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**Electrical energy storage (EES) systems
— Safety requirements for grid-integrated
EES systems — Electrochemical-based
systems**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Institute of Electrical Engineers of Japan (IEEJ)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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Electrical energy storage (EES) systems — Safety requirements for grid-integrated EES systems — Electrochemical-based systems

Introduction

This Japanese Industrial Standard has been prepared based on **IEC 62933-5-2 : 2020**, Edition 1, with some modifications of the technical contents to reflect the unique conditions in Japan.

Annex JA to Annex JF contain the contents derived from **IEC TS 62933-5-1 : 2017**, and are not given in the corresponding International Standard. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JG.

1 Scope

This Standard provides safety requirements for battery energy storage system (BESS) which is a grid-connected electrical energy storage system where a battery-like electrochemical storage subsystem is used. It primarily describes safety aspects for people and, where appropriate, safety matters related to the surroundings and living beings.

Electrical energy storage (EES) system includes any type of grid-connected BESS which can both store electrical energy from a grid or any other source and provide electrical energy to a grid.

Unidirectional energy storages which only receive the supply of electrical power from a grid, such as UPS, are not included in the scope of this Standard.

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

This Standard provides further safety provisions that arise due to the use of an electrochemical storage subsystem in energy storage systems that are beyond the general safety considerations described in Annex JA to Annex JF.

This Standard 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 (e.g. chain of failures) between the subsystems (e.g. battery system and AC/DC converter) as presently understood.

NOTE 1 Types of grids are provided in JB.1.

NOTE 2 While the corresponding International Standard cites IEC TS 62933-5-1 : 2017 as one of its the normative references, this Standard has directly incorporated the contents of the said IEC in Annex JA to Annex JF and

deleted its number from the normative references clause.

NOTE 3 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

IEC 62933-5-2 : 2020 *Electrical energy storage (EES) systems — Part 5-2 : Safety requirements for grid-integrated EES system — Electro-chemical-based systems* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent editions (including amendments) shall be applied.

JIS C 0366 *Voltage bands for electrical installations of buildings*

JIS C 0920 *Degrees of protection provided by enclosures (IP Code)*

NOTE Normative reference in the corresponding International Standard : IEC 60529 *Degrees of protection provided by enclosures (IP Code)*

JIS C 5750-4-3 *Dependability management — Part 4-3 : Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA)*

NOTE Normative reference in the corresponding International Standard : IEC 60812 *Failure modes and effects analysis (FMEA and FMECA)*

JIS C 5750-4-4 *Dependability management — Part 4-4 : Analysis techniques for system reliability — Fault Tree Analysis (FTA)*

NOTE Normative reference in the corresponding International Standard : IEC 61025 *Fault tree analysis (FTA)*

JIS C 8715-2 : 2019 *Secondary lithium cells and batteries for use in industrial applications — Part 2 : Tests and requirements of safety*

NOTE Normative reference in the corresponding International Standard : 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*

JIS C 60068-2-52 *Environmental testing — Part 2-52 : Tests — Test Kb : Salt mist, cyclic (sodium chloride solution)*

NOTE Normative reference in the corresponding International Standard : IEC 60068-2-52 *Environmental testing — Part 2-52 : Tests — Test Kb : Salt mist, cyclic (sodium chloride solution)*

JIS C 60364 (all parts) *Low-voltage electrical installations*

NOTE Normative reference in the corresponding International Standard : IEC 60364 (all parts) *Low-voltage electrical installations*

JIS C 60364-4-44 *Low-voltage electrical installations — Part 4-44 : Protection for safety — Protection against voltage disturbances and electromagnetic disturbances*

NOTE Normative reference in the corresponding International Standard : IEC 60364-4-44 *Low-voltage electrical installations — Part 4-44 : Protection for safety — Protection against voltage disturbances and electromagnetic disturbances*

JIS C 60664-1 : 2009 *Insulation coordination for equipment within low-voltage systems — Part 1 : Principles, requirements and tests*

NOTE Normative reference in the corresponding International Standard : IEC 60664-1 : 2007 *Insulation coordination for equipment within low-voltage systems — Part 1 : Principles, requirements and tests*

JIS C 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*

NOTE Normative reference in the corresponding International Standard : 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*

JIS C 62477-1 : 2017 *Safety requirements for power electronic converter systems and equipment — Part 1 : General*

NOTE Normative reference in the corresponding International Standard : IEC 62477-1 : 2012 + AMD1 : 2016 *Safety requirements for power electronic converter systems and equipment — Part 1 : General*

JIS Z 8051 : 2015 *Safety aspects — Guidelines for their inclusion in standards*

NOTE Normative reference in the corresponding International Standard : ISO/IEC Guide 51 : 2014 *Safety aspects — Guidelines for their inclusion in standards*

IEC 60079-7 : 2015 + AMD1 : 2017 *Explosive atmospheres — Part 7 : Equipment protection by increased safety “e”*

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 60364-6 : 2016 *Low voltage electrical installations — Part 6 : Verification*

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 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 + AMD1 : 2014 *Power installations exceeding 1 kV a.c. — Part 1 : Common rules*
- 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 62485-2 *Safety requirements for secondary batteries and battery installations — Part 2 : Stationary batteries*
- IEC 62933-1 *Electrical energy storage (EES) systems — Part 1 : Vocabulary*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **IEC 62933-1** 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 <https://www.iso.org/obp/ui>

Note 1 to entry 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.

Note 2 to entry The definitions 3.6 to 3.31 are not contained in the corresponding International Standard but have been added to this Standard from IEC 62933-1 and IEC terminological database for better understanding of the contents.

3.1

battery energy storage system (BESS)

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

Note 1 to entry BESS includes a flow battery energy system.

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**.

Note 3 to entry It is also called “electrical energy storage system using batter-

ies”.

3.2

occupied site

location that is within or adjacent to a building or structure with an overhead cover, where people live or work, and that has continuous presence of people in vicinity to the electrochemical accumulation subsystem

Note 1 to entry A location that is not an occupied site and is without continuous presence of people in vicinity to the electrochemical accumulation subsystem is called “unoccupied site”.

3.3

type test

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

3.4

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

3.5

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

3.6

grid

all installations and plant provided for the purpose of generating, transmitting and receiving/distributing electricity, and connection between these installations

(SOURCE : IEC 60050-601 : 1985, 601-01-01, added)

3.7

grid-connected

connected to an electric power system

3.8

utility grid

part of an electric power network that is operated by a utility or grid operator within a defined area of responsibility

Note 1 to entry Utility grid is normally used for electricity transfer from or to grid users or other grids. The grid users can be electricity producers or consumers. The area of responsibility is fixed by national legislation or regulation.

3.9**electrical energy storage (EES)**

installation and its function able to absorb electrical energy, to store it for a certain amount of time and to release electrical energy

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

Note 1 to entry The term “electrical energy storage” may also be used to indicate the activity that an apparatus, described in the definition, carries out when performing 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.

Note 3 to entry Absorption, storage and release of energy performed by electrical energy storage may include energy conversion process.

3.10**electrical energy storage system (EESS)**

grid-connected installation with defined electrical boundaries, comprising at least one electrical energy storage, which extracts electrical energy from a grid, stores this energy internally in some manner and injects electrical energy into a grid 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 grid than the energy it stored (compressed air energy storage is a typical example where additional thermal energy is required).

Note 3 to entry Electrical boundaries are the boundaries [point of connection (POC)] that separate the entire electrical facility on the side of the EES system (either single EES system or several EES systems regarded as one system) and the grid.

Note 4 to entry Electrical energy storage system (EESS) includes battery energy storage system (BESS).

3.11**point of connection (POC)**

reference point on the electric power system where an EES system is connected

Note 1 to entry An EES system may have several POCs arranged in two different classes : primary POC and auxiliary POC. From an auxiliary

POC it is not possible to charge electrical energy, in order to store it internally and, finally, discharge it to the grid, but a primary POC can be used to feed the auxiliary subsystem and the control subsystem. In the absence of an auxiliary POC, the primary POC can be named simply as POC.

3.12

primary POC

point of connection where the EES system charges electrical energy from the grid, in order to store it internally and, finally, discharge it to the grid

Note 1 to entry Generally, the primary POC is connected to the EES system primary subsystem through the primary connection terminal.

3.13

auxiliary POC

EES system point of connection with the grid used to feed the auxiliary subsystem, only if 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, so, by the auxiliary POC.

3.14

expected service life

period from the site adjustment test of the EES system to its end of service

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

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 phrase “removed from its intended use stage” does not necessarily 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 “life-cycle” is defined in **ISO Guide 64 : 2008, 2.5** and in **IEC 60050-901 : 2013, 901-07-12**.

3.16

EES 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 system of which it is a part.

3.17**primary subsystem**

EESS subsystem consisting of the components/subsystems that are directly responsible for storing electrical energy and extracting electrical energy

Note 1 to entry Generally the primary subsystem is connected to the primary POC (through the primary connection terminal) and comprises at least the accumulation subsystem and the power conversion subsystem.

3.18**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, 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).

3.19**power conversion subsystem**

EESS subsystem where energy is converted from the available form at the output of the accumulation subsystem of the EES system to electrical energy with the same characteristics (voltage, frequency etc.) present at the primary POC

Note 1 to entry Generally, the power conversion subsystem is connected to the accumulation subsystem and to the primary POC through the primary connection terminal.

3.20**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, 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.

3.21

control subsystem

EESS subsystem used 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, 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 A control subsystem is normally fed by the auxiliary subsystem.

3.22

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

3.23

management subsystem

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

3.24

protection subsystem

EESS subsystem containing an arrangement of one or more protection equipment, and other devices intended to perform one or more specified protection functions

Note 1 to entry The protection subsystem includes one or more protection equipment, instrument transformer(s), transducers, wiring, tripping circuit(s), auxiliary supply(ies). Depending upon the principle(s) of the protection subsystem, it may include one end or all ends of the protected section and, possibly, automatic re-closing equipment.

Note 2 to entry The switches and fuses are excluded.

(SOURCE : IEC 60050-448 : 1995, 448-11-04, modified — The original definition has been adapted for the EES system and note 2 to entry has been generalized to exclude all the switches and fuses and not only the circuit breakers.)

3.25

grid-disconnected state

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

3.26

stopped state

operating state in which the EES system is in grid-disconnected state and the accumulation subsystem is not connected to the power conversion subsystem

Note 1 to entry Where no switches are available between the accumulation subsystem and the power conversion subsystem, other solutions may ensure the galvanic separation (for example extractable batteries).

Note 2 to entry In this state the auxiliary subsystem is energized.

3.27

shutdown

command to move the EES system to the stopped state from another operating state

Note 1 to entry This command may also be a consequence of an emergency condition.

3.28

marine environment

service environment that is located at sea or at seashore

3.29

battery management system (BMS)

electronic system which has functions mainly to control the electric current in case of overcharge, overcurrent, overdischarge, and overheating of the electrochemical accumulation subsystem

Note 1 to entry It monitors and/or manages the state of the electrochemical accumulation subsystem, calculates secondary data, reports that data and/or controls its environment to ensure the safety, performance and/or service life of the electrochemical accumulation subsystem.

(SOURCE: JIS C 8715-2 : 2019, 3.12, modified)

3.30

extra low voltage (ELV)

voltage not exceeding the relevant voltage limit of band I specified in JIS C 0366

(SOURCE : IEC 60050-826 : 2004, 826-12-30)

3.31

safety extra low voltage (SELV)

AC voltage the r.m.s. value of which does not exceed 50 V or ripple-free DC voltage the value of which does not exceed 120 V, between conductors, or between any conductor and reference earth, in an electric circuit which has galvanic separation from the supplying electric power system by such means as a separate-winding transformer

Note 1 to entry Maximum voltage lower than 50 V AC or 120 V ripple-free DC may be specified in particular requirements, especially when

direct contact with live parts is allowed.

Note 2 to entry The voltage limit should not be exceeded at any load between full load and no-load when the source is a safety isolating transformer.

Note 3 to entry Ripple-free qualifies conventionally an r.m.s. ripple voltage not more than 10 % of the DC component; the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free DC system and 70 V for a nominal 60 V ripple-free DC system.

(SOURCE : IEC 60050-851 : 2008, 851-15-08)

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.

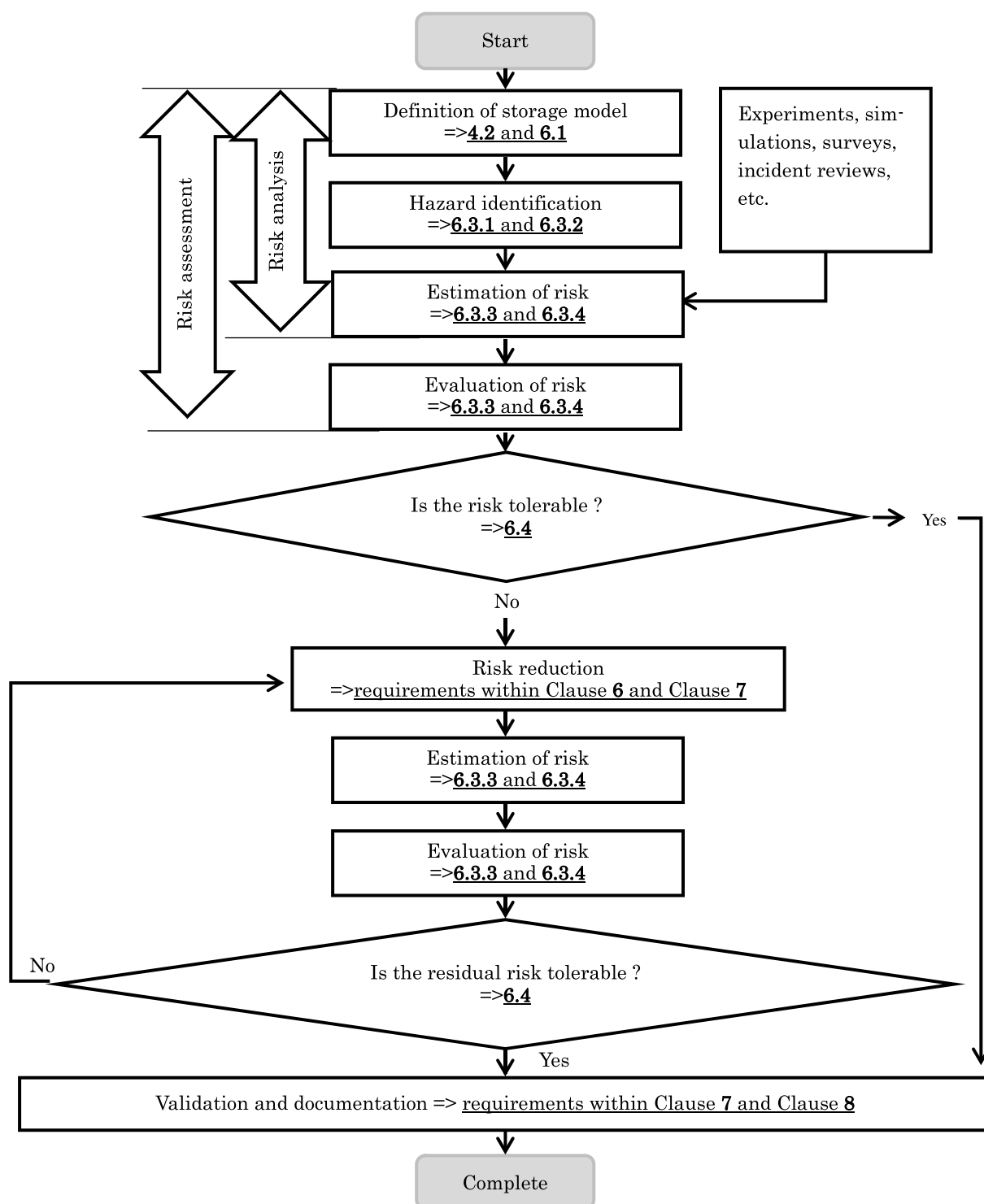


Figure 1 General description for risk assessment and reduction of BESS

Risks can depend on many factors including location, chemistry and the size/scale 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 electro-chemical accumulation subsystem of the BESS can depend on their environment, per-

formance characteristics and any associated costs and benefits.

As described in **JIS Z 8051**, 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 **JIS Z 8051**.

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 (FAT) (see 7.10, 7.11 and 8.2);
- transport (see 7.10, 7.11 and 8.2);
- installation, commissioning and site acceptance testing (SAT) (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. **JIS C 62477-1**, **JIS C 8715-2**).

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 Clause 7 and Clause 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 Standard 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 BEE is connected	V-L	$V \leq 1 \text{ kV AC or } 1.5 \text{ kV DC}$
	V-H	$V > 1 \text{ kV AC or } 1.5 \text{ kV DC}$
“Energy capacity” of BESS	E-S	Small : $E \leq 20 \text{ kWh}$
	E-L	Not small : $E > 20 \text{ kWh}$
“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. molten salt)
	C-D	BESS using flow battery
	C-Z	Others
NOTE 1 Denominations of BESS categorization are described in this Standard as “V-X/E-X/S-X/C-X”, with X being any sub-categorization that is shown in the right side of the denomination, e.g., as V-L or V-H. Some characteristics can be omitted if any limitation of category does not apply. NOTE 2 To apply this Standard 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”. NOTE 4 Li-based batteries are all classified as “C-A” regardless of non-aqueous/aqueous classification by the Fire Service Act in Japan...		

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

Table 2 Examples of BESS use

Use scene	Site	Access restrictions/conditions during operation and maintenance
Residential	• Installed in individual homes • Shared by a small number of homes and a large number of apartments in an apartment building etc.	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 use scene can be as follows : V-L/E-S (or E-L)/S-O (or S-U)/C-A (or C-B)	
Commercial	• Installed in small businesses • Shared by a large number of homes • A mixture of the above uses such as a street or an 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 use scene can be as follows : V-H/E-L/S-O (or S-U)/C-A (or C-B, C-C or C-D)	
Industrial	• Installed in large businesses such as factories, data centers, warehouses etc. • 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 usually part of a professional operating and maintenance regime.
	An example of using Table 1 in this BESS use scene can be as follows : V-H/E-L/S-O (or S-U)/C-A (or C-B, C-C or C-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 use scene can be as follows : V-H/E-L/S-O (or S-U)/C-A (or C-B, C-C or C-D)	

4.3 BESS changes in ownership, control or use

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

Annex A provides further information regarding ownership of BESS.

5 Hazard considerations

The general hazard considerations for EESS are provided in Annex JA.

6 BESS system risk assessment

6.1 BESS structure

6.1.1 General characteristics

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

An example of a BESS including a primary POC, auxiliary POC and control subsystem is shown in Figure 2 and Table 3. In some cases, it is possible that one or more subsystems or components are not present. The communication arrangements between management, communication, protection and the other subsystems are shown as dotted arrow lines.

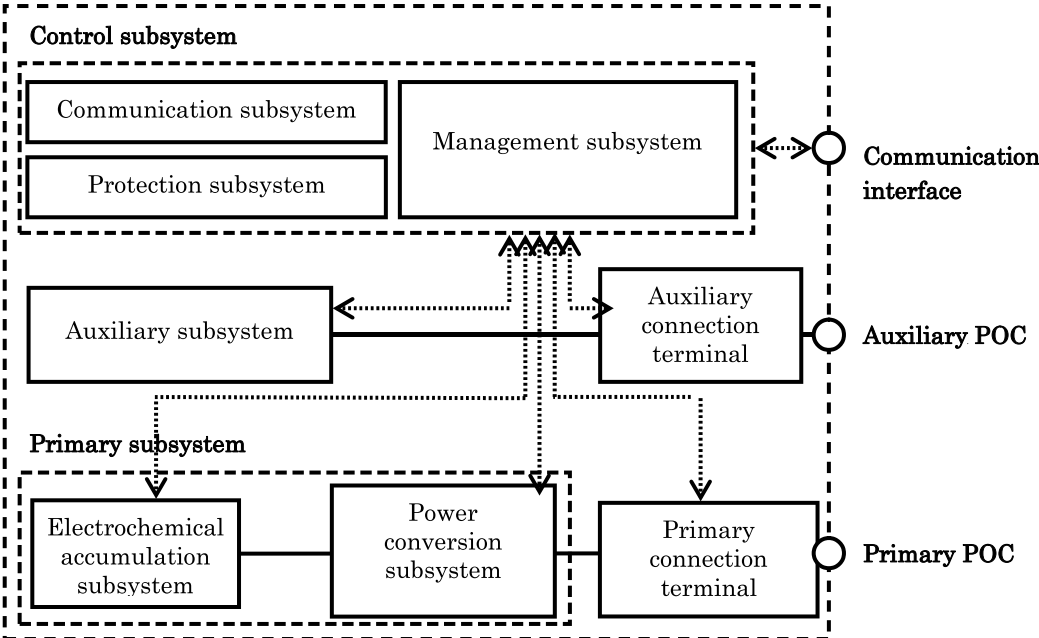


Figure 2 An example of BESS architecture

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

Table 3 Examples of components within subsystems of a BESS

Subsystems	Components, specifications, etc.
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. BMS), 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”
 - electrochemical accumulation subsystem heating circuit
- specific auxiliary subsystem of category “C-D”
 - heat exchanger
 - fluid management system (pump, tank, piping, valve, etc)

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 Annex JB 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 car-

ried 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 BESS are described in Annex JB and Annex JC.

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 Annex JC.

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 first principles risk analysis [e.g. failure mode and effect analysis (FMEA) : see **JIS C 5750-4-3**];
- top-down analysis [e.g. fault tree analysis (FTA) : see **JIS C 5750-4-4**];
- combined and/or integrated analysis [e.g. hazard and operability study (HAZOP) : see **IEC 61882**, STAMP (systems theoretic accident model and processes)].

6.4 System level risk assessment

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

NOTE If the systems are reliant upon electronics and software, an evaluation of the functionality of these controls would 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 Clause 7 and Clause 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 JD.1.

The priority of risk reduction approaches (from **JIS Z 8051 : 2015, 6.3.5**) shall be :

- a) inherently safe design;
- b) guards and protective devices;
- c) 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 and/or 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 planned and executed in accordance with BESS risk assessment processes specified in Clause 6.

NOTE 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 JD.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 JD.3 are applicable.

7.4 Overcurrent protection design

The general safety considerations of EESS described in JD.4 are applicable.

7.5 BESS disconnection and shutdown

The general safety considerations of EESS described in **JD.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 **JD.6** are applicable.

7.7 Staff training

The general safety considerations of EESS described in **JD.7** are applicable.

7.8 Safety design

The general safety considerations of EESS described in **JD.8** are applicable. Additional safety requirements necessary to reduce the risks of BESS through safety design are described in **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 be spread outside of the subsystem itself.

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 isolation 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 no evidence can be obtained that no worker is 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.

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 **JIS C 60364** series.

The electrical installation of category “V-H” BESS shall be in accordance with **JIS C 61936-1 : 2010 + Amd 1 : 2014** and **JIS C 60364** (all parts).

The electrical protection for any subsystem connected to the DC side of BESS shall

be safe in accordance with **IEC 61660-1** and **IEC 61660-2**.

The live parts of subsystems and the components of BESS that have hazardous voltage [above extra-low voltage (ELV)] 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 not be connected to 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 use 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 **JIS C 62477-1 : 2017, 4.4.3.4**.

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

Duplication (or redundancy) of components may 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.

NOTE ... Where the BESS enclosure alone does not provide adequate protection especially during transportation, the enclosure should be reinforced by external equipment etc. In this case, the added reinforcement is regarded as part of the BESS structure.

The 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 component malfunction.

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

The 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 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.

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 8.2.3.1, 8.2.3.2 and 8.2.3.3.

7.10.4 Protection from hazards arising from EMC

Safety functions of safety-related subsystems of BESS shall not be disturbed by EMC.

Where expected EMC 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.

7.10.5 Protection from fire hazards

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

NOTE 1 The non-combustibility test is described in ISO 1182.

NOTE 2 This Standard has added "non-flammable materials" to the materials used whereas the corresponding International Standard only mentions "non-combustible materials", based on the understanding that composing BESS only with parts of non-combustible materials is difficult and that the term "non-combustible material" is intended to include non-flammable materials.

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 result of system level risk assessments (see Clause 6). Fire-load calculations on the BESS, or the experimental fire characteristics recommended in 8.2.5 with details in Annex C are applicable for the process of 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.

Thermal partition 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 mechan-

ical 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 Standard, but it is not required that the equipment still be in full working order. It is permitted to use fusible links, thermal cut-outs (return type over-temperature protection device), over-current 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 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 single fault conditions on control and other circuits can be found in **IEC 62368-1**.

Operator safety after an abnormal operation or a single fault should be checked by system testing with suitable simulated signals in accordance with **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 Exposure to moisture ingress

The BESS shall be designed to prevent the effect from moisture ingress.

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

For category “S-U” BESS, a minimum IP code of IPX4 shall be determined in accordance with **JIS C 0920**.

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 areas normally presenting hazards within the context of this Standard.

NOTE..... Protection by enclosure is considered as access control.

In the case of BESS equipped with control subsystem, the BMS 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 code of IP2X shall be determined in accordance with **JIS C 0920**.

7.11.2 BESS disconnection and shutdown

7.11.2.1 General

In addition to the operational states that are defined in **JD.5**, a non-operational condition (the isolated condition for maintenance) is defined as follows : “The isolated condition for maintenance is a system condition that allows for safe working on the DC power circuitry and electrochemical accumulation subsystem.”

7.11.2.2 Grid disconnected state

The general requirements that are described in **JD.5.2** 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. Auxiliary power is still present to facilitate an automatic power-up sequence, or to power monitoring systems. This state is typi-

cally achieved using contactors or motorized circuit breakers. During their installation, the possibility of automatic re-energization or insufficient isolation shall be minimized to ensure safety of the workers on the site.

NOTE This Standard has made the above minimization a requirement rather than a recommendation, because automatic re-energization etc. has to be made sure never to occur if safety of workers is to be of utmost priority.

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 around the DC side of the BESS may 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 may be given to providing visible isolation with the lockable isolation device as is required in some jurisdictions.

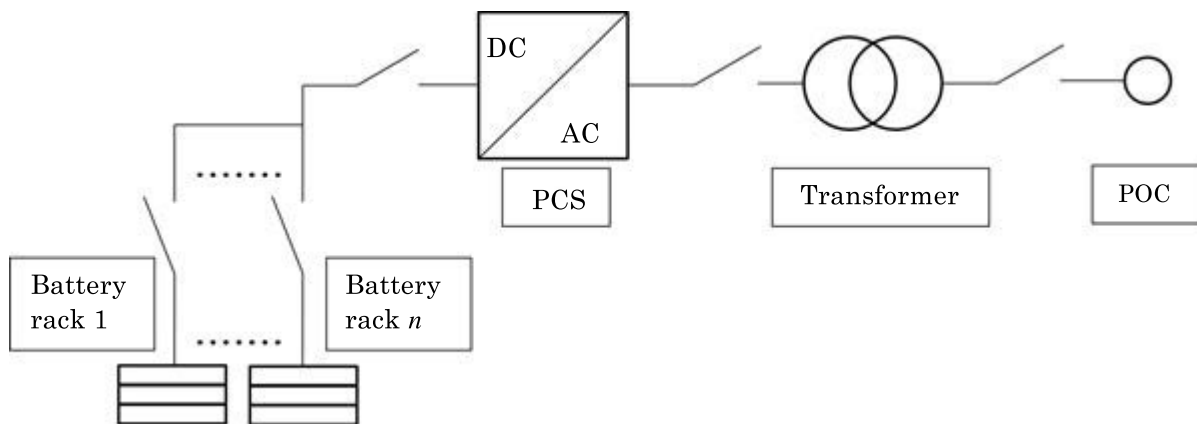


Figure 3 Example of isolated condition (whole isolation of BESS)

The procedure to isolate the system shall :

- allow for disabling of the fire suppression system where a release of the 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 permanently attached to the system 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;
- 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 electric circuits shall be properly rated to protect electric circuits against short-circuits.

Electrochemical accumulation subsystems 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 an earth fault shall be reported to operators. DC side protection is not necessary for safety extra-low voltage (SELV) battery voltage.

The BESS shall protect the batteries against overcharge and impulse voltage, 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 varistor. 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.

Limited current circuits shall be so designed that the limits are not exceeded under normal operating conditions and in the event of a single failure within the equipment. If an overcurrent happens, it shall be reported to operators.

Unintentional islanding of BESS should be considered in accordance with **JB.8**.

Testing shall be conducted, and compliance shall be assessed, in accordance with **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

In conditions of category “V-L/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 Standard 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 “V-L/S-U/C-A, C-B, C-D and C-Z” BESS shall have appropriate signage to identify restricted areas. The sign shall specify that flammable gases can be released from the BESS.

Category “V-H/S-O/C-A, C-B, C-D and C-Z” BESS themselves shall be provided with detection systems for flammable gases generated by electrochemical accumulation subsystems. When a flammable gas is detected, it 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.

In category “V-H/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.

In 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 % (lower explosion limit of hydrogen) at the time of any incidents.

For category “V-H/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 “V-L/S-O/C-A, C-B, C-D and C-Z” BESS shall be located in the site with appropriate ventilation systems.

NOTE 1 The installation in a site where appropriate ventilation is ensured is considered equivalent to the installation in a site equipped with appropriate ventilation systems.

Category “V-H/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,

NOTE 2 This is applicable to large scale BESS that have independent air conditioning subsystems and consist of dispersedly installed subsystems. The ventilation system for such BESS is required to take in and vent the surrounding air appropriately so as to help proper functioning of the air conditioning subsystems.

- 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.

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.

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 “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 8.2.5.

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 of known reliability shall be used.

It shall be possible for operators to monitor the temperatures of the internal atmosphere of the parts in the system enclosure regarded to be in need of temperature monitoring by risk assessment.

NOTE..... If the operator is a user etc. without specialized knowledge of the system, monitoring may be performed using a simplified temperature indication (e.g. icon showing whether the temperature is outside or within the

charge/discharge temperature range).

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 conditions shall be reported to operators.

When the monitored temperature(s) exceed(s) the(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 on the BESS site. An incident of toxic gas detection shall be reported (to operators) by both audible alerts and visual signals. Installation manuals shall include a statement that the BESS cannot be installed in the site without toxic gases detection systems.

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. The sign shall specify that toxic gases can be released from the BESS.

For category “E-L/S-O” BESS, a detection system for toxic gases generated by 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-L/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 outlet of toxic gases. 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 work space 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 sites 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-L/ S-O” BESS shall be installed with the protective measures described above.

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 the 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 a 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.

For rooms of electrochemical accumulation subsystems, appropriate information on the required flow of air, temperature of the environment, etc. shall be provided in the installation instructions where the electrochemical accumulation subsystem installation is supplied with the BESS. See Annex F for good practice for warning signs regarding BESS safety.

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

7.13 Life cycle safety management

7.13.1 Operation and maintenance

7.13.1.1 General

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

NOTE 1 For the safety maintenance of BESS, the observance of a product life-time and operational procedure, performance of daily maintenance, and emergency measures are very important. It is common, therefore, for the manufacturer and owner or other stakeholders to have prior agreement on these matters, and perform maintenance between life cycles

and make appropriate modifications if required.

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

NOTE 2 The replacement will take into account the potential for any secondary use.

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

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

7.13.1.2 Operation and maintenance plan

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

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

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

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

- a) how to maintain safety during maintenance [including safety instructions and specification of required personal protective equipment (PPE) for the various maintenance operations],
- b) methods to detect, manage and control fire, explosion and toxic gas retention, etc., including possibilities for venting gases outside in an emergency situation,
- c) prohibited operating processes, for example,
 - prohibition of overcharge
 - prohibition of over discharge (to avoid polarity inversion)

- prohibition of charge or discharge in operating temperature exceeding the limit provided by the manufacturer
- d) emergency contact number(s),
- e) safety issues to be disclosed in public (e.g. restricted area around the BESS),
- f) how to use safety subsystems,
- g) how to use protection subsystems,
- h) locking and unlocking procedures of all the protection subsystems,
- i) the identification and specification of hazardous parts of the BESS.

NOTE These requirements do not prevent any other necessary safety issues from being described within any manuals and guidelines.

Information concerning the design and the installation processes shall always be accessible and checked during maintenance processes which might include the following :

- The BESS components that are operated frequently under automatic and/or remote control.
- Failure and/or malfunctions can be caused by the ingress of soil, overgrowth of plants, filter or clogging up of filter or pipe, etc.
- Cleaning and consumable replacement schedules should be included in the operation and maintenance plan.
- The nature and content of the design or construction safety information that is to be provided to users by the supplier or manufacturer. This shall include but may not be limited to :
 - all subsystem parameters related to safety,
 - combination of subsystems and software that may impact on system safety for equivalent (replacement) devices,
 - past trouble instances, issues and quality problems associated with replacement of devices that may be deemed equivalent,
 - measurement accuracy and the condition of installation of sensors,
 - sensitivity and the condition of installation of gas sensors.

Information concerning the necessity to ensure that the equipment is unlikely to present a hazard within the meaning of this Standard during the operation specified by the supplier shall be provided to the user.

If it is necessary to take special precautions to avoid the introduction of hazards when operating, installing, servicing, transporting or storing equipment, the necessary instructions shall be made available.

7.13.1.3 Preventive maintenance

A periodic maintenance schedule shall be developed by the manufacturer or system integrator. The periodic maintenance schedule should include consideration of fre-