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Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems —

Part 3: Docking-type tiedown systems

Assistances et aides techniques pour les personnes invalides ou handicapées — Systèmes d'attache du fauteuil roulant et de retenue de l'occupant —

Partie 3: Systèmes de fixation par arrimage

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10542-3 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

ISO 10542 consists of the following parts, under the general title *Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint sytems*:

— *Part 1: Requirements and test methods for all systems*

— *Part 2: Four-point strap-type tiedown systems*

— *Part 3: Docking-type tiedown systems*

— *Part 4: Clamp-type tiedown systems*

— *Part 5: Systems for specific wheelchairs*

Introduction

Providing effective protection for the wheelchair-seated occupant of a motor vehicle usually requires that after-market equipment be installed to secure the wheelchair and restrain the person in the wheelchair. ISO 10542-1 specifies requirements and test methods for all wheelchair tiedown and occupant-restraint systems (WTORS). Its provisions apply as amended and supplemented by this part of ISO 10542 for wheelchair tiedown and occupant-restraint systems that use a manual or powered docking system to secure the wheelchair.

At the time of the drafting of this part of ISO 10542, docking tiedown devices were most often used to allow wheelchair users to independently secure their wheelchairs in private vehicles. Extending the use of docking tiedown devices to public vehicles places the added demand that docking devices engage with, and safely secure, a wide range of wheelchair types. Therefore, this part of ISO 10542 also contains a specification for a universal docking interface geometry (UDIG). When adopted by both the wheelchair and wheelchair securement industries, the UDIG specification will allow the user increased independence in wheelchair securement for a wide range of vehicles, while in all likelihood reducing the time required for loading and unloading wheelchair passengers.

Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems —

Part 3: Docking-type tiedown systems

1 Scope

This part of ISO 10542 specifies design and performance requirements and recommendations, instructions and warnings for both installers and users, and product marking and labelling, for wheelchair tiedown and occupant-restraint systems (WTORS) that use a docking-type wheelchair tiedown. It specifies the universal docking interface geometry (UDIG) and a method of testing wheelchair movement. It is applicable to docking-type wheelchair tiedown devices intended for securing all types of manual and powered forward-facing wheelchairs, including scooters with three or more wheels, used by adult passengers and drivers of motor vehicles.

This part of ISO 10542 is applicable primarily to complete WTORS, but a portion of this part of ISO 10542 can also be applied to components and sub-assemblies sold separately and for replacement parts.

2 Normative references

The following referenced documents are indispensable for the application 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 10542-1:2001, *Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems — Part 1: Requirements and test methods for all systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10542-1 and the following apply.

3.1
docking-type tiedown
docking-type securement
method of wheelchair tiedown by which portions of the wheelchair structure, or add-on components fastened to the wheelchair, align, mate and engage with a docking tiedown device fastened to the vehicle, upon manoeuvring of the wheelchair into position in the vehicle

NOTE Securement of the wheelchair can occur automatically during wheelchair engagement, or could require manual intervention through operation of a mechanical lever or electrical switch. Release of the wheelchair will usually require operation of a mechanical lever or electrical switch.

3.2
docking tiedown device
docking securement device
assembly of fixtures and components intended by the manufacturer for installation in motor vehicles for the purpose of securing a wheelchair by engaging with, and locking onto, securement points on the wheelchair frame or on wheelchair securement adaptors attached to the wheelchair frame

3.3
powered docking tiedown device
powered docking securement device
docking tiedown device that requires external power to secure and/or release the wheelchair

3.4
universal docking interface geometry
UDIG
specifications for the size, shape, and location of wheelchair securement points, including surrounding clear zones, intended for use with a variety of docking tiedown devices installed in a wide range of vehicles

3.5
UDIG adaptor
wheelchair tiedown adaptor that conforms to the UDIG specification given in Annex A of this part of ISO 10542

3.6
wheelchair tiedown adaptor
wheelchair securement adaptor
hardware attached temporarily or permanently to the wheelchair frame to accommodate wheelchair securement by a wheelchair tiedown device

4 Design requirements and recommendations

4.1 Docking tiedown devices

4.1.1 The design requirements of ISO 10542-1:2001, 4.1, 4.2 and 4.3, shall apply, with the addition that the docking tiedown device shall

a) provide a rear head restraint if the docking tiedown device includes a back restraint,

b) provide auditory and visual means for indicating to the wheelchair user and vehicle driver when the wheelchair has been successfully secured or released,

c) include an accessible manual override to release the wheelchair in the event of loss of power to any power-operated mechanisms,

d) remain in the locked position until manually released, in the event of loss of power to any power-operated mechanisms,

e) allow for accessible operation of any electrical or mechanical devices necessary for engaging or disengaging the docking components, and

f) prevent inadvertent release during normal or emergency vehicle operation.

4.1.2 If the docking tiedown device is intended to secure a wide range of wheelchairs in a wide range of public and private vehicles, it shall be designed to engage effectively with wheelchair securement geometry specified in Annex A and according to the performance requirements given in Clause 6.

4.1.3 The engagement mechanism of the docking tiedown device should operate effectively when the following misalignment occurs on the approach of a wheelchair to a docking tiedown:

a) the wheelchair is laterally displaced from the mid-line of the docking station up to a maximum of 75 mm in either direction;

b) the wheelchair reference plane is rotated from the longitudinal centreline of the vehicle up to a maximum of 10° in either direction;

c) the structural components on the wheelchair that comprise the wheelchair securement points are angled relative to the vertical up to a maximum of 10° in any direction;

d) the height of any structural components of the wheelchair securement points vary vertically up to a maximum of 50 mm.

NOTE This is to allow for variation in height due to low tyre pressure or increased load in the wheelchair.

4.2 Wheelchair securement adaptors

4.2.1 Wheelchair securement adaptors shall be designed so that they do not become loose inadvertently during normal use.

4.2.2 If a wheelchair securement adaptor is intended by the manufacturer to be used for securing a wide range of wheelchair types in a wide range of public and private vehicles, the structural components that comprise the wheelchair securement points shall be in accordance with Annex A and the performance requirements given in Clause 6.

5 Information, identification and instruction

5.1 Identification and labelling

5.1.1 In addition to the requirements of ISO 10542-1:2001, 5.1.1 a) and b), the docking tiedown device and any replacement parts shall be permanently and legibly labelled to state that the device conforms to this part of ISO 10542.

5.1.2 A permanent notice shall be provided with the WTORS, indicating the proper use and operation of the docking tiedown device and the manual override. The notice design (size of lettering, colour and luminance contrast of the background) should take account of people with reduced vision.

5.2 Instructions for WTORS installers

The requirements of ISO 10542-1:2001, 5.2 apply, with the exception of 5.2.2 c). In addition, the manufacturer's instructions to the installer of a WTORS with docking-type tiedown device shall include statements specifying

a) that the WTORS conforms to this part of ISO 10542,

b) the procedure for manoeuvering a wheelchair to achieve effective engagement and disengagement with the docking tiedown device,

c) recommended locations for electrical switches or other devices intended for use by the wheelchair occupant or vehicle driver,

d) where to position the docking tiedown device in the vehicle relative to occupant-restraint anchor points for the most effective use of vehicle-anchored occupant-restraint systems,

e) the requirements for electrical wiring and, when appropriate, instructions for connecting to the power supply of the vehicle,

f) where the fuses or circuit breakers should be mounted to provide for easy access,

g) any required modifications to the vehicle,

h) a warning to consult the vehicle manufacturer before relocating original vehicle equipment,

i) a warning against damaging structural parts of the vehicle during installation of the docking tiedown device,

j) that the permanent notice provided with the WTORS indicating the proper use and operation of the docking tiedown device and the manual override should be posted in a visible location close to the installed device,

k) a description of the geometry and location of the wheelchair tiedown adaptor(s) or wheelchair securement point(s) needed to achieve effective engagement with the docking tiedown device, and

l) general information on any wheelchair securement adaptors that must be provided for the wheelchair in order to achieve effective engagement with the docking tiedown device.

5.3 Instructions for users

The requirements of ISO 10542-1:2001, 5.3, apply, with the exception of 5.3.2 a). In addition, the user instructions for a WTORS with docking tiedown device shall include statements specifying

a) that the WTORS conforms to this part of ISO 10542,

b) the schedule for any maintenance requirements, including routine lubrication and adjustments,

c) how to release the wheelchair from the docking device in the event of a power failure,

d) the procedure for manoeuvring a wheelchair to achieve effective engagement and disengagement with the docking tiedown device,

e) a description of the geometry and location of the wheelchair tiedown adaptor(s) or wheelchair securement point(s) needed to achieve effective engagement with the docking tiedown device, and

f) general information on any wheelchair securement adaptors that must be provided for the wheelchair in order to achieve effective engagement with the docking tiedown device.

6 Performance requirements and recommendations

6.1 The performance requirements of ISO 10542-1:2001, 6.1, 6.2 and 6.4, apply.

6.2 Docking devices should minimize wheelchair movement during normal vehicle operation.

NOTE Annex B presents an optional test for evaluating the potential for linear and rotational wheelchair movement.

7 Test report

The requirements of ISO 10542-1:2001, Clause 7, apply, with the exception of 7.4. In addition, the test report shall include the following:

a) a description of the modifications to the surrogate wheelchair used in the test;

b) a statement indicating whether the docking tiedown device conforms to the design requirements of 4.1;

c) if applicable, a statement that the wheelchair securement adaptor(s) conform to the requirements of 4.2;

d) a statement indicating that the appropriate requirements of Clause 5 have been met.

Annex A
(normative)

UDIG specifications

A.1 General

This annex specifies the universal docking interface geometry (UDIG) for wheelchair structural components and/or wheelchair securement adaptors intended to permit engagement between vehicle-installed docking tiedown devices and wheelchairs compliant with these specifications. These specifications also include the three-dimensional clear zones surrounding the UDIG within which a UDIG-compatible docking tiedown device can effectively function. The purpose of the UDIG is to allow wheelchair users to independently secure and release their wheelchairs in public and private motor vehicles by ensuring engagement compatibility between wheelchair securement points, including wheelchair securement adaptors, and docking tiedown devices installed in the vehicle. Adoption of this UDIG specification by wheelchair and WTORS manufacturers will facilitate the safe and independent travel of wheelchair users and the efficiency of transporting wheelchair users by transport service providers.

A.2 Principle

The criteria used to formulate the UDIG specifications are that it should

a) not impede the proper use and positioning of occupant-restraints,

b) not preclude the use of other types of tiedown devices, such as four-point strap systems or clamping systems,

c) permit the retrofitting of UDIG adaptors to existing wheelchairs,

d) require minimal structural design modifications to most common wheelchairs,

e) enable effective wheelchair securement in a wide range of private and public motor vehicles,

f) facilitate the design of UDIG adaptors, wheelchair securement points and docking tiedown devices that will withstand the wheelchair securement loads consistent with the frontal-impact test specified in ISO10542-1:2001, Annex A,

g) minimize any increase in the mass of the wheelchair,

h) minimize any loss of aesthetics or function of the wheelchair, and

i) not interfere with other wheelchair features or functions.

A.2.1 Specifications

A wheelchair securement adaptor that conforms to this UDIG specification shall

a) have geometry in accordance with Figure A.1,

b) be spatially located relative to the wheelchair and ground plane as shown in Figure A.2,

c) have operational clear zones in which UDIG-compatible docking engagement mechanisms can function without obstruction (see item 6 in Figures A.3 and A.4),

d) have a horizontal segment when mounted on wheelchairs with a mass > 30 kg (see item 3 in Figure A.1),

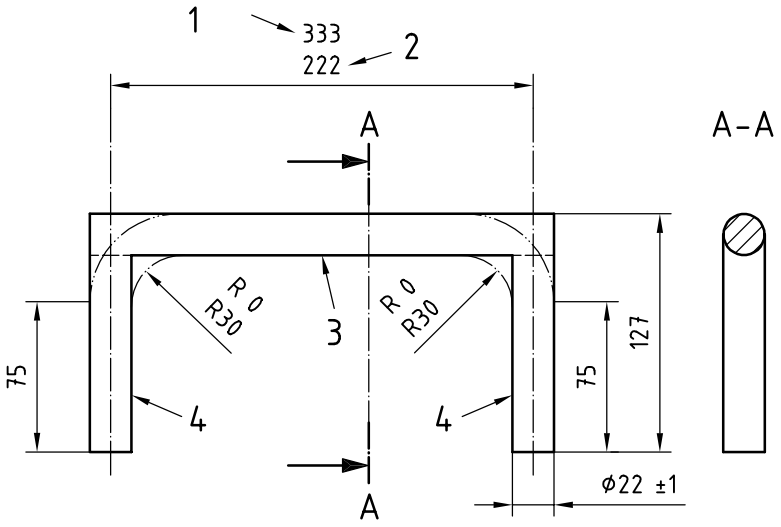
e) attach to the wheelchair structure using the attachment zones shown in Figures A.3 and A.4.

NOTE 1 The intent of the specifications is to provide at least 25 mm clearance between any part of the UDIG and any part of the wheelchair, except in those locations indicated by item 5 in Figures A.3 and A.4, for attachment of the UDIG securement points to the wheelchair.

NOTE 2 The horizontal component is not required on wheelchairs with a mass < 30 kg in order to permit lighter-weight manual wheelchairs with sideways-folding frames to be folded without having to remove the UDIG adaptor.

Zones specified for use for attachment of UDIG securement points as indicated by item 5 in Figures A.3 and A.4 should not be designed for engagement with the docking tiedown device, as obstruction may occur.

Dimensions in millimetres
tolerance ± 3 mm unless otherwise indicated

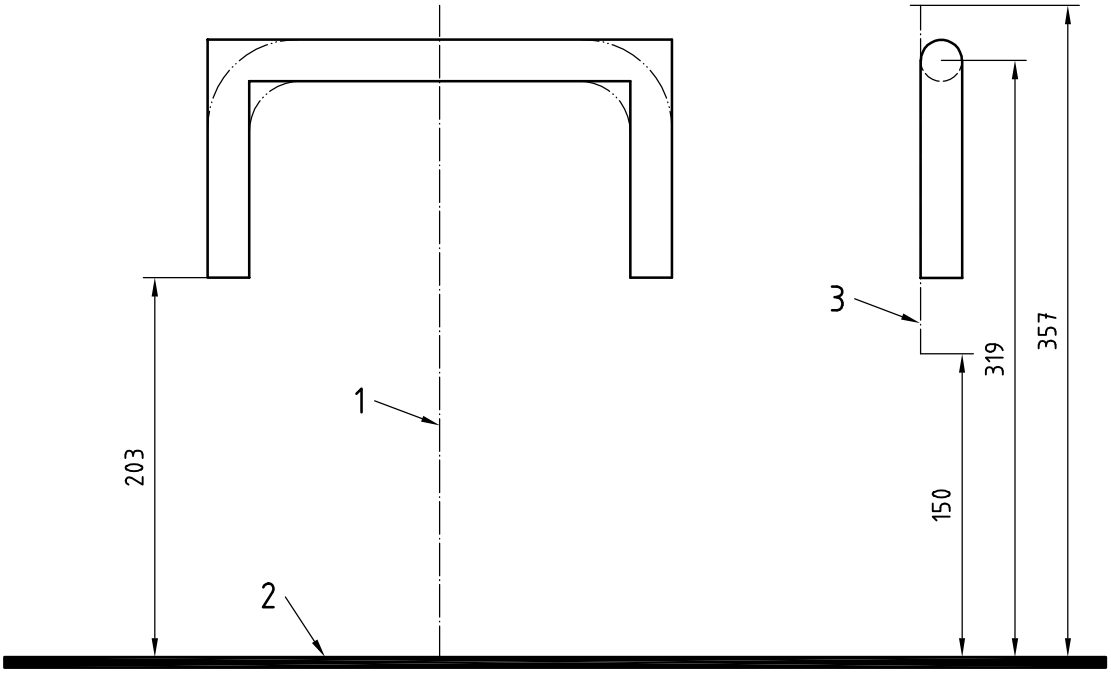


Key

1 maximum UDIG width
2 minimum UDIG width
3 horizontal segment
4 vertical segment

Figure A.1 — Specification UDIG

Dimensions in millimetres
tolerance ± 3 mm unless otherwise indicated



Key

1 wheelchair reference plane (centre line)

2 wheelchair ground plane

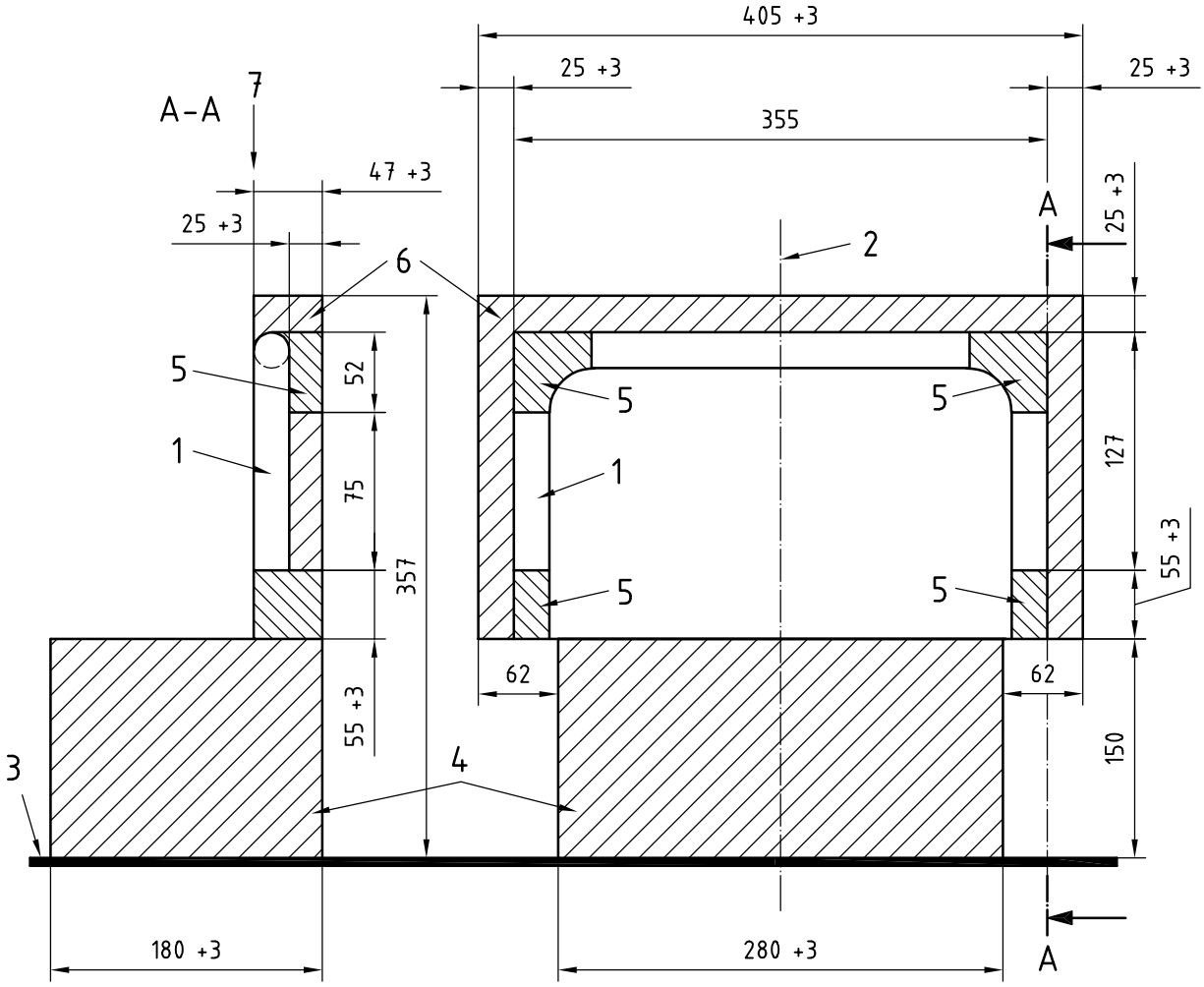
3 transverse plane at rearmost structure of wheelchair, including wheels and tyres

[a] The UDIG is located symmetrically about this plane.

[b] Defined by a vertical line in the side view that passes through the most rearward point on the most rearward structural component of the wheelchair in a zone from 150 mm to 357 mm above the ground plane.

Figure A.2 — Specification for vertical and horizontal location of UDIG adapter

Dimensions in millimetres
tolerance ± 3 mm unless otherwise indicated

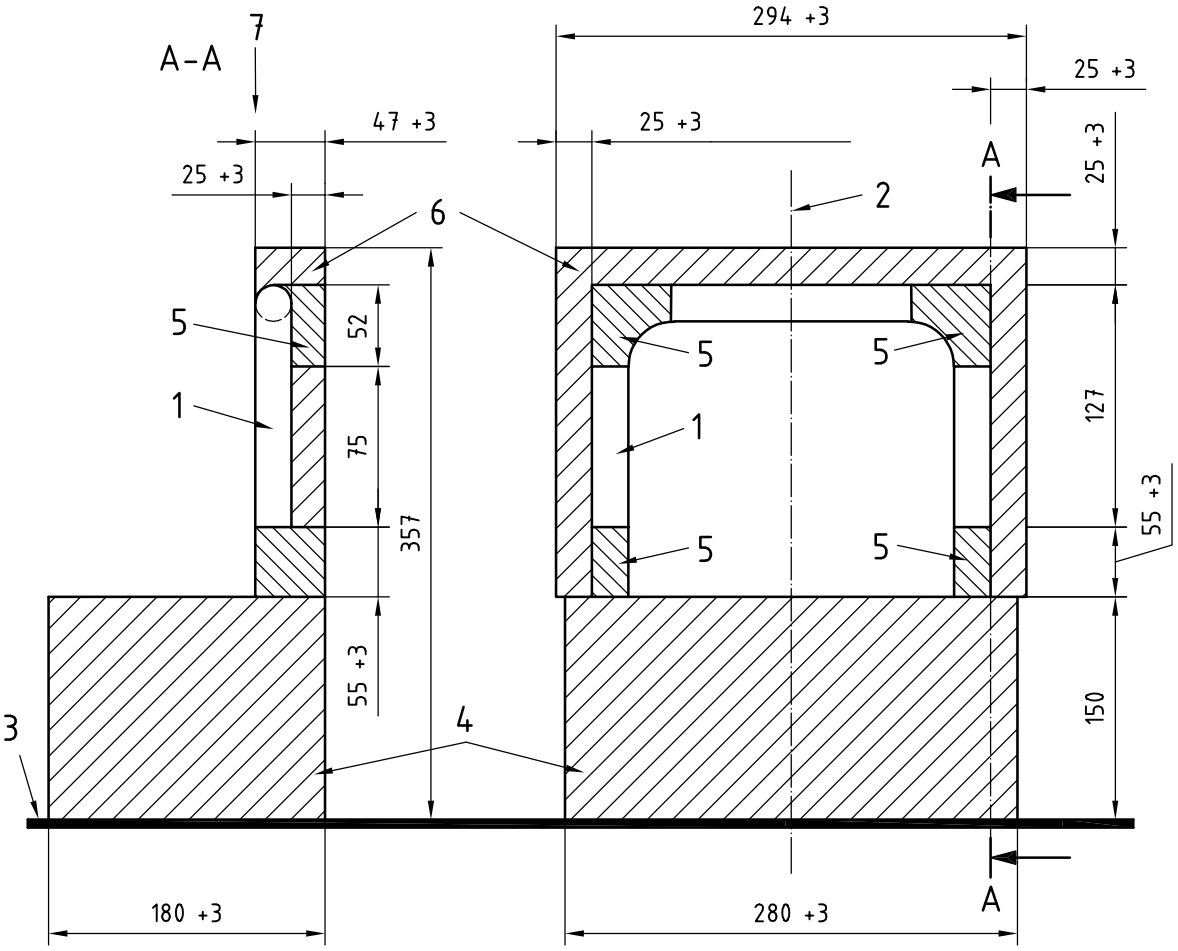


Key

1 UDIG
2 wheelchair reference plane
3 wheelchair ground plane
4 docking station clear zone (typically falls between anti-tip devices of wheelchairs)
5 attachment zones (in which hardware for attaching UDIG adaptor to wheelchair may be located)
6 clear space around UDIG (in which docking engagement mechanism may function without obstruction)
7 location of rear-most wheelchair structure (150 mm to 357 mm above ground plane)

Figure A.3 — Specification of UDIG clear zones (shown in maximum width configuration)

Dimensions in millimetres
tolerance ± 3 mm unless otherwise indicated



Key

1 UDIG
2 wheelchair reference plane
3 wheelchair ground plane
4 docking station clear zone (typically falls between anti-tip devices of wheelchairs)
5 attachment zones (in which hardware for attaching UDIG adaptor to wheelchair may be located)
6 clear space around UDIG (in which docking engagement mechanism may function without obstruction)
7 location of rear-most wheelchair structure (150 mm to 357 mm above ground plane)

Figure A.4 — Specification of the UDIG clear zones (shown in minimum width configuration)

Annex B
(informative)

Test for wheelchair movement

B.1 Principle

To safeguard other passengers and provide the wheelchair-seated occupant with a comfortable ride, a docking tiedown device should limit the movement of a wheelchair relative to the vehicle interior during normal or emergency driving manoeuvres. This annex specifies equipment, test conditions and test procedures for measuring the potential for lateral, forward and rotational movement of wheelchairs allowed by a docking tiedown device. This is done by simulating the magnitudes of forces that can act on an occupied wheelchair during emergency driving manoeuvres using a tilt table. To assess the performance of the docking securement device independent of variations in wheelchair structures and locations of wheelchair and occupant centres of gravity, the tests are conducted using the rigid surrogate wheelchair (SWC) according to ISO 10542-1:2001, Annex E.

B.2 Device to be tested

A complete, unused, commercial or prototype, docking tiedown device, fitted for the test with a wheelchair securement adaptor suitable for use with the SWC.

B.3 Test apparatus

B.3.1 Flat platform that

a) does not visibly deflect during testing (i.e. tilting) under the load of the secured SWC occupied by an ATD, in accordance with ISO 10542-1:2001, Annex A,

b) has a surface area large enough to accommodate the docking tiedown device and the SWC when configured for the frontal impact test in accordance with ISO 10542-1:2001, Annex A, and as shown in Figures B.1 and B.3,

c) can be tilted to an angle of $\left(25^{+1}_{0}\right)°$ to the horizontal at a rate of at least 20°/min to 30°/min,

d) has a surface with a coefficient of friction equivalent to that used in most transport vehicles, but not greater than 0,3, as determined in accordance with ISO 7176-13.

B.3.2 SWC designed in accordance with ISO 10542-1:2001, Annex E, and modified so that

a) the fixed front wheels are replaced with two 100 mm to 125 mm diameter caster wheels, and

b) caster stems are located within 25 mm of the vertical line passing through the fixed front wheel axle and the floor contact point.

B.3.3 ATD used in the frontal impact test according to ISO10542-1:2001, Annex A.

B.3.4 Means of restraining the ATD to the SWC back and seat, such as rope, webbing, or belt material.

B.3.5 Means of measuring the linear and rotational movements of the SWC to an accuracy of ± 3 mm and ± 3°, respectively.

B.4 Test procedures

Perform the following steps in the order given.

a) Designate fore and aft reference points on the SWC for measuring the linear and rotational movement as follows:

   1) the rear reference point (RRP), located on the most rearward structure of the SWC that intersects with the SWC reference plane, at the height of the P point, as shown in Figures B.1, B.3 and B.4;

   2) the forward reference point (FRP), located on a forward structure of the SWC that intersects with the SWC reference plane, most likely between the footrests, as shown in Figures B.1 and B.3.

b) Check all tyres on the SWC to ensure inflation in accordance with ISO10542-1:2001, Annex E.

c) Mount the docking tiedown device on the tilt platform in accordance with the manufacturer's instructions.

d) Locate the SWC on the tilt table and secure to the docking tiedown device so that the SWC reference plane is parallel to the tilt axis and the tilt platform centre line (see Figure B.1).

e) Position the ATD in the SWC sitting upright and symmetrical about the SWC reference plane, with the pelvis as close to the backrest of the wheelchair as possible, and the forearms and hands resting on the thighs.

f) Restrain the ATD pelvis and torso snugly to the SWC seat using rope, webbing or belt material.

g) Tilt the test platform at a uniform rate to an angle of 25° ± 3°, as shown in Figures B.2 and B.4.

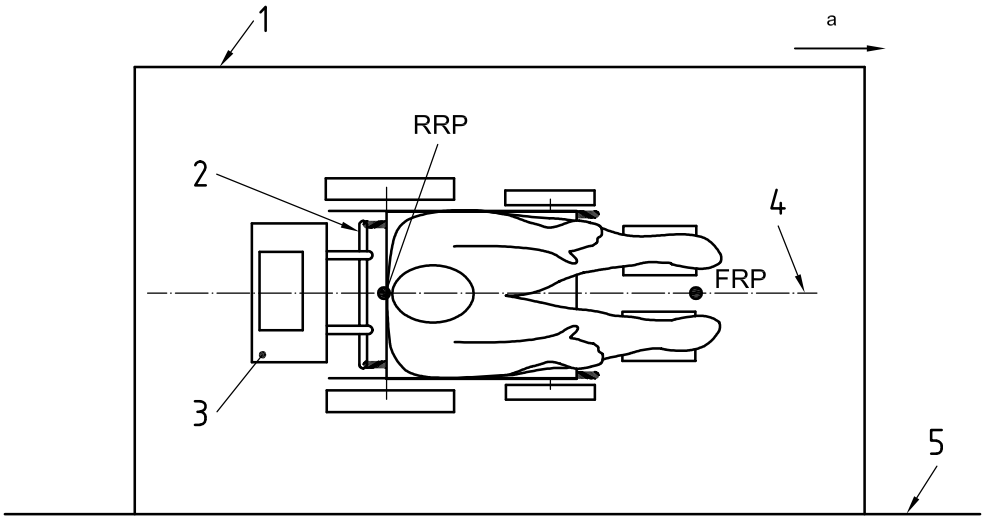
h) While the platform remains tilted to 25° ± 3°, measure the perpendicular displacement of RRP relative to the tilt platform to an accuracy of ± 3 mm, as shown in Figure B.2. Measure the angular displacement of a line joining the FRP and the RRP relative to the centre line of the tilt platform (Figure B.2). Measure the distance by which any wheels have been raised off the surface of the tilt platform.

   NOTE Using laser screen pointers mounted at RFP and FRP and projecting down to the tilt platform surface, parallel to the SWC reference plane, is one simple method of obtaining points on the tilt platform that can be used for measurement of both linear and angular displacements.

i) Perform the tilt test and measurement procedure for a total of three times, repositioning the SWC and ATD to their initial position between trials, as necessary.

j) Compute and record the average of each measurement for the three trials.

k) Reinstall the docking securement device on the tilt platform so that the SWC reference plane is perpendicular to the tilt axis and centre line of the tilt platform, and the front of the SWC is facing downward during the test. Repeat steps h) and i) while measuring and recording only the forward displacement of the RRP relative to the tilt platform.

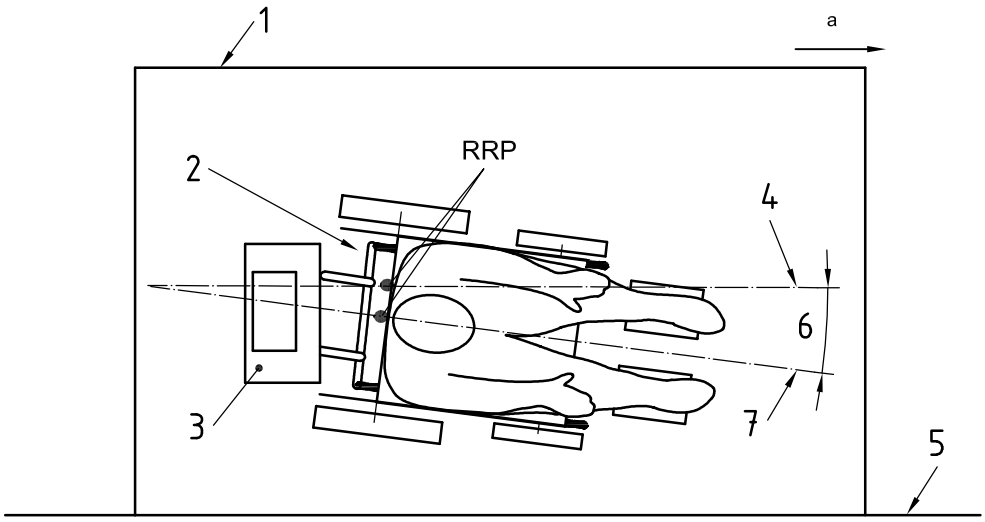


Key

1 tilt test platform
2 wheelchair securement adaptor
3 docking tiedown device
4 wheelchair reference plane and mid-line of test platform
5 test platform tilt axis

[a] Forward.

Figure B.1 — SWC loaded with ATD and secured by docking securement device on tilt platform prior to lateral tilt test — Top view

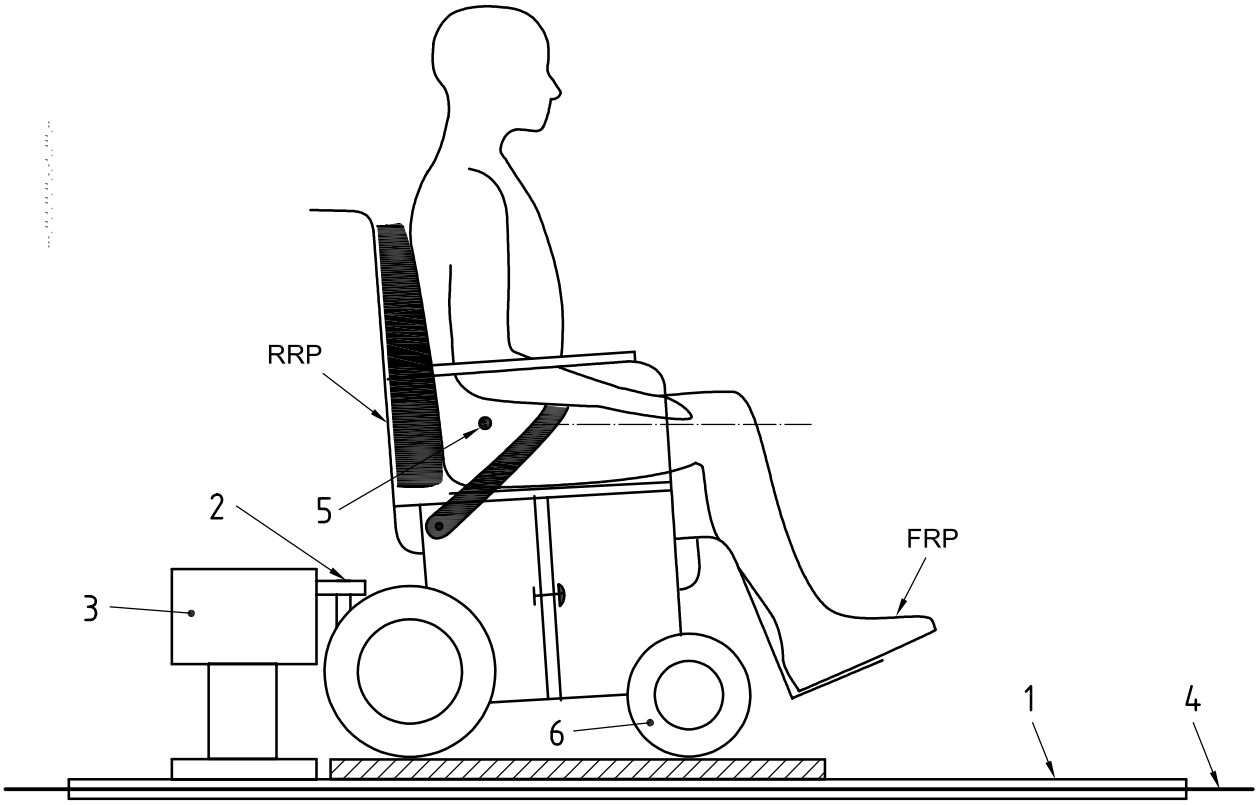


Key

1 tilt test platform
2 wheelchair securement adaptor
3 docking tiedown device
4 mid-line of test platform
5 test platform tilt axis
6 wheelchair rotation angle
7 wheelchair reference plane

[a] Forward.

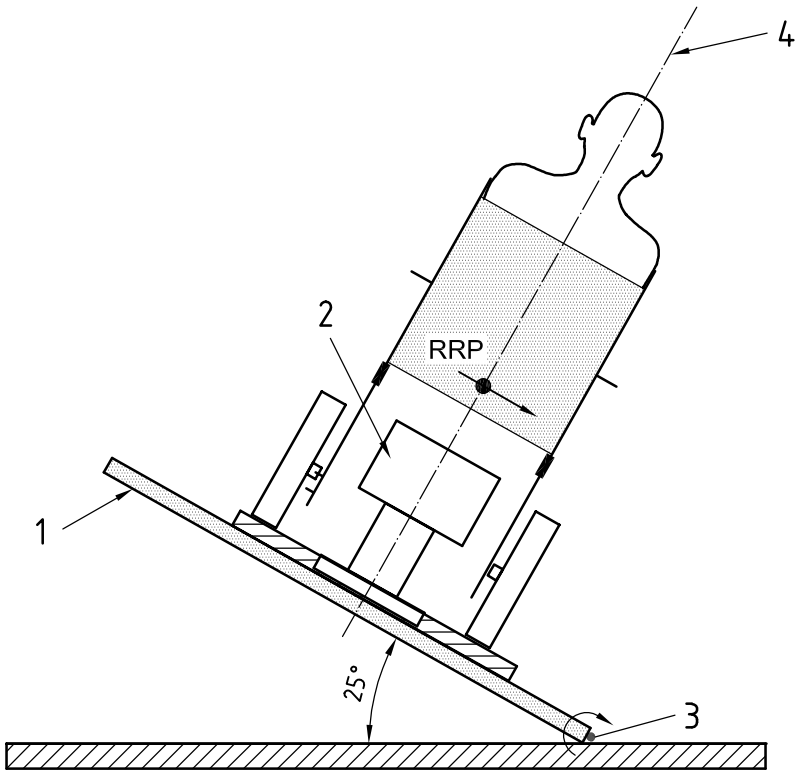
Figure B.2 — SWC loaded with ATD and secured by docking tiedown device on tilt platform during lateral tilt test — Top view



Key

1 tilt test platform
2 wheelchair securement adaptor
3 docking tiedown device
4 test platform tilt axis
5 P point
6 right front caster wheel

Figure B.3 — SWC loaded with ATD and secured by docking tiedown device on tilt platform prior to a lateral tilt test — Side-view



Key

1 tilt test platform
2 docking tiedown device
3 test platform tilt axis
4 wheelchair reference plane

Figure B.4 — SWC and ATD secured on test platform and laterally tilted to 25° — Rear view

Bibliography

[1] ISO 7176-13, *Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces*

ICS 11.180.10

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