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Wheelchairs —

Part 31:

Lithium-ion battery systems and chargers for powered wheelchairs – Requirements and test methods

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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.

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

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This version of ISO 7176-31 was developed to standardize requirements for use of Lithium-ion batteries in wheelchairs. Lithium chemistries in their various derivatives are becoming more common in wheelchairs so it is now appropriate to standardize performance and safety requirements for this application. Additionally, a number of national and international standards have been published that define the safety and performance of lithium batteries in more general applications. These standards form the basis for this document.

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Wheelchairs —

Part 31:

Lithium-ion battery systems and chargers for powered wheelchairs – Requirements and test methods

WARNING — The use of this part of ISO 7176 can involve hazardous materials, operations and equipment. It does not purport to address all of the safety or environmental problems associated with its use. It is the responsibility of users of this standard to take appropriate measures to ensure the safety and health of personnel and the environment prior to application of the standard. Particular care should be taken regarding the possible emission of toxic fumes resulting from lithium battery fires.

1 Scope

This part of ISO 7176 specifies requirements and test methods for lithium batteries and battery systems intended for use in electrically powered wheelchairs, and their charging systems.

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 7176-25, *Wheelchairs — Part 25: Batteries and chargers for powered wheelchairs*

ISO 7176-2, *Wheelchairs — Part 2: Determination of dynamic stability of electrically powered wheelchairs*

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

ISO 7176-8, *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 7176-14, *Wheelchairs — Part 14: Power and control systems for electrically powered wheelchairs and scooters — Requirements and test methods*

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

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

IEC 60335-2-29:2016, +Amd1:2019, *Household and similar electrical appliances — Safety — Part 2-29: Particular requirements for battery chargers*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 62133-2, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary lithium cells, and for batteries made from them, for use in portable applications - Part 2: Lithium systems*

IEC 61960-3, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them*

IEC 62619, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 battery cell

basic manufactured unit providing a source of electrical energy by direct conversion of chemical energy, that consists of electrodes, separators, electrolyte, container and terminals, and that is designed to be charged electrically

[SOURCE: IEC 62133-2, 3.7]

3.2 battery pack

energy storage device, which is comprised of one or more cells or modules electrically connected

Note 1 to entry: Some battery management functions are, by necessity, integrated into the battery; others may need to be integrated into the control and drive system.

Note 2 to entry: It may incorporate a protective housing and be provided with terminals or other interconnection arrangement.

[SOURCE: IEC 62619, 3.10 modified]

3.3 battery module

group of cells connected together either in a series and/or parallel configuration with or without protective devices (e.g. fuse or PTC) and monitoring circuitry

[SOURCE: IEC 62133-2, 3.9 modified]

3.4 lithium ion battery

secondary battery with an organic solvent electrolyte and positive and negative electrodes which utilize an intercalation compound in which lithium is stored

Note 1 to entry: A lithium ion battery does not contain lithium metal.

[SOURCE: IEC 482-05-07 modified]

3.5 battery management system BMS

electronic system associated with a battery which has functions to maintain safety and prevent damage such as protection from over-charge, over-discharge, over-current, over-heating, and cell imbalance.

Note 1 to entry: It monitors and/or manages its state, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life.

Note 2 to entry: The function of the BMS can be assigned to the battery pack or to wheelchair that uses the battery. (See [Figure 1](#))

Note 3 to entry: The BMS can be divided and it can be found partially in the battery (pack) and partially on the wheelchair that uses the battery.

3.6

battery system

battery

system which comprises one or more cells, modules or battery packs

Note 1 to entry: It has a battery management system (BMS) to cut off in case of over-charge, over-current, over-discharge, over-heating and cell imbalance

Note 2 to entry: The battery system can have cooling or heating units.

[SOURCE: IEC 62619, 3.11 modified]

3.7

capacity

C

capacity expressed in ampere-hours (Ah)

3.8

rated capacity

capacity value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: Note to entry: The rated capacity is the quantity of electricity C5 Ah (ampere-hours) declared by the manufacturer which a single cell can deliver when discharged at the reference test current of 0,2 It A to a specified final voltage, after charging, storing and discharging under specified conditions.

3.9

Energy storage capacity

Watt hour rating

energy storage capacity expressed in watt hours (Wh)

[SOURCE: IEC 62619, 3.21]

3.10

Battery management system

BMS

emission of flames from a cell, module, battery pack, or battery system

[SOURCE: IEC 62619, 3.17]

3.11

battery charging system

Battery charger, battery system and interconnecting components in the charging circuit, including connectors and protective devices.

Note 1 to entry: Note to entry: Parts of the battery charging system can be in the wheelchair.

3.12

safety extra-low voltage

voltage not exceeding 42 V between conductors and between conductors and earth, the no-load voltage not exceeding 50 V

Note 1 to entry: When safety extra-low voltage is obtained from the supply mains, it is to be through a safety isolating transformer or a convertor with separate windings, the insulation of which complies with double insulation or reinforced insulation requirements.

Note 2 to entry: The voltage limits specified are based on the assume that the safety isolating transformer is supplied at its rated voltage.

Note 3 to entry: Safety extra-low voltage is also known as SELV.

[SOURCE: IEC 60335-1:2020, 3.4.2]

3.13

safety isolating transformer

transformer, the input winding of which is electrically separated from the output winding by an insulation at least equivalent to double insulation or reinforced insulation, that is intended to supply a battery charging circuit having an output voltage not exceeding 120 V ripple-free direct current

Note 1 to entry: Note to entry: Ripple-free means an r.m.s. ripple voltage not exceeding 10 % of the DC component.

[SOURCE: IEC 60335-2-29:2016 +Amd1:2019, 3.4.3]

4 Lithium Batteries

4.1 Battery performance and safety requirements

4.1.1 General

Lithium batteries shall comply with IEC 62133-2.

The safety of the battery system requires the consideration of two sets of applied conditions:

- a) intended use.
- b) reasonably foreseeable misuse.

The battery system shall be so designed and constructed that they are safe under conditions of both intended use and reasonably foreseeable misuse.

4.1.2 Internal short-circuit within a cell

An internal short-circuit within a cell shall not result in fire of the entire battery system or fire propagating outside the battery system.

Compliance is verified to 7.3.2 of IEC 62619.

4.1.3 Battery cyclic endurance

Compliance is verified to 7.3.3 of IEC 62619.

4.1.4 Thermal runaway

The cyclic endurance of a battery is defined by the number of charge/discharge cycles it can perform under specific conditions.

The manufacturer shall declare the number of charge/discharge cycles when tested according to IEC 61960-3.

4.1.5 Transport and storage

Packing and transportation of batteries is covered in national and international regulations.

For storage of cells or batteries under various climatic conditions, the characteristics regarding charge retention and corrosion effects shall be observed. The manufacturer's recommendations shall be followed.

Compliance is verified by inspection of wheelchair's instruction manual.

4.2 Requirements for battery management systems

4.2.1 General

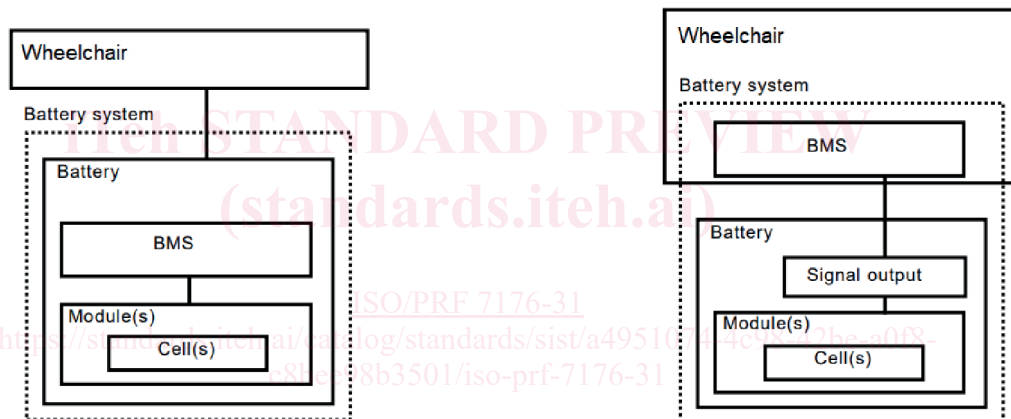
The BMS evaluates the condition of cells and batteries, and it maintains cells and batteries within the specified cell operating region. Key factors of the cell operating region are voltage, temperature and current. (See IEC 62619 Figure A.1)

For the BMS tests, the battery system includes the BMS function in the application side as well, if applicable to the design.

The requirements of BMS are listed from [4.2.2](#).

NOTE 1 The function of the BMS can be assigned to the battery system or to the wheelchair that uses the battery. (See [Figure 1](#))

NOTE 2 The BMS can be divided and it can be found partially in the battery system and partially on the wheelchair that uses the battery. (See [Figure 1](#)).



a) All functions of BMS are in the battery pack b) BMS functions are divided between battery pack and wheelchair side

Figure 1 — Examples of BMS locations and battery system configurations

4.2.2 Functional requirements

The battery management system shall provide at least the following functional requirements:

- a. Cell /and battery over-voltage protection
- b. Cell /and battery under-voltage protection
- c. Battery over-current protection
- d. Battery over-temperature protection
- e. Battery under-temperature protection
- f. Battery status

Compliance is checked by reviewing documentation provided by the wheelchair/battery manufacturer.