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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical energy storage (EES) systems –
Part 4-4: Environmental requirements for battery-based energy storage systems (BESS) with reused batteries

Systèmes de stockage de l'énergie électrique (EES) –
Partie 4-4: Exigences environnementales pour les systèmes de stockage de l'énergie sur batterie (BESS) avec batteries réutilisées

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 4-4: Environmental requirements for battery-based energy storage systems (BESS) with reused batteries

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

Draft	Report on voting
120/333/FDIS	120/338/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62933 series, published under the general title *Electrical energy storage (EES) 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The increased use of renewable energy is enhancing the decarbonization of energy production by reducing CO_2 emissions caused by the use of fossil fuels. The production of renewable energy with solar and wind power is however associated with large temporal output fluctuations.

This causes increased voltage and frequency instabilities in the power grid. These irregularities can be advantageously counteracted with battery-based energy storage systems (BESS).

Such battery-based energy storage systems can be assembled with reused batteries coming from other electric energy storage installations or electric vehicles.

The reuse of batteries enhances all facets of the life cycle thinking (LCT) by reducing premature product obsolescence.

Reused cells, modules or battery assemblies entail particular attention toward the possible impact on the environment they will have due to their being a pre-aged component.

The impacts to the environment resulting from reused batteries are reviewed and appropriate requirements are defined.

This document complements, when reused batteries are involved, the information and guidance provided by IEC TS 62933-4-1.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 4-4: Environmental requirements for battery-based energy storage systems (BESS) with reused batteries

1 Scope

This part of the IEC 62933 series describes environmental issues when reused batteries are considered for a BESS.

It provides details and requirements for identifying and preventing environmental issues in each life cycle stage, i.e., from the design to the disassembly of such reused batteries in a BESS.

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

IEC TS 62933-4-1:2017, *Electric energy storage (EES) systems – Part 4-1: Guidance on environmental issues – General specification*

IEC Guide 109:2012, *Environmental aspects – Inclusion in electrotechnical product standards*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

3.1.1
battery-based energy storage system
BESS
electrical energy storage system with an accumulation subsystem based on batteries with secondary cells

Note 1 to entry: Battery energy storage systems include flow battery energy systems.

3.1.2
reuse, noun
operation by which secondary batteries that are not waste are used again in an application

3.1.3
life cycle thinking
LCT
consideration of all relevant environmental aspects during the entire (product) life cycle

[SOURCE: IEC Guide 109:2012, 3.10, modified – in the definition "of products" has been replaced with "(product)".]

3.1.4
life cycle assessment
LCA
compilation and evaluation of the inputs, outputs and the potential environmental impacts product system throughout its life cycle

[SOURCE: ISO 14040:2006, 3.2]

3.1.5
environment
surroundings in which a product or system exists, including air, water, land, natural resources, flora, fauna, humans and their interrelation

[SOURCE: IEC Guide 109:2012, 3.3]

3.1.6
environmental aspect
element of an organization's activities or products that can interact with the environment

Note 1 to entry: A significant environmental aspect has or can have a significant environmental impact.

[SOURCE: IEC Guide 109:2012, 3.4]

3.1.7

environmental impact
change to the environment, whether adverse or beneficial, wholly or partly resulting from environmental aspects

[SOURCE: IEC Guide 109: 2012, 3.5, modified – in the definition "an organization's" has been omitted.]

3.1.8
life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to the final disposal

[SOURCE: IEC Guide 109:2012, 3.8]

3.1.9
installation
one apparatus or set of devices and/or apparatuses associated in a given location to fulfil specified purposes, including all means for their satisfactory operation

[SOURCE: IEC 60050-151:2001, 151-11-26]

3.1.10
service life
total period of useful life of a cell or battery in operation

[SOURCE: IEC 60050-482:2004, 482-03-46, modified – the notes have been deleted.]

3.1.11
customer
person or organization that receives a product or service

Note 1 to entry: The customer will be the user or a distributor.

[SOURCE: ISO 9000:2014, 3.2.4, modified – in the definition, "could or does" and "that is intended for or required by this person or organization" have been deleted, the example has been omitted and the note has been modified.]

3.2 Abbreviated terms

BESS	battery-based energy storage system
BMS	battery management system
EV	electric vehicle
LCA	life cycle assessment
LCT	life cycle thinking
PPE	personal protective equipment
SoC	state of charge
SoH	state of health

4 General

Batteries of the BESS accumulation subsystem can be derived from installations and systems where they have been operated with specific user profiles and environmental conditions for sizable periods of time. Details of these use conditions can be fragmentary or unknown, complicating the reuse of the batteries.

Clause 5 and Clause 6 provide guidance and requirements to properly select and use reused batteries for a BESS and thus prevent premature failures and unwanted negative impacts on the environment.

5 Identifying environmental issues of EES systems

5.1 General

The guidance on general environmental aspects and their impacts caused by EES systems is given in IEC TS 62933-4-1.

Environmental aspects and requirements specific to the use of reused batteries in the accumulation subsystem of a BESS are addressed in the present document.

5.2 Guide for addressing environmental issues

ISO Guide 64 addresses environmental issues in product standards and outlines the relationship between provisions in product standards and the environmental aspects and impacts of the product.

ISO Guide 64 recommends the use of life cycle thinking when defining environmental provisions for a product for which a standard is drafted.

The following clauses in ISO Guide 64:2008 are referred to in this document.

– Clause 3 – Basic principles and approaches
– Clause 4 – Environmental aspects to be considered for systematically addressing environmental issues in product standards
– Clause 5 – Identifying product environmental aspects using a systematic approach
– Clause 6 – Guidance for integrating environmental provisions in the product standards

The major stages in the life cycle thinking process referred to in ISO Guide 64 are as follows:

- Design, procurement and acquisition, such as design, procurement of products/components and location of assembly where some EES systems, depending on storage technologies, can be integrated as a system in a factory while others can be integrated as a system on-site.
- Assembly and installation, such as on-site deployment of an already integrated EES system, on-site integration of products/components, on-site test and checking of operations and commissioning test.
- Operation and maintenance, such as on-site repair, partial replacement of a product/component.
- Disassembly, such as disassembly into products/components and shift in location, depending on storage technologies, of an already integrated EES system.

The service life of a product, such as an ESS, starts from the commissioning test at the end of the "installation stage" and ends when it is removed from its intended use during the "disassembly stage".

This document focuses on environmental issues on a BESS. For battery specific emissions into the environment, see Annex A.

Table B.1 in Annex B shows the relationship between the stages of the life cycle and the respective subclauses of the present document.

5.3 Aspects resulting from the implementation of reused batteries in a BESS

A reused battery of a BESS can have its origin in single cells and modules reclaimed from a disassembled electric vehicle (EV) or a BESS or consist in complete battery assemblies, with or without attached battery management and environmental control systems, coming from similar sources.

One of the key tasks when planning to reuse batteries is the assessment that all of their components satisfy the requirements of homogeneity in terms of design, manufacturing, age and operating history, and that their present status allows their economically viable, safe and environmentally sound operation in the future BESS.

The following relevant product life stages can be identified:

- specification of the required performance of the battery in the BESS;
- selection and procurement of the reused battery;
- fit-for-service verification of the reused battery;
- installation of the reused battery and ancillary equipment;
- operation in the BESS with the reused battery;
- disposal and recycling of the reused battery at its end of service life.

The reuse of batteries is desirable for environmental reasons, but they should not induce heightened environmental risk levels in a BESS, and adequate steps for their selection and characterization should be implemented.

The crucial information necessary for risk mitigation is knowledge of the first-life service history, usage data and the actual state of health (SoH). It is possible that the access to such data is not forthcoming due to invoked intellectual property rights or business and trade secrets.

Possible sources of risks which can be carried by a reused battery into a BESS are:

– Damaged or over-aged separators in the cells which can induce internal shorts and thermal runaway.
– Decomposed electrolyte and accumulated gaseous decomposition products which can cause the release of toxic, corrosive, and flammable compounds.
– Degraded cell container integrity which can cause electrolyte creep and conductive paths to ground, i.e., ground shorts.
– Imbalanced cell capacities which can be induced by excessive periods of high current demand in the first-life application, and which are not properly recoverable by the BMS of the BESS.
– Lost first-life service and SoH data due to a defective or missing BMS which does not allow a proper assessment of the health of incoming batteries destined for a reuse in the BESS.
– Lost traceability of the cells of the battery pack to its manufacturer and implemented design version which does not allow to properly pair them for use in a BESS and cause performance imbalances.
– Early deterioration of other components (e.g., insulation, controls, wiring) that are part of the reused battery assembly, and which can cause premature system outages and failures.

6 Environmental guidelines of EES system

6.1 Environmental aspects resulting from a BESS with reused batteries

6.1.1 General

The results generated throughout the assessments of the environmental aspects detailed below shall be accessible and safeguarded. Local regulations on environmental aspects can apply.

The economical attractiveness of reused batteries depends on the operational benefits achieved minus cost of other life cycle stages, for example, the cost of the ultimate and environmentally sound recycling or disposal of the battery materials.

Reused batteries can be supplied in various layouts, forms or assembly structures and can require that particular measures are to be taken in case of a fault developing within the battery.

6.1.2 Requirements at the design stage

The use of reused batteries in the BESS shall be considered in accordance with IEC Guide 109:2012, 4.3, to maximize resource and energy conservation and minimize pollution and waste.

The following requirements shall be fulfilled:

– The operating conditions of the reused battery in terms of power demands, ambient temperatures and energy turnovers per defined time period shall be defined.
– A contingency plan for their ultimate disposal and recycling shall be established to provide data for decision making in this matter.
– A contingency plan for battery failure mitigation shall be established and implemented to prevent a possible negative impact on the environment.