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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This first edition cancels and replaces ISO/TR 24496:2012, which has been technically revised.

The committee responsible for this document is ISO/TC 136, *Furniture*.

Introduction

The test methods in this document are based on the manner in which anthropometric measurements 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. This posture does, however, 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, ISO 20685 and ISO 14738.

This document is meant to be used in conjunction with requirements documents. Such documents will specify which of the dimensions are to be measured. It is possible that not all of the measurements that can be taken by this document will be specified by the individual requirements document.

For the background and 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:

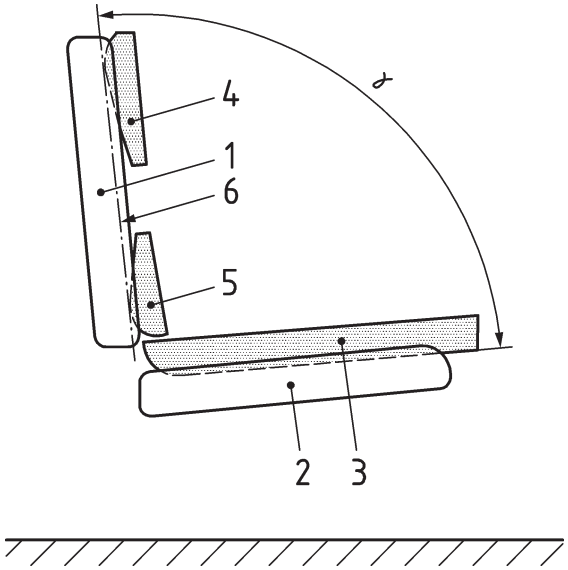
— IEC Electropedia: available at http://www.electropedia.org/

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

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.



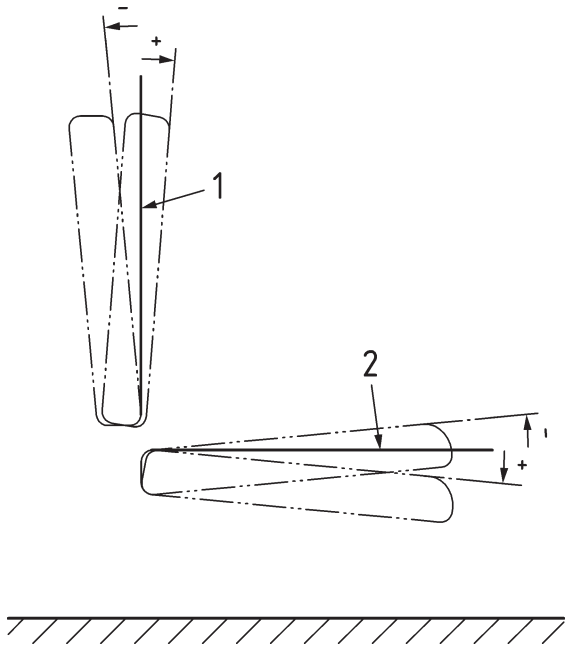
Key

1 backrest
2 seat
3 CMD (Chair Measurement Device) 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
angle – origin and sign convention
right horizontal viewed from the right side of the chair; when the user is seated in the chair and the angle sign convention is clockwise, angle rotation is positive (+) and counterclockwise is negative (–)

Note 1 to entry: See Figure 2.



Key

1 vertical

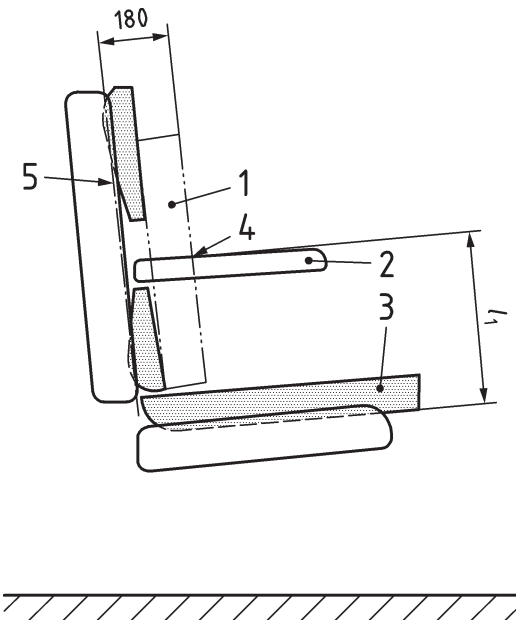
2 horizontal (0°)

Figure 2 — Angle – origin and sign convention

3.3
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 180 mm from the backrest line

Note 1 to entry: See Figure 3.

Dimensions in millimetres



Key

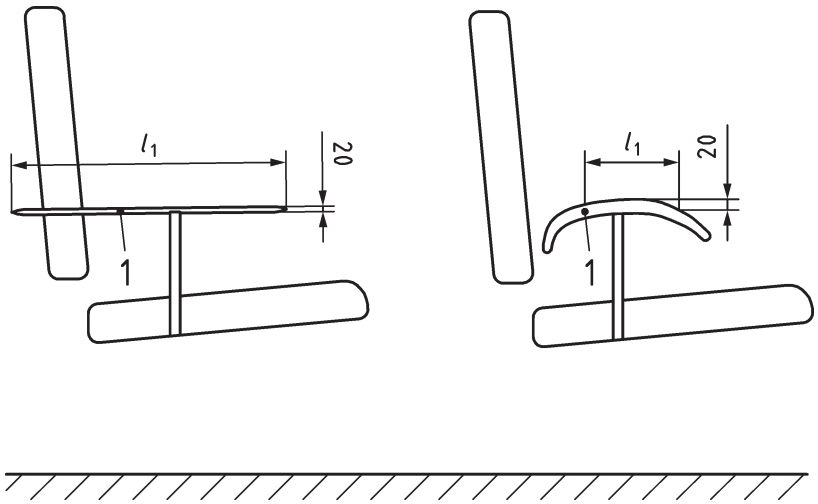
1 CMD vertical member
2 armrest
3 CMD buttocks pad
4 intersection of projection of vertical member front face and armrest
5 backrest line
l_1 armrest height

Figure 3 — Armrest height

3.4
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 4.

Dimensions in millimetres



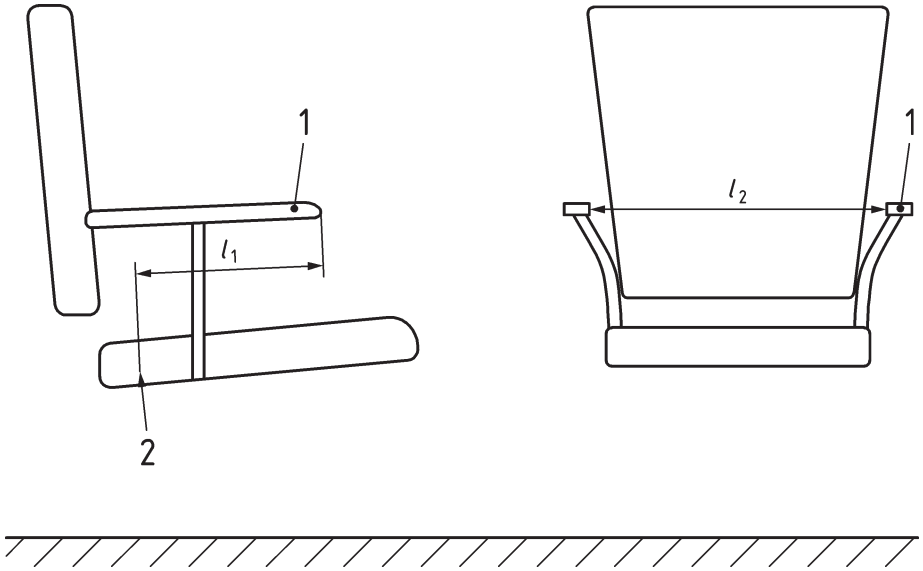
Key

1 armrest
l_1 armrest length

Figure 4 — Armrest length

3.5
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 5, Figure 7 and 3.28.



Key

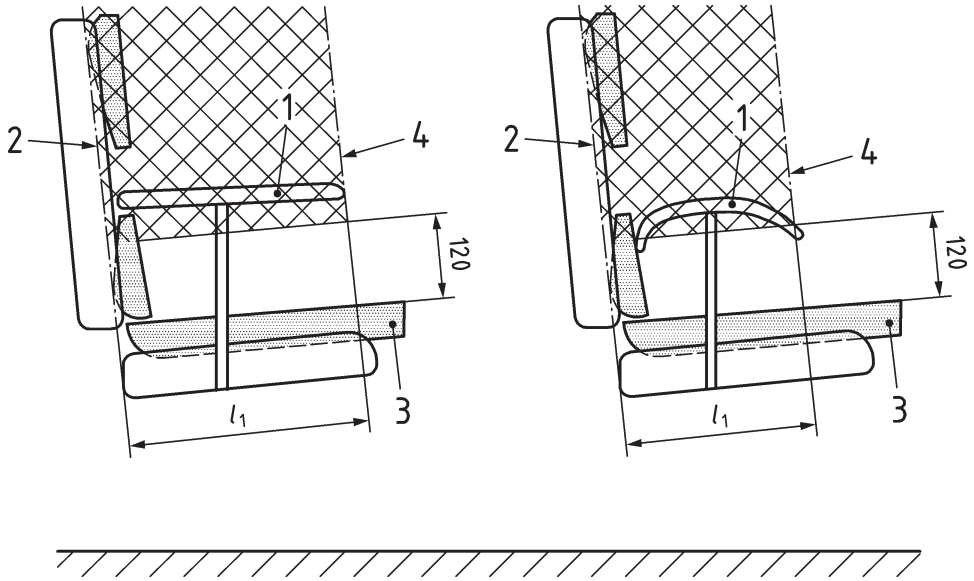
1 armrest
2 rear of seat width zone
l_1 armrest pad measurement zone
l_2 distance between armrests

Figure 5 — Distance between armrests

3.6
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 6.

Dimensions in millimetres



Key

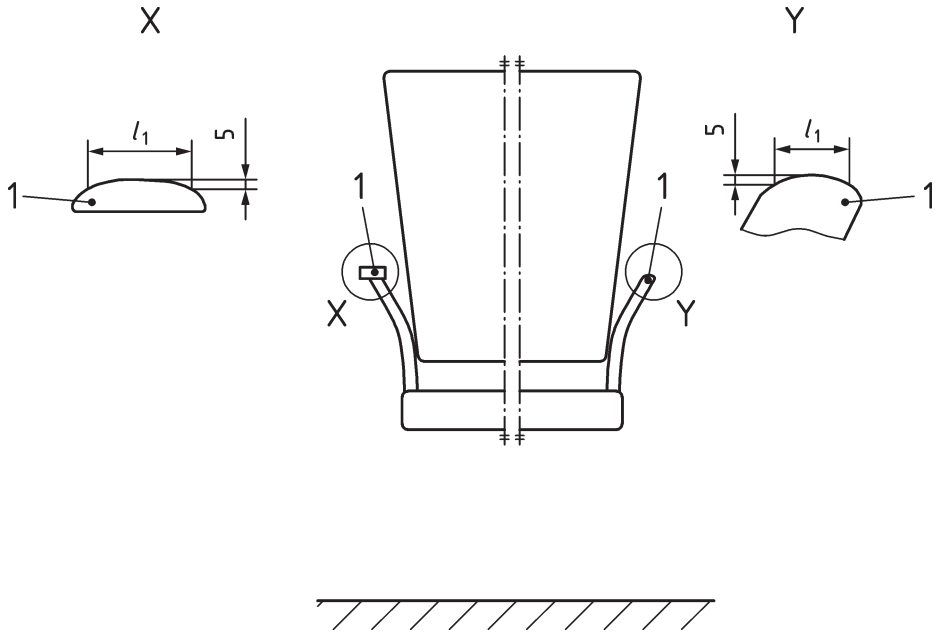
1 armrest
2 backrest line
3 CMD buttocks pad
4 measurement zone
l_1 front of armrest position

Figure 6 — Front of armrest position

3.7
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 7.

Dimensions in millimetres



Key

1 armrest

l_1 armrest width

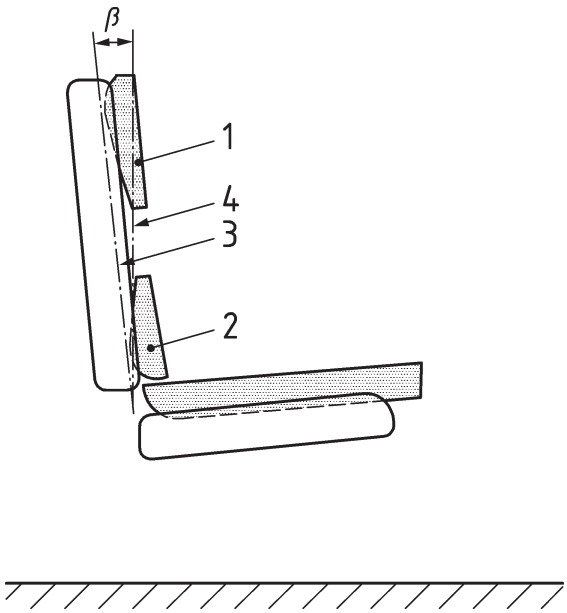
Figure 7 — Armrest width

3.8
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.

3.9
backrest angle to vertical
β
angle between vertical and the loaded backrest

Note 1 to entry: See Figure 8.



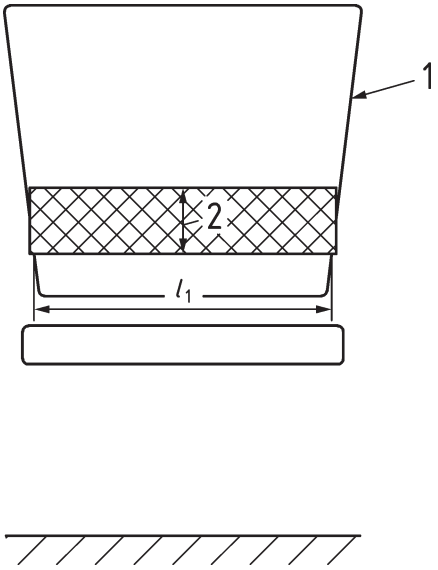
Key

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

Figure 8 — Backrest angle to vertical

3.10
backrest width
smallest horizontal dimension of the backrest within the lumbar zone

Note 1 to entry: See Figure 9 and 3.18.



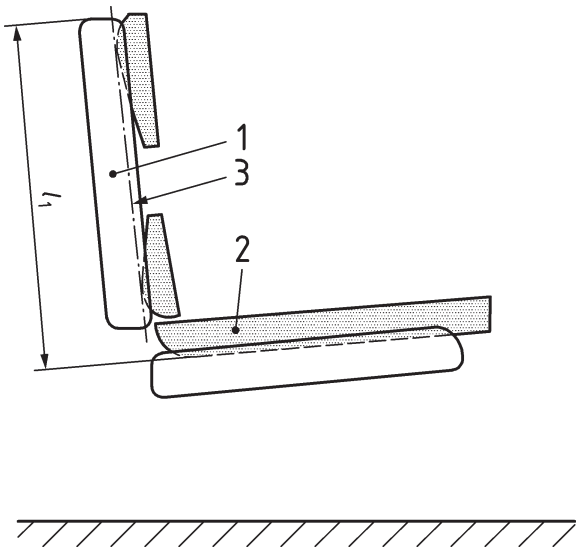
Key

1 backrest
2 lumbar zone
l_1 backrest width

Figure 9 — Backrest width

3.11
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 10.



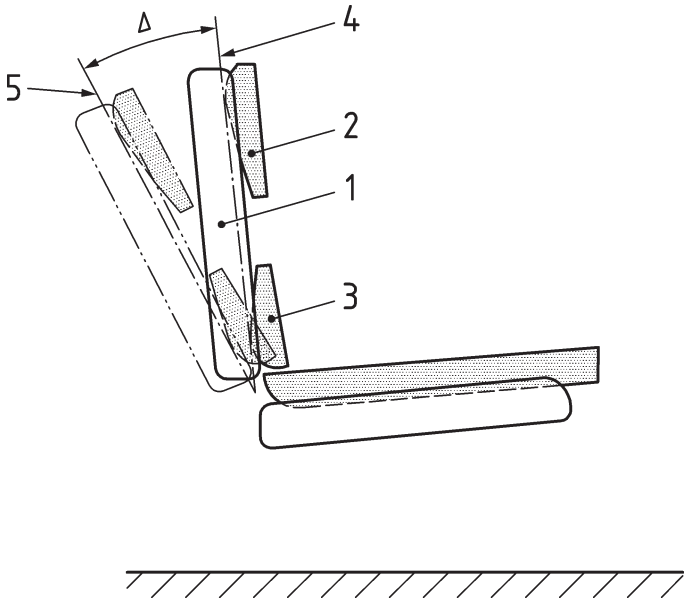
Key

1 backrest
2 CMD buttocks pad
3 backrest line
l_1 backrest height

Figure 10 — Backrest height

3.12
backrest inclination – range
tilt range of the backrest from its foremost inclination to its most rearward inclination

Note 1 to entry: See Figure 11.



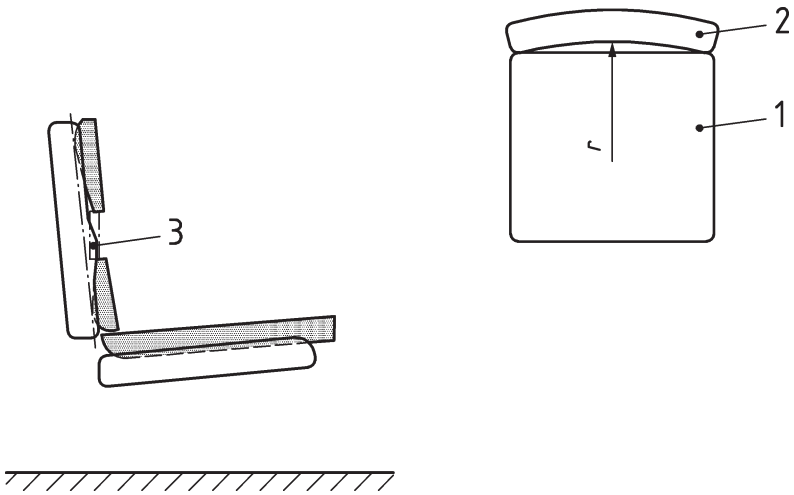
Key

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 11 — Backrest inclination – range

3.13
backrest radius – horizontal
horizontal radius of the backrest measured within the lumbar zone

Note 1 to entry: See Figure 12 and 3.18.



Key

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

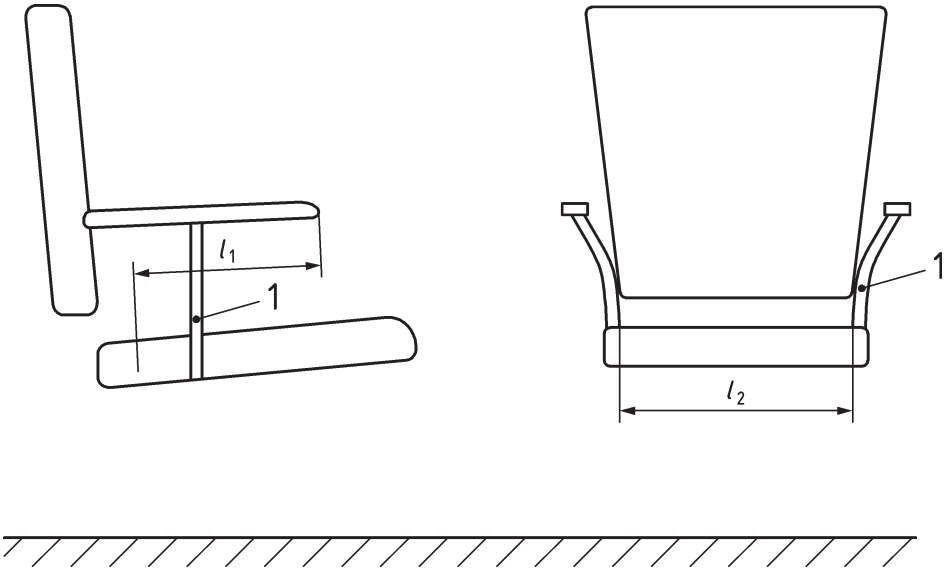
Figure 12 — Backrest radius – horizontal

3.14
chair measuring device
CMD
instrument for measuring dimensions of chairs

Note 1 to entry: Specified in Annex A.

3.15
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 13 and 3.28.



Key

1 armrest assembly

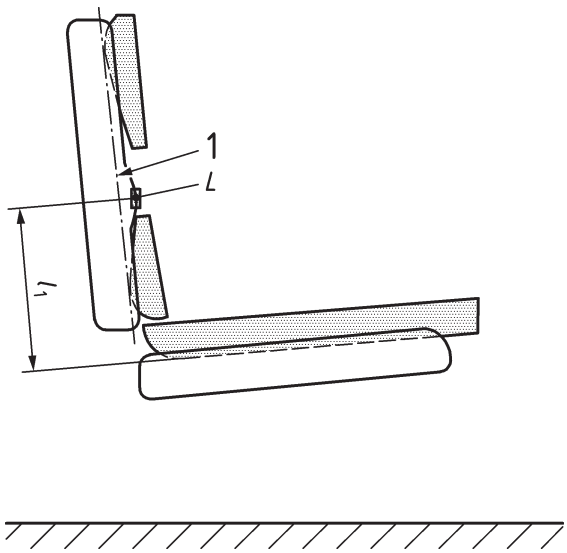
l_1 rear of seat surface width zone to front of armrest

l_2 hip breadth clearance

Figure 13 — Hip breadth clearance

3.16
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 14 and Figure 35.



Key

1 backrest line

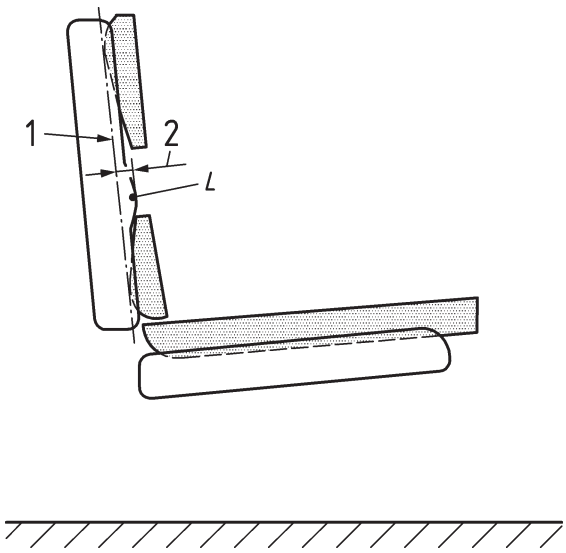
l_1 height of lumbar support

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

Figure 14 — Lumbar support – height

3.17
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 15 and Figure 35.



Key

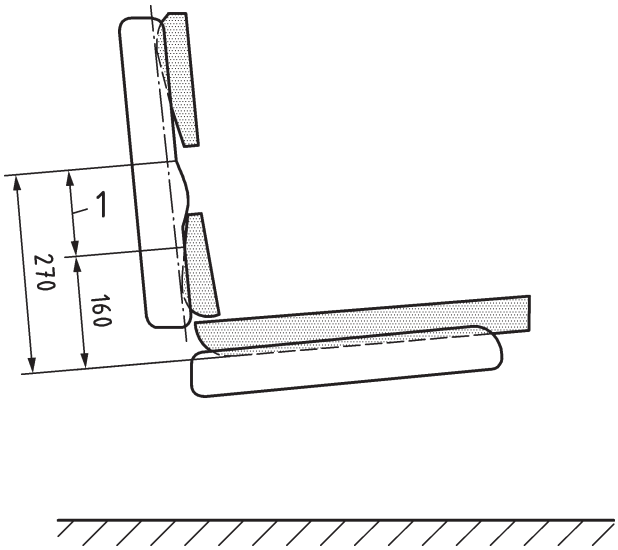
1 backrest line
2 protrusion of lumbar support
L most prominent segment (or segments) of the lumbar support

Figure 15 — Lumbar support – protrusion

3.18
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 16.

Dimensions in millimetres



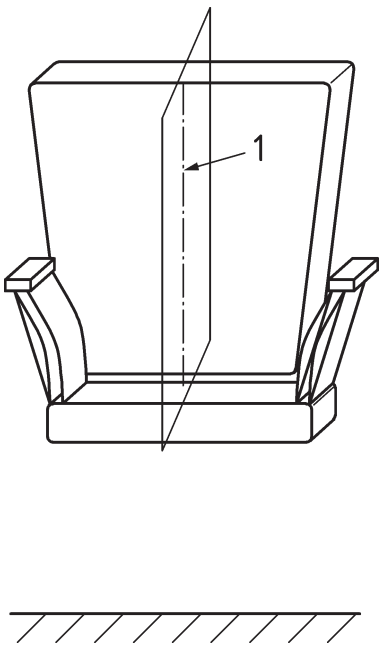
Key

1 lumbar zone

Figure 16 — Lumbar zone

3.19
median plane
vertical plane dividing the chair into two generally symmetrical parts (right and left)

Note 1 to entry: See Figure 17.



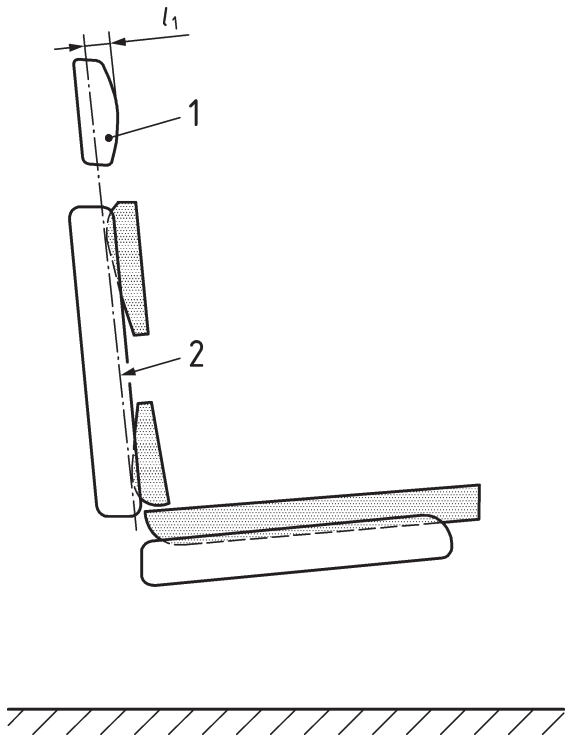
Key

1 median plane

Figure 17 — Median plane

3.20
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 18.



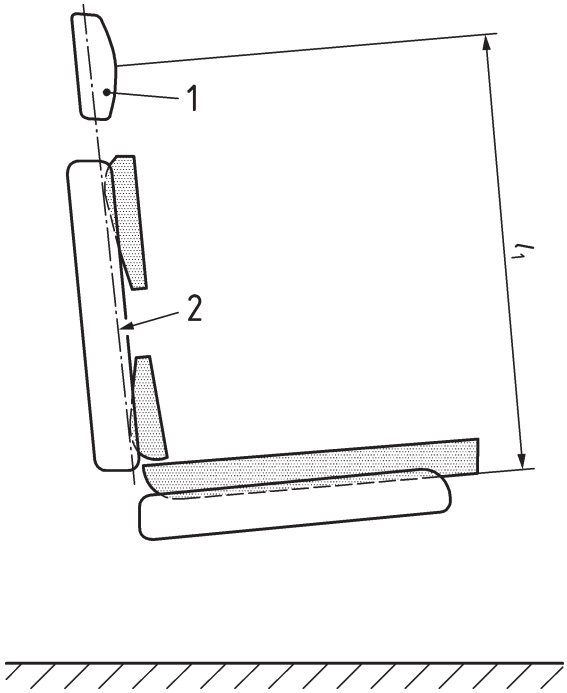
Key

1 neck/head rest
2 backrest line
l_1 neck/head rest protrusion

Figure 18 — Neck/head rest protrusion

3.21
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 19.



Key

1 neck/head rest

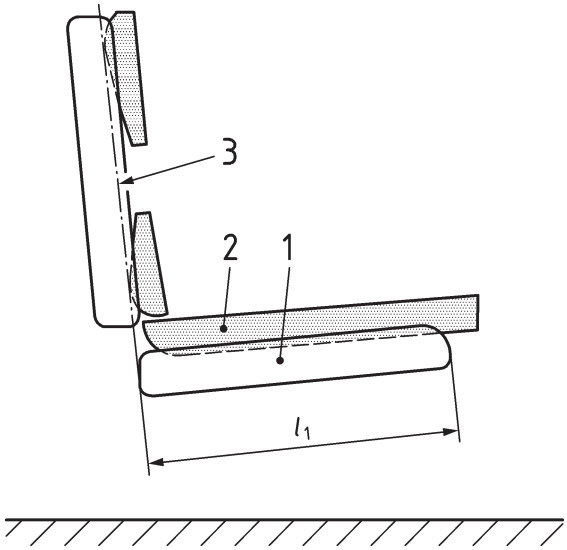
2 backrest line

l_1 neck/head rest height

Figure 19 — Neck/head rest height

3.22
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 20.



Key

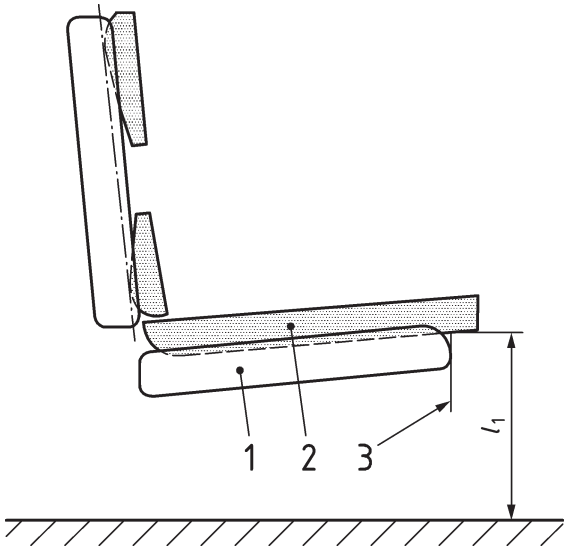
1 seat
2 CMD buttocks pad
3 backrest line
l_1 seat depth

Figure 20 — Seat depth

3.23
seat height
vertical distance, measured at the front of the seat, from the loaded seat 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 seat height.



Key

1 seat
2 CMD buttocks pad
3 front of seat
l_1 seat height

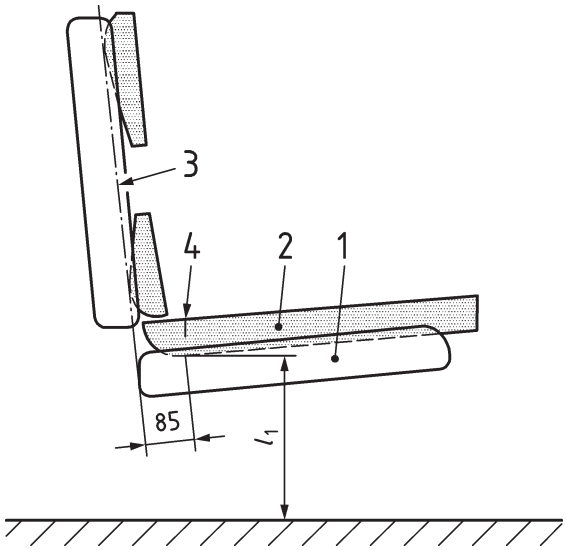
Figure 21 — Seat height

3.24
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 22.

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

Dimensions in millimetres



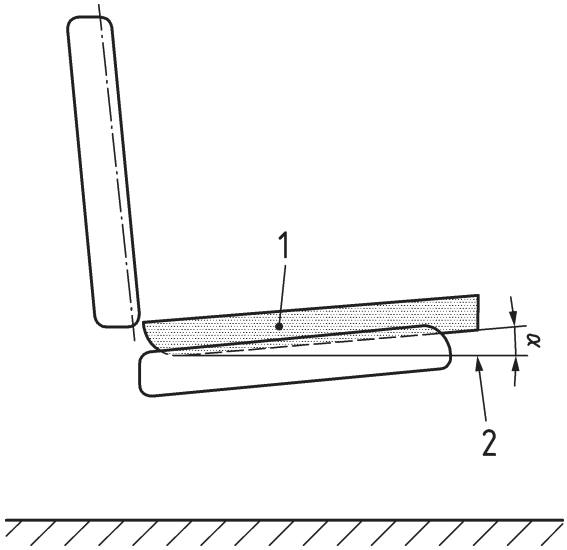
Key

1 seat
2 CMD buttocks pad
3 backrest line
4 sitting height line marked on the CMD
l_1 sitting height

Figure 22 — Sitting height

3.25
seat inclination
angle between the loaded CMD buttocks and the horizontal

Note 1 to entry: See Figure 23.



Key

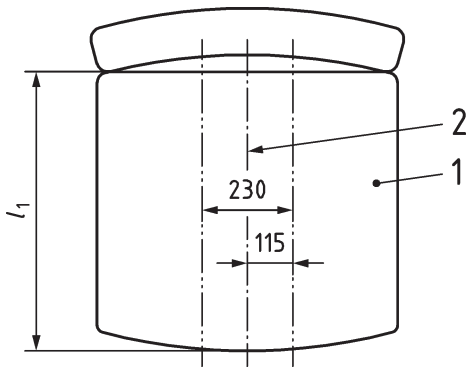
1 CMD buttocks pad
2 horizontal
α seat inclination

Figure 23 — Seat inclination

3.26
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 24.

Dimensions in millimetres



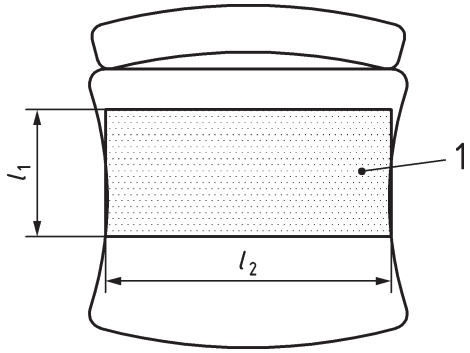
Key

1 seat
2 median plane
l_1 seat surface depth

Figure 24 — Seat surface depth

3.27
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 25 and 3.28.



Key

1 seat

l_1 seat surface width zone

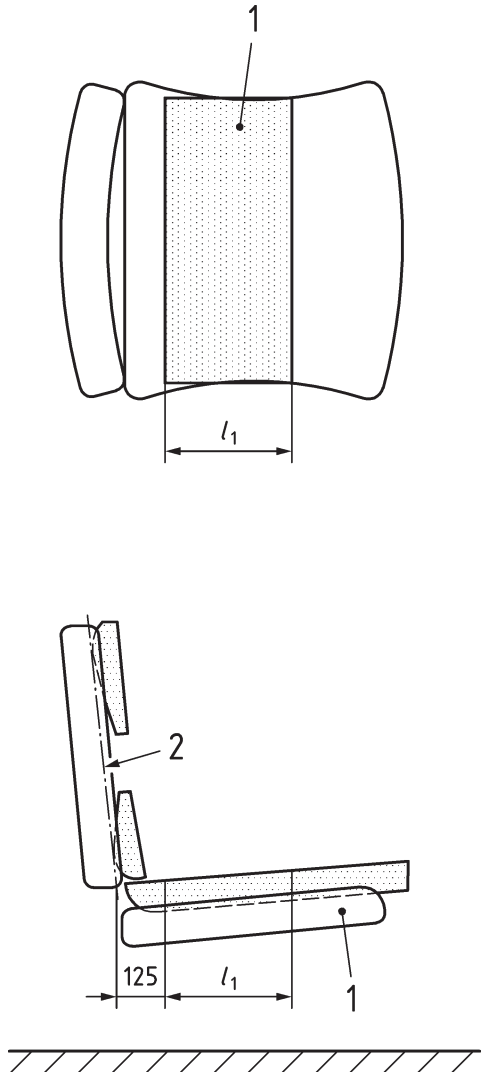
l_2 seat surface width

Figure 25 — Seat surface width

3.28
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 26.

Dimensions in millimetres



Key

1 seat surface

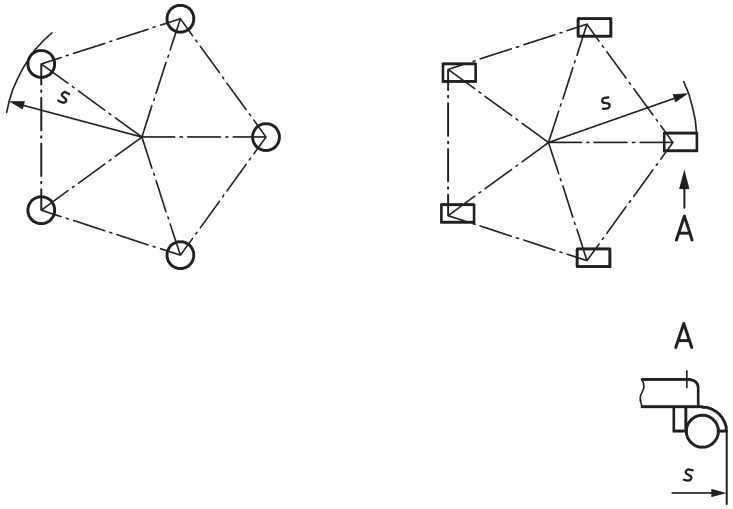
2 backrest line

l_1 seat surface width zone = 120 mm

Figure 26 — Seat surface width zone

3.29
under-frame — maximum off-set
maximum off-set of the under-frame is the maximum distance between the outermost point of the under-frame including castors or glides and the axis of rotation

Note 1 to entry: See Figure 27.



a) Under-frame without castors **b) Under-frame with castors**

Key

s maximum off-set of under-frame

Figure 27 — Under-frame — 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

Clause no.	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
6.3.2.7or 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	N.A.[a]
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	Offset of the underframe	±8 mm

[a] N.A. = not applicable

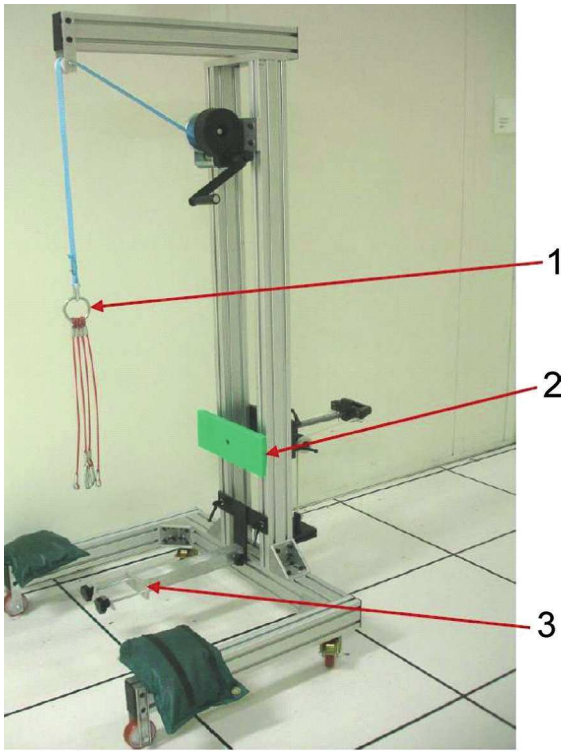
5 Test equipment

5.1 Floor surface

A rigid, horizontal and flat surface.

5.2 CMD placement fixture

A 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.



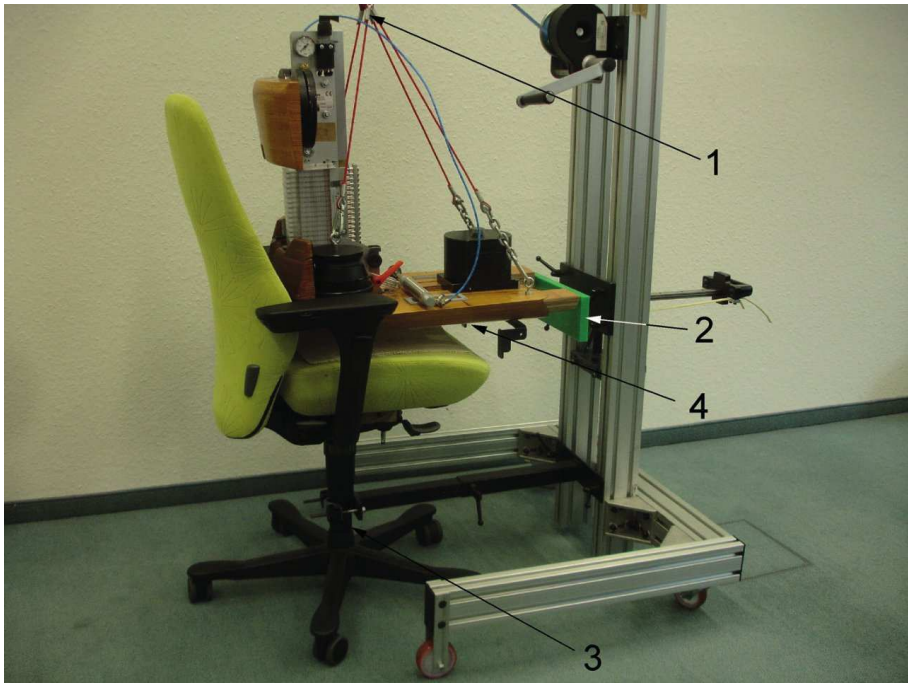
Key

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)

The device is specified in Annex A.

5.4 High friction material

Friction cloth for placing 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 (6.2), the measurements shall be taken as specified in the measurement procedures (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 (5.1) with the seat in the highest position.

b) Adjust all of the following to the mid-position of their range: seat depth, back rest tilt tension, back rest 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 counterclockwise of the horizontal without forcing the functions of the chair. If the chair has no position counterclockwise 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 will change the seat inclination, the horizontal seat position shall take precedence.

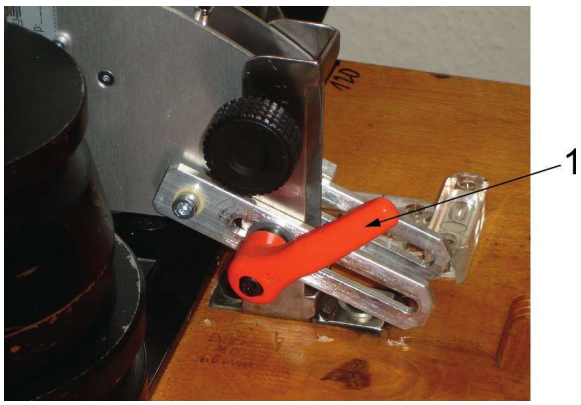
e) Mark a line in the centre of the backrest so that the mark is visible from the top of the backrest. Place marks on either side of the seat 182 mm from the seat's centre near the front of the seat to assist in placing the CMD centrally in the chair.

6.2.2 Initial placement of CMD on chair

a) Load the CMD according to 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) of 6.2.2 (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 (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 back rest (see Figure 31).

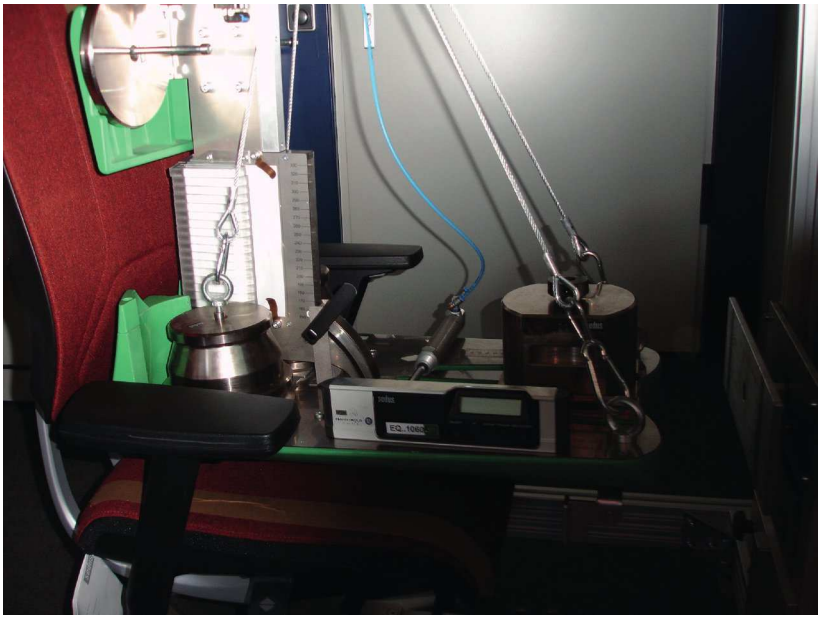
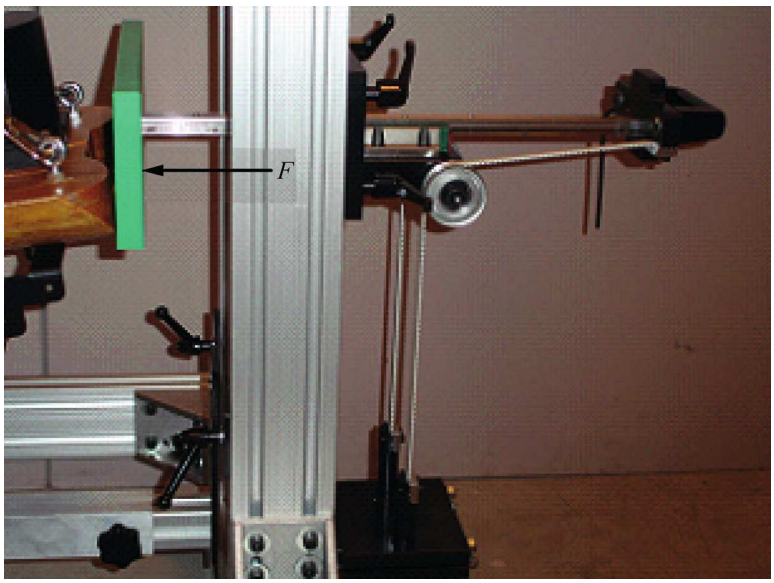


Figure 31 — CMD hovering above chair

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

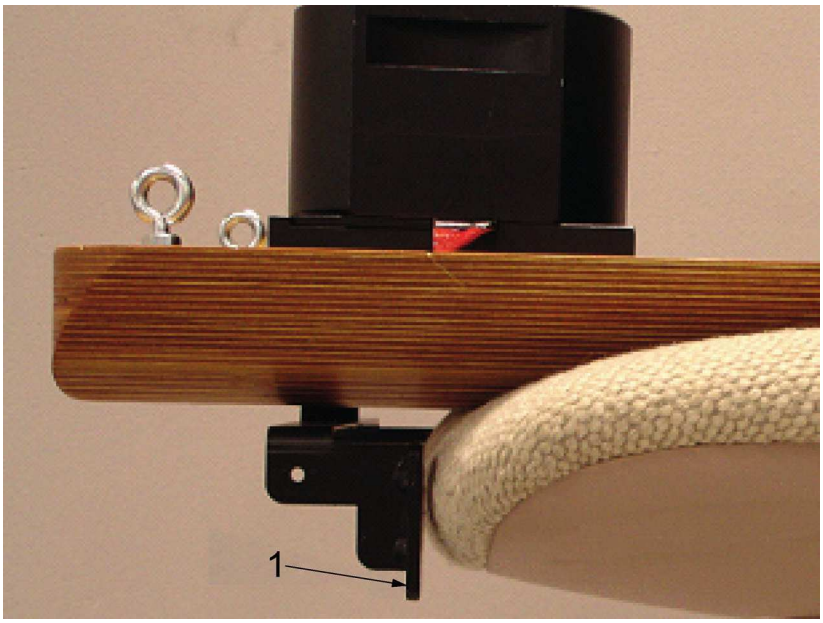
g) With this force acting, lower the CMD on to the seat while maintaining CMD alignment with the median plane. Use the previously located marks at the top of the backrest and the front of the seat to help keep the CMD aligned with the chair. Ensure that the seat depth indicator does not touch the chair 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 (3.28).

Mark the top of the lumbar zone (3.18) 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 ± 0,5) 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).

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 may 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 ± 0,5) 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.

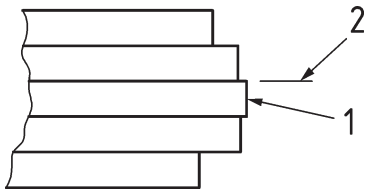
C Maximum vertical height

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 ± 0,5) N to the vertically stacked segments.

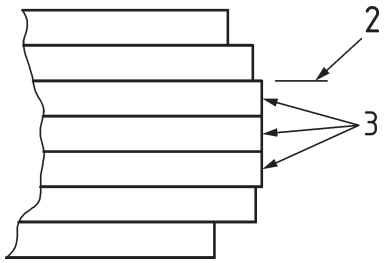
If only one segment is at a horizontal protrusion, record the dimension of the top of the segment as maximum lumbar height [see Figure 34 a)].

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

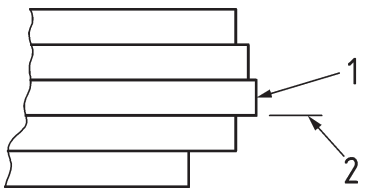
Figure 34 — Maximum vertical height

D Minimum vertical height

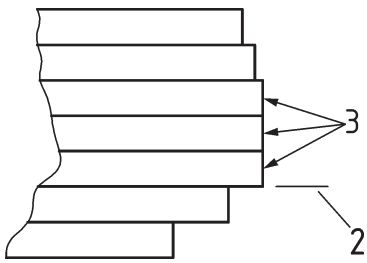
When available, make the various backrest and lumbar adjustment such that the lumbar support is at the least height that can be attained. If the backrest is to be adjusted, move the CMD vertical member to its 90° position and lock it. After the adjustments are complete, release the lock, let it settle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

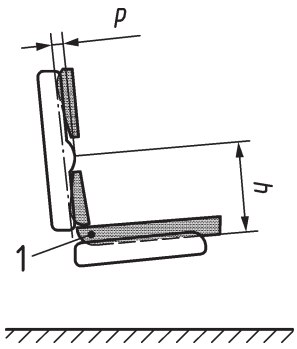
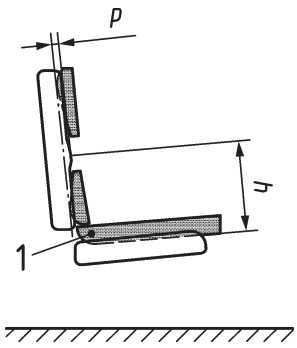
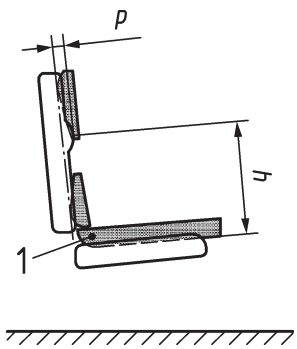
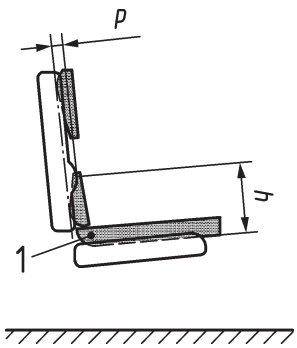
2 maximum lumbar height

3 multiple segments with maximum horizontal protrusion

Figure 35 — Minimum vertical height

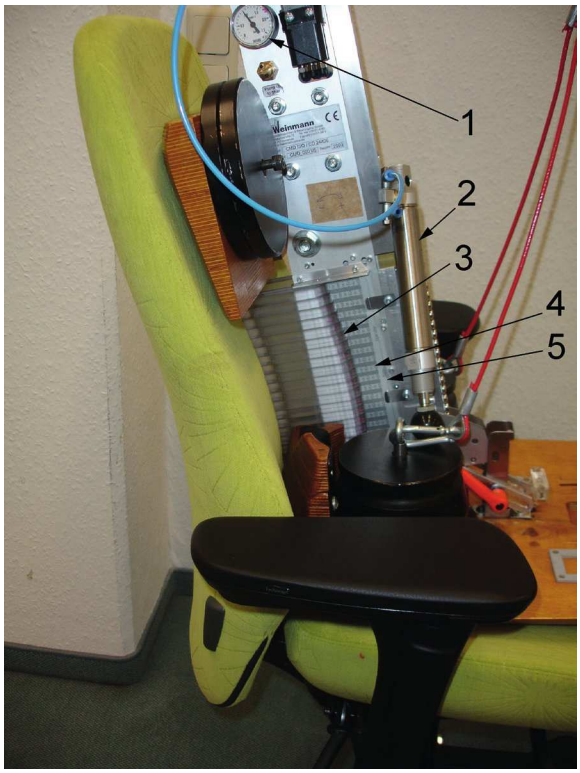
The measurement process (A through D) is illustrated in Table 2.

Table 2 — Lumbar support measurement steps

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

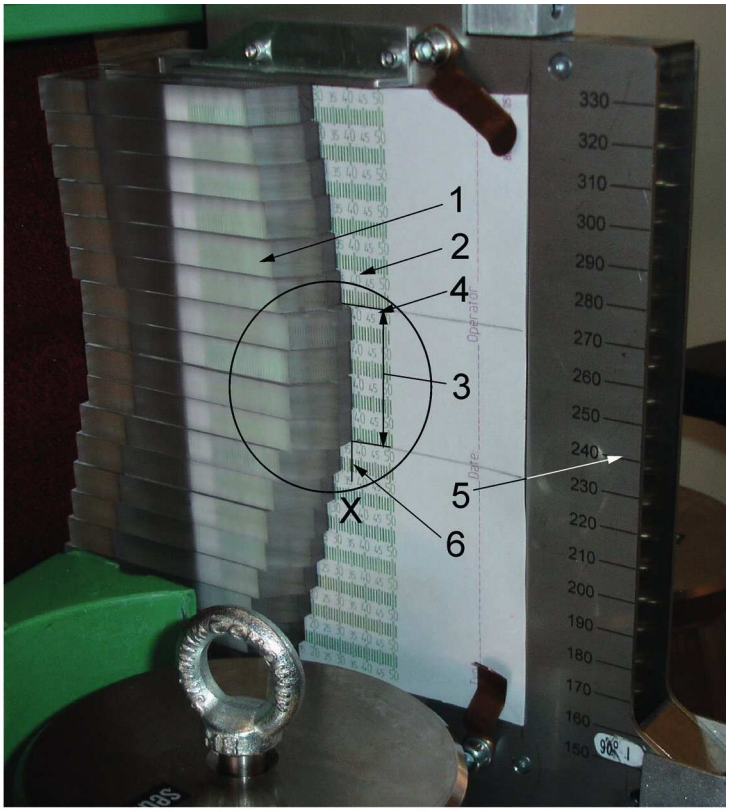
Remove the force on the vertically stacked segments and return them to their start position. If adjustments have been made during the execution of this clause, reposition the lumbar support adjustments to the position used in 6.2.1 b).

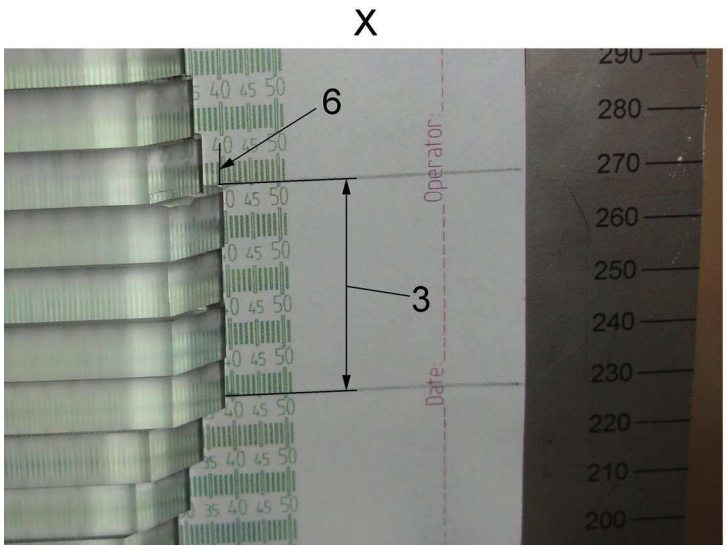


Key

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)





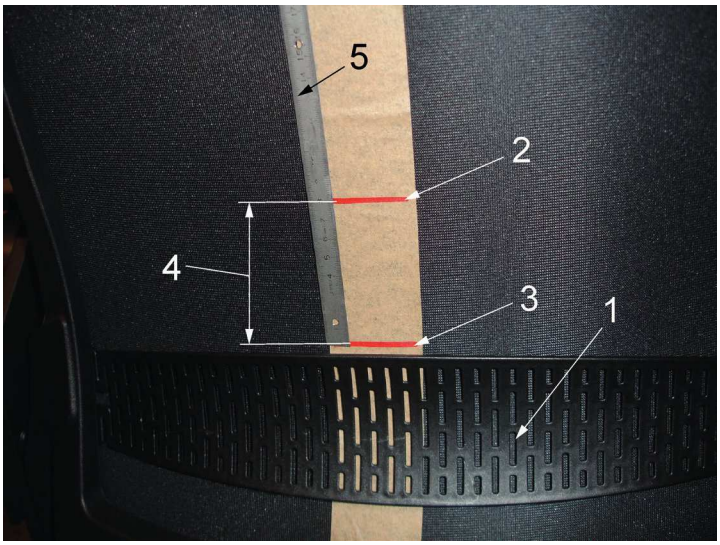
Key

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

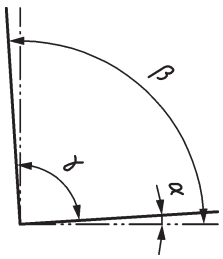
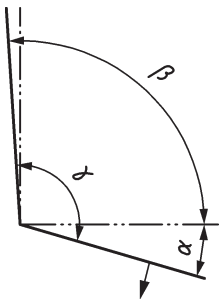
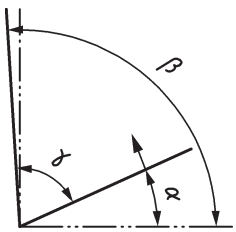
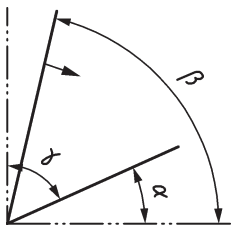
Measure the angle of inclination of the seat and backrest to the horizontal and angle between seat and backrest in the sequence given in Table 3. Before carrying out the measurement, the chair shall be positioned according to 6.2.1 b). The vertical member of the CMD shall be unlocked. See Figure 2 for 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 2, in sequence, to ensure appropriate positioning of the chair for each measurement. Record those measurements required in the applicable standards document. If the adjustment of a chair feature causes another feature measurement to change, that is acceptable.

NOTE 1 It may not be possible 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 may need to be secured to the chair to prevent dislodgement.

Table 3 — Angle measurement sequence

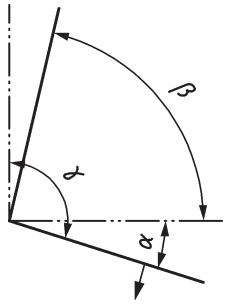
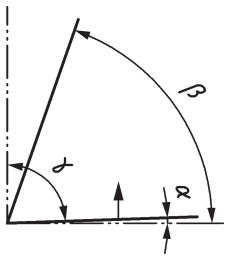
Measurement sequence	Graphical presentation of measurement	Settings	Inclination of seat α[a]	Backrest angle β[b]	Angle between backrest and seat γ[c]
1	 **Figure 43**	— Set seat as horizontal as possible — Set backrest as vertical as possible			
2	 **Figure 44**	— Set only the seat to its most forward 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)*

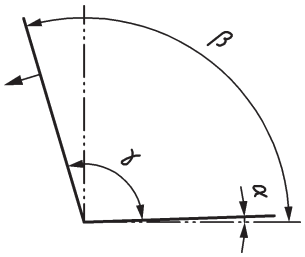
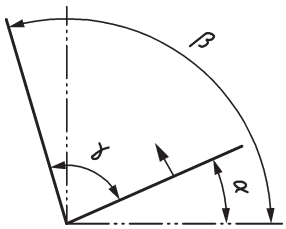
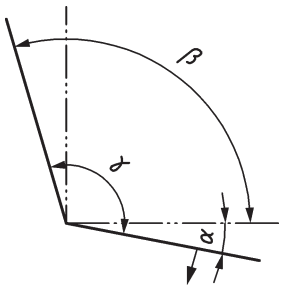
Measurement sequence	Graphical presentation of measurement	Settings	Inclination of seat α^a	Backrest angle β^b	Angle between backrest and seat γ^c
5	 **Figure 47**	— Set seat to its most forward tilt position — Backrest remains at the same adjustment as the prior step, but may move			
6	 **Figure 48**	— Set seat as horizontal as possible — Backrest remains at the same adjustment as the prior step, but may move			

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]
7	 **Figure 49**	— Seat remains at the same adjustment as the prior step, but set backrest recline resistance adjustments to their minimum. — Move the top section of the rear buttocks weights (2 kg × 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.			
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 Back 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”) (3.8).

Calculate the back to seat movement ratio as follows:

[backrest angle $_{\text{most forward (sequence 5)}}$ – backrest angle $_{\text{most rearward (sequence 8)}}$]/[seat angle $_{\text{most forward (sequence 5)}}$ – seat angle $_{\text{most rearward (sequence 8)}}$]

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.

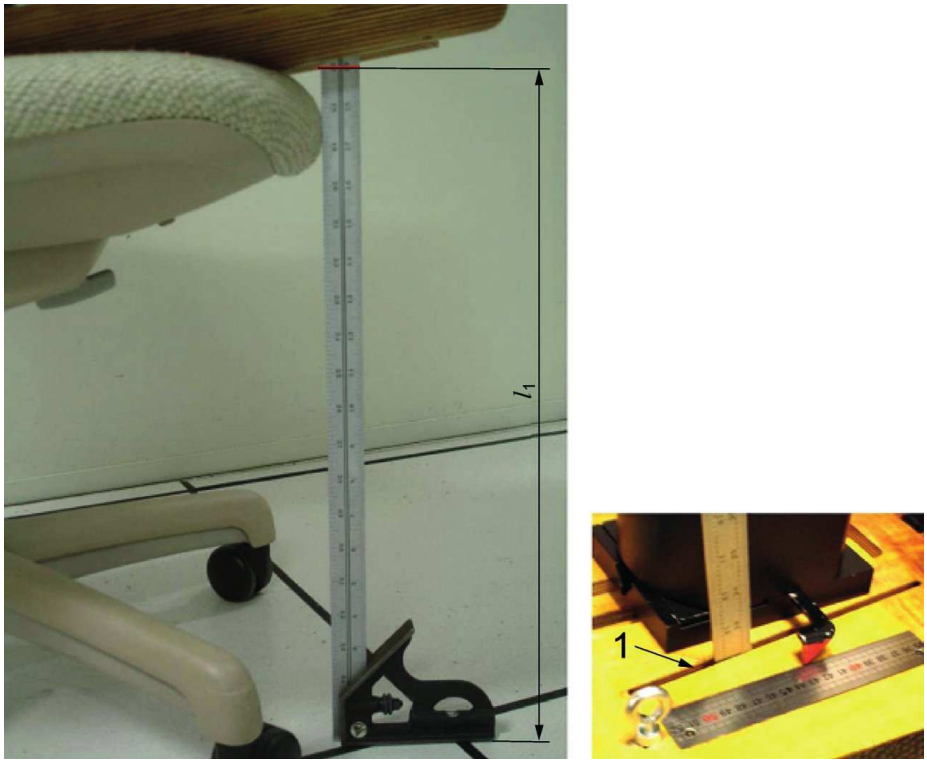
Position the CMD in the chair according to 6.2.2 and 6.2.3.

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 (3.23) 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

l_1 seat height

Figure 52 — Seat height measurement (two views)

Measure the sitting height (3.24) 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). 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

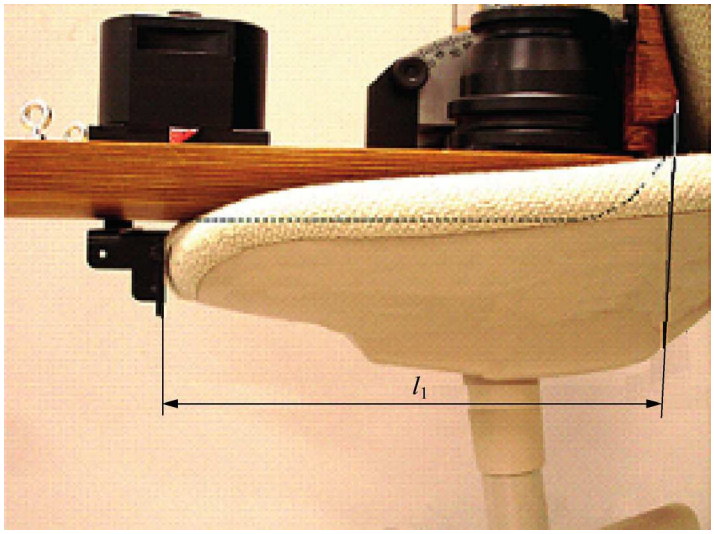
1 sitting height fore and aft position mark

l_1 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 (3.22) 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).



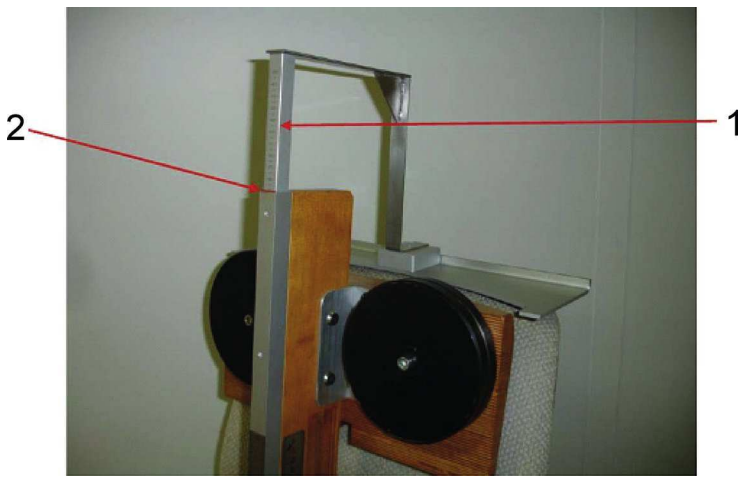
Key

l_1 seat depth

Figure 54 — Seat depth measurement

6.3.2.4 Backrest height

Slide the backrest height (3.11) gauge until it touches the top of the backrest. Read the height on the scale (see Figure 55).



Key

1 backrest height scale

2 backrest height

Figure 55 — Backrest height measurement

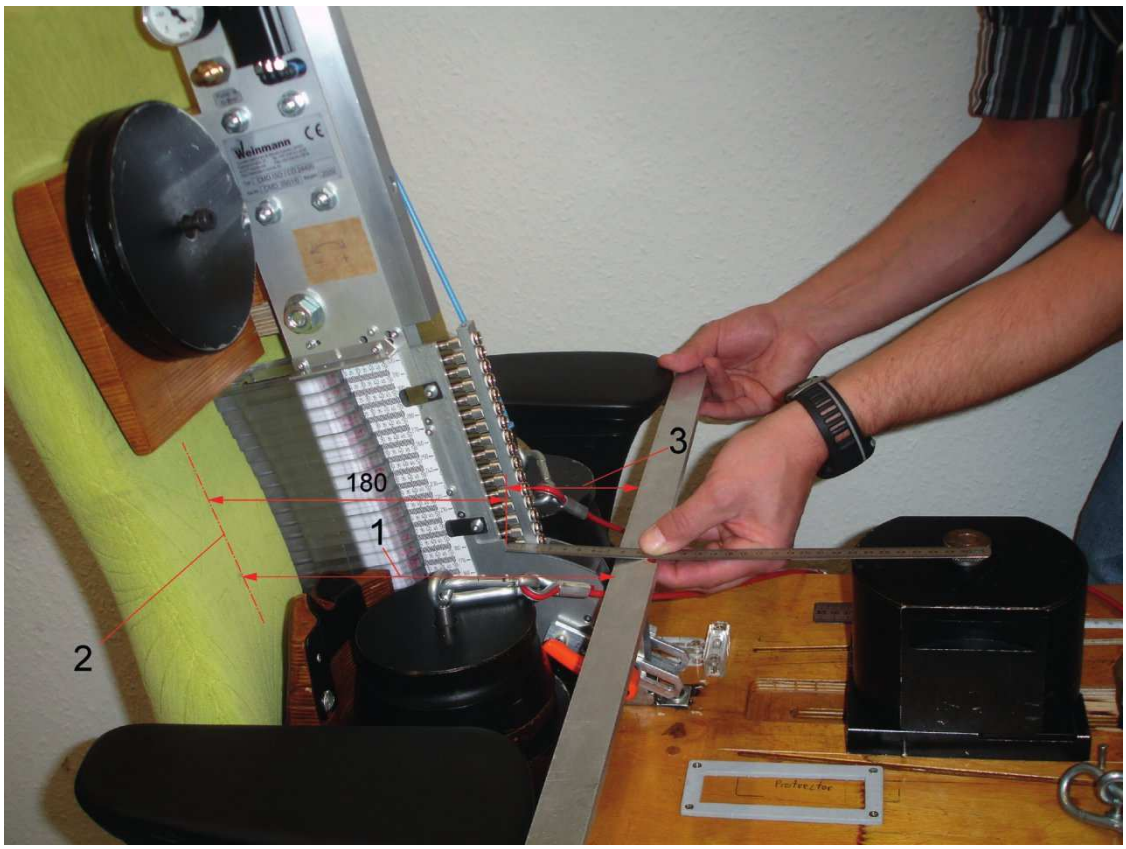
6.3.2.5 Front of armrest position

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 3.6).

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 180 mm (see Figure 56) (see 3.6 and Figure 6).

Dimensions in millimetres



Key

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

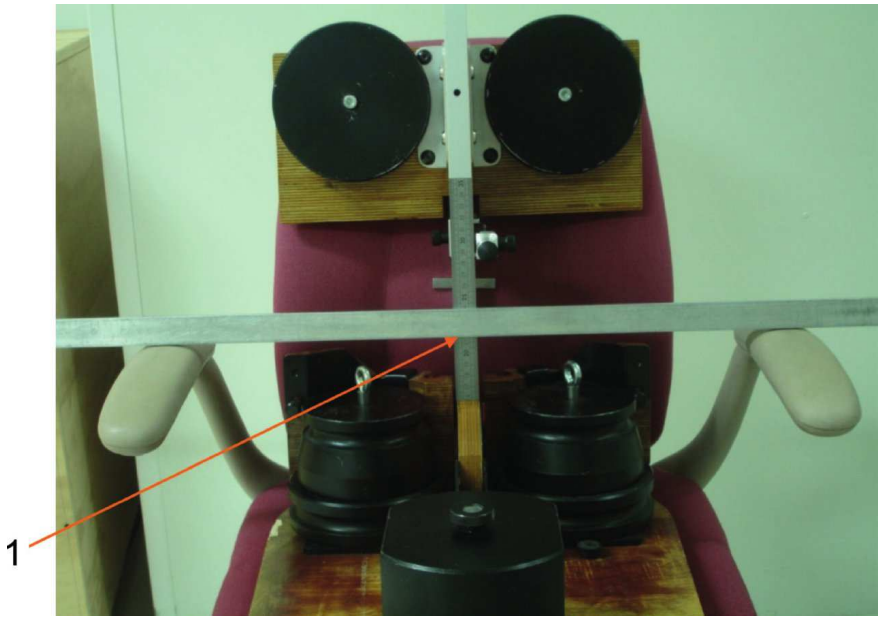
Figure 56 — Front of armrest position

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 (3.3) 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).



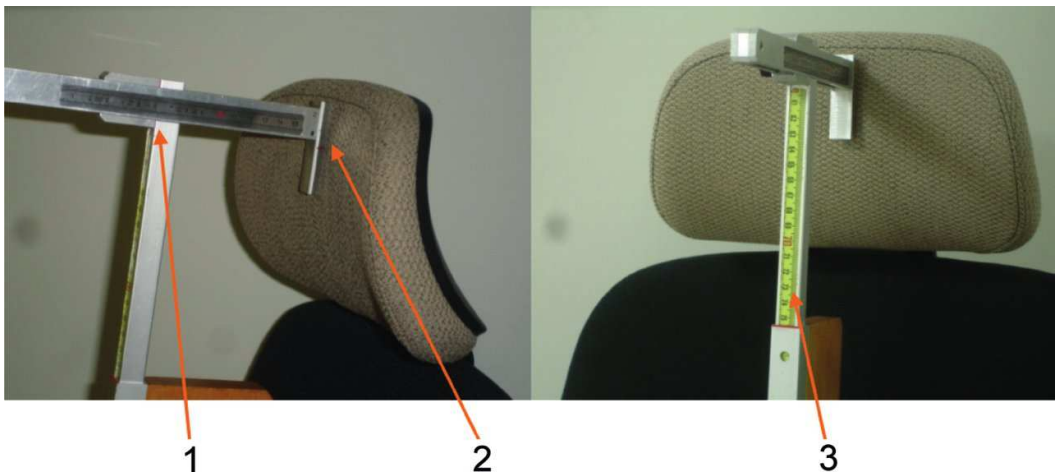
Key

1 armrest height

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 (3.21) from the ruler at the front of the vertical height adjustment tube and the neck/head rest protrusion (3.20) 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 (3.23) and sitting height (3.24) according to 6.3.2.2.

6.3.3.3 Seat depth

Measure the seat depth (3.22) according to 6.3.2.3.

6.3.3.4 Backrest height

Measure the height to the top of the backrest (3.11) according to 6.3.2.4.

6.3.3.5 Front of armrest position

Measure the front of the armrest position (3.6) 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 3.6).

6.3.3.6 Armrest height

Measure the armrest height (3.3) according to 6.3.2.7.

6.3.3.7 Neck/head rest height and protrusion

Measure the neck/head rest height (3.21) and neck/head rest protrusion (3.20) 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 (3.27) 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 (3.26) within the span, 115 mm either side of the median plane (see Figure 24).

6.3.4.4 Backrest width

Measure the narrowest backrest width (3.10) within 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. If evaluating to a requirements document, a radius template(s) may be used to assess the chair to the requirement. Otherwise, measure the radius of the back using any appropriate radius gauge or radius template(s). 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).

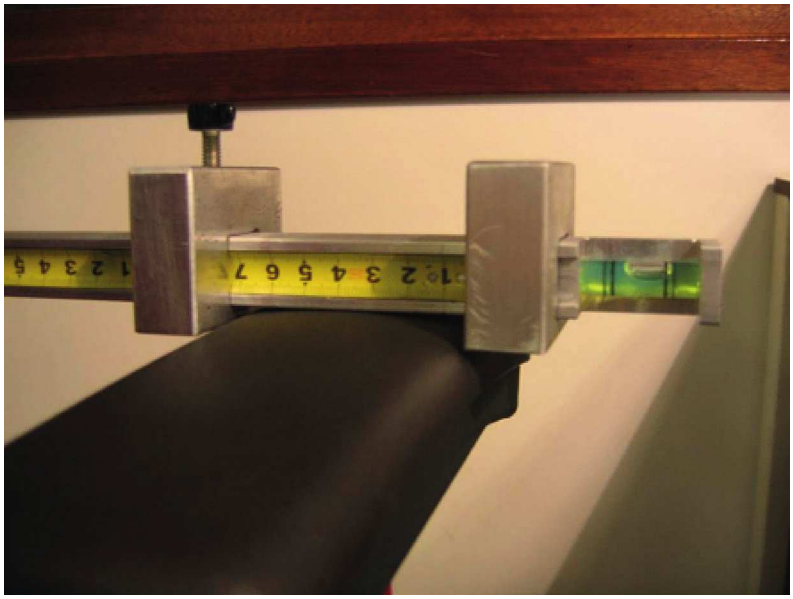
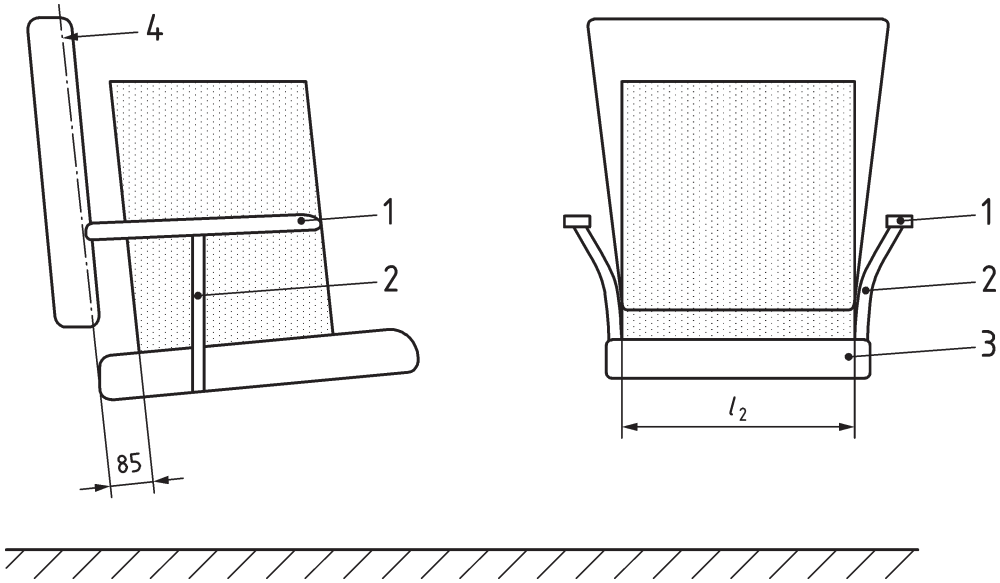


Figure 60 — Armrest width callipers

6.3.4.8 Hip breadth clearance

Adjust the armrests to their widest possible position. Measure the minimum width between the armrest assembly from 85 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
l_2 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 5) in each position from the rear of the seat width zone forward to the front edge of the seat (see Figure 26) within the measurement zone 5 mm down from the top of the armrest (see Figure 7).

6.3.4.10 Maximum offset of the underframe

Measure the maximum offset of the underframe as the distance from the axis of chair rotation to the outermost point of the base/castor/glide (see Figure 27).

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 files which can be found under the following link: http://isotc.iso.org/livelink/livelink?func=ll&objId=1864863&objAction=browse&viewType=1

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

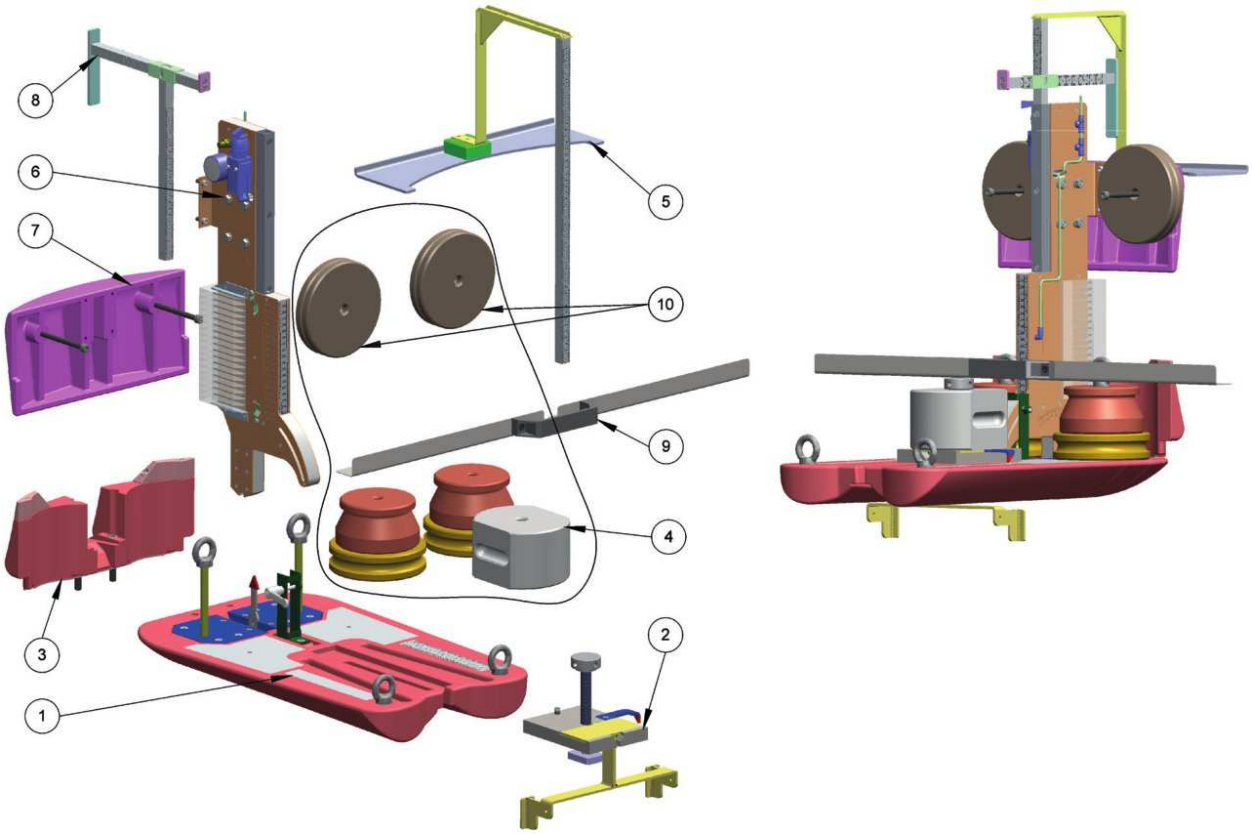
Table A.1 — CMD drawing list

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	QTY
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	A014–24496–2	armrest measuring bar	1
10[a]	P021–24496–3	thoracic weight	1

[a] Two weights each side.

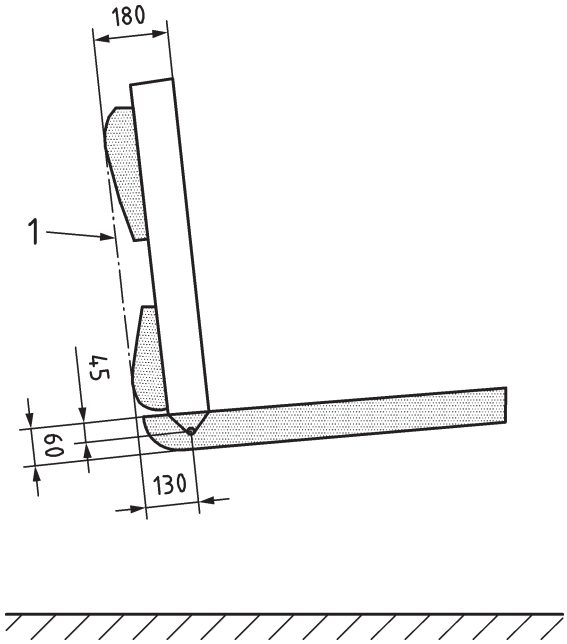
Also necessary is a manual air pump and air tube to connect the pneumatic (not drawn)

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 3.3 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 7250-1:2008, 4.2.5 (Elbow height, sitting).

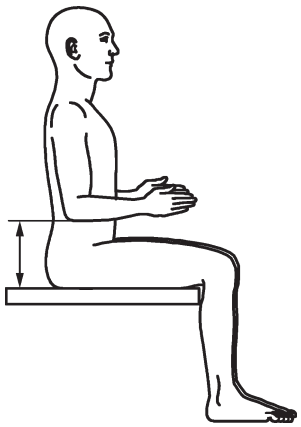


Figure B.1 — Armrest height

B.4 Armrest length

See 3.4.

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 3.5.

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 3.6.

Anthropometric equivalent: there is no anthropometric equivalent; however, this dimension is related to the lower abdominal depth (body thickness). See ISO 7250-1:2008, 4.2.15 (Abdominal depth, sitting).

B.7 Armrest width

See 3.7.

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

B.8 Backrest angle to vertical

See 3.9.

There is no direct anthropometric equivalent.

B.9 Backrest width

See 3.10.

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).

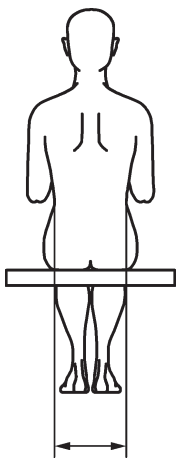


Figure B.2 — Backrest width

B.10 Backrest height

See 3.11.

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 3.12.

There is no direct anthropometric equivalent.

B.12 Backrest radius — Horizontal

See 3.13.

There is no anthropometric equivalent.

B.13 CMD (chair measuring device)

See 3.14.

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

B.14 Hip breadth clearance

See 3.15.

Anthropometric equivalent: breadth of the body measured across the widest portion of the hips. See Figure B.3 and ISO 7250-1:2008, 4.2.11 (Hip breadth, sitting).

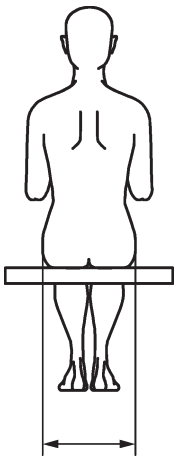


Figure B.3 — Hip breadth

B.15 Lumbar support — height

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.4).

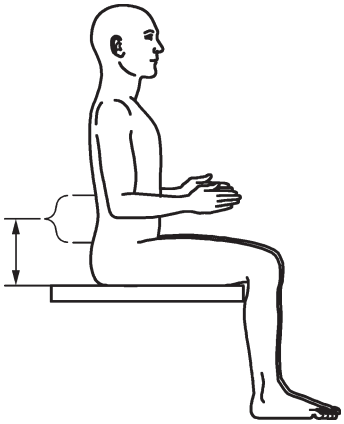


Figure B.4 — Lumbar Region

B.16 Lumbar support — protrusion

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.5).

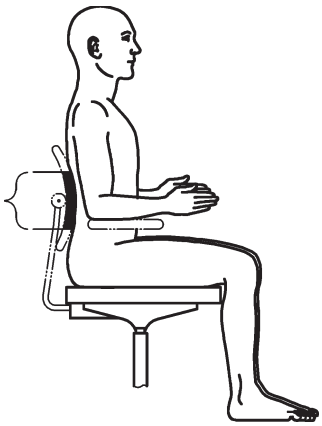
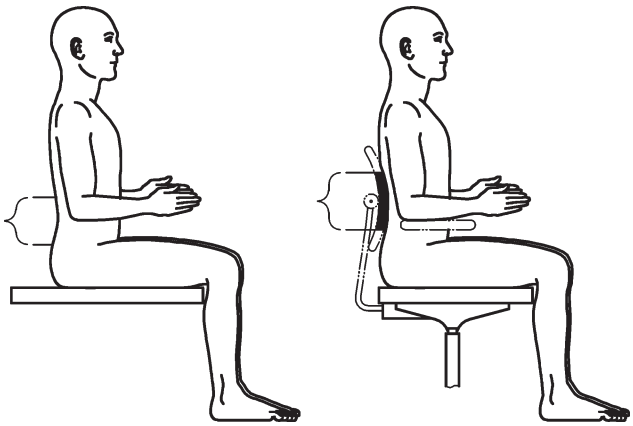


Figure B.5 — Protrusion of lumbar

B.17 Lumbar zone

See 3.18.

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 3.19.

There is no anthropometric equivalent.

B.19 Neck/head rest protrusion

See 3.20.

There is no direct anthropometric equivalent.

B.20 Neck/head rest height

See 3.21.

There is no direct anthropometric equivalent for head rest height. See ISO 7250-1:2008, 4.2.3 (Cervicale height, sitting).

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

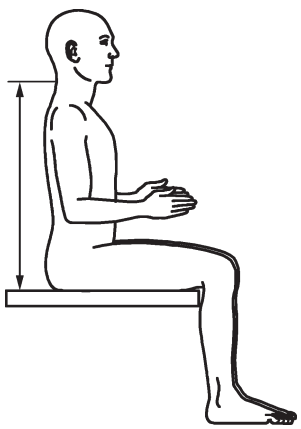


Figure B.7 — Neck rest height

B.21 Seat depth

See 3.22.

Anthropometric equivalent: horizontal distance from the hollow of the knee to the rearmost point of the buttock. See Figure B.8 and see ISO 7250-1:2008, 4.4.6 [Buttock-popliteal length (seat depth)].

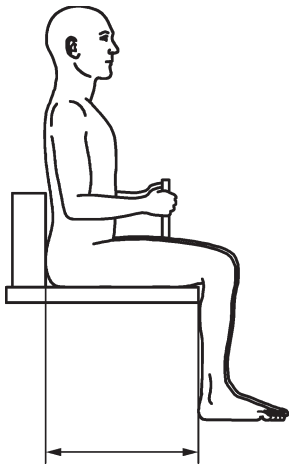


Figure B.8 — Seat depth

B.22 Seat height

See 3.23.

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 7250-1:2008, 4.2.12 [Lower leg length (popliteal height)].

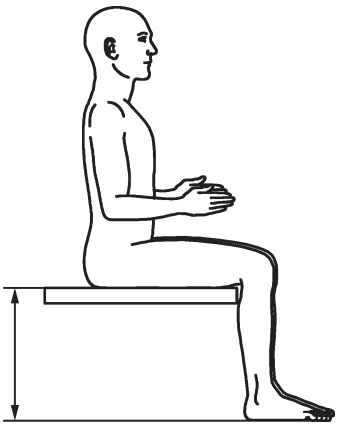


Figure B.9 — Seat height

B.23 Sitting height

See 3.24.

There is no direct anthropometric equivalent.

B.24 Seat inclination

See 3.25.

There is no anthropometric equivalent.

B.25 Seat surface depth

See 3.26.

There is no direct anthropometric equivalent.

B.26 Seat surface width

See 3.27.

Anthropometric equivalent: breadth of the body measured across the widest portion of the hips. See Figure B.10 and ISO 7250-1:2008, 4.2.11 (Hip breadth, sitting).

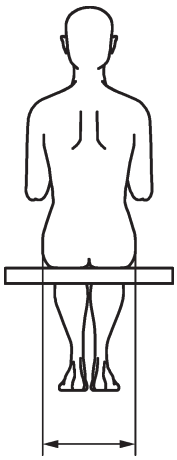


Figure B.10 — Seat width

B.27 Seat surface width zone

See 3.28.

There is no direct anthropometric equivalent.

B.28 Under-frame — maximum off-set

See 3.29.

There is no direct anthropometric equivalent.

Annex C
(informative)

Development history and rationale

C.1 Purpose

The purpose of this annex is to provide the reader with the background and rationale for the provisions contained in this document.

C.2 History of development

The process of developing this document was started in October 2000. The idea that such a document should be developed came about during the ISO/TC 136 meeting in Hamburg in which several participants mentioned their dissatisfaction with the known existing chair measurement systems. It was also understood that the large variety of measurement methods in use around the world made it difficult to make comparisons between chairs. An ad hoc group was formed to develop a chair measurement system that would address the major weakness, the lack of a load on the backrest, of the various dummies used to measure the chair. This group, in addition to preparing a measurement system, was to prepare a draft of a standard procedure to perform the measurements.

The first task of the ad hoc group was to review the existing chair measurement systems to draw from them their greatest strengths. The systems examined include the following:

— BIFMA CMD;

— BS 5940-1;

— DIN 4551;

— EN 1335–1 and EN 1335–3;

— German Sedometer;

— ISO 9241-5;

— NF D 61040;

— Swedish dummy;

— UNI 7498.

This group assembled a list of measurements that could be taken using the above standards. In addition, some dimensions were added for consideration that is based on the ergonomic factors listed in ISO 9241-5.

The group then searched for a system from which they could build on for the proposed ISO system. They found most of them used a form of some sort of buttocks that is loaded with weight to simulate the weight of a person sitting in a chair. They further examined these systems and found that the EN 1335–1 system worked well. The exception is that its buttocks tended to concentrate the pressure of the weight on the buttocks onto just one spot on the chair. They found that substituting the buttocks from EN 1335–3 corrected the excessive pressure concentration.

The characteristic of excessive pressure concentration was present in all of the systems buttocks measured. Since no currently available system had an ideal pressure pattern, the decision was made to build the ISO system with the EN 1335–3 buttocks as a base.

Some debate was had about how to size the ISO chair measurement device(s). Note that many of the standards refer to the measurement device itself as the “measuring dummy”. The committee working on the development of this document preferred the use of the term “chair measuring device”, or “CMD”, which will be used throughout this discussion and the standard itself. There was a brief discussion about the fact that theoretically, a range of different size CMDs should be used to measure a chair for suitability of use for different size people. That idea was rejected because all the current systems in use were based on a single-size CMD. The use of multiple CMDs was considered overly complicated and unnecessary. It was believed a system based on the 50th percentile person would yield sufficiently accurate measurements.

There were two basic philosophies discussed with respect to the best way to measure the range of adjustments of a chair.

— One method that has been used is to measure the effect of individual adjustment on a given chair characteristic. With this method, all other adjustable features are usually set at a midpoint while measuring only the adjustment of interest.

— The other method is one in which all the adjustable features were set into two states. The chair would be measured with all adjustments to set to their largest size and then measured again with all adjustments set to their smallest size.

The latter of these methods was chosen for use in this document primarily because many of the adjustment features of a chair affect the way the CMD installs onto the chair. If the first method was used, the CMD would have to be reinstalled nearly every time a feature was adjusted, increasing the measurement time and complexity compared to the later method. Two exceptions were made to this “max/min” decision. One is the measurement on backrest profile in the lumbar region; the other is the measurement of seat and back inclinations. This was done simply because they do not fit into a max/min chair set-up definition.

Another item to be resolved was the issue of choosing the proper CMD back form. Several back forms are in existence and might be used but they all interfered with measuring the shape of a chair’s lumbar support. It was decided to construct separate thoracic and pelvic back elements to be held together by a beam spaced out away from the backrest.

A CMD based on the above decision was developed and eight were made and used in the initial trials. A trial set of measurement methods was developed by the ad hoc group and distributed for guidance. They were based on the ergonomic principles outlined in ISO 9241-5.

The greatest difficulty encountered during these trials was finding a way to place the CMD in a chair in a realistic and consistent manner. Two methods tried at first were as follows.

— To set the CMD in the seat of the chair and push it back by various methods until the CMD back contacted the backrest firmly enough to resist further movement. This was done with varying portions of the CMD weights installed on the CMD. The push back forces varied and some cases were based strictly on the discretion of the CMD user.

— Another technique was to tilt the chair at various angles and lower the CMD into it.

All of these attempts had varying degrees of difficulty and did not yield consistent measurements due to inconsistent CMD placement. Eventually, it was decided to develop a gantry 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 held the CMD in a constant orientation. Trials with the gantry confirmed the consistency of the results when using the gantry for placement. Additionally, all users noted that the use of the gantry was easier to use than the previously attempted methods.

Early users of the CMD found the lumbar support measuring mechanism to be extremely time consuming and observed that it was difficult to identify a single point at which the lumbar support was most prominent. An alternative to the initial paddle measurement system consisting of a series of 1 cm high by 6 cm wide segments arranged between the pelvic and thoracic elements were proposed. These probes are activated simultaneously with air pressure to measure the protrusion of the backrest in the lumbar region. Trials with this method found that it provided an instantaneous view of the backrest

profile in the lumbar region. Besides greatly simplifying the lumbar support measurement process, it confirmed the observation that virtually all backrest lumbar support profiles have a maximum protrusion that is several centimetres high. It was decided to revise the term “maximum protrusion point” or “S” point to “maximum protrusion segment”.

In the process of confirming the appropriateness of the lumbar measuring devices, it was noted that most commercially available chairs had back support devices that could be adjusted to heights well above the lumbar region of the human back. Since it is not the purpose of this document to judge the appropriateness of those features, it was decided to provide the ability to measure the backrest profile of a chair in those larger regions.

Another issue raised was the fact that considerable manual force was often needed to bring the backrest to the full recline position during the measurement process. This led to considerable variation in the measurement of back travel as it was difficult to avoid deflecting the back while forcing it to its most rearward position. This variable deflection was giving inappropriate and inconsistent back angle readings. In an attempt to correct this, the upper pelvic weights are specified to be moved to the thoracic position for the most rearward angle measurement of the backrest only. Additionally, the back tension adjustment has also been specified to be set at its minimum for the same measurement. The result of those changes is that most backrests moved to the fully reclined position automatically with the application of the thoracic weight. For those that did not, only a low force is required to be applied to bring the backrest to its full recline position. That low level force has not caused any inconsistency in backrest angle measurement.

As the experts made the measurements of seat and back inclinations and their ranges, it was noted that the CMD position tended to shift slightly as a chair was adjusted to its various extremes. This affected the angles measured. As long as the measurement series was made with the same sequence of moves from one set of chair adjustments to the next, measurements could be repeated accurately. A change in sequence frequently resulted in a change in results. For this reason, the sequence of moves from one chair adjustment to the next is specified. This is the only measurement sequence specified in this document.

C.3 Standard organization

This document uses the conventional ISO standard layout with a much expanded definition of terms clause. It is critical that these terms be thoroughly understood to be able to the make the measurements described in this document. However, the definitions should not be used as a description of the measurement method. Those are called out in Clause 6.

C.4 Rationale for measurement zones

C.4.1 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.4.2 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.4.3 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.5 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.6 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).

Initially, this document was written with the uncertainty measures that came from BIFMA/CMD-2002 to provide some indication of what uncertainty to expect until such time as there was data available based on the methods in this document.

The initial activity attempting to gather this data was conducted in North America organized by BIFMA. It was conducted in early 2012. It consisted of three measurements of eight different chairs. It proved short of statistical rigor, 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 by the CEN/TC 207 group at the CATAS laboratory. It consisted of two back-to-back measurements on each of three chairs by nine different measurement teams. In mid-2013, a round robin study was conducted in North America. This study consisted of 11 measurements each on three chairs (not the same chairs used in Europe) made by a total of 13 teams. One of the teams making measurements in North America also participated in the European study.

Prior to conducting the 2013 studies, a training video was prepared by BIFMA and posted to the Web. Its address is: https://www.youtube.com/watch?v=xdG0ifME4xw. 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.

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1) Withdrawn.

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