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TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid-integrated EES systems – General specification

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

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FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62933-5-1, which is a technical specification, has been prepared by IEC technical committee TC 120: Electrical Energy Storage (EES) Systems.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
120/89/DTS	120/100/RVC

Full information on the voting for the approval of this technical specification 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

Many governments' plans for how electricity will be generated and managed in the future have been determined. Such current plans cannot be implemented without long-term storage with capacities in the multi-MWh range.

There are a number of types of storage technologies that have emerged. Examples of these technologies are pumped hydro storage (PHS), electrochemical batteries, flywheel storage systems and hydrogen and synthetic natural gas (SNG). Pumped hydro storage has been widely used in terms of the total amount of the stored energy. A flywheel is a model of kinetic energy storage with a high power density, excellent cycle stability and long life. While some flywheels are intended for short term operation, others can operate over longer periods of time of up to a few hours. Batteries require development primarily to decrease cost, and for some technologies to increase energy density as well. Hydrogen and synthetic natural gas (SNG) added to natural gas are likely to be essential elements of future electric grids because of their energy storage duration and capacity. Hydrogen and SNG should be further researched and developed across a broad front, including physical facilities, interactions with existing uses of gas for supply and distribution network, optimal chemical processes, safety, reliability and efficiency. The IEC White Paper “Electrical Energy Storage” (2011-12) may provide further background information on concerned EES systems.

The IEC expects to keep pace, as in other areas in the past, with the need for international consensus standards for the safety of new storage technologies. It encourages regulators to anticipate the requirement to guarantee the safety of these technologies, and to contribute to shaping suitable international standards upon which harmonized regulations may be based.

For mature EES systems various IEC standards exist covering technical features, testing and system integration. For other technologies there are only a few standards, covering special topics.

Up to now no general standard addressing safety for EES system integration into an electrical grid has been developed.

The rapid growth and the new technologies involved in electrical energy storage in the near future, as well as their installation by consumers will impose particular requirements for safety. At the same time, society and governments will need assurance of safety before the much-needed systems can be deployed.

This document stands as a decisive step towards the gradual alignment with specific technologies and applications concerning the safety of packaged or site-assembled grid-integrated EES system.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 5-1: Safety considerations for grid-integrated EES systems – General specification

1 Scope

This part of IEC 62933, which is a Technical Specification, specifies safety considerations (e.g. hazards identification, risk assessment, risk mitigation) applicable to EES systems integrated with the electrical grid.

This document provides criteria to foster the safe application and use of electric energy storage systems of any type or size intended for grid-integrated applications

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 62933-1[1], *Electrical energy storage (EES) systems – Part 1: Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62933-1 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

3.1
accumulation subsystem
storage subsystem
EESS subsystem, comprising at least one electrical energy storage, where the energy is stored in some form

Note 1 to entry: Mechanical energy, electrochemical energy, electromagnetic energy are frequent forms of stored energy.

Note 2 to entry: Generally (see Figure 8), the accumulation subsystem is connected to the power conversion subsystem that performs the necessary power conversion to electrical energy; however, in some cases, a power conversion is embedded in the accumulation subsystem (e.g. in electrochemical secondary cells the energy is directly available in the electrical form).

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1 Under preparation. Stage at the time of publication: IEC CDV 62933-1:2017.

3.2
auxiliary POC
EES system point of connection (POC) with the electric power system used to feed the auxiliary subsystem, only if the primary POC is not used to feed each subsystem

Note 1 to entry: Generally, an auxiliary POC can be replaced with another source of electrical energy (e.g. a diesel generator).

Note 2 to entry: The control subsystem is normally fed by the auxiliary subsystem and, therefore, by the auxiliary POC.

3.3
auxiliary subsystem
EESS subsystem containing equipment intended to perform particular functions additional to storing/extracting electrical energy which is done in the primary subsystem

Note 1 to entry: Generally (see Figure 8) the auxiliary subsystem is connected to the auxiliary POC through the auxiliary connection terminal.

Note 2 to entry: The equipment of the auxiliary subsystem (auxiliary equipment) is normally indispensable for setting up all the EESS operational states and assessing the correct performance (operation) of the primary and control subsystems during any operating mode.

Note 3 to entry: The auxiliary subsystem can be configured to take the energy from the primary subsystem (see Figure 8).

3.4
auxiliary subsystem de-energized
condition of service in which an auxiliary subsystem of the EES system does not have any energy source within the subsystem to feed the auxiliary equipment and is not connected to an external source of energy

Note 1 to entry: In this state the auxiliary subsystem is not fed by a possible UPS.

Note 2 to entry: "UPS" is defined in IEC 62040-1:2008, 3.1.1.

3.5
communication subsystem
EESS subsystem containing an arrangement of hardware, software, and propagation media to allow the transfer of messages from one EESS component/subsystem to another, including the data interface with external links

[SOURCE: IEC TS 62443-1-1:2009, 3.2.25, modified – the original definition has been particularized for the EES system.]

3.6
control subsystem
EESS subsystem serving for monitoring and controlling the EESS, by including all equipment and functions for acquisition, processing, transmission, and display of the necessary process information

Note 1 to entry: Generally (see Figure 8) the control subsystem may be connected to the communication interface and it comprises at least the management subsystem, the communication subsystem and the protection subsystem.

Note 2 to entry: The control subsystem is normally fed by the auxiliary subsystem.

[SOURCE: IEC TS 62351-2:2008, 2.2.195, modified – the second part of the original definition has been particularized for the EES system architecture, the first part of the original definition and notes to entry have been deleted.]

3.7
dead, adj.
DEPRECATED: de-energized, adj.
at an electric potential equal to or not significantly different from that of earth at the worksite

Note 1 to entry: This entry was numbered 651-01-15 in IEC 60050-651:1999.

[SOURCE: IEC 60050-651:2014, 651-21-09]

3.8
duty-cycle of the EES system
combination of controlled phases (charge phase, pause, discharge phase, etc.) starting from an initial state of charge and ending at a final state of charge, used in the EES system characterization, specification and testing for a certain operating mode

3.9
EESS module
EESS unit
part of an EES system, which is itself an EES system

Note 1 to entry: The EESS module is a specific EESS subsystem.

Note 2 to entry: In an EESS module the terminals, auxiliary and control subsystems may be absent; they may be centralized at EES system level.

3.10
EESS subsystem
part of an EES system, which is itself a system

Note 1 to entry: A subsystem is normally at a lower indenture level than the EES system of which it is a part.

[SOURCE: IEC 60050-192:2015, 192-01-04, modified – the original definition has been particularized for the EES system.]

3.11
electrical energy storage
EES

installation able to absorb electrical energy, to store it for a certain amount of time and to release electrical energy during which energy conversion processes may be included

EXAMPLE A device that absorbs AC electrical energy to produce hydrogen by electrolysis, stores the hydrogen, and uses that gas to produce AC electrical energy, is an electrical energy storage.

Note 1 to entry: The term “electrical energy storage” may also be used to indicate the activity of an apparatus described in the definition of this term during the performance of its own functionality.

Note 2 to entry: The term “electrical energy storage” should not be used to designate a grid-connected installation; "electrical energy storage system" is the appropriate term.

3.12
electrical energy storage system
EES system
EESS
grid-connected installation with defined electrical boundaries, comprising at least one electrical energy storage, which extracts electrical energy from an electric power system, stores this energy internally in some manner and injects electrical energy into an electrical power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment

Note 1 to entry: The EES system is controlled and coordinated to provide services to the electric power system operators or to the electric power system users.

Note 2 to entry: In some cases, an EES system may require an additional energy source (non electrical) during its discharge, providing more energy to the electric power system than the energy it stored (compressed air energy storage is a typical example where thermal energy is requested).

3.13
electrical installation
assembly of electrical equipment which is used for the generation, transmission, conversion, distribution and/or use of electric energy

Note 1 to entry: The electrical installation includes energy sources such as batteries, capacitors and all other sources of stored electric energy.

Note 2 to entry: This entry was numbered 651-01-04 in IEC 60050-651:1999.

[SOURCE: IEC 60050-651:2014, 651-26-01]

3.14
emergency stop
operating procedure intended to stop, as quickly as possible, an operation which has become dangerous

3.15
end of service life
life cycle stage of the EES system starting when it is removed from its intended use stage

Note 1 to entry: According to ISO Guide 64:2008, the sentence “removed from its intended use stage” does not mean “dismantled”. In fact, at the end of the service life, the EES system can either be reused/recovered or disposed of (after treatment, whenever necessary), possibly after dismantling and further processes.

Note 2 to entry: The term ”life-cycle” is defined in ISO Guide 64:2008, 2.5, and in IEC 60050-901:2013, 901-07-12, as “life cycle”.

[SOURCE: IEC 60050-904:2014, 904-01-17, modified – the original definition has been particularized for the EES system and notes to entry have been added]

3.16
end of service life values
value of unit parameters of an EES system that designate the end of service life

Note 1 to entry: EES system unit parameters, such as rated energy capacity, step response performances, rated powers, are generally determined by consensus between the user and the supplier.

3.17
energized, adj.
live, adj.
at an electric potential different from that of earth at the worksite and which presents an electrical hazard

Note 1 to entry: A part is energized when it is electrically connected to a source of electric energy. It can also be energized when it is electrically charged and/or under the influence of an electric or magnetic field.

Note 2 to entry: This entry was numbered 651-01-14 in IEC 60050-651:1999. It has been modified as follows: The word “significant” has been removed as it could not be quantified.

[SOURCE: IEC 60050-651:2014, 651-21-08]

3.18
expected service life
T_{SL}
design duration for which the EES system unit parameters are greater than end of service life values at continuous operating conditions

Note 1 to entry: Generally this duration is expressed in years or in duty-cycles.

[SOURCE: IEC 62477-1:2012, 3.14, modified – the original definition has been particularized for the EES system and the note to entry has been added]

3.19
explosion hazard
condition of an EES system with a potential for an undesirable consequence from explosion

Note 1 to entry: Explosion hazard is a condition where danger exists because hazardous substances that are present may react (e.g., detonate, deflagrate) in a mishap with potential unacceptable effects (e.g., death, injury, damage) to people, property, operational capability, or the environment.

3.20
failure mode
DEPRECATED: fault mode
manner in which failure occurs

Note 1 to entry: A failure mode may be defined by the function lost or other state transition that occurred.

[SOURCE: IEC 60050-192:2015, 192-03-17]

3.21
failure modes and effects analysis
FMEA
DEPRECATED: fault mode and effects analysis
qualitative method of analysis that involves the study of possible failure modes and faults in sub items, and their effects at various indenture levels

Note 1 to entry: The term "fault mode and effects analysis" in IEC 60050-191:1990 (now withdrawn; replaced by IEC 60050-192:2015) is deprecated, since a fault (192-04-01) is a state and cannot logically have a mode, whereas a failure mode (192-03-17) is a change of state.

[SOURCE: IEC 60050-192:2015, 192-11-05]

3.22
failure modes, effects and criticality analysis
FMECA
DEPRECATED: fault mode, effects and criticality analysis
quantitative or qualitative method of analysis that involves failure modes and effects analysis together with a consideration of the probability of the failure mode occurrence and the severity of the effects

Note 1 to entry: The term "fault mode, effects and criticality analysis" in IEC 60050-191:1990 (now withdrawn; replaced by IEC 60050-192:2015) is deprecated, since a fault (192-04-01) is a state and cannot logically have a mode, whereas a failure mode (192-03-17) is a change of state.

[SOURCE: IEC 60050-192:2015, 192-11-06]

3.23
fault tree analysis
FTA
deductive analysis using fault trees

Note 1 to entry: See also fault tree (192-11-07).

[SOURCE: IEC 60050-192:2015, 192-11-08]

3.24
fire hazard
condition of an EES system with a potential for an undesirable consequence from fire

Note 1 to entry: Fire hazard is a condition where danger exists because flammable solids, liquids, gases or their mixture are present in quantities/concentrations that may result in uncontrolled combustion with potential for death, injury, or damage to people, property, operational capability, or the environment.

[SOURCE: ISO 13943:2008, 4.112, modified – the original definition has been particularized for the EES system and note 1 to entry has been added.]

3.25
grid-connected state
operating state in which the EES system is connected to the primary POC

3.26
grid-disconnected state
operating state in which the EES system is disconnected from the primary POC

3.27
harm
physical injury or damage to persons, property, and livestock

[SOURCE: IEC 60050-903:2013, 903-01-01]

3.28
hazard
potential source of harm

Note 1 to entry: In English, the term "hazard" can be qualified in order to define the origin of the hazard or the nature of the expected harm (e.g. "electric shock hazard", "crushing hazard", "cutting hazard", "toxic hazard", "fire hazard", "drowning hazard").

Note 2 to entry: In French, the synonym "risque" is used together with a qualifier or a complement to define the origin of the hazard or the nature of the expected harm (e.g. "risque de choc électrique", "risque d'écrasement", "risque de coupure", "risque toxique", "risque d'incendie", "risque de noyade").

Note 3 to entry: In French, the term "risque" also denotes the combination of the probability of occurrence of harm and the severity of that harm, in English "risk" (see 903-01-07).

[SOURCE: IEC 60050-903:2013, 903-01-02]

3.29
hazard and operability studies
HAZOP studies
structured and systematic technique for examining a defined system with the objective of: identifying potential hazards in the system (the hazards involved may include both those essentially relevant only to the immediate area of the system and those with a much wider sphere of influence, for example some environmental hazards) and identifying potential operability problems with the system and in particular identifying causes of operational disturbances and production deviations likely to lead to non conforming products

3.30
hazardous substance
hazardous material
substance which can affect human health or the environment with an immediate or retarded effect or is capable of posing an unacceptable risk to health, safety, property or to the environment

Note 1 to entry: It may concern other substances than those officially recognized as such in existing hazardous material classification systems, for example, Global Harmonized System (GHS), Transport of Dangerous Goods (TDG).

3.31
intentional islanding
intentional island
island that is intentionally created, usually to restore or maintain power to a section of the utility grid affected by a fault

Note 1 to entry: The generation and loads may be any combination of customer-owned and utility-owned, but there is an implicit or explicit agreement between the controlling utility and the operators of customer-owned generation for this situation.

Note 2 to entry: The term “island” is defined in IEC 60050-617:2009, 617-04-12.

[SOURCE: IEC 62116:2014, 3.6, modified – the note 2 to entry has been added.]

3.32
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 60050-901:2013, 901-07-12]

3.33
long duration application
long term application
energy intensive application
EES system application generally not very demanding in terms of step response performances but with long charge and discharge phases at variable powers

Note 1 to entry: Reactive power exchange with the electric power system may be present along with the active power exchange

Note 2 to entry: The term “electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.34
management subsystem
EESS subsystem providing the functionality needed for the safe, effective and efficient EES system operation

3.35
mechanical hazard
condition of an EES system with a potential for an undesirable consequence from physical force

Note 1 to entry: Mechanical hazard is a condition where physical factors may give rise to injury due to the mechanical properties of products/product parts.

Note 2 to entry: The definition has been formulated along the same lines as that in ISO 13943:2008, 4.112.

3.36
modularity
property of an EES system that specifies the extent to which it has been composed out of separate parts called EESS modules

[SOURCE: ISO/IEC 14543-2-1:2006, 3.2.9, modified – the original definition has been particularized for the EES system]

3.37
operating state
particular combination of EESS element states bound to a specific operation of an EES system during a required time

3.38
personal protective equipment
PPE
any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards whilst performing live working