International Standard

ISO 19453-6

Second edition
2026-09

Road vehicles — Environmental conditions and testing for electrical and electronic equipment for drive system of electric propulsion vehicles —

Part 6:
Traction battery packs and systems

Véhicules routiers — Spécifications d'environnement et essais de l'équipement électrique et électronique pour les véhicules à propulsion électrique —

Partie 6: Packs et systèmes de batterie de traction

Reference number
ISO 19453-6:2026(en)

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Published in Switzerland

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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.

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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

This second edition cancels and replaces the first edition (ISO 19453-6:2020), which has been technically revised.

The main changes are as follows:

— relinking references to the withdrawn ISO 19453-1 to ISO 19453-5 with the corresponding sections after the merger of this series with the ISO 16750 (all parts) [1] series.

A list of all parts in the ISO 16750 (all parts) [1] 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.

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Introduction

For over fifty years, traction batteries for electric vehicles have been developed to achieve high energy density and high-power output. Specifically, lead-acid battery, Ni-Cd battery and Ni-MH battery with aqueous electrolyte were most applied to electric vehicles in the early days. Thermal activated batteries, such as molten salt batteries, like sodium sulfur battery, and Zebra battery, were also examined. Lithium-ion battery penetrated the consumer market in portable battery application from 1991. Currently, it is the most promising candidate of traction battery for electric vehicles. ISO 6469-1 [2] specifies safety requirement for rechargeable energy storage system (RESS), and the ISO 12405 (all parts) [3] series was published to specify performance and reliability tests. This document focuses on environmental and endurance tests of lithium-ion battery systems.

The ISO 16750 (all parts) [1] series specifies the test conditions on environment and reliability for electrical and electric equipment for road vehicles. For the 2023 edition of the ISO 16750 (all parts) [1] series, the corresponding parts of the ISO 19453 (all parts) [4] series were merged and reflected into their ISO 16750 (all parts) [1] counterparts. The battery pack or system is the electric system which charges and discharges electricity through the converter. The test condition for mechanical load in ISO 16750-3 [5] is too severe to apply to the battery pack or system from the standpoint of frequency range and amplitude of vibration in the test input spectrum. The test conditions for climatic load in ISO 16750-4 [6] are also excessive to apply to the battery pack or system, because the lithium-ion battery pack is designed to control temperature within an adequate operational range. That is the reason why appropriate conditions for the lithium-ion battery are specified in this document.

The purpose of this document is to assist its user in systematically defining, applying or both, a set of internationally accepted environmental conditions, tests and operating requirements, which are based on the anticipated actual environment in which the equipment will be operated and exposed to during its life cycle. This document has been developed based on fundamental investigations and vehicle measurements on voltage class A and B battery pack/system. The following environmental factors have been considered in the development:

— World geography and climate

Electric propulsion vehicles are operated in nearly all terrestrial regions of the earth. Significant variation in environmental conditions due to climatic environment, including diurnal and seasonal cycles, can therefore be expected. Consideration has been given to worldwide ranges in the temperature, humidity, precipitation and atmospheric conditions, including dust, pollution and altitude.

— Type of electric propulsion vehicle

Operating environment in an electric propulsion vehicle can depend on its electric powertrain architecture, as well as its mass, size, supply voltage and so on. Consideration has been given to typical types of series production electric propulsion vehicle architectures, such as hybrid electric vehicles, battery electric vehicles, range extender hybrid electric vehicles, and fuel cell vehicles, but not including equipment specific for fuel cell system.

— Vehicle use conditions and operating modes

Environmental conditions in and on the vehicle vary significantly with vehicle use (e.g. driving, charging during parking, etc.). Operating modes, such as starting, driving, braking, stopping and so on, have been considered, in particular, for traction battery system.

— Battery durability

For battery system, it is necessary to be resistant to environmental conditions experienced during manufacture, shipping, handling, storage, vehicle assembly, vehicle usage and vehicle maintenance and repair.

— Component mass and volume

The mass of battery pack is generally in the range of around 20 kg up to 60 kg for HEV, 80 kg to 150 kg for PHEV, and more than 200 kg for BEV (weight assumptions from the year 2020). The battery pack has

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generally a large volume and thermal capacity. It is necessary, not only to prepare a large chamber, but it will also take a long time to keep the thermal equivalent when performing a thermal shock test.

— Mounting location in the vehicle

HEV battery packs are generally installed inside the vehicle, PHEV battery packs are installed both outside and inside, and BEV battery packs are generally installed outside. The environmental condition, such as water splashing, dust, salt spray, humidity or corrosion for battery packs installed outside the vehicle interior is more severe than for battery packs installed inside. In this document, test conditions are specified according to mounting location.

a) Applicability to manufacturers' responsibility

Due to technology limitations or variations in vehicle design, the vehicle manufacturer may be required to place a component in a location where it cannot withstand the environmental conditions described in the ISO 16750 (all parts) [1] series. Under these circumstances, it is the responsibility of the vehicle manufacturer to provide the necessary environmental protection.

b) Applicability to wiring harnesses, cables and electrical connectors

Although some environmental conditions and tests in the ISO 16750 (all parts) [1] series may be relevant to vehicle wiring harnesses, cables and connectors, its scope is not sufficient to be used as a complete standard. It is, therefore, not recommended that the ISO 16750 (all parts) [1] series be directly applied to such devices and equipment.

c) Applicability to parts or assemblies inside the equipment

The ISO 16750 (all parts) [1] series describes environmental conditions and tests to be applied to electrical and electronic equipment directly mounted in or on the vehicle. It is not intended for direct application to parts or assemblies that are part of the equipment. For example, the ISO 16750 (all parts) [1] series should not be directly applied to integrated circuits (ICs) and discrete components, electrical connectors, printed circuit boards (PCBs), gauges, etc., that are attached in or on the equipment. Electrical, mechanical, climatic and chemical loads for such parts and assemblies can be quite different from those described in the ISO 16750 (all parts) [1] series.

On the other hand, it is desirable to use the ISO 16750 (all parts) [1] series to help derive environmental conditions and test requirements for parts and assemblies that are intended for use in road vehicle equipment. For example, a temperature range from −40 °C to 90 °C may be specified for parts or assemblies contained inside a piece of equipment having a temperature range of −40 °C to 70 °C and an additional temperature rise of 20 K.

d) Applicability relative to system integration and validation

The user of the ISO 16750 (all parts) [1] series is cautioned to understand that its scope is limited to conditions and testing at the equipment level and, therefore, does not represent all conditions and testing necessary for complete verification and validation of the vehicle system, for example, cold water shock tests were omitted from this document. Environmental and reliability testing of equipment parts and vehicle systems can be required. For example, the ISO 16750 (all parts) [1] series does not necessarily ensure that environmental and reliability requirements for solder joints, solderless connections, integrated circuits and so on are met. Such items are assured at the part, material or assembly level. Additionally, vehicle and system level testing might be required to validate the equipment in the vehicle application.

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Road vehicles — Environmental conditions and testing for electrical and electronic equipment for drive system of electric propulsion vehicles —

Part 6:
Traction battery packs and systems

1 Scope

This document specifies requirements for lithium-ion traction battery packs or systems used in battery electric, hybrid electric and fuel cell electric road vehicles. This document describes the most relevant environmental stresses and specifies tests and test boundary conditions. This document establishes a classification of battery packs or systems and defines different stress levels for testing when a classification is applicable and required. The objective of this document is to specify standard test procedures and conditions to enable the observation of the reliability of the lithium-ion traction battery in the vehicle.

This document specifies tests for a battery pack or system of voltage class A and B.

This document provides the necessary information to set up a dedicated test plan for a battery pack or system subject to agreement between the customer and supplier. If required, the relevant test procedures and/or test conditions can also be selected from this document.

NOTE This document only covers requirements and test conditions for a traction battery pack or system used in passenger cars.

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 6469-3, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 16750-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-4, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

ISO 16750-4:2023, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

ISO 16750-5, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 5: Chemical loads*

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

IEC 60068-2-14, *Environmental testing - Part 2-14: Tests - Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock*

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IEC 60068-2-38, *Environmental testing - Part 2-38: Tests - Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60068-2-60, *Environmental testing - Part 2-60: Tests - Test Ke: Flowing mixed gas corrosion test*

IEC 60068-2-64, *Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16750-1, ISO 20653 and the following 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 http://www.electropedia.org/

3.1
BMS
battery management system
electronic system that controls, manages, detects or calculates electric and thermal functions of the battery pack or system and that provides communication between the battery pack or system and other vehicle controllers

3.2
ITCS
internal temperature control system
internal thermal management system of a battery pack or system that can heat or cool the battery pack or system to a target temperature determined by the battery management system *(BMS)* (3.1)

EXAMPLE Liquid-based heating/cooling system.

3.3
main contactor
electronic or mechanic switching/disconnecting device for the battery pack or system *main power supply live part* (3.4)

3.4
main power supply live part
conductor or conductive part intended to be energized during normal operation, but explicitly excluding the Class A auxiliary voltage supply and the electric chassis, which is defined as the vehicle's electrically connected conductive parts serving as a reference potential

3.5
MAST
multiaxial simulation table
multiaxial system to induce vibrations or shocks in all three axial dimensions to the device under test (DUT)

3.6
PSD
power spectral density
measure of signal's power content versus frequency

Note 1 to entry: A power spectral density (PSD) is typically used to characterize broadband random signals. The amplitude of the power spectral density (PSD) is normalized by the spectral resolution employed to digitize the signal.

3.7
rated capacity
total number of ampere-hours that can be withdrawn from a fully charged battery pack or system under test conditions defined by the battery pack or system manufacturer

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3.8
technical tightness
inherent characteristic of a system that prevent fluids, gases or dusts from passing from the external to the internal environment or from the internal to the external environment, or both

4 Symbols and abbreviated terms

4.1 Symbols

1C	One-hour charge or discharge rate for the rated battery pack or system capacity
C/3	Three-hour charge or discharge rate for the rated battery pack or system capacity
RT	Room temperature value as defined in ISO 16750-1
t_{ch}	Duration with an electrical current charging the battery pack or system
t_{dch}	Duration with an electrical current discharging the battery pack or system
T_{amb}	Ambient temperature of a climate/temperature chamber
T_{ITCS}	Temperature of the internal temperature control system, for example liquid coolant, of a battery pack or system
T_{max}	Highest ambient temperature of a battery pack or system specified by the manufacturer (e.g. storage)
T^*_{max}	Maximum temperature by electric operation, can be lower than T_{max}
$T_{max,DUT}$	Highest operating temperature of a battery pack or system specified by the manufacturer
$T_{max,ITCS}$	Highest temperature at which an internal temperature control system, for example liquid coolant, of a battery pack or system can be used. Specified by the manufacturer
T_{min}	Lowest ambient temperature of a battery pack or system specified by the manufacturer (e.g. storage)
T^*_{min}	Low temperature, allows large currents, can be higher than T_{min}
$T_{min,DUT}$	Lowest operating temperature of a battery pack or system specified by the manufacturer
$T_{min,ITCS}$	Lowest temperature at which an internal temperature control system, for example liquid coolant, of a battery pack or system can be used. Specified by the manufacturer
X-axis	Vehicle driving direction
Y-axis	Perpendicular to vehicle driving direction and vertical axis
Z-axis	Vertical axis

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