INTERNATIONAL STANDARD

ISO 12405-3

First edition
2014-05-15

Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems —

Part 3: Safety performance requirements

Véhicules routiers à propulsion électrique — Spécifications d'essai pour packs et systèmes de batterie de traction aux ions lithium —

Partie 3: Exigences de performance de sécurité

Reference number
ISO 12405-3:2014(E)

© ISO 2014



COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Symbols and abbreviated terms **4**
5 General requirements **5**
5.1 General conditions 5
5.2 Test sequence plan 6
5.3 Preparation of the DUT for testing 6
5.4 Pre-conditioning cycles 7
5.5 General safety requirements 7
6 Mechanical tests **7**
6.1 Vibration 7
6.2 Mechanical shock 8
7 Climatic tests **8**
7.1 Dewing (temperature change) 8
7.2 Thermal shock cycling 9
8 Simulated vehicle accidents **9**
8.1 Inertial load at vehicle crash 9
8.2 Contact force at vehicle crash 11
8.3 Water immersion 14
8.4 Exposure to fire 14
9 Electrical tests **16**
9.1 Short circuit 16
10 System functionality tests **16**
10.1 Overcharge protection 16
10.2 Overdischarge protection 17
10.3 Loss of thermal control/cooling 17
Annex A (informative) **Battery systems and related parts** **19**
Annex B (informative) **Description of the screen referenced in 8.4 Exposure to fire** **23**
Bibliography **24**

© ISO 2014 – All rights reserved

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.

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 21, *Electrically propelled road vehicles*.

ISO 12405 consists of the following parts, under the general title *Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems*:

— *Part 1: High-power applications*

— *Part 2: High-energy applications*

— *Part 3: Safety performance requirements*

© ISO 2014 – All rights reserved

Introduction

Lithium-ion battery systems are efficient rechargeable energy storage systems for electrically propelled road vehicles. The requirements for lithium-ion battery systems to be used as power source for the propulsion of electric road vehicles are significantly different to those batteries used for consumer electronics or for stationary applications.

Lithium-ion batteries can store electricity at relatively high-energy density compared to other battery chemistries currently available. Under current state of art, most lithium-ion batteries use organic electrolytes which are classified as Class 3 “flammable liquid” under the “UN Recommendations on the Transport of Dangerous Goods — Model Regulations”. Therefore, mitigating potential hazards associated with fire or explosion of lithium-ion batteries is considered an important issue.

This part of ISO 12405 provides specific test procedures and related requirements to ensure an appropriate and acceptable level of safety of lithium-ion battery systems specifically developed for propulsion of road vehicles.

© ISO 2014 – All rights reserved

Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems —

Part 3: Safety performance requirements

1 Scope

This part of ISO 12405 specifies test procedures and provides acceptable safety requirements for voltage class B lithium-ion battery packs and systems, to be used as traction batteries in electrically propelled road vehicles. Traction battery packs and systems used for two-wheel or three-wheel vehicles are not covered by this part of ISO 12405. This part of ISO 12405 is related to the testing of safety performance of battery packs and systems for their intended use in a vehicle. This part of ISO 12405 is not intended to be applied for the evaluation of the safety of battery packs and systems during transport, storage, vehicle production, repair, and maintenance services.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6469-1, *Electrically propelled road vehicles — Safety specifications — Part 1: On-board rechargeable energy storage system (RESS)*

ISO 6469-3, *Electrically propelled road vehicles — Safety specifications — Part 3: Protection of persons against electric shock*

ISO/TR 8713, *Electrically propelled road vehicles — Vocabulary*

ISO 12405-1:2011, *Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems — Part 1: High-power applications*

ISO 12405-2:2012, *Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems — Part 2: High-energy applications*

ISO 20653, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 and the following apply.

3.1
battery control unit
BCU
electronic device that controls, manages, detects, or calculates electric and thermal functions of the battery system that provides communication between the battery system and other vehicle controllers

Note 1 to entry: See also Annex A for further explanation.

© ISO 2014 – All rights reserved

3.2
battery pack
energy storage device that includes cells or cell assemblies normally connected with cell electronics, voltage class B circuit, and overcurrent shut-off device, including electrical interconnections and interfaces for external systems

Note 1 to entry: For further explanation, see A.2.

Note 2 to entry: Examples of external systems are cooling, voltage class B, auxiliary voltage class A, and communication.

3.3
battery pack subsystem
representative portion of the battery pack

3.4
battery system
energy storage device that includes cells or cell assemblies or battery pack(s), as well as electrical circuits and electronics

Note 1 to entry: For further explanation, see A.3.1 and A.3.2. Battery system components can also be distributed in different devices within the vehicle.

Note 2 to entry: Examples of electronics are the BCU and contactors.

3.5
bus
vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 t

3.6
capacity
total number of ampere-hours that can be withdrawn from a fully charged battery under specified conditions

3.7
cell electronics
electronic device that collects and possibly monitors thermal or electric data of cells or cell assemblies and contains electronics for cell balancing, if necessary

Note 1 to entry: The cell electronics can include a cell controller. The functionality of cell balancing can be controlled by the cell electronics or it can be controlled by the BCU.

3.8
customer
party that is interested in using the battery pack or system and, therefore, orders or performs the test

EXAMPLE A vehicle manufacturer.

3.9
device under test
DUT
in this part of ISO 12405, a battery pack or battery system

3.10
explosion
sudden release of energy sufficient to cause pressure waves and/or projectiles that can cause structural and/or physical damage to the surroundings of the DUT

Note 1 to entry: The kinetic energy of flying debris from the battery pack or system can be sufficient to cause damage to the surroundings of the DUT as well.

© ISO 2014 – All rights reserved

3.11
fire
continuous emission of flames from a DUT (approximately more than 1 s)

Note 1 to entry: Sparks and arcing are not considered as flames.

3.12
heavy-duty truck
vehicle designed and constructed for the carriage of goods and having a maximum mass exceeding 12 t

3.13
high-energy application
characteristic of device or application for which the numerical ratio between maximum allowed electric power output (power in W) and electric energy output (energy in Wh) at a 1 C discharge rate at RT for a battery pack or system is typically lower than 10

Note 1 to entry: Typically, high-energy battery packs and systems are designed for applications in BEVs.

3.14
high-power application
characteristic of device or application for which the numerical ratio between maximum allowed electric power output (power in W) and electric energy output (energy in Wh) at a 1 C discharge rate at RT for a battery pack or system is typically equal to or higher than 10

Note 1 to entry: Typically, high-power battery packs and systems are designed for application in HEVs and FCVs.

3.15
isolation resistance
resistance between live parts of the voltage class B electric circuit and the electric chassis, as well as the voltage class A system

3.16
leakage
escape of liquid or gas from a DUT except for venting

3.17
maximum working voltage
highest value of a.c. voltage (rms) or of d.c. voltage, which can occur in an electrical system under any normal operating conditions according to the battery manufacturer's specifications, disregarding transients

3.18
medium-duty truck
vehicle designed and constructed for the carriage of goods and having a maximum mass exceeding 3,5 t but not exceeding 12 t

3.19
midi bus
vehicle designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 t

3.20
rated capacity
supplier's specification of the total number of ampere-hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions such as discharge rate, temperature, discharge cut-off voltage, etc.

3.21
room temperature
RT
temperature of (25 ± 2) °C

© ISO 2014 – All rights reserved

3.22
rupture
loss of mechanical integrity of the enclosure of the DUT resulting in openings that do not fulfil protection degree IPXXB according to ISO 20653

Note 1 to entry: The kinetic energy of released material is not sufficient to cause structural and/or physical damage to the surrounding of the DUT.

3.23
state of charge
SOC
available capacity in a battery pack or system expressed as a percentage of rated capacity

3.24
supplier
party that provides battery systems and packs

EXAMPLE A battery manufacturer.

3.25
venting
release of excessive pressure from a DUT intended by design to preclude rupture or explosion

3.26
voltage class A
classification of an electric component or circuit with a maximum working voltage of ≤30 V a.c. (rms) or ≤60 V d.c., respectively

Note 1 to entry: See ISO 6469-3.

3.27
voltage class B
classification of an electric component or circuit with a maximum voltage of (>30 and ≤1 000) V a.c. (rms) or (>60 and ≤1 500) V d.c., respectively

Note 1 to entry: See ISO 6469-3.

4 Symbols and abbreviated terms

a.c. alternating current

BCU battery control unit

BEV battery electric vehicle

d.c. direct current

DUT device under test

FCV fuel cell vehicle

HEV hybrid electric vehicle

RESS rechargeable energy storage system

RT room temperature [(25 ± 2) °C]

SOC state of charge

UNECE United Nations Economic Commission for Europe

© ISO 2014 – All rights reserved