TECHNICAL REPORT

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Guidelines for the application of the ISO 7176 series on wheelchairs

Lignes directrices pour l'application de la série ISO 7176 sur les fauteuils roulants

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Contents

Page

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.

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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 13570, was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

This Technical Report is based on the book:

A Guide to Wheelchair Selection: How to Use the ANSI/RESNA Wheelchair Standards to Buy a Wheelchair

written by Peter Axelson, Jean Minkel and Denise Chesney, published in 1994 by the Paralyzed Veterans of America, Washington, DC, USA.

Guidelines for the the application of the ISO 7176 series on wheelchairs

1 Scope

The purpose of this Technical Report is to explain how you can use the International Standards on wheelchairs to select your next wheelchair. The actual standards are very technical and, at first glance, you may not understand how this information will help you select a wheelchair or scooter. This Technical Report is meant to help you understand the purpose for and content of International Standards on wheelchairs.

This Technical Report is divided into six clauses.

a) How to use this Technical Report.

b) Standardized testing and information disclosure: Provides background information on standardized testing of wheelchairs. Discusses how chairs are tested and how information is disclosed.

c) General considerations: Discusses general considerations related to choosing a powered or manual wheelchair.

d) Incorporating personal body characteristics: Relates your physical characteristics to the fit of a chair, either manual or powered.

e) Manual wheelchairs: Discusses manual wheelchair test procedures.

f) Powered wheelchairs: Discusses powered wheelchair test procedures; focuses on three- and four-wheeled scooters as well as full-sized powered wheelchairs.

In the manual and powered wheelchair sections, the test procedures are grouped into three categories:

— performance,

— safety, and

— dimensions.

For each test procedure, this Technical Report includes

— reasons why you might need this information,

— a brief description of the standardized test procedure,

— how the results of the test will be disclosed in the manufacturer's technical product literature, and

— how to interpret the results of the test for your own situation.

2 How to use this Technical Report

If you are an experienced rider, you may know which elements of performance, safety and dimension are important to you. If not, or if you are a novice, we highly recommend that you involve other knowledgeable people in selecting your wheelchair. Many rehabilitation specialists have the expertise and training in using these standards and can help you select an appropriate wheelchair.

An excellent approach to the wheelchair selection process is to set priorities based on your mobility and seating needs. Setting priorities will help you identify the features that are most important to you and those on which you are willing to compromise. For example, if you live in a small apartment and need to fit your wheelchair into the boot (trunk) of your car, you will probably want to look specifically at the overall dimensions, foldability, and weight of the wheelchair. On the other hand, if you use a van and have an accessible apartment or home, you may not need a folding wheelchair. This Technical Report will help you understand the test results that pertain to the factors most important to you. Armed with this information, you will be able to accurately compare products and make an informed purchasing decision.

3 Standardized testing and information disclosure

3.1 General

Purchasing a wheelchair can be a harrowing experience and finding the right chair among so many choices might seem impossible. Comparing wheelchair characteristics and performance has been difficult in the past because manufacturers used different standards and procedures to measure and test their chairs. For example, one manufacturer measured seat width from the outside of the seat rails, another measured from inside the rails, and a third measured the distance between the armrest panels. Thus, if you requested a chair with a seat width of 18 inches, the actual distance from the outside of the seat rails could be anywhere from 17 inches to 19 inches. This inconsistency, as well as a general concern for user safety, led to the development of standardized wheelchair measurements and test procedures. The results of these procedures will provide you with the information you need for true comparison shopping.

3.2 Background on tests and standards

The ISO Technical Committee on wheelchairs has been working to provide consumers with objective information about the characteristics and performance of wheelchairs. The committee includes rehabilitation engineers, wheelchair manufacturers, agency representatives, wheelchair users, and wheelchair prescribers.

The standards developed by the committee consist of a number of test procedures that apply to all wheelchairs and some that apply only to powered wheelchairs, including scooters. The test procedures are detailed instructions on how to perform the tests or measurements on wheelchairs. Some of the test procedures suggest minimum performance criteria for durability and safety, while others disclose the results of the tests for comparison purposes. The information obtained from the tests is designed to help you make better-educated selections. See Figure 1. The standardized test procedures also allow you to compare the test results of wheelchairs from different manufacturers. Since many of the test procedures set minimum performance levels, they also help manufacturers produce better products.

3.3 Standards increase your buying power

The standards are voluntary: manufacturers are not required by law to use the test procedures. However, if consumers start using the results as a basis for wheelchair selection, the manufacturers who do not use the standards may lose sales. The US Department of Veterans Affairs (VA), the single largest purchaser of wheelchairs in the United States, is adopting the standards for future wheelchair purchasing. Marketplace pressure will most likely encourage overall compliance with the standards.

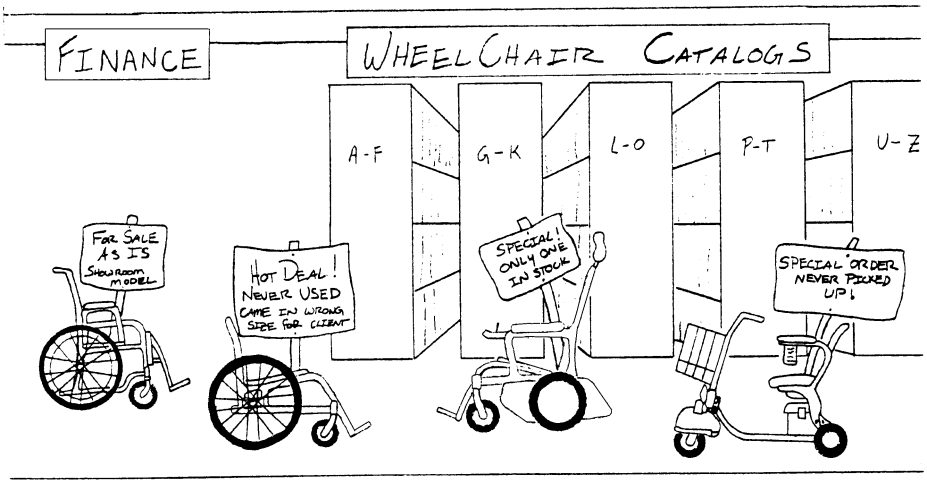

Figure 1 — Finding the right chair among so many choices might seem impossible

3.4 More about International Standards

To gain the maximum benefit from the standardized testing, both consumers and professionals must understand how to use the information.

The following is a list of the test standards, listed by their ISO number designation, that apply to all wheelchairs, with a brief description of the test procedure.

ISO 6440:1985, Wheelchairs — Nomenclature, terms and definitions. This part establishes the terms and definitions used in the test procedures.

ISO 7193:1985, Wheelchairs — Maximum overall dimensions. This part establishes suggested maximum dimensions of a chair for other organizations to use as guidelines for architectural accessibility.

ISO 7176-1:1999, Wheelchairs — Part 1: Determination of static stability. This test determines how stable the wheelchair is when it is resting on a sloped surface.

ISO 7176-3:1988, Wheelchairs — Part 3: Determination of efficiency of brakes. This test determines how well the wheel locks (parking brakes) prevent the wheelchair from rolling on a sloped surface. This test also determines the minimum stopping distance of a powered wheelchair at its maximum speed.

ISO 7176-5:1986, Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space. This part addresses the overall length, width, height, folded width, mass and turnaround space of the chair.

ISO 7176-7:1998, Wheelchairs — Part 7: Measurement of seating and wheel dimensions. This part addresses the dimensional information needed to fit a chair to a rider. Standard methods of measurement eliminate the problems that result from variations in measurement methods.

ISO 7176-8:1998, Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths. This part addresses the strength and durability of a wheelchair.

ISO 7176-11:1992, Wheelchairs — Part 11: Test dummies. This part addresses the dimensional and mass (weight) specifications of the dummies to be used when conducting the tests.

ISO 7176-13:1989, Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces. This test describes the roughness or slipperiness of the surface to be used for testing.

ISO 7176-15:1996, Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling. This part tells what information manufacturers are required to disclose and how it should be disclosed in their product literature, if they choose to comply with the standards.

ISO 7176-16:1997, Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods. This test addresses the extent to which upholstery will burn and how fire retardant the upholstery is.

ISO 7176-19:—[1], Wheelchairs — Part 19: Wheeled mobility devices for use in motor vehicles. This part sets out the design and performance requirements, and associated test methods, for wheelchairs that are intended for use as a seat in a motor vehicle.

ISO 7176-20:—[1], Wheelchairs — Part 20: Determination of the performance of stand-up type wheelchairs. This part addresses the performance of a manual or powered wheelchair that has a mode to assist the occupant and support the occupant while in the standing position.

ISO 7176-22:2000, Wheelchairs — Part 22: Set-up procedures. This part specifies the procedures for configuring and adjusting a wheelchair prior to testing.

ISO 7176-23:—[1], Wheelchairs — Part 23: Attendant-operated stair-climbing devices — Requirements and test methods. This part determines the performance of stair climbing devices that are operated by an attendant.

ISO 7176-24:—[1], Wheelchairs — Part 24: User-operated stair-climbing devices — Requirements and test methods. This part determines the performance of stair-climbing devices that are operated by the occupant.

The following is a list of test procedures that apply to powered wheelchairs only:

ISO 7176-2:1990, Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs. This part addresses how stable a powered wheelchair is in the rearward, forward and lateral directions when it is driven.

ISO 7176-4:1997, Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range. This test addresses the energy consumption of a powered wheelchair on a standardized track.

ISO 7176-6:—[1], Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs. This part addresses the maximum speed in forward and reverse. It also determines the minimum time from stationary to maximum speed (acceleration) and from maximum speed to a complete stop (retardation).

ISO 7176-9:—[1], Wheelchairs — Part 9: Climatic tests for electric wheelchairs. This part addresses the effects of rain and temperature changes on the functioning of a powered wheelchair.

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1) To be published.

ISO 7176-10:1988, Wheelchairs — Part 10: Determination of obstacle-climbing ability of electric wheelchairs. This test determines how high an obstacle a powered wheelchair can climb over.

ISO 7176-14:1997, Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods. This test addresses safety, how well the fail-safe braking mechanism works, the force required to actuate the controls, and other issues related specifically to powered wheelchairs.

ISO 7176-21:—[1)], Wheelchairs — Part 21: Electromagnetic compatibility of electrically powered wheelchairs and motorized scooters — Requirements and test methods This part addresses the electromagnetic emissions and electromagnetic immunity of powered wheelchairs, including scooters.

3.5 How chairs are tested

The International Standards on wheelchairs are specific instructions on how to perform the test procedures. Some of the test procedures have minimum performance requirements, including flammability and climatic tests, static and impact strength tests, and power and control systems tests for powered wheelchairs. The results of the minimum performance tests are either pass or fail. These tests ensure minimum performance and safety of the product. See Figure 2.

Figure 2 — Testing of wheelchairs has become more sophisticated over the years

Most of the test procedures are performance tests that produce quantified information about a chair. The results give information for comparison purposes only; there is no pass or fail determination. These comparisons are meaningful because, for the first time, each manufacturer uses the same tests. Until now, different manufacturers described their wheelchairs using different terms. By comparing test results of different chairs, you can begin comparative wheelchair shopping.

Most of the tests are conducted with a test dummy in the chair to represent the weight of a person. The results for chairs tested in this “loaded” condition more closely approximate the fit and performance of a chair when it is actually occupied. Your own body size, body proportions riding style may affect the actual fit and performance of a chair.

For wheelchair components that are adjustable, the manufacturer adjusts the wheelchair configuration and controls to obtain the extreme range of outcomes for a specific test procedure. For example, rear axle position and other adjustable features affect the stability of a chair. In this case, the manufacturer tests the wheelchair with its rear

wheels and other adjustable features in both the least and most stable configurations. These results give a range of tipping angles that reflects the least stable and most stable configurations that can be obtained by adjusting the rear wheels and other features of the wheelchair. On a powered wheelchair with an adjustable controller, the manufacturer will disclose a range of stopping distances to reflect the adjustability of speed and retardation (deceleration).

3.6 How information is disclosed

Manufacturers that wish to comply with the International Standards on wheelchairs must comply with ISO 7176-15, which specifies which test results must be contained in the pre-sale technical product literature. A list of the additional tests that the manufacturer is required to perform is contained in annex A. The manufacturer is not required to disclose the results of these additional tests in the technical product literature, but the consumer can request this information. See Figure 3.

Figure 3 — To be in compliance with the ISO test procedures, manufacturers are required to disclose certain information about the chair in their pre-sale technical product literature

The test results of particular procedures are disclosed as performance values, which at first may have little or no meaning to you. For example, a manufacturer may disclose the rear-tipping angle of a wheelchair, but there is no minimum performance value available for comparison at this time. However, you can look up the tip angle or the range of tip angles for a specific wheelchair with which you have experience, then look at the tip angles of other wheelchairs and figure out how these chairs will perform compared with the chair you know. For example, suppose your current wheelchair has a rear tip angle of four degrees. You can determine if the wheelchair you are considering is more or less tippy than your current chair by finding out if its rear tip angle is greater or less then four degrees. As you gain experience using one wheelchair, the information about other wheelchairs will become more meaningful to you.

NOTE The performance ratings are usually based on testing only one wheelchair. The results disclosed represent the maximum performance of a new wheelchair tested without failure. The performance you get from your wheelchair will vary depending on your body size and proportion, physical strength, abilities, skills and riding habits and on environmental conditions.

4 General considerations

4.1 Manual versus powered wheelchairs

4.1.1 General

Rehabilitation programmes used to emphasize that if it was possible for you to push a manual wheelchair, you should do so. The saying was “Use it or lose it.” However, many people with marginal ability to use a manual wheelchair find that they deplete all their energy resources just trying to get where they want to go. Once they get there, they have no energy left to do what they want to do. Worse yet, people with 20 or 30 years of experience pushing a manual wheelchair realise that their shoulders are worn out as a result of the years of “using it” and not “losing it.” Should healthy manual wheelchair riders spend some time in a powered wheelchair? To answer this question, do some self-examination. Ask yourself which type of mobility meets your needs. See Figure 4.

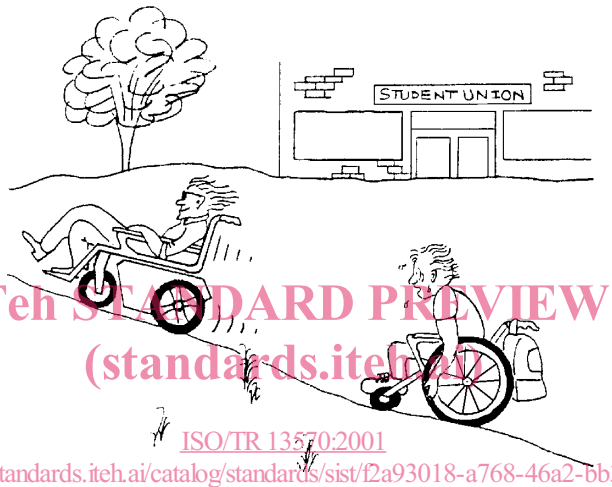

Figure 4 — In some environments, a manual wheelchair may not leave you with the energy that you will need when you get to your destination

4.1.2 Some reasons to select manual mobility

You have sufficient upper body strength and overall endurance to propel your wheelchair all day.

Reducing the weight or increasing the manoeuvrability of the wheelchair would enhance your independence.

Some of your daily activities are easier to perform in a manual chair.

A manual wheelchair is smaller, lighter and less expensive to maintain and repair.

You are not experiencing chronic pain in your arms or shoulders.

4.1.3 Some reasons to select powered mobility (including scooters)

You have insufficient endurance or functional ability to propel a manual wheelchair independently.

You need to conserve energy during long-distance wheeling to work or school.

Powered mobility would enable you to be more independent in your daily living, work and recreational activities.

You have access to personal or public transportation that accommodates a full-sized powered chair or scooter for longer distance travel.

Many powered wheelchair riders have a manual wheelchair to use when a powered wheelchair is inconvenient. When travelling, a powered wheelchair user may use a manual wheelchair and have a person help with mobility. Other users may rely on a manual wheelchair at home and at work and use a powered wheelchair for travelling to and from work. There is something to be said for the use of a powered wheelchair to prevent overuse of the shoulder muscles, although this option is not often discussed. Financial considerations are important as well, since powered wheelchairs are expensive. Whether the primary wheelchair is powered or manual, a backup manual wheelchair should be available in the event of breakdown of the main wheelchair.

4.2 Rigid versus folding manual wheelchairs

If you plan to use a manual wheelchair, the first decision you have to make is whether it should be rigid or folding. Nonfolding fixed-frame chairs are more rigid, whereas folding chairs tend to have a little more flex in the frame. This flex can be an advantage when you are travelling over slightly uneven surfaces, because all the wheels of the chair tend to stay on the ground. When you use a rigid wheelchair on an uneven surface, one wheel often lifts off the ground. However, on a hard floor surface, a rigid-frame chair gives a more responsive feeling, since all the energy you expend goes into propulsion and none goes into flexing the frame of the chair. Many people prefer the aesthetics of a rigid frame (see Figure 5), although both types are available in lightweight models and in a variety of colours. Some of the advantages and disadvantages are listed in Table 1.

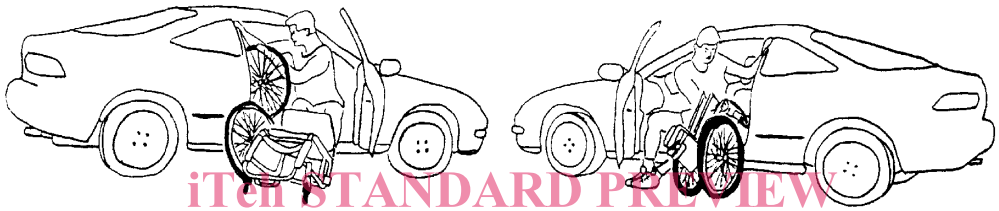

Figure 5 — Getting a folding wheelchair into and out of a car can be quicker than a rigid-frame chair. However, many riders prefer the performance of a rigid-frame chair on hard surface floors

Table 1 — Rigid versus folding wheelchairs

	Advantages	Disadvantages
Rigid frame	• Frame design requires fewer components and thus has more strength for a given mass • Usually a lighter chair than a similarly equipped folding chair • Fewer removable parts • Required to meet National Wheelchair Basketball Association specifications • Seat-to-back angle is often adjustable	• Requires removal of quick-release rear wheels for loading into car • May feel bumpier on uneven surfaces • Does not fold into as small a package for stowing in car or aeroplane
Folding frame	• Folds into compact package for stowing in car or aeroplane • Flexes to enable all four wheels to stay on the ground when riding on uneven surfaces • Can be folded and stowed without removing parts	• More moving, adjustable, and removable components • May not meet rider's sports or leisure activity needs • Seat-to-back angle usually not adjustable • Lateral stability can decrease as the chair flexes or starts to fold

4.3 Direct-drive versus belt-drive powered wheelchairs

When the motors are mounted directly to the drive wheels with only gears in between, the system is called a direct-drive system. When belts connect the motors to the drive wheels, the system is called a belt-drive system. Most wheelchairs are only available one way or the other. Keep in mind when comparing two scooters that one may have a direct-drive system while the other may have a belt-drive system. Full-sized powered chairs are also manufactured with either a direct-drive or a belt-drive system.

Like the rigid-frame manual wheelchair, the direct-drive system has no flex or slack. The drive wheels respond directly to the actions of the motors. The belt, on the other hand, introduces a slight delay between the action of the motor and the wheel. Depending on your trunk balance, you may find the delay in a belt-driven chair provides a more comfortable ride. Unfortunately, belts can slip if they are not properly adjusted or if they are wet, and the rear wheels will not always respond when you want them to. You must look at the advantages of direct drive versus belt drive and make the best choice for your needs and your environment. See Figure 6.

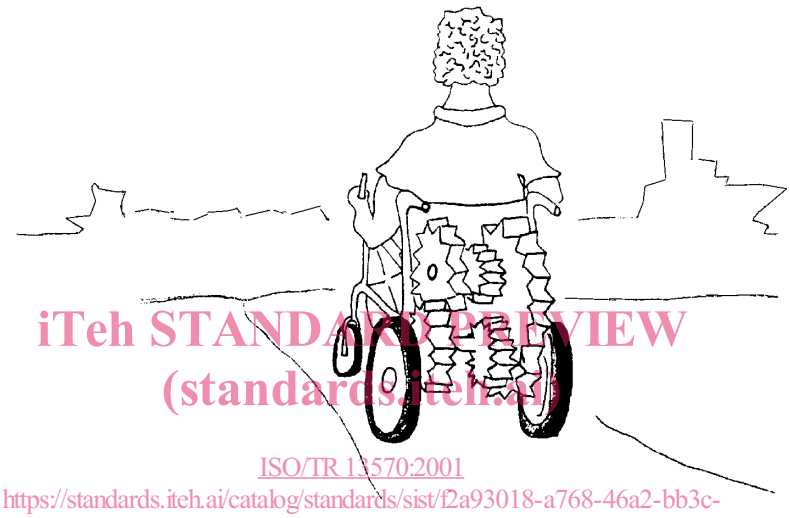

Figure 6 — Many users choose lower maintenance direct-drive chairs despite some drawbacks

Some of the advantages and disadvantages of the two drive systems are listed in Table 2.

Table 2 — Direct-drive versus belt-drive powered wheelchairs

	Advantages	Disadvantages
Direct drive	• Requires little maintenance • No exposed parts to get dirty wear	• Can be noisy during operation • Gears wear if not properly lubricated
Belt drive	• Belts can be easily replaced • Generally quiet during operation • Can provide a smooth ride	• Chair will drive in a circle if a belt breaks • Belts can slip when wet, reducing control • Generally requires more maintenance • May require adjustments if there is a change in temperature • Belts can be noisy during start-up