IEC 62933-5-2

Edition 1.0 2020-04

INTERNATIONAL STANDARD

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colour inside

Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems

Systèmes de stockage de l'énergie électrique (EES) – Partie 5-2: Exigences de sécurité pour les systèmes EES intégrés dans un réseau – Systèmes électrochimiques

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems

FOREWORD

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International Standard IEC 62933-5-2 has been prepared by IEC technical committee 120: Electrical Energy Storage (EES) Systems.

This International Standard is to be used in conjunction with IEC TS 62933-5-1:2017.

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

FDIS	Report on voting
120/173/FDIS	120/182/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.

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 "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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

All the electrical energy storage systems (EESS) follow the general safety requirements as described in IEC TS 62933-5-1, which is based on a systems approach. IEC 62933-5-2 follows the same structure as IEC TS 62933-5-1 and provides additional requirements for battery energy storage systems (BESS). The additional requirements are provided for the following reasons:

a) BESS can be integrated into a significant range of electrical grids.

b) The level of safety requirements awareness can vary between utilities, system integrators, operators and end-users.

c) Although the safety of individual subsystems is generally covered by international standards at ISO and IEC levels, the safety matters that arise due to the combination of electrochemical accumulation subsystems and any electrical subsystems are not always considered. BESS are complex at the systems level due to the variety of potential battery options and configurations, including the combination of subsystems (e.g. control systems for electrochemical accumulation subsystems, electrochemical accumulation subsystems, power conversion subsystems and auxiliary subsystems). Compliance with standards and related material produced specifically for the safety of subsystems cannot be sufficient to reach an acceptable level of safety for the overall system.

d) BESS can have additional safety hazards, due, for example, to the presence of chemicals, the emission of toxic gases, chemicals spilt around the electrochemical accumulation subsystems and to events critical for safety from electrochemical accumulation subsystems that cause safety issues for the entire BESS. They can cause loss of power at any part of the systems and buildings that can result in additional threats to safety. From a systems perspective, these individual hazards can have a system wide impact.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems

1 Scope

This part of IEC 62933 primarily describes safety aspects for people and, where appropriate, safety matters related to the surroundings and living beings for grid-connected energy storage systems where an electrochemical storage subsystem is used.

This safety standard is applicable to the entire life cycle of BESS (from design to end of service life management).

This document provides further safety provisions that arise due to the use of an electrochemical storage subsystem (e.g. battery system) in energy storage systems that are beyond the general safety considerations described in IEC TS 62933-5-1.

This document specifies the safety requirements of an “electrochemical” energy storage system as a "system" to reduce the risk of harm or damage caused by the hazards of an electrochemical energy storage system due to interactions between the subsystems as presently understood.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitute 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 60068-2-52, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60079-7:2015, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*
IEC 60079-7:2015/AMD1:2017

IEC 60079-13, *Explosive atmospheres – Part 13: Equipment protection by pressurized room "p" and artificially ventilated room "v"*

IEC 60079-29 (all parts), *Explosive atmospheres – Gas detectors*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-44, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-6:2016, *Low voltage electrical installations – Part 6: Verification*

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

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60812, *Failure modes and effects analysis (FMEA and FMECA)*

IEC 61000-1-2, *Electromagnetic compatibility (EMC) – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

IEC 61025, *Fault tree analysis (FTA)*

IEC 61660-1, *Short-circuit currents in d.c. auxiliary installations in power plants and substations – Part 1: Calculation of short-circuit currents*

IEC 61660-2, *Short-circuit currents in d.c. auxiliary installations in power plants and substations – Part 2: Calculation of effects*

IEC 61882, *Hazard and operability studies (HAZOP studies) – Application guide*

IEC 61936-1:2010, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*
IEC 61936-1:2010/AMD1:2014

IEC 62305-2, *Protection against lightning – Part 2: Risk management*

IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62477-1:2012, *Safety requirements for power electronic converter systems and equipment – Part 1: General*
IEC 62477-1:2012/AMD1:2016

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

IEC 62619:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

IEC 62933-1, *Electrical energy storage (EES) systems – Part 1: Vocabulary*

IEC TS 62933-5-1:2017, *Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid integrated EES systems – General specification*

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62933-1, IEC TS 62933-5-1 and the following apply.

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 Where differences in definitions appearing in IEC 62933-1 and IEC TS 62933-5-1 exist, the definition given in IEC 62933-1 prevails, unless otherwise specified here.

3.1
battery energy storage system
BESS
electrical energy storage system with accumulation subsystem based on batteries with secondary cells

Note 1 to entry: The battery energy storage system includes a flow battery energy system (IEC 62932-1:2020, 3.1.15).

Note 2 to entry: Batteries are defined in IEC 60050-482:2004, 482-01-04, and secondary cells are defined in IEC 60050-482:2004, 482-01-03.

3.2
occupied site
location that is within or adjacent to a building or structure with an overhead cover, where people live or work

Note 1 to entry: A location that is not an occupied site is called "unoccupied site".

3.3
type test
conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-151:2001, 151-16-16]

3.4
routine test
conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

3.5
factory acceptance test
FAT
factory activity to demonstrate that the EES system, subsystems, components and additionally supplied systems/devices are in accordance with the specifications

[SOURCE: IEC 62381:2012, 3.1.3, modified – Original definition has been particularized for the ESS system.]

3.6
site acceptance test
SAT
on site activity to demonstrate that the EES system can operate in accordance with the applicable system specifications and installation instructions

[SOURCE: IEC 62381:2012, 3.1.4, modified – Original definition has been particularized for the ESS system .]

4 Basic guidelines for safety of BESS

4.1 General

An assessment and reduction of the risk associated with the BESS as manufactured and as intended to be installed shall be conducted according to the sequence shown in Figure 1.

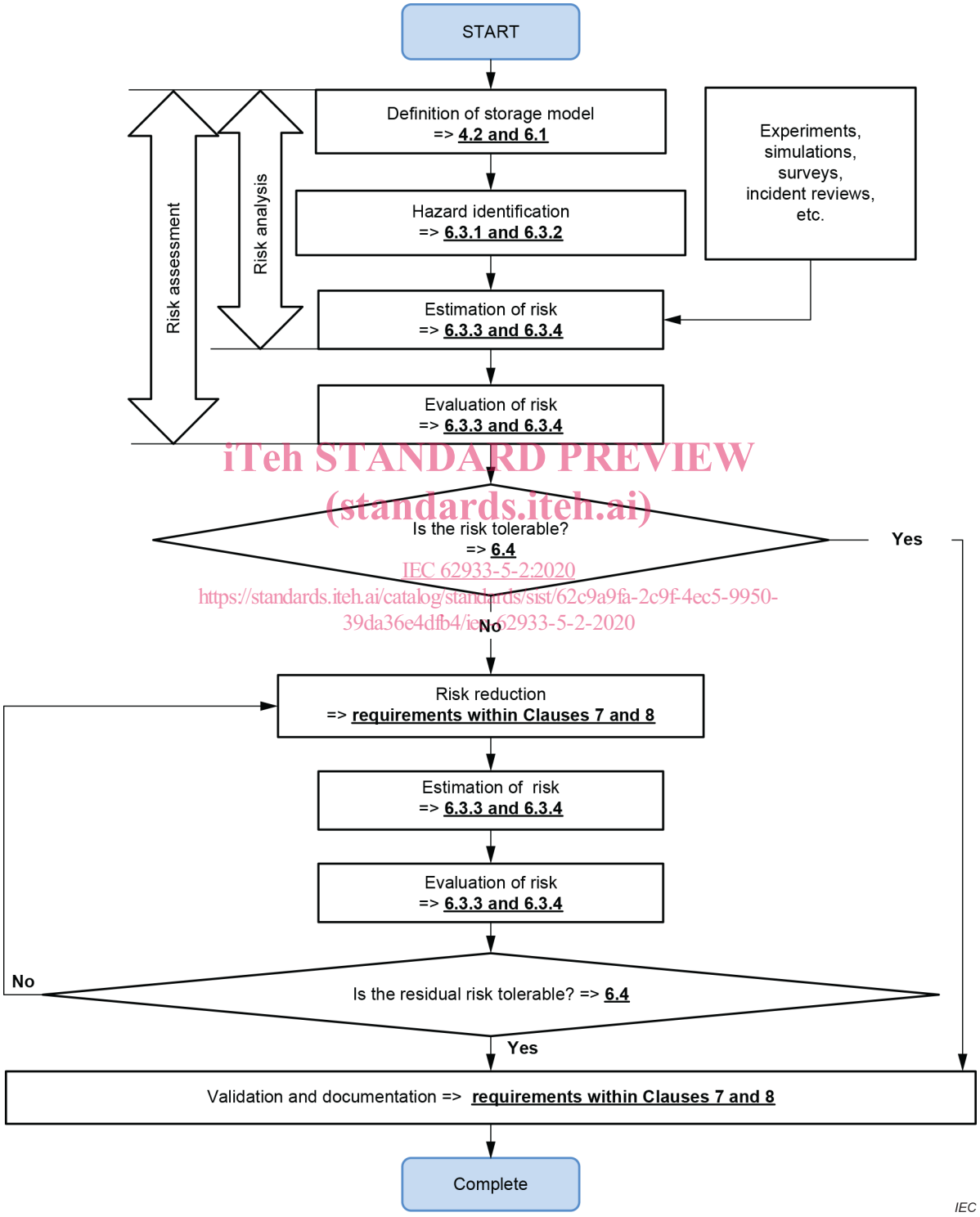

Figure 1 – General description for risk assessment and reduction of BESS

Risks can depend on many factors including location, chemistry and the size/scale (e.g. power) of the BESS and will need to be assessed accordingly. The location of BESS can range from single domestic situations, commercial and industrial applications, to utility scale systems; risks need to be assessed accordingly. Selection of chemistry for the electrochemical accumulation subsystem of the BESS can depend on their environment, performance characteristics and any associated costs and benefits.

As described in ISO/IEC Guide 51, risk reduction measures taken during design are "inherently safe design", "guards and protective devices", and "information for end users". Additional measures at the use phase (life cycle safety management) are also described in ISO/IEC Guide 51.

4.2 Approach to BESS safety

The design of the BESS and its intended installation and integration with the built environment shall accommodate the specific risks that arise during each phase of the BESS life cycle. These life cycle phases typically include, but are not limited to:

- manufacturing/final assembly and factory acceptance testing (see 7.10, 7.11, and 8.2);
- transport (see 7.10, 7.11, and 8.2);
- installation, commissioning and site acceptance testing (see 7.10, 7.11, 7.12 and 8.2);
- operation (see 7.13);
- maintenance and repair (see 7.13);
- repurposing or decommissioning (see 7.13).

During the installation process, soundness of communication among subsystems which are critical to minimizing risk and facilitating incident response shall be ensured to avoid any malfunctions of the protection subsystems. After the installation of the BESS, these subsystems shall be verified by inspection or other suitable means so that their proper functions are assured before the BESS is placed into service.

All health, safety and environment (HSE) requirements applicable to the BESS as installed shall be satisfied during system maintenance and repair.

The safety design considerations and risk analyses for each identified life cycle phase shall be documented and supplied in accordance with Clause 6 and 7.13.

A BESS that is designed and constructed to provide a specified level of reliability and durability shall include not only the levels of safety as a design feature of the overall system but also the subsystem safety level which is necessary to achieve the specified level. At the subsystem level, all integrated electrochemical energy storage subsystems shall comply with appropriate safety standards (e.g. IEC 62477-1, IEC 62619).

Safety measures for interactions between subsystems shall be consistent with the result of the system level safety risk assessment.

Commonly used electrochemical-based BESS POC (point of connection) voltages, energy capacity, site occupancy and chemistry of electrochemical accumulation subsystems are distinguished as listed in Table 1.

Detailed implementation of safety measures required in Clauses 7 and 8 can be optimized in accordance with the result of the system risk assessment of BESS (see Clause 6) using the basic conditions in Table 1.

NOTE 1 Chemistries that are not in common widespread use for stationary applications are not considered in this document but can be considered in future editions

NOTE 2 "Energy capacity" of BESS" means the total energy capacity of electrochemical accumulation subsystems which are equipped behind one POC.

Table 1 – BESS categories

Features for categorization	Category denominations	Explanation
"POC voltage" where BESS is connected	V-L	Low: V ≤ 1 kV AC or 1,5 kV DC
	V-H	High: V > 1 kV AC or 1,5 kV DC
"Energy capacity" of BESS	E-S	Small: E ≤ 20kWh
	E-L	Not small: E > 20kWh
"Site occupancy" in relation to electrochemical accumulation subsystem	S-O	Occupied site (see 3.2)
	S-U	Unoccupied site (see 3.2)
"Chemistry" of electrochemical accumulation subsystem	C-A	BESS using non-aqueous electrolyte battery (e.g. Li-based)
	C-B	BESS using aqueous electrolyte battery (e.g. Lead acid, Ni-based)
	C-C	BESS using high temperature battery (e.g. NaS, NaNiCl)
	C-D	BESS using flow battery
	C-Z	Others
NOTE 1 Denominations of BESS categorization are described as "V-X / E-X / S-X / C-X" in any requirements of this document (e.g. V-H / E-L / S-U / C-C). Some characteristics can be omitted if any limitation of category does not apply. NOTE 2 To apply this document to both BESS and other electrochemical-based EESS including chemical based supercapacitors, the latter EESS are included in category "C-Z". NOTE 3 Combinations of two or more electrochemical accumulation chemistries are included in category "C-Z".		

Examples of BESS use can be described as shown in Table 2.