Technical Specification

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Wheelchair seating —

Part 15: Selection, placement and fixation of flexible postural support devices in seating

Sièges de fauteuils roulants —

Partie 15: Choix, mise en place et fixation des dispositifs de soutien postural dans les sièges

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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 document 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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This document was prepared by Technical Committee ISO/TC 173, *Assistive products*, Subcommittee SC 1, *Wheelchairs*.

A list of all parts in the ISO 16840 series can be found on the ISO website.

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.

Introduction

Postural support devices, such as positioning supports, are typically used to provide increased postural stability and/or to maintain or correct the occupant's posture, in order to help maintain and increase day-to-day functionality for the individual. Postural support devices can also help to reduce the development of skeletal deformities, or to correct them. These devices, having postural support purposes, are not to be confused with belts and similar devices designed to act as vehicular occupant restraints. Postural support devices may improve the occupant's safety in other ways, especially when used to prevent falls in or out of the seating system.

In the US, Axelson reported that deaths from strangulation had occurred due to wheelchair occupants slipping down in their chairs as a result of inappropriate placement of pelvic positioning belts[1]. In the UK, the records of the MHRA (Medicines and Healthcare Products Regulatory Agency) show that, over a 15-year period, there had been four reported deaths and 17 serious injuries involving, or attributed to, pelvic postural support devices or anterior trunk postural support devices. These deaths are thought to have occurred as a result of inappropriate placement or adjustment of the supports, or their failure.

There appears to be confusion as to best practice in the selection and fixation of flexible postural support devices (e.g. the updated MHRA recommendations in the UK[2]), and the reasons why postural supports need to be placed and adjusted according to the occupant's needs. This document has been produced to specify these criteria to be applied to positioning supports when used in seating systems and chairs, including wheelchairs and bathroom equipment (such as shower chairs), and, where applicable, hoists. This document has been created to support clinicians, engineers, carers, manufacturers, retailers and repairers.

NOTE 1 In this document, nomenclature has been based on ISO 7176-26 and ISO 16840-1. Thus, a support described as a positioning support can have the name adapted to include a description of its function based on the part of the body to which it is applied: e.g. a pelvic positioning support helps to position the pelvis, but might not be applied directly to the pelvis (e.g. the thighs) to achieve this. On the other hand, an anterior pelvic support would be applied anterior to the pelvis.

NOTE 2 Positioning support placement can differ based on clinical and risk assessment.

Wheelchair seating —

Part 15: Selection, placement and fixation of flexible postural support devices in seating

1 Scope

This document specifies requirements for the selection, placement and fixation of flexible postural support devices within seating devices and systems and to chairs, including wheelchairs and bathroom equipment. Seating devices can be involved in one or more situations, including hoists, static seating, wheelchair seating, shower chairs, etc. The devices enable the seated person (the occupant) to be positioned to maximize their functional activities in a safe environment. These requirements are formulated to achieve a balance of posture maintenance and safety.

This document covers flexible positioning supports (padded or otherwise) used for postural positioning and/or safety. It does not cover belts and harnesses used in transportation for restraint, postural support devices made from rigid materials such as metal, wood, or hard plastics, or postural support devices designed solely for use in sports-related seating.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7000:2019, *Graphical symbols for use on equipment — Registered symbols*

ISO 7176-26:2007, *Wheelchairs — Part 26: Vocabulary*

ISO 15223-1:2021, *Medical devices — Symbols to be used with information to be supplied by the manufacturer — Part 1: General requirements*

ISO 16840-1, *Wheelchair seating — Part 1: Vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces*

ISO 16840-3, *Wheelchair seating — Part 3: Determination of static, impact, and repetitive load strengths for postural support devices*

ISO 16840-10, *Wheelchair seating — Part 10: Resistance to ignition of postural support devices — Requirements and test method*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176-26:2007, ISO 16840-1 and the following apply.

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

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

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

3.1.1
support

3.1.1.1
anterior support
postural support device (3.1.5.2) intended to be in contact with the anterior surface of a body segment

EXAMPLE Anterior head support, anterior lower leg support, anterior pelvic support, anterior shoulder support, anterior trunk support, and anterior upper arm support.

Note 1 to entry: The anterior surface is based on the anterior surface when the person is seated in a typical upright sitting position.

Note 2 to entry: The term can include the part of the anatomy receiving the support.

Note 3 to entry: The following are deprecated terms: anterior head strap, forehead strap, forehead support, headband, knee block, knee strap, lap belt, pelvic stabilizer, pelvic strap, safety belt, seat belt, sub-ASIS bar, backpack strap, shoulder bar, shoulder hook, shoulder retractor, shoulder strap, anterior thoracic support, butterfly strap, butterfly harness, chest harness, chest strap, H-strap, harness, spiderman strap, Y-strap, humeral strap.

[SOURCE: ISO 7176-26:2007, 4.7.23, modified — Examples and Notes to entry have been updated.]

3.1.1.2
circumferential support
postural support device (3.1.5.2) which supports a body segment on at least three sides from at least three directions

EXAMPLE Circumferential ankle support, circumferential chest support, circumferential neck support, and circumferential wrist support.

Note 1 to entry: The term can include the part of the anatomy receiving the support.

Note 2 to entry: The following are deprecated terms: ankle strap, cervical collar, circumferential cervical support, collar, Houdini strap.

[SOURCE: ISO 7176-26:2007, 4.7.29, modified — Examples and Notes to entry have been updated.]

3.1.1.3
inferior support
postural support device (3.1.5.2) intended to be in contact with the inferior surface of a body segment

EXAMPLE Inferior lower leg support, inferior pelvic support, and inferior thigh support.

Note 1 to entry: The inferior surface is based on the inferior surface when the person is seated in a typical upright sitting position

Note 2 to entry: The term can include the part of the anatomy receiving the support.

Note 3 to entry: The following are deprecated terms: stump support, obliquity pad, thigh wedge.

Note 4 to entry: An inferior support usually applies to the buttocks and thighs, and is used with, or as part of, a seat cushion.

[SOURCE: ISO 7176-26:2007, 4.7.28, modified — Examples and Notes to entry have been updated.]

3.1.1.4
lateral support
postural support device (3.1.5.2) intended to be in contact with the lateral surface of a body segment

EXAMPLE Lateral head support, lateral knee support, lateral lower leg support, lateral pelvic support, lateral trunk support, lateral upper arm support, and lateral thigh support.

Note 1 to entry: The term can include the part of the anatomy receiving the support.

Note 2 to entry: The following are deprecated terms: head side support, lateral headrest, adductor pad, adductor strap, calf strap, calf support, leg block, leg guide, leg pad, leg strap, leg rest pad, hip block, hip guide, hip pad, lateral hip support, body side support, lateral, lateral support on its own, lateral pad, lateral thoracic pad, lateral thoracic support, scoliosis pad, side cushion, trunk pad, humeral block, protractor, adductor pad, adductor wedge, leg block, leg pad, leg strap, thigh block, thigh strap.

[SOURCE: ISO 7176-26:2007, 4.7.26, modified — Examples and Notes to entry have been updated.]

3.1.1.5
medial support
postural support device (3.1.5.2) intended to be in contact with the medial surface of a body segment

EXAMPLE Medial knee support, medial lower leg support, and medial thigh support.

Note 1 to entry: The term can include the part of the anatomy receiving the support.

Note 2 to entry: The following are deprecated terms: pommel, adduction strap, adductor pad, adductor wedge, leg adductor support, leg dividing support, wedge, wedge pad.

[SOURCE: ISO 7176-26:2007, 4.7.25, modified — Examples and Notes to entry have been updated.]

3.1.1.6
posterior support
postural support device (3.1.5.2) intended to be in contact with the posterior surface of a body segment

EXAMPLE Posterior foot support, posterior head support, posterior lower leg support, posterior lumbar support, posterior sacral support, and posterior upper arm support.

Note 1 to entry: The posterior surface is based on the posterior surface when the person is seated in a typical upright sitting position.

Note 2 to entry: The term can include the part of the anatomy receiving the support.

Note 3 to entry: The following are deprecated terms: heel cup, heel loop, heel strap, calf pad, calf panel, calf strap, calf support, leg strap, leg support, leg rest pad, lower leg support, posterior leg support, lower leg support, lumbar pad, lumbar roll, posterior pelvic support, elbow block, humeral block, protractor.

[SOURCE: ISO 7176-26:2007, 4.7.24, modified — Examples and Notes to entry have been updated.]

3.1.1.7
superior support
postural support device (3.1.5.2) intended to be in contact with the superior surface of a body segment

EXAMPLE Superior foot support, superior forearm support, and superior thigh support.

Note 1 to entry: The superior surface is based on the superior surface when the person is seated in a typical upright sitting position.

Note 2 to entry: The term can include the part of the anatomy receiving the support.

Note 3 to entry: The following are deprecated terms: toe cup, toe loop, forearm hook, forearm strap, leg strap, thigh strap.

[SOURCE: ISO 7176-26:2007, 4.7.27, modified — Examples and Notes to entry have been updated.]

3.1.2
linear support surface measures

Note 1 to entry: Where the support's local axis is referred to, the axis system is that used in *A clinical application guide to standardized wheelchair seating measures of the body and seating support surfaces*[3].

Note 2 to entry: When describing the *width* (3.1.2.4) and *depth* (3.1.2.1) of an item used in the horizontal plane, the width dimension is expressed before the depth dimension.

Note 3 to entry: When describing the width and *length* (3.1.2.2) of an item used in the vertical plane and viewed from the front, the width dimension is expressed before the length dimension.

3.1.2.1
depth
linear dimension of a seating support surface measured along or parallel to the support's local horizontal X axis

Note 1 to entry: This is the measure from the back to the front of the item.

3.1.2.2
length
linear dimension of a seating support surface measured along or parallel to the support's local vertical (Y) axis

3.1.2.3
thickness
dimension measured perpendicular to a seating support surface

3.1.2.4
width
linear dimension of a seating support surface measured along or parallel to the support's local horizontal (Z) axis

Note 1 to entry: This is the measure from one lateral side to the other when viewed from the front.

Note 2 to entry: When describing a *postural support device* (3.1.5.2) (PSD), width is stated prior to a second dimension such as *depth* (3.1.2.1).

3.1.2.5
height
distance from a top point on a seating support surface to a specified reference horizontal surface, measured along the vertical (Y) axis of the seating support surface, and at right angles to its horizontal (Z) axis

3.1.2.6
vertical height
gravitational vertical distance from the highest point on a seating support surface to a specified reference horizontal surface

Note 1 to entry: The vertical *height* (3.1.2.5) often does not equate to the height when a seating support surface is not in an upright sitting position.

3.1.3
posture

3.1.3.1
fixed posture
non-reducible posture
position at one or more joints where there is no passive range of motion in any direction

Note 1 to entry: This is a clinically related term and application.

3.1.3.2
flexible posture
reducible posture
position at one or more joints where there is passive range of motion in one or more directions

Note 1 to entry: Clinically this is usually applied to movement towards a more neutral reference posture.

3.1.4
occupant
DEPRECATED: user
person supported by the wheelchair seating system

[SOURCE: ISO 7176-26:2007, 4.2.2]

3.1.5
support device

3.1.5.1
flexible postural support device
flexible PSD
postural support device (3.1.5.2) that is capable of conforming to the shape of the anatomy when applied to the *occupant* (3.1.4)

Note 1 to entry: This includes any component of a flexible postural support device which can in itself be non-flexible, such as a frame mount or adjustment buckle.

3.1.5.2
postural support device
PSD
structure, attached to a seat or chair, which has a surface that comes in contact with the *occupant's* (3.1.4) body and is used either to support, correct or stabilize the occupant's sitting posture

Note 1 to entry: The structure of the terms is such that the terms describe the application rather than the construction of each device. Therefore, many of the terms describe both flexible and non-flexible solutions amongst the deprecated terms.

Note 2 to entry: Postural support device is also referred to in this document as positioning support or postural support.

[SOURCE: ISO 7176-26:2007, 4.7.3, modified — The deprecated term "postural support" has been removed. In the definition, "wheelchair" has been changed to "a seat or a chair" and "modify or accommodate" has been changed to "support, correct or stabilize". Example has been removed. Notes to entry have been added.]

3.1.6
restraints

3.1.6.1
restraint
measure or condition that keeps someone or something under control

3.1.6.2
occupant restraint
vehicular occupant restraint
system or device intended to restrain a motor-vehicle *occupant* (3.1.4) during an impact in order to prevent ejection, and prevent or minimize contact with the vehicle interior components and other occupants

Note 1 to entry: Securement points may be located on hardware components that are permanently or temporarily fastened to a wheelchair.

[SOURCE: ISO 7176-26:2007, 4.11.16, modified — The preferred term "vehicular occupant restraint" has been added.]

3.1.6.3
protective restraint
device, including, but not limited to, a wristlet, anklet, vest, mitt, straight jacket, body/limb holder, or other type of strap that is intended for medical purposes and that limits the *occupant's* (3.1.4) movements to the extent necessary for treatment, examination, or protection of the occupant or others

[SOURCE: FDA Code of Federal Regulations Title 21,[4] modified — "Patient" has been replaced by "occupant".]

3.2 Abbreviations

For the purpose of this document, the following abbreviations apply.

ASIS anterior superior iliac spine

PEG percutaneous endoscopic gastrostomy

PSIS posterior superior iliac spine

4 Aims and principles of application of flexible PSDs

4.1 General

Flexible PSDs are designed to control body movements, either blocking, minimising or guiding movements of specific body segments to achieve desired outcomes, including safety. Typical outcomes include increased sitting stability, maintained or corrected posture, increased reach, enhanced propulsion of a mobility device, and maintenance of a desired seated position for safety purposes. In many cases, the purpose of a flexible PSD can be a combination of one or all of these factors.

NOTE 1 This can also apply to abdominal compression devices to improve exhalation which are attached to the seating system (see 6.2.5). In this case, there can be safety considerations as to the effect on the device that a change in seated position can incur.

NOTE 2 Often impairments and activity limitations can be addressed by optimizing the seating system's angular and linear dimensions specific to the occupant. Only thereafter should flexible PSDs be added to compliment the system.

A flexible PSD shall be prescribed for stability when the primary purpose is to stabilize part of the body, in static or dynamic situations, to enhance function in other parts (e.g. to stabilize the lower body segments in order to increase the ability to reach outside the base of support or prevent forwards sliding, or to stabilize one arm for an occupant with dystonia to enable functioning of the other arm). This shall be achieved by restricting movement of the related body segment (e.g. using a pelvic postural support in conjunction with an anterior flexible trunk support to enable a powered wheelchair occupant to navigate uneven terrain safely).

NOTE 3 Where the occupant's posture is assessed to be flexible, a flexible PSD can be used in conjunction with other PSDs to improve postural alignment by applying a combination of corrective forces. In turn, this can reduce strain on joints and internal organs and help prevent further secondary complications (such as contractures, pressure injuries or respiratory complications) as well as increase comfort and function.

NOTE 4 Where the occupant's posture is assessed as being fixed, a flexible postural support device can be used in conjunction with other PSDs to support and maintain the optimal achievable and tolerable posture by applying a combination of maintaining forces. This can help prevent further postural decline.

The occupant should be assessed as to the correct style of PSD to be prescribed, and measured in accordance with Annex A so that the correct size of PSD is prescribed in accordance with Annex B.

A flexible PSD shall be prescribed for safety when the primary purpose is to protect the occupant from injury (e.g. to prevent falling from the seat).

NOTE 5 This can be achieved by limiting movement of one or more body segments.

Where the occupant is unable to remove the device independently, by consequence or design, prior to prescription a risk assessment shall be carried out to ascertain whether the device can be considered a restraint (see 4.2 and Annex C).

Seating systems and chairs shall be prescribed which have space available to mount PSDs in the positions required by this document.

4.2 Restraint versus positioning

'Restraint' is a term that has contextually different meanings and connotations. For this reason, RESNA (Rehabilitation Engineering and Assistive Technology Society of North America) has produced a position paper on restraints. This includes clarification on the differences between supports and restraints and the respective purposes of vehicular occupant restraints and protective restraints (see RESNA, 2013[5]).

If a pelvic positioning support can be perceived as a restraint, the decision to use the support should be made by an interdisciplinary team, including carers, with the justification documented. The justification shall show that appropriate thought was given to alternative interventions, including, but not limited to, contracture management, tone management, and therapeutic intervention to address behavioural issues. Decisions shall, where practicable, be taken with the consent of the occupant, in the best interests of the occupant to ensure safety and function.

Any desired outcome resulting from the limitation of movement shall also be documented (e.g. to minimize the risk of falls). It shall also be documented where there is an aim to restrict movement in one part of the body, in order to facilitate greater function in another (e.g. stabilization of the trunk to improve functional reach).

Where positioning supports are determined as being the best method of postural management, a comprehensive clinical assessment shall be carried out demonstrating that the support is essential to achieve an appropriate postural position.

4.3 Safety

4.3.1 General

The health risks and benefits of the use of a PSD shall be assessed.

4.3.2 PSD-body interface

The risk to the occupant's skin integrity from where the PSD interfaces with the body shall be assessed and minimized.

4.3.3 Forces on bony prominences

The risk of increasing pressure and shear forces from bony prominences such as the ischial tuberosities, ASISs, PSISs, iliac crests and sternum on the tissues covering these parts of the body shall be assessed and minimized.

4.3.4 Physiological function

The impact on breathing, swallowing, vision, digestive function, cardiovascular function, bladder function, etc. shall be assessed and optimized.

4.3.5 Ancillary medical devices

The positioning of PSDs shall not impede the positioning and function of catheters, pumps, or other ancillary medical devices.

4.3.6 Skeletal structure

The forces applied through the positioning of PSDs shall not create or lead to worsening of skeletal deformities.

4.4 Paediatric needs

4.4.1 General

The needs of a child with a developing skeleton and function means that the positioning of supports to accommodate growth and development requires particular attention and therefore should be reviewed regularly.

NOTE 1 The frequency of review depends on the age of the child, the child's rate of growth and the rate of change of the causes of their need for supports.

4.4.2 Hip joint development

The hip joint, or acetabulofemoral joint, is the joint between the head of the femur and the acetabulum. Its primary function is to support the body's weight and aid balance in standing. The development of both the acetabulum and the head of the femur depends on weight-bearing activities and walking during childhood. In a non-ambulatory child, the hip joint is under-developed, and is extremely vulnerable to dislocation. In individuals with cerebral palsy in particular, hip subluxation or dislocation can be common during the teenage years. In some cases, corrective surgery is required.

When applying a PSD, the impact of the applied force on the hip joint shall be taken into account.

EXAMPLE A medial (to lateral) strap (to encourage abduction) places an abducting/external rotation force on the hip. This can be painful when the hip is subluxed or dislocated.

NOTE 1 Even when a person has been previously ambulant, a long-term disability causing weakness and muscle tone changes around the hip joint can increase the chance of hip dislocation. Changes in range of motion are also common.

A full physical assessment should be carried out prior to prescription of a flexible PSD to understand fully the abilities and limitations in range of motion.

NOTE 2 Differentiating between the hip range of motion and posterior pelvic tilt in particular is critical for optimal positioning.

NOTE 3 Where the seat to back support angle of the seat is too acute for the individual to tolerate due to limitations in hip flexion range of motion, applying a postural support to hold the individual in that position can be painful.

The natural angle of the femur is at 5° of abduction from the midline. The cushion, and any medial and lateral thigh supports, shall facilitate this position unless the clinical seating assessment indicates an alternative position is required (e.g. to support a fixed deformity or joint contracture).

4.5 Materials

4.5.1 Testing

4.5.1.1 Static, impact and repetitive load strengths

PSDs shall be tested in accordance with the tests in ISO 16840-3, and shall pass the tests where there are pass or fail criteria.

4.5.1.2 Flammability

PSDs shall be tested in accordance with the flammability test in ISO 16840-10.

4.5.2 Pressure distribution

Pressure distribution, e.g. by padding, surface contours, or elastic fabrics, shall be provided where the PSD interacts with the occupant's body in order to protect the occupant from harm from the PSD webbing materials (e.g. where it is in contact with bony prominences or where significant force is applied over soft tissues).

Pressure distribution elements shall be designed to follow the contours of the occupant's body, and to dissipate evenly the forces of the support on the occupant's body. The design shall not lead to curling of the padded support such that the forces no longer follow the contours of the occupant's body. Where edging is applied to the pad to stop fraying of the pad, the edging material shall not provide a risk to the tissue integrity of the occupant, from wrinkling or other deformations, or from localized pressure points.

The risk of pressure injuries and abrasions shall be evaluated when flexible PSDs are being considered to stabilize body segments experiencing significant forces in occupants with high tone patterns.

The dimensions of any webbing and padding (see Annex B) shall be selected to meet the positioning needs of the occupant, taking into account the body mass of the part of the body to which the PSD is applied, the skin fragility, and the forces needed to manage the occupant's posture with that PSD.

4.5.3 Closure systems

4.5.3.1 General

Postural supports shall have a closure system (e.g. buckle, hook-and-loop) that allows the occupant to be released from the postural support when needed, but not accidentally. When tested in accordance with ISO 16840-3, the supports, in combination with the prescribed closure system, shall meet the pass criteria given therein. The type of closure system selected shall suit the occupant's and/or the carer's ability to open the closure system (see Annex C for further information).

Closure systems shall be selected and located such that they do not create a risk of harm to the occupant by digging into soft tissues (e.g. to the stomach or genitalia) or rubbing against bony prominences. Closure systems shall provide no risk of encroaching on moving parts of the wheelchair or seating system.

Where a hook-and-loop closure system is used, the hook side shall be positioned so that it is not in direct contact with the occupant, as it can cause skin irritation.

NOTE Hook components in hook-and-loop closures risk being clogged up with extraneous materials, which can decrease their ability to attach to the loop component.

4.5.3.2 to 4.5.3.6 list various types of closure systems which are commonly available, but this is not necessarily a comprehensive list.

4.5.3.2 Side release buckle

Side release buckles should not be used with individuals with poor manual dexterity or strength who need to release themselves from their support, as these buckles require a relatively strong pinch action to release.

NOTE The release from a side release buckle can be achieved single-handedly.

4.5.3.3 Push button buckle

Where push button buckles are used, a buckle shall be selected with the appropriate spring strength, buckle tongue release and button size to meet the occupant and carer's needs.

NOTE 1 Push button buckles originate from the transport industry.

NOTE 2 Push-button buckles are also prone to collecting food and other debris which can result in a failure of the closure mechanism.

4.5.3.4 Latch buckle

Latch buckles are appropriate for occupants with limited manual dexterity who can exert a pull on the latch.

NOTE 1 Latch buckles are modelled on the buckles found in aircraft seat belts.

Latch buckles shall be positioned so that they cannot be accidentally released by the occupant.

NOTE 2 Accidental release of a latch buckle is more likely if the buckle has been placed off centre near the natural resting position for the elbow.

NOTE 3 Due to ease of operation, there can be a greater risk of accidental release.

4.5.3.5 Swivel buckle

Swivel buckles are appropriate where a more dynamic relationship between the components of the support is required.

NOTE Swivel buckles are attached by a latching action, have a push release, and allow the two components of the support to rotate relative to each other.

4.5.3.6 Magnetic buckle

Magnetic buckles use magnets to bring the two halves together, with a hook or mechanical latch to lock them together. Typically, the buckle is released by lifting the latch or pulling a release cord.

NOTE Magnetic buckles are particularly valuable for single-handed attachment.

4.5.3.7 Security buckle

A security cover on a buckle, or a buckle with a design feature to limit access to the release mechanism, is appropriate where the occupant would be placed at risk if they released the postural support.

NOTE 1 Examples are push-button buckles fitted with covers having a small aperture for accessing the release button, and side release buckles with a secondary sliding tab that blocks release. The carer needs to be able to release the buckle with, for example, a small pointed device for use on a small aperture.

NOTE 2 For restraint versus positioning considerations, see 4.2.

4.6 Transportation

It is important to clarify the difference between wheelchair postural supports and occupant restraint belts. The difference is evident in the descriptors: 'support' versus 'restraint'.

— Wheelchair postural supports are intended to maintain or correct a person's posture, or position, in their wheelchair. These supports are not intended to be used for, nor do they necessarily have the required strength to be used as, occupant restraints during vehicle transport.

— Wheelchair occupant restraint belts are generic devices which are used to restrain a wheelchair occupant in the event of a vehicular collision.

Where a postural support or other secondary support has been clinically prescribed, this is intended to assist in the corrective positioning of a wheelchair occupant who cannot independently maintain an optimal position in their wheelchair. In the absence of that postural support, the wheelchair occupant would probably adopt a sub-optimal posture. When an occupant adopts a sub-optimal posture, there can be consequences for the occupant restraint system. Specifically, it can be difficult for the occupant restraint to be fitted in such a way that it makes contact with the wheelchair occupant (e.g. in sub-ASIS, mid-sternal, or mid-clavicle regions) in the manner that is required for its correct functioning.

Where a positioning support has been clinically prescribed, and is fitted to a wheelchair, it shall be left in position during transport unless the risk assessment dictates otherwise.

NOTE 1 Without such support, the occupant can be unable to maintain position independently in the wheelchair, or can be put at risk of other complications, due, for example, to sliding, leaning, falling forwards or getting their head caught.

An occupant restraint belt shall be used in addition to a clinically-prescribed flexible postural support device when a wheelchair occupant is being transported in a vehicle. Where provided in transport, occupant restraints shall always be used.

NOTE 2 Some wheelchairs are designed so that the occupant restraint belt can be fitted directly to the wheelchair rather than by the more conventional method of attaching it to the vehicle. They do not possess the design characteristics of postural supports, e.g. option to select an anchor point on the wheelchair frame, padding to distribute force, anatomical sub-ASIS pads. The occupant restraint belt serves the purpose of wheelchair occupant restraint in a vehicle only and is not designed to act as a postural support.

Postural support devices are not intended to substitute occupant restraint belts, unless indicated by a documented risk assessment (e.g. when the postural support impinges on the correct routing of the occupant restraint).

Prior to every journey, pelvic postural supports and anterior trunk supports shall be checked for position and fit, to minimize the risk to the occupant of falling, sliding in or out of the seating system, or sliding under (submarining under) the supports during the journey.

5 Pelvic positioning

5.1 General

The pelvis is formed by two hip bones, the sacrum, and the coccyx. Each adult hip bone is itself formed of three bones (ilium, ischium, and pubis) which are fused together. This fusion usually occurs during the late teens.

The sacrum is a wedge-shaped bone inferior to the spine, which forms a solid base on which the spinal column sits. This supports the weight of the upper body which is then spread across the pelvis to the legs. Position and control of the pelvis is critical to postural alignment and control. This is because the lowest vertebra in the spinal column, L5, is attached to the top of the pelvis. The pelvis can normally rotate in three dimensions: posteriorly and anteriorly as viewed in the sagittal plane; obliquely to the left or right when viewed frontally; and rotationally when viewed transversely.

Postural reflexes drive people to strive to maintain the centre of gravity within this base of support. Therefore, any change in position of the pelvis in turn affects the shape of the spinal column. For example, when the pelvis tilts posteriorly, forward flexion tends to occur in the spine leading to a kyphotic posture. When the pelvis rotates obliquely (in the frontal plane), this usually causes lateral flexion of the spine leading to a scoliotic posture.

The positioning of the pelvis is therefore critical for the alignment of the spine.

The position of the pelvis also greatly changes the distribution of interface pressure between the occupant and seating support surfaces. This is an important consideration for the prevention of pressure injuries.

NOTE If an asymmetry, or postural deviation, of the pelvis is flexible, this means the pelvis is able to be supported in a reference neutral position using postural support devices. If the asymmetry, or postural deviation, is fixed, then the pelvis might need to be supported in an asymmetrical position.

A pelvic asymmetry may be allowed, or even increased, to: address pain, skin breakdown, and tone issues; optimize head position to address vision, swallowing, and saliva control; and/or facilitate an upright mid to upper trunk to maximize respiration, upper extremity function, and spinal deformity prevention, or address other client-specific objectives. Supports to achieve this can include the seat cushion, anterior ischial support, posterior support to the sacrum, and/or other positioning supports.

5.2 Anterior pelvic support

5.2.1 General

Flexible pelvic positioning supports are described by the number of points at which they need to be placed on a chair. Secondary to this, and where there is a built-in adjustability, they are described by the arrangement for making the width adjustment when tightening the support into position.

In this document, details of 2- and 4-point positioning belts are provided, but there are instances where a 3-point belt can be more appropriate, for example to control the rotation of the pelvis. For example, this can be the case when the pelvis has an anterior tendency on one side, where two points of attachment are appropriate on that side (see 5.2.3), whereas on the other side there might be a posterior tendency, where a single point of attachment is warranted (see 5.2.2). In this case, the belt usually has a 3-dimensionally-contoured pad with enough stiffness to press against bony structures, translating tightening into forces normal to the surfaces.

NOTE 1 An example of this is teardrop-shaped sub-ASIS pads which can be strategically applied to the inner faces of a hook-and-loop-compatible belt to press against the anterior-lateral aspect of the pelvis. For these, the pull-type matters because, as the belt is tightened, it determines whether the sub-ASIS pad will shift (and act upon the occupant) or remain neutral relative to the seating system (to block movement).

NOTE 2 While the materials, dimensions and mounting positions of flexible PSDs can impact maintaining a specific body alignment, the pull-direction of adjustment straps in a flexible PSD might not significantly impact achieving or maintaining this position other than improving ease of access to the straps for some occupants or caregivers.

The direction of pull (towards/away from centreline, towards right/left) is for the convenience of the caregiver or occupant self-tightening a belt, providing mechanical advantage. For example, when standing in front of the occupant, it is often easier to pull forward to tighten a 'rear-pull belt' than to push away from yourself to tighten a 'centre pull belt'. For an occupant who is self-tightening, the ideal orientation of the cinching strap can accommodate their range of motion and strength (some might have stronger extensor muscles and weaker flexors, so pushing is easier than pulling to tighten).

However, the pull type has little or no effect on positioning the user of the belt, whether over their thighs or pelvis. The belt gets tighter, but aside from the temporary shifting that can occur if the friction between the inner surface of the belt and the occupant's clothing is high enough, tightening does not affect control of asymmetrical tendencies (obliquity, rotation). There just isn't enough friction to exert this control reliably, especially considering clothing can shift against the skin, and even if it could, over-tightening can create an unsafe risk of tissue damage.

5.2.2 Point of PSD attachment

If wheelchairs are delivered with a belt in place at the junction of the back support and the seat frame a health care provider should assess whether that placement is appropriate. Prior to issuing the wheelchair, the position of the pelvic positioning belt should be checked, and where necessary moved to an attachment point on the seat frame to suit the needs of the occupant, such that the belt is positioned anterior to the greater trochanters when used as described in 5.2.3.

NOTE Further pelvic positioning can be aided by appropriate posterior pelvic support (see 5.5) and anterior ischial support, to reduce posterior pelvic tilt and consequential collapse into spinal kyphosis.

The wheelchair and PSD documentation shall indicate the unsuitability of supplying a pelvic positioning support at the junction of the back support and seat, and offer guidance on the appropriate support positioning options.

5.2.3 2-point pelvic positioning support

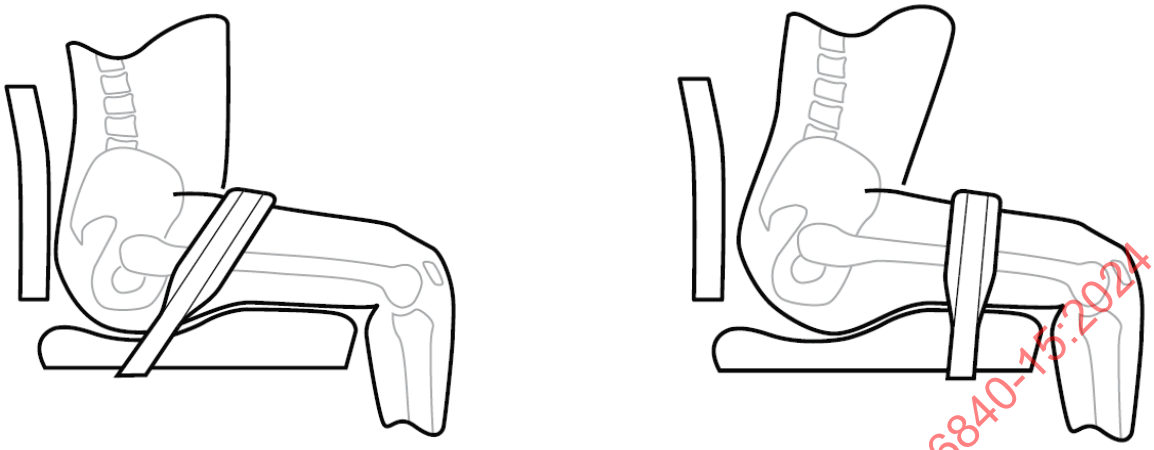
5.2.3.1 General

2-point pelvic positioning supports are usually chosen to manage the positioning of an occupant with a tendency towards a posterior pelvic tilt.

The support shall be placed in such a way that it minimizes forward translation, or forward sliding, of the pelvis. To achieve this, it is recommended to attach it so that the support falls anterior to the greater trochanters (see Figure 1a).

NOTE This still permits the pelvis to rotate forward, thereby allowing unweighting of the ischial tuberosities and allowing increased forward reach, while preventing the pelvis from sliding under or 'submarining' under the support, and at the same time removing any risk of the support rising into the soft tissues of the belly.

In some cases (for example, with very active wheelchair users), placing the support at the mid-thigh is preferable because it provides the least interference with forward leaning while stabilizing the legs during the push stroke and preventing forward sliding of the pelvis (see Figure 1b).



a) Anterior to the greater trochanter **b) Mid-thigh**

Figure 1 — Positioning of a pelvic postural support

5.2.3.2 Centre pull

The support is adjustable around the area of the buckle (see Figure 2), with the means to tighten the support, preferably with a D-ring on the end of the tightening strap, or other means for grasping the adjustment strap.

NOTE The carer or occupant can make use of the two pads coming together as a visual indication that the support is adjusted tightly enough.

Where the occupant tightens their own strap, orientate the support so that the tightening strap is positioned to accommodate the occupant's left- or right-handedness

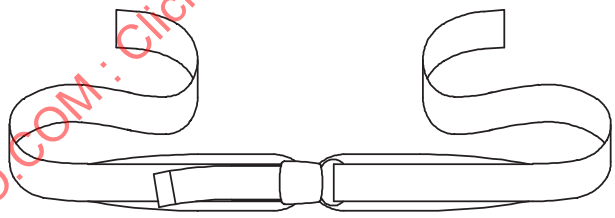


Figure 2 — Centre pull 2-point pelvic positioning support

5.2.3.3 Dual pull

The support is adjustable around the area of the buckle (see Figure 3), with the means to tighten the support, preferably with a D-ring or equivalent, on the end of each of two opposing tightening straps.

NOTE The availability of a second tightening strap doubles the amount of adjustability.

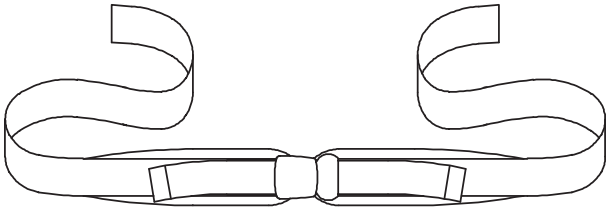


Figure 3 — Dual pull 2-point pelvic positioning support

5.2.3.4 Rear-pull

The support is adjustable around the lateral ends of the padding (see Figure 4), with the means to tighten the support, preferably with a D-ring or equivalent, on the end of two tightening straps.

NOTE The increased leverage obtainable from the lateral adjustment points can help when trying to manage flexible pelvic obliquity, for example. Some occupants who adjust their own supports find it easier to pull on each strap separately with their left arm and then with their right arm across their bodies to tighten the right and left straps respectively.

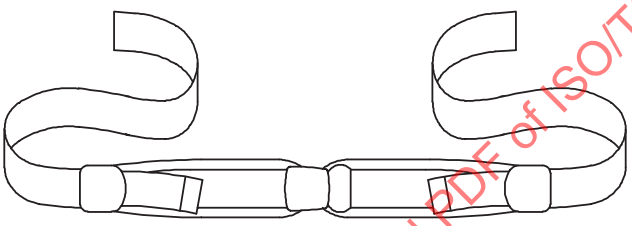


Figure 4 — Rear-pull 2-point pelvic positioning support

5.2.4 4-point pelvic positioning support

5.2.4.1 General

A 4-point support consists, usually, of a pair of larger straps and a pair of narrower anchor straps (see Figure 5). When reducing excess anterior pelvic tilt or anterior rotation of one of the ASISs, the larger straps of the 4-point support attached to the back support's support structure are there to pull back on the ASISs at the level of the PSISs to level them with the PSISs. Solid posterior support at the PSISs is recommended, to provide sufficient counterforce.

To control the support from riding up into the soft tissues of the abdomen, secondary straps are usually applied to anchor the support to the seat rail, often angled anteriorly and distal to the greater trochanters.

For occupants who tend to slide forward, and under, standard pelvic positioning belts, a large strap support can be needed across the thighs, perpendicular to the seat, with secondary straps applied to anchor the support to the seat rail, often angled posteriorly.

NOTE 4-point flexible pelvic supports can be based on the configuration of any 2-point flexible pelvic supports (5.2.3), e.g. centre pull, dual pull, rear-pull. An example of a centre pull 4-point pelvic positioning support is shown in Figure 5.

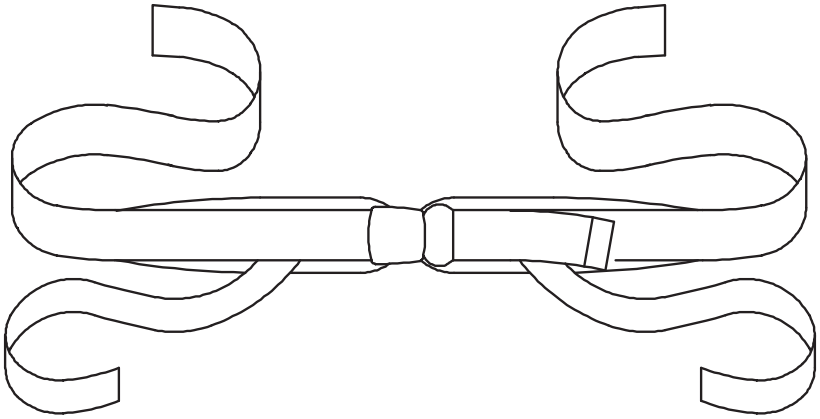


Figure 5 — Centre pull 4-point pelvic positioning support

5.2.4.2 Centre pull

The larger straps of a padded 4-point pelvic positioning support shall have a means to tighten the support. If this is achieved by centre pull, the support shall be adjustable around the area of the buckle, with the means to tighten the support, preferably with a D-ring or equivalent, on the end of the tightening strap (see Figure 5).

5.2.5 Attachment of flexible pelvic postural supports

The positioning support that is being used to position the pelvis shall be attached to the seating or wheelchair frame so that it keeps the support firmly in position. The support shall be attached in the required position and shall be adjusted as the occupant's needs change. Annex D describes various solutions to attach the positioning support.

NOTE 1 There are risks to drilling holes in the framework, since this can weaken the structure of the framework, and this also restricts the movement of the support to a different position.

NOTE 2 There can be further challenges to overcome, in that different manufacturers use different constructions for the framework, from circular tubing to rectangular extrusions. In addition, there are often pieces of wheelchair architecture located precisely where the support is ideally positioned.

Where an anchor point is provided, the anchor itself and the route taken by the PSD (whether static or dynamic in use) shall not impinge on the normal operation of the seat or wheelchair. This requirement shall also be met when choosing an anchor point that is subject to movement in normal use, but is otherwise non-removable.

NOTE 3 This can include the operation of the brakes, seat functions (such as tilt, recline, riser), the fitting or removal of arm supports, or rotation of the wheels or castors.

NOTE 4 An anchor point is usually mounted to a fixed chair or seating component and not to a removable and/or adjustable component (such as arm support), which can render the PSD ineffective or unsafe.

Any change in support provided by the PSD through all movement positions shall be taken into account when determining anchor points (for example, an anterior pelvic support can become tighter or looser through adjustment of the recline angle, or the same can occur to an anterior trunk support fixed in part to the seat frame when a reclining back support is adjusted). PSDs should be anchored at points which move in tandem with the occupant and seat (for example, typically a pelvic PSD can be mounted to the seat rail and a trunk support to the back support).

5.3 Inferior pelvic support

An inferior pelvic support shall be used to control the pelvis from underneath.

Recommendations for hook-and-loop fixation patterns for the seat cushion and the underlying seat base are to be found in Annex F.

NOTE 1 A flexible inferior pelvic postural support device can be seen in the form of a series of adjustable webbing straps. They can be used to change the shape of a flat seat cushion to reduce pressure on the ischial tuberosities and/or provide pre-ischial support.

NOTE 2 A seat cushion can be used to supply inferior pelvic support: the term seat cushion has been widely accepted as the generic term for this primary postural support device.

5.4 Lateral pelvic support

A lateral pelvic support is one that is used to control the lateral aspect of the pelvis.

NOTE 1 This function is often performed by hip or thigh lateral supports, side guards, arm support assemblies, or elements of the seat cushion.

NOTE 2 Good lateral pelvic support can also help control pelvic rotation as viewed in the transverse plane.

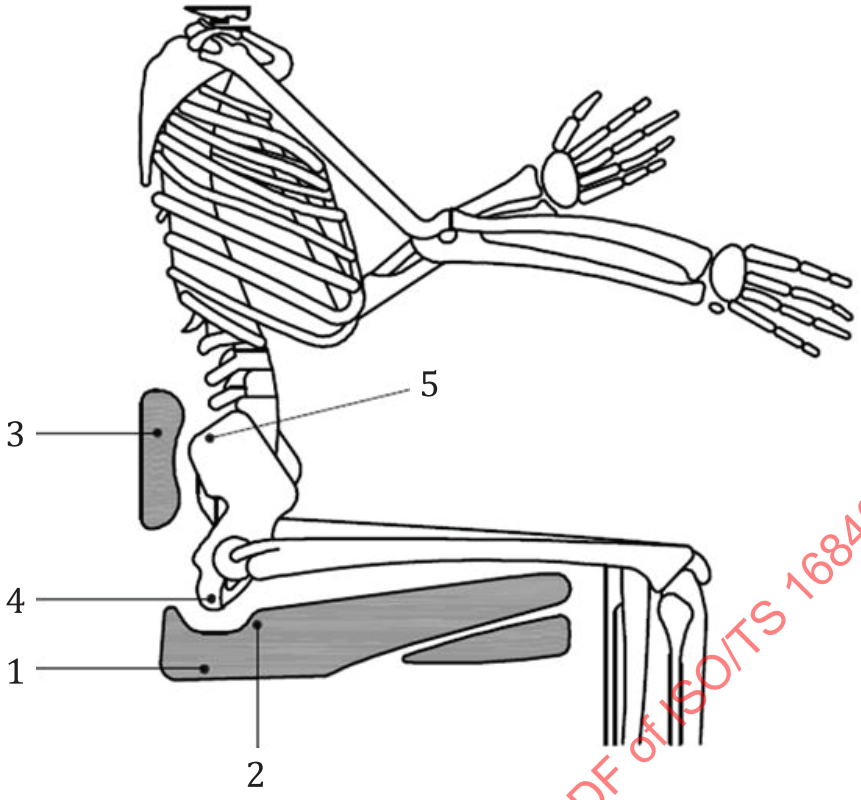
5.5 Posterior pelvic support

A posterior pelvic support is a surface contacting the posterior aspect of the pelvis or buttocks, intended to block or minimize posterior rotation of the pelvis. Typically, this surface is integrated into a back support and contacts the upper part of the pelvis/buttocks (see “PSIS block” in Figure 6).

The posterior pelvic block should not be placed in the lumbar region of the spine since the occupant tends to lean back into it if placed at this higher level, leading to increased posterior tilt and spinal kyphosis.

NOTE 1 Flexible posterior pelvic supports are generally seen in the form of a series of adjustable webbing straps. They can be used to change the shape of a flat back support canvas/cushion to provide specific posterior support to the spine. For example, the strap at the PSIS level can be tightened to provide additional support posterior to the pelvis. Alternatively, foam blocks can be used.

NOTE 2 A third point of control of this sagittally viewed rotation can be a small thickness pre-ischial ridge in the cushion, placed anterior to the ischial tuberosities (see “pre-ischial ridge” in Figure 6). This effect can be achieved also where there is a buttocks recess in the cushion, by its anterior edge.



Key

1	horizontal seat base under ischial tuberosities	3	PSIS block
2	pre-ischial ridge	4	ischial tuberosity
		5	PSIS

Figure 6 — Posterior pelvic support

6 Trunk supports

6.1 General

The trunk plays a critical physiological and anatomical role. The trunk contains and supports the body cavity in which most key physiological activities take place: cardiovascular, respiratory, digestive, urological and reproductive.

Poor alignment of the spine results in unequal pressure through the spinal discs, placing them at greater risk of herniation and subsequent nerve root irritation.

The alignment of the vertebrae and the ribs is therefore of critical importance to permit optimal physiological function, as is the positioning of any supports intended to accommodate or correct any mis-positioning of the anatomical features.

The trunk is pivotal in providing support to the head, the correct position of which affects communication, socialization, breathing, eating, hearing, balance, vision and other daily functional activities. Thus, helping an individual's control of their trunk is required to assist control of their head.

6.2 Anterior trunk support

6.2.1 General

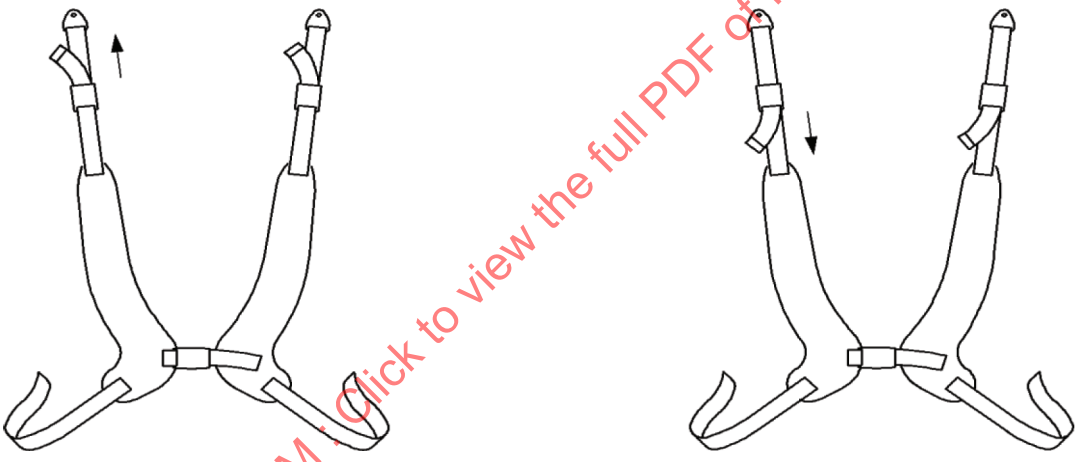
An anterior trunk support shall always be used with an appropriately positioned and adjusted pelvic positioning support in place, since there is a risk of strangulation if the anterior trunk support rides up or if the occupant slips down in the seat.

Guidance on the prevention of strangulation is given in Annex E.

With both supports, the positive and/or negative impact on functional reach, respiration and leaning forward when wheeling up ramps or thresholds should be evaluated. Care shall also be taken in assessing whether limiting trunk mobility with an anterior trunk support can cause skin breakdown, especially on the back and buttocks. When kyphosis is present, the emphasis shall first be on evaluating whether the seat support depth and angle and/or the back height and angle need to be modified before an anterior trunk support is used to address this postural deformity.

NOTE 1 Anterior trunk supports are designed to provide principal support and control across the chest/rib cage, and/or across the shoulders.

NOTE 2 Anterior trunk supports can be configured with different styles of straps at the shoulders, to permit attachment and adjustment from the front or rear of the occupant. These features can be found on most types of anterior trunk support, whether designed for support at the shoulders or the torso.



a) Rear-pull **b) Front-pull**

Figure 7 — Rear-pull versus front-pull anterior trunk supports

5-point supports shall not be used for anterior pelvic support where the occupant is not able or willing to move themselves away from the groin strap independently.

NOTE 3 5-point supports incorporating a groin strap integral to anterior trunk supports are commonly used in general toddler stroller/buggy/pushchair seating to prevent behavioural forward sliding, where the occupant has the ability to reposition themselves if they are uncomfortable due to contact with the strap.

6.2.2 Fixed versus dynamic anterior support

Anterior trunk supports are available that provide varying stretch in the materials from which they are constructed. Non-stretch materials provide the firmest positioning support but restrict the occupant's movements and are more likely to cause skin breakdown in users with high tone patterns. A degree of elasticity can be provided at the straps over the shoulders, and/or at the lateral fixing straps.

If selecting a dynamic harness with elasticity in the support materials, the support shall meet the requirements of ISO 16840-3. Ensure that the degree of elasticity is appropriate to the occupant's assessed needs.

For a circumferential chest support, elasticity is recommended to avoid restriction in breathing.

6.2.3 Rear-pull anterior support

Where adjustment of the upper strap of a flexible anterior trunk support is required from behind the occupant, a rear-pull support shall be used (Figure 7).

NOTE A rear-pull support can be used where the occupant wants to avoid having the assistant touching their body, or where extra leverage in adjusting the support is needed. It can also be preferable when a front pull support would cause irritation to the neck or face due to the buckle placement.

6.2.4 Front-pull anterior support

Where adjustment of the upper strap of a flexible anterior trunk support is required from in front of the occupant, a front-pull support shall be used (Figure 7).

NOTE A front-pull support can be used where the occupant wishes to and can make the tension adjustment themselves, or where the occupant is uncomfortable with having an assistant behind them.

6.2.5 Abdominal support

Sometimes it will be necessary to support soft tissues of the upper body including across the abdomen. Here an abdominal support (Figure 8) can be used.

NOTE The benefits of this support are: support for sagging abdominal muscles; strengthening abdominal muscles and weakened abdominal walls; reducing pain while laughing; avoiding discomfort while coughing; avoiding squeezing or cramping up of muscles; assisting toning of abdominal muscles.

An abdominal support shall wrap around the abdomen and low to mid torso and attach to the back support or back support rails.

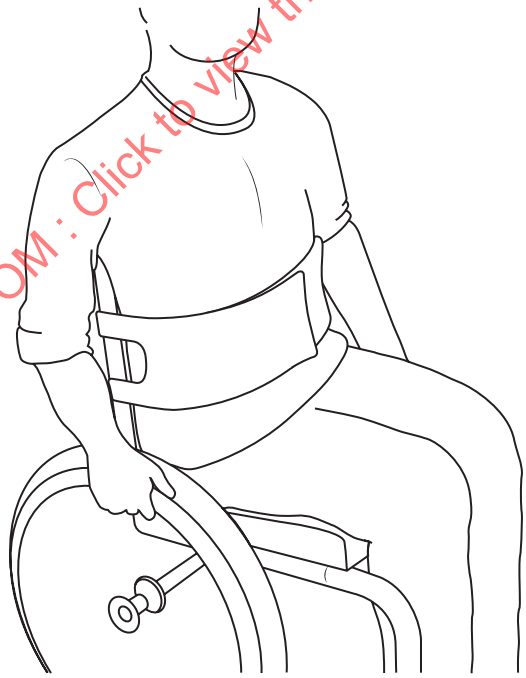


Figure 8 — Abdominal support

6.2.6 Anterior chest support

An anterior chest support shall be made up of a single pad that fits anterior to the sternum, affixed by two upper and two lower straps (see Figure 9).

NOTE 1 Chest supports are available in a variety of shapes such as vest or X (butterfly). Chest supports can feature a front closure. In some cases, a modified chest support can be provided, based on an individual risk assessment, to accommodate an individual clinical requirement (e.g. to avoid pressure to a PEG feeding tube or a pump used for drug administration).

NOTE 2 An anterior chest support is designed with one central pad which fits anterior to the sternum, fixed by four adjustable straps, two of which go over the shoulder. It enables the occupant to extend the trunk in order to reduce a flexible kyphosis.

NOTE 3 An anterior chest support can be front-pull or rear-pull and can be made of non-stretch or elastic materials, according to the needs of the occupant.

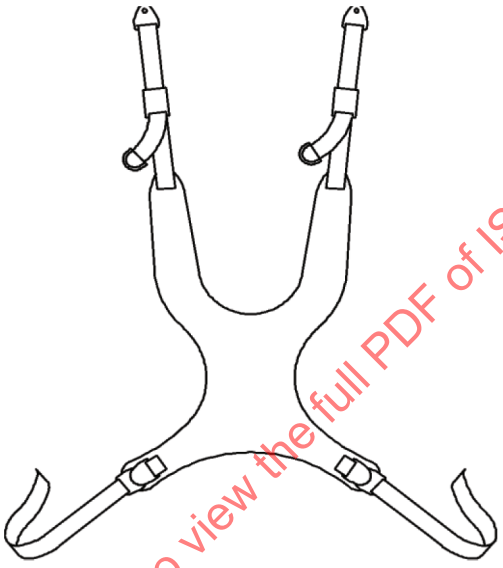


Figure 9 — Anterior chest support

6.2.7 Circumferential chest support

A circumferential chest support (see Figure 10) shall wrap around the torso at the appropriate height on the rib cage.

NOTE A circumferential chest support can be used in conjunction with a suitable posterior PSIS support to minimize posterior tilt of the pelvis and subsequent collapsing of the spine, thereby also reducing the risk of the neck coming into contact with the support.

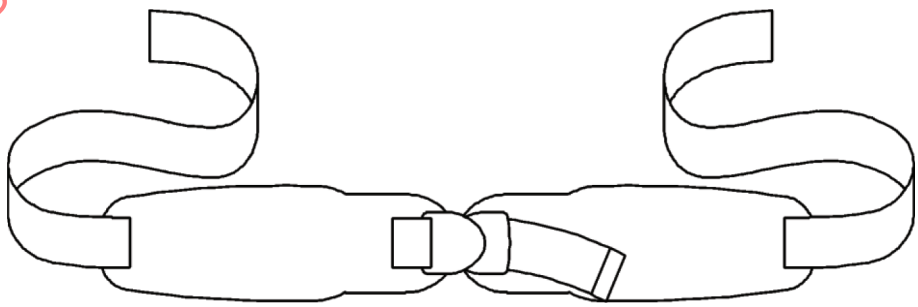


Figure 10 — Circumferential chest support

6.2.8 Anterior shoulder support

An anterior shoulder support shall be made up of two padded shoulder straps, each fastened by an upper and a lower strap (see Figure 11). To deter the shoulder straps from coming off the shoulders, the straps can be connected by a central strap and closure at the lower sternum. A central strap shall be affixed to the padded shoulder straps in such a position as to prevent the central strap from rising above the sternum.

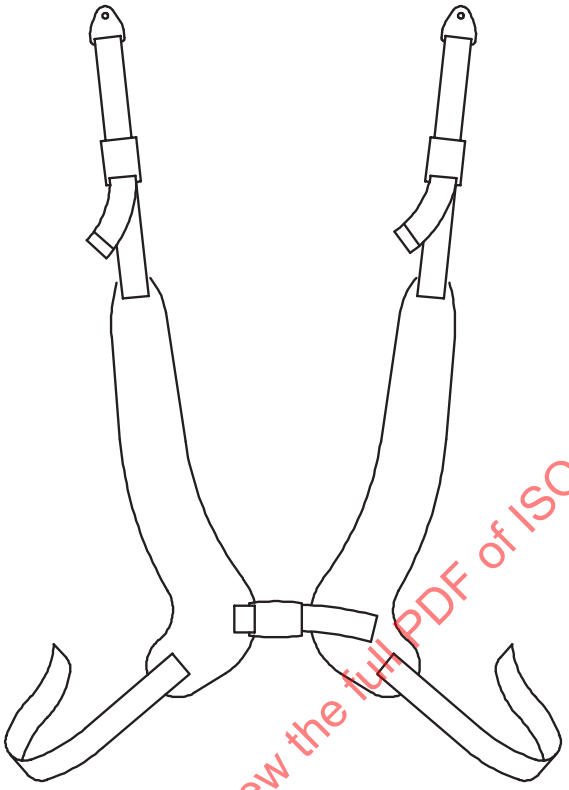


Figure 11 — Anterior shoulder support

6.2.9 Attachment of flexible anterior trunk supports

Anterior trunk supports are fitted as follows.

a) The occupant shall be positioned in their optimal posture prior to the fitting and adjustment of a support.

b) Suitable posterior pelvic support and anterior ischial support shall be provided if determined appropriate per clinical assessment to reduce or correct a flexible posterior pelvic tilt position, and consequential collapse into kyphosis or further kyphosis.

c) An appropriate pelvic positioning support shall be applied prior to the fitting and adjustment of an anterior postural support.

d) Upper support straps shall be fitted at an optimal angle and height to avoid sliding off the shoulders or pressing into the neck or shoulders, which often shall involve the use of support guides.

NOTE 1 Creating an optimal mounting height for the upper support straps by prescribing an excessively tall back support can harm trunk alignment and upper extremity mobility and add excess weight to the seating system.

e) Upper straps shall be positioned such that each strap sits over the shoulder, medial to the acromioclavicular joint, at least 10 mm lateral to the neck.

f) The fixation point of the upper straps shall be adjusted such that the angle of pull is level with the occupant's shoulders ± 20 degrees. The back support height should be set level with, or be adjustable

to, the occupant's sitting shoulder height ± 10 mm, unless another means is provided to allow the upper straps to be placed horizontally behind the shoulders.

NOTE 2 If the upper straps are too low, they can pull the occupant down in the seat. If they are too high, they might not provide appropriate force to hold the shoulders against the seat, and the straps can cause irritation to the neck or ears.

g) The fixation points of the upper straps shall be adjusted to sit mid-clavicle such that they do not impinge on the neck [see 6.2.8 e)].

h) The lower straps shall be fitted towards the bottom quarter of the back support such that the straps pull downwards towards the lower part of the chair's back support frame or the seat frame.

i) The lower straps shall be fitted such they do not impede chest expansion during inhalation.

j) The main body of a chest support shall sit over the sternum.

k) Once the upper straps and support body have been positioned correctly, the final fitting shall be achieved using the adjustment on the lower straps.

l) The centre point of a chest support shall not sit above the suprasternal/jugular notch.

m) The centre strap of an anterior shoulder support shall sit below the sternum, level with the lower ribs, and fastened at the front.

n) Only anterior shoulder supports explicitly recommended for use in a crossover configuration shall be crossed over.

o) The crossover point on any anterior shoulder support designed to be used in a crossover configuration shall not sit higher than mid-sternum.

The position of *in situ* medical devices such as PEG tubes or drug administration pumps should be checked. Where required, harnesses and straps can be adjusted, in line with a) to o) in 6.2.9.

6.3 Lateral trunk support

Most lateral trunk supports are made from inflexible rigid plates covered in padding and therefore are outside the scope of this document. However, some do include fixation for a strap across the chest. The primary purpose of this strap is to enable this flexible end of the lateral supports to provide some anterior support.

Where a lateral trunk support is used, it shall not restrict rib cage expansion during inhalation.

NOTE See the requirements and guidance on anterior trunk supports in 6.2.1, 6.2.5 and Annex E.

6.4 Posterior trunk support

In most cases, posterior trunk support is provided within the back support.

Where provided, tension adjustable back supports are made up of a series of straps, adjustable via hook-and-loop fixings, over which a padded back canvas is placed (see 5.4).

Where supplied, webbing straps shall be adjusted to suit the posterior support requirements of the intended occupant. This shall include providing appropriate support to the PSISs.

7 Flexible leg supports

7.1 General

Leg positioning is critical as the position of the legs can influence the position of the hips and pelvis, and consequently the trunk and head. The femurs provide a long lever to the hip joint, and so postural support to the upper legs and knees can have significant effects on the hips.

7.2 Medial thigh support

Flexible medial thigh supports are straps (see Figure 12) which are attached to the seat medial to the inner thigh and are routed over the top of the thigh towards the lateral thigh. They are designed to aid control of pelvic obliquity and/or pelvic rotation, or the degree of abduction of an individual leg.

Where medial thigh supports are used, a risk assessment shall be completed with attention given to pressure injury risk under the thighs and the integrity of the hip joint. Especially when hip adductor high tone is present, medial postural supports may lead to hip subluxation or dislocation, pain, and/or increased hypertonicity. Hip dislocation can then lead to a pelvic obliquity, pressure injuries, and scoliosis.

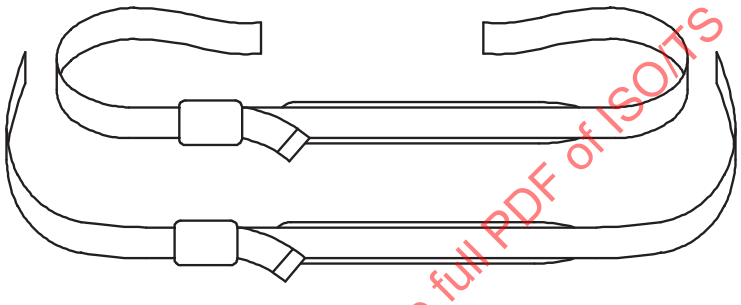


Figure 12 — Medial upper leg support

When fitting medial upper leg supports, the risk of pressure injuries from straps, stitching or changes in fabric inferior to the occupant's buttocks and/or thighs shall be taken into account. The proximity of straps to the occupant's genitals, where they can cause discomfort or irritation, shall be assessed for appropriate positioning of the supports.

7.3 Posterior lower leg support

A posterior lower leg support (see Figure 13) is designed to be used where there is a need to stop the feet from falling posterior to the foot support and is attached to the lower leg support assembly.

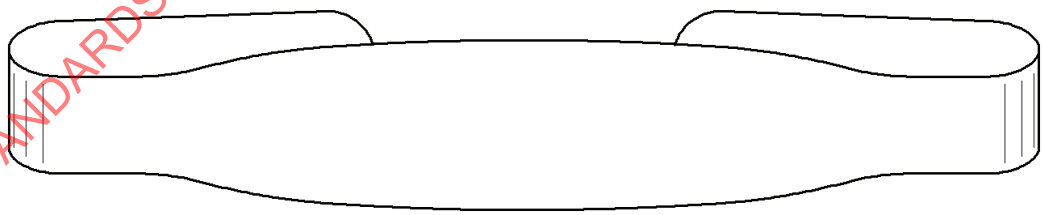


Figure 13 — Posterior lower leg support

8 Flexible foot supports

8.1 General

Foot position can be critical to postural positioning because this relates to hamstring tension. This tension may be caused by hamstring contractures and/or high tone. When the hamstrings are shortened, they pull the client into a posterior pelvic tilt, hip extension, and/or knee flexion as they cross the hips and thighs. When the feet are anchored to a foot support that is too far anterior, this forces the client into knee extension. This pulls on the hamstrings, increasing hip extension and posterior pelvic tilt. This has a cascade effect, often causing ischial and sacral pressure injuries, a kyphotic posture with a forward head and pain. Similar patterns may occur when the seat support surface is too deep, which also increases tension on the hamstring due to the associated excess knee extension. When using a flexible PSD to stabilize the feet on a foot support, the occupant's popliteal angle shall first be evaluated, and the seating system shall accommodate this dimension in the footplate anterior-posterior position. The occupant's thigh length shall also be evaluated, and the seating system's seat support surface shall be less than this dimension.

Restricting the movement of one or both feet in a seating system can prevent injuries from the feet coming off the foot support, improve sitting balance by stabilizing the lower extremities, decrease the risk of skin breakdown by positioning the feet in a fixed position or aid the function of an anterior knee support. Conversely, anchoring the feet adds another step to performing transfers, which can lead to injuries when the flexible PSD is not detached, increase the time needed to transfer and decrease the level of independence of the user with transfers. Care shall also be taken in that the flexible PSD can cause skin breakdown at the foot or ankle. This is especially a risk for occupants who do not tolerate wearing shoes.

When using flexible foot supports, the repeatability of a prescribed posture shall be taken into account.

NOTE 1 Where the repeatability or sustainability of the prescribed posture is likely to be poor, such as in the presence of severe tone patterns without dynamic seating components, fixing the position of the feet can result in higher than desired force being applied to the knee or ankle. This can lead to skin breakdown, seating system damage, and/or fractures.

NOTE 2 The use of a PSD to restrict movement at the distal extremity of the body places the occupant at high risk of injury if a) the pelvis is not adequately stabilized within the seating to prevent movement of the body transferring loads to the distal extremity PSDs (i.e. wrist or ankle supports), and b) the fitting of the extremity supports occurs before fitting of the pelvic supports, or the pelvic support is removed while the ankles are restrained.

8.2 Circumferential ankle support

Circumferential ankle supports most often comprise a padded strap that wraps around the ankle, with webbing straps which pull the foot down on the foot support (see Figure 14).

NOTE 1 This added pressure under the sole of the foot stimulates a plantar reflex, which can have a positive effect on the occupant's posture.

NOTE 2 Circumferential ankle supports can be fitted to allow some minor foot movement, allowing for greater comfort.

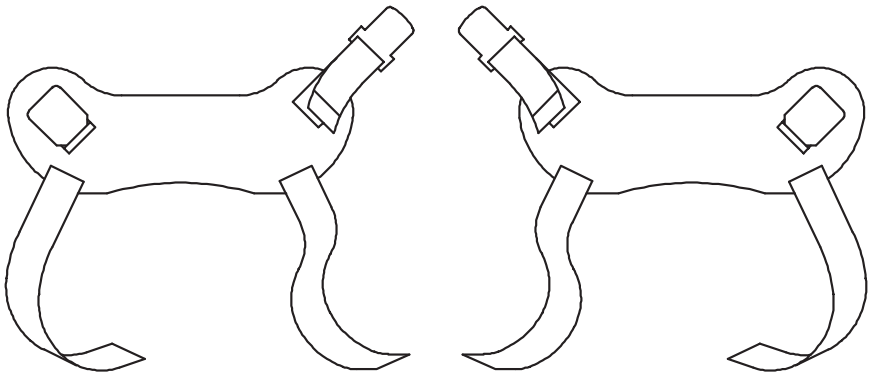


Figure 14 — Circumferential ankle support

8.3 Superior foot support

A superior foot support most often comprises one or two parallel foot straps that are superior to the toes and or mid-foot, and fitted to a rigid inferior foot support (see Figure 15).

NOTE 1 Each strap is typically fixed medially and laterally to the foot.

The effect of pulling down on the top of the foot should be taken into account, since this can stimulate a reflex to pull the foot upwards against the strap. Where a superior foot support is used over a shoe and/or sock, the likelihood of the foot being removed shall be taken into account, as this would leave the shoe alone being strapped to the inferior foot support.

NOTE 2 Superior foot supports comprise one or two straps, which can be padded. Superior foot supports are one means of achieving control of the foot.

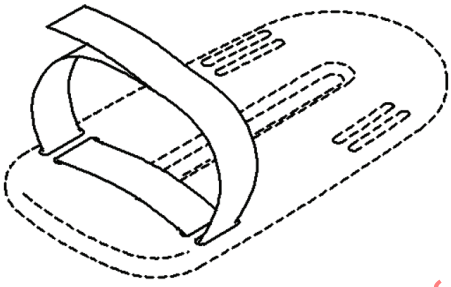


Figure 15 — Superior foot support

8.4 Attachment of flexible foot supports to equipment

8.4.1 General

When using superior foot supports and circumferential ankle supports, the security of the fixation of the inferior foot support to which they are fitted shall be taken into account.

NOTE When fitted to hinged (flip-up) foot supports, foot movement might not be sufficiently restricted.

8.4.2 Circumferential ankle support

The positioning of fixation points shall not allow the support to be in direct contact with the foot, in order to prevent the risk of pressure points. The lateral distance and the tension in the securing straps shall be adjusted to the required control of freedom appropriate for the occupant's foot.

NOTE 1 A circumferential strap is generally anchored by two straps. The straps are typically fixed medially and laterally to the heel.

NOTE 2 The webbing straps can pull down vertically for close control of the foot's position or be placed at an angle away from the heel, to allow for some degree of voluntary movement.

8.4.3 Superior foot support

The fixation points shall not be in direct contact with the foot, in order to prevent the risk of pressure-induced skin injuries.

9 Flexible head supports

9.1 General

Head alignment and stability are critical for breathing, communication, swallowing, hearing, balance and vision. Head alignment can be achieved through solid head rests or supports, but there are times when a flexible head support can increase the occupant's functionality.

9.2 Anterior head support

Flexible anterior head supports are typically applied to the forehead in order to help prevent forward movement or flexion of the head and neck, when the occupant is unable to maintain a functional upright position. Where a flexible anterior head support is used, a risk assessment shall be documented to demonstrate that the benefits of the support outweigh the risks (e.g. neck injury resulting from hitting an obstacle while a wheelchair is in motion). Alternative and complementary solutions shall be used where necessary [such as posterior head support used in conjunction with tilt, or a circumferential head support (soft orthotic collar)]. A trunk and a pelvic PSD shall be used in conjunction with an anterior head support to decrease the risk of the body falling or sliding while the head is anchored to the seating system.

Usage of such straps shall be timed and targeted to ensure they are applied only when required and appropriate (e.g. when the seat is stationary). All carers shall be trained in the correct use and positioning of the strap, and how to spot signs of distress when in use.

Flexible anterior head support straps shall not be used as a means of head support in transportation, due to the risk of neck injury from the motion of the vehicle (e.g. sharp braking).

Due to the risks involved in the use of anterior head supports (such as the support sliding down over the face or throat when in use), occupant use shall be supervised by carers. Instructions for use and individual risk assessment shall provide guidance.

NOTE Dynamic anterior head support straps are sometimes used across the forehead in combination with a posterior head support, in order to help prevent the head from falling forwards. This type of dynamic head support is designed to support the head while allowing neck rotation.

9.3 Attachment of anterior head supports to equipment

Flexible anterior head supports shall be fixed to a solid head support with the strap fitted over the forehead, ensuring sufficient counter-support posterior to the head/occiput. Any additional anterior head support shall be employed only as part of an overall postural support system that stabilizes the lower legs, pelvis and trunk.

10 Flexible arm supports

10.1 General

Flexible PSDs in the form of flexible arm supports shall not be used as a means of restraint.

The positioning of the occupant's arms and hands is important for overall posture, comfort, and safety. Arms that slide off the lateral sides of arm supports can decrease sitting balance and the ability to achieve and maintain midline, stretch the shoulder capsule (potentially causing pain and subluxation), develop more dependent oedema and/or strike the sides of the wheelchair. Arms that shift out of alignment on the arm supports may develop pressure injuries. In the presence of high tone patterns or reflexive movements, arms may strike the wheelchair or door frames and injure the occupant and others. For users with decreased motor control, lacking the ability to stabilize one or both arms can limit access to communication devices, drive controls, and other switch-operated devices.

Flexible PSDs at the upper arm, forearm or wrist provide for positioning properly and stabilizing the arms for those who do not propel their seating system with their upper extremities. The occupant should be evaluated to assess whether these PSDs limit or improve function and whether they can cause skin

breakdown, especially in those with high tone patterns. Alternatives include more extensive padding of the seating system components or selecting specific cover materials. Exploring medical and other seated-related triggers of the forceful arm movements should be considered for those with high tone patterns.

NOTE 1 Options for flexible PSDs for the upper extremities can include supports at the upper arm, forearm or wrist. Some of the supports can include a strap anchoring the body segment to the arm support directly, while others involve a cuff with straps anchoring the cuff to the arm support.

Wrist straps are sometimes used to control movement, e.g. in Huntingdon's disease. They are often used to improve function, for example where involuntary movements affect the occupant's daily activity, quality of life, and social participation. Wrist supports are used, in combination with other anterior postural supports, to restrict undesired movement to stabilize overall posture. This can be helpful in improving head control in powered wheelchairs.

NOTE 2 The use of a PSD to restrict movement at the distal extremity of the body places the occupant at high risk of injury if a) the pelvis is not adequately stabilized within the seating to prevent movement of the body transferring loads to the extremity PSDs (i.e. wrist or ankle supports) and b) the fitting of the distal extremity supports occurs before fitting of the pelvic supports, or the pelvic support is removed while the wrists are restrained.

NOTE 3 Use of wrist straps to control behaviour (e.g. to prevent tampering with passenger restraint systems, or where violence towards others can occur) is controversial. Where this is the case, other longer-term solutions can be explored, e.g. behavioural management programmes.

Use of circumferential wrist supports shall be timed and targeted such that they are applied only when required. The length of the strap shall be adjusted to optimize possible non-problematic arm movement.

Where possible, circumferential wrist supports shall be affixed on opposite sides, so that the left strap is attached to the right side of the chair and vice versa.

NOTE 4 This allows functional movement within the space in front of the body, while preventing the arms from flailing outwards, for example where the individual can be at risk of injury to themselves or others.

11 Disclosure information

11.1 Product labelling

Because of the acknowledged risks of falls or strangulation in case the occupant slides out of position, pelvic positioning belts and anterior trunk supports shall be permanently and visibly labelled with the 'Caution' and 'Consult the instructions for use' symbols depicted in ISO 15223-1:2021, namely ISO 7000-0434A (or ISO 7000-0434B) and ISO 7000-1641 from ISO 7000:2019.

The symbols can be placed in either a vertical or a horizontal arrangement, as shown in Figure 16.

a) Vertical arrangement **b) Horizontal arrangement**

Figure 16 — Examples of combining 'Caution' and 'Consult instructions for use' symbols

For other types of flexible PSD, if the PSD manufacturer's risk analysis finds that there are risks associated with the installation or use of the PSD which the occupant, caregiver, or wheelchair technician shall be warned of, the PSD shall have these symbols permanently and visibly labelled on the device.

Warning symbols used on the PSD shall also be shown in the PSD's instructions for use, along with explanatory text where needed.

If the manufacturer's risk analysis finds there is a significant risk of unsafe conditions due to improper daily use of a PSD, the PSD manufacturer shall consider adding a cautionary label to the PSD. Figure 17 shows an example that can be created for 'Correct positioning of an anterior trunk support' on a PSD.

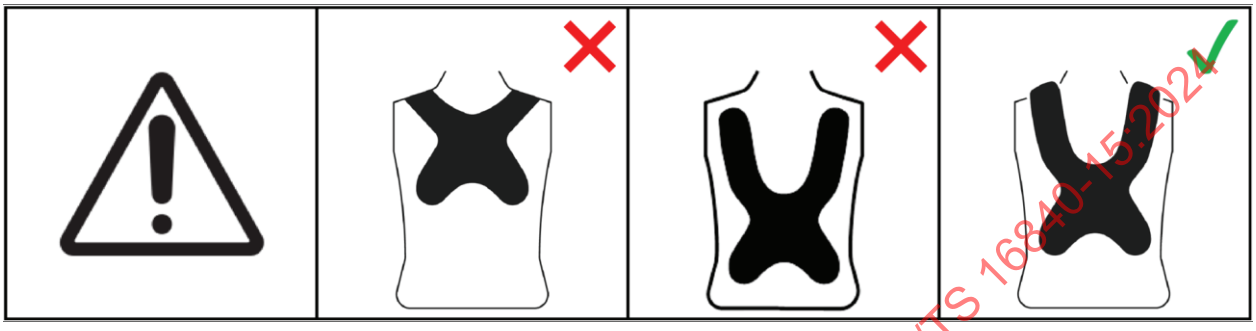


Figure 17 — Anterior trunk support label

To facilitate access to the instructions for use and other helpful information, the PSD can include a label printed with a machine-readable 2D barcode, such as a QR code or Data Matrix code, having a link to a website with the information (see Figure 18 for example).

Figure 18 — Example of QR code linking with a website to access instructions

11.2 Fitting instructions

PSD manufacturers shall provide fitting instructions for all PSDs.

PSD manufacturers shall provide refitting instructions for all factory-fitted supports if their removal is reasonably expected during the lifespan of the PSD (e.g. to enable seat cushion covers or the PSDs to be washed).

Fitting instructions shall include directions on how to, where to, and where not to fit the support in accordance with this document.

Fitting instructions shall include details on any specific fasteners, tightening torque or tools required.

The wheelchair and PSD documentation shall caution regarding the potential unsuitability of mounting a pelvic positioning support at the junction of the back support and seat and offer guidance on the appropriate support positioning options. Consideration shall be given to the guidance in this standard, the design of the particular chair and fastener, and the occupant's needs.

11.3 Instructions for use

PSD manufacturers shall provide user instructions for all flexible PSDs. Instructions for use shall include, as applicable:

a) any special requirements as to who can prescribe and fit a postural support;

b) the intended use and limitations of use, e.g. load limits, physical or cognitive ability;

c) how to adjust the PSD to fit the occupant;

d) how to operate closure systems;

e) how to check the PSD for visual signs of wear or damage and how often;

f) how to check for correct occupant positioning and how often;

g) how to check for correct fit and adjustment;

h) the results of tests to any relevant testing standards which apply;

i) safety warnings, including:

   1) the need for awareness of signs of occupant distress;

   2) the need for any periodic checking the occupant's skin for associated pressure injuries;

   3) risks of strangulation due to poor positioning;

   4) keeping closure systems and attachment hardware free from debris;

j) explanations of any safety labels (as described in 11.1);

k) emergency release;

l) use and limitations of use in transportation, including the text "Not suitable for use as an occupant restraint in transportation";

m) how to use the PSD in combination with other critical items (e.g. instructions for anterior trunk supports shall include the text "Only use in combination with a properly adjusted pelvic positioning support");

n) cleaning and decontamination instructions.

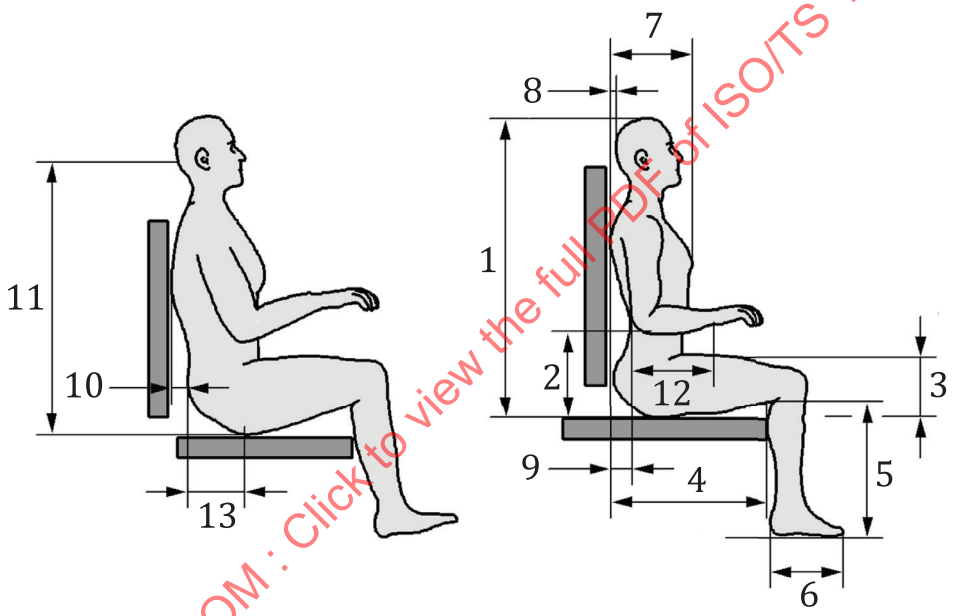
Annex A
(normative)

How to measure a person

A.1 Linear measures of a seated person

The dimensions of the elements of a seated person are given in ISO 16840-1 and in Waugh and Crane, 2013. [3] These documents describe bony landmarks that can, in the main, be palpated. The lines between these points provide segment lines for different parts of the body which are used to measure their absolute and relative angles at any one chosen position.

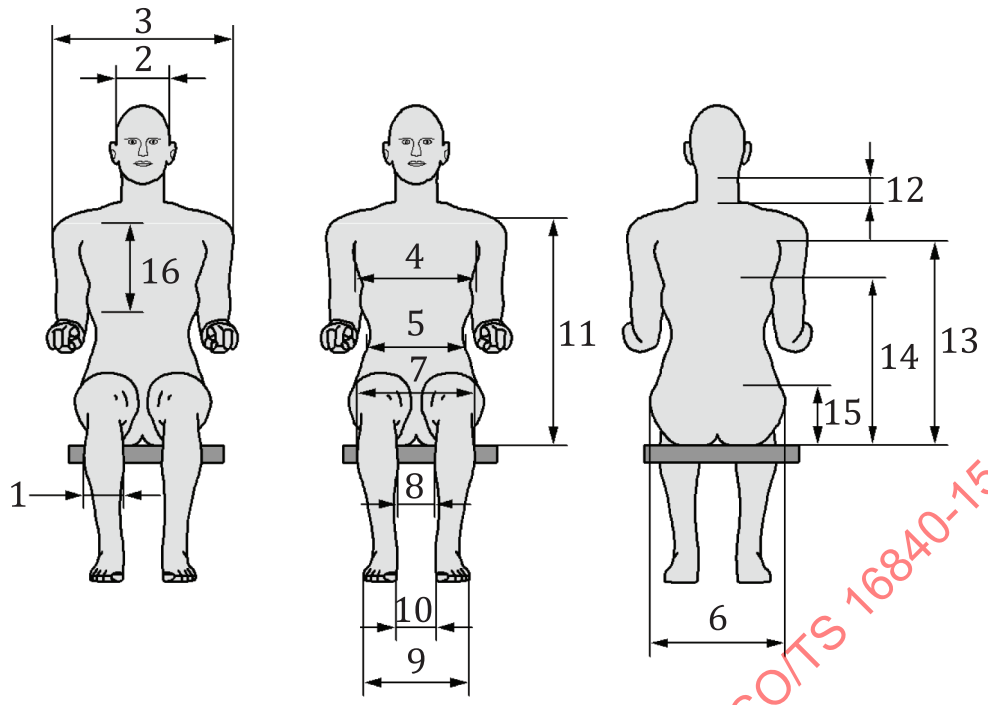
Linear measures of the seated body relevant to the elements of the dimensions of the seating system shall be as described and summarized in Figures A.1, A.2 and A.3.



Key

1 maximum sitting height
2 elbow height
3 thigh height
4 buttock/thigh depth
5 lower leg length
6 foot depth
7 trunk depth
8 occiput depth
9 lumbar curve depth
10 thoracic curve depth
11 occiput height
12 forearm depth
13 ischial depth

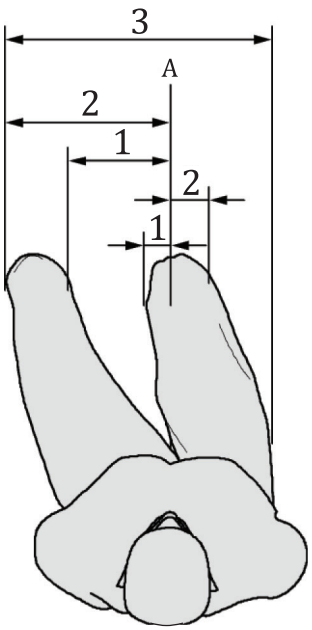
Figure A.1 — Examples of linear measures of the body in the sagittal view



Key

1	knee width	9	external foot width
2	head width	10	internal foot width
3	shoulder width	11	shoulder height
4	chest width	12	occiput to C7
5	waist width	13	axilla height
6	hip width	14	scapula height
7	external knee width	15	PSIS height
8	internal knee width	16	sternal length

Figure A.2 — Examples of linear measures of the body in the frontal view



Key

1	medial knee to centreline	3	maximum lower body width
2	lateral knee to centreline	A	centreline of seat

Figure A.3 — Examples of linear measures of the body in the transverse view

A.2 Measurements of the seated body for sizing PSDs

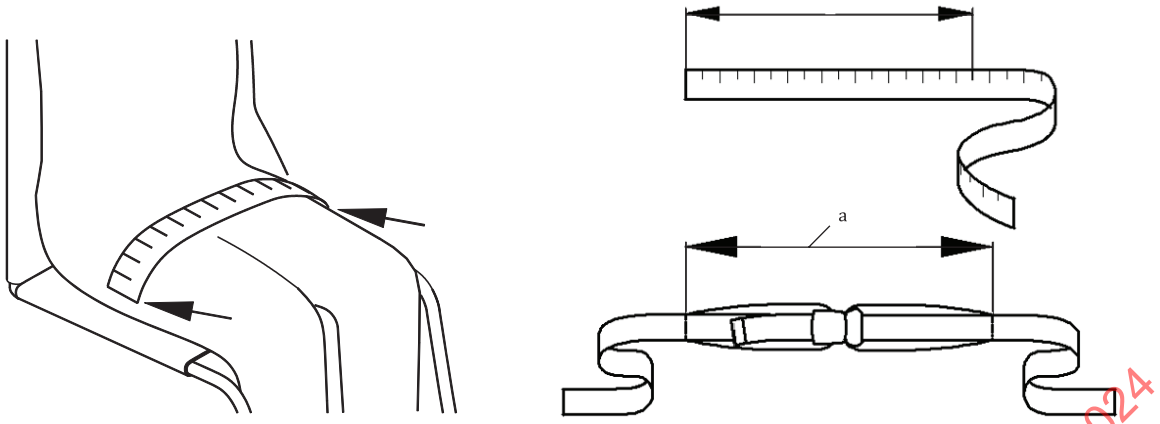
A.2.1 General

Measurements of the body for a PSD shall be made at the intended location of the PSD.

A.2.2 Pelvic positioning support

A.2.2.1 Posterior pelvic tilt management

For a support managing posterior pelvic tilt, the distance from the lateral side of one thigh to the lateral side of the other thigh shall be measured with a flexible tape, as shown in Figure A.4. This value shall be used to select the flexible PSD padded length (see B.2.3.2).



a Padded length.

Figure A.4 — Measurement for a pelvic positioning support – posterior pelvic tilt management

A.2.2.2 Anterior pelvic tilt management

For a support managing anterior pelvic tilt, the distance from one lateral side of the pelvis horizontally level with the ASISs to the other lateral side at the same level shall be measured with a flexible tape, as shown in Figure A.5. This value shall be used to select the flexible PSD padded length (see B.2.3.2).

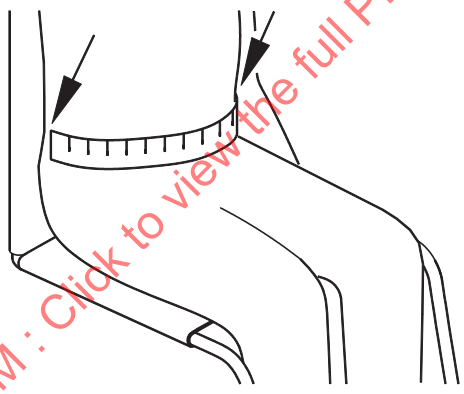


Figure A.5 — Measurement for a pelvic positioning support – anterior pelvic tilt management

A.2.3 Anterior trunk support

The shoulder width shall be measured as shown in Figure A.6.

NOTE This is measure 3 in Figure A.2.

This width shall be used to determine the size of support (see B.3).

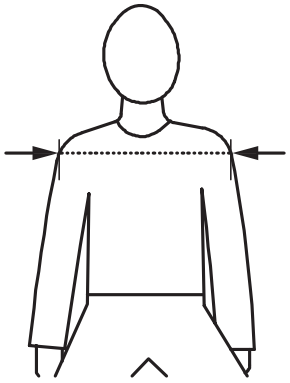


Figure A.6 — Measurement for an anterior trunk support

A.2.4 Circumferential chest support

The circumferential distance shall be measured with a flexible tape, around the torso to the back support on each side (see Figure A.7), at the height where the support is to be applied, to select the size of support (see B.4).

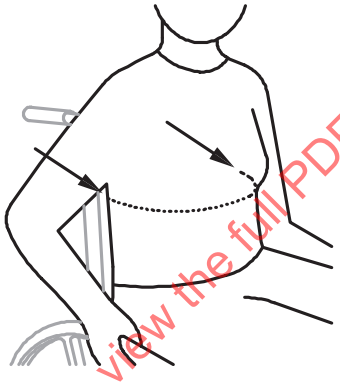


Figure A.7 — Measurement points for a circumferential chest support

A.2.5 Circumferential ankle support

The circumference above the ankle bone shall be measured with a flexible tape (see Figure A.8). The circumference shall be measured with the user wearing shoes and ankle foot orthoses (AFOs) if these are typically worn in the seating system.

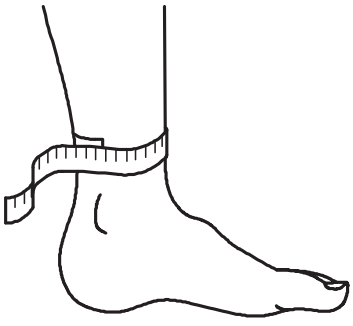


Figure A.8 — Measurement for a circumferential ankle support

A.2.6 Posterior lower leg support

Measure from the fixation points on the chair frame, wrapping behind the occupant's lower legs using a flexible tape (see Figure A.9).

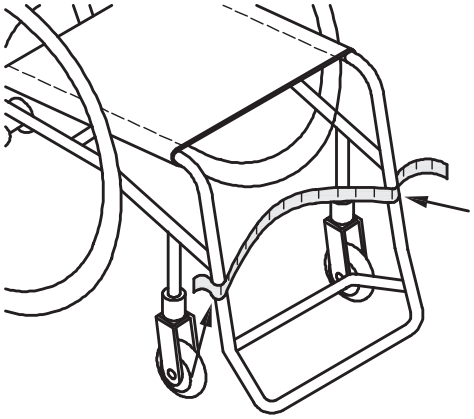


Figure A.9 — Measurement for a posterior lower leg support

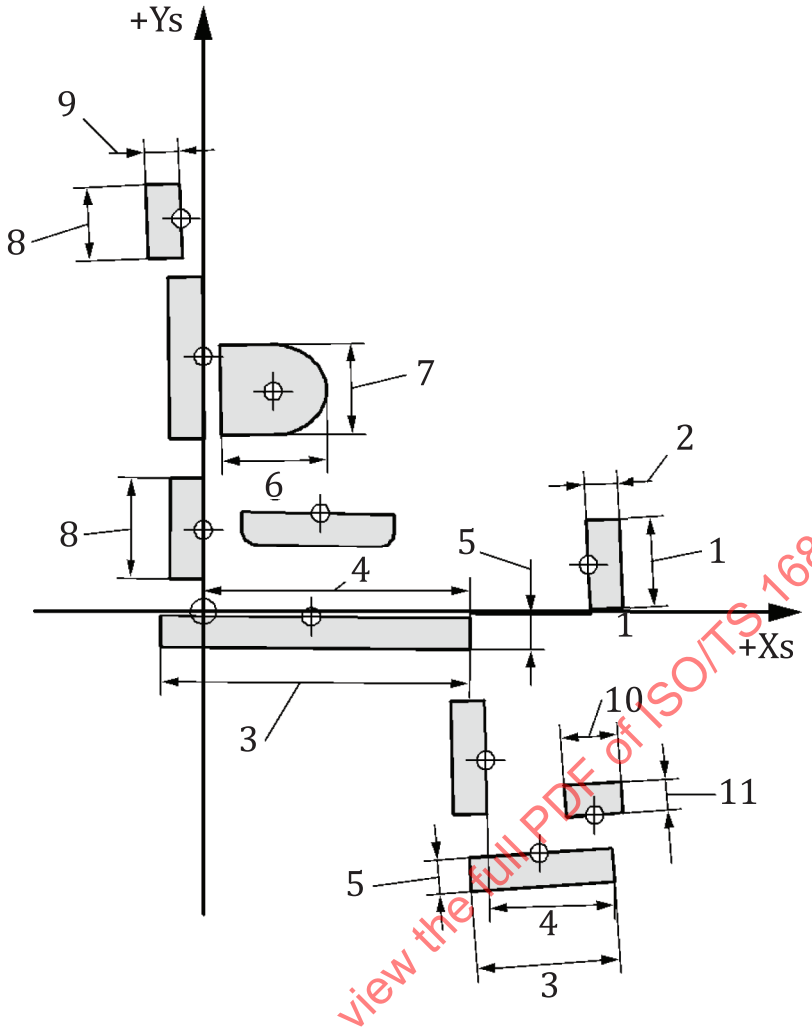
Annex B
(normative)

How to measure a device

B.1 Linear measures of elements of a seating system

The dimensions of the elements of a seating system are given in ISO 16840-1 and in Waugh and Crane, 2013[3]. For examples see Figures B.1 and B.2.

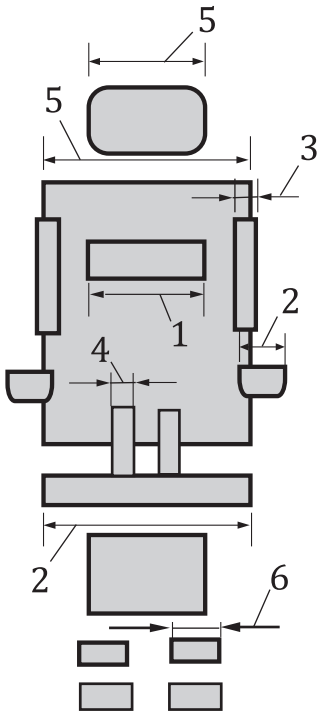
NOTE Height is a positional measure indicating the distance from either the seat surface or floor to the uppermost surface. If the back support is reclined, this dimension remains unchanged. However, the vertical distance to the seat surface or floor, which is termed the vertical height, will change.



Key

1	anterior support length	8	posterior support length
2	anterior support thickness	9	posterior support thickness
3	inferior support depth	10	superior support depth
4	inferior support effective depth	11	superior support thickness
5	inferior support thickness	Y_s	seat vertical axis
6	lateral support depth	X_s	seat posterior-anterior axis
7	lateral support length		

Figure B.1 — Linear measures of support surfaces in the sagittal view



Key

1	anterior support width	4	medial support thickness
2	inferior support width	5	posterior support width
3	lateral support thickness	6	superior support width

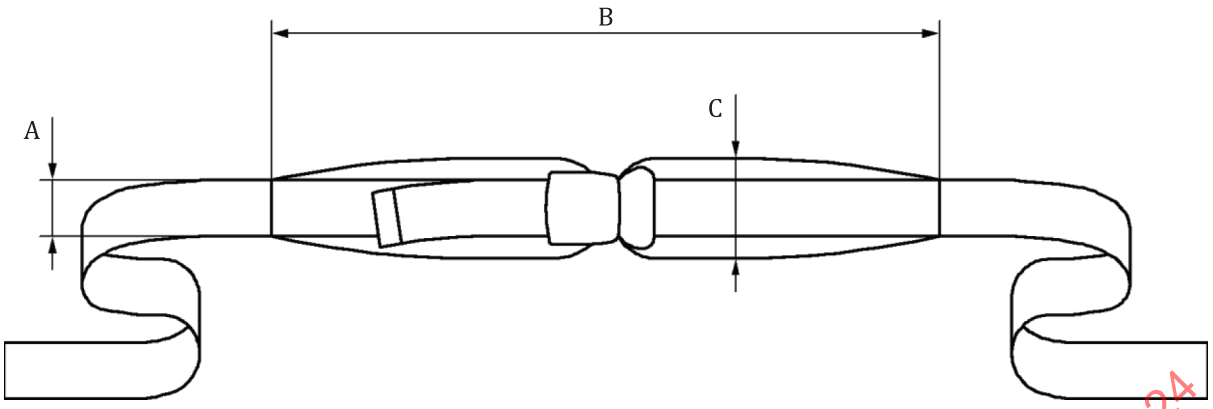
Figure B.2 — Linear measures of generic support surfaces in the frontal view

B.2 Pelvic positioning flexible PSD

B.2.1 General

The pelvic positioning support dimensions for flexible PSD width and length are as shown in Figure B.3.

NOTE Because a pelvic positioning belt can be used in various positions (e.g. across the pelvis or across the thighs), the guidance given in Figure B.1 and in 3.1.6 is not applied to flexible pelvic positioning PSDs with respect to width, depth and length measures.



Key

A flexible PSD width

B flexible PSD padded length

C flexible PSD pad width

Note Flexible PSD length is not shown.

Figure B.3 — Pelvic positioning flexible PSD dimensions

B.2.2 Flexible PSD width

B.2.2.1 Webbing

Up to 25 mm shall be designated as small; 26 mm to 38 mm shall be designated as medium; and 39 mm to 50 mm shall be designated as large. A tolerance interval of ±3 mm shall be applied to these measurements.

NOTE 1 The common flexible PSD widths for webbing are 25 mm, 38 mm and 50 mm.

NOTE 2 The flexible PSD webbing width is shown in Figure B.3.

B.2.2.2 Padding

Flexible PSD pad width shall be the measure at the point on the pad with the greatest flexible PSD pad width (see Figure B.3).

B.2.3 Flexible PSD length

B.2.3.1 Webbing

The total flexible PSD length of the support shall be the distance, when the support is laid flat, between the most lateral fixing points of the webbing.

B.2.3.2 Padding

The flexible PSD padded length shall be measured on a fastened and fully tightened support, from the most lateral end of one pad to the most lateral end of the other pad (see Figure B.3).

NOTE When the distance between the pads is adjustable (as is commonly done at the centre buckle), the measurement is taken at the minimum adjustment (i.e. where all adjustment has been taken up).

B.3 Anterior trunk support

An anterior trunk support shall be described by the range of shoulder width measures (see A.2.3) for which it is designed. Examples are given in Table B.1.

Table B.1 — Anterior trunk support size selection

Anterior trunk support size	Designed for shoulder width (Figure A.6)	Possibly described previously as
Size 15–24	150 mm to 240 mm	XX Small
Size 24–28	240 mm to 280 mm	X Small
Size 28–33	280 mm to 330 mm	Small
Size 33–41	330 mm to 410 mm	Medium
Size 41–48	410 mm to 480 mm	Large
Size 48–55	480 mm to 550 mm	X Large

B.4 Circumferential chest support

The size of a circumferential chest support shall be described by the range of chest measures covered in A.2.4 for which it is designed. Examples are given in Table B.2.

Table B.2 — Circumferential chest support size selection

Chest support size	Circumferential measure of person's chest (Figure A.7)	Possibly described previously as
Size 31–41	310 mm to 410 mm	X Small
Size 40–49	400 mm to 490 mm	Small
Size 47–58	470 mm to 580 mm	Medium
Size 55–66	550 mm to 660 mm	Large
Size 62–73	620 mm to 730 mm	X Large

B.5 Circumferential ankle support

The size of a circumferential ankle support shall be described by the range of ankle measures covered in A.2.5 for which it is designed. Examples are given in Table B.3.

Table B.3 — Circumferential ankle support size selection

Ankle support size	Circumferential measure (Figure A.8)	Possibly described previously as
Size 14–17	140 mm to 170 mm	X Small
Size 17–20	170 mm to 200 mm	Small
Size 20–23	200 mm to 230 mm	Medium
Size 23–28	230 mm to 280 mm	Large
Size 28–33	280 mm to 330 mm	X Large