation from one measuring device to the next;

— changes in the operating environment during measurement operations affecting both the size and shape of the element to be measurement and the measurement device;

— differences in the understanding of the persons conducting the measurement of directions on how to operate the measurement equipment and how to stage the element to be measurement.

Some of the standards associated with assessing measurement system variation include the following:

— ASTM E691;

— ANSI/ASME B 89.7.3.3;

— ISO/IEC Guide 98 1;

— ISO/IEC Guide 98 3;

— ISO/IEC Guide 98 4;

— ISO 5725 (all parts).

The initial activity attempting to gather data was conducted in North America in 2012. It consisted of three measurements of eight different chairs. It proved short of statistical rigour but provided considerable feedback on ways to improve the description of the measurement methods that minimized misinterpretations of the directions.

The appropriate changes were made in the descriptive language of the standard. A follow-up round robin study series was initiated in early 2013 in Europe. It consisted of eleven measurements on three chairs.

Prior to conducting the 2013 studies, a training video[20] was prepared by BIFMA. This video was used to train the measurement participants in the studies mentioned above.

The results of the two studies were compared and compiled. The uncertainty values given in 4.4 are a result of that compilation.

Bibliography

[1] ISO 5725 (all parts), *Accuracy (trueness and precision) of measurements methods and results*

[2] ISO 7250-1:2017, *Basic human body measurements for technological design — Part 1: Body measurement definitions and landmarks*

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

[4] ISO 14738, *Safety of machinery — Anthropometric requirements for the design of workstations at machinery*

[5] ISO 20685 (all parts), *3-D scanning methodologies for internationally compatible anthropometric databases*

[6] ISO/TR 7250-2:2010, *Basic human body measurements for technological design — Part 2: Statistical summaries of body measurements from national populations*

[7] ISO/IEC Guide 98-1, *Uncertainty of measurement — Part 1: Introduction to the expression of uncertainty in measurement*

[8] ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

[9] ISO/IEC Guide 98-4, *Uncertainty of measurement — Part 4: Role of measurement uncertainty in conformity assessment*

[10] ANSI/ASME B 89.7.3.3, *Guidelines for Assessing the Reliability of Dimensional Measurement Uncertainty Statements*

[11] ASTM E691, *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*

[12] BIFMA/CMD-1-2002, *Universal Measurement Procedure for the use of BIFMA Chair Measuring Device (CMD)*

[13] BS 5940-1[1], *Office furniture — Specification for design and dimensions of office workstations, desks, tables and chairs*

[14] DIN 4551[1], *Office furniture — Office swivel chairs — Safety requirements, testing*

[15] EN 1335-1, *Office furniture — Office work chair — Part 1: Dimensions; Determination of dimensions*

[16] EN 1335-3[1], *Office furniture — Office work chair — Part 3: Test methods*

[17] NF D 61-040[1)], *Office furniture — Seats — General characteristics*

[18] UNI 7498[1]*Office furniture — Chairs and footrests — Dimensions and constructive characteristics*

[19] SS 83 914*0, Furniture — Determination of functional dimensions of furniture seating (including wheelchairs)*

[20] BIFMA, Training video “BIFMA Training for ISO CMD 7”. Available at: https://www.youtube.com/watch?v=xdG0ifME4xw

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