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Wheelchairs —

Part 2: Determination of dynamic stability of electrically powered wheelchairs

Fauteuils roulants —

Partie 2: Détermination de la stabilité dynamique des fauteuils roulants électriques

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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

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

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

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

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

This third edition cancels and replaces the second edition (ISO 7176-2:2001), which has been technically revised.

The main changes compared to the previous edition are as follows:

— revision of ramp requirements;

— provision for remote control testing.

A list of all parts in the ISO 7176 series can be found on the ISO website.

Introduction

It is important to understand the dynamic stability characteristics of a wheelchair for prescription and adjustment purposes. Wheelchair users and prescribers should understand the safety implications of dynamic stability, particularly when setting up seating systems that offer a large range of configurations. They should consider the environment in which the wheelchair is to be used and the hazards that are likely in that environment while considering possible configurations of the wheelchair when meeting those hazards.

This document specifies tests for dynamic stability under a range of operating conditions with various wheelchair configurations. The effectiveness of stability controlling systems are evaluated by the procedures listed in this document.

Wheelchair instability is a significant contributor to accidents causing injury. Consequently, it is desirable that all parties involved in the supply of wheelchairs understand the factors that contribute to instability. Parties interested in this document could be wheelchair designers and manufacturers, prescribers, therapists, building designers, public facility providers and test houses.

The purpose of this document is to define tests that will consistently demonstrate dynamic stability limits under a variety of proven stability challenges. Tests are designed to reveal the effects of adjustments and configurations.

This document will help interested parties define suitable environments and intended use of the wheelchair.

Although this document does not specify requirements, it is an essential reference document for other documents that do specify stability.

Wheelchairs —

Part 2: Determination of dynamic stability of electrically powered wheelchairs

1 Scope

This document specifies test methods for determining the dynamic stability of electrically powered wheelchairs.

This document is applicable to electrically powered wheelchairs, including scooters, with a maximum nominal speed not exceeding 15 km/h, intended to carry one person. This document is not applicable to manual wheelchairs with add-on power kits used for, or to assist, propulsion.

2 Normative references

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

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

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

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

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

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

3 Terms and definitions

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

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

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

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

3.1
wheel lift
loss of contact between a wheel and the test surface during conditions of instability

Note 1 to entry: This does not include transient loss of contact due to surface irregularity or transitions.

Note 2 to entry: This does not include loss of contact such as a transition onto or rotation of cluster wheels.

4 Principle

The wheelchair is subjected to a number of driving tests, simulating use of a wheelchair, while its movements are observed for the occurrence of a range of defined conditions of instability. Accessories are not accounted for during these tests.

5 Apparatus

5.1 Rigid, flat, horizontal test plane, with coefficient of friction of greater than 0,6 measured by the method specified in ISO 7176-13 and of sufficient size to conduct the tests. The test plane shall have a surface that lies between two imaginary horizontal planes 20 mm apart and has no more than 0,5 ° variation in slope or cross slope throughout the test.

The test plane shall be long enough to allow the wheelchair to reach maximum speed.

NOTE An area of approximately 10 m × 3 m is normally of sufficient size but the testing of larger and/or faster wheelchairs might need a larger test plane.

5.2 Rigid, flat, inclined area, with run up and run down, shall be long enough to allow the wheelchair to reach maximum speed and come to a stop within the stated inclination.

The test area of the ramp shall be long enough to allow the wheelchair to come to a stop within the stated inclination which shall be within the tolerance of ±1°.

The testing area of the ramp shall have a surface that lies between two imaginary parallel planes 50 mm apart.

The test ramp shall have a coefficient of friction in the test area that meets the requirements of ISO 7176-13.

The test area shall run immediately from the horizontal test plane via a transition with a radius of less than 25 mm.

The traversed surface shall be free of loose material and steps greater than 5 mm in height.

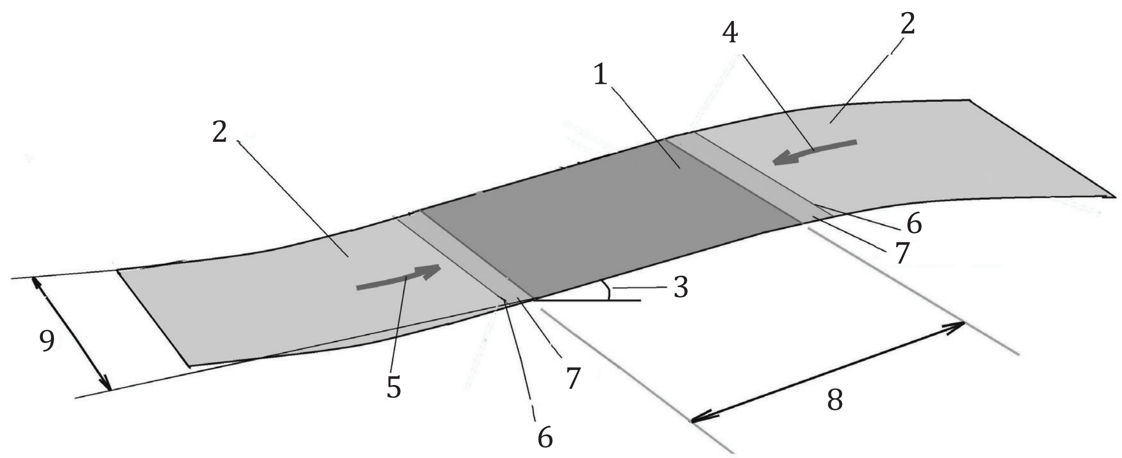
A ramp approximately 10 m × 3 m is normally of sufficient area, but the testing of larger and/or faster wheelchairs may need a larger ramp.

NOTE 1 The ramp can be of a variable angle type or individual ramps for each required angle.

NOTE 2 Run up and run down areas on either end of the test area need not meet the above criteria.

NOTE 3 Figure 1 provides a recommended configuration for the test area and transition.

NOTE 4 A ramp of approximately 10 m × 3 m is normally of sufficient area but the testing of larger and/or faster wheelchairs might need a larger ramp.



Key

1 test area
2 run up/run down area
3 defined slope angle
4 downward path
5 upward path
6 transition
7 transition zone
8 length of test area
9 test area width - sufficient to allow the wheelchair to complete the test in Clause 10

Figure 1 — General arrangement of test area

5.3 Rigid vertical step transition, with the following properties:

a) immediately adjacent to a horizontal test plane and followed by a further horizontal plane onto which a wheelchair can be driven via the step from the horizontal test plane;

b) step heights of 15 mm, 25 mm, 50 mm, and multiples of 25 mm above that if claimed by the manufacturer;

c) a top edge of the step with a radius of 6 mm ± 1 mm;

d) the tolerance on total step height shall be ±2 mm.

NOTE 1 This can be either a single step with adjustable height or separate fixed steps.

NOTE 2 An area of approximately 1 m × 5 m is normally of sufficient size for the higher plane.

5.4 Test dummy, in accordance with ISO 7176-11.

5.5 Means for remote control, for use at the discretion of test personnel, to control the speed of the wheelchair and to cause a turn through 90 ° on a predetermined radius.

EXAMPLE 1 For joystick-controlled wheelchairs, a remote control apparatus with proportional servos to control fore/aft and lateral movement of the joystick (see Annex A).

EXAMPLE 2 For tiller-steered wheelchairs, a remote controlled proportional servo for the speed control and a spring load with a remote controlled release for the tiller, so that when the tiller is released, the spring causes the tiller to turn on a predetermined radius (see Annex A). For tests requiring a variable turn radius required in 10.6, the steering tether can be replaced by an actuator. Alternatively, a device to limit the tiller rotation at predetermined turn angles can be used.

6 Initial set-up of test wheelchair

6.1 General

Prepare the test wheelchair in accordance with ISO 7176-22, set-up level 2, modified as specified in 6.2.

6.2 Anti-tip devices

Test the wheelchair with anti-tip devices if they are provided and the instructions for use state that they are to be used. If the anti-tip devices are adjustable, set them to their least effective position. If they can be adjusted so that they will not contact the ground if the wheelchair tips, this may be considered the least effective position.

If anti-tip devices are not provided, or the instructions for use do not state that they are to be used, test the wheelchair without them.

6.3 Batteries

The wheelchair should be equipped with batteries as specified by the manufacturer. However, batteries containing free electrolyte can be hazardous if spillage occurs during testing. Such batteries may be replaced by the nearest capacity equivalent valve-regulated, absorbent glass mat, or gel-type batteries, with supplementary weights if necessary to give an equivalent mass distribution.

6.4 Test load

6.4.1 General

Select the test load and set it up as specified in 6.4.2 or 6.4.3.

6.4.2 Test dummy

a) Select, position and secure the appropriate dummy in accordance with ISO 7176-22.

b) Set up the means to remotely control the wheelchair, if a remote control system is chosen. If using remote control, set up the means (see Annex A).

6.4.3 Human test occupant

For some tests, it might be necessary to use a human test occupant. For such cases, select a suitable human test occupant as specified in ISO 7176-22 and see Annex B for safety recommendations.

7 Test procedure

Conduct the tests specified in Clauses 8, 9 and 10 using the scoring system specified in Annex C to quantify the dynamic response of the wheelchair.

Wherever practicable, test using a test dummy as specified in 6.4.2. Where a test dummy can not be used, use a human test occupant as specified in 6.4.3.

For safety reasons, perform each test at slow speed initially and repeat using gradually increasing speeds until a score of 0 or the maximum speed is achieved.

The tests may be performed in any sequence.

If the stability score is found to be 1 or 0 for a particular slope or step height, end the test and record a 0 for the higher levels for that test.

NOTE 1 Continuation of the test could be dangerous to the tester and damaging to the wheelchair.

NOTE 2 Video recordings of the movement of the wheelchair, replayed in slow motion and stop action, can assist observing and scoring the wheelchair responses.

8 Tests for rearward dynamic stability

8.1 General

While remaining within any constraints mandated by the manufacturer in the user manual, all user and dealer adjustable parts shall be adjusted to create a least stable configuration or, configurations, for a wheelchair. This determination may require several iterations to determine the configuration or configurations, that is or are the least stable.

Table 1 provides guidance for setting up the wheelchair in its least stable configuration. Some wheelchairs have drive configurations that limit the speed. It will often be necessary to explore a wide range of possible configurations, including those where speed is limited. The least stable configuration may be different between tests described in 8.3, 8.4, 8.5, 8.6, 8.7 and 8.8. The least stable configuration shall be determined for each test. The least stable configuration is the configuration that returns the lowest score in each test.

8.2 Wheelchair preparation

Prepare the wheelchair as specified in Clause 6 with the following additions: Set all adjustable components to their least stable configuration for the wheelchair in the rearward direction within the constraints specified by the manufacturer in the device user manual. These components include, but are not limited to, the rear wheel position, castor attachment to the frame, seat position, back position, seat-to-back angle, leg-to-seat angle, and seat height and speed. Typical adjustments for least stable rearward settings are mentioned in Table 1. If any of the adjustments results in an unwanted setting, e.g. the castor wheels contact any other part of the wheelchair, increase/decrease the adjustment just enough to ensure a proper function of the wheelchair. Make every effort to minimize castor shimmy during tests. There may be several ways of doing this including adjusting castor rake and castor cant.

Table 1 — Least stable rearward stability typical settings

Adjustable wheelchair component	Least stable position
Rear wheel position, fore-aft	Forward
Castor attachment to frame, fore-aft	Back
Seat position, fore-aft	Back
Seat position, vertical	High
Seat back position, recline	Back
Seat position, tilt	Back
Back position, fore-aft	Back
Leg to seat angle	Minimum
Speed setting	Maximum

8.3 Starting forward

NOTE This test determines stability when a wheelchair starts on a horizontal surface and on an uphill slope.

a) Position the wheelchair on the horizontal test plane.

b) From a stationary position, operate the control device to give maximum acceleration in the forward direction.

c) Observe the dynamic response of the wheelchair and score it according to Annex C.

d) Repeat b) and c) on the 3°, 6° and 10° ramps or other ramp angles as specified by the manufacturer or those commissioning the tests specifying requirements starting with the wheelchair on each ramp facing uphill. If the manufacturer recommends a technique for driving on a slope, test the wheelchair using the recommended technique. If the manufacturer specifies a maximum slope, testing is to be done for all ramp angles up to and including that slope, otherwise the test methods are unmodified.

8.4 Braking when travelling forward on horizontal or uphill

NOTE This test determines stability when a wheelchair stops on a horizontal surface and rocks backward as a counter movement. This test also determines stability when stopping on an uphill slope if the wheelchair rolls or rocks backward before coming to a complete stop.

a) Run the wheelchair at maximum forward speed on the horizontal test plane.

b) Apply retardation by releasing the control device.

c) Observe the dynamic response of the wheelchair and score it according to Annex C.

d) Repeat a) to c) applying retardation by turning the wheelchair power off.

e) Repeat a) to c) applying retardation by quickly applying full speed command in the opposite direction, keeping the control device at maximum retardation until the wheels turn in the opposite direction.

f) Record the lowest score from the three methods of a) to e) and the method which gave this result.

g) Repeat a) to f) travelling forward uphill on the 3°, 6° and 10° ramps or other ramp angles as specified by the manufacturer. If the manufacturer recommends a technique for driving on a slope, test the wheelchair using the recommended technique. If the manufacturer specifies a maximum slope, testing is to be done up to that slope, otherwise the test methods are unmodified.

8.5 Braking when travelling backward

NOTE This test determines stability when a wheelchair stops suddenly from maximum reverse speed travelling on the horizontal and also travelling downhill travelling backward.

a) Run the wheelchair at maximum reverse speed on the horizontal test plane.

b) Apply retardation by releasing the control device.

c) Observe the dynamic response of the wheelchair and score it according to Annex C.

d) Repeat a) to c) applying retardation by turning the wheelchair power off.

e) Repeat a) to c) applying retardation by quickly applying full speed command in the opposite direction, keeping the control device at maximum retardation until the wheels turn in the opposite direction.

f) Record the lowest score from the three methods of a) to e) and the retardation method which gave this result.

