INTERNATIONAL STANDARD

ISO 7176-1

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Wheelchairs —

Part 1:
Determination of static stability

Fauteuils roulants —

Partie 1: Détermination de la stabilité statique

Reference number
ISO 7176-1:1999(E)

Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

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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 3.

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.

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

This second edition cancels and replaces the first edition (ISO 7176-1:1986), which has been technically revised.

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 efficiency of brakes*

— *Part 4: Determination of energy consumption of electric wheelchairs and scooters — Theoretical range*

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

— *Part 6: Determination of maximum speed, acceleration and retardation 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 the 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 of electric wheelchairs — Requirements and test methods*

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

— *Part 16: Requirements and test methods for resistance to ignition of upholstered parts*

The following parts are also on the programme of work:

— *Part 17: Serial interface for electric wheelchair controllers*

— *Part 19: Requirements and test methods for transportation wheelchairs for use in motor vehicles*

— *Part 20: Determination of the performance of stand-up type wheelchairs*

— *Part 21: Requirements and test methods for electromagnetic compatibility of 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*

Annexes A and B of this part of ISO 7176 are for information only.

Introduction

It is important to know the static-stability characteristics of a wheelchair for prescription and adjustment purposes. Some users need large reserves of stability to ensure their safety while others prefer finely balanced wheelchairs which have better manœuvrability.

This part of ISO 7176 specifies tests in which static stability is measured with wheel locks (parking brakes) applied, as is the case if the wheelchair is standing on a slope. Tests are also made with the wheels unlocked, simulating the situation where the wheelchair is standing on a slope with the wheels against obstacles, the situation on a level surface with the wheels unlocked and the wheelchair user reaching for an object, or instability while rolling. These tests also give information about the ease with which a wheelchair can be tipped about its rear wheels, such as happens when negotiating kerbs or balancing on the rear wheels.

Wheelchairs —

Part 1:
Determination of static stability

1 Scope

This part of ISO 7176 specifies the test methods for determining the static tipping stability of wheelchairs, including scooters. This part of ISO 7176 is applicable to wheelchairs and vehicles that are included in the 12.21 series described in ISO 9999 and are intended to provide indoor and outdoor mobility for people with disabilities whose mass does not exceed the maximum mass of the test dummy given in ISO 7176-11.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 7176. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 7176 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6440, *Wheelchairs — Nomenclature, terms, and definitions.*

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

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

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

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

ISO 9999, *Technical aids for disabled persons — Classification.*

3 Terms and definitions

For the purposes of this part of ISO 7176, the terms and definitions given in ISO 6440 and the following apply:

3.1
lockable wheels
wheels equipped with parking brakes, or wheels whose rolling motion is locked by the means of propulsion (e.g., by hands, levers, motors)

3.2
tipping angle
angle of the test plane from the horizontal at which the forces become zero under all uphill wheels

NOTE A number of methods are available with which to determine when the forces become zero under the uphill wheels. These include, but are not limited to, the following: the ability to pull pieces of paper from beneath the wheels, visual identification of when the wheels lift from the test plane or the use of force-sensing instrumentation.

3.3
antitip device
wheelchair component to limit the extent of tipping

3.4
rear antitip-device tipping angle
angle of the test plane from the horizontal at which the forces become zero under the rear wheels

4 Principle

Depending upon the direction of tip, wheelchairs can tip about the point of contact with the ground when the wheels are locked with respect to the frame or about the wheel axle when the wheel locks (see 3.1) are not applied. The angle of slope on which the wheelchair will tip about the most unstable axis is measured on a test plane with an adjustable slope by increasing the angle of the test plane until the tipping angle is reached.

5 Apparatus

5.1 Flat, hard test plane that is large enough to accommodate the wheelchair to be tested such that the surface of the test plane lies between two imaginary parallel planes 5 mm apart throughout the test.

NOTE 1 The imaginary planes are intended to provide a measure of control on the flatness of the test plane.

NOTE 2 Visible lines parallel and normal to the axis of tip of the test plane assist in positioning the wheelchair.

5.2 Means by which the slope of the test plane can be **adjusted**.

NOTE If the slope of the test plane is increased in a continuous fashion, then the rate of increase in the slope should not exceed 1°/s as the tipping angle is approached. If the slope of the test plane is increased in a stepwise fashion, the steps should not be so abrupt that they affect the validity of the tipping angle.

5.3 Means to prevent the wheels or antitip devices from **rolling**, that does not affect the wheelchair´s freedom to tip about the appropriate axis for the test.

5.4 Means to prevent the wheels or antitip devices from **sliding**, that does not affect the wheelchair's freedom to tip about the contact points on the test plane.

NOTE 1 See annex A for examples.

NOTE 2 Placing rigid barriers in contact with the downhill wheels is not acceptable for the tests when the downhill wheels are locked, because it changes the axis of rotation.

5.5 Means to limit the extent of **tipping** of the wheelchair relative to the test plane, that does not affect the stability of the wheelchair, restrict the chair's freedom to deform or restrict the chair's freedom to tip.

5.6 Means to measure the angle, with an accuracy of ± 0,2°, of the slope of the test plane with respect to the horizontal.

5.7 Test dummies that conform to the requirements of ISO 7176-11.

6 Preparation of the test wheelchair

6.1 To prepare for the test, either

a) set up the wheelchair with the equipment specified by the manufacturer for the test, or

b) if the equipment is not specified, set up the wheelchair for normal use, including any armrests, leg supports and footrests.

6.2 If the wheelchair has pneumatic tyres, either

a) inflate them to the pressure recommended by the wheelchair manufacturer, or

b) if no pressure is so recommended, inflate them to the maximum pressure recommended by the tyre manufacturer.

6.3 Adjust any parking brakes according to the manufacturer's instructions.

6.4 Remove any loose cushions.

6.5 If there is a risk of fluid spilling from batteries during the test, replace the batteries by an object of the same mass and centre of gravity.

7 Adjusting the wheelchair

Each test (except for the antitip-device test, specified in clause 11) requires that any adjustable parts of the wheelchair be set to the most and least stable configurations for the direction of tip. Adjustments to be considered are shown in Tables 1 to 3. Experiments may be needed to determine the most and least stable configurations of other components. Unless otherwise specified, make such adjustments in accordance with ISO 7176-22 and consistent with the normal operation of the wheelchair, as defined by the manufacturer.

NOTE In addition to the most and least stable configurations, other configurations (e.g. midposition) may be tested.

8 Placing the test dummy in the wheelchair

8.1 Select one of the test dummies specified in ISO 7176-11, the mass of which is equal to the maximum mass of occupant recommended by the manufacturer. If a dummy of the same mass is not readily available, select the dummy with the nearest greater mass.

8.2 Determine the angle of the wheelchair backrest reference plane by the method specified in ISO 7176-7.

8.3 Ensure that the hinge between the body and thigh portions of the test dummy is free while the test dummy is being positioned in the wheelchair.

8.4 Position the test dummy centrally on the seat of the wheelchair.

8.5 Adjust the fore-aft position of the test dummy until the back reference plane of the test dummy body is as close as possible to the angle determined for the wheelchair backrest reference plane in 8.2.

8.6 Secure the test dummy to the wheelchair so that it is restrained in the upright seated position (unless otherwise specified) during the test procedure and so that the angles between the components of the test dummy do not change. Ensure that the means by which the test dummy is secured to the wheelchair (e.g. bolts, straps, locks to test-dummy joints) does not deform any part of the wheelchair or affect stability.

9 Test for static stability in the forward direction

9.1 General

If the wheelchair has two wheels at the front, measure the forward tipping angles as follows:

a) for wheelchairs without lockable front wheels, as specified in 9.2 and 9.4 only, or

b) for wheelchairs with lockable front wheels, as specified in 9.2 to 9.5.

NOTE 1 If the wheelchair has a single front wheel or if the two front wheels are very close together, it will tip about an axis connecting one front and one rear wheel. In such cases, omit the tests specified in clause 9. This aspect of stability is measured in clause 12.

NOTE 2 The test methods specified in clauses 9 to 12 of this part of ISO 7176 may be performed in any sequence.

CAUTION — The tests can be hazardous. Appropriate safety precautions should be taken to protect test personnel.

9.2 Wheels unlocked and the wheelchair in the least stable configuration

9.2.1 Set adjustable parts of the wheelchair in the least stable configuration for forward stability. Table 1 illustrates the effect of typical adjustments.

Table 1 — Forward stability

Adjustable wheelchair component	Least stable	Most stable
Rear-wheel position, fore-aft	Forward	Back
Castor attachment to frame, fore-aft	Back	Forward
Seat position, fore-aft	Forward	Back
Seat position, vertical	High	Low
Seat-back position, fore-aft	Forward	Back
Seat-back position, recline	Upright	Back
Seat position, tilt	Upright	Back
Elevating legrest position	Up	Down

9.2.2 With the test plane horizontal, place the wheelchair on the test plane so that it will face down the slope when the plane is inclined. Position the wheelchair so that a line through the axles of the downhill wheels is parallel ± 3° to the axis of tip of the test plane.

9.2.3 Position any downhill castors or steered wheels such that they trail uphill, and any uphill castors or steered wheels such that they trail downhill.

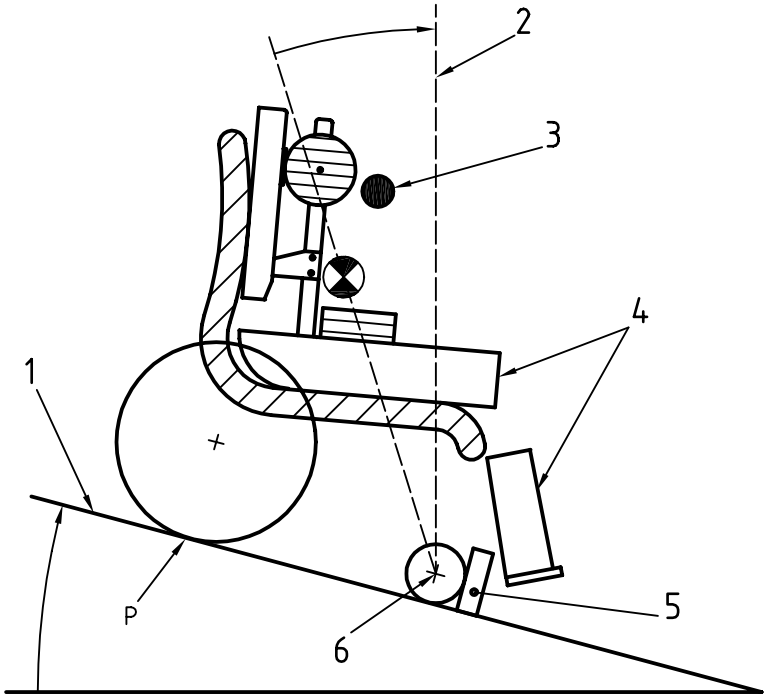
9.2.4 Set up the means to prevent the wheelchair from rolling on the test plane (see 5.3 and Figure 1).

NOTE See annex B for a general explanation of the figures.

9.2.5 Increase the slope of the test plane until the tipping angle (as defined in 3.2) is reached.

NOTE If the increase in the slope is too rapid or abrupt, the apparent tipping angle may be greater or less than the actual tipping angle.

Ensure that the result is not affected by inadvertent contact between the wheelchair and the test equipment or floor.



Key

1 Test plane
2 Vertical
3 Tip restraint
4 Test dummy
5 Roll restraint
6 Axis of rotation

Figure 1 — Forward stability, front wheels unlocked

9.2.6 Recheck the positions of the test dummy and wheelchair to ensure that no inadvertent movement has occurred. If the configuration of the wheelchair reproducibly or irreversibly changes during the test (e.g. if the tyre rolls off the rim or the wheelchair partially folds),

a) record the nature of the occurrence and the angle of the test plane at which this occurs in the comments section of the test report [13 j)]; and

b) complete the test.

9.2.7 Measure and record the tipping angle to the nearest 1°.

9.2.8 Lower the test plane to horizontal.

9.3 Wheels locked and the wheelchair in the least stable configuration

9.3.1 Follow the procedures specified in 9.2.1 to 9.2.3.

9.3.2 Lock the downhill wheels.

9.3.3 Set up the means to prevent the wheelchair from sliding on the test plane (see 5.4 and Figure 2).

9.3.4 Follow the procedures specified in 9.2.5 to 9.2.8.