INTERNATIONAL STANDARD

ISO 7176-24

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Wheelchairs —

Part 24: Requirements and test methods for user-operated stair-climbing devices

Fauteuils roulants —

Partie 24: Exigences et méthodes d'essai pour les monte-escalier manipulés par l'utilisateur

Reference number
ISO 7176-24:2004(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 7176-24 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

ISO 7176 consists of the following parts, under the general title *Wheelchairs*:

— *Part 1 Determination of static stability*

— *Part 2 Determination of dynamic stability of electric wheelchairs*

— *Part 3 Determination of effectiveness of brakes*

— *Part 4 Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*

— *Part 5 Determination of overall dimensions, mass and turning space*

— *Part 6 Determination of maximum speed, acceleration and deceleration of electric wheelchairs*

— *Part 7 Measurement of seating and wheel dimensions*

— *Part 8 Requirements and test methods for static, impact and fatigue strengths*

— *Part 9 Climatic tests for electric wheelchairs*

— *Part 10 Determination of obstacle-climbing ability of electric wheelchairs*

— *Part 11 Test dummies*

— *Part 13 Determination of coefficient of friction of test surfaces*

— *Part 14 Power and control systems for electric wheelchairs — Requirements and test methods*

— *Part 15 Requirements for information disclosure, documentation and labelling*

— *Part 16 Resistance to ignition of upholstered parts — Requirements and test methods*

— *Part 19 Wheeled mobility devices for use in motor vehicles*

— *Part 21 Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and motorized scooters*

— *Part 22 Set-up procedures*

— *Part 23 Requirements and test methods for attendant-operated stair-climbing devices*

— *Part 24: Requirements and test methods for user-operated stair-climbing devices*

— *Part 26: Vocabulary*

Introduction

This part of ISO 7176 is written as a response to the need for a common language in the field of stair-climbing devices, to give a means of evaluating important safety issues, and to establish a means of qualifying and quantifying the performance of user-operated stair-climbing devices under the various conditions and environments encountered in their operation. Other relevant wheelchair standards of the ISO 7176 series might be applicable to stair-climbing devices that can also be used as wheelchairs. This allows users and manufacturers to compare the pertinent safety and utility issues of all functions and features of a given stair-climbing device.

The tests given in this part of ISO 7176 are used to gather comparative information about factors relating to the safety and performance of a user-operated stair-climbing device whilst in climbing mode on stairs and in climbing mode or crawling mode on landings as well as in driving mode on level ground. They include identification of suitable operating environments for each device and indications of various performance criteria in climbing mode for on-stairs operations and on level ground.

This part of ISO 7176 specifies tests for the “reference configuration” of the stair-climbing device. Since some stair-climbing devices have adjustable components and/or alternative parts, testing in different configurations may be needed to determine if a given variation conforms to this part of ISO 7176.

This part of ISO 7176 calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the manufacturer or test house from legal obligations relating to health and safety at any stage.

A Technical Report, ISO/TR 13570:2001, *Guidelines for the application of the ISO 7176 series on wheelchairs*, is also available giving a simplified explanation of these parts of ISO 7176.

Wheelchairs —

Part 24: Requirements and test methods for user-operated stair-climbing devices

1 Scope

This part of ISO 7176 is applicable to user-operated stair-climbing chairs and user-operated stair-climbing wheelchair carriers where the stair-climbing device climbs backwards up the stairs, with the user facing downstairs, and climbs down the stairs in a forward position with the user facing downstairs.

This part of ISO 7176 specifies requirements and test methods for electrically powered stair-climbing devices that are user-operated. It also includes ergonomic, labelling and disclosure requirements.

This part of ISO 7176 specifies tests to demonstrate the stair-climbing device's ability to perform safely on stairs with a pitch of 35° or higher, if claimed by the manufacturer.

NOTE Attendant-driven stair-climbing devices are dealt with in ISO 7176-23.

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 3880-1, *Building Construction — Stairs — Vocabulary*

ISO 7176-1, *Wheelchairs — Part 1: Determination of static stability*

ISO 7176-2:2001, *Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs*

ISO 7176-3, *Wheelchairs — Part 3: Determination of effectiveness of brakes*

ISO 7176-4, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*

ISO 7176-5, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space*

ISO 7176-6:2001, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs*

ISO 7176-7:1998, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*

ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*

ISO 7176-9, *Wheelchairs — Part 9: Climatic tests for electric wheelchairs*

ISO 7176-11, *Wheelchairs — Part 11: Test dummies*

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

ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods*

ISO 7176-15, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

ISO 7176-16:1997, *Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods*

ISO 7176-21:2003, *Wheelchairs — Part 21: Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and motorized scooters*

ISO 7176-22, *Wheelchairs — Part 22: Set-up procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3880-1, ISO 7176-7, ISO 7176-15 and the following apply.

3.1
stair-climbing device
non-fixed device intended to transport a person and/or occupied wheelchair by climbing up or down stairs

NOTE A hierarchic system of various types of stair-climbing devices is given in Annex A.

3.2
user-operated stair-climbing device
stair-climbing device operated by the user while seated in it

3.3
self-standing (adjective)
stable while at rest on a surface (test plane, stairs or landing) when subjected only to the force of gravity

3.4
balancing (adjective)
maintaining a position of unstable equilibrium through the application of other forces in addition to the force of gravity

3.5
stair-climbing chair
stair-climbing device that includes a seat for the user

3.6
stair-climbing wheelchair carrier
stair-climbing device that carries an occupied wheelchair

3.7
docking system
means of attaching a wheelchair to a stair-climbing wheelchair carrier

3.8
climbing
ascending or descending stairs

3.9
driving
performing wheelchair functions with electric power

NOTE 1 Typical wheelchair functions provide wheeled mobility over level ground, moderate slopes and small obstacles.

NOTE 2 Some stair-climbing chairs and some stair-climbing wheelchair carriers include such wheelchair functions.

3.10
crawling
moving on landings

NOTE Any means by which a stair-climbing device provides for moving on landings is considered crawling, including: manual propulsion, power-assisted manual propulsion and driving. Using the climbing mechanism to move on a landing is also considered crawling.

3.11
winding stairs
stairs built in a curved construction

3.12
user
person being transported in and operating the stair-climbing device

3.13
U-shaped stairs
two stairs at an angle of 180° to each other and connected by an intermediate landing

3.14
skew angle
angle of deviation between the pitch line of the stairs and the longitudinal axis of the stair-climbing device when viewed from above

3.15
minimum reserve battery charge
minimum battery charge sufficient for ascending a minimum of 20 steps and descending a minimum of 20 steps when loaded with the maximum load

3.16
external force
force that acts on the system consisting of a stair-climbing device, a test wheelchair (if used) and the user

EXAMPLE To apply forces by holding onto handrails.

3.17
climbing mode exit restriction
means that prevent the movement of a stair-climbing device by an operational mode other than climbing mode whilst on stairs

3.18
safe stairs indicator
means used to assess whether stairs are safe to climb

3.19
cluster
type of climbing mechanism where some cams revolve around the central axis of the cluster

NOTE The usual number of cams in a cluster ranges from 2 to 5. Some examples of types of clusters are shown in Figure 1.

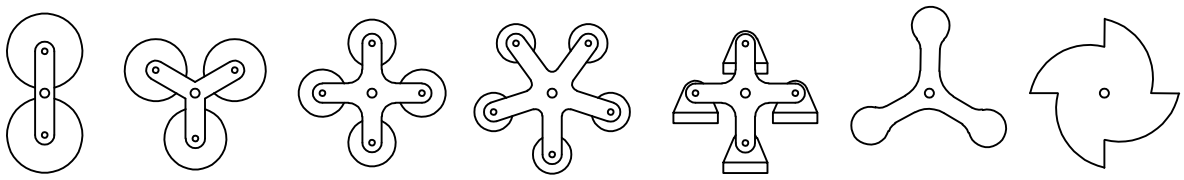


Figure 1 —Examples of clusters

3.20
cam
that part of the cluster which is intended to come into contact with the stairs or the ground

NOTE If the cam is a wheel, it could be freely rotating or have unidirectional freewheel function or be temporarily braked or even driven. If the cam is an eccentric or notch, it usually has a nearly circular or spiral shape of varying diameter. Some cams may consist of hinged posts or “shoes”.

3.21
adverse situation
any situation that is likely to cause harm to the user, attendant or nearby person

NOTE Ths includes tipping, sliding, tumbling, squeezing, trapping or any other situation that is reasonably considered to be dangerous.

3.22
front vertical plane
vertical plane that is perpendicular to the horizontal component of forward direction of travel and tangential to the most forward point of the climbing mechanism when the stair-climbing device is in its climbing mode and positioned on stairs with a pitch of 30° ± 5°

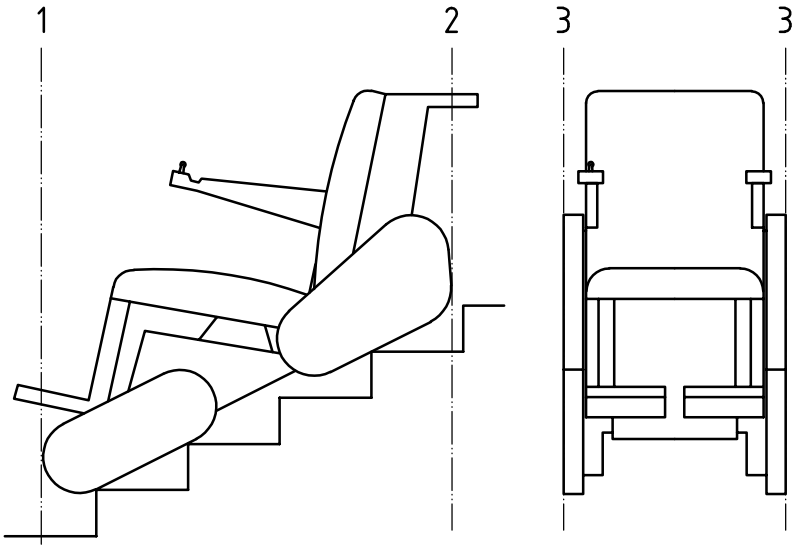
See Figure 2.

3.23
rear vertical plane
vertical plane that is perpendicular to the horizontal component of forward direction of travel and tangential to the most backward point of the climbing mechanism when the stair-climbing device is in climbing mode and positioned on stairs with a pitch of 30° ± 5°

See Figure 2.

3.24
side vertical plane
vertical plane that is parallel to the horizontal component of forward direction of travel and tangential to the outermost point of the stair-climbing device when in climbing mode with its seat reclined and positioned on stairs with a pitch of 30° ± 5°

See Figure 2.



Key

1 front vertical plane
2 rear vertical plane
3 side vertical plane

Figure 2 — Reference planes

3.25
speed
mean velocity of a stair-climbing device as it moves along the pitch of the stairs whilst climbing

3.26
exaggerated test set-up
configuration of the stair-climbing device under test when the stair-climbing device is in its least stable configuration with respect to the test direction for each test that simulates foreseeable adverse behaviour of the user

NOTE Foreseeable adverse behaviour of the user is considered to be either: leaning forward in a situation where the stair-climbing device is at its least stable position and most sensitive to forward or downward stability or placing a backpack at the backrest of the stair-climbing device in a situation where it is at its least stable position and most sensitive to backward or upward stability.

3.27
tread
horizontal part or upper surface of a step

3.28
going
horizontal distance between the nosings of two consecutive steps, measured perpendicular to the lower nosing

3.29
rise
vertical distance between two consecutive steps

3.30
upper transition
transition between the stairs and the upper landing

3.31
lower transition
transition between the stairs and the lower landing

3.32
least stable configuration
set-up of the stair-climbing device that gives least stability in the test direction

3.33
least stable position
placement of the stair-climbing device on the stairs that gives least stability in the test direction

3.34
reversing width (type 1)
minimum distance between two vertical and parallel walls between which an occupied stair-climbing device with full differential steering can turn 180° with one single and smooth turning manoeuvre when in driving mode

3.35
reversing width (type 2)
minimum distance between two vertical and parallel walls between which an occupied stair-climbing device with direct steering or limited differential steering can turn 180° with one initial forward drive, one single backward drive and one final forward drive when in driving mode

3.36
minimum outer stair radius
smallest possible distance from the central axis of the winding test stairs to that point of the outer excursion of the stair-climbing device, which is most remote from the centre of the stairs while climbing winding stairs

3.37
minimum inner stair radius
smallest possible distance from the central axis of the winding test stairs to that point of the inner excursion of the stair-climbing device, which is nearest to the centre of the stairs while climbing winding stairs

4 Performance requirements

4.1 Skew angle

Stair-climbing devices cannot always approach or be positioned on stairs with perfect axial alignment and therefore all stair-climbing devices shall be able to accommodate skew angle operations.

When tested in accordance with Clause 8, all stair-climbing devices shall achieve a score of 2 or more (see Table 1), either by the stair-climbing device correcting the skew angle automatically or by continuing to climb safely at skew angle.

4.2 Braking effectiveness

When tested in accordance with Clause 9, no brake failure, notable loss of traction or instability, nor the occurrence of any other adverse situation shall occur.

4.3 Static stability

When tested in accordance with 10.2.2.2 (climbing mode) and 10.2.2.3 (crawling mode), the minimum performance value shall be 7° in forwards, backwards and sideways directions. If the manufacturer claims that the stair-climbing device is capable of negotiating sloped landings, the minimum performance value shall be 7° above the claimed angle in forwards, backwards and sideways directions.

NOTE 1 The angle of 7° is the safety margin.

NOTE 2 The static stability of stair-climbing devices, when in driving mode, may be determined in accordance with 10.2.2.4, although there is no performance requirement.

When tested in accordance with 10.2.3, the stair-climbing device shall remain in a stable position on the straight test stairs without the occurrence of any adverse situation. If the stair-climbing device rolls into another stable position during testing, this shall be deemed to be acceptable.

4.4 Dynamic stability

When tested in accordance with 11.2.2, a score of 2 or more as given in Table A.1 of ISO 7176-2:2001 shall be achieved.

When tested in accordance with 11.2.3, a score of 2 or more as given in Table 1 (see 8.3) shall be achieved.

4.5 Step transition safety

When tested in accordance with Clause 12, the stair-climbing device shall remain stable and shall not induce potential harm to the user or damage to the stairs or to the stair-climbing device.

4.6 Static, impact and fatigue strength

After testing in accordance with Clause 13, the stair-climbing device and the connection(s) between the stair-climbing device and the test wheelchair (where applicable) shall meet all the following requirements.

a) The stair-climbing device shall be capable of operating as described by the manufacturer.

b) No component shall be fractured or have visible cracks.

NOTE Cracks in surface finishes, such as paint, which do not extend into the structural material do not constitute a failure.

c) No nut, bolt, screw, locking pin, adjustable component or similar item shall have become detached after having been tightened, adjusted or replaced once, with the exception that the footrests may be adjusted after each of the two footrest impact tests carried out in accordance with ISO 7176-8.

d) No electrical connector shall be displaced or disconnected.

e) All parts intended to be removable, foldable or adjustable shall operate as described by the manufacturer.

f) All power-operated systems shall operate as described by the manufacturer and all attachable parts shall be attachable/detachable as intended by the manufacturer.

g) Handgrips shall not be displaced.

h) No multi-position or adjustable component shall be displaced from the pre-set position, except as permitted in c).

i) No component or assembly of parts shall exhibit gross deformation, free play or loss of adjustment that adversely affects the function of the stair-climbing device.

4.7 Climatic safety

After testing in accordance with Clause 14, the stair-climbing device shall continue to function properly.

4.8 Power and control systems

All stair-climbing devices shall conform to ISO 7176-14, with the following modifications and additions.

a) The stair-climbing device shall be prepared for testing as described in Clause 6, with the exception that the tests shall be carried out without a test wheelchair, test dummy or human test person having been loaded.

b) All tests shall be carried out at maximum recommended speed (see 6.5.2).

c) The stair-climbing device shall be tested:

— on the horizontal test plane in climbing mode, in driving mode (if applicable) and in crawling mode (if applicable);

— on the straight test stairs in climbing mode.

WARNING — The tests given in ISO 7176-14 can be hazardous. It is essential that precautions be taken to protect test personnel.

d) In addition to ISO 7176-14:1997, Clause 11, list items a), b), c), d), e) and h), the following shall be included in the test report:

— a statement as to which requirements were met by the stair-climbing device, the battery and its charger;

— a statement as to which requirements were not met by the stair-climbing device, the battery and its charger;

— any reasons for terminating the test;

— any observations of relevance to the tests.

4.9 Flammability

All stair-climbing devices shall conform to ISO 7176-16, with the following modifications and additions.

a) The stair-climbing device shall be prepared for testing as described in Clause 6, with the exception that the tests shall be carried out without a test wheelchair, test dummy or human test person having been loaded.

WARNING — The tests given in ISO 7176-16 can be hazardous. It is essential that precautions be taken to protect test personnel.

b) In addition to ISO 7176-16:1997, Clause 5, the following shall be included in the test report:

— a statement as to whether the stair-climbing device met the requirements of ISO 7176-16;

— any observations of relevance to the tests.

4.10 Electromagnetic compatibility

When tested in accordance with Clause 15, the stair-climbing device shall meet the requirements of ISO 7176-21.

4.11 Safety equipment

4.11.1 General

The stair-climbing device shall be fitted with the items of safety equipment specified in 4.11.2 to 4.11.6.

NOTE Recommendations for additional items of safety equipment (anterior thoracic supports, safe stairs indicators and headrests) are given in Annex B.

4.11.2 On/off switch

There shall be at least one means to:

— switch on the stair-climbing device;

— switch off the stair-climbing device.

NOTE These means may be combined into a single device.

When the on/off switch is turned off, the control device shall not cause any driven wheels or driven climbing mechanisms to move.

4.11.3 “Key off” power

When the stair-climbing device is turned off, internal circuits or leakage paths shall not drain the battery excessively.

With the on/off switch turned off, the stair-climbing device shall not draw from the battery set any current greater than the rated 20 h capacity of the smallest capacity battery specified for the stair-climbing device, corresponding to a four-month discharge period.

4.11.4 Emergency system

The stair-climbing device shall be equipped with an emergency system. The means to activate the emergency system shall be readily accessible to the user.

Activating the emergency system while the stair-climbing device is climbing shall bring the stair-climbing device to a complete stop at which it shall remain.

When the emergency system has been activated, turning-off power shall not override the emergency system.

The deactivation of the emergency system shall require a set of at least two sequential user actions specified by the manufacturer.

NOTE The on/off switch and the means to activate the emergency system need not be separate switches, although provisions should be included to prevent accidental activation of the emergency system. Emergency systems that can be deactivated by the user when the emergency situation is resolved would allow the stair-climbing device to be driven off the stairs.

4.11.5 Battery charge indicator

The stair-climbing device shall be equipped with a battery charge indicator capable of informing the user when the minimum reserve battery charge has been reached.

The stair-climbing device shall have the capacity to ascend a minimum of 20 steps plus descend a minimum of 20 steps after the battery charge indicator discloses that the minimum reserve battery charge has been reached.

4.11.6 Climbing mode exit restriction

For stair-climbing devices that have other operational modes in addition to climbing mode, it shall not be possible to exit or override the climbing mode or change to an operational mode other than climbing mode while on stairs unless it is declared by the manufacturer in writing that this is intended/permitted.

4.12 Ergonomic aspects

If the stair-climbing device is intended to be dismantled for ease of carrying:

— any component part that has a mass greater than 10 kg shall be provided with suitable handling devices (e.g. handles) or

— the user manual shall indicate the points where the component part can be lifted safely and/or give a method for handling during assembly.

5 Test apparatus

5.1 Straight test stairs, consisting of eight steps, each having a rise of 180 mm $\pm$ 5 mm. The overall pitch shall be 35° with a tolerance of $^{+1}_{0}$° (see Figure 3). The steps shall be numbered from the lowest step upwards. A riser shall close the front face of each step. All step nosings shall fall within a region contained between two imaginary parallel planes 10 mm apart and inclined at the overall pitch of the stairs.

The step nosings shall be of a rigid material, smooth and rounded to a radius of 8 mm $\pm$ 1 mm. Each step shall be level and shall have a coefficient of friction conforming to ISO 7176-13.

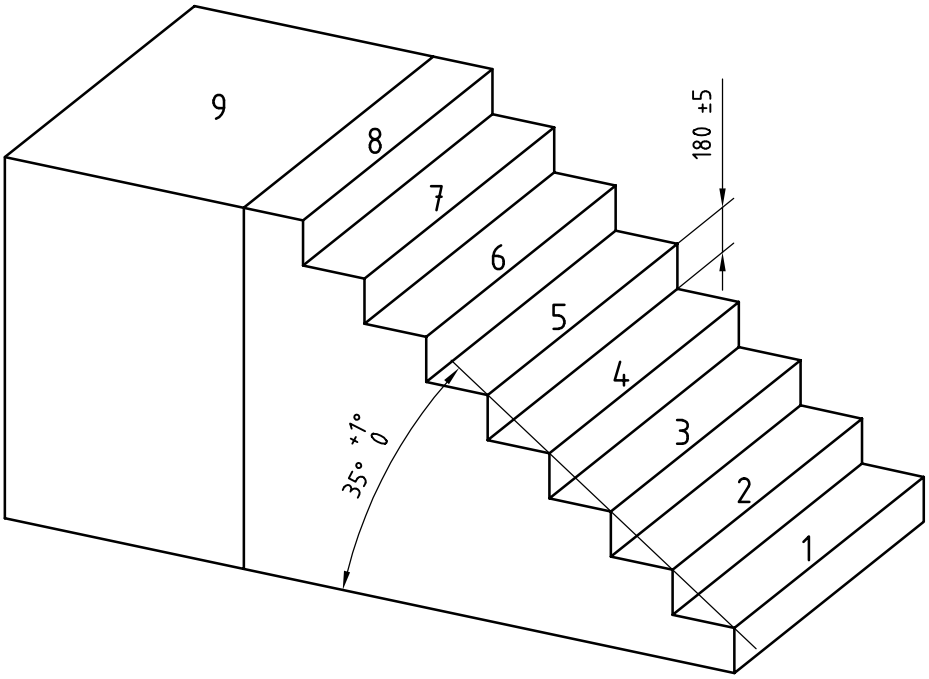
The straight test stairs shall be capable of being connected to the upper landing. When the straight test stairs are placed on the horizontal test plane, this plane represents its lower landing.

The entire straight test stairs shall be capable of being tilted in downwards and upwards directions by means of the lifting gear (5.10).

Provision for a handrail, to be mounted if required, shall be incorporated on both sides of the test stairs.

NOTE For ease of testing it is recommended to use straight test stairs that are at last 500 mm wider than the stair-climbing device.

Dimensions in millimetres



Key

1 to 8 step numbers

9 upper landing

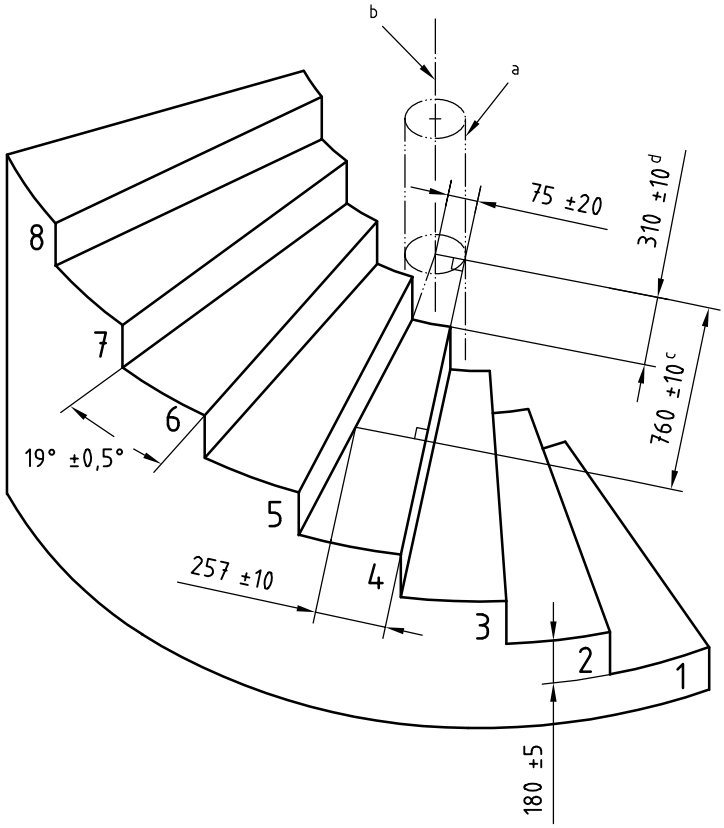
Figure 3 — Straight test stairs with upper landing

5.2 Winding test stairs, consisting of eight steps, each having a rise of 180 mm ± 5 mm. The winding angle shall be 19° ± 0,5° per step. The step nosings shall be tangential to a virtual cylinder about the central axis of the stairs, which has a radius of 75 mm ± 20 mm. The going of each step shall be 257 mm ± 10 mm when measured perpendicular to the step nosing at a point that is 760 mm ± 10 mm from the central axis of the stairs when measured parallel to the step nosing. The inner radius of the stairs shall be 310 mm ± 10 mm. The steps shall be numbered from the lowest step upwards. A riser shall close the front face of each step (see Figure 4).

The step nosing shall be of a rigid material, smooth and rounded to a radius of 8 mm ± 1 mm. Each step shall be level and shall have a coefficient of friction that conforms to ISO 7176-13. The width of the stairs shall be at least 500 mm wider than the stair-climbing device under test including the test wheelchair (if used) and the user.

The winding test stairs shall be capable of being connected to the upper landing. When the winding test stairs are placed on the horizontal test plane, this plane represents its lower landing. Provision for a handrail, to be mounted if required, shall be incorporated on both sides of the test stairs.

Dimensions in millimetres



Key

1 to 8 step numbers

a Virtual cylinder that is located about the central axis of the stairs and has a radius of 75 mm ± 20 mm.

b Central axis of the stairs.

c Distance between central axis of the stairs and that point on the step nosing where the going is measured.

d Inner radius of stairs.

Figure 4 — Winding test stairs

5.3 Upper landing, consisting of a platform with a height equal to the height of the top steps in 5.1 and 5.2, with a tolerance of ± 5 mm (see Figure 3). The top of the platform shall have a coefficient of friction that conforms to ISO 7176-13. The platform shall be capable of being firmly connected to the straight test stairs or winding test stairs.

NOTE 1 The minimum recommended area of the upper landing is 2 000 mm × 2 000 mm.

NOTE 2 Some or all of the test apparatus in 5.1, 5.2 and 5.3 may be built in one piece.

5.4 Horizontal test plane, rigid and of sufficient size to accommodate the stair-climbing device, the straight test stairs, the winding test stairs and the upper landing during testing. The plane shall be flat such that the whole surface is contained between two imaginary horizontal parallel planes 5 mm apart. The surface of the plane shall have a coefficient of friction conforming to ISO 7176-13.

NOTE The two imaginary horizontal parallel planes are intended to provide a measure of control of the flatness of the horizontal test plane.

5.5 Adjustable barriers, capable of detecting the maximum excursion and/or operating area of the stair-climbing device on each step of 5.1 and 5.2 and on top of 5.3 and 5.4. The detecting surface of the barriers shall be flat, vertical and perpendicular to the step nosing when it is placed on a step.

NOTE Adjustable barriers may be physical planes, lights or any other appropriate means for detecting the maximum excursion of the stair-climbing device.

5.6 Test wheelchair, of the type or model recommended for transport in the stair-climbing device by the manufacturer of the stair-climbing device. If the manufacturer recommends several wheelchairs, the heaviest wheelchair shall be used. If no wheelchair is recommended, the surrogate wheelchair conforming to Annex C shall be used.

5.7 Test dummy, conforming to ISO 7176-11.

5.8 Energy consumption instrumentation, conforming to ISO 7176-4.

5.9 Means for measuring time, (e.g. stopwatch) with an accuracy of 0,1 s.

5.10 Lifting gear, capable of lifting the straight test stairs so that they can be tilted downwards and upwards (see Figure 5) and capable of lifting the combined mass of straight test stairs plus loaded stair-climbing device.

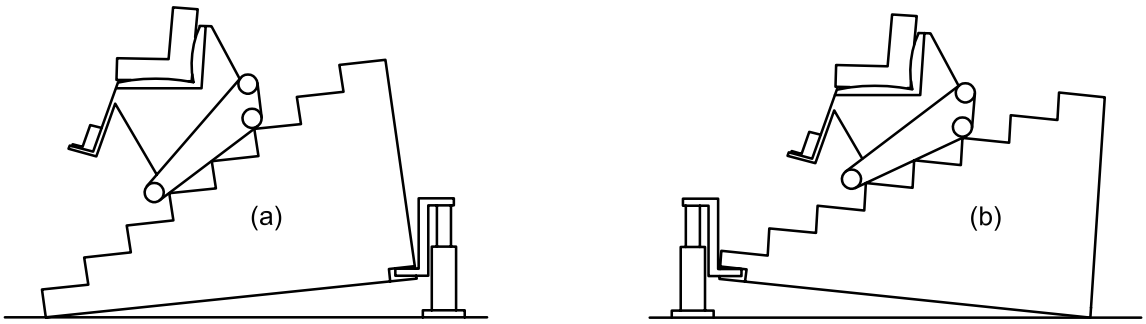


Figure 5 — Example of lifting gear with test stairs tilted downwards (a) or upwards (b)

5.11 Means for measuring linear dimension, (e.g. tape measure) capable of measuring up to 500 mm with an accuracy of ± 1 mm and 500 to 5 000 mm with an accuracy of ± 10 mm.

5.12 Handrail barrier, with a width of 400 mm ± 10 mm and a height of at least 1 000 mm to simulate the space for imaginary handrails and the two side distances to the wall at an intermediate landing of U-shaped stairs.

5.13 Acceleration rig, with a minimum pulling/pushing device length of 1 m, capable of pulling or pushing the stair-climbing device with constant force across the upper landing.

NOTE 1 An example of an acceleration rig is shown in Figure 6.

NOTE 2 The minimum length of the device is 1 m in order to reduce deviations from the straight line of action.

5.14 Tyre pressure gauge, capable of measuring tyre pressure up to 6 bar with an accuracy of ± 0,2 bar.

5.15 Dummy securement, conforming to ISO 7176-8:1998, 5.14.

5.16 Surrogate bag, (e.g. backpack) attached to the rear of the backrest to simulate the load of items typically carried by the user. The surrogate bag shall have a mass of 7 kg ± 0,25 kg, shall fit within a space measuring 35 cm × 20 cm × 42 cm and its centre of gravity shall be located at 30 cm ± 2 cm below the point of attachment.

5.17 Ammeter, with an accuracy of not less than 5 % of $I_{2\,900}$, given by the equation:

$$I_{2\,900} = \frac{C_{20}}{2\,900}$$

where

$I_{2\,900}$ is the numerical value of the current, expressed in amperes (A), drawn from the battery set corresponding to a four-month discharge period (2 900 h);

C_{20} is the rated 20 h capacity, expressed in ampere hours (Ah), of the smallest capacity battery specified for the stair-climbing device, by the manufacturer.

6 Preparation of the stair-climbing device

6.1 General

Before carrying out any of the test methods given in this part of ISO 7176, prepare the stair-climbing device as described in 6.2 to 6.9, unless otherwise stated in the individual test method.

6.2 Equipment and reference configuration

Equip and configure the stair-climbing device for climbing in accordance with the manufacturer's recommendations.

For adjustable parts where there are no manufacturer's recommendations, set any adjustable parts of the stair-climbing device, where applicable, in accordance with ISO 7176-22, replacing the term “wheelchair” by “stair-climbing device” and with the following changes and additions.

a) If the manufacturer of the stair-climbing device claims that it can be delivered with wheels of various diameters, select the wheel diameter recommended by the manufacturer. If there is no such recommendation select the medium diameter or, if there is no medium diameter, the next size greater than the medium diameter or, if there is no next size greater than the medium diameter, the size closest to the medium diameter.

b) Apply the adjustments for drive wheels as specified in ISO 7176-22 for any drive wheels, manoeuvring wheels and guide wheels.

c) If the seat height can be adjusted in a way other than as specified in ISO 7176-22, adjust the seat to a height recommended by the manufacturer. If there is no manufacturer's recommendation, adjust as close as possible to 530 mm for adults' stair-climbing devices and 420 mm for children's stair-climbing devices when on level ground.

d) Apply the adjustments for castors as specified in ISO 7176-22 for any castor wheels, pivot wheels and pivot drive wheels.

e) Where possible, adjust the castor stem angle to vertical with a tolerance of $^{+1^\circ}_{0}$. If this is not possible, adjust to the nearest position to vertical (in the positive direction, where possible).

f) Adjust any anti-tippers as recommended by the manufacturer. If there is no manufacturer's recommendation, adjust so that it is as close as possible to the following position:

   1) the most backward point of the anti-tippers is at the same backward position as the most backward point of the stair-climbing device when on a horizontal plane;

   2) the loaded stair-climbing device can be tipped for 10° ± 2° before the anti-tippers contact the ground;

   3) if it is not possible to achieve both settings at one time, give priority to the setting of the 10° tipping angle.

6.3 Battery charge

Charge batteries to at least 75 % of their rated nominal capacity.

6.4 Tyre inflation

If the stair-climbing device has pneumatic tyres, inflate them to the pressure recommended by the manufacturer of the stair-climbing device. If a pressure range is given, inflate the tyres to the highest pressure in the range. If there is no recommendation for inflation pressure from the stair-climbing device manufacturer, inflate the tyres to the maximum pressure recommended by the tyre manufacturer.

6.5 Speed setting

6.5.1 General

The speed setting is dependent on the type of test and shall be set as specified in 6.5.2 or 6.5.3.

6.5.2 Maximum recommended speed

If a test method is performed at maximum recommended speed (as determined in accordance with Annex D) set the stair-climbing device to the highest speed that is recommended by the manufacturer for normal use of the required operational mode.

6.5.3 Maximum test speed

If a test method is performed at maximum test speed:

— when speed is dependent on a motor, set the stair-climbing device to the highest possible speed of the required operational mode;

— when speed is governed by manual user input, let the stair-climbing device climb with a speed that is 20 % above the maximum recommended speed of the required operational mode [see 18.3 l) and 18.4 m)].

NOTE The 20 % speed rise is the upper limit of the maximum test speed but does not constitute an extra high test speed.

6.6 Loading of stair-climbing devices

6.6.1 Loading of stair-climbing chairs

If the stair-climbing chair has height-adjustable foot supports, adjust them to the maximum length for climbing as recommended by the manufacturer. If there are no manufacturer's recommendations, set the foot supports to the longest configuration but with a minimum clearance of 50 mm on level ground.

Load the stair-climbing chair with a test dummy, as described in 5.7. Its mass shall correspond to the maximum rated load specified by the manufacturer [see 18.2 a), 18.3 c) and 18.4 l)].

NOTE If it is specified for a given test that a test dummy or a human test person may be used, weights, such as sandbags, may be attached to a vest or garment worn by a test person to supplement the body mass of the test person and maintain the location of the centre of gravity of the test person as close as possible to that of a test dummy of equivalent mass.

WARNING — It is essential that appropriate precautions be taken to ensure the safety of test personnel and the test person.

Where possible, position and, if necessary, fix the test dummy's feet on the footrests as specified in ISO 7176-7. If this position of the test dummy's feet is not possible or if there is an indication that it would represent an unrealistic seating position compared to a user of a stair-climbing chair, correct the position of the test dummy's feet to represent a more realistic seating position, then record the position and the reason it was found to be necessary.

If a given test requires the dummy to be secured to the seat or backrest, use the dummy securement as described in 5.15.

6.6.2 Loading of stair-climbing wheelchair carriers

If the manufacturer of the stair-climbing device specifies one or more wheelchair type(s) or model(s) to be transported, select the heaviest of these as the test wheelchair. Load the test wheelchair with a test dummy, as described in 6.7, the mass of which shall be the maximum rated load claimed by the manufacturer [see 18.2 a) and 18.3 c)] minus the mass of the test wheelchair.

NOTE 1 If the specified test wheelchair is not available, a surrogate wheelchair conforming to Annex C and of the same mass may be used.

If the manufacturer of the stair-climbing device does not specify a wheelchair type or model to be transported, calculate the mass of the test wheelchair from the maximum rated load claimed by the manufacturer [see 18.2 a), 18.3 c) and 18.4 l)] minus 100 kg and use a test wheelchair of that calculated mass together with a test dummy as described in 5.7, with a mass of 100 kg. If this is not possible (e.g. where the maximum rated load is less than 100 kg) use a test dummy of 75 kg mass or less, together with a test wheelchair with a mass calculated from the maximum rated load minus the mass of the test dummy. Record the manner of loading and the results in the test report.

If the test wheelchair has length-adjustable foot supports, adjust them to the maximum length but with a minimum clearance of 50 mm on level ground.

Where possible, position and, if necessary, fix the test dummy's feet on the footrests as specified in ISO 7176-7. If this position of the test dummy's feet is not possible or if there is an indication that it would represent an unrealistic seating position compared to a user of a stair-climbing wheelchair carrier, correct the position of the test dummy's feet to represent a more realistic seating position, then record the position and the reason it was found to be necessary.

If a given test requires the dummy to be secured to the seat or backrest, use the dummy securement as described in 5.15.

Dock the test wheelchair in the stair-climbing wheelchair carrier and configure the stair-climbing device for climbing in accordance with the manufacturer's instructions.

NOTE 2 Where convenient for the purposes of the test or where recommended by the manufacturer, the test wheelchair may be docked in the stair-climbing wheelchair carrier before the test dummy is loaded into the wheelchair.

NOTE 3 If it is specified for a given test that a test dummy or a human test person may be used, weights, such as sandbags, may be attached to a vest or garment worn by a test person to supplement the body mass of the test person and maintain the location of the centre of gravity of the test person as close as possible to that of a test dummy of equivalent mass.

WARNING — It is essential that appropriate precautions be taken to ensure the safety of test personnel and the test person.

6.7 Exaggerated test set-up

Where an exaggerated test set-up is required, configure the stair-climbing device as follows, depending on the required direction.

For the exaggerated test set-up in a forward or downward direction, set the stair-climbing device to its least stable configuration in the forward direction in accordance with Annex E. Lean the torso of the dummy forward to achieve an angle as close as possible to 30° to the vertical. If there is a user restraint system that engages automatically without user input, lean the dummy forward to the maximum forward angle allowed by the restraint system.

For the exaggerated test set-up in a backwards or upwards direction, set the stair-climbing device to its least stable configuration in the backwards direction in accordance with Annex E. Unless the user manual contains a statement warning against the hazard of attaching items to the back of the stair-climbing device, hang the surrogate bag from the back of the seat (of stair-climbing device or transported wheelchair) at the most convenient location (e.g. handgrips or top of backrest).

For the exaggerated test set-up in the sideways direction, just set the stair-climbing device to its least stable configuration in the sideways direction in accordance with Annex E.

6.8 On/off switch

If a specific test requires operation of the stair-climbing device, turn the on/off switch on in accordance with the manufacturer's instructions.

6.9 Setting to operational mode

If a specific operational mode setting is required for a particular test, set the stair-climbing device in this operational mode in accordance with the manufacturer's instructions.

NOTE Changing to various operational modes may also call for re-configuration of the stair-climbing device such as reclining the seat or the test wheelchair for climbing or bringing it to an upright position for moving on level ground.

7 Test conditions

Test conditions shall be such that the test apparatus in 5.1 to 5.4 remains immobile during testing.

The ambient temperature shall be +20 °C ± 5 °C and the relative humidity shall be 30 % to 75 %.

8 Skew angle

8.1 Principle

The test methodology for determining the ability of the stair-climbing device to accommodate skew angle operations consists of performing a series of functional tests on straight test stairs with the stair-climbing device in climbing mode and at a skew angle then evaluating its performance.

8.2 Procedure

WARNING — This test can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel and the test person.

This test is applicable to all stair-climbing devices.

Use the straight test stairs and the upper landing for conducting the test procedure.

Prepare the stair-climbing device as specified in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Perform all tests [a), b), c)] with the stair-climbing device set in its climbing mode.

If the angle between the climbing mechanism and the seat and/or backrest of a stair-climbing chair or the angle between the climbing mechanism and the transported wheelchair on a stair-climbing wheelchair carrier is not adopted automatically (e.g. upright on stairs and reclined on landings and level ground), perform the tests twice with the stair-climbing device set to both extreme angles.

Set the stair-climbing device to its exaggerated test set-up in the forward direction, as described in 6.7.

Perform all tests at maximum test speed (see 6.5.3) throughout the test sequence, even during transitions on to and off landings.

Unless the user manual contains a warning that identifies letting go of the handrails as a hazard, perform the test without the use of handrails.

a) Position the stair-climbing device on the lower landing at a skew angle of 9°, unless the manufacturer claims that the stair-climbing device exceeds the minimum requirement of 9°, in which case position the stair-climbing device on the lower landing at the skew angle claimed by the manufacturer $^{+1^\circ}_{0}$.

b) Let the stair-climbing device climb up the stairs from the lower landing to the upper landing in accordance with the manufacturer's recommendations and score the performance in accordance with Table 1.

c) Repeat a) at the same skew angle, with the stair-climbing device positioned on the upper landing and let the stair-climbing device climb down the stairs to the lower landing in accordance with the manufacturer's recommendations.

d) Identify and record the lowest score of the test.

8.3 Expression of results

The results of the test shall be evaluated in accordance with Table 1.

Table 1 — Scoring system for quantifying the results of the skew angle test and the dynamic stability test

Observed Response		Score
No tip, normal operation	All contact points[a] remain in contact with the test surface[b] AND stair climbing is consistent with manufacturer's instructions for use, force required is consistent with manufacturer's instructions for use.	5
Minor tip, normal operation	One contact point lifts and returns to the test surface causing no visible tip of the entire stair-climbing device AND stair climbing is consistent with manufacturer's instructions for use, force required is consistent with manufacturer's instructions for use.	4
Transient tip moderately greater force needed	All contact points of one end[c] of the stair-climbing device lift and return to the test surface. No other part of the stair-climbing device contacts the test surface OR Stair climbing is consistent with manufacturer's instructions for use, force required is moderately greater than for normal use, stair climbing is not interrupted.	3
Transient tip with other contact moderately greater force needed with other contact	All contact points of one end of the stair-climbing device lift and return to the test surface. A part of the stair-climbing device other than a contact point contacts the test surface. OR Stair climbing is consistent with manufacturer's instructions for use, force required is moderately greater than for normal use, a part of the stair-climbing device other than a contact point contacts the test surface, and stair climbing is not interrupted.	2
Partial tip significant force needed	All contact points of one end of the stair-climbing device lift off, and the stair-climbing device comes to rest on a part of the stair-climbing device other than a contact point, not more than 10° from its original orientation OR Force required is significantly greater than for normal use, stair climbing is interrupted.	1
Full tip not able to complete test	Stair-climbing device tips completely over, coming to rest at least 10° from its original orientation (unless caught by a restraining device or testing personnel for test purposes) OR Test was unable to be completed.	0

[a] A contact point is any point of the climbing mechanism which is intended to contact the test surface during testing.

[b] The test surface may either be the horizontal test plane, the straight test stairs or the upper landing respectively.

[c] The ends of the stair-climbing device may either be the front end, rear end, left side or right side.

8.4 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) skew angle tested;

b) results of the test, evaluated in accordance with 8.3;

c) any difficulties encountered during testing;

d) any observation of relevance to the test;

e) any of the particular tests that could not be carried out including reasons why.

9 Braking effectiveness

9.1 Principle

The test methodology for determining the effectiveness of brakes consists of subjecting the stair-climbing device to various braking tests and measuring and comparing the braking distances as well as observing the performance of the stair-climbing device during the test.

NOTE This test is an extension and adaptation of ISO 7I76-3.

9.2 Test method

9.2.1 General

WARNING — These tests can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel and the test person.

These tests are applicable to all stair-climbing devices.

Prepare the stair-climbing device as specified in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Perform all tests (where applicable) at maximum test speed (see 6.5.3).

NOTE Several test methods in 9.2 require the positioning of the stair-climbing device on steps, identified individually by a number. The stair-climbing device is deemed to be on a numbered step when half its length is across the nosing of the step ± 50 mm.

9.2.2 Test on level ground

Test the stair-climbing device in accordance with ISO 7176-3.

Perform the tests with the stair-climbing device set in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

9.2.3 Test on stairs

9.2.3.1 General

Perform the tests using the straight test stairs, with the stair-climbing device set in its climbing mode.

9.2.3.2 Brake test downstairs

a) Position the stair-climbing device on step 7 and set it in its least stable configuration for the backwards direction in accordance with Annex E.

NOTE 1 When the stair-climbing device is in its least stable configuration for the backwards direction, it is in a more stable configuration for testing in the forward direction.

b) Let the stair-climbing device climb down the stairs at maximum test speed.

c) Commence braking by the normal means in accordance with the manufacturer's recommendations when the most downward point of the climbing mechanism comes in contact with step 2.

d) Actuate the brake(s) to the maximum effect and maintain in operation until the stair-climbing device is brought to a complete stop. Measure the braking distance.

e) Repeat the test another two times.

f) Calculate and record the average downstairs braking distance together with any observations relevant to the test, such as tracking behaviour, loss of stability, sliding and brake failure and any other adverse situation.

NOTE 2 The downstairs braking distance is also needed for the tests of dynamic stability described in 11.2.3.6.

9.2.3.3 Brake test upstairs

a) Position the stair-climbing device on step 2 and set it in its least stable configuration for the forward direction in accordance with Annex E.

NOTE 1 When the stair-climbing device is in its least stable configuration for the forward direction, it is in a more stable configuration for testing in the backwards direction.

b) Let the stair-climbing device climb up the stairs at maximum test speed.

c) Commence braking by the normal means in accordance with the manufacturer's recommendations when the most upward point of the climbing mechanism comes in contact with step 7.

d) Actuate the brake(s) to the maximum effect and maintain in operation until the stair-climbing device is brought to a complete stop. Measure the braking distance.

e) Repeat the test another two times.

f) Calculate and record the average upstairs braking distance together with any observations relevant to the test, such as tracking behaviour, loss of stability, sliding and brake failure and any other adverse situation.

NOTE 2 The upstairs braking distance is also needed for the tests of dynamic stability described in 11.2.3.7.

9.2.3.4 Effect of repeated full application of brakes

Condition the brakes for the test by letting the stair-climbing device climb upstairs and downstairs on the straight test stairs as quickly as possible in the following manner.

a) From step 2 bring the stair-climbing device, with maximum acceleration, to full upward speed, then bring it to a full stop as quickly as possible on step 7.

b) From step 7 bring the stair-climbing device, with maximum acceleration, to full downward speed, then bring it to a full stop as quickly as possible on step 2.

c) Perform these procedures five times in succession and without pause.

Immediately following this conditioning, carry out the braking test described in 9.2.3.2.

Calculate and record whether there is any difference between this test and the results obtained from the brake test downstairs (9.2.3.2).

9.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) results of testing in accordance with 9.2.2;

b) results of testing in accordance with 9.2.3;

c) average braking distances measured in accordance with 9.2.3.2 and 9.2.3.3;

d) difference (if any) between the braking distances measured in accordance with 9.2.3.2 and 9.2.3.4 together with any observation such as brake failure, loss of traction (skidding), instability (tipping) or the occurrence of any other adverse situation;

e) any observation of relevance to the test;

f) any of the particular tests that could not be carried out, including reasons why.

10 Static stability

10.1 Principle

The test methodology for determining the static stability of stair-climbing devices consists of subjecting the stair-climbing device to various tests of their stability on level ground and on stairs and observing its performance.

NOTE This test is an extension and adaptation of ISO 7176-1.

10.2 Test methods

10.2.1 General

WARNING — These tests can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel.

These tests are applicable to all stair-climbing devices.

Prepare the stair-climbing device as specified in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy, as described in 6.6, but do not use a human test person.

NOTE The tests described require the positioning of the stair-climbing device on steps identified individually by a number. The stair-climbing device is deemed to be on a numbered step when half its length is across the nosing of the step ± 50 mm.

Perform the tests described in 10.2.2 and 10.2.3 with the on/off switch turned off, unless the manufacturer's instructions require the power to remain on when the stair-climbing device is in a static position, in which case this shall be recorded in the test report.

If the angle between the climbing mechanism and the seat and/or backrest of a stair-climbing chair or the angle between the climbing mechanism and the transported wheelchair on a stair-climbing wheelchair carrier is not adopted automatically (e.g. upright on stairs and reclined on landings and on level ground), perform the tests twice with the stair-climbing device set to both extreme angles.

10.2.2 Test for static stability on level ground

10.2.2.1 General

Carry out the tests for static stability on level ground in accordance with ISO 7176-1, with the modifications and additions given in 10.2.2.2 to 10.2.2.4.

10.2.2.2 Climbing mode

Perform the tests for static stability in forwards, backwards and sideways directions as specified in ISO 7176-1, with the stair-climbing device set in climbing mode and configured in the exaggerated test set-up with respect to the test direction for each test, as described in 6.7 and placed on the test plane in its least stable position with respect to the test direction for each test in accordance with Annex E.

10.2.2.3 Crawling mode

If the stair-climbing device has a crawling mode, perform the tests for static stability in forwards, backwards and sideways directions as specified in ISO 7176-1, with the stair-climbing device set in the mode for crawling on landings and configured in the exaggerated test set-up with respect to the test direction for each test, as described in 6.7 and placed on the test plane in its least stable position with respect to the test direction for each test in accordance with Annex E.

10.2.2.4 Driving mode

If the stair-climbing device has a driving mode, perform the tests for static stability in forwards, backwards and sideways directions as specified in ISO 7176-1, with the stair-climbing device set in driving mode and configured in the least stable configuration and least stable position with respect to the test direction for each test in accordance with Annex E.

10.2.3 Test for static stability on stairs

10.2.3.1 General

Perform the tests for static stability on the straight test stairs and use the lifting gear in order to tilt them.

Perform the tests for static stability given in 10.2.3.2 to 10.2.3.3 with the stair-climbing device set in the climbing mode.

10.2.3.2 Downward tipping on stairs

Place the loaded stair-climbing device on the straight test stairs. Set the stair-climbing device for normal ascending and in the exaggerated test set-up with respect to the downward direction, as described in 6.7 and least stable position in downward direction in accordance with Annex E.

Tilt the straight test stairs to an angle of 7° in the downward direction or, if the manufacturer claims that the stair-climbing device is capable of climbing stairs with a higher pitch than 35°, tilt the straight test stairs to an angle that is 7° greater than the claimed angle.

Record as to whether the stair-climbing device remains in a stable position without any adverse situation.

If the stair-climbing device has different configurations for ascending and descending, repeat the test with the stair-climbing device in the setting for descending.

10.2.3.3 Upward tipping on stairs

Place the loaded stair-climbing device on the straight test stairs. Set the stair-climbing device for normal ascending and in the exaggerated test set-up with respect to the upward direction, as described in 6.7 and least stable position in upward direction in accordance with Annex E.

Tilt the straight test stairs to an angle of 7° in the upward direction.

Record as to whether the stair-climbing device remains in a stable position without any adverse situation.

If the stair-climbing device has different configurations for ascending and descending, repeat the test with the stair-climbing device in the setting for descending.

10.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) results of testing in accordance with 10.2;

b) angles tested in accordance with 10.2.2.2, 10.2.2.3, 10.2.3.2, 10.2.3.3;

c) angle determined in accordance with 10.2.2.4;

d) any information required by ISO 7176-1;

e) any observation of relevance to the test.

11 Dynamic Stability

11.1 Principle

The test methodology for determining the dynamic stability of stair-climbing devices consists of subjecting a stair-climbing device to various tests of its stability in each of its movement functions and evaluating the results obtained.

NOTE 1 This test is an extension and adaptation of ISO 7176-2.

NOTE 2 Dynamic stability is tested under conditions that can reduce stability. Such conditions are often encountered during normal use of the stair-climbing device.

11.2 Test methods

11.2.1 General

WARNING — These tests can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel and the test person.

Prepare the stair-climbing device as specified in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

If the angle between the climbing mechanism and the seat and/or backrest of a stair-climbing chair or the angle between the climbing mechanism and the transported wheelchair on a stair-climbing wheelchair carrier is not adopted automatically (e.g. upright on stairs and reclined on landings and level ground), perform the tests twice with the stair-climbing device set to both extreme angles.

Perform all tests with the stair-climbing device set in its exaggerated test set-up with respect to the test direction for each test, as described in 6.7.

Perform all tests at maximum test speed (see 6.5.3) throughout the test sequence, even during transitions on to and off landings.

Unless the user manual contains a warning that identifies letting go of the handrails as a hazard, perform the test without the use of handrails.

NOTE 1 For some tests, the downstairs and upstairs braking distances (as determined in accordance with 9.2.3.2 and 9.2.3.3 respectively) are needed.

NOTE 2 The tests given in 11.2 require the positioning of the stair-climbing device on steps identified individually by a number. The stair-climbing device is deemed to be on a numbered step when half its length is across the nosing of the step ± 50 mm.

11.2.2 Dynamic stability on level ground

These tests are applicable to stair-climbing devices with a driving mode.

Test the dynamic stability of stair-climbing devices that have a driving mode, in accordance with ISO 7176-2, with the stair-climbing device in its least stable configuration and least stable position with respect to the test direction for each test in accordance with Annex E.

Perform the tests in the driving mode setting.

11.2.3 Dynamic stability on stairs

11.2.3.1 General

These tests are applicable to all stair-climbing devices.

Perform these tests using the straight test stairs, with the stair-climbing device in the climbing mode setting.

At each stage of the test, identify and record the points at which an adverse situation occurs.

NOTE 1 A videotape may be used to analyse results.

Evaluate the score for each test in accordance with Table 1 immediately after each test run.

NOTE 2 The tests given in 11.2.3 may be performed in any order.

11.2.3.2 Upward test on upper transition

Perform the test as follows.

a) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7.

b) Position the stair-climbing device on step 3.

c) Let the stair-climbing device climb at maximum test speed upstairs and over the upper transition until all parts intended to contact the landing are on the upper landing; continue to move in climbing mode at least 200 mm from step 8, and stop. Perform this procedure in one single movement without interruption.

d) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

e) Set the stair-climbing device in its exaggerated test set-up for the upward direction, as described in 6.7 and repeat b) to d) of this procedure.

11.2.3.3 Downward test on upper transition

Perform the test as follows.

a) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7.

b) Position the stair-climbing device on the upper landing of the straight test stairs at least 200 mm away from step 8.

c) Move the stair-climbing device with maximum test speed towards the stairs and over the upper transition and climb downward until it is fully accommodated on step 3, and stop. Perform this procedure in one single movement without interruption.

d) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

e) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7 and repeat b) to d) of this procedure.

11.2.3.4 Upward test on lower transition

Perform the test as follows.

a) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7.

b) Position the stair-climbing device on the lower landing at least 200 mm away from step 1.

c) Move the stair-climbing device at maximum test speed towards the stairs and over the lower transition and climb upward until it is fully accommodated on step 5, and stop. Perform this procedure in one single movement without interruption.

d) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

e) Set the stair-climbing device in its exaggerated test set-up for the upward direction, as described in 6.7 and repeat b) to d) of this procedure.

11.2.3.5 Downward test on lower transition

Perform the test as follows.

a) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7.

b) Position the stair-climbing device on step 5.

c) Let the stair-climbing device climb at maximum test speed downstairs and over the lower transition until all parts intended to contact the landing are on the lower landing; continue to move in climbing mode at least 200 mm away from step 1, and stop. Perform this procedure in one single movement without interruption.

d) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

e) Set the stair-climbing device in its exaggerated test set-up for the downward direction, as described in 6.7 and repeat b) to d) of this procedure.

11.2.3.6 Dynamic stability when downwards braking on stairs

Perform the test as follows.

a) Position the stair-climbing device on step 3 and set it in its exaggerated test set-up, as described in 6.7, and least stable position for the downward direction in accordance with Annex E.

b) Let the stair-climbing device slowly climb up the stairs until it is above step 3 by the same margin as the downstairs braking distance (see 9.2.3.2). Mark the stair-climbing device against step 3.

c) Without any change or re-positioning, climb the stair-climbing device to step 7.

d) Let the stair-climbing device climb down the stairs at maximum test speed. When the mark reaches step 3, bring the stair-climbing device to a complete stop by the normal means recommended by the manufacturer.

e) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

f) Repeat a) to e) but when the mark reaches step 3, bring the stair-climbing device to a complete stop by applying a command for maximum climbing in the opposite direction.

g) Repeat a) to e) but when the mark reaches step 3, bring the stair-climbing device to a complete stop by operating the emergency switch.

h) If the on/off switch can be operated by the user while sitting in the stair-climbing device, repeat a) to e) but when the mark reaches step 3 bring the stair-climbing device to a complete stop by operating the on/off switch.

i) Position the stair-climbing device on step 3 and set it into its exaggerated test set-up, as described in 6.7 and least stable position for the upward direction, in accordance with Annex E.

j) Let the stair-climbing device slowly climb up the stairs until it is above step 3 by the same margin as the downstairs braking distance (see 9.2.3.2). Mark the stair-climbing device against step 3.

k) Without any change or re-positioning, raise the stair-climbing device to step 7.

l) Let the stair-climbing device climb down the stairs at maximum test speed. When the mark reaches step 3, bring the stair-climbing device to a complete stop by the normal means recommended by the manufacturer.

m) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

n) Repeat i) to m) but when the mark reaches step 3, bring the stair-climbing device to a complete stop by applying a command for maximum climbing in the opposite direction.

o) Repeat i) to m) but when the mark reaches step 3, bring the stair-climbing device to a complete stop by operating the emergency switch.

p) If the on/off switch can be operated by the user whilst sitting in the stair-climbing device, repeat i) to m) but when the mark reaches step 3 bring the stair-climbing device to a complete stop by operating the on/off switch.

q) Identify and record the braking procedure that gives the least dynamic stability.

11.2.3.7 Dynamic stability when upwards braking on stairs

Perform the test as follows.

a) Position the stair-climbing device on step 6 and set it in its exaggerated test set-up, as described in 6.7, and least stable position for the downward direction in accordance with Annex E.

b) Let the stair-climbing device slowly climb down the stairs until it is below step 6 by the same margin as the upstairs braking distance (see 9.2.3.3). Mark the stair-climbing device against step 6.

c) Without any change or re-positioning, climb the stair-climbing device to step 2.

d) Let the stair-climbing device climb up the stairs at maximum test speed. When the mark reaches step 6, bring the stair-climbing device to a complete stop by the normal means recommended by the manufacturer.

e) Repeat the test procedure another two times and evaluate the results in accordance with Table 1. Record the lowest evaluated score in the test report.

f) Repeat a) to e) but when the mark reaches step 6, bring the stair-climbing device to a complete stop by applying a command for maximum climbing in the opposite direction.

g) Repeat a) to e) but when the mark reaches step 6, bring the stair-climbing device to a complete stop by operating the emergency switch.

h) If the on/off switch can be operated by the user while sitting in the stair-climbing device, repeat a) to e) but when the mark reaches step 6 bring the stair-climbing device to a complete stop by operating the on/off switch.

i) Position the stair-climbing device on step 6 and set it in its exaggerated test set-up, as described in 6.7 and least stable position for the upward direction in accordance with Annex E.

j) Let the stair-climbing device slowly climb down the stairs until it is below step 6 by the same margin as the upstairs braking distance (see 9.2.3.3). Mark the stair-climbing device against step 6.

k) Without any change or re-positioning, let the stair-climbing device climb to step 2.

l) Let the stair-climbing device climb up the stairs at maximum test speed. When the mark reaches step 6, bring the stair-climbing device to a complete stop by the normal means recommended by the manufacturer.

m) Perform this procedure three times and record the lowest evaluated score in accordance with Table 1.

n) Repeat i) to m) but when the mark reaches step 6, bring the stair-climbing device to a complete stop by applying a command for maximum climbing in the opposite direction.

o) Repeat i) to m) but when the mark reaches step 6, bring the stair-climbing device to a complete stop by operating the emergency switch.

p) If the on/off switch can be operated by the user whilst sitting in the stair-climbing device, repeat i) to m) but when the mark reaches step 6 bring the stair-climbing device to a complete stop by operating the on/off switch.

q) Identify and record the braking procedure that gives the least dynamic stability.

11.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) results of testing in accordance with 11.2;

b) lowest score for each individual test, evaluated in accordance with Table 1;

c) any adverse situation that occurred during testing;

d) any manufacturer's recommendations that were disregarded, including reasons why;

e) any other observations relevant to the test;

f) any of the particular tests that could not be carried out, including reasons why.

12 Step transition safety

12.1 Principle

The test methodology for determining the step transition safety consists of simulating the approach of a stair-climbing device to the uppermost step of a flight of stairs as if to descend it then observing its response.

12.2 General

WARNING — This test can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel.

This test is applicable to all stair-climbing devices.

Perform the test using the upper landing, the straight test stairs and the acceleration rig.

NOTE For easier and safer test performance, the upper landing on top of the eight steps of the straight test stairs may be substituted by a landing on top of two steps.

Prepare the stair-climbing device as specified in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy, as described in 6.6, but do not use a human test person.

If the angle between the climbing mechanism and the seat and/or backrest of a stair-climbing chair or the angle between the climbing mechanism and the transported wheelchair on a stair-climbing wheelchair carrier is not adopted automatically (e.g. upright on stairs and reclined on landings and level ground), perform the tests twice with the stair-climbing device set to both extreme angles.

Unless the user manual contains a warning that identifies letting go of the handrails as a hazard, perform the test without the use of handrails.

12.3 Test procedure

a) Turn on the on/off switch but do not actuate the control device.

b) Configure the stair-climbing device in the exaggerated test set-up in a forward direction.

c) Set the stair-climbing device into its climbing mode.

Configure the loaded stair-climbing device in its working position as intended by the manufacturer for stair-climbing. Position the stair-climbing device on the upper landing, facing toward and perpendicular to the step nosing with a test run up of 100 mm ± 10 mm (distance from the most forward point of contact of the stair-climbing device with the test platform to the step nosing). Retain the stair-climbing device at this position but do not apply the brakes.

Attach the acceleration rig to the frame of the stair-climbing device as close as possible to the surface of the test platform, as shown in Figure 6. Arrange the acceleration rig such that the stair-climbing device will be pulled or pushed horizontally forward with a force of 100 ± 10 N. Take care not to generate any additional impact during the test procedure.

Release the stair-climbing device from its initial position, accelerate forward and observe the behaviour of the stair-climbing device.

WARNING — Make provisions to restrain the stair-climbing device if it should fall.

d) Repeat c) but with the stair-climbing device configured in the exaggerated test set-up in a backward direction.

e) Repeat c) and d) with the stair-climbing device in its freewheel or pushing mode (if applicable).

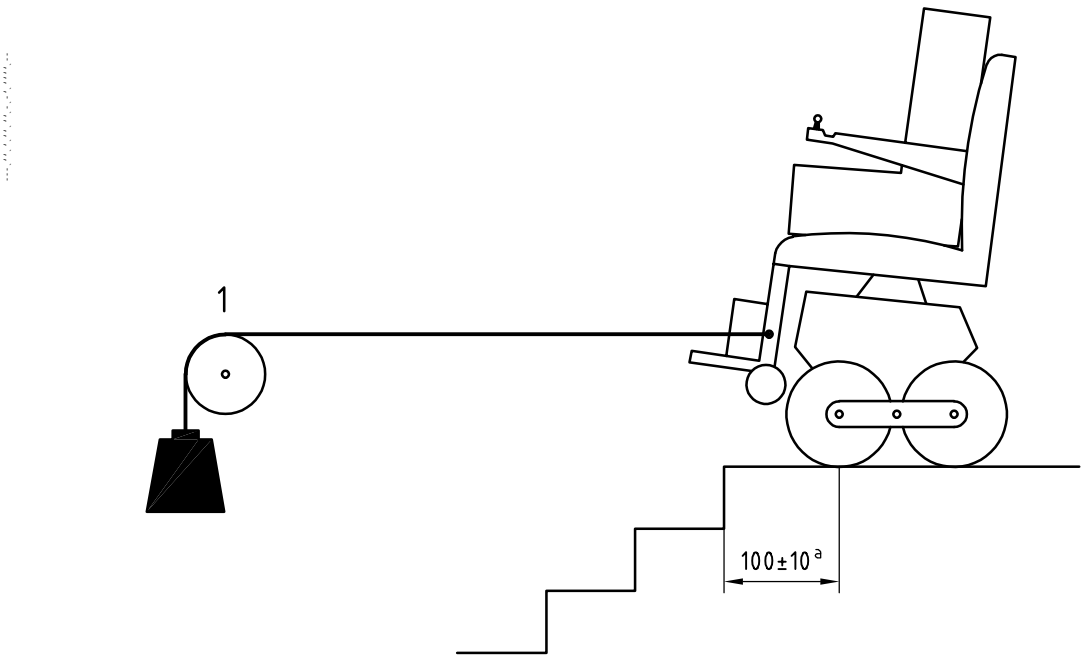
f) Repeat c) and d) with the stair-climbing device in its crawling mode (if applicable).

g) Repeat c) and d) with the stair-climbing device in its driving mode (if applicable).

h) Repeat c) to g) but with the emergency system activated while resting on the upper landing.

i) Repeat c) to g) but with the on/off switch turned off while resting on the upper landing.

Dimensions in millimetres



Key

1 acceleration rig

a Test run up.

Figure 6 — Example of test for step transition safety with acceleration rig

12.4 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) whether the stair-climbing device was pulled or pushed forward by the test force;

b) whether the stair-climbing device came to rest on the test platform before crossing the step nosing;

c) whether the stair-climbing device was pulled or pushed over the step nosing and came to rest on the first step, moving no further and without the occurrence of an adverse situation;

d) whether the stair-climbing device was pulled or pushed over the step nosing, did not stop and continued to move down without the occurrence of an adverse situation;

e) whether the stair-climbing device moved down at least one step and was out of control;

f) whether the stair-climbing device tipped in any direction;

g) any manufacturer's recommendations that were disregarded, including reasons why;

h) any other observations relevant to the test;

i) any of the particular tests that could not be carried out, including reasons why.

13 Static, impact and fatigue strength

13.1 Principle

The test methodology for determining the static, impact and fatigue strength of stair-climbing devices consists of subjecting the same stair-climbing device to a series of tests of its static, impact and fatigue strengths and evaluating its performance.

13.2 General

WARNING — These tests can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch parts in case of separating) be taken to protect test personnel and the test person.

Prepare the stair-climbing device as specified in Clause 6.

Depending on the construction of the stair-climbing device it may not be possible to perform all tests listed in a) to d), which shall be noted in the test report together with the reason(s) for exclusion.

Perform the static, impact and fatigue strength tests in the following sequence:

a) static strength tests in accordance with ISO 7176-8;

b) static strength tests in accordance with 13.3.1 and 13.3.2;

NOTE 1 The static strength tests in a) and b) may be performed in any order.

c) impact strength tests in accordance with 13.4;

NOTE 2 The impact strength tests may be performed in any order.

d) fatigue strength tests in accordance with 13.5.

13.3 Static strength tests

13.3.1 Static strength test for docking systems

This test is applicable to all stair-climbing devices.

Carry out this test on stair-climbing wheelchair carriers only, using the horizontal test plane and with the stair-climbing device set in its climbing mode.

Dock the stair-climbing device together with the test wheelchair and set to a configuration where the test wheelchair is carried by the docking device as recommended by the manufacturer.

NOTE The test wheelchair may be docked to the stair-climbing device or vice versa.

If the angle between the test wheelchair and the stair-climbing device needs adoption when changing between driving on level ground and stair-climbing, adjust the angle for stair climbing as recommended by the manufacturer.

If the manufacturer of the test wheelchair states that the seat or backrest of the test wheelchair can be reclined or the test wheelchair can be placed in more than one position (e.g. reclined and upright), in relation to the stair-climbing device, select a position that gives the minimum seat plane angle.

Select and place the appropriate test dummy on the seat of the test wheelchair as described in 6.6 but do not use a human test person.

Place the loaded stair-climbing device on the horizontal test plane in the position it would be in when standing on a stair landing prior to or after climbing as described by the manufacturer.

Set up a means for restraining the stair-climbing device from being moved when test forces are applied with restraints that are capable of withstanding the forces generated during the test.

Before commencing the test, set up a means of preventing the stair-climbing device from tipping.

Apply the restraints to the stair-climbing device in a manner that prohibits tipping or veering out of the stair-climbing device. Fix the restraints to the stair-climbing wheelchair carrier as close as possible to but not at the docking points.

For stair-climbing devices that are equipped with two single handles, attach the restraint to both handles. Take care to prevent any additional and/or relieving loads other than the test load.

Set up a means for applying a test load so that:

a) the test force acts vertically (at initiation of the test);

b) the test force acts on the upper surface of the lap portion of the dummy, at half width and 280 mm $\pm$ 10 mm in front of the hinges of the dummy when measured parallel to the lap portion of the dummy.

Slowly increase the load until a force F, expressed in Newtons (N) is reached, as given by the equation

$$F = 0{,}5 \times g \times \left(m_{\mathrm{D}} + m_{\mathrm{TW}} \right)$$

where

g is the gravitational constant equal to 9,81 m/s^2;

m_{D} is the mass of the appropriate dummy, expressed in kilograms;

m_{TW} is the mass of the test wheelchair, expressed in kilograms.

If the manufacturer claims that the stair-climbing device is capable of withstanding a force that exceeds the minimum requirement of force F, apply the force claimed.

Maintain the load for a period of 5 s to 10 s, then remove the load.

Record any cracks, breaks or gross deformations and components that needed to be tightened, adjusted or replaced.

13.3.2 Static strength test for handgrips

This test is applicable to stair-climbing devices which have handgrips that project backwards and/or upwards. It is not applicable to handgrips on handles that consist of a transverse bar.

NOTE This test may be conducted whether or not the stair-climbing device is loaded with the test wheelchair (where appropriate) and the test dummy or human test person.

Set the stair-climbing device into its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

Position the stair-climbing device on the horizontal test plane and set up a means as described in ISO 7176-8 for testing handgrips.

Mark the position of the handgrip on the structural part to which it is attached, as a datum for later detection of any relative movement of the handgrip.

Perform the test in accordance with ISO 7176-8:1998, 8.7 with a pull off force of 750 N.

If the manufacturer claims that the stair-climbing device exceeds this force, apply the force claimed.

Record any movement of the handgrip relative to the structural part to which it is attached, as well as any cracks, breaks or gross deformation which occurs as well as components that needed to be tightened, adjusted or replaced as a result of testing.

13.4 Impact strength test

This test is applicable to stair-climbing devices with a driving mode.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy, as described in 6.6 but do not use a human test person.

Perform the impact strength test with the stair-climbing device on the horizontal test plane and in its driving mode.

Test the stair-climbing device in accordance with the impact strength test in ISO 7176-8:1998, Clause 9.

Do not test parts which are not part of the stair-climbing device such as the footrests, backrest or handrims, etc. of the test wheelchair.

Record any cracks, breaks or gross deformation and any components that needed to be tightened, adjusted or replaced as a result of testing.

13.5 Fatigue strength test

13.5.1 General

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

This test is applicable to all stair-climbing devices.

13.5.2 Number of test cycles

13.5.2.1 Stair-climbing devices without a driving mode

Stair-climbing devices without a driving mode shall be tested for a minimum of 150 000 steps of climbing in accordance with 13.5.3. If the manufacturer of a stair-climbing device without a driving mode claims that the stair-climbing device exceeds this minimum requirement of 150 000 steps of climbing, extend the test until the claimed number of steps has been completed.

NOTE The minimum requirement of 150 000 steps is based on a nominal 82 steps per day for a life of five years.

13.5.2.2 Stair-climbing devices with a driving mode

Stair-climbing devices with a driving mode shall be tested for 133 333 cycles on the two-drum test machine as specified in ISO 7176-8:1998, 10.4. If the manufacturer of a stair-climbing device with a driving mode claims that the stair-climbing device exceeds this minimum requirement of 133 333 cycles on the two-drum test machine, extend the test until the claimed number of cycles has been completed.

NOTE 1 This value is 2/3 of 200 000 cycles which is the minimum required number of cycles for testing a wheelchair on the two drum test machine in accordance with ISO 7176-8.

In addition, the stair-climbing device shall be tested for 50 000 steps of climbing in accordance with 13.5.3. If the manufacturer of a stair-climbing device with a driving mode claims that the stair-climbing device exceeds this minimum requirement of 50 000 steps of climbing, extend the test until the claimed number of steps has been completed.

NOTE 2 This value is 1/3 of 150 000 steps which is the minimum requirement for stair-climbing devices without a driving mode.

13.5.3 Test arrangements

13.5.3.1 General

Perform the fatigue tests using one of the two alternative test arrangements given in 13.5.3.2 and 13.5.3.3.

NOTE Climbing may be performed up and/or down stairs.

13.5.3.2 Test arrangement using the straight test stairs

Set the stair-climbing device in its climbing mode.

Perform the test at a speed as close as possible to one step per second.

Let the stair-climbing device climb up and/or down the entire straight test stairs as recommended by the manufacturer using a human test person.

NOTE An auxiliary power source for the stair-climbing device may be used for this test or, alternatively, provision may be made to charge or replace the batteries during the test.

Periodically check the position of the test wheelchair (if used) and the test dummy or human test person and correct if necessary.

Perform the test until the stair-climbing device fails or completes the required number of steps stated in 13.5.2, then stop.

Record any cracks, breaks or gross deformation and any components that needed to be tightened, adjusted or replaced.

13.5.3.3 Test arrangement using the escalator test machine

Use the escalator test machine as specified in Annex F.

Position the stair-climbing device on the escalator test machine so that all parts of the climbing mechanism are on the straight flight of steps (see Figures 7 and 8).

Set the stair-climbing device into its climbing mode.

Restrain the stair-climbing device longitudinally by devices attached to the frame of the stair-climbing device as close as possible to the pitch line of the steps.

NOTE 1 If necessary, non-structural covers that restrict access to the attachment point may be removed.

Arrange the restraints of the stair-climbing device so that they are parallel to the pitch line to ± 10° and such that the stair-climbing device has free movement along the pitch line of 30 mm ± 5 mm.

Take care to avoid restraints generating any forces that offset or twist the stair-climbing device.

Arrange the restraints so that it is not possible for the stair-climbing device to move laterally more than ± 50 mm from its mid-position.

Set the retarder of the escalator test machine to counterweight the stair-climbing device and hold it as stationary as possible on the escalator test machine when it climbs upstairs. Set the retarder so that the tension forces in the longitudinal restraints do not exceed 5 % of the total weight of the loaded stair-climbing device.

NOTE 2 Small variations of the speed of the escalator test machine derived from any complicated kinematics of any climbing mechanisms can be disregarded.

Perform the test at a speed as close as possible to one step per second.

NOTE 3 An auxiliary power source for the stair-climbing device may be used for this test or, alternatively, provision may be made to charge or replace the batteries during the test.

Perform the climbing according to the manufacturer's instructions.

Periodically check the position of the test wheelchair (if used) and the test dummy or human test person and correct, if necessary.

Perform the test until the stair-climbing device fails or completes the number of steps stated in 13.5.2, then stop.

Record any cracks, breaks or gross deformation and any components that needed to be tightened, adjusted or replaced.

13.6 Expression of results

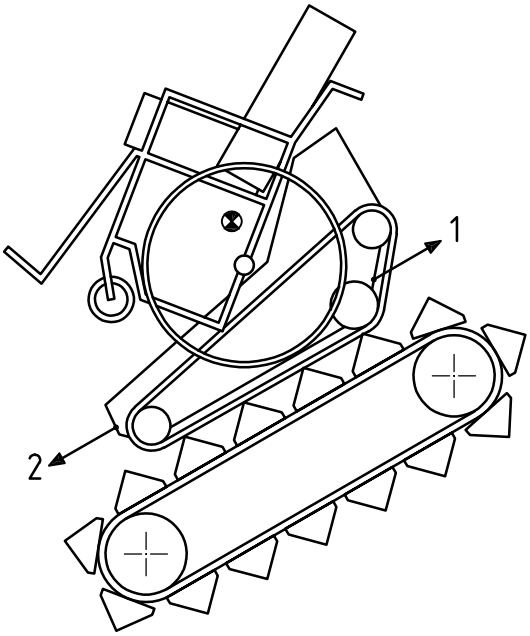
After completing all the tests in 13.2 a) to d), examine the stair-climbing device to determine whether it meets the requirements of 4.6.

Check the test records to establish if any parts were adjusted, tightened or replaced more than once.

Test all power operated systems on the stair-climbing device to establish if they operate as described by the manufacturer.

Test all attachable parts to establish if they can be attached/detached as intended by the manufacturer.

If any of the requirements of 4.6 are not met, the stair-climbing device shall be deemed to have failed the test.

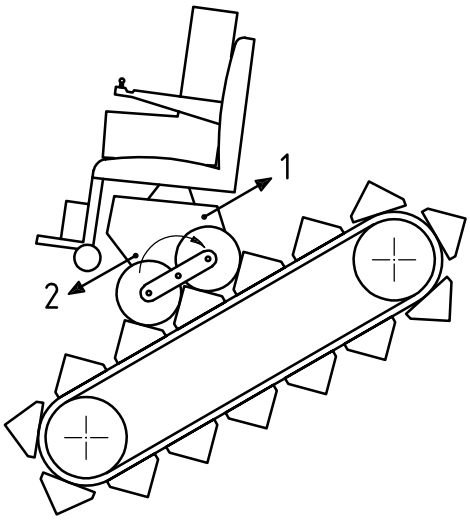


Key

1 upper longitudinal restraint

2 lower longitudinal restraint

Figure 7 — Stair-climbing device with tracks on the escalator test machine



Key

1 upper longitudinal restraint

2 lower longitudinal restraint

Figure 8 — Stair-climbing device with clusters on the escalator test machine

13.7 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) a statement as to whether or not the stair-climbing device met the requirements given in 4.6;

b) a description of any failures identified by the test evaluation in 13.6 and the configuration of the stair-climbing device during the tests;

c) a statement as to whether or not the stair-climbing device met any claims by the manufacturer above the minimum requirements;

d) any manufacturer's recommendations that were disregarded, with reasons why;

e) any observation of relevance to the test;

f) any of the particular tests that could not be carried out, including reasons why.

14 Climatic safety

14.1 Principle

The test methodology for determining the climatic safety of the stair-climbing device consists of subjecting the stair-climbing device to the climatic tests given in ISO 7176-9 and then assessing its function by means of functional checks.

14.2 Test methods

14.2.1 General

WARNING — The tests can be hazardous. It is essential that appropriate precautions (e.g. insulation from heat and cold) be taken to protect test personnel and the test person.

Prepare the stair-climbing device as described in Clause 6.

When exposing the stair-climbing device to the environmental test conditions, do not load the stair-climbing device with the test wheelchair, test dummy or human test person.

When performing the functional check, load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

14.2.2 Test on level ground

The test is applicable to stair-climbing devices with a driving mode and/or crawling mode.

Test the stair-climbing device in accordance with ISO 7176-9, with the stair-climbing device set in its driving mode (if applicable) and in its crawling mode (if applicable).

14.2.3 Test on stairs

This test is applicable to all stair-climbing devices.

Test the stair-climbing device in accordance with ISO 7176-9 with the following modifications and additions.

a) Set the stair-climbing device in its climbing mode.

b) Perform the functional check on the straight test stairs that are connected to the upper landing, at maximum recommended speed (see 6.5.2), before being subjected to the environmental conditions and at the end of each particular test as follows: position the loaded stair-climbing device 200 mm in front of the lower landing, crawl toward the stairs and climb up at least four steps and perform a braking manoeuvre to a full stop, then climb up to the upper landing and crawl 200 mm and stop, then crawl back to the stairs and climb down at least four steps and perform a braking manoeuvre to a full stop, then climb down to the lower landing and crawl 200 mm and stop.

14.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) a statement as to whether the stair-climbing device met the requirements given in 4.7;

b) any functional changes in the stair-climbing device after testing;

c) any evidence of damage to the device after testing;

d) any observation of relevance to the test.

15 Electromagnetic compatibility

15.1 Principle

The test methodology for determining the electromagnetic compatibility of a stair-climbing device consists of subjecting it to the electromagnetic compatibility tests given in ISO 7176-21 with certain modifications and additions and observing its performance in relation to the requirements of ISO 7176-21.

15.2 Test method

15.2.1 General

WARNING — These tests can be hazardous. It is essential that appropriate precautions (e.g. access restriction) be taken in order to protect test personnel.

These tests are applicable to all stair-climbing devices.

Prepare the stair-climbing device as specified in Clause 6 but do not load the test wheelchair, test dummy or human test person.

15.2.2 EMC on level ground

Test the stair-climbing device in accordance with ISO 7176-21, with the stair-climbing device set in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

15.2.3 EMC on stairs

Test the stair-climbing device in accordance with ISO 7176-21 with the following modifications:

a) set the stair-climbing device in its climbing mode;

b) replace the definitions of the reference planes given in ISO 7176-21 with the definitions given in 3.22 to 3.24;

c) verify the functional requirement in accordance with 14.2.3 b);

d) construct the support system so that the stair-climbing device is supported as if on stairs that have a pitch of 30° ± 5;

e) replace the wheel speed monitor with a speed monitor that:

   1) is capable of monitoring the speed of each of the climbing mechanisms to an accuracy of 5 %;

2) is capable of calculating the average speed change, and the differential speed change, if the climbing mechanisms can be driven differentially, from the measured speed of the climbing mechanisms, according to the equations in ISO 7176-21 for average wheel speed change and differential wheel speed change;

3) has a time constant not exceeding 0,1 s;

4) does not introduce any conductive path between the stair-climbing device and the ground plane;

5) does not perturb nor is susceptible to the electromagnetic fields measured or generated during the test.

f) instead of equipping the wheelchair in accordance with ISO 7176-21:2003, 7.1, set up the stair-climbing device as specified in 6.2 to 6.5, 6.8 and 6.9 of this part of ISO 7176 but do not fit the test wheelchair and the test dummy and do not use the exaggerated test set-up. Only for the functional checks may a human test person may be used. Fit non-spill batteries if the stair-climbing device is to be tipped during testing.

15.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) a statement as to whether the stair-climbing device met the requirement given in 4.10;

b) any manufacturer's recommendations that were disregarded during testing, including reasons why;

c) any observation of relevance to the test;

d) any of the particular tests that could not be carried out, including reasons why.

16 Required safety equipment

16.1 Principle

The test methodology for determining the function of the safety equipment with which the stair-climbing device is equipped consists of subjecting the stair-climbing device to various functional tests of its safety equipment and evaluating their performance in relation to the requirements given in 4.11.

These tests are applicable to all stair-climbing devices with the exception of the climbing mode exit restriction test (see 16.2.5).

16.2 Test methods

16.2.1 On/off switch

Position the stair-climbing device on the horizontal test plane. Switch off the on/off switch and attempt to move the stair-climbing device in any operational mode without switching it on. Record any movement of the stair-climbing device.

Position the stair-climbing device on the straight test stairs and repeat the test.

NOTE 1 Some stair-climbing devices can have operational modes, the activation of which is dependent on whether the stair-climbing device is positioned on level ground or on stairs.

NOTE 2 It is not important for this test whether or not the stair-climbing device is loaded with the test wheelchair (where appropriate) and the test dummy or human test person.

16.2.2 “Key off” power

Disconnect the stair-climbing device's battery set and connect either the direct current source or the voltage source specified in ISO 7176-14 instead via the circuit breaker also specified in ISO 7176-14 and the ammeter.

With the stair-climbing device switched off, adjust the voltage source so that the voltage at the stair-climbing device's battery leads is equal to the nominal voltage of the battery set $^{+10\ \%}_{0}$. Record the steady-state current.

NOTE 1 When they are switched on, some stair-climbing devices can draw transient currents that are much greater than their steady-state currents. During this test such transient currents could overload the ammeter. The ammeter may be bypassed until the current reaches a steady state.

NOTE 2 It is not important for this test whether or not the stair-climbing device is loaded with the test wheelchair (where appropriate) and the test dummy or human test person.

16.2.3 Emergency system

Connect the straight test stairs to the upper landing and position both on the horizontal test plane.

Prepare the stair-climbing device as described in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device in its climbing mode.

Position the stair-climbing device on the upper landing and set it into its least stable configuration for the backwards direction in accordance with Annex E.

NOTE 1 The stair-climbing device is set in its least stable configuration for the backwards direction in order to test the stair-climbing device in a more stable configuration for the forwards direction.

Let the stair-climbing device climb down stairs with maximum recommended speed, as described in 6.5.2.

When the climbing mechanism comes into contact with step 4 of the straight test stairs, activate the means specified by the manufacturer for the activation of the emergency system. Observe whether the stair-climbing device stops.

If the stair-climbing device does not stop, terminate the test and record the results and observations from the test.

If the stair-climbing device stops, attempt to let it climb up and down the stairs under its own power after any single user action and any combination of multiple user actions, excluding that set of user actions, specified by the manufacturer for the deactivation of the emergency system. Observe whether the stair-climbing device remains in its position.

If the stair-climbing device moves, terminate the test and record the results and observations from the test.

NOTE 2 Repeat with different single user actions and then with different combinations of multiple user actions excluding that set of user actions specified by the manufacturer for the deactivation of the emergency system, until all options have been exhausted.

With the stair-climbing device on the stairs, turn off the on/off switch and wait for at least 10 s. Turn on the on/off switch again and attempt to let it climb up and down the stairs under its own power after any single user action and any combination of multiple user actions excluding that set of user actions specified by the manufacturer for the deactivation of the emergency system. Observe whether the stair-climbing device remains in its position.

NOTE 3 Repeat with different single user actions and then with different combinations of multiple user actions excluding that set of user actions specified by the manufacturer for the deactivation of the emergency system, until all options have been exhausted.

If the stair-climbing device moves, terminate the test and record the results and observations from the test.

With the stair-climbing device on the stairs and the emergency system activated, deactivate the emergency system as specified by the manufacturer. Identify if this procedure needs more than one user action before the stair-climbing device accepts any command to move. Then let the stair-climbing device climb up and down for at least 3 steps. Observe any abnormal behaviour of the stair-climbing device.

Repeat these tests after setting the stair-climbing device in its least stable configuration for the forwards direction in accordance with Annex E and climbing up stairs with maximum recommended speed as described in 6.5.2 after a start from the lower landing in the upwards direction.

NOTE 4 The stair-climbing device is set in its least stable configuration for the forwards direction in order to test the stair-climbing device in a more stable configuration for the backwards direction.

16.2.4 Battery charge indicator

Prepare the stair-climbing device as specified in Clause 6, with the exception that it is acceptable not to charge the batteries to at least 75 % of their rated nominal capacity as described in 6.3 because the test simply requires starting with batteries at a state of charge greater than the reserve charge.

Use the straight test stairs connected to the upper landing and position both on the horizontal test plane.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device into its climbing mode.

Perform the test at maximum recommended speed, as described in 6.5.2.

Drive the stair-climbing device from the lower to the upper landing and back to the lower landing until the battery charge indicator discloses that only the minimum reserve battery charge is left. Continue to let the stair-climbing device climb up and down while counting the number of steps climbed up and down until the stair-climbing device comes to stop due to a flat battery.

Record the number of steps ascended and the number of steps descended between the first indication that the minimum reserve battery charge has been reached and the end of the test.

16.2.5 Climbing mode exit restriction

WARNING — This test can be hazardous. It is essential that appropriate precautions (e.g. restraints that catch the stair-climbing device in case of falling) be taken to protect test personnel and the test person.

This test is applicable to stair-climbing devices that have a climbing mode and other operational modes, unless it is declared by the manufacturer in writing, that exiting or overriding the climbing mode or changing to an operational mode other than climbing mode while on stairs is intended/permitted.

Prepare the stair-climbing device as described in Clause 6.

NOTE Some parts of this test method require the positioning of the stair-climbing device on steps identified by their number. The stair-climbing device is on a numbered step when half its length is across the step nosing ± 50 mm.

Connect the straight test stairs to the upper landing and position both on the horizontal test plane.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device into its climbing mode.

Perform the test at maximum recommended speed, as described in 6.5.2, as follows.

a) Place the stair-climbing device on the upper landing, climb down the straight test stairs to step 4 and stop. Attempt to exit the climbing mode while standing on the stairs. If it is possible to exit the stair-climbing mode, attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

b) Repeat a) but without exiting the climbing mode, attempt to enter a mode other than the climbing mode while the stair-climbing device is standing on the stairs. If it is possible to enter any operational mode other than the climbing mode, attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

c) Repeat a) but while the stair-climbing device is standing on the stairs actuate the emergency system. Attempt to move the stair-climbing device up or down the stairs in any operational mode. Then de-activate or release the emergency system and attempt to enter any operational mode other than climbing mode. Attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

d) Repeat a) but while the stair-climbing device is standing on the stairs turn off the on/off switch. Wait for at least 10 s and turn on the on/off switch again. Attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

e) Repeat a) but continue to climb downstairs without stopping at step 4. When over step 4, without interrupting the maximum command of the speed input device, attempt to exit the climbing mode. If it is possible to exit the stair-climbing mode, attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

f) Repeat a) but continue to climb downstairs without stopping at step 4. When over step 4, without exiting the climbing mode and without interrupting the maximum command of the speed input device, attempt to enter any operational mode other than climbing mode. If it is possible to enter any operational mode other than the climbing mode, attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

g) Repeat a) but continue to climb downstairs without stopping at step 4. When over step 4, without exiting the climbing mode and without interrupting the maximum command of the speed input device, activate the emergency system. Attempt to move the stair-climbing device up or down the stairs in any operational mode. Then deactivate the emergency system and attempt to enter any operational mode other than climbing mode. Attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

h) Repeat a) but continue to climb downstairs without stopping at step 4. When over step 4, without exiting the climbing mode and without interrupting the maximum command of the speed input device, turn off the on/off switch. Wait for at least 10 s and switch on the on/off switch again. Attempt to move the stair-climbing device up or down the stairs in any operational mode other than climbing mode.

i) Repeat a) to h) but let the stair-climbing device climb up the straight test stairs after a start from the lower landing.

16.3 Test report

In addition to the information specified in Clause 17, the test report shall include:

a) a statement as to whether the stair-climbing device met all the requirements of 4.11;

b) the results from each test;

c) any manufacturer's recommendations that were disregarded during testing, including reasons why;

d) any observation of relevance to the test.

17 Test report

In addition to the specific data recorded in each test, the test report shall contain the following information:

a) a statement that the tests have been carried out in accordance with ISO 7176-24;

b) name and address of the testing institution;

c) name and address of the manufacturer of the stair-climbing device;

d) date of issue of the test report;

e) type of the stair-climbing device and any serial and batch numbers (including its classification according to Annex A, where applicable);

f) equipment and reference configuration of the stair-climbing device under test (see 6.2), including the position of any adjustable part;

g) name, model and mass of the test wheelchair (if used);

h) mass of test dummy (or test person with any additional weights) used;

i) any deviation from the requirements given in Clause 6, including reasons why;

j) a photograph of the stair-climbing device under test;

k) actual test conditions (as specified in Clause 7);

l) a statement as to whether the stair-climbing device met all the requirements of this part of ISO 7176;

m) results and details of the various tests carried out in accordance with this part of ISO 7176.

18 Labelling and documentation

18.1 General

The manufacturer's documentation and labelling shall conform to the requirements of ISO 7176-15 and in addition shall be in the official language(s) of the country in which the stair-climbing device is marketed.

18.2 Labels

Each stair-climbing device shall have permanent and easily visible labels. The labels shall include the following:

a) the maximum rated load in kilograms as follows:

   — for stair-climbing chairs the maximum user mass;

   — for stair-climbing wheelchair carriers the maximum total mass (mass of transported wheelchair plus mass of user);

b) a statement to the effect that “Before use, the user shall receive training from a qualified instructor”.

18.3 User manual

The user manual shall provide the following information:

a) a statement of conformity to this part of ISO 7176 based on the intended use of the product disclosed in the user manual and other manufacturer's documentation;

b) the recommended wheelchair types(s) or model(s) intended to be carried (for stair-climbing wheelchair carriers only);

c) the maximum rated load in kilograms as follows:

   — for stair-climbing chairs the maximum user mass;

   — for stair-climbing wheelchair carriers the maximum total mass (mass of transported wheelchair plus mass of user);

d) a statement to the effect: “Before use, the user shall receive training from a qualified instructor”;

e) if the stair-climbing device is equipped with an anterior thoracic support, a statement to the effect: “When using the stair-climbing device, the anterior thoracic support shall be used” (see Annex B);

f) a statement to the effect: “The use of a stair-climbing device can entail a higher degree of risk and require greater ability of the operator than that required to use a wheelchair”;

g) the maximum pitch of the stairs in degrees that can be negotiated safely;

h) if the stair-climbing device is intended for use on winding stairs;

i) the type of stair-climbing device including its classification (according to Annex A) and any serial and batch numbers;

j) any limitations in the permissible dimensions of rise and/or going of stairs and any limitation in stair surfaces, e.g. deep-pile carpets;

k) any limitation in the permissible slope of the upper and lower landings;

l) the maximum recommended climbing speed in steps per minute, as determined in accordance with Annex D and the maximum driving speed in m/s (if applicable);

m) a warning that any use of the stair-climbing device is dangerous if the user is not aware of and/or does not follow the manufacturer's instructions;

n) a statement to the effect: “Stability tests were performed using test dummies and (where appropriate) standard test wheelchairs. Results might vary in real-life situations”;

o) if the stair-climbing device is intended to be dismantled for ease of carrying and component parts with a mass greater than 10 kg are not provided with suitable handling devices, the user manual shall indicate the points where the component parts can be lifted safely and/or give a method for handling during assembly;

p) if the stair-climbing device is available with a headrest and the use of the stair-climbing device requires that the seat or the backrest be reclined to an angle of more than 25° to the vertical, a statement to the effect: “When using the stair-climbing device, a headrest shall be used”.

18.4 Manufacturer's specification sheets

The manufacturer's specification sheets shall provide the following information:

a) occupied length (see Annex G);

b) occupied width (see Annex G);

c) reversing width (type 1), if applicable (see Annex G);

d) reversing width (type 2), if applicable (see Annex G);

e) minimum stair width for straight stairs (see Annex G);

f) minimum landing area for U-shaped stairs (see Annex G);

g) minimum outer stair radius on winding stairs, if applicable (see Annex G);

h) minimum inner stair radius on winding stairs, if applicable (see Annex G);

i) total mass of the empty stair-climbing device, in kilograms;

j) mass of the heaviest part of the stair-climbing device when it is taken apart without the use of tools for the purpose of transportation or stowing, in kilograms;

k) recommended wheelchair type(s) or model(s) intended to be carried (for stair-climbing wheelchair carriers only);

l) maximum rated load in kilograms, as follows:

   — for stair-climbing chairs the maximum user mass;

   — for stair-climbing wheelchair carriers the maximum total mass (mass of transported wheelchair plus mass of user);

m) maximum recommended climbing speed in steps per minute and the maximum recommended driving speed in metres per second (if applicable);

n) maximum pitch of the stairs, in degrees, that can be negotiated safely;

o) any limitations in the permissible dimensions of rise and/or going of stairs and any limitation in stair surfaces, e.g. deep-pile carpets;

p) any limitation in the permissible slope of the upper and lower landings;

q) whether the stair-climbing device is intended for use on winding stairs;

r) theoretical number of steps the stair-climbing device is able to climb before the battery is discharged as determined in accordance with Annex H.

Annex A
(normative)

Types of stair-climbing devices with typical representations

Table A.1 illustrates the most common system that is used to classify stair-climbing devices.

To give an overview of the different types of stair-climbing device, attendant driven stair-climbing devices are included in this annex. Requirements and test methods for attendant driven stair-climbing devices are given in ISO 7176-23.

Table A.1 — Classification of stair-climbing devices

Attendant operated stair-climbing device				**User operated stair-climbing device**			
Self-standing		Balancing		Self-standing		Balancing	
Stair-climbing chair	Stair-climbing wheelchair carrier	Stair-climbing chair	Stair-climbing wheelchair carrier	Stair-climbing chair	Stair-climbing wheelchair carrier	Stair-climbing chair	Stair-climbing wheelchair carrier
Type A	Type B	Type C	Type D	Type E	Type F	Type G	Type H
see Figure A.1	see Figure A.2	see Figure A.3	see Figure A.4	see Figure A.5	see Figure A.6	see Figure A.7	At present no known specimen

Classification of various types of stair-climbing devices could also be based on their ability to climb straight stairs only, or both straight stairs and winding stairs.

Another way of distinguishing between various types of stair-climbing devices is whether or not a driving mode is incorporated (at present some models of stair-climbing devices of types A, C, D, E and G have a driving mode).

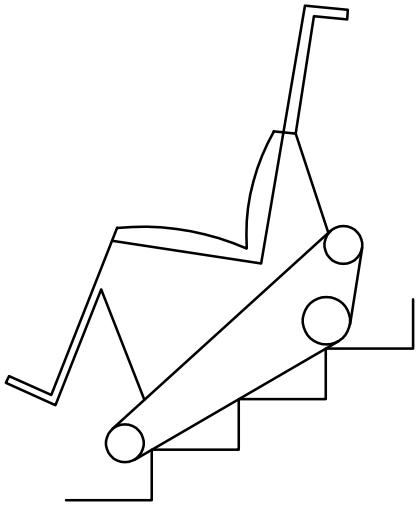


Figure A.1 — Typical representation of an attendant operated, self-standing stair-climbing chair (Type A)

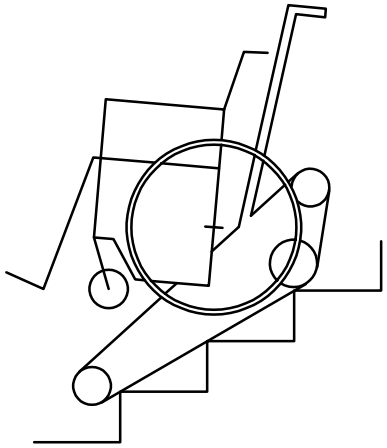


Figure A.2 — Typical representation of an attendant operated, self-climbing wheelchair carrier (Type B)

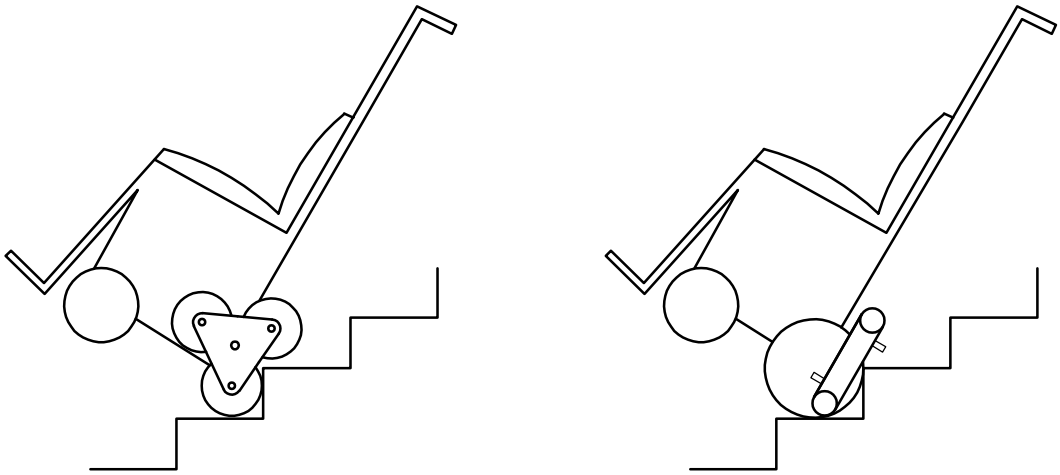


Figure A.3 — Typical representations of an attendant operated, balancing stair-climbing chair (Type C)

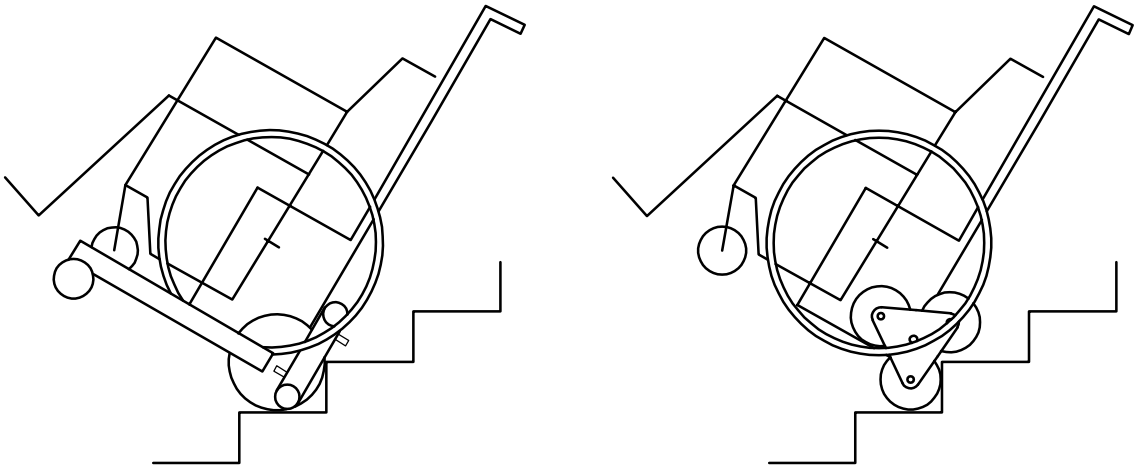


Figure A.4 — Typical representations of an attendant operated, balancing stair-climbing wheelchair carrier (Type D)

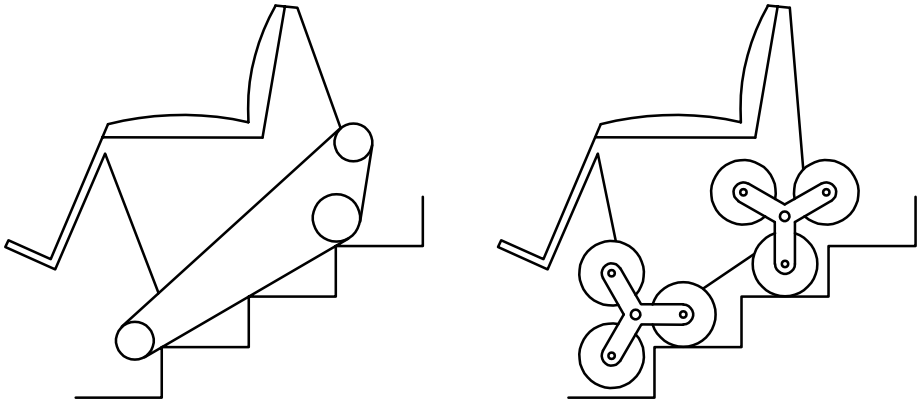


Figure A.5 — Typical representations of a user operated, self-standing stair-climbing chair (Type E)

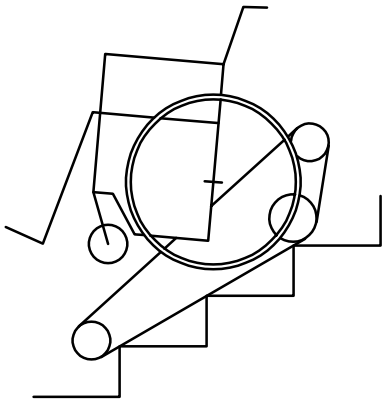


Figure A.6 — Typical representation of a user operated, self-standing stair-climbing wheelchair carrier (Type F)

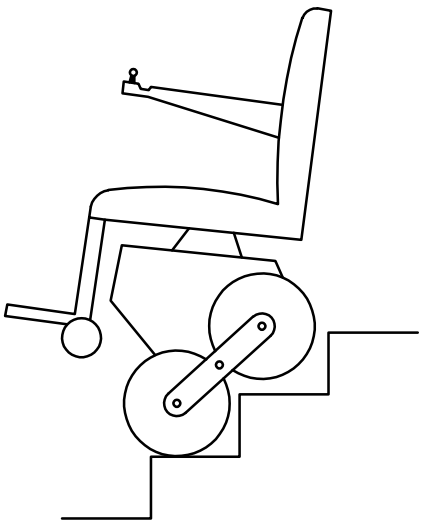


Figure A.7 — Typical representation of a user operated, balancing stair-climbing chair (Type G)

Annex B
(informative)

Recommended safety equipment

B.1 General

Manufacturers of stair-climbing devices should incorporate appropriate safety equipment into stair-climbing devices. This annex gives recommendations for the most common types of safety equipment for stair-climbing devices and their functions and features.

B.2 Anterior thoracic support

The stair-climbing device should be equipped with an anterior thoracic support capable of restricting excessive movement of the user during stair-climbing.

NOTE 1 The anterior thoracic support could consist, e.g., of a lap belt, diagonal belt, chest belt or ankle support, depending on what the manufacturer finds most appropriate for safe use on the stair-climbing device.

NOTE 2 The anterior thoracic support need not be crash proof as, e.g., in motor vehicles.

Stair-climbing devices fitted with an anterior thoracic support should contain a statement in the user manual to the effect that: “When using the stair-climbing device, the anterior thoracic support shall be used”.

B.3 Headrest

Stair-climbing devices which require that the seat or the backrest be reclined to an angle of more than 25° to the vertical when in use, should have provision(s) for attaching a headrest.

The manufacturer of a stair-climbing device that has a provision for attaching a headrest, should have available for purchase a headrest appropriate for the body size of various users. The “headrest height above seat” dimension (see ISO 7176-7:1998, dimension 10) should be capable of covering the area from 680 mm to 844 mm above the seat when intended for adults.

If the stair-climbing device has provision(s) for attaching a headrest, the user manual should contain a statement to the effect that: “When reclining the stair-climbing device, the headrest shall be used”.

B.4 Safe stairs indicator

The stair-climbing device should be fitted with a safe stairs indicator.

NOTE 1 The safe stairs indicator may either be a device fixed to the stair-climbing device or a hand-held accessory that is used by the user when approaching stairs with unknown pitch or with unusual step dimensions.

NOTE 2 The stair-climbing device may be fitted with a stair inclinometer although this is not the only critical factor in assessing stair safety. Other factors influencing stair safety include limitations in rise and/or going, unevenness of rise and/or going, structural integrity, step tilt from horizontal in lateral or longitudinal planes, surface material, presence of other users on stairs.

Annex C
(normative)

Surrogate wheelchair

The surrogate wheelchair shall be used only if the manufacturer of the stair-climbing device does not recommend a particular type or model of wheelchair for use with the stair-climbing device.

The overall dimensions of the surrogate wheelchair shall be determined in accordance with ISO 7176-5; the seat and wheel dimensions shall be measured as specified in ISO 7176-7.

The surrogate wheelchair shall:

a) be a durable four-wheel, handrim propelled, rear-wheel driven wheelchair;

b) have a total mass equal to the maximum mass of the wheelchair ± 3 kg (calculated as described in 6.6.2);

c) have a centre of gravity located 450 mm ± 50 mm above the ground and 150 mm ± 50 mm in front of the rear axle;

d) have a frame which is designed to provide docking point(s) to the stair-climbing device;

e) have a total width of 540 mm ± 40 mm;

f) have a total length of 1 120 mm ± 60 mm;

g) have an effective seat width of 420 mm ± 40 mm, an effective seat depth of 430 mm ± 40 mm and a seat plane angle of 4° ± 2°;

h) have a seat surface height at the front edge of 550 mm ± 40 mm;

i) have a backrest with a width of 400 mm ± 40 mm, a height of 420 mm ± 40 mm and a backrest angle of 10° ± 2°;

j) have a footrest-to-seat dimension of 480 mm ± 40 mm;

k) have a footrest length of 180 mm ± 40 mm;

l) have a footrest-to-leg angle of 90° ± 5°;

m) have a leg-to-seat surface angle of 110° ± 5°;

n) have armrests;

o) have a handrim diameter of 530 mm ± 40 mm;

p) have a propelling wheel diameter of 600 mm ± 20 mm;

q) have a horizontal location of wheel axle of 30 mm ± 20 mm;

NOTE 1 The horizontal and vertical location of wheel axle are defined in ISO 7176-7:1998 as dimensions 25 and 26. These dimensions specify the position of the manoeuvring wheels with respect to the seat.

r) have a vertical location of wheel axle of 150 mm ± 20 mm;

s) have a front wheel diameter of 150 mm ± 80 mm.

NOTE 2 One of the following models of wheelchairs from mass production may be used as the surrogate wheelchair, provided its dimensions are selected appropriately and mass and location of centre of gravity are set or adjusted according to the specifications given in this annex[1)]:

Meyra, Service 3.600,

Ortopedia, Universal 9083,

Otto Bock, Start Basic,

Sunrise Medical, Breezy 200,

Vermeiren, Standard 28TII

1) The above makes are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 7176 and does not constitute an endorsement by ISO of these products.

Annex D
(normative)

Determination of maximum recommended speed

D.1 Principle

The test methodology for determining the ability of the stair-climbing device to function at maximum recommended speed consists of operating the stair-climbing device at maximum speed on level ground and on stairs, and measuring the time taken to achieve certain distances.

NOTE This test is used to verify the manufacturer's information concerning the maximum recommended speed on straight test stairs and is an extension and adaptation of ISO 7176-6.

D.2 Test procedure

D.2.1 General

Prepare the stair-climbing device as described in Clause 6.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person (see 6.6).

Perform tests (where applicable) at maximum recommended speed, in accordance with 6.5.2.

NOTE The test methods given in this annex require the positioning of the stair-climbing device on steps identified by their number. The stair-climbing device is on a numbered step when half its length is across the step nosing ± 50 mm.

D.2.2 Maximum recommended speed on level ground

This test is applicable to stair-climbing devices that have a driving mode.

Carry out the test for the determination of maximum speed on a horizontal surface in accordance with ISO 7176-6:2001, 6.1, using the horizontal test plane described in 5.4 and with the stair-climbing device set in its driving mode.

D.2.3 Maximum recommended speed on stairs

This test is applicable to all stair-climbing devices.

Carry out this test using the straight test stairs and the upper landing, with the stair-climbing device set in its climbing mode.

Let the loaded stair-climbing device climb up the whole of the straight test stairs, with the speed input device at the position for maximum recommended speed.

Measure the time taken to ascend the distance between step 3 and step 7 and record to within one tenth of a second. Perform the test three times and calculate the mean time for ascending these four steps.

Let the loaded stair-climbing device climb down the whole of the straight test stairs, with the speed input device at the position for maximum recommended speed.

Measure the time taken to descend the distance between step 7 and step 3 and record to within one tenth of a second. Perform the test three times and calculate the mean time for descending these four steps.

From the values obtained, calculate the average speeds in steps per minute for ascending and for descending and round to one decimal point.

D.3 Test report

In addition to the information specified in Clause 17, the test report shall include the following:

a) maximum speed on level ground expressed in metres per second;

b) maximum recommended speed on stairs expressed in steps per minute for ascending and descending, determined in accordance with D.2.3.

Annex E
(normative)

Configuration and position of stair-climbing devices for stability tests

E.1 Least stable configuration

E.1.1 General

Remove any loose cushions.

Replace any batteries that risk leaking fluid during the test by an object of the same mass and centre of gravity.

If the seat can be swivelled to more than one position around the vertical axis adjust it to the forward-facing position.

E.1.2 Forwards

Set adjustable parts and the wheels and climbing mechanisms in the least stable configuration for forward stability in accordance with Table E.1.

Table E.1 — Adjustments for least stable forward stability

Adjustable component	Least stable
Wheelchair (if used) docking position, fore-aft	Forwards
Wheelchair (if used) docking position, tilt	Upright
Seat position, fore-aft	Forwards
Seat position, vertical	High
Seat position, tilt	Upright
Backrest position, fore-aft shift	Forwards
Backrest position, tilt	Upright
Elevating legrest position	Up

E.1.3 Backwards

Set adjustable parts and the wheels and climbing mechanisms in the least stable configuration for backward stability in accordance with Table E.2.

Table E.2 — Adjustments for least stable backward stability

Adjustable component	Least stable
Wheelchair (if used) docking position, fore-aft	Backwards
Wheelchair (if used) docking position, tilt	Recline
Seat position, fore-aft	Back
Seat position, vertical	High
Seat position, tilt	Recline
Backrest position, fore-aft shift	Back
Backrest position, tilt	Recline
Elevating legrest position	Down

E.1.4 Sideways

Set adjustable parts and the wheels and climbing mechanisms in the least stable configuration for sideways stability in accordance with Table E.3.

Table E.3 — Adjustments for least stable sideways stability

Adjustable component	Least stable
Wheelchair (if used) docking position, fore-aft	Forward
Wheelchair (if used) docking position, tilt	Upright
Seat position, vertical	High
Seat position, tilt	Upright
Backrest position, tilt	Upright
Elevating legrest position	Up

E.2 Least stable position

E.2.1 Least stable position on level ground

E.2.1.1 General

Set the stair-climbing device in its climbing mode and in its least stable configuration with respect to the test direction (forwards, backwards or sideways) and place it on the appropriate test surface.

NOTE 1 The appropriate test surface depends on the test being carried out and may be either the tilting platform specified in ISO 7176-1 for the static stability test or the rigid, flat, horizontal test plane and the rigid, flat inclined test ramp specified in ISO 7176-2 for the dynamic stability tests on level ground.

Place the stair-climbing device on the test surface in its least stable position (forward or backward) as specified in E.2.1.2, E.2.1.3 or E.2.1.4.

If it is not possible to achieve both the setting for the least stable configuration and the setting for the least stable position at one time, give priority to the setting for the least stable position.

NOTE 2 The use of either a test dummy or a human test person depends on the test being carried out.

E.2.1.2 Stair-climbing devices with tracks

E.2.1.2.1 Forwards

Where possible, set the track-driven stair-climbing device in its least stable position in the forward direction, by setting it in its least stable configuration for forward stability and placing it on the tilting platform with:

a) the horizontal fore-aft distance between the most forward ground contact point of climbing mechanism and centre of gravity as short as possible;

b) the vertical distance between the most forward ground contact point of climbing mechanism and centre of gravity as long as possible;

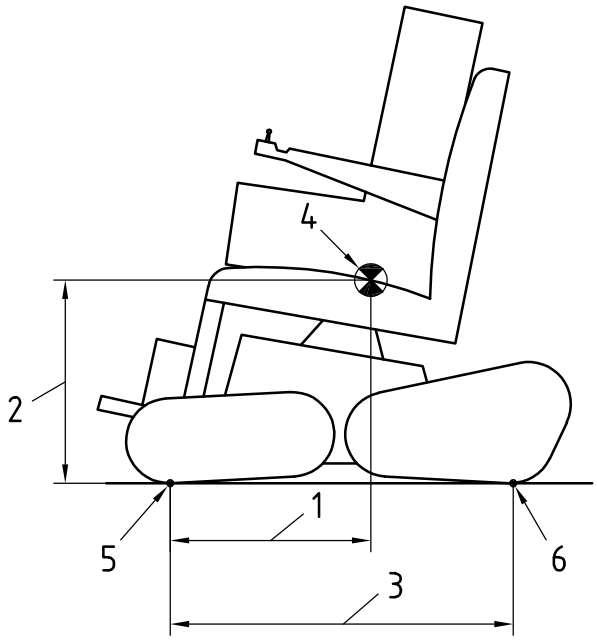
c) the horizontal fore-aft distance between the most forward ground contact point of climbing mechanism and most backward ground contact point of climbing mechanism as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear ends are dependent on each other by transmission), give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than $3° \pm 0{,}5°$ in the forward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a track-driven stair-climbing device on level ground and in the forward direction is given in Figure E.1.

NOTE In addition to track-driven stair-climbing devices, this test method is also applicable to stair-climbing devices with other types of climbing mechanisms which appear, from a lateral view, to have a nearly straight base line such as, e.g., stepping rails, etc.



Key

1 short [see E.2.1.2.1 a)]
2 long [see E.2.1.2.1 b)]
3 short [see E.2.1.2.1 c)]
4 centre of gravity
5 most forward point of contact to the ground
6 most backward point of contact to the ground

Figure E.1 — Least stable position of a track-driven stair-climbing device, on level ground, forward direction (example)

E.2.1.2.2 Backwards

Where possible, set the track-driven stair-climbing device in its least stable position in the backward direction, by setting it in its least stable configuration for backward stability and placing it on the tilting platform with:

a) the horizontal fore-aft distance between the most backward ground contact point of climbing mechanism and centre of gravity as short as possible;

b) the vertical distance between the most backward ground contact point of climbing mechanism and centre of gravity as long as possible;

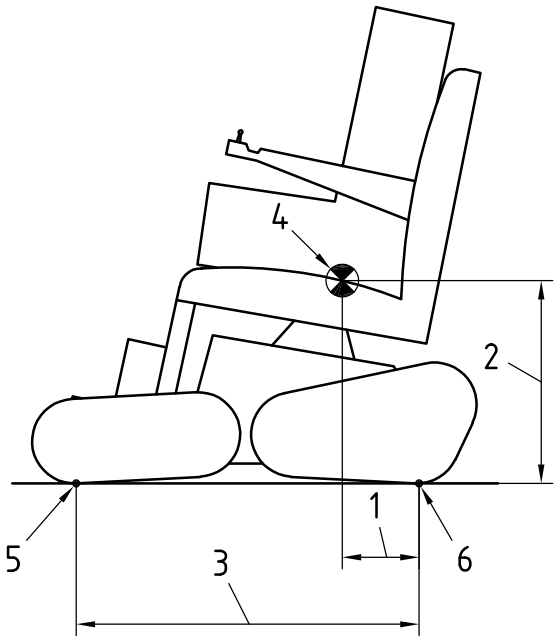
c) the horizontal fore-aft distance between the most backward ground contact point of climbing mechanism and most forward ground contact point of climbing mechanism as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear ends are dependent on each other by transmission), give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than $3° \pm 0{,}5°$ in the backward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a track-driven stair-climbing device on level ground and in the backward direction is given in Figure E.2.

NOTE In addition to track-driven stair-climbing devices, this test method is also applicable to stair-climbing devices with other types of climbing mechanisms which appear, from a lateral view, to have a nearly straight base line such as, e.g., stepping rails.



Key

1 short [see E.2.1.2.2 a)]
2 long [see E.2.1.2.2 b)]
3 short [see E.2.1.2.2 c)]
4 centre of gravity
5 most forward point of contact to the ground
6 most backward point of contact to the ground

Figure E.2 — Least stable position of a track-driven stair-climbing device, on level ground, backward direction (example)

E.2.1.3 Stair-climbing devices with clusters on two axles

E.2.1.3.1 Forwards

Where possible, set the stair-climbing device with clusters on two axles in its least stable position in the forward direction, by setting it in its least stable configuration for forward stability and placing it on the tilting platform with:

a) the central axis of the front cluster as far as possible in front of the cam in contact with the ground, without interfering with the freedom of the stair-climbing device to tip sufficiently by forward 3° ± 0,5° before the next forward cam comes into contact with the ground;

b) the central axis of the rear cluster vertically above the cam that is in contact with the ground. If it is not possible to achieve these settings at one time (e.g. front and rear clusters are connected by a transmission), give priority to the setting of the front cluster;

c) the horizontal fore-aft distance between the most forward cluster and centre of gravity as short as possible;

d) the vertical distance between the most forward cluster and centre of gravity as long as possible;

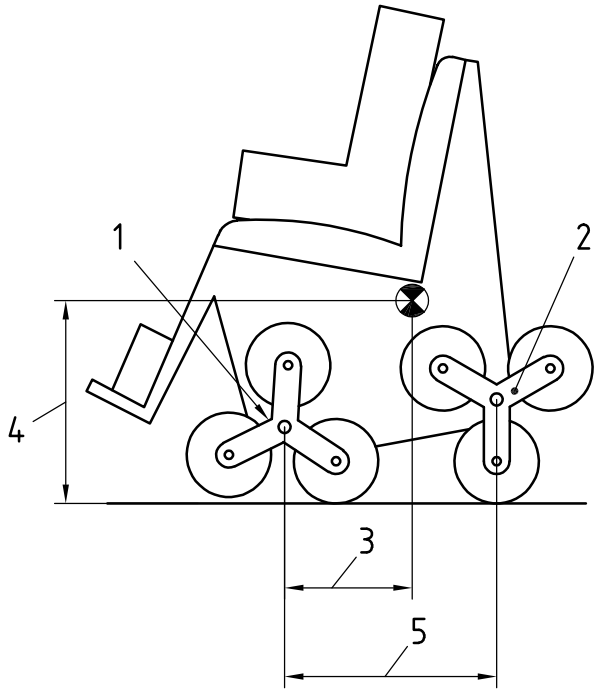
e) the horizontal fore-aft distance between the most forward cluster and most backward cluster as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear clusters are dependent on each other), give priority to the settings in the order as listed.

An example of the least stable position of a stair-climbing device with clusters on two axles, on level ground and in the forward direction is given in Figure E.3.

NOTE 1 Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.

NOTE 2 In addition to stair-climbing devices with clusters on two axles, this test method is also applicable to stair-climbing devices with similar types of climbing mechanisms which appear, from a lateral view, to have a striding mechanism such as, e.g, stepping legs.



Key

1 front cluster position [see E.2.1.3.1 a)]
2 rear cluster position [see E.2.1.3.1 b)]
3 short [see E.2.1.3.1 c)]
4 long [see E.2.1.3.1 d)]
5 short [see E.2.1.3.1 e)]

Figure E.3 — Least stable position of a stair-climbing device with clusters on two axles, on level ground, forward direction (example)

E.2.1.3.2 Backwards

Where possible, set the stair-climbing device with clusters on two axles in its least stable position in the backward direction, by setting it in its least stable configuration for backward stability and placing it on the tilting platform with:

a) the central axis of the rear cluster as far as possible to the rear of the cam in contact with the ground, without interfering with the freedom of the stair-climbing device to tip backwards sufficiently by 3° ± 0,5° before the next rearward cam comes into contact with the ground;

b) the central axis of the front cluster is vertically above the cam in contact with the ground. If it is not possible to achieve these settings at one time (e.g. front and rear clusters are connected by a transmission) give priority to the setting of the rear cluster;

c) the horizontal fore-aft distance between the most backward cluster and centre of gravity as short as possible;

d) the vertical distance between the most backward cluster and centre of gravity as long as possible;

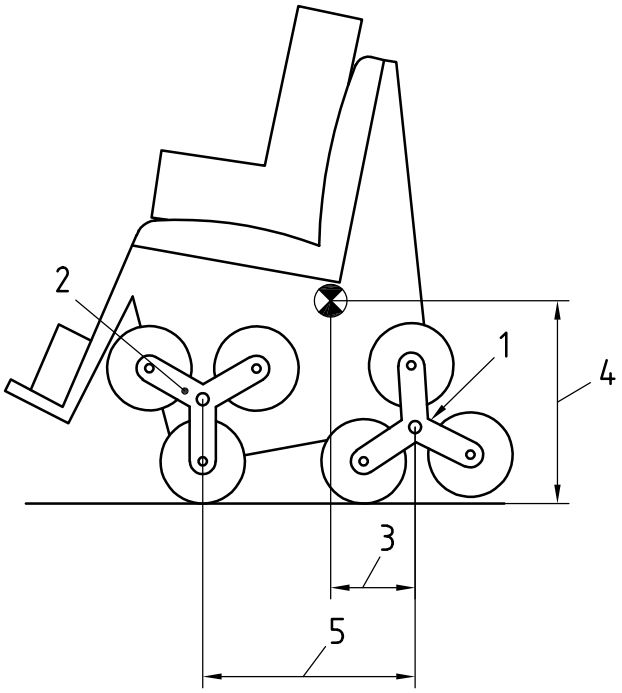
e) the horizontal fore-aft distance between the most backward cluster and most forward cluster as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear cluster are dependent on each other), give priority to the settings in the order as listed.

An example of the least stable position of a stair-climbing device with clusters on two axles, on level ground and in the backward direction is given in Figure E.4.

NOTE 1 Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.

NOTE 2 In addition to stair-climbing devices with clusters on two axles, this test method is also applicable to stair-climbing devices with similar types of climbing mechanisms which appear, from a lateral view, to have a striding mechanism such as, e.g., stepping legs.



Key

1 rear cluster position [see E.2.1.3.2 a)]
2 front cluster position [see E.2.1.3.2 b)]
3 short [see E.2.1.3.2 c)]
4 long [see E.2.1.3.2 d)]
5 short [see E.2.1.3.2 e)]

Figure E.4 — Least stable position of a stair-climbing device with clusters on two axles, on level ground, backward direction (example)

E.2.1.4 Stair-climbing devices with clusters on one axle

E.2.1.4.1 Forwards

Where possible, set the stair-climbing device with clusters on one axle in its least stable position in the forward direction, by setting it in its least stable configuration for forward stability and placing it on the tilting platform with:

a) the horizontal fore-aft distance between the most forward cam and centre of gravity as short as possible;

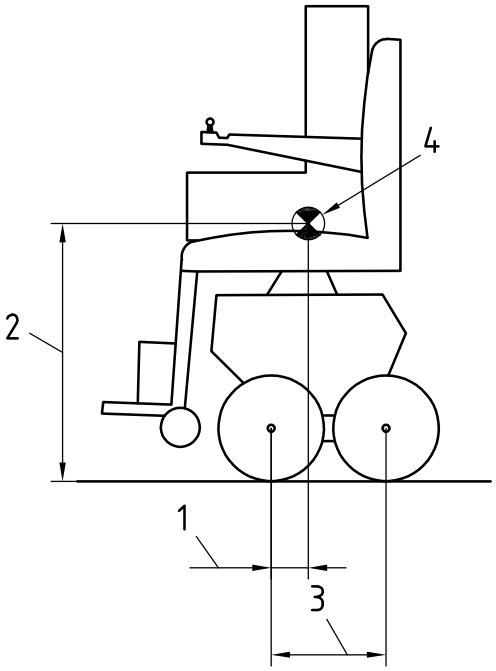
b) the vertical distance between the most forward cam and centre of gravity as long as possible;

c) the horizontal fore-aft distance between the most forward and most backward cam as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear cams are dependent on each other), give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than $3° \pm 0{,}5°$ in the forward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a stair-climbing device with clusters on one axle, on level ground and in the forward direction is given in Figure E.5.



Key

1 short [see E.2.1.4.1 a)]
2 long [see E.2.1.4.1 b)]
3 short [see E.2.1.4.1 c)]
4 centre of gravity

Figure E.5 — Least stable position of a stair-climbing device with clusters on one axle, on level ground, forward direction (example)

E.2.1.4.2 Backwards

Where possible, set the stair-climbing device with clusters on one axle in its least stable position in the backward direction, by setting it in its least stable configuration for backward stability and placing it on the tilting platform with:

a) the horizontal fore-aft distance between the most backward cam and centre of gravity as short as possible;

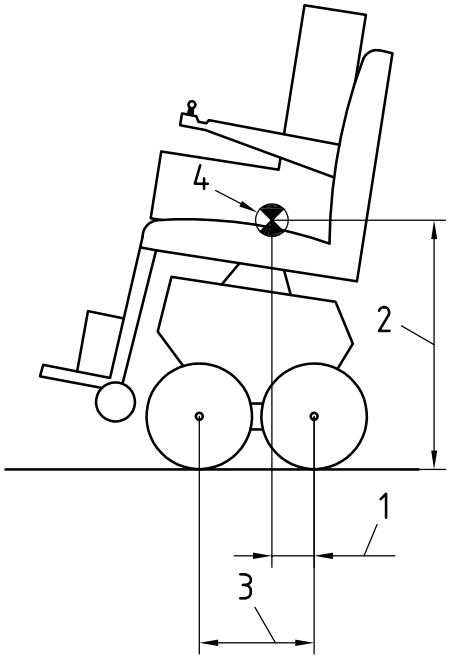
b) the vertical distance between the most backward cam and centre of gravity as long as possible;

c) the horizontal fore-aft distance between the most backward and most forward cam as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of rear and front cams are dependent on each other) give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than 3° ± 0,5° in the backward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a stair-climbing device with clusters on one axle, on level ground and in the backward direction is given in Figure E.6.



Key

1 short [see E.2.1.4.2 a)]
2 long [see E.2.1.4.2 b)]
3 short [see E.2.1.4.2 c)]
4 centre of gravity

Figure E.6 — Least stable position of a stair-climbing device with clusters on one axle, on level ground, backward direction (example)

E.2.2 Least stable position on stairs

E.2.2.1 General

Where possible, set the stair-climbing device in its climbing mode and place it in both its least stable configuration and least stable position on the straight test stairs with respect to the test direction (downward or upward).

Place the stair-climbing device on the straight test stairs in its least stable position (downward or upward) as specified in E.2.2.2, E.2.2.3 or E.2.2.4.

If it is not possible to achieve both the setting for the least stable configuration and the setting for the least stable position at one time, give priority to the setting for the least stable position.

NOTE The use of either a test dummy or a human test person depends on the test being carried out.

E.2.2.2 Stair-climbing devices with tracks

E.2.2.2.1 Downwards

Where possible, set the track-driven stair-climbing device in its least stable position in the downward direction, by setting it in its least stable configuration for forward stability and placing it on the straight test stairs with:

a) the stair-climbing device overhanging the lowermost contacted step as far as possible in the downward direction, without interfering with the freedom of the stair-climbing device to tip downwards sufficiently by 3° ± 0,5° before coming into contact with the next lower step;

b) the horizontal fore-aft distance between the most downward ground contact point of the climbing mechanism and centre of gravity as short as possible;

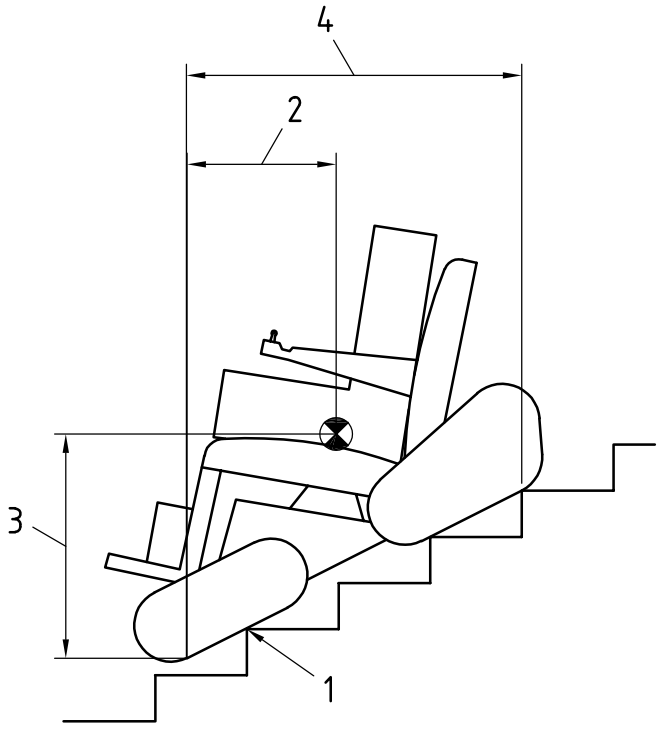
c) the vertical distance between the most downward ground contact point of the climbing mechanism and centre of gravity as long as possible;

d) the horizontal fore-aft distance between the most downward ground contact point of the climbing mechanism and most upward ground contact point of the climbing mechanism as short as possible.

If it is not possible to achieve these settings at one time (e.g. if the positions of the front and rear ends are dependent on each other), give priority to the settings in the order as listed.

An example of the least stable position of a track-driven stair-climbing device on stairs and in the downward direction is given in Figure E.7.

NOTE In addition to track-driven stair-climbing devices, this test method is also applicable to stair-climbing devices with other types of climbing mechanism which appear, from a lateral view, to have a nearly straight base line such as stepping rails.



Key
1 position of the stair-climbing device on the stairs [see B.2.2.2.1 a)
2 short [see E.2.2.2.1 b)]
3 long [see E.2.2.2.1 c)]
4 short [see E.2.2.2.1 d)]

Figure E.7 — Least stable position of a track-driven stair-climbing device, on stairs, downward direction (example)

E.2.2.2.2 Upwards

Where possible, set the track-driven stair-climbing device in the least stable position in the upward direction, by setting it in its least stable configuration for backward stability and placing it on the straight test stairs with:

a) the stair-climbing device overhanging the uppermost contacted step as far as possible in the upward direction, without interfering with the freedom of the stair-climbing device to tip sufficiently upward by 3° ± 0,5° before coming into contact with the next higher step;

b) the horizontal fore-aft distance between the most upward ground contact point of the climbing mechanism and centre of gravity as short as possible;

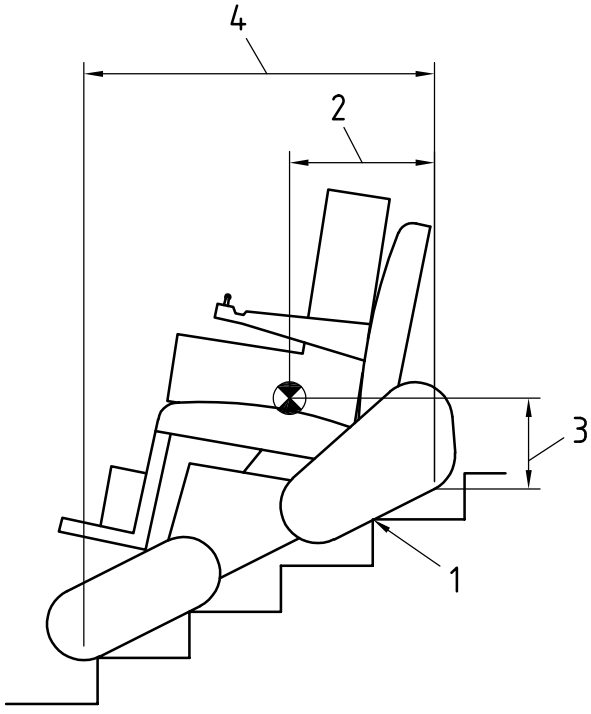
c) the vertical distance between the most upward ground contact point of the climbing mechanism and centre of gravity as long as possible;

d) the horizontal fore-aft distance between the most upward ground contact point of climbing mechanism and most downward ground contact point of the climbing mechanism as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear ends are dependent on each other) give priority to the settings in the order as listed.

An example of the least stable position of a track-driven stair-climbing device on stairs and in the upward direction is given in Figure E.8.

NOTE In addition to track-driven stair-climbing devices, this test method is also applicable to stair-climbing devices with other types of climbing mechanisms which appear, from a lateral view, to have a nearly straight base line such as stepping rails.



Key

1 position of the stair-climbing device on the stairs [see E.2.2.2.2 a)]
2 short [see E.2.2.2.2 b)]
3 long [see E.2.2.2.2 c)]
4 short [see E.2.2.2.2 d)]

Figure E.8 — Least stable position of a track-driven stair-climbing device, on stairs, upward direction (example)

E.2.2.3 Stair-climbing devices with clusters on two axles

E.2.2.3.1 Downwards

E.2.2.3.1.1 Smaller clusters

Determination of smaller clusters and larger clusters is explained in Annex I.

Where possible, set the stair-climbing device with smaller clusters on two axles in the least stable position in the downward direction, by setting it in its least stable configuration for forward stability and placing it on the straight test stairs with:

a) the central axis of the front cluster horizontally in front of the cam in contact with the step;

b) the central axis of the rear cluster vertically above the cam in contact with the step. If it is not possible to achieve these settings at one time (e.g. front and rear clusters are connected by transmission) give priority to the setting of the front cluster;

c) the horizontal fore-aft distance between the most downward cluster and centre of gravity as short as possible;

d) the vertical distance between the most downward cluster and centre of gravity as long as possible;

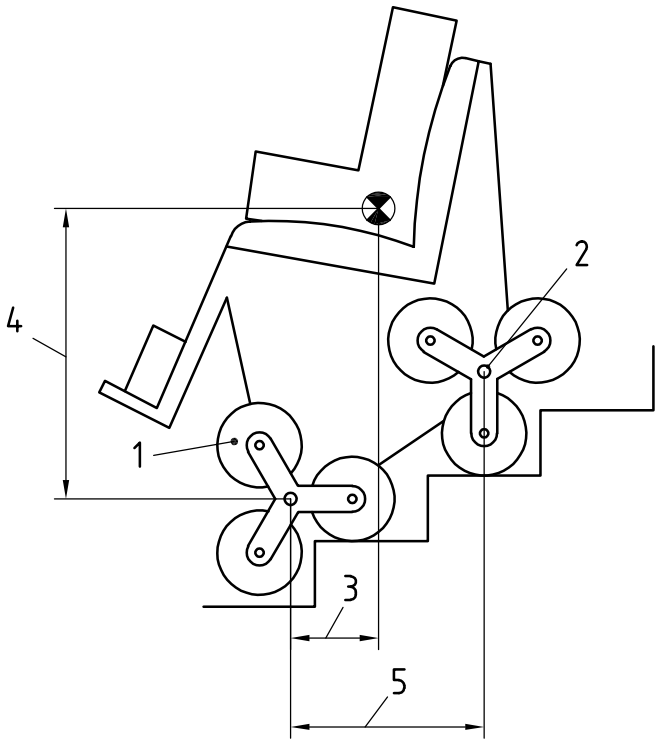
e) the horizontal fore-aft distance between the most downward cluster and most upward cluster as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear clusters are dependent on each other) give priority to the settings in the order as listed.

If the settings from a) to e) give a freedom to tip of less than $3° \pm 0{,}5°$ in the downward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a stair-climbing device with smaller clusters on stairs and in the downward direction is given in Figure E.9.

NOTE Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.



Key

1 front cluster position [see E.2.2.3.1.1 a)]
2 rear cluster position [see E.2.2.3.1.1 b)]
3 short [see E.2.2.3.1.1 c)]
4 long [see E.2.2.3.1.1 d)]
5 short [see E.2.2.3.1.1 e)]

Figure E.9 — Least stable position of a stair-climbing device with smaller clusters on two axles, on stairs, downward direction (example)

E.2.2.3.1.2 Larger clusters

Determination of smaller clusters and larger clusters is explained in Annex I.

Where possible, set the stair-climbing device with larger clusters on two axles in its least stable position in the downward direction, by setting it in its least stable configuration for forward stability and placing it on the straight test stairs with:

a) the front cluster turned so that it is possible to tip the stair-climbing device about its contacting cam sufficiently downward by 3° ± 0,5° before the next lower cam comes in contact with the next lower step;

b) the central axis of the rear cluster vertically above the cam in contact with the ground. If it is not possible to achieve these settings at one time (e.g. front and rear clusters are connected by transmission), give priority to the setting of the front cluster;

c) the horizontal fore-aft distance between the most downward cluster and centre of gravity as short as possible;

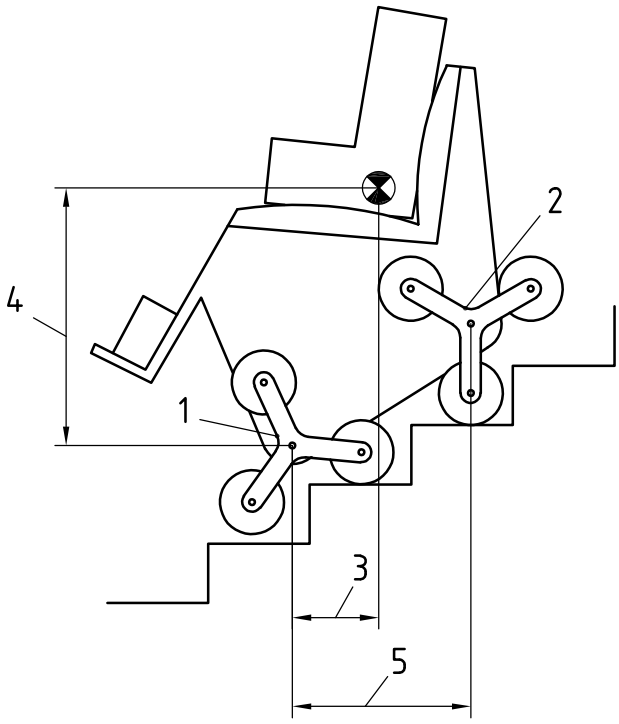
d) the vertical distance between the most downward cluster and centre of gravity as long as possible;

e) the horizontal fore-aft distance between the most downward cluster and most upward cluster as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear clusters are dependent on each other) give priority to the settings in the order as listed.

An example of the least stable position of a stair-climbing device with larger clusters on stairs and in the downward direction is given in Figure E.10.

NOTE Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.



Key

1 front cluster position [see E.2.2.3.1.2 a)]
2 rear cluster position [see E.2.2.3.1.2 b)]
3 short [see E.2.2.3.1.2 c)]
4 long [see E.2.2.3.1.2 d)]
5 short [see E.2.2.3.1.2 e)]

Figure E.10 — Least stable position of a stair-climbing device with larger clusters on two axles, on stairs, downward direction (example)

E.2.2.3.2 Upwards

Where possible, set the stair-climbing device with clusters on two axles in its least stable position in the upward direction, by setting it in its least stable configuration for backward stability and placing it on the straight test stairs with:

a) the rear cluster turned so that it is possible to tip the stair-climbing device about its contacting cam sufficiently upward by 3° ± to 0,5° before the next higher cam comes in contact with the next higher step;

b) the central axis of the front cluster vertically above the cam in contact with the ground. If it is not possible to achieve these settings at one time (e.g. rear and front clusters are connected by transmission), give priority to the setting of the rear cluster;

c) the horizontal fore-aft distance between the most upward cluster and centre of gravity as short as possible;

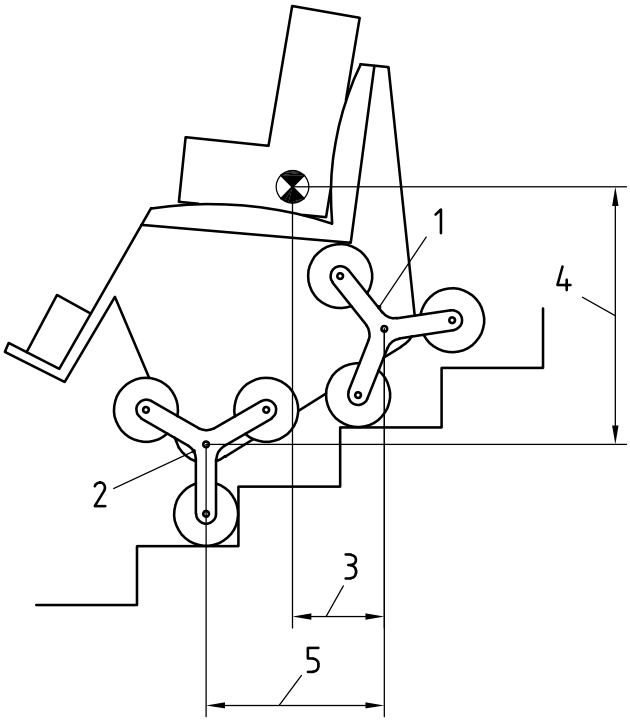
d) the vertical distance between the most upward cluster and centre of gravity as long as possible;

e) the horizontal fore-aft distance between the most upward cluster and most downward cluster as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of front and rear clusters are dependent on each other), give priority to the settings in the order as listed.

An example of the least stable position of a stair-climbing device with larger clusters on stairs and in the upward direction is given in Figure E.11.

NOTE Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.



Key

1 rear cluster position [see E.2.2.3.2 a)]
2 front cluster position [see E.2.2.3.2 b)]
3 short [see E.2.2.3.2 c)]
4 long [see E.2.2.3.2 d)]
5 short [see E.2.2.3.2 e)]

Figure E.11 — Least stable position of a stair-climbing device with clusters on two axles, on stairs, upward direction (example)

E.2.2.4 Stair-climbing devices with clusters on one axle

E.2.2.4.1 Downwards

Where possible, set the stair-climbing device with clusters on one axle in its least stable position in downward direction, by setting it in its least stable configuration for forward stability and placing it on the straight test stairs with:

a) the horizontal fore-aft distance between the lowermost cam and centre of gravity as short as possible;

b) the vertical distance between the lowermost cam and centre of gravity as long as possible;

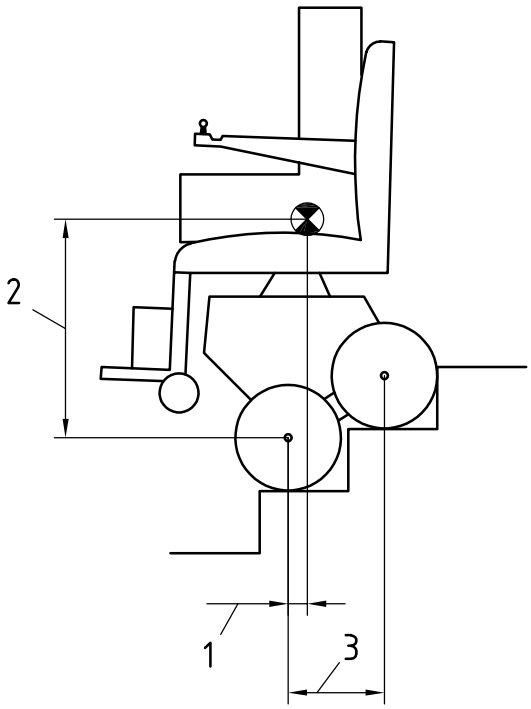
c) the horizontal fore-aft distance between the lowermost and the uppermost cam as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of lowermost and uppermost cams are dependent on each other), give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than $3° \pm 0{,}5°$ in the downward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a stair-climbing device with clusters on one axle, on stairs and in the downward direction is given in Figure E.12.

NOTE Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.



Key

1 short [see E.2.2.4.1 a)]
2 long [see E.2.2.4.1 b)]
3 short [see E.2.2.4.1 c)]

Figure E.12 — Least stable position of a stair-climbing device with clusters on one axle, on stairs, downward direction (example)

E.2.2.4.2 Upwards

Where possible, set the stair-climbing device with clusters on one axle in its least stable position in the upward direction, by setting it in its least stable configuration for backward stability and placing it on the straight test stairs with:

a) the horizontal fore-aft distance between the uppermost cam and centre of gravity as short as possible;

b) the vertical distance between the uppermost cam and centre of gravity as long as possible;

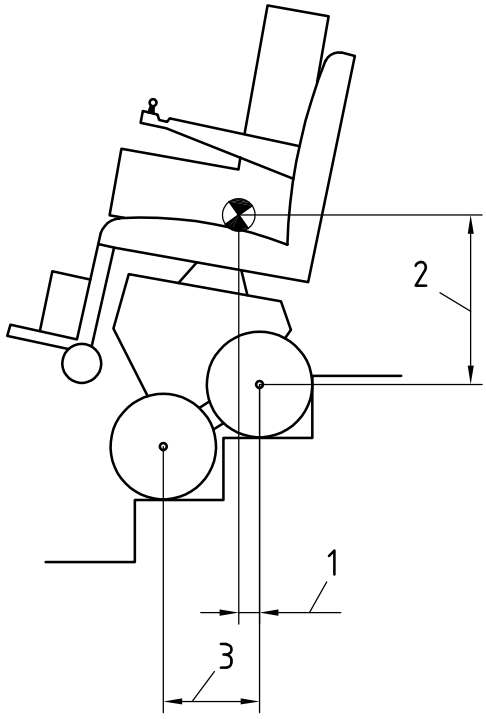
c) the horizontal fore-aft distance between the uppermost and the lowermost cam as short as possible.

If it is not possible to achieve these settings at one time (e.g. positions of uppermost and lowermost cams are dependent on each other) give priority to the settings in the order as listed.

If the settings from a) to c) give a freedom to tip of less than $3° \pm 0{,}5°$ in the upward direction, correct the configuration of the climbing mechanism to the minimum extent in order to achieve this value.

An example of the least stable position of a stair-climbing device with clusters on one axle, on stairs and in the upward direction is given in Figure E.13.

NOTE Repeated resetting may be necessary because the setting of one cluster may influence the position of the other cluster and vice versa.



Key

1 short [see E.2.2.4.2 a)]
2 long [see E.2.2.4.2 b)]
3 short [see E.2.2.4.2 c)]

Figure E.13 — Least stable position of a stair-climbing device with clusters on one axle, on stairs, upward direction (example)

Annex F
(normative)

Escalator test machine

The escalator test machine shall consist of the following:

a) stairs moving with at least five steps along a flat plane that is inclined 30° ± 2° to the horizontal;

b) stairs of a width that is at least 100 mm greater than the width of the stair-climbing device under test;

c) steps with going and rise of dimension and size to accommodate the climbing mechanism of the stair-climbing device appropriately;

NOTE For most stair-climbing devices a going and rise of 146 mm ± 20 mm is suitable.

d) step nosings with a radius of 4 mm ± 2 mm;

e) provision for the escalator test machine to be set in motion by the stair-climbing device using the stair-climbing device's climbing system and gravity;

f) provision to adjust the turning resistance of the escalator test machine so that the stair-climbing device, when climbing upstairs, is not moving upwards or downwards but the steps of the escalator are pushed downstairs;

g) provision to mount the stair-climbing device on the moving stairs and capability of bearing the weight of the loaded stair-climbing device;

h) provision to hold the stair-climbing device on the escalator test machine during the test in the position for climbing as intended by the manufacturer;

NOTE In order to achieve this, restraints are fixed to the frame of the stair-climbing device.

i) means of measuring the tension forces of the longitudinal restraints in the range of 10 N to 400 N to an accuracy of 5 %;

j) lateral restraints that restrict sideways movement to ± 50 mm, such that the restraints do not restrict climbing of the stair-climbing device;

k) provision to count the number of steps climbed by the stair-climbing device.

Annex G
(normative)

Determination of outer dimensions and operating area

G.1 Test methods

G.1.1 General

WARNING — Some of the tests given in Annex G can be hazardous. It is essential that precautions be taken to protect test personnel.

Prepare the stair-climbing device as described in Clause 6.

If the speed of the stair-climbing device is adjustable, perform tests at maximum recommended speed, as described in 6.5.2.

G.1.2 Determination of occupied length

This test is applicable to all stair-climbing devices.

Load the stair-climbing device with the test wheelchair (where applicable) and the appropriate test dummy or a human test person, as described in 6.6.

Position the loaded stair-climbing device on the horizontal test plane. Set the stair-climbing device in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

Use the adjustable barriers for detecting the maximum extension of the stair-climbing device in fore-aft direction.

Measure, to an accuracy of ± 25 mm, the maximum extension in fore-aft direction.

If the manufacturer states that the seat or backrest can be reclined or the test wheelchairs can be positioned in more than one position in relation to the stair-climbing device (e.g. reclined and upright), repeat the test in each extreme position.

Identify the greatest of all measured extensions in fore-aft direction and record as the occupied length of the stair-climbing device.

G.1.3 Determination of occupied width

This test is applicable to all stair-climbing devices.

Load the stair-climbing device with the test wheelchair (where applicable) and the appropriate test dummy or a human test person, as described in 6.6.

Position the loaded stair-climbing device on the horizontal test plane. Set the stair-climbing device in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

Use the adjustable barriers for detecting the maximum extension of the stair-climbing device in the side-to-side direction.

Measure, to an accuracy of ± 25 mm, and record the maximum extension in the side-to-side direction as the occupied width of the stair-climbing device.

G.1.4 Determination of reversing width (type 1)

This test is applicable to stair-climbing devices with a driving mode that uses full differential steering.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Position the loaded stair-climbing device on the horizontal test plane. Set the stair-climbing device in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

Construct a corridor with an adjustable width by using two parallel adjustable barriers that can be used to detect the turn-around width.

Using only one single turning manoeuvre, turn the wheelchair around in the corridor in the most suitable manner for the stair-climbing device.

Gradually reduce the width of the corridor and determine the minimum corridor width in which the stair-climbing device can be turned around without touching the walls.

Measure, to an accuracy of ± 25 mm, the minimum corridor width.

If the manufacturer states that the seat or backrest can be reclined or the test wheelchairs can be positioned in more than one position in relation to the stair-climbing device (e.g. reclined and upright), repeat the test in each extreme position.

Identify the greatest measured corridor width for the different seat positions and record it as the reversing width (type 1) of the stair-climbing device.

G.1.5 Determination of reversing width (type 2)

This test is applicable to stair-climbing devices with a driving mode that uses direct steering or limited differential steering.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Position the loaded stair-climbing device on the horizontal test plane. Set the stair-climbing device in its driving mode, if it has one, or its crawling mode or, if there is also no crawling mode, its climbing mode.

Construct a corridor with an adjustable width by using two parallel adjustable barriers that can be used to detect the reversing width (type 2).

Using only one forward, one backing and finally one forward drive, turn the wheelchair around in the corridor in the most suitable manner for the stair-climbing device.

Gradually reduce the width of the corridor and determine the minimum corridor width in which the stair-climbing device can be turned around without touching the walls.

Measure, to an accuracy of ± 25 mm, and record the minimum corridor width.

If the manufacturer states that the seat or backrest can be reclined or the test wheelchairs can be positioned in more than one position in relation to the stair-climbing device (e.g. reclined and upright), repeat the test in each extreme position.

Identify the greatest measured corridor width for the different seat positions and record it as the reversing width (type 2) of the stair-climbing device.

G.1.6 Determination of minimum stair width for straight stairs

This test is applicable to all stair-climbing devices.

Connect the straight test stairs to the upper landing and position the adjustable barriers at both sides of each step.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Position the stair-climbing device on the lower landing for ascending the stairs, following the manufacturer's instructions. Set the stair-climbing device into its climbing mode.

Let the stair-climbing device climb upstairs so that the whole stair-climbing device is on the upper landing as recommended by the manufacturer.

Gradually reduce the width of the stairs and determine the minimum stair width that can be ascended without the stair-climbing device, the test wheelchair (if used), or the test dummy coming into contact with the adjustable barrier. Measure parallel to the step nosings and to an accuracy of $\pm$ 25 mm, the distance between the barriers.

Position the stair-climbing device on the upper landing for descending the stairs in accordance with the manufacturer's instructions.

Let the stair-climbing device climb downstairs so that the whole stair-climbing device is on the lower landing as recommended by the manufacturer.

Gradually reduce the width of the stairs and determine the minimum stair width that can be descended without the stair-climbing device, the test wheelchair (if used), or the test dummy coming into contact with the adjustable barrier. Measure parallel to the step nosings and to an accuracy of $\pm$ 25 mm, the distance between the barriers.

Record the greater of the test results obtained in the tests for ascending and descending as the minimum stair width for straight stairs.

G.1.7 Determination of minimum landing area for U-shaped stairs

This test is applicable to all stair-climbing devices.

Connect the straight test stairs to the upper landing, which simulates the intermediate landing for the first part of the test.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device in its climbing mode.

Let the stair-climbing device climb straight upwards on to the upper landing as recommended by the manufacturer until it is fully accommodated on it and with no part of the stair-climbing device below its top plane. Then change (if necessary) to the crawling mode for performing a U-turn. Let the stair-climbing device crawl toward the landing for a minimum horizontal distance of 200 mm.

Establish a datum mark on the stair-climbing device against the step nosing of step 8 (or take any other appropriate measures) for later positioning of the stair-climbing device on the horizontal test plane at the step line (see next paragraph). Let the stair-climbing device climb down to the horizontal test plane.

Place the straight test stairs on the horizontal test plane, which simulates the intermediate landing for the second part of the test. On the horizontal test plane and as an elongation of step 1 of the straight test stairs, draw a step line that represents the step nosing of the uppermost step of the lower stairs as shown in

Figure G.1. Position the handrail barrier with the 400 mm long edge at the step line and next to the straight test stairs. Position three adjustable barriers on the horizontal test plane. Position two of them as lateral barriers perpendicular to step 1 of the straight test stairs and one of them as frontal barrier parallel to step 1 of the straight test stairs.

Position the stair-climbing device with the datum mark against the step line and close to the handrail barrier.

Let the stair-climbing device crawl around the handrail barrier to prepare for climbing the straight test stairs, which represent the upper stairs.

Perform the 180° turn as recommended by the manufacturer, unless there is no such recommendation, in which case perform the turn in the most suitable manner, smoothly and with a minimum of stopping but without reversing direction, and without the occurrence of an adverse situation.

Complete the 180° turn before the stair-climbing device starts to climb the first step of the straight test stairs, which represents the lowermost step of the upper stairs.

Gradually reduce the size of the landing and determine the minimum landing size in which the stair-climbing device can manoeuvre without the stair-climbing device, the test wheelchair (if used), or the dummy coming into contact with the adjustable barrier.

Measure parallel to the step nosings and to an accuracy of $\pm$ 25 mm, the minimum length between the two lateral barriers for ascending.

Measure horizontally and perpendicular to the step nosings and to an accuracy of $\pm$ 25 mm, the minimum width between the step line and the frontal barrier for ascending.

NOTE 1 Some experimentation might be necessary to determine the minimum dimensions for ascending.

Position the stair-climbing device on the straight test stairs and close to the handrail barrier.

Let the stair-climbing device climb straight downwards on to the lower landing until it is fully accommodated on the horizontal test plane. Then change (if necessary) to the crawling mode for performing a U-turn.

Let the stair-climbing device crawl around the handrail barrier to prepare for climbing the lower stairs (simulated by the area beyond the step line) as recommended by the manufacturer.

Perform the 180° turn as recommended by the manufacturer, unless there is no such recommendation, in which case, perform the turn in the most suitable manner, smoothly and with a minimum of stopping but without reversing direction, and without the occurrence of an adverse situation.

Complete the 180° turn before the datum mark crosses the step line, which represents the step nosing of the uppermost step of the lower stairs.

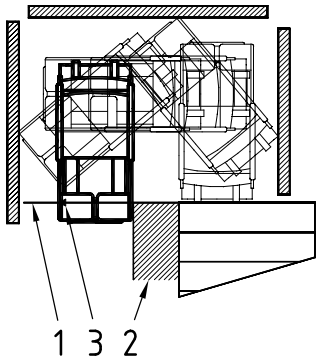
Gradually reduce the size of the landing and determine the minimum landing size in which the stair-climbing device can manoeuvre without the stair-climbing device, the test wheelchair (if used), or the dummy coming into contact with the adjustable barrier.

Measure parallel to the step nosings and to an accuracy of $\pm$ 25 mm, the minimum length between the two lateral barriers for descending.

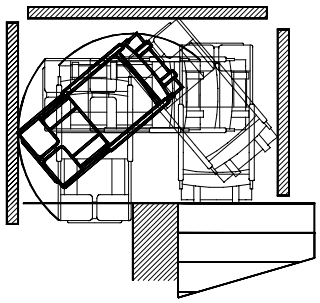
Measure horizontally and perpendicular to the step nosings and to an accuracy of $\pm$ 25 mm, the minimum width between the step line and the frontal barrier for descending.

NOTE 2 Some experimentation might be necessary to determine the minimum dimensions for descending.

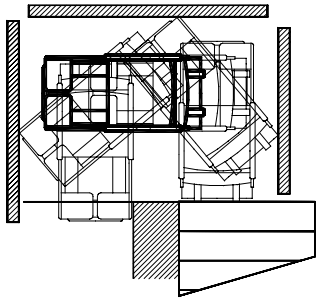
If the manufacturer states that the seat or backrest can be reclined or the test wheelchairs can be positioned in more than one position in relation to the stair-climbing device (e.g. reclined and upright), repeat the test in each extreme position.



pos. 1



pos. 2



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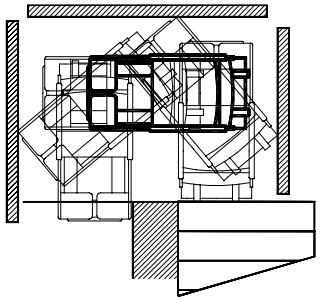

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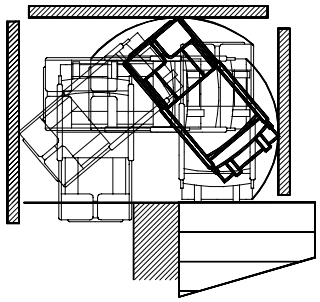

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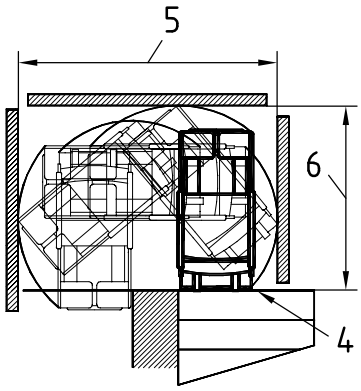

pos. 6

Key

1 step line representing nosing of uppermost step of lower stairs
2 handrail barrier
3 mark against nosing of uppermost step of lower stairs
4 step 1 of straight test stairs representing first step of upper stairs
5 length of minimum landing area for U shaped stairs
6 width of minimum landing area for U shaped stairs

Figure G.1— Determination of length and width of minimum landing area for U-shaped stairs

Identify the greatest measured length-dimensions and the greatest measured width-dimensions for the different seat positions and record them as the length and the width of the minimum landing area for U-shaped stairs.

G.1.8 Determination of minimum outer stair radius on winding stairs

This test is applicable to stair-climbing devices intended for use on winding stairs.

Connect the winding test stairs to the upper landing and position adjustable barriers on each step. Set the adjustable barriers at a distance from the central axis of the stairs to limit the outer radius of the space needed to climb the winding test stairs.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device into its climbing mode.

NOTE This test may be performed in conjunction with the test described in G.1.9.

Position the loaded stair-climbing device on the lower landing for ascending the stairs in accordance with the manufacturer's instructions, for the shortest going or the minimum stair radius. If there is no such instruction, position the stair-climbing device at a point where the going is as expressed by the following equation:

$$G = \frac{D}{2} + M$$

where

G is the going for testing, in millimetres;

D is the diameter of the largest wheel of the climbing mechanism, in millimetres;

M is the safety margin, equal to 50 millimetres.

Let the stair-climbing device climb upwards so that it is on the upper landing as recommended by the manufacturer.

If during this test run an adverse situation occurs, repeat the test run from a starting position that is shifted 50 mm $\pm$ 2 mm away from the starting position of the previous test run in the outward direction. Repeat this procedure until the test run can be completed without the occurrence of an adverse situation.

While climbing the stairs from that starting point which gives the first test run without the occurrence of an adverse situation, move the adjustable barriers on each step as close as possible to the stair-climbing device but without the barriers interfering with the stair-climbing device, the test wheelchair (if used) or the test dummy.

Measure, to an accuracy of $\pm$ 25 mm, the greatest distance between the central axis of the stairs and the barriers for ascending.

Position the loaded stair-climbing device on the upper landing for descending the stairs following the manufacturer's instructions for the shortest going or the minimum stair radius. If there is no such instruction, position the stair-climbing device at a point where the going is as specified by the above equation.

Climb the stair-climbing device downstairs so that it is on the lower landing as recommended by the manufacturer.

If during this test run an adverse situation occurs, repeat the test run from a starting position that is shifted 50 mm $\pm$ 2 mm away from the starting position of the previous test run in the outward direction. Repeat this procedure until the test run can be completed without the occurrence of an adverse situation.

While climbing the stairs from that starting point which gives the first test run without the occurrence of an adverse situation, move the adjustable barriers on each step as close as possible to the stair-climbing device but without the barriers interfering with the stair-climbing device, the test wheelchair (if used) or the test dummy.

Measure, to an accuracy of ± 25 mm, the greatest distance between the central axis of the stairs and the barriers for descending.

Record the greater of the test results obtained in the tests for ascending and descending as the minimum outer stair radius on winding stairs.

G.1.9 Determination of minimum inner stair radius on winding stairs

This test is applicable to stair-climbing devices intended for use on winding stairs.

Connect the winding test stairs to the upper landing and position adjustable barriers on each step. Prepare the adjustable barriers for later determination of the inner radius of the space needed to climb the winding test stairs.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

Set the stair-climbing device in its climbing mode.

NOTE This test may be performed in conjunction with the test given in G.1.8.

Position the loaded stair-climbing device on the lower landing for ascending the stairs in accordance with the manufacturer's instructions, for the shortest going or the minimum stair radius. If there is no such instruction, position the stair-climbing device at a point where the going is calculated according to the equation given in G.1.8.

Let the stair-climbing device climb upwards so that the stair-climbing device is on the upper landing as recommended by the manufacturer.

If during this test run an adverse situation occurs, repeat the test run from a starting position that is shifted 50 mm ± 2 mm away from the starting position of the previous test run in the outward direction. Repeat this procedure until the test run can be completed without the occurrence of an adverse situation.

While climbing the stairs from the starting point that gives the first test run without the occurrence of an adverse situation, move the adjustable barriers on each step as close as possible to the stair-climbing device but without the barriers interfering with the stair-climbing device, the test wheelchair (if used) or the test dummy.

Measure, to an accuracy of ± 25 mm, the greatest distance between the central axis of the stairs and the barriers for ascending.

Position the loaded stair-climbing device on the upper landing for descending the stairs following the manufacturer's instructions for the shortest going or the minimum stair radius. If there is no such instruction, position the stair-climbing device at a point where the going is calculated according to the equation given in G.1.8.

Let the stair-climbing device climb downstairs so that it is on the lower landing as recommended by the manufacturer.

If during this test run an adverse situation occurs, repeat the test run from a starting position that is shifted 50 mm ± 2 mm away from the starting position of the previous test run in the outward direction. Repeat this procedure until the test run can be completed without the occurrence of an adverse situation.

While climbing the stairs from the starting point that gives the first test run without the occurrence of an adverse situation, move the adjustable barriers on each step as close as possible to the stair-climbing device but without the barriers interfering with the stair-climbing device, the test wheelchair (if used) or the test dummy.

Measure, to an accuracy of ± 25 mm, the greatest distance between the central axis of the stairs and the barriers for descending.

Record the greater of the test results obtained in the tests for ascending and descending as the minimum inner stair radius on winding stairs.

G.2 Test report

In addition to the information specified in Clause 17, the test report shall include the dimensions determined in accordance with G.1.2 to G.1.9.

Annex H
(normative)

Determination of theoretical energy consumption

H.1 Principle

The test methodology for determining the theoretical energy consumption of a stair-climbing device consists of letting the stair-climbing device climb repeatedly up and down the test stairs for a set number of steps, with the batteries fully charged, then measuring the ampere hours used and calculating from that the theoretical number of steps that the device is able to climb before the battery is completely discharged.

NOTE This test is an extension and adaptation of ISO 7176-4.

H.2 Test method

H.2.1 General

Prepare the stair-climbing device as described in Clause 6.

If the speed of the stair-climbing device is adjustable, perform tests at maximum recommended speed, as described in 6.5.2.

Load the stair-climbing device with the test wheelchair (where appropriate) and the appropriate test dummy or a human test person, as described in 6.6.

NOTE The test methods given in this annex require the positioning of the stair-climbing device on steps identified by their number. The stair-climbing device is on a numbered step when half its length is across the step nosing ± 50 mm.

H.2.2 Energy consumption on level ground

The test is applicable to stair-climbing devices that have a driving mode.

Test the stair-climbing device in its driving mode in accordance with ISO 7176-4.

H.2.3 Energy consumption on stairs

This test is applicable to all stair-climbing devices.

Carry out this test using the straight test stairs and the upper landing.

Fully charge the batteries in accordance with the manufacturer's instructions.

NOTE 1 The batteries should not be charged as described in 6.3.

Set the stair-climbing device in its climbing mode.

Position the stair-climbing device on the lower landing immediately before step 1. Climb upwards to a position on the upper landing immediately behind step 8 and then climb back downwards to the starting position. Perform this procedure a total of ten times.

Measure the ampere hours used by the stair-climbing device during the test.

NOTE 2 This test will normally not totally discharge the battery of a stair-climbing device but care should be taken not to discharge the battery below the level recommended by the manufacturer.

Calculate the theoretical number of steps the stair-climbing device is able to perform up and down according to the equation:

$$N = \frac{C \times S}{E}$$

where

N is the theoretical number of steps (up and down) that the stair-climbing device is capable of climbing before the battery is completely discharged;

C is the capacity of the battery in ampere hours at a 5 h rate of discharge as declared by the battery manufacturer;

S is the number of climbed steps, equal to 80;

E is the number of ampere hours used during the test.

H.3 Test report

In addition to the information specified in Clause 17, the test report shall include:

a) the theoretical distance range of the stair-climbing device on level ground, determined as described in H.2.2;

b) the theoretical number of steps (up and down) that the stair-climbing device is capable of climbing, determined as described in H.2.3;

c) the capacity of the battery in ampere hours at a 5 h rate of discharge declared by the battery manufacturer.

Annex I
(normative)

Distinction between smaller and larger clusters

This Annex explains and identifies the borderline, b, between smaller and larger clusters.

Smaller clusters are those where the distances between the central axis of the cluster and the centres of its cams are smaller than their respective value b, given in Table I.1. This will give more than 3° tipping angle on the straight test stairs when the central axis of the cluster is horizontally in front of the centre of the contacting cam.

Larger clusters are those where the distances between the central axis of the cluster and the centres of its cams are greater than their respective value b, given in Table I.1. This will give less than 3° tipping angle on the straight test stairs when the central axis of the cluster is horizontally in front of the centre of the contacting cam.

Table I.1 — Borderline, b, between smaller and larger clusters

Number of cams per cluster	**3**	**4**	**5**
Borderline value b (mm)	190,8	171,3	182,6
NOTE These values are derived from the rise of the test stairs, which is r = 180 mm.			

For stair-climbing devices with clusters on two axles, the least stable position on stairs in the downward direction depends on the size of the cluster (see E.2.2.3.1). The distance between the central axis of the cluster and the centres of its cams is crucial when determining if a cluster is a smaller or a larger one. Other important factors for this determination are the number of cams per cluster, n, which usually ranges between 2 and 5 and the rise of the step, r, which is 180 mm for the straight test stairs.

If a cluster is positioned on stairs (see Figure I.1) so that its central axis is horizontally in line with the centre of the load bearing cam, the angle α, between the vertical and a line connecting the contact point of this cam with the contact point of the cam that will come into contact with the next lower tread, is calculated according to the following equation. Examples with n = 3, 4 and 5 are given in curved brackets (accolades):

$$\alpha = \frac{360}{2n}$$

$$\left\{ n = 3 \ldots\ldots\ldots \alpha = \frac{360}{2 \times 3} = 60 \right\}$$

$$\left\{ n = 4 \ldots\ldots\ldots \alpha = \frac{360}{2 \times 4} = 45 \right\}$$

$$\left\{ n = 5 \ldots\ldots\ldots \alpha = \frac{360}{2 \times 5} = 36 \right\}$$

Dimension in millimetres

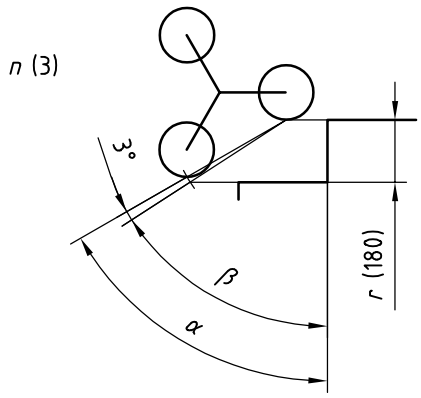

Figure I.1 — Angles α and β (example with n = 3)

The borderline size of the cluster is where the length of the connecting line is such that, after a tip of 3°, the next cam will come into contact with the next lower tread.

Hence the angle, β, between a line connecting the two consecutive cams and the vertical is given as follows (and as shown in Figure I.1):

$$\beta = \alpha - 3$$

$$\{n = 3 \ldots\ldots\ldots \beta = \alpha - 3 = 57\}$$
$$\{n = 4 \ldots\ldots\ldots \beta = \alpha - 3 = 42\}$$
$$\{n = 5 \ldots\ldots\ldots \beta = \alpha - 3 = 33\}$$

The length of the connecting line, d, between cam axles is then given by the following equation:

$$d = \frac{r}{\cos\beta}$$

$$\left\{n = 3 \ldots\ldots\ldots d = \frac{180}{\cos 57} = 330{,}5\right\}$$
$$\left\{n = 4 \ldots\ldots\ldots d = \frac{180}{\cos 42} = 242{,}2\right\}$$
$$\left\{n = 5 \ldots\ldots\ldots d = \frac{180}{\cos 33} = 214{,}6\right\}$$

where r is the rise of the step equal to 180 mm for test stairs (see Figure I.2).

Dimension in millimetres

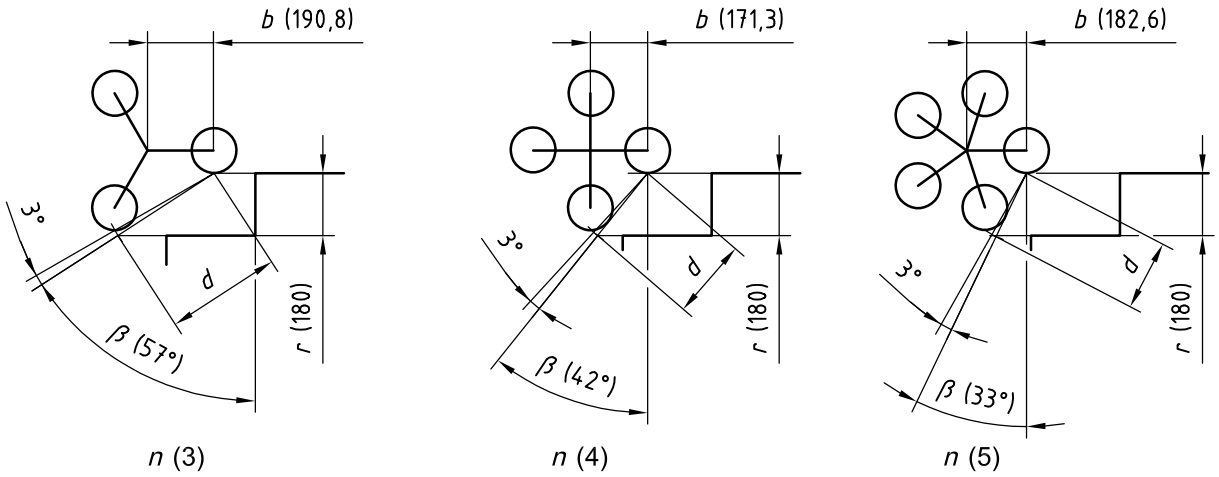

Figure I.2 — Lengths of d and b (examples with n = 3, 4 and 5)

Finally the borderline, b, which is the distance between the central axis of the cluster and the centres of its cams can be calculated from the relation between radius and side length of a polygon according to the following equation (and as shown in Figure I.2):

$$b = \frac{d}{2 \times \cos\left(\frac{n-2}{n} \times 90\right)}$$

$$\left\{ n = 3 \ldots\ldots\ldots b = \frac{330,5}{2 \times \cos\left(\frac{3-2}{3} \times 90\right)} = 190,8 \right\}$$

$$\left\{ n = 4 \ldots\ldots\ldots b = \frac{242,2}{2 \times \cos\left(\frac{4-2}{4} \times 90\right)} = 171,3 \right\}$$

$$\left\{ n = 5 \ldots\ldots\ldots b = \frac{214,6}{2 \times \cos\left(\frac{5-2}{5} \times 90\right)} = 182,6 \right\}$$

The whole set of calculations compiled into one formula in common notation is given as follows:

$$b = \frac{\frac{r}{\cos\left(\frac{360}{2n} - 3\right)}}{2\cos\left(\frac{n-2}{n} \times 90\right)}$$

Together with this formula and the given values of n and r, the distance b has been calculated for clusters with 3, 4 and 5 cams as expressed in Table I.1. The formula may be used for clusters with any number of cams.

Following this formula, for n = 2 a borderline b = 1 719,7 mm is derived. Since this is far too great to be encountered in practice, all clusters with n = 2 are smaller clusters.

ICS 11.180.10

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