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## Wheelchairs —

### Part 4 : Determination of energy consumption of electric wheelchairs

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*Fauteuils roulants —*

*Partie 4 : Détermination de la consommation d'énergie des fauteuils roulants électriques*

ISO 7176-4:1988  
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Reference number  
ISO 7176-4:1988 (E)

## 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7176-4 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*.

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

# Wheelchairs —

## Part 4 : Determination of energy consumption of electric wheelchairs

### 0 Introduction

ISO 7176 at present consists of the following parts :

- 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.
- Part 5 : Determination of overall dimensions, mass and turning space.
- Part 6 : Determination of maximum speed, acceleration and retardation of electric wheelchairs.
- Part 7 : Determination of seating dimensions — Definitions and measuring methods.
- Part 8 : Static, impact and fatigue strength for manual wheelchairs.
- 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 controls.

The energy consumption is not an unambiguous quality. It varies with a number of different factors such as temperature, driving pattern, tyres, the topography of the country and the ground. Thus this part of ISO 7176 cannot be used for absolute measurement.

None the less, energy consumption is a very important quality for wheelchair users, and it is therefore important to compare different wheelchairs.

### 1 Scope and field of application

This part of ISO 7176 specifies a method for determining the energy consumption of electric wheelchairs.

### 2 References

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

ISO 7176-11, *Wheelchairs — Part 11 : Test dummies*.<sup>1)</sup>

ISO 7930, *Wheelchairs — Type classification based on appearance characteristics*.

### 3 Definitions

For the purposes of this part of ISO 7176, the definitions given in ISO 6440 apply.

### 4 Principle

The wheelchair is driven back and forth along a test track and the energy consumption is measured with a watt-hour meter. Measurements are taken for the wheelchair being driven on a flat track and both up and down an inclined track.

### 5 Test planes

The test planes shall consist of the following tracks :

- a) a hard flat horizontal plane at least 18 m in length;

NOTE — Chipboard, polyvinyl chloride and concrete surfaces are suitable for representing indoor surfaces.

- b) a hard flat horizontal plane at least 13 m in length;

- c) a hard flat plane inclined 5° to the horizontal and at least 13 m in length.

NOTE — Asphalt and concrete surfaces are suitable for representing outdoor surfaces.

1) At present at the stage of draft.

## 6 Test wheelchair

Unless otherwise specified and wherever appropriate, the following conditions shall be fulfilled during testing.

**6.1** The wheelchair shall be fully equipped for normal use including armrests and leg supports with footrests, but excluding seat cushions.

**6.2** If the wheelchair has pneumatic tyres, the air pressure in them shall be adjusted in accordance with the manufacturer's instructions. If a pressure range is specified, the lowest recommended pressure shall be selected.

**6.3** During the tests the wheelchair shall be loaded with a test dummy of appropriate size, constructed and positioned in accordance with ISO 7176-11, or with a person of the same mass. The dummy shall be secured to prevent movement from its position during the tests. If a human equivalent is used, motion of the body from the stated dummy position shall be minimized.

**6.4** The body support system, if adjustable, shall be set to correspond to natural sitting posture, with the lowest part of the leg support/footrest 50 mm above the test plane and the seat corresponding to the mid-point sitting height. Pivoting body support systems shall be set in the forward position. The slope of the seat relative to the horizontal shall be as close as possible to 4°. The slope of the backrest relative to the vertical shall be as close as possible to 10° of recline. The angle

between the seat and the leg support shall be as close as possible to 90°. All other parts of the body support system shall be set at their middle position.

**6.5** The batteries (accumulators) shall be attached to the wheelchair to give the mass distribution recommended by the manufacturer.

NOTE — The energy may be supplied either from the batteries or from an external power source of equivalent impedance.

**6.6** Before the tests start, the whole wheelchair, fully equipped, shall be kept at a temperature of 18 to 22 °C for a minimum period of 8 h. The test procedure shall be carried out under the same temperature conditions.

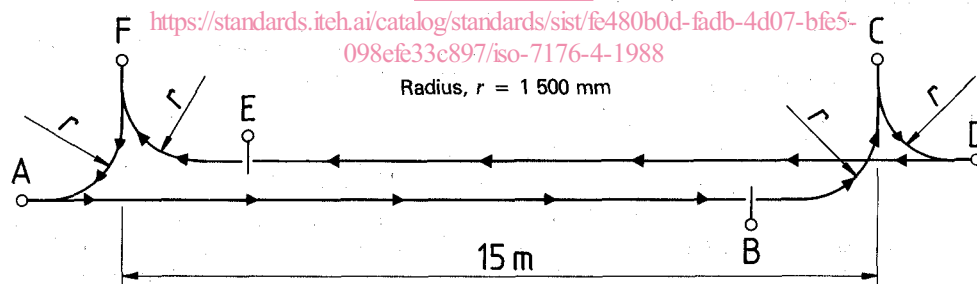
## 7 Test procedures

NOTE — The wheelchair may be either driven along the test tracks or operated on a simulator that reproduces the work cycles corresponding to the specified operating cycles.

### 7.1 Test representing indoor use of wheelchair

Drive the wheelchair over plane 5 a) for 10 cycles in accordance with the operating cycle shown in the figure.

Measure the total energy consumption,  $E$ , using a watt-hour meter capable of integrating the voltage and current characteristics of the power source.<sup>1)</sup>



Start and end each cycle at A. Employ maximum acceleration and retardation when changing speed.

Perform each cycle as follows :

Section of cycle	Speed	Direction	At end of section
A to B	Maximum (not greater than about 3 km/h)	Forwards	Stop at B
B to C	About 1 km/h	Forwards	Stop at C
C to D	About 1 km/h	Backwards	Stop at D
D to E	Maximum (not greater than about 3 km/h)	Forwards	Stop at E
E to F	About 1 km/h	Forwards	Stop at F
F to A	About 1 km/h	Backwards	Stop at A

Figure — Operating cycle for the test representing indoor use

1) Details of a suitable watt-hour meter may be obtained from the Secretariat of ISO/TC 173.

## 7.2 Test representing outdoor use of wheelchair

The procedure consists of three parts (7.2.1, 7.2.2 and 7.2.3).

Measure the energy consumption using a suitable watt-hour meter (see 7.1) for each of the following tests.

**7.2.1** Drive the wheelchair forwards 10 m over plane 5 b) 10 times, starting from a standing position, then employing maximum acceleration to full speed followed by a maximum retardation to full stop. Turn the wheelchair manually.

Note the total energy consumption,  $E_1$ .

**7.2.2** Employ the same procedure as in 7.2.1, except that the wheelchair is driven up plane 5 c).

Note the total energy consumption,  $E_2$ .

**7.2.3** Employ the same procedure as in 7.2.1, except that the wheelchair is driven down plane 5 c).

Note the total energy consumption,  $E_3$ .

NOTE — 7.2.2 and 7.2.3 may be combined so that the wheelchair is driven up and down the slope alternately. The wheelchair is turned manually between runs.

## 8 Expression of results

### 8.1 Test representing indoor use

The theoretical energy consumption in watt hours per kilometre is given by multiplying the total energy consumption,  $E$ , expressed in watt hours, during the ten cycles by 3,3 ( $E \times 3,3$ ).

The nominal range,  $l_1$ , in kilometres, is given by the equation

$$l_1 = \frac{Q U l_2}{E}$$

where

$Q$  is the nominal capacity, expressed in ampere hours, of the battery measured at five hours rate;

$U$  is the voltage, in volts, of the wheelchair power source;

$l_2$  is the distance, in kilometres, covered during the test ( $l_2 = 0,3$  km).

### 8.2 Test representing outdoor use

The average energy consumption,  $\bar{E}$ , expressed in watt hours, is given by the equation

$$\bar{E} = 0,8 E_1 + 0,1 (E_2 + E_3)$$

where  $E_1$ ,  $E_2$  and  $E_3$  are as defined in 7.2.

The theoretical energy consumption in watt hours per kilometre is given by multiplying the total energy consumption,  $E$ , expressed in watt hours, by 10 ( $E \times 10$ ).

The nominal range,  $l_3$ , in kilometres, is given by the equation

$$l_3 = \frac{Q U l_4}{\bar{E}}$$

where

$Q$  and  $U$  are as defined in 8.1;

$l_4$  is the distance, in kilometres, covered during each part of the test ( $l_4 = 0,1$  km).

## 9 Test report

The test report shall contain the following information :

- a reference to this part of ISO 7176;
- the product type and type designation (see ISO 7930);
- the name and address of the manufacturer;
- a photograph of the wheelchair equipped as during the tests;
- the name and address of the test institution;
- the test results, in accordance with clauses 7 and 8;
- details of the test load used during the tests.

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