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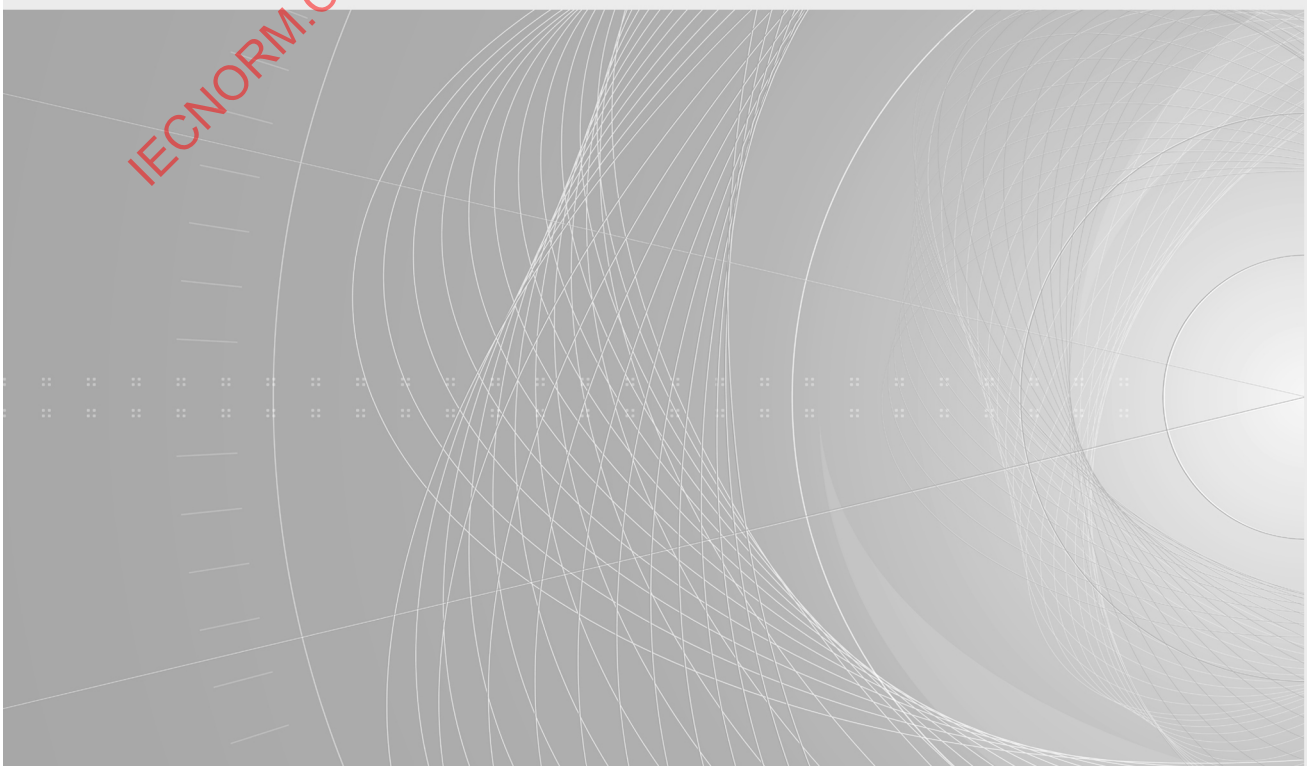
TECHNICAL SPECIFICATION

Electrical energy storage (EES) systems –
Part 4-1: Guidance on environmental issues – General specification



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

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FOREWORD

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

IEC TS 62933-4-1 which is a technical specification, has been prepared by IEC technical committee 120: Electrical Energy Storage (EES) Systems.

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

Enquiry draft	Report on voting
120/93/DTS	120/98/RVDTS

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62933 series, published under the general title *Electrical energy storage (EES) systems*, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

INTRODUCTION

Electrical energy storage systems (EES systems) have been integrated into the grid systems. The EES systems play one of the key roles in grid operation. Integrating the EES systems with the grid systems may further bring benefits such as efficient utilization in renewable energy sources. A variety of electrical energy storage technologies have been used widely in small and large sizes, for residential, industrial and utility siting, and in renewable energy stabilization and other applications. An EES system is an integrated system with components that are well standardised, however, system aspects specific to EES systems have not been well discussed. Furthermore, environmental issues for product level have been discussed horizontally in other IEC documents; however, specific environmental aspects of systems have not been well discussed. Therefore, a standard method for assessing environmental issues in EES systems is indispensable.

Under these circumstances, this document describes, in accordance with ISO Guide 64:2008, principles and approaches for environmental issues of EES systems in both normal and abnormal operating conditions, and presents guidelines to address environmental impacts to and from EES systems, including the chronic impacts on humans.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 4-1: Guidance on environmental issues – General specification

1 Scope

This part of IEC 62933, which is a Technical Specification, describes environmental issues associated with electrical energy storage systems (EES systems), and presents guidelines to address the environmental impacts to and from EES systems including the impacts to humans due to chronic exposure associated with the mentioned environmental impacts.

It is the aim of this document to describe environmental issues that are uniquely and only applicable to EES systems. However, it is not the aim of this document to describe environmental issues that are applicable to any systems.

It is not the aim of this document to describe environmental issues associated with components and products used in EES systems.

This document applies to all EES systems regardless of the type of electrical energy storage technologies.

This document considers the issues in both normal and abnormal operating conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

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

NOTE It has been considered useful to repeat some terms from exterior sources for convenience.

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/

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

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

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

Note 2 to entry: Generally (see Figure 1), 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 electrical form).

3.2
auxiliary subsystem
EESS subsystem containing equipment intended to perform particular functions additional to the storage/extraction of electrical energy which is done in the primary subsystem

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

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

Note 3 to entry: The auxiliary subsystem can be configured to take the energy from the primary subsystem (see Figure 1).

3.3
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 one, including the data interface with external links

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

3.4
component
constituent part of a device which cannot be physically divided into smaller parts without losing its particular function

[SOURCE: IEC 60050-151:2001, 151-11-21]

3.5
control subsystem
EESS subsystem serving for monitoring and controlling the EESS, by including all equipment and functions for acquisition, processing, transmission, and display of the necessary process information

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

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

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

3.6
earth leakage current
current flowing from the live parts of the installation to earth, in the absence of an insulation fault

[SOURCE: IEC 60050-442:1998, 442-01-24]

3.7
electrical energy storage system
EES system
EESS
grid-integrated installation with defined electrical boundaries, comprising at least one EES, whose purpose is to extract electrical energy from an electric power system, store this energy internally in some manner and inject electrical energy into an electrical power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment

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

Note 2 to entry: In some cases, an EES system may require an additional energy source during its discharge, providing more energy to the electric power system than the energy it stored (electric power system is defined in IEC 60050-601:1985, 601-01-01).

3.8
environment
natural and man-made surroundings in which an EES system is installed, operates and interacts, including buildings and facilities, air, water, land, natural resources, flora, fauna (including human inhabitants) of those surroundings

[SOURCE: IEC 60050-904:2014, 904-01-01, modified – the original definition has been particularized for the EES system surroundings.]

3.9
environmental aspect
element of an EES system that can interact with the environment

[SOURCE: IEC 60050-904:2014, 904-01-02, modified – the original definition has been particularized for the EES system surroundings]

3.10
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partly resulting from environmental aspects

[SOURCE: IEC 60050-904:2014, 904-01-03]

3.11
environmental issue
any environmental impact to and from EES systems including the impacts to humans during or after chronic exposure

3.12
life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to final disposal

[SOURCE: IEC 60050-901:2013, 901-07-12]

3.13
life cycle thinking
consideration of all relevant environmental aspects (of a product) during the entire (product) life cycle

[SOURCE: ISO Guide 64:2008, 2.6]

3.14
malfunction
situation for which the electrical equipment does not perform the intended function due to a variety of reasons, including:

– variation of a property or of a dimension of the processed material or of the work piece;
– failure of one (or more) of its component parts or services;
– external disturbances (e.g. shocks, vibration, electromagnetic interference);
– design error or deficiency (e.g. software errors);
– disturbance of its power supply;
– surrounding conditions (e.g. condensation due to temperature change)

[SOURCE: IEC 60050-903:2013, 903-01-16]

3.15
management subsystem
EESS subsystem providing the functionality needed for the safe, effective and efficient EES system operation

3.16
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 electric power system, 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.

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

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

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 and comprises at least the accumulation subsystem and the power conversion subsystem (see Figure 1).

3.18
protection subsystem
EESS subsystem containing an arrangement of one or more protection equipments, 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(s). Depending upon the principle(s) of the protection subsystem, it may include one end or all ends of the protected section and, possibly, automatic reclosing 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 particularized 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.]

3.19
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

Note 1 to entry: Generally (see Figure 1) the power conversion subsystem is connected to the accumulation subsystem and to the primary POC through the primary connection terminal.

3.20
product
any goods or service

[SOURCE: ISO Guide 64:2008, 2.8]

4 General

The environmental impact of an EES system is determined based on the identification of environmental issues associated with the EES system technology being applied and its location in relation to the surrounding environment. The impact assessment is conducted in accordance with Clause 5. Based on the results of the impact assessment, the provisions of Clause 6 are applied to address the impact of the EES system on the surrounding environment.

5 Identifying environmental issues in EES systems

5.1 General

Clause 5 describes three viewpoints to identify environmental issues in EES systems. The first viewpoint is given by ISO Guide 64:2008 (viewpoint 1), whereas this document deals with issues in systems, therefore ISO Guide 64:2008 is expanded to cover system aspects (viewpoint 2: System aspects). Furthermore, this document deals with environmental issues independent from electrical energy storage technologies, therefore, another viewpoint (viewpoint 3: Electrical energy storage technology independence) is discussed. The identified environmental issues in Clause 6 include consideration of all three viewpoints unless documentation is provided that supports one or more viewpoints as not relevant.

5.2 Viewpoint 1: Guide for addressing environmental issues (ISO Guide 64:2008)

Viewpoint 1 is based on ISO Guide 64:2008, which describes “product life cycle” thinking, however, it is read as “system life cycle” in this document. Similarly, “material” is read as “product.”

The following elements from ISO Guide 64:2008 are referred to.

a) Clause 3: Basic principles and approaches.

b) Clause 4: Environmental aspects to be considered for systematically addressing environmental issues in product standards.

c) Clause 5: Identifying product environmental aspects using a systematic approach.

d) Clause 6: Guidance for integrating environmental provisions in the product standard.

e) Four major stages in 3.2.1, "life cycle thinking",, are described as follows:

1) “(product) acquisition” such as design, procurement of products/components, assembly in factory, where some EES systems, depending on storage technologies, can be integrated as a system in a factory while others may be integrated as a system on-site;
2) “installation” such as on-site placement of an already integrated EES system, on-site integration from products/components, on-site test and checking of operations, commissioning test;
3) “operation & maintenance” including online repair, partial replacement of a product/component;
4) “disassembly” such as disassembly into products/components, displacement, depending on storage technologies, of an already integrated EES system.

Service life, a term used in other parts of the IEC 62933 series, starts from the commissioning test at the end of the “installation stage” and ends when it is removed from its intended use during the “disassembly stage”.

5.3 Viewpoint 2: System aspects

5.3.1 General

Viewpoint 2 is expanded from viewpoint 1 to cover issues that are applicable to systems (namely “system aspects”), where bi-directional issues are defined, namely “system to environment” and “environment to system.”

5.3.2 System to environment

Output(s) from the EES system to the environment caused by interaction among subsystem(s) or interaction between subsystem(s) and component(s) is(are) treated as system-to-environment issue(s) in this document, where the subsystems and components (auxiliary connection terminal and primary connection terminal) are shown in Figure 1.

5.3.3 Environment to system

Input(s) from the environment to the EES system that cause(s) interaction among subsystem(s) or interaction between subsystem(s) and component(s) resulting in malfunction of the EES system is(are) treated as environment-to-system issue(s) in this document.

5.4 Viewpoint 3: Electrical energy storage technology independence

A typical installation of an EES system, as shown in Figure 1, includes an accumulation subsystem, power conversion subsystem, auxiliary subsystem and so on. Various types of storage technologies are known to exist according to the IEC White Paper “Electrical Energy Storage”, where mechanical (PHS, CAES, FES), electrochemical (secondary batteries, flow batteries), chemical (H2), electrical (DLC, SMES), and thermal storage systems are described.

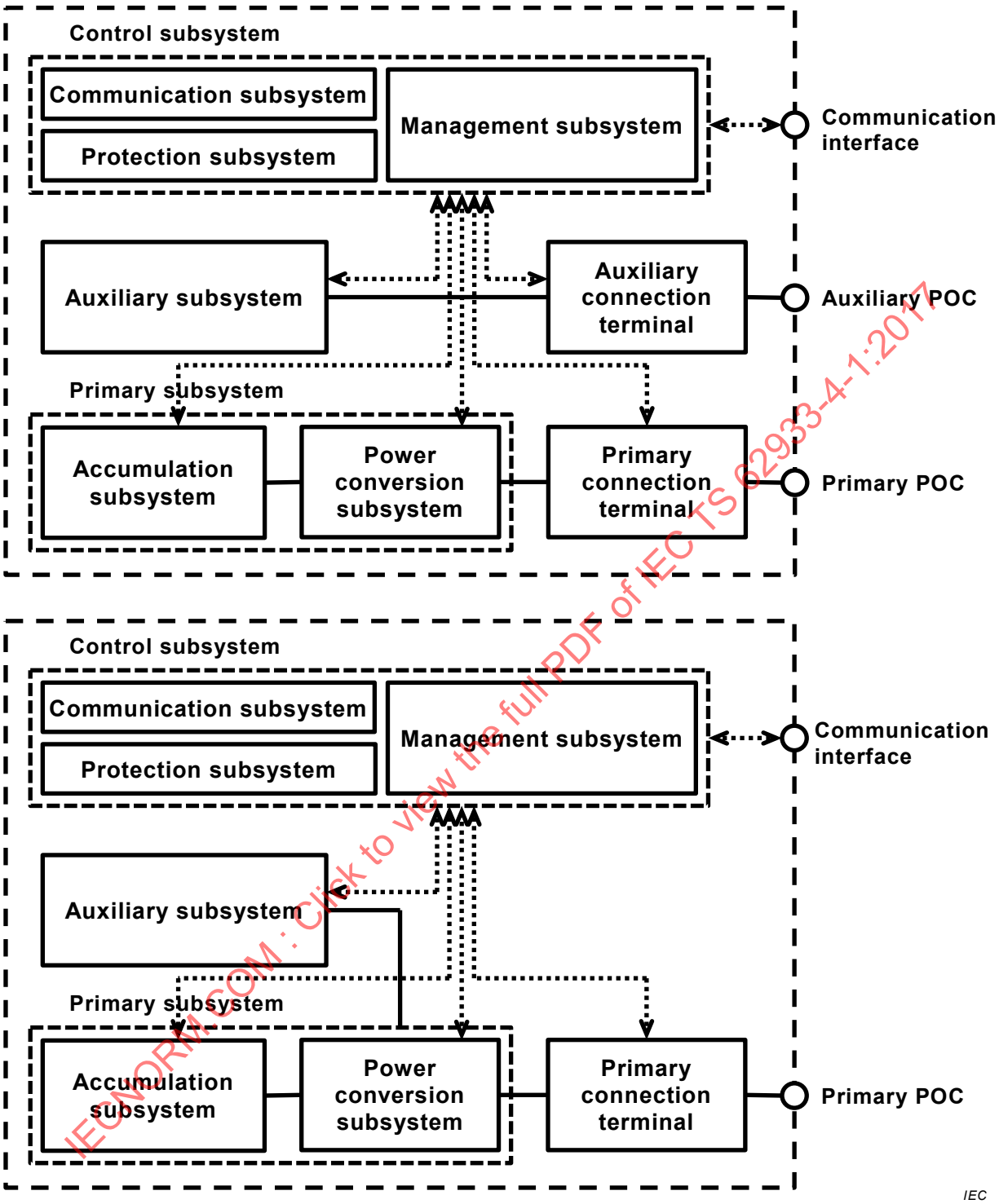

Figure 1 – EES system architecture in the two main EESS configurations

There are issues which are caused independently of the storage technologies and issues which are caused depending on the specific storage technology. The former include loss of energy during the charging/ discharging cycle, and result in exhaustion of the lost energy, typically heat emission from the system (such as fire caused by an extreme case of heat emission). The latter include a specific type of materials used in the storage technology, typically leakage of chemicals used in a specific type of for example electrochemical batteries that are not used in other types of storage technologies, for example PHS.

6 Environmental guidelines of EES systems

6.1 General

Clause 6 describes the environmental guidelines of EES systems, based on the principles and approaches described in Clause 5.

6.2 Guidelines for issues from the EES system to the environment

An EES system's environmental impacts are related to the environmental inputs that are used and consumed, the EES system's processes employed and the environmental outputs that are generated at all stages of the EES system life cycle. The guidelines for issues derived from the above mentioned impacts, namely issues from the EES system to the environment are described in Table 1.

NOTE 1 See Annex A for the potential issues that are not included in Table 1.

Table 1 – Guidelines for issues from the EES system to the environment

ISO Guide 64:2008 issue category	EES system issue	Life cycle	Guideline
Input			
Materials	(not applicable)	(not applicable)	(not applicable)
Water	(not applicable)	(not applicable)	(not applicable)
Energy	(not applicable)	(not applicable)	(not applicable)
Land	(not applicable)	(not applicable)	(not applicable)
Output			
Emissions to air, water, soil	Leakage of substance(s) including smoke and gasses to soil and other natural environment, including river, ocean	Installation, operation & maintenance, Disassembly	(not applicable)
Waste	(not applicable)	Disassembly	(not applicable)
Noise, vibration, radiation, heat	Vibration, sonic noise, audible noise, heat, electromagnetic radiation	O&M	Appropriate measures should be considered according to the relevant local regulations
Intermediate, co-products and other releases	Earth leakage current	Operation & maintenance	Appropriate measures should be considered according to the relevant local regulations where applicable
Other relevant aspects			
Risk to the environment from accidents or unintended use	Heat, fire	O&M	Appropriate measures should be considered according to the relevant local regulations
Risk to the environment from accidents or unintended use	Explosion	O&M	(not applicable)
Risk to the environment from accidents or unintended use	Electromagnetic radiation	Operation & maintenance	(not applicable)
Customer Information	Customer information	All stages of system life cycle	It should be considered, if applicable, to obtain the customer information of products used in an EES system and to show the obtained information as the customer information of the EES system

6.3 Guidelines for issues from the environment to the EES system

Impacts on an EES system are related to the natural and artificial environmental conditions where the EES system is in the installation and operation & maintenance stages. The guidelines for issues derived from the above mentioned impacts, namely issues from the environment to the EES system are considered in 6.3. Appropriate measures should be considered in one of the following ways:

- according to the product standards,
- according to the EES systems standards for specific types of electrical energy storages, or
- according to the relevant local regulations,

against the following items where applicable:

– lightning
– seismic risk (including earthquake, landslide, collapse, subsidence)
– flooding, water, rain
– temperature
– pressure
– wind
– ice and snow
– life form invasion (including invasion of mice which bite the wires, human invasion to obtain comfortable temperatures for living and insect invasion causing ventilation malfunction)
– vibration/resonance
– dust, smoke
– fire, external fire
– external electromagnetic sources
– humidity
– salt mist/salt water/erosive chemical
– corrosion
– solar irradiation
– sediment build up

6.4 Guidelines for issues from the EES system to humans with a chronic impact

An EES system's chronic environmental impacts on humans are related to:

- the environmental inputs that are used and consumed,
- the EES system's processes employed, and
- the environmental outputs that are generated at all stages of the EES system life cycle.

The guidelines for issues derived from the above mentioned impacts, namely issues from the EES system to humans with a chronic impact, are considered in 6.4.

The issues listed in 6.2 together with the guidelines apply also to issues from the EES system to humans having a chronic impact. Therefore, where the issue has a chronic impact, appropriate measures should be considered in one of the following ways:

– according to the product standards,
– according to the EES systems standards for specific types of electrical energy storages, or
– according to the relevant local regulations.

Annex A
(informative)

Examples of potential issues that are not selected as issues from the EES system to the environment

Subclause 6.2 lists the guidelines for issues from the EES system to the environment. During the process of creating the list, there were potential issues that were finally not selected for inclusion in 6.2. Table A.1 shows the examples of potential issues that were not selected as the issues from the EES system to the environment.

Table A.1 – Examples of potential issues that were not selected

Potential Issues	Reasons not being selected
Change in landscape or geography including light pollution (acquisition, installation, operation & maintenance stage)	This applies not only to EES systems but also to other building systems.
Dust (installation, operation & maintenance, and disassembly stage)	This applies not only to EES systems but also to other building systems.
Odour (operation & maintenance stage)	Technology dependent, i.e. this relates only to the storage types that make odour.
Transportation of disposal (disassembly stage)	This applies not only to EES systems but also to other building systems.
Disposal of waste including hazardous materials (operation & maintenance and disassembly stage)	Technology dependent, for example this relates to electrochemical and chemical storage in the case of hazardous materials, or this relates to mechanical (PHS) storage in the case of sand waste.
Rehabilitation of the land after removal of the system (disposal stage)	Physical rehabilitation of the land applies not only to EES systems but also to other building systems. Chemical rehabilitation of the land is technology dependent, i.e. this relates only to electrochemical and chemical storage.

Table A.2 shows the result of the assessment using viewpoints 1 (ISO Guide 64:2008), 2 (system aspects) and 3 (electrical energy storage technology independence) described in Clause 5.