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

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



120/353/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 62933-5-2 ED2

DATE OF CIRCULATION:

2024-03-15

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2024-06-07

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120/326/CD, 120/348/CC

IEC TC 120 : ELECTRICAL ENERGY STORAGE (EES) SYSTEMS

SECRETARIAT:

Japan

SECRETARY:

Mr Masatake SAKUMA

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 8, TC 21, SC 21A, TC 22, SC 22E, TC 57, TC 64, TC 69, TC 82, TC 88, TC 105, CISPR

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC☐ ENVIRONMENT☐ QUALITY ASSURANCE☒ SAFETY☒ SUBMITTED FOR CENELEC PARALLEL VOTING☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

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TITLE:

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

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

This CDV reflects the observations made in 120/348/CC.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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 62933-5-1(Future):20xx.

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

FDIS	Report on voting
120/XX/FDIS	120/XX/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.

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

- 236 • reconfirmed,
- 237 • withdrawn,
- 238 • replaced by a revised edition, or
- 239 • amended.

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INTRODUCTION

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

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

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

Although the safety of individual subsystems is generally covered by international standards at ISO and IEC levels, the safety matters that arise due 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.

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 EES systems that are beyond the general safety considerations described in IEC 62933-5-1(Future).

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.

ISO/IEC 31010, Risk management — Risk assessment techniques

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 60364-4-44, *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 60664-1:2020, *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 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

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

IEC 62619:2022, *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 62933-5-1: (Future), *Electrical Energy Storage (EES) systems – Part 5-1: Safety considerations for grid integrated EES systems – General specification*

IEC 62933-5-3, *Electrical energy storage (EES) systems Part 5-3: Safety requirements for electrochemical based EES systems considering initially non-anticipated modifications - partial replacement, changing application, relocation and loading reused battery -*

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 and IEC 62933-5-1(Future) 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 62933-5-1(Future) exist, the definition given in IEC 62933-1 prevail, unless otherwise specified here.

3.1

type test

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

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

3.2

routine test

conformity test made on each individual item during or after manufacture

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

356 **3.3**

357 **battery management system**

358 **BMS**

359 electronic system associated with a battery which has functions to controlling current in case of
360 overcharge, overcurrent, over discharge, and overheating and which monitors and/or manages
361 its state, calculates secondary data, reports that data and/or controls its environment to
362 influence the battery's safety, performance and/or service life

363 [SOURCE: IEC 62619:2022, 3.12,]

364 [SOURCE: IEC 60050-617:2009, 617-04-01, modified – the original definition has been
365 particularized for the EES system and notes to entry have been added.]

366 **3.4**

367 **system integrator**

368 the manufacturer who integrates the individual subsystem and completes functions properly as
369 a single system.

370 **4 Basic guidelines for safety of BESS**

371 **4.1 General**

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

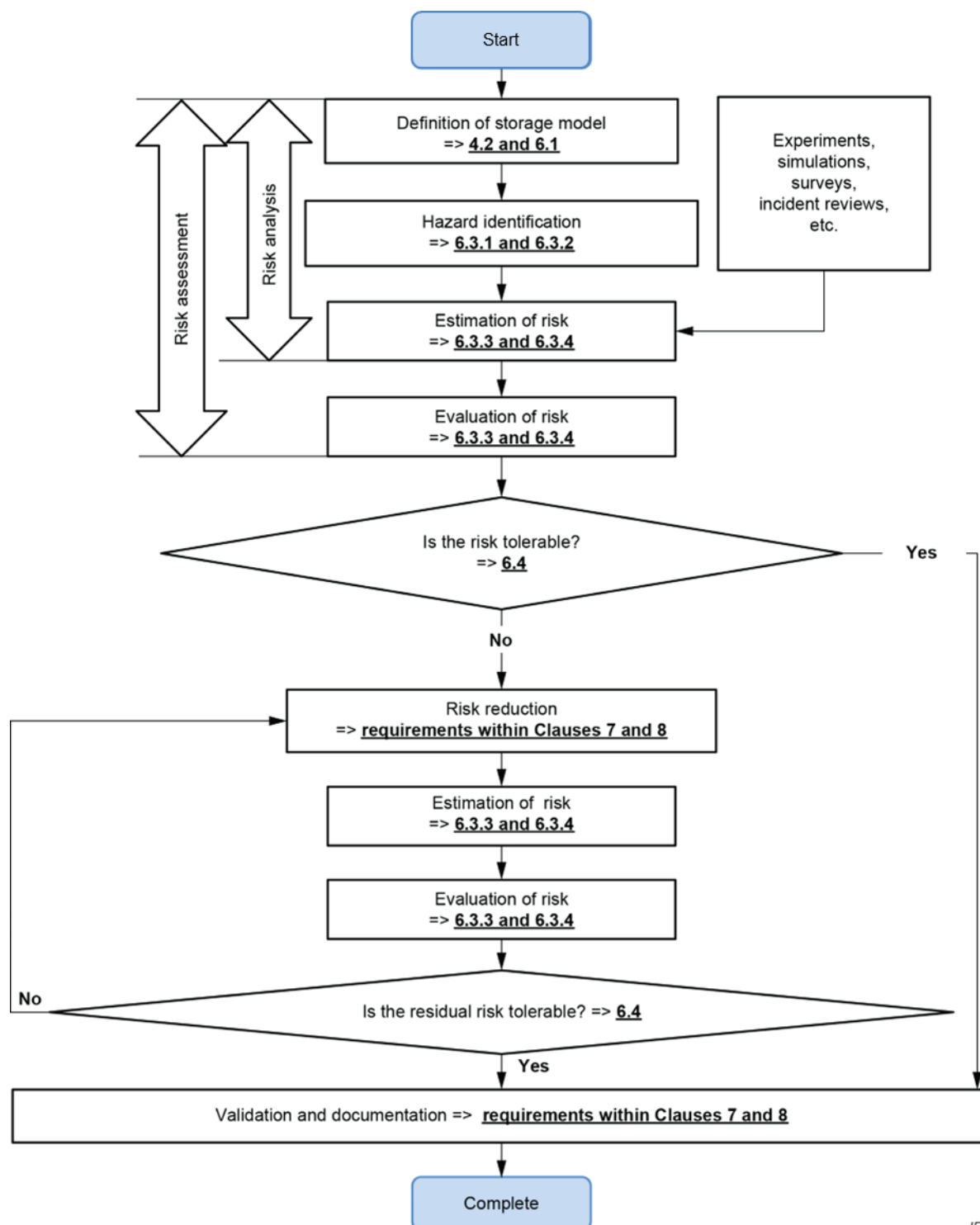


Figure 1 – General description for risk assessment and reduction of BESS

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

Common BESS POC (point of connection) voltages, energy capacity, site occupancy and chemistry of electrochemical accumulation subsystem 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 total energy capacity of electrochemical accumulation subsystems which are equipped behind one POC.

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Table 1 – BESS categories

Features for categorization	Category denominations	Explanation
“POC voltage” where BESS is connected	V-L	Low: $V \leq 1 \text{ kV AC or } 1.5 \text{ kV DC}$
	V-H	High: $V > 1 \text{ kV AC or } 1.5 \text{ kV DC}$
“Energy capacity” of BESS	E-S	Small: $E \leq 20\text{kWh}$
	E-LI	Large: $E > 20\text{kWh}$ / Integrated within one enclosure
	E-LS	Large: $E > 20\text{kWh}$ / Separated by two or more enclosures
“Site occupancy” in relation to electrochemical accumulation subsystem	S-O	Occupied site (see IEC 62933-1)
	S-U	Unoccupied site (see IEC 62933-1)
“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-LI / 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 super-capacitors, 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”. NOTE 4 Li-based batteries are categorized as C-A, no matter whether those electrolytes are non-aqueous liquids or solid electrolytes (typically referred to as solid state).		

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

425

426

Table 2 – Examples of BESS application

Application environment	Site	Access restrictions/conditions during operation and maintenance
Residential	installed in individual homes or shared by a small number of homes, apartments buildings or villas.	can be placed in a location that is not accessible for regular maintenance without cooperation of the inhabitants of the home and is not part of a professional operating and maintenance regime.
	An example of using Table 1 in this BESS application environment can be as follows: “V-L / E-S or LI /S-O or U / C-A or B”.	
Commercial	installed in small businesses, shared by a large number of homes etc., or a mixture of the above uses such as a street or an large apartment building.	placed in a location that is accessible for regular maintenance during business hours and is usually part of a professional operating and maintenance regime.
	An example of using Table 1 in this BESS application environment can be as follows: “V-H or L / E-LI /S-O or U / C-A, B, C or D”.	
Industrial	installed in large businesses like factories, data centres, warehouses etc., or shared by a large number of homes, such as a city quarter.	placed in a location that is accessible for regular maintenance during business hours and is part of a professional operating and maintenance regime.
	An example of using Table 1 in this BESS application environment can be as follows: “V-H / E-LI or E-LS /S-O or U / C-A, B, C or D”.	
Utility	connected directly to the utility grid.	placed in a location that is continuously accessible for regular maintenance and is part of a professional operating and maintenance regime. The system is typically placed inside a restricted access area, or access to the system itself is restricted to authorized people.
	An example of using Table 1 in this BESS application environment can be as follows: “V-H / E-LS / S-O or U / C-A, B, C or D”.	

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428 **4.3 BESS changes in ownership, control or use**

429 In all cases where a transfer of ownership or operational responsibility occurs, the monitoring
 430 log information should be transferred to the new owner as part of the system documentation,
 431 including measures for complying with the requirements in 7.13.2 and 7.13.3. When it is
 432 necessary to control identified BESS risks, there should be clarification on the roles and
 433 responsibilities for managing and controlling any existing or new safety risks arising out of the
 434 changes that are planned or have taken place.

435 Annex A provides further information regarding ownership of BESS.

436

437 **5 Hazard considerations**

438 The general hazard considerations for EESS in IEC 62933-5-1(Future):20xx, Clause 5, are
 439 applicable.

6 BESS system risk assessment

6.1 BESS structure

6.1.1 General characteristics

A storage model of the BESS with clarifying features as shown below shall be created for an appropriate safety risk assessment.

An example of a BESS including a primary POC, auxiliary POC and control subsystem is shown in Figure 2 and Table 2. In some cases, it is possible that one or more subsystems or components are not included. The communication arrangements between management, communication, protection and the other subsystems are shown as dotted arrow lines.

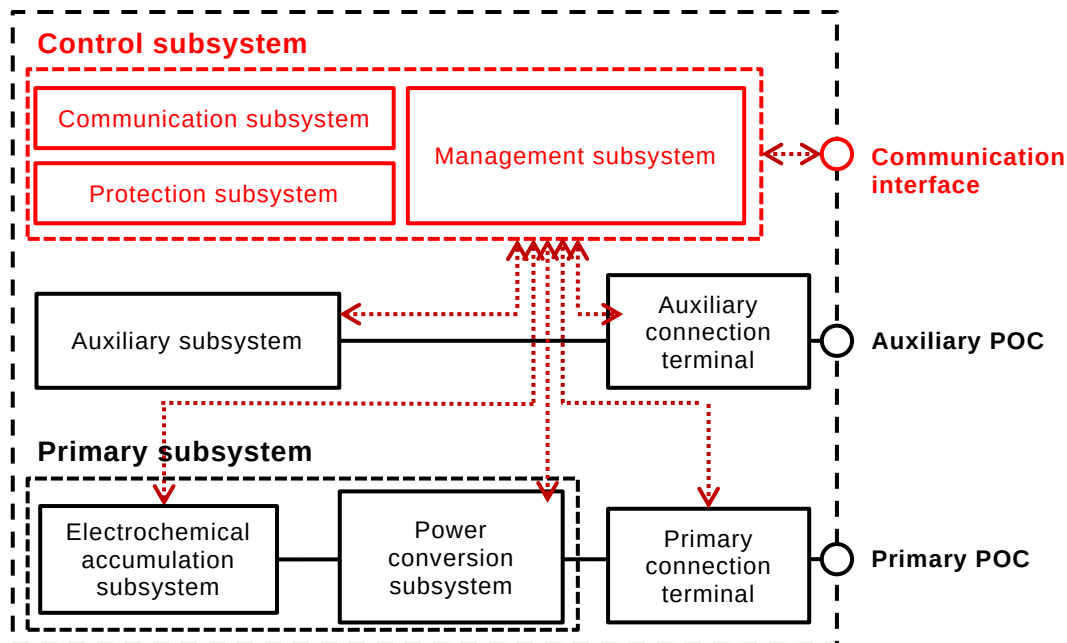


Figure 2 – An example of BESS architecture

NOTE Figure 2 is an example of a typical BESS architecture. There can be the cases which do not fit in Figure 2.

Table 3 – Examples of components within subsystems of a BESS

Subsystems	Components
Management subsystem	System controller and/or energy management system
Communication subsystem	Operation panel (human interface), system communication and/or monitoring, meter communication,
Protection subsystem	Relays (earth, overcurrent, over voltage, under voltage, over frequency, under frequency, etc.)
Auxiliary subsystem	Fire, heat, and/or smoke detection system(s), fire suppression system, fire extinguisher, HVAC (heating, ventilation and air conditioning), system anchors, auxiliary transformers, auxiliary power distribution switchgear, auxiliary power uninterruptible power supply (UPS)
Auxiliary connection terminal	Connection terminals, cable (type, fire rating, thermal rating, chemical rating, size and flexibility)
Electrochemical accumulation subsystem	Battery (incl. battery management system), communication devices, protective devices, mechanical fixing, cables NOTE There are many cases where BESS include multiple numbers or types of electrochemical accumulation subsystems
Power conversion subsystem	Transformer, AC/DC converter, inverter, PCS controller, switches
Primary connection terminal	Connection terminal, cable (type, thermal rating, chemical rating, size and flexibility)
Others	Room and/or building/enclosure, foundation, water supply, HVAC system of the building, fuses, safety markings

6.1.2 Specific characteristics

The main types of BESS that have been previously categorized according to 4.2 can differ not only in the chemistry of the electrochemical accumulation subsystem but also according to the type of auxiliary subsystems as given below:

specific auxiliary subsystem of category “C-C” (BESS using high temperature battery)

- electrochemical accumulation subsystem heating circuit

specific auxiliary subsystem of category “C-D” (BESS using flow battery)

- heat exchanger
- fluid management system (pump, tank, piping, valve. etc)

6.1.3 Specific BESS implementation location

For reasons of difficult access and egress, roof top BESS installations or BESS installations at elevated floor levels are not recommended. Should such an installation of a BESS still be envisaged, the risk analysis procedure (see clause 6.3) shall consider additional risk reduction measures that can need to be taken to make sure that the residual risk is tolerable and acceptable by concerned emergency services.

6.2 Description of BESS conditions

The basic description of BESS conditions shall be categorized in accordance with Table 1 (see 4.2). The more detailed description in accordance with IEC 62933-5-1(Future):20xx7, 6.2, is applicable to BESS.

6.3 Risk analysis

6.3.1 General

A risk analysis (hazard identification and risk estimation) of the BESS shall be carried out in accordance with 4.1, 4.2, 6.3.2, 6.3.3 and 6.3.4.

The general considerations for analysing any risk of EESS are described in IEC 62933-5-1(Future).

An iterative approach shall be applied (because several successive applications can reduce the risk and make the best use with available technology). In carrying out this process, it is necessary to consider the safety of the BESS during all the phases of its life cycle.

Useful information about BESS hazards and risks is provided in Annex B.

6.3.2 Hazard identification specific to BESS

The scenario, as a result of BESS risk assessment, shall include specific subsystem failure modes (identified hazards specific to BESS) as starting points for the analysis.

6.3.3 Risk consideration

BESS risk scenarios shall include all interactions between subsystems. Examples of scenarios include but are not limited to:

propagation from electrochemical accumulation subsystem(s) to others

propagation from non-accumulation subsystems

simultaneous failures/faults of multiple subsystems

loss of subsystem function related to safety

6.3.4 System level risk analysis

The system level BESS risk shall be assessed at a component, module and final system level. A suitable analysis shall be performed to demonstrate that suitable risk analysis has been carried out at a component, module and final system level.

The general conditions of "system level risk analysis" are described in IEC 62933-5-1(Future):20xx, 6.3.3.

The system level BESS risk analysis shall be performed based on the risk (BESS size/severity) and complexity of the system using one of the following techniques or an equivalent one

- bottom-up 1st principles risk analysis (e.g. FMEA (Failure Mode and Effect Analysis): see IEC 60812)
- top-down analysis (e.g. FTA (Fault Tree Analysis): see IEC 61025)
- combined and/or integrated analysis (e.g. HAZOP (Hazard and Operability Study): see IEC 61882, STAMP)
- structured What IF Technique (see ISO/IEC 31010)

6.4 System level risk assessment

All risks shall be assessed for their impact on operators, users and neighbours who can occupy the site of the BESS, and graded as tolerable or not.

If the systems are reliant upon electronics and software, an evaluation of the functionality of these controls shall be conducted. A suitable functional safety standard for example, can be utilized for this purpose.

If some risks are not tolerable, appropriate measures shall be taken, according to the requirements in Clauses 7 and 8.

Documentation attached to the assessment and reduction of risk of the BESS shall be available and shall comprise all requirements specified in Clause 6.

7 Requirements necessary to reduce risks

7.1 General measures to reduce risks

The general safety considerations for an EESS are described in IEC 62933-5-1(Future):20xx, 7.1.

The priority of risk reduction approaches (from ISO/IEC Guide 51:2014, 6.3.5) shall be:

inherently safe design;

guards and protective devices;
information for end users.

Inherently safe design measures are the first and most important step in the risk reduction process. This is because protective measures inherent to the characteristics of the product or system are likely to remain effective, whereas experience has shown that even well-designed guards and protective devices can fail or be violated, and information for use might not be followed.

Guards and protective devices shall be used whenever an inherently safe design measure does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (e.g. emergency stop equipment) might have to be implemented.

The end user has a role to play in the risk reduction procedure by complying with the information provided by the designer/supplier. However, information for use shall not be a substitute for the correct application of inherently safe design measures, guards or complementary protective measures.

All the safety design measures required in 7.2 to 7.12 shall be considered in accordance with BESS risk assessment processes specified in Clause 6.

Some of the specified measures can be waived provided that clear demonstration is made in the risk assessment that safety objectives supported by the waived measures are clearly achieved, even without the implementation of the concerned measure.

7.2 Preventive measures against damage to neighbouring inhabitants

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.2, are applicable.

7.3 Preventive measures against physical injury or damage to the health of workers and residents

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.3, are applicable.

7.4 Over current protection design

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.4, are applicable.

7.5 BESS disconnection and shutdown

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.5, are applicable. Additional safety requirements necessary to reduce risks of BESS during disconnection and shutdown are described in 7.11.2.

7.6 Operation and maintenance

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.6 are applicable.

7.7 Staff training

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.7, are applicable.

7.8 Safety design

The general safety considerations of EESS described in IEC 62933-5-1(Future):20xx, 7.8, are applicable. Additional safety requirements necessary to reduce risks of BESS through safety design are described in sub-clause 7.10, 7.11.1, 7.11.3, and 7.12.

7.9 General requirements for BESS safety

Any failure or fault with a subsystem should not affect to the safety of the other subsystem.

Any subsystem that develops a fault which could affect the safe operation of the BESS should be capable of being isolated from other subsystems. The safety functions of subsystems shall not be affected by such isolations and shall operate independently.

The BESS design should minimize noise, vibration and extreme temperatures generated from the BESS.

The architecture of subsystems within the BESS should not prevent operators from recognizing hazardous parts, sections and conditions.

Additionally, for category "V-H" BESS, measures shall be taken for preventing any remote dangerous operations if there is no evidence that can be obtained that workers are not at risk at the site.

Ergonomic principles specified in an appropriate standard (e.g. ISO 9241 (all parts)) should be taken into account in designing machinery so as to reduce the mental or physical stress of, and strain on, the operator. These principles should be considered when allocating functions to operator and machine (degree of automation) in the basic design.

BESS using reused or repurposed batteries shall comply with clause 9 of IEC 62933-5-3.

7.10 Inherently safe design of BESS

7.10.1 Protection from electrical hazards

The electrical installation of category "V-L" BESS shall be in accordance with appropriate parts of the IEC 60364 series.

The electrical installation of category "V-H" BESS shall be in accordance with IEC 61936-1 and IEC 60364.

The electrical protection for the subsystem connected to the DC side of the BESS shall be safe in accordance with standards (e.g. IEC 61660-1 and IEC 61660-2).

The live parts of subsystems and the components of BESS that have hazardous voltage (above safety extra-low voltage (SELV)) circuits shall not be accessible to unauthorized people. The parts of BESS which are likely to cause electric shock shall be securely covered. The conductive parts of BESS which people are likely to touch shall be separated from any parts at hazardous voltage. The protection can be achieved by one of the following methods:

- preventing a current from passing through the body of any person or any livestock;
- limiting the current which can pass through a body to a non-hazardous value.

The electric wires and insulation shall each be rated for the maximum current, voltage and temperature.

All conductive parts of a BESS which can come in contact with a hazardous voltage through a single insulation fault shall be connected to earth in accordance with appropriate standards, manufacturer instructions and local regulations.

The physical spacing of circuits including securing leads and terminals, etc., shall be sufficient to prevent inadvertent short-circuits and/or the potential for arc flash.

Connection points of bare conductors shall be appropriately spaced and of suitable structure to prevent inadvertent short-circuits between electrochemical accumulation subsystems.

A risk assessment in accordance with the procedures contained in IEC 62305-2 shall be made to evaluate if lightning protection is needed. If the assessment indicates that protection against lightning is required, then it shall be provided.

The voltage measurement systems associated with the BESS should be using a voltage reference.

Safety-related components (for example, certain sensors) of known reliability shall be used.

Protective devices, such as guards, shall be designed to be effective, as their failure can expose persons to hazards, and also because a reduction in their effectiveness could encourage attempts to defeat them.

The touch current and discharge energy shall be limited in accordance with IEC 62477-1, 4.4.5.5.

The BESS shall be provided with an overcurrent protection function at the electrochemical accumulation subsystem connection.

NOTE. The positions and the kind of overcurrent protection function are decided according to the risk analysis and type of electrochemical accumulation subsystem.

Duplication (or redundancy) of components can be used so that, if one component fails, another component or components continue to perform the respective function(s), thereby ensuring that the safety function remains available.

Testing shall be conducted, and compliance shall be assessed in accordance with 8.2.1.3, 8.2.1.4, 8.2.1.5, and 8.2.1.6.

7.10.2 Protection from mechanical hazards

The components which people are likely to touch shall not have sharp edges.

Where edges or corners could be hazardous to personnel depending on the location or application in the equipment, they shall be rounded or smoothed.

Hazardous moving parts of the equipment (which means moving parts that have the potential to cause injury) shall be so arranged, enclosed or guarded as to reduce the risk of injury to persons.

The structure of the BESS shall have adequate protection and reduce the risk of subsystems and components dropping during operating conditions, transportation, assembly, installation and disassembly.

Especially in case of transportation, if it is difficult for the BESS enclosure itself to provide enough protection, it can be reinforced with additional jigs or fixtures. These are also considered as parts of the structure.

BESS shall be designed to keep operators and workers safe in normal operation.

The location and structure of the BESS shall be such as to not cause risks to workers in the event of a component malfunction.

Failure of interconnections between BESS subsystems shall not lead to a hazardous situation.

BESS shall be designed and installed to allow the installation and removal of battery modules using appropriate lifting equipment, unless the weight of the individual modules is low enough to be safely handled by at most two people.

Validation shall be conducted, and compliance shall be assessed in accordance with sub-clause 8.2.2.1, 8.2.2.2 and 8.2.2.3.

7.10.3 Protection from explosion

Flammable materials shall not be placed in the path of gas or heat exhaust from electrochemical accumulation subsystems.

Category "E-S" BESS shall not have parts located in explosive atmospheres.

In category "E-LI or E-LS" BESS, control subsystems and those components placed in any explosive atmospheres shall be provided with a suitable gas purging system in accordance with appropriate standards, manufacturer instructions and local regulations.

A BESS enclosure or compartment shall not vent any flammable gases into any enclosed spaces where arc-producing elements are located.

Testing shall be conducted, and compliance shall be assessed in accordance with sub-clause 8.2.3.1, 8.2.3.2 and 8.2.3.3.

A BESS enclosure or compartment shall consider projectile containment.

7.10.4 Protection from hazards arising from electric, magnetic, and electromagnetic fields

Safety functions of safety-related subsystems of BESS shall not be disturbed by electric, magnetic, and electromagnetic fields.

Where expected electric, magnetic, and electromagnetic noise levels could have an adverse impact on the operation of the BESS, the BESS shall be adequately protected to reduce those noise levels within the system manufacturer's instructions.

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.4.

NOTE1 The appropriate standards and local regulations can be applied to evaluate the clearance for safety. Another topic to be evaluated is the free space necessary to perform the maintenance activities.

NOTE2 Clearance distances between BESS containers shall be carefully determined to prevent fire propagation jump from one container to nearby container taking into consideration a number of other sizing criteria such as container accessibility, need for walking passes and access requirements from fire brigade vehicles.

7.10.5 Protection from fire hazards

Only non-combustible materials shall be used in the construction of the BESS enclosure or supporting structures and assemblies.

NOTE Non-combustibility test is described in ISO 1182.

Integration of electrochemical accumulation subsystems and their surroundings shall be designed to prevent chains of thermochemical reactions or fire propagation (e.g. separating into a battery section, charging equipment section and a section which includes a DC conductor, circuit breaker and discharge circuit). Where applicable, both fire and thermal risks that are adjacent to the BESS shall also be considered.

Compliance shall be reviewed by conducting safety design checks in accordance with the results of system level risk assessments (see Clause 6). Fire-load calculations on the BESS or experimental fire characteristics recommended in sub-clause 8.2.5 with details in Annex C is applicable for the process of the system risk assessment.

The inside of the BESS shall be separated into a battery section, charging equipment section and a section which includes a circuit breaker and discharge circuit, using fire-proof partitions (e.g. metal plates, non-flammable boards etc.).

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.5.

7.10.6 Protection from temperature hazards

The components that have the potential to be at high temperature shall not be accessible to operators or any other personnel. The parts which are likely to cause burns shall be securely covered.

NOTE The temperature limits for accessible parts specified in Table 15 of IEC62477-1 can be referenced.

Thermal partitions such as a metal plate or appropriate physical spacing shall be provided between the electrochemical accumulation subsystems and the control subsystem.

7.10.7 Protection from chemical effects

The choice of materials used in enclosures and wires of the BESS shall consider degradation, corrosion, wear (due to long-term use) and toxicity in accordance with the system risk analysis performed and local regulations.

Consideration shall be given to adverse long-term changes in electrical and mechanical properties of certain insulating materials.

The effects of electrolyte spillage from the battery shall be prevented. This requirement does not apply to batteries with sealed structures.

The structure of the BESS shall be designed to prevent the scattering of hazardous fluid from electrodes or electrolytes in electrochemical accumulation subsystems in accordance with local regulations.

7.10.8 Protection from hazards arising from auxiliary, control and communication system malfunctions

Equipment shall be so designed that the risk of fire or electric shock due to mechanical or electrical overload or failure, or due to an abnormal operation or careless use, is limited as far as practicable. After an abnormal operation or a single fault, the equipment shall remain safe for an operator within the meaning of this document, but it is not required that the equipment still be in full working order. It is permitted to use fusible links, thermal cut-outs, overcurrent protection or similar devices as long as they are able to provide adequate protection.

BESS shall be designed to prevent a hazardous condition even if the energy supply (from both a primary POC and an auxiliary POC) is interrupted or has fluctuated.

When a safety critical component fails or operates abnormally, the system shall enter a safe state automatically.

Testing shall be conducted, and compliance shall be assessed in accordance with 8.2.8.

Guidance on conducting an abnormal operation and a single fault conditions can be found in IEC 62368-1 and IEC 62933-5-1(Future).

Operator safety after an abnormal operation or a single fault should be checked by system testing with suitable simulated signals in consideration of IEC 62368-1.

7.10.9 Protection from hazards arising from environments

7.10.9.1 General

The BESS shall be designed to prevent a hazardous condition even if the BESS is exposed to conditions as given in 7.10.9.2 and 7.10.9.3.

7.10.9.2 Protection from exposure to moisture and pollution

BESS shall include in the risk assessment an evaluation of minimum IP ratings for moisture and foreign object ingress.

IP rate should be considered according to local environment, including indoor or outdoor.

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.9.2.

For an BESS installation where there can be exposure to pollution in the form of dust, the minimum IP rating shall be IP5X.

For installations where there can be exposure to moisture, the minimum IP rating shall be IPX4.

NOTE IP rate for Indoor/outdoor will be determined according to the result of risk assessment.

7.10.9.3 Exposure to marine environments

In case of installation in marine environments, the BESS shall be designed so as not to result in hazardous events during or after exposure to marine environments (e.g. salt fog).

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.9.3.

7.11 Guards and protective measures

7.11.1 General

In addition to the inherently safe design of the BESS which is described in 7.10, guards and protective measures shall be used in a BESS. The minimum requirements of the guards and protective measures are given in 7.11.

Access control is integral to safe operation of a BESS, and appropriate locks and restriction to unauthorized personnel access shall be included in the system design. A safety interlock shall be provided where hazards within the context of this standard are normally present and operator

access involves access to areas normally presenting hazards within the context of this document.

Protection provided by an enclosure can be regarded as restricted access.

In the case of a BESS with a control subsystem, the battery management system in any electrochemical accumulation subsystem shall monitor all relevant safety parameters of the battery as required in the applicable standards and report those parameters to the control subsystem.

For those BESS located where there is the potential for direct contact by untrained persons, a minimum IP rate of IP2X shall be determined in accordance with IEC 60529.

7.11.2 BESS disconnection and shutdown

7.11.2.1 General

In addition to the operational states that are defined in IEC 62933-5-1(Future):20xx, 7.5, a non-operational condition (the isolated condition for maintenance) is defined in this document. The isolated condition for maintenance is a system condition that allows for safe working on the DC power circuits, AC power circuits and DC auxiliary circuits of the electrochemical accumulation subsystem.

7.11.2.2 Grid disconnected state

The general requirements that are described in IEC 62933-5-1(Future) shall apply. Additionally, isolating devices shall be used to allow local manual operation to override remote operation. The isolating devices shall be lockable in the disconnected state.

7.11.2.3 Stopped state

In the stopped state, the system has performed a shutdown sequence which includes the disconnection of the electrochemical accumulation subsystem from the power conversion subsystem, and the disconnection of the power conversion subsystem from the primary connection terminal. The stopped state can result from a regular command, or an emergency shutdown event command. This state is typically achieved using contactors or motorized circuit breakers. During their installation, the possibility of automatic re-energization or the state that cannot be completely electrically isolated shall be minimized for workers on the site.

Auxiliary power shall be allowed to be present to facilitate an automatic power-up sequence, or to power monitoring systems.

When the EES system is disconnected and the accumulation subsystem is not connected to the power conversion system, the EES system is considered to be in a stopped state. In this state, the accumulation system can be energized and there is a risk that the stored energy will be converted to thermal energy or other forms of energy by aging or other effects. In the stopped state, part of the auxiliary subsystem should remain powered as it contains critical subsystems for safety and monitoring.

7.11.2.4 Isolated condition for maintenance

In the isolated condition for maintenance, it should be safe to work on at least the DC power circuit and storage component of the system. The whole isolation of the BESS (see Figure 3) or the partial isolation of the DC side of the BESS can be selected in accordance with the area that should be maintained. The BESS shall be capable of being locked in the isolated condition locally or via a removable disconnection tool so that it can only be connected by authorized personnel after the maintenance procedure. In order to bring the system to an isolated condition, the BESS shall first be brought to the stopped state as defined above. It shall then be capable of being brought and locked into a grid disconnected state, and then it shall be safely isolated (including keeping any power supply for safety-related subsystems of the BESS active). Consideration can be given to providing visible isolation with the lockable isolation device as is required in some jurisdictions.

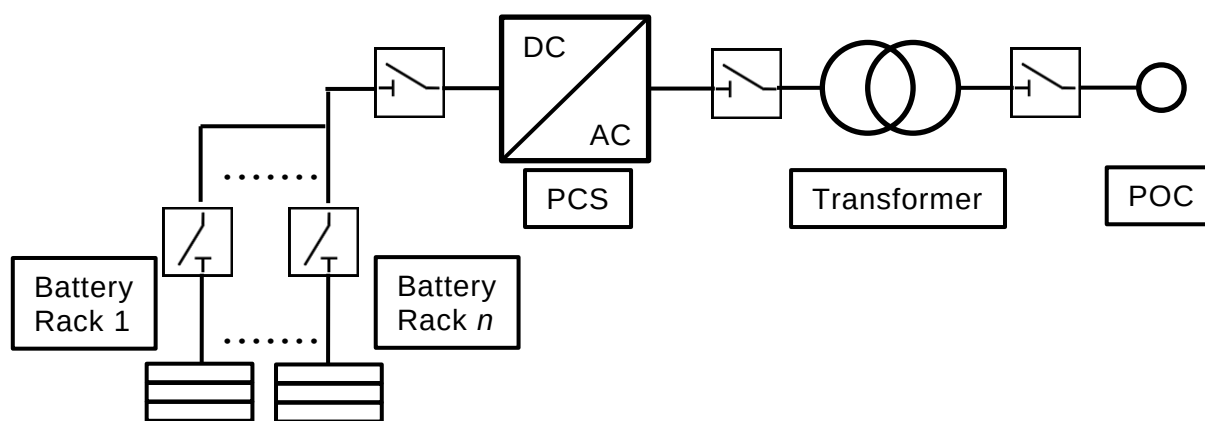


Figure 3 – Example of isolated condition (whole isolation of BESS)

The procedure to isolate the system shall:

allow for disabling of the fire suppression system where a release of fire suppression agent can be harmful to people working in or near the system.

allow the fire detection systems, HVAC, lighting and utility outlets to remain operational in the isolated state, to provide safe and comfortable working conditions.

The instructions to isolate the system shall:

- be available in a single location that is easily accessible to the person who carries out the system isolation, provide clear instructions and checks to achieve and confirm full isolation of the system, and
- provide clear instructions for restoring the system back to the operational (stopped) state.

The individual isolating devices referred to by the instructions shall be clearly marked.

7.11.3 Other guards and protective functions of BESS

7.11.3.1 Protection from electrical hazards

Protective devices and circuits shall be properly rated to protect electric circuits against short-circuits.

Electrochemical accumulation subsystems (within the energy storage system) shall be provided with a protective function to stop or limit short-circuit currents.

Earth fault protection shall be kept within both the AC and the DC sides of the power conversion subsystem. Detection of any earth fault in the BESS shall be reported to operators. This protection is mandatory if the AC and DC side are electrically isolated from a distribution grid. DC side protection is not necessary for safety extra-low voltage (SELV) battery voltage.

The BESS shall protect the batteries against overcharge and impulse voltages, including under a single fault condition within the charger. Protection can be accomplished by turning off the charger, or by interrupting the charging current or inrush current. If an overcharge happens, it shall be reported (to operators) by both audible alerts and visual signals.

The complete rating of a replaceable fuse should be marked on the fuse holder or adjacent to the fuse holder so that the rating of a fuse is obvious even if the fuse is removed. Other necessary information such as I^2t time delay or breaking capacity shall be indicated with the rating. The fuse replacement procedure shall be described in the BESS information described by the safety design and functions set out in 7.12.

Overcurrent conditions in electrochemical accumulation subsystems shall be reported to operators.

In the event of a single failure within the equipment, circuits shall be designed so that the current limits are not exceeded. If an over current condition occurs, it shall be reported to operators.

Unintentional islanding of the BESS should be considered in accordance with IEC 62933-5-1(Future):20xx, 6.2.8.

Testing shall be conducted, and compliance shall be assessed in accordance with sub-clauses 8.2.1.1 and 8.2.1.2.

7.11.3.2 Protection from mechanical hazards

BESS enclosures that provide protection from access to hazardous parts shall be sufficiently robust to prevent mechanical damage due to possible mechanical abuse.

Testing shall be conducted, and compliance shall be assessed in accordance with 8.2.2.1 and 8.2.2.2.

7.11.3.3 Protection from explosion

For categories "E-S / S-O / C-A, C-B, C-D and C-Z", detection systems for flammable gases generated by the electrochemical accumulation subsystems shall be provided at the site where the BESS is located. When a flammable gas is detected, it shall be reported (to operators) by both audible alerts and visual signals. It is a requirement of this document that the BESS cannot be installed in the site without any detection systems for flammable gases, and that this requirement shall be contained in the installation manuals.

Category "E-S / S-U / C-A, C-B, C-D and C-Z" BESS shall have appropriate signage to identify restricted areas. The signage shall specify that flammable gases can be released from the BESS.

Category "E-LI or E-LS / S-O / C-A, C-B, C-D and C-Z" BESS, shall be provided with integral detection systems for flammable gases generated by electrochemical accumulation subsystems. An incident of flammable gas detection shall be reported (to operators) by both audible alerts and visual signals. The handling procedure of the detection systems shall be described in the system documentation as described in 7.12.

For category "E-LI or E-LS / S-U / C-A, C-B, C-D and C-Z" BESS, the path of exhausted flammable gases shall be identified and documented in the installation manual. Appropriate signage to identify a restricted area shall be provided around any flammable gas outlet. Information of the path of the exhausted flammable gases shall be provided by the supplier to the owner.

For category "C-A, C-B, C-D and C-Z" BESS, electrochemical accumulation subsystems can exhaust hydrogen. To prevent explosion or fire, the BESS shall not have any ignition sources where the density of hydrogen can be over 4 % LFL (lower explosion limit of hydrogen) at the time of any incidents.

For category "E-LI or E-LS / C-A, C-B, C-D and C-Z" BESS, appropriate reliable and/or redundant means to avoid flammable gas build-up inside the BESS shall be implemented.

Category "E-S / S-O / C-A, C-B, C-D and C-Z" BESS shall be located in a site with appropriate ventilation systems.

NOTE 1 It can be considered equivalent to installation in a location of a ventilation system when it is installed in a place where proper ventilation is ensured.

NOTE 2 It is important to consider the ventilation systems for S-U BESS.

Category "E-LI or E-LS / S-O / C-A, C-B, C-D and C-Z" BESS shall be installed with appropriate ventilation systems as provided for in the following:

- the ventilation systems shall be able to keep an appropriate temperature within the enclosure,
- forced ventilation systems shall be provided where there is insufficient natural ventilation,
- the ventilation openings shall be designed and installed to prevent the spread of fires and water ingress.

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.3.1, 8.2.3.2 and 8.2.3.3.

NOTE 3 For large-scale BESS with distributed installation of air conditioning subsystems, it is important that ventilation subsystems are functioning as intended to be able to take in air and discharge to the ambient atmosphere as intended. .

7.11.3.4 Protection from fire hazards

A risk of fire can result from excessive temperatures either under normal operating conditions or due to overload, component failure, insulation breakdown or loose connections. Fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire, nor cause damage to the surroundings or the equipment. Cell firing is regarded as the most probable cause among component failure. However, the cause of ignition is not limited to cell ignition. All subsystems inside the entire storage equipment could become source of ignition and once one of subsystem gets fire and propagates to cells, subsequent propagation among cells takes place. In this clause, the measures to suppress fire propagation are described, regardless the cause of fires originating within the equipment.

NOTE. The fire suppression system is an automatically operating subsystem installed in the BESS, and fire extinguishers is portable and manual or semi-fixed fire extinguishing equipment installed in BESS. Category "S-O" BESS shall have a fire detection system, fire alarms deploying both audible alerts and visual signals, and fire extinguishers within the BESS location.

For category "E-LI or E-LS / S-O" BESS, if the electrochemical accumulation subsystems of the BESS have doors, the doors shall be fire protecting doors.

Category "S-U" BESS shall have a fire detection system, fire alarms deploying both audible alerts and visual signals, and fire extinguishers within a safe and easily accessible location.

A signal of fire detection sent from the fire detection system shall be transmitted to the fire alarms with location data via a communication network and fire suppression system, or via secure relays and receivers where applicable.

If a fire incident is detected, the fire suppression system, if any, shall automatically operate and the fire alarms shall be automatically started.

Testing shall be conducted, and compliance shall be assessed, in accordance with sub-clause 8.2.5.

Salt water should not be used on live electrical equipment.

NOTE It is valid to use salt water of appropriate concentration to discharge the storage batteries after extinguishing the fire while preventing electric shock.

Physical separation and extinguishing agent are two key measures against fire propagation. Extinguishing agent includes, but not limited to agent such as cooling agent and fire propagation suppressing film. These two measures should be taken against both propagation among subsystems and propagation among battery subsystem (cells / modules). The two cases are separately described below.

1) Against subsystem-to-subsystem propagation

The most critical propagation is the one from one subsystem to battery subsystem which contains number of cells in it. Physical separation is the way commonly taken and when regarded as necessary, thick metal panel is placed between subsystems. Extinguishing agent should be properly distributed within the entire equipment. Cooling type and/or fire propagation suppressing film should be effectively placed depending on the type of the assumed ignition.

2) Against propagation among battery subsystems

The measures to suppress fire propagation should be designed separately in each layer and be multi-layered as a whole. Measures should be designed separately for module-to-module propagation, rack-to-rack propagation, and container-to-container propagation.

a) module-to-module fire propagation

In order to protect the modules from the heat and flames caused by the ignition of adjacent modules, protective measures such as inserting fire spread prevention plates between modules or arranging them via metal plates of appropriate thickness can be adopted.

In addition, methods such as the use of local fire extinguishing devices (extinguishing agents, fire propagation suppressing film, etc.), which make the entire module group hard to burn by forced water cooling, have begun to be adopted.

b) rack-to-rack and container to container fire propagation

Regarding fires in adjacent racks and containers, it is necessary to consider not only heat propagation but also flame propagation and high-pressure, high-temperature gas propagation.

It is most popular countermeasures to make the protective guard such as firewall and metal case/rack. In addition, it is important to suppress flames and high-temperature gas intrusion.

When installing multiple containers or buildings outdoors, please be aware that there may be regulations in each country regarding the separated distance and separation methods.

NOTE1 Measures can be designed separately for cell-to-cell fire propagation inside of the module. Regardless of whether the cell is ignited internally or externally, once the cell is ignited it must be prevented from propagating to other cells. It is most popular to countermeasure is the direct heat transfer suppression. It used to be made by battery manufacture. In addition, stationary storage batteries systems are often used in environments where the cells are not enclosed, so there are some cases where local fire extinguishing systems for cells are used in racks and packages. To adopt such a local fire extinguishing system, it is necessary to determine the structure of the module and the type and shape of the extinguishing agent. Calorie calculation is important for extinguishing agents that aim for a cooling effect, and how to create a sealed space is important for extinguishing agents and fire propagation suppressing film that aim for a suffocating effect. A film-type fire extinguisher container that can effectively function over a wide area in the limited space within the module (easy to install fire propagation suppressing film) is effective as a module-side countermeasure.

NOTE2 If installing a liquid cooling system or fire suppression system in the BESS, it is insulated and isolated to the battery and battery circuit, and care should be taken to prevent leaking. In addition, after the suppression system is activated, attention is paid to short circuits and ground faults.

NOTE3 A fire suppression system using the suffocation effect that does not use water or liquids are used with caution.

NOTE4 Also, confirming that the fire has been extinguished after suppression is taken care. Especially in the case of the fire suppression system using the suffocation effect, there is a risk of re-ignition if oxygen enter the space when the extinguish is confirmed. So after enough preliminary consideration, it is conducted.

NOTE5 When fire propagation suppressing film is installed, extinguishing performance is checked in advance.

7.11.3.5 Protection from temperature hazards

The BESS can have one or more critical temperatures which should be identified. According to the identified critical temperatures (e.g. touchable surface temperatures, power electronic component temperatures, and electrochemical accumulation subsystem temperatures), safety provisions shall be implemented to prevent these temperatures from being reached within the BESS.

Safety-related components (for example, certain sensors) of known reliability shall be used.

It shall be possible for operators to monitor the temperatures where the risk assessment concludes that any temperature monitoring is required in the internal atmosphere of the system enclosure.

If the operator does not have specialized knowledge, monitoring can be done by a simple display of the state of the temperature (icon to indicate whether the temperature is outside or inside charge /discharge, range, etc).

It shall be possible for operators to monitor the temperatures of subsystems in the BESS.

It shall be possible for operators to monitor operating conditions of ventilation subsystems, and detection of abnormal condition shall be reported to operators.

When monitored temperature(s) exceed those limit(s) provided by the manufacturer, it shall be reported to operators.

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.6.1, 8.2.6.2 and 8.2.6.3.

7.11.3.6 Protection from chemical effects

Containment and/or neutralization of spilt hazardous fluids shall be provided. Methods utilized for containment shall be sufficient to hold the maximum quantity of fluids that could occur and

if located outdoors designed to prevent inadvertent filling with rain. Instructions regarding the provision of suitable spill containment and neutralization shall be provided by the system manufacturer with the installation instructions.

For category "C-D" BESS, an automatic leak detection to indicate the release of hazardous fluids shall be provided.

For category "E-S / S-O" BESS, a detection system for toxic gases generated by electrochemical accumulation subsystems shall be provided in the BESS or the BESS installation. An incident of toxic gas detection shall be reported (to operators) by suitable alerts and signals (e.g. audible and visual). Also, evacuation during alerting from toxic gas shall be strongly recommended in any information for users.

For category "E-S / S-U" BESS, appropriate signage to indicate a restricted area shall be provided at the site where the BESS is located or on the BESS itself. The sign shall specify that toxic gases can be released from the BESS.

For category "E-LI or E-LS / S-O" BESS, a detection system for toxic gases generated by the electrochemical accumulation subsystems shall be provided in the BESS. An incident of toxic gas detection shall be reported (to operators) by suitable alerts and signals (e.g. audible and visual). Installation manuals shall include information on how to handle the detection system for toxic gases.

For category "E-LI or E-LS / S-U" BESS, the path of exhausted toxic gases shall be identified and documented in the installation manual. Appropriate signage to identify a restricted area shall be provided around an toxic gas outlet. Information of the path of exhausted toxic gases shall be provided by the supplier to the owner.

For category "S-O" BESS, gas concentration reduction measures shall be provided in order to protect the workspace from the high density of toxic gases from electrochemical accumulation subsystems in the BESS.

Category "E-S / S-O" BESS shall be located in the site that have protective measures against the hazards above such as, but not limited to:

- elimination of the generation of hazardous chemicals,
- dilution of hazardous chemicals,
- collection of hazardous chemicals (e.g. by a scrubber for hazardous gases),
- limitation of human access.

Category "E-LI or E-LS/ S-O" BESS shall be installed with the protective measures described above bullets. Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.7.1, 8.2.7.2, and 8.2.7.3.

7.12 Information for end users

Safety information as listed below should be available for end users:

Warning signs and signals (including any limitation of available environments, confirmed by the validation and testing specified in 8.2.9).

On-site signage and labelling which show any hazardous part of BESS clearly.

Warning devices (audible alerts and visual signals), or others.

A sequence diagram of safety designs shall be described via methods as specified in an appropriate international standard. (an example of reference document is IEC 60617 (all parts))

All the BESS information about the safety design and functions shall be kept accessible and available to all applicable BESS stakeholders.

Expected usage.

Operational period in the environment (lifecycle)

How to respond after the end of service life.

For rooms of electrochemical accumulation subsystems, appropriate information on the required flow of air shall be provided in the installation instructions where the electrochemical

1039 accumulation subsystem installation is supplied with the BESS. See Annex F for good practice
1040 for warning signs regarding BESS safety.

1041 Any other necessary information shall be provided in accordance with local regulations.

1042 **7.13 Life cycle safety management**

1043 **7.13.1 Operation and maintenance**

1044 **7.13.1.1 General**

1045 Any party which has responsibility for operations and maintenance should be mindful of their
1046 own safety when they work near the BESS. Incorrect operation and inadequate or neglected
1047 maintenance can cause harm by fire, gas poisoning and electric shock. It is necessary for all
1048 stakeholders to protect themselves from such risks.

1049 Most BESS are expected to be operated automatically and remotely via information networks.
1050 The BESS is expected to be operational for decades. During such time, BESS parts will be
1051 replaced at regular scheduled preventive maintenance or as the result of unplanned events,
1052 such as the maintenance plan, preventive maintenance, system condition monitoring, partial
1053 subsystems or component replacement, or design change due to aging degradation.

1054 NOTE The replacement will take into account the potential for any secondary use

1055 The availability of original parts for repair and replacement can be limited, or the parts can be
1056 unavailable, therefore compatible parts might be used. From a systems safety perspective,
1057 replacement parts shall be confirmed to be safe in the system before replacement because
1058 combinations of those parts or subsystems are important for monitoring of the system condition.

1059 Any changes by on-site workers shall not be overwritten by any remote actions during the
1060 maintenance process by off-site workers, to keep on-site workers safe. Consideration shall be
1061 given to adverse long-term changes in the electrical and mechanical properties of certain
1062 insulating materials.

1063 To ensure maintenance safety of the BESS, it is extremely important throughout the product
1064 life, to comply with operating methods, to conduct daily maintenance and to respond to
1065 abnormal conditions. Therefore, it is agreed between the manufacture and the owner in advance,
1066 the maintenance procedures during the BESS life cycle, and the modifications that can need to
1067 be made as appropriate as necessary.

1068 Personnel safety considerations for remote operation of the BESS shall be confirmed in case
1069 of emergency.

1070 **7.13.1.2 Operation and maintenance plan**

1071 An emergency response plan for safety shall be prepared, which shall include the requirements
1072 of 7.13.1.2.

1073 A safety manual shall include at least descriptions of methods to communicate BESS problems,
1074 warnings to local firefighting agencies, workers and the surrounding residents, and the correct
1075 use of insulated tools.

1076 When adjusting with a screwdriver or a similar tool while under applied voltage, protection
1077 against electric shock or energy hazard caused by inadvertent touch to the applied voltage
1078 sections shall be provided. Measures shall be taken to ensure that the possibility of inadvertent
1079 touch to incorrect parts with the tool is considered in the protection design.

1080 An operation and maintenance manual shall be provided to the BESS owner or their designated
1081 agent and include but not be limited to:

- 1082 a) how to maintain safety during maintenance (including safety instructions and specification
1083 of required personal protective equipment (PPE) for the various maintenance operations),
- 1084 b) methods to detect, manage and control fire, explosion and toxic gas retention, etc including
1085 possibilities for venting gases outside in an emergency situation.
- 1086 c) prohibited operating processes, for example,
1087 – prohibition of overcharge