BS ISO 16840-3:2022
Incorporating corrigendum November 2023

BSI Standards Publication

Wheelchair seating

Part 3: Determination of static, impact, and repetitive load strengths for postural support devices

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Full document details: BS ISO 16840-3:2022

National foreword

This British Standard is the UK implementation of ISO 16840-3:2022. It supersedes BS ISO 16840-3:2014 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CH/173/1, Wheelchairs.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2023

ISBN 978 0 539 29396 8

ICS 11.180.10

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2022.

Amendments/corrigenda issued since publication

Date	Text affected
30 November 2023	Implementation of ISO corrected text 28 February 2023

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INTERNATIONAL STANDARD

ISO 16840-3

Third edition
2022-10

Corrected version
2023-02

Wheelchair seating —

Part 3: Determination of static, impact, and repetitive load strengths for postural support devices

Sièges de fauteuils roulants —

Partie 3: Détermination de la résistance aux charges statiques, dynamiques et cycliques pour les dispositifs de maintien de la posture

Reference number
ISO 16840-3:2022(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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

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

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

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

This third edition cancels and replaces the second edition (ISO 16840-3:2014), which has been technically revised.

The main changes are as follows:

— the structure of the document has been updated;

— test results have been added;

— pass/fail requirements have been established.

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.

This corrected version of ISO 16840-3:2022 incorporates the following corrections:

— Missing list items were added to 6.10 and B.5.8;

— Text clarified in A.5.3.

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Introduction

Postural support devices (PSDs), constructed as additional components to wheelchair seating or as wheelchair seating in its own right, are widely available and used extensively by people with disabilities. The selection or prescription of the most appropriate PSD is intended to be, where appropriate, partially dependent on knowledge of the PSD's ability to withstand static, impact, and repetitive loads. This document specifies test methods and requirements for the strength of PSDs as manufactured, which are designed to identify likely points of failure by breaking, yielding, or loosening of components - it is not intended to predict the long-term useful life. The useful life of a device depends upon many variables of use, aging, and environment: the way in which it is installed, the frequency of use and forces to which it is subjected, abrasion points, vibration and fatigue, cleaning and periodic maintenance, and temperature, humidity and UV exposure.

The tests involve mounting the PSD to a rigid test fixture to simulate mounting on a wheelchair. Rigid test fixtures are used to provide a worst-case situation by minimizing shock-absorption that can come, for example, from the damping effects of flex in the wheelchair frame, and also to make these tests repeatable by removing the variable of wheelchair type. Repetitive, static, and impact loads are then applied, as appropriate, according to the type of PSD, to determine if the minimum strength requirements are met.

When a series of strength/impact tests are performed on a PSD, the same sample PSD is used throughout and the tests conducted in series, from least stringent [lowest forces] to most stringent [highest forces]. In this manner, the PSD will be subjected to lower forces, which would typically be more frequently encountered in daily use, before being subjected to the higher forces that pose a greater risk of failure. If the sample PSD fails in a less stringent test, there is generally no reason to conduct more stringent tests until the PSD has been redesigned. Individual tests can be conducted using a unique sample PSD for each test, but this will not provide the same level of assurance about performance.

Some of the tests represented in this document are derived from ISO 7176-8. Many of the pass/fail criteria, test principles and test equipment are the same for this document as for ISO 7176-8.

Parts of this document are continuing to be developed so that future revisions can include the results of work in the following areas:

— further development of the test forces based on clinical data in order to determine actual impact, static, and repetitive forces that PSDs are subjected to;

— the collection of further data on the most common failures experienced in actual use of PSDs is ongoing;

— addressing any additional unaddressed PSD testing needs, including gaps as currently identified in Table 1.

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Wheelchair seating —

Part 3: Determination of static, impact, and repetitive load strengths for postural support devices

1 Scope

This document specifies requirements for static, impact, and repetitive load strengths for postural support devices (PSDs) with associated attachment hardware intended for use with an undefined wheelchair seating system. It specifies the test methods for determining whether the minimum performance requirements have been met to release a product into use. It also specifies requirements for disclosure of the test results. Not all tests apply to all PSDs.

This document includes sets of tests for these particular types of PSDs listed in Table 1:

Table 1 — Index of tests

PSD	Repetitive	Static	Impact
Seat cushion supporting structure	X		X
Back cushion supporting structure	X	X	X
Pelvic positioning	X	X	
Anterior trunk support	X	X	
Lateral support		X	
Medial knee support		X	
Head support	X	X	
Lower arm positioning devices	a	a	
Foot support		b	b

NOTE 1 Seat Cushion Supporting Structure is the system upon which the seat cushion is mounted.

NOTE 2 Back Cushion Supporting Structure is the system upon which the back support is mounted.

a Repetitive and static tests are under development for non-integrated, lower arm positioning devices. Arm support static test protocols are defined in ISO 7176-8 for supports which are integrated within the wheelchair.

b Static and impact foot support test protocols are defined in ISO 7176-8 for supports which are integrated within the wheelchair.

This document is also applicable to other seating systems.

The test methods can be used to verify the manufacturer's claims that a product meets the requirements of this document. This document does not apply to PSDs that are designed to fail under certain static, dynamic, or repetitive loads.

This document does not apply to the strength of PSDs under crash conditions in a motor vehicle.

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This document does not evaluate long-term useful life.

NOTE 1 ISO 16840-4 provides crash test methods and requirements for wheelchair seating systems when used as part of a wheelchair seat in a motor vehicle.

NOTE 2 For user masses greater or less than those specified in this document, appropriate extrapolation of test apparatus dimensions, mounting point separation, forces, etc. can be carried out, and the test parameters noted in the test report.

NOTE 3 Rigid surrogate test fixtures are utilized to provide a standardized test method, and consequently this document does not involve a test of a PSD on a particular wheelchair.

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 898-7, *Mechanical properties of fasteners — Part 7: Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm*

ISO 7176-8:2014, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*

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

ISO 16840-2, *Wheelchair seating — Part 2: Determination of physical and mechanical characteristics of seat cushions intended to manage tissue integrity*

JIS K 7312, *Physical testing methods for molded products of thermosetting polyurethane elastomers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176-26 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
active support surface
postural support device that is power assisted to change its position or support surface shape

EXAMPLE An alternating pressure seat cushion or an electronically operated back support surface that reclines.

3.2
integrated lateral trunk support
lateral support that has a continuous structure with a back support

Note 1 to entry: See Figure 1.

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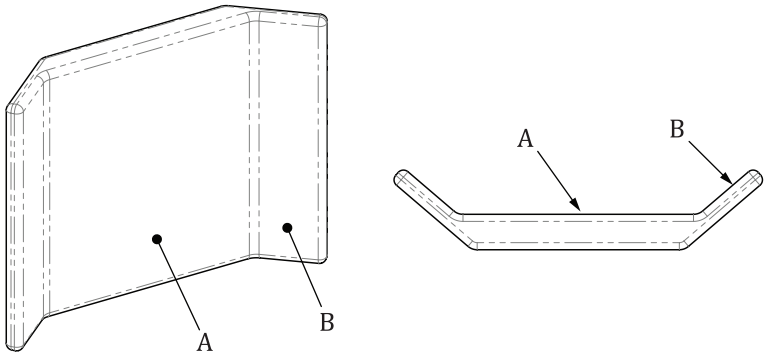


Key

A back support

B integrated lateral trunk support

Figure 1 — Example of a support viewed from above showing a cross-section of a back support with an integrated lateral trunk support

3.3
deformable support surface
support surface that conforms to the shape of the body part being supported

Note 1 to entry: The surface can possibly return to its original shape.

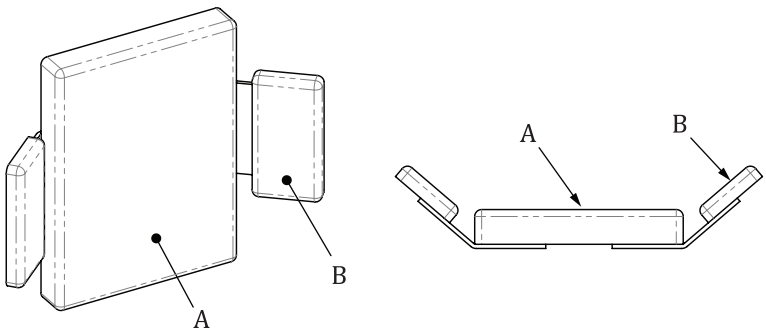
EXAMPLE Foam or fluid seat supports.

3.4
non-integrated
detachable, with or without the use of tools

Note 1 to entry: Items held in place by hook and loop fastenings are considered non-integrated.

3.5
non-integrated lateral support
lateral support that is mounted as a separate entity

Note 1 to entry: See Figure 2.



Key

A back support

B non-integrated lateral trunk support

Figure 2 — Example of a back support with a non-integrated lateral trunk support, viewed from above

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3.6
dynamic attachment hardware
hardware that, when a force is applied, allows a postural support device to move and return to its original position when the force is removed

EXAMPLE A PSD designed with a spring that allows movement.

3.7
mounting point
specified attachment location

3.8
passive support surface
postural support device that moves in response to the body part being supported and is not powered-assisted

Note 1 to entry: Passive support surfaces do not necessarily move back to a specific position.

EXAMPLE A mobile arm support is a passive support surface that allows movement with minimal resistance.

3.9
pivot axis
axis about which a device rotates

3.10
postural support device
PSD
structure, attached to a seat or chair, that has a surface that contacts the occupant's body and is used either to support, correct, or stabilize the occupant's posture

Note 1 to entry: For the purpose of this document, a PSD shall include its mounting components.

Note 2 to entry: Specific to wheelchair back supports and seat cushions, testing is intended to verify performance of the mounting components and the structural components.

3.11
slippage
shift in the relative position at an adjustment point of connected components of a postural support device

3.12
displacement
permanent change in the position of a surface or point relative to a fixed reference point, as a result of yielding, fracturing, or slippage

3.13
elastic deformation
temporary change in dimension or shape while under load

3.14
permanent deformation
retained change in dimension or shape after removal of a load

3.15
seat cushion supporting structure
SCSS
structural component(s) installed as part of a seating system to hold a seat cushion in place

3.16
back cushion supporting structure
BCSS
structural component(s) installed as part of a seating system to hold a back support in place

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4 Principle

4.1 Overview

4.1.1 General

A postural support device is subjected to forces that represent repetitive loading, static loading, and impact loading typically expected during normal use of the device, as specified in each annex.

4.1.2 Repetitive load

A PSD subjected to repetitive loads shall be tested in accordance with the method given in Annex A.

4.1.3 Static load

A PSD subjected to static loads shall be tested in accordance with the method given in Annex B.

4.1.4 Impact load

A PSD subjected to impact loads shall be tested in accordance with the method given in Annex C.

4.2 PSD Sample

The same PSD sample shall be used for the complete set of tests, conducted in order from least stringent [lowest forces] to most stringent [highest forces]. Order of testing should be as progressing from repetitive loading to static loading, then impact loading. Testing shall be conducted either until a device is considered to have failed or until completion of all tests.

Individual tests can be conducted using a unique sample PSD for each test, but the results shall not be reported as evidence of conformance with this document.

5 Requirements

When tested in accordance with Annexes A, B and C, a PSD shall meet all the following requirements:

a) No PSD shall show evidence of fractures or visible cracks.

b) No belts, harnesses or other textiles, including those that are used as support structures, shall show evidence of tears or broken stitches.

NOTE Seat and back cushions themselves, which are not structural components, are not addressed in this document and are thus exempt from this requirement.

c) No nut, bolt, screw, locking pin, component or similar item shall loosen or detach.

d) No PSD shall show evidence of slippage at any adjustment point after forces have been removed, of more than 10 mm or 5° compared with its original set-up. If a set-up load is required, measurement shall be relative to the set-up loaded state.

e) No component or assembly of parts shall exhibit permanent deformation after forces have been removed, of more than 10 mm or 5°, compared with its original set-up. If a set-up load is required, measurement shall be relative to the set-up loaded state.

f) No PSD shall become permanently displaced more than 10 mm or 5° at the point of loading from the set-up loaded state, except in the case of pelvic positioning supports or anterior trunk supports:

   1) pelvic positioning supports shall not demonstrate a vertical displacement of the loading pad of greater than 3 % of the loading pad width, when measured in the set-up loaded state after the test load has been applied and removed.

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2) anterior trunk supports shall not demonstrate an angular displacement of the loading pad of greater than 5° in angle, when measured in the set-up loaded state after the test load has been applied and removed;

g) No electrical component shall disconnect or demonstrate damage that compromises the specified use.

h) No power-operated component (e.g. pneumatic, electrical, hydraulic) shall cease to be operational.

i) No parts that are designed to be removable, foldable, or adjustable shall cease to operate.

6 Test report requirements

6.1 The test report shall contain the following items:

6.2 Statement that the PSD and attachment hardware have been tested to this document, i.e. ISO 16840-3:2022.

6.3 Testing institution

a) Name;

b) Address;

c) Accreditations or certifications (if any);

d) Unique test report reference such as a report or contract number.

6.4 Dates

a) Date(s) of tests;

b) Date of report issue.

6.5 Manufacturer or entity requesting the testing

a) Name;

b) Address.

6.6 Product identification

a) Product name or model;

b) Serial number and/or batch number (if any).

Maximum user mass tested for the PSD where relevant.

6.7 Test apparatus used

Rigid test fixtures and/or adjacent parts used for each test.

6.8 Test equipment

Confirmation that prior to testing, equipment was calibrated or verified against measurement standards traceable to international or national measurement standards (where applicable);

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Measurement equipment including, but not limited to, the following:

a) Linear measurement devices;

b) Angular measurement devices;

c) Force gauges.

6.9 Setup of the device

a) Description of setting, adjustments of PSDs used for each test;

b) Type or types of removable covering material, if any;

c) Repetitive load test, if applicable:

   i) force or torque applied.

d) Static load test, if applicable:

   i) maximum force or torque applied.

e) Impact load test, if applicable.

6.10 Test results

a) List of all the tests applied to the device in accordance with Table 1;

b) Statement of whether the same sample PSD was used for the series of tests, or if tests were conducted separately, using a unique sample PSD for each test;

c) Statement of whether the requirements of Clause 5 have been met

d) Repetitive load test results, if applicable:

   i) Number of cycles completed;

   ii) Statement of Pass/Fail according to the requirements of Clause 5. If any failure mode occurred, describe the failure mode and observations;

   iii) Comments on any additional observations.

e) Static load test results, if applicable:

   i) Maximum load applied;

   ii) Statement of Pass/Fail according to the requirements of Clause 5. If any failure mode occurred, describe the failure mode and observations;

   iii) Comments on any additional observations;

   iv) PSDs except for anterior pelvic and trunk supports, report:

      — maximum elastic deformation before one of the failure modes occurred;

      — permanent deformation that remains after the load has been returned to the set-up loaded state.

   v) For anterior pelvic supports, report:

      — maximum linear displacement resulting from elastic deformation while under load.

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