IEC 62973-4

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Rolling stock – Batteries for auxiliary power supply systems –
Part 4: Secondary sealed nickel-metal hydride batteries

Applications ferroviaires – Materiel roulant –Batteries pour systemes d'alimentation auxiliaire –
Partie 4: Batterie d'accumulateurs nickel-hydrure métallique étanche

IEC 62973-4:2021-01(en-fr)

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FOREWORD

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International Standard IEC 62973-4 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
9/2638/FDIS	9/2665/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This document is to be used in conjunction with IEC 62675, IEC 63115-1 and IEC 63115-2.

A list of all parts in the IEC 62973 series, published under the general title *Railway applications – Rolling stock – Batteries for auxiliary power supply systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – ROLLING STOCK – BATTERIES FOR AUXILIARY POWER SUPPLY SYSTEMS –

Part 4: Secondary sealed nickel-metal hydride batteries

1 Scope

This part of IEC 62973 applies to secondary sealed nickel-metal hydride battery technologies for auxiliary power supply systems used on rolling stock.

This document specifies the requirements of the characteristics and tests for the sealed nickel-metal hydride cells and supplements IEC 62973-1 which applies to any rolling stock types (e.g. light rail vehicles, tramways, streetcars, metros, commuter trains, regional trains, high speed trains, locomotives, etc.). Unless otherwise specified, the requirements of IEC 62973-1 apply.

This document also specifies the requirements of the interface between the batteries and the battery chargers.

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.

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60077-1, *Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules*

IEC 62485-2, *Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries*

IEC 62675, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride prismatic rechargeable single cells*

IEC 62902:2019, *Secondary cells and batteries – Marking symbols for identification of their chemistry*

IEC 62973-1:2018, *Railway applications – Rolling stock – Batteries for auxiliary power supply systems – Part 1: General requirements*

IEC 63115-1:2020, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride cells and batteries for use in industrial applications – Part 1: Performance*

IEC 63115-2:2021, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride cells and batteries for use in industrial applications – Part 2: Safety*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

- IEC Electropedia: available at http://www.electropedia.org/;
- ISO Online browsing platform: available at http://www.iso.org/obp.

NOTE All typical battery related descriptions are defined in IEC 60050-482.

3.1.1
nickel-metal hydride battery
Ni-MH battery
secondary battery with an electrolyte of aqueous potassium hydroxide, a positive electrode containing nickel as nickel hydroxide and a negative electrode of hydrogen in the form of a metal hydride

Note 1 to entry: Nickel-metal hydride battery contains assembly of sealed cells.

[SOURCE: IEC 60050-482:2004, 482-05-08, modified – Abbreviation and Note 1 to entry have been added.]

3.1.2
cell
basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals and usually separators, that is a source of electric energy obtained by direct conversion of chemical energy

Note 1 to entry: In this document cell means secondary sealed nickel-metal hydride cell.

[SOURCE: IEC 60050-482:2004, 482-01-01, modified – Note 1 to entry has been replaced.]

3.1.3
sealed cell
cell which remains closed and does not release either gas or liquid when operated within the limits specified by the manufacturer

Note 1 to entry: A sealed cell may be equipped with a safety device to prevent a dangerously high internal pressure and is designed to operate during its life in its original sealed state.

[SOURCE: IEC 60050-482:2004, 482-05-17]

3.1.4
secondary cell
cell which is designed to be electrically recharged

Note 1 to entry: The recharge is accomplished by way of a reversible chemical reaction.

[SOURCE: IEC 60050-482:2004, 482-01-03]

3.1.5
battery module
group of cells connected together either in series and/or parallel configuration with or without protective devices (e.g. fuse or PTC) and monitoring circuitry

[SOURCE: IEC 62973-1:2018, 3.1.9, modified – "temperature sensor" has been replaced with "PTC".]

3.1.6
rated capacity
C_5 < at the 5 h rate >
capacity value of a battery determined under specified conditions and declared by the battery manufacturer

Note 1 to entry: In this document, rated capacity is at the 5 h rate; C_5.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Abbreviation and Note 1 to entry have been added.]

3.1.7
state of charge
SOC
remaining capacity to be discharged, normally expressed as a percentage of the full battery rated capacity as expressed in relevant standards

Note 1 to entry: Practical definitions of SOC are dependent upon chosen technologies.

[SOURCE: IEC 62973-1:2018, 3.1.6]

3.1.8
depth of discharge
DOD
capacity removed from a battery during discharge in relation to its full rated capacity expressed as a percentage

Note 1 to entry: It is the complement of SOC.

Note 2 to entry: As one increases, the other decreases by the same amount.

Note 3 to entry: Practical definitions of DOD are dependent upon chosen technologies.

[SOURCE: IEC 62973-1:2018, 3.1.7]

3.1.9
end user
organization which operates the battery system

Note 1 to entry: The end user is normally an organization which operates the vehicle equipped with the battery system, unless the responsibility is delegated to a main contractor or consultant.

[SOURCE: IEC 62973-1:2018, 3.1.11]

3.1.10
system integrator
organization which has the technical responsibility of the complete battery system and charging system

Note 1 to entry: The system integrator can be the end user or the train manufacturer, or none of them.

[SOURCE: IEC 62973-1:2018, 3.1.12]

3.1.11
manufacturer, <in railways>
organization which has the technical responsibility for its scope of supply

Note 1 to entry: The manufacturer can be the train builder or the system integrator of a battery system, a cell manufacturer, etc. If necessary to explicitly distinguish, “train manufacturer”, “battery system manufacturer” or “cell manufacturer” is expressed.

[SOURCE: IEC 62973-1:2018, 3.1.13]

3.2 Abbreviated terms

AC	Alternating Current
C_5	Capacity at the 5-h rate
DC	Direct Current
DOD	Depth of Discharge
LRU	Line Replaceable Unit
Ni-MH battery	Nickel-Metal Hydride battery
OCV	Open Circuit Voltage
SOC	State of Charge

4 General requirements

4.1 Definitions of components of a battery system (images are examples)

Figure 1 shows the definition of cell(s), battery module, crate, tray and battery box.

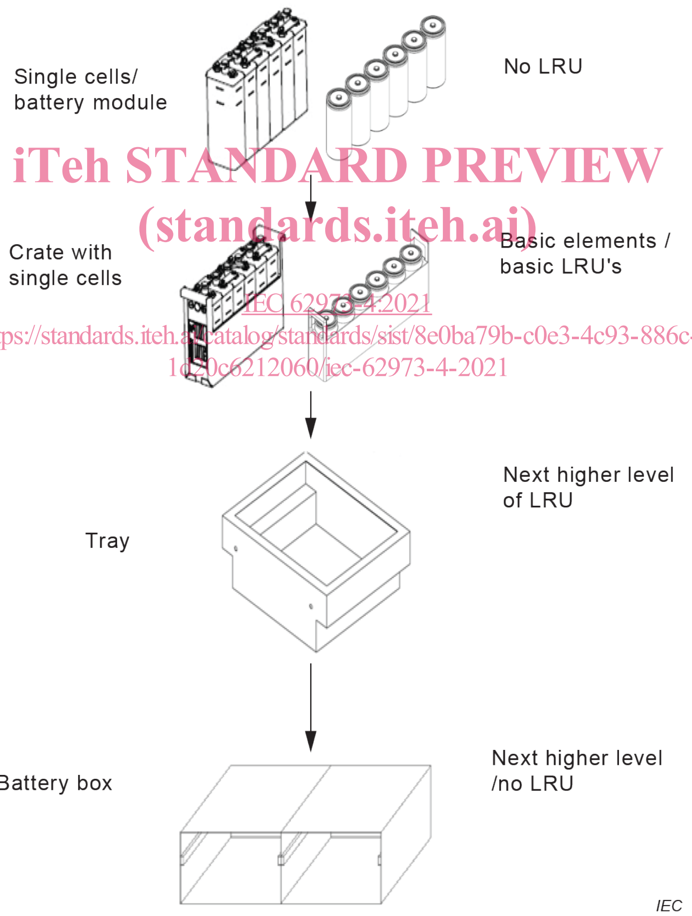


Figure 1 –Definition of cell(s), battery module, crate, tray and battery box

Some batteries may not include all of the above components, e.g. single cells may be installed in a tray without crates.

4.2 Definition of battery type

4.2.1 General

A battery consists of a number of cells or battery modules and/or assembled in trays, crates, and then assembled in a battery box.

A cell consists of positive and negative plates, electrolyte, metal container and sealing cap. Positive and negative terminals, which are apart by a separator, are housed and sealed in the metal container with a sealing cap.

The sealing cap consists of a positive terminal, a pressure release valve and an insulator which are insulated to a negative part that forms a container. The container wears an insulating envelope.

The positive active material is nickel hydroxide, and the negative active material is hydrogen absorbed nickel-alloy.

The electrodes are surrounded by electrolyte, an aqueous solution mainly of potassium hydroxide (KOH), and distilled or deionized water. The electrolyte does not chemically change or degrade due to charge/discharge cycles.

4.2.2 Cell designation

Sealed nickel-metal hydride cells shall be designated by a letter L, M, H or X which signifies:

– low rate of discharge (L);
– medium rate of discharge (M);
– high rate of discharge (H);
– very high rate of discharge (X).

NOTE These cells are typically but not exclusively used for the following discharge rates (see IEC 63115-1:2020):

L: up to and including 0,5 I_t A;

M: up to and including 3,5 I_t A;

H: up to and including 7,0 I_t A;

X: up to and above 7,0 I_t A.

These currents are expressed as multiples of I_t A, where I_t A = C_5 Ah/1 h.

4.2.3 Prismatic cells

Prismatic cell is the cell in the form of a rectangular parallelepiped.

4.2.4 Cylindrical cells

Cylindrical cell is the cell in the form of a cylinder. The overall height is equal to, or greater than the overall diameter.

4.3 Environmental conditions

4.3.1 Battery system

Refer to IEC 62973-1:2018, 4.3.

4.3.2 Battery module

Ni-MH battery modules can operate at temperatures in the range of −20 °C to +45 °C.

Deviations may be agreed between the end user and/or system integrator and cell/battery manufacturer.

4.4 System requirements

4.4.1 System voltage

The battery nominal voltages of Ni-MH is 1,2 V per cell.

The charging voltage for the Ni-MH battery is dependent on the number of cells and temperature.

The optimized number of cells in a Ni-MH battery calculated by the battery manufacturer shall allow operating between the minimum and maximum equipment operating voltage range considering the operating conditions and battery load profile. Then the operational battery charging voltage at 20 °C shall be set considering the calculated number of cells and individual cell charging characteristics. Refer to IEC 62973-1:2018, 4.4.1.

The battery nominal voltages and the discharge voltages are different. As an example, the following Figure 2 shows typical discharges of a Ni-MH cell at various constant discharging currents that vary by battery discharge rate designation (e.g. L, M, and H as set out in 4.2.2 and IEC 63115-1). These currents are expressed as multiples of I_t A, where I_t A = C_5 Ah/1 h, (see IEC 63115-1 and IEC 61960-3).

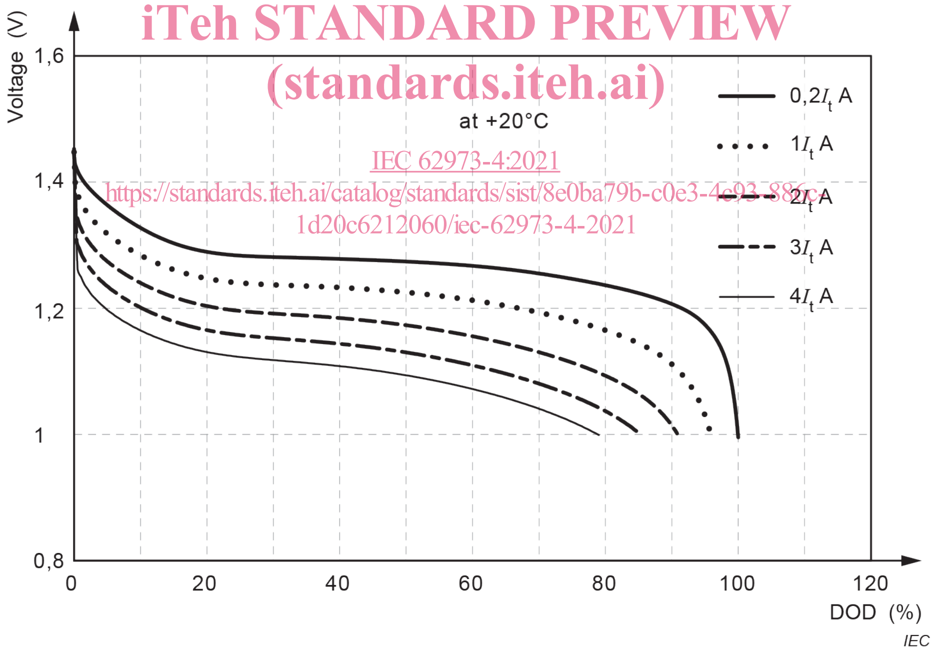
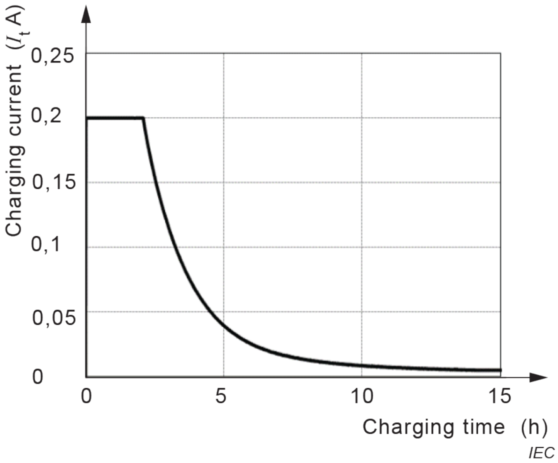


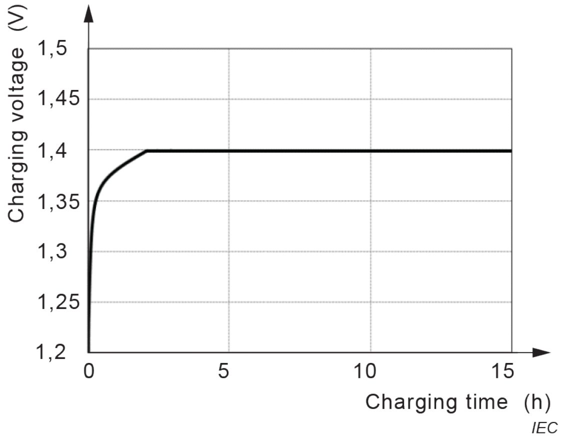
Figure 2 – Example of discharge curves at various constant discharge currents based on percentage of capacity

The following example, Figure 3 a) shows a typical charge of a Ni-MH cell at constant charging current at 0,2 I_tA for initial phase followed by Figure 3 b) constant charging voltage for the last phase depending on the Ni-MH battery technology.

Charging curves shall be available from battery manufacturers.



a) **Example of charging current rate curve**



b) **Example of charging voltage curve**

Figure 3 – Examples of Ni-MH charge curves

4.4.2 Charging requirements

The required battery charging voltage and the optimum charging method are specified according to Table 1.

Table 1 – Requirements of the charging characteristics

Requirements	Characteristics
Normal condition	Float charge by battery charger with temperature compensation and charging condition required by the battery manufacturer.
Charging method	See 4.5.3
Steady state control tolerance of the battery charge voltage output at the charging system	±1,5 % or lower tolerance
Charging voltage ripple	≤ 5 % (according to IEC 60077-1 with disconnected battery)
Charging current ripple	The battery charging current shall be DC, as any superimposed AC component in the charging current can lead to a temperature increase of the battery. The AC content in the charging current should not exceed values as set out in IEC 62485-2.
Temperature compensation	Required. In some case, in agreement between the end user and manufacturer, the temperature compensation voltage control charging may not be required.
Detection of temperature	Signal from sensor on battery or battery compartment, detection inside battery charging system.

NOTE DC ripple factor is calculated from the following formula:

$$\text{DC ripple factor} = \frac{U_{\text{max}} - U_{\text{min}}}{U_{\text{max}} + U_{\text{min}}} \times 100$$

where U_{max} and U_{min} are the maximum and minimum values, respectively, of the pulsating voltage.

See IEC 60077-1.

Figure 4 shows a typical electrical schematic for an interface between the battery box and the battery charging system.

Other configurations of the battery charging system may be available and the battery charging system may be included in the battery box by agreement between the end user and/or the integrator and the battery manufacturer. See Annex A.

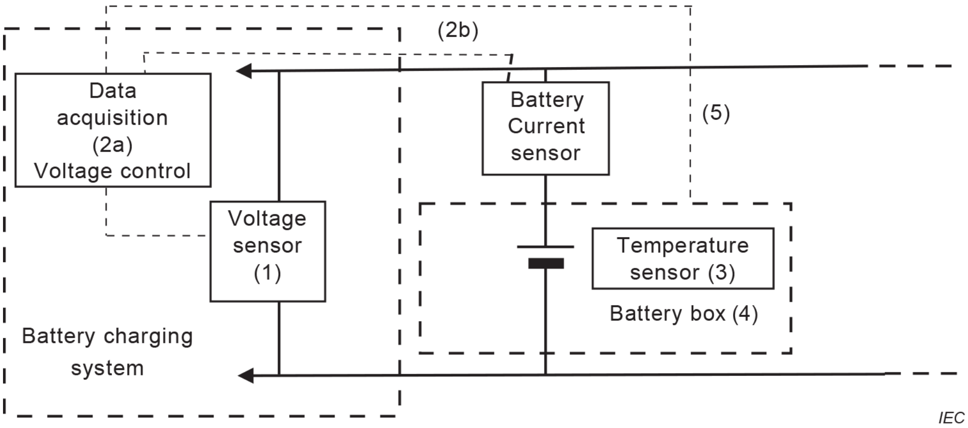


Figure 4 – Example of interfaces between battery box and battery charging system

The interface system between the battery charging system and the battery box as shown in Figure 4 consists of:

a) Battery voltage sensing and regulation; maximum ±1 % tolerance (see (1) in Figure 4);

b) Temperature data acquisition, (2a), including wiring (2b) to the sensor (3); typically, better than ±2,5 K tolerance;

c) Temperature sensor (3): maximum tolerance ±2 K for the specified temperature range preferably attached to the battery, minimum one sensor per battery system (see (3)); The choice of the temperature sensor shall be agreed between the system integrator and the suppliers of the battery and battery charging system;

d) Position of the temperature sensor (3) within the battery box (4);

e) Cabling between battery and battery charger; part of system integration in the rolling stock (5).

The system integrator will check if and how the effect of the wiring needs to be compensated, considering voltage drop in the power cables and resistance in the temperature sensor wires.

The impact of the sensor wiring depends on the type of temperature sensor, data acquisition system and/or location of the voltage sensor. If there are significant influences, it is possible to compensate these influences in the battery charger control system upon agreement between the system integrator and the manufacturer of the battery charging system.

With the recommended temperature sensors, the influence of the wiring resistance on the temperature acquisition can be neglected.

The charging voltage of the battery shall be limited to the maximum voltage at the equipment in Table 1 of IEC 62973-1:2018. The temperature compensation voltage control should be limited to these values considering the charging cell voltage values in Table 2 multiplied by the number of cells in series for the battery.

The typical charging voltages per cell for most applications are shown in Table 2 with temperature compensation voltage control. Higher or lower values, within the above limits, can be selected depending on sizing and application parameters (e.g. a single level float charge voltage of 1,40 V/cell without temperature compensation voltage control charging is typical).