

INTERNATIONAL STANDARD

COMMENTED VERSION

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

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 Basic guidelines for safety of BESS	11
4.1 General	11
4.2 Approach to BESS safety	13
4.3 BESS changes in ownership, control or use	15
5 Hazard considerations	15
6 BESS system risk assessment	16
6.1 BESS structure	16
6.1.1 General characteristics	16
6.1.2 Specific characteristics	17
6.1.3 Specific BESS implementation location	17
6.2 Description of BESS conditions	17
6.3 Risk analysis	17
6.3.1 General	17
6.3.2 Hazard identification specific to BESS	17
6.3.3 Risk consideration	18
6.3.4 System level risk analysis	18
6.4 System level risk assessment	18
7 Requirements necessary to reduce risks	18
7.1 General measures to reduce risks	18
7.2 Preventive measures against damage to neighbouring inhabitants	19
7.3 Preventive measures against physical injury or damage to the health of workers and residents	19
7.4 Over current protection design	19
7.5 BESS disconnection and shutdown	19
7.6 Operation and maintenance	19
7.7 Staff training	19
7.8 Safety design	20
7.9 General requirements for BESS safety	20
7.10 Inherently safe design of BESS	20
7.10.1 Protection from electrical hazards	20
7.10.2 Protection from mechanical hazards	21
7.10.3 Protection from explosion	22
7.10.4 Protection from hazards arising from electric, magnetic, and electromagnetic fields	22
7.10.5 Protection from fire hazards	22
7.10.6 Protection from temperature hazards	23
7.10.7 Protection from chemical effects	23
7.10.8 Protection from hazards arising from auxiliary, control and communication system malfunctions	23
7.10.9 Protection from hazards arising from environments	24
7.11 Guards and protective measures	24
7.11.1 General	24

7.11.2	BESS disconnection and shutdown	25
7.11.3	Other guards and protective functions of BESS	26
7.12	Information for end users	31
7.13	Life cycle safety management	32
7.13.1	Operation and maintenance	32
7.13.2	Partial system change	35
7.13.3	Design revision	36
7.13.4	End of service life management	37
7.13.5	Measures for validating life cycle safety management	37
8	System validation and testing	37
8.1	General	37
8.2	Validation and testing of BESS	43
8.2.1	Electrical hazards	43
8.2.2	Mechanical hazards	48
8.2.3	Explosion	49
8.2.4	Hazards arising from electric, magnetic, and electromagnetic fields	52
8.2.5	Fire hazards (propagation)	52
8.2.6	Temperature hazards	54
8.2.7	Chemical effects	55
8.2.8	Hazards arising from auxiliary, control and communication system malfunctions	55
8.2.9	Hazards arising from environments	56
8.2.10	IP rating of BESS enclosure and protective guards	57
9	Guidelines and manuals	57
Annex A (informative)	Ownership models of BESS	58
Annex B (informative)	BESS hazards and risks	59
B.1	General introduction	59
B.2	Hazards concerns to be addressed	65
B.2.1	General	65
B.2.2	Fire hazards	65
B.2.3	Chemical hazards	65
B.2.4	Electrical hazards	66
B.2.5	Stored electrical energy hazards	66
B.2.6	Physical hazards	66
B.2.7	High-pressure hazards	66
B.3	Hazard considerations under normal operating conditions	66
B.3.1	Fire and explosive hazards	66
B.3.2	Chemical hazards	67
B.3.3	Electrical hazards	67
B.3.4	Physical hazards	68
B.4	Hazard considerations under emergency/abnormal conditions	68
B.4.1	Fire hazards	68
B.4.2	Chemical hazards	68
B.4.3	Electrical hazards	70
B.4.4	Physical hazards	70
B.5	Commercially available battery technologies	70
B.5.1	Lithium ion (Li-ion) batteries (C-A)	70
B.5.2	Lead-acid batteries (C-B)	71
B.5.3	Nickel batteries (C-B)	73

B.5.4	High-temperature sodium batteries (C-C).....	75
B.5.5	Flow batteries (C-D)	77
B.5.6	Lithium metal solid state batteries (C-Z)	78
B.6	Other technologies.....	79
Annex C (informative) Large scale fire testing on BESS.....		80
Annex D (informative) Test methods for protection from hazards arising from environments		81
D.1	General.....	81
D.2	Outdoor installations subject to moisture exposure	81
D.3	Outdoor installation near marine environments	81
Annex E (informative) Information required for validation of BESS life cycle safety management.....		82
E.1	Overview	82
E.2	General introduction	82
E.3	Operation and maintenance process	82
E.4	Preventive maintenance.....	82
E.5	Measuring and monitoring of system soundness	83
E.6	Staff training	83
E.7	Partial system change.....	83
E.8	Design revision	83
Annex F (informative) BESS safety signage.....		85
Annex G (informative) Example of testing for verification of thermal control operation.....		86
Annex H (informative) Examples of test procedures and methods that can be applicable to BESS		87
H.1	Overview	87
H.2	Examples of testing procedures	87
H.2.1	Electrical hazards test procedure and test method in 8.2.1	87
H.2.2	Mechanical hazards test procedures and test methods in 8.2.2.....	95
H.2.3	Explosion hazards test procedure and test method in 8.2.3	98
H.2.4	Hazards arising from electric, magnetic, and electromagnetic fields test procedure and test method in 8.2.4.....	102
H.2.5	Fire hazards test procedure and test method in 8.2.5	103
H.2.6	Temperature hazards test procedure and test method in 8.2.6.....	104
H.2.7	Explosion hazards test procedure and test method in 8.2.7	105
H.2.8	Hazards arising from auxiliary, control and communication system malfunctions test procedure and test method in 8.2.8	107
H.2.9	Hazards arising from environments test procedure and test method in 8.2.9	108
H.2.10	IP rating of BESS enclosure and protective guards test procedure and test method in 8.2.10	110
Annex I (informative) Risk analysis		111
Annex J (informative) Aisle and access requirements		113
Bibliography.....		115
List of comments.....		118
Figure 1 – General description procedure for risk assessment and reduction of BESS		12
Figure 2 – An example of BESS architecture.....		16
Figure 3 – Example of isolated condition (whole isolation of BESS)		26

~~Figure 4 — Incompatibility of capacity and/or usage in a BESS~~

Figure 4 – Example for the scheme of dielectric voltage test and insulation resistance test	47
Figure H.1 – Composition of circuits for short-circuit test – AC short circuit.....	87
Figure H.2 – Composition of circuits for short-circuit test – DC short circuit	88
Figure H.3 – Composition of circuits for short-circuit test – Switching element short-circuit.....	88
Figure H.4 – Composition of circuits for short-circuit test – Short-circuit in rack exterior.....	88
Figure H.5 – Composition of circuits for earth fault test – AC earth fault.....	90
Figure H.6 – Composition of circuits for earth fault test – DC earth fault	90
Figure H.7 – Impulse withstand voltage test points	92
Figure H.8 – Dielectric test points	93
Figure H.9 – Insulation resistance test points.....	94
Figure H.10 – Impact test using a steel ball	95
Figure H.11 – Test probe A.....	96
Figure H.12 – Test probe B.....	97
Figure H.13 – Gas release profile of an overheated NMC pouch cell of 100 % SOC.....	99
Figure H.14 – Diagram of the abuse chamber used for signal cell testing.....	99
Figure H.15 – Example of gas sensor placement accuracy verification test.....	100
Figure H.16 – Circuit composition for communication error test.....	108
Figure J.1 – Minimum width of aisle	113
Figure J.2 – Maximum length of escape route.....	114
Table 1 – BESS categories	14
Table 2 – Examples of BESS use application.....	15
Table 3 – Examples of components within subsystems of a BESS	16
Table 4 — Examples of incompatibilities that can arise from system changes	
Table 4 – Overview of validation and testing for BESS.....	39
Table B.1 – Hazards of BESS in common	61
Table B.2 – Hazards of BESS using non-aqueous electrolyte battery (category "C-A").....	62
Table B.3 – Hazards of BESS using aqueous electrolyte battery (category "C-B").....	63
Table B.4 – Hazards of BESS using high temperature battery (category "C-C")	64
Table B.5 – Hazards of BESS using flow battery (category "C-D")	65
Table H.1 – Criteria for judgment of short-circuit test (secondary).....	89
Table H.2 – Rated impulse withstand voltage for equipment energized directly from mains supply.....	91
Table H.3 – Example of minimum values of insulation resistance.....	94
Table H.4 – Limits for electromagnetic conductive disturbance from DC voltage ports	102
Table H.5 – Electromagnetic wave tolerance performance evaluation criteria.....	103
Table H.6 – IP rate of BESS installed locations.....	108

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This commented version (CMV) of the official standard IEC 62933-5-2:2025 edition 2.0 allows the user to identify the changes made to the previous IEC 62933-5-2:2020 edition 1.0. Furthermore, comments from IEC TC 120 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

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

This second edition cancels and replaces the first edition published in 2020. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) New BESS categories: This document created new BESS energy categories “E-LI” (integrated within one enclosure), and “E-LS”(separated by two or more enclosures), because the safety measures are different for systems with one enclosure and systems with multiple enclosures.
- b) Location risk: This document added information about differences in risk depending on location.
- c) Reused or repurposed battery: Regarding ensuring the safety of BESS using reused or repurposed batteries, a reference to the new standard IEC 62933-5-3 was added.
- d) Protection from fire hazards: Based on an analysis of BESS fires occurring around the world, the number of fire propagation measures have been significantly increased.
- e) System validation and test: Test methods and criteria have been clarified. In addition, the validation of measures against gas generation and fire spread has been significantly revised.

This International Standard is to be used in conjunction with IEC 62933-5-1:2024.

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

Draft	Report on voting
120/415/FDIS	120/436/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

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

- a) ~~BESS~~ Electrochemical-based ~~EESS~~ can be integrated into a significant range of electrical grids.
- b) The level of safety requirements awareness can vary between utilities, system integrators, operators and end-users.
- c) Although the safety of individual subsystems is generally covered by international standards at ISO and IEC levels, the safety matters that arise due the combination of electrochemical accumulation subsystems and any electrical subsystems are not always considered. ~~BESS~~ Electrochemical-based ~~EESS~~ are complex at the systems level due to the variety of potential battery options and configurations, including the combination of subsystems (e.g. control systems for electrochemical accumulation subsystems, electrochemical accumulation subsystems, power conversion subsystems and auxiliary subsystems). Compliance with standards and related material produced specifically for the safety of subsystems cannot be sufficient to reach an acceptable level of safety for the overall system.
- d) ~~BESS~~ Electrochemical-based ~~EESS~~ can have additional safety hazards, due, for example, to the presence of chemicals, the emission of toxic gases, chemicals spilt around the electrochemical accumulation subsystems and to events critical for safety from electrochemical accumulation subsystems that cause safety issues for the entire ~~BESS~~ electrochemical-based ~~EESS~~. They can cause loss of power at any part of the systems and buildings that can result in additional threats to safety. From a systems perspective, these individual hazards can have a system wide impact.

1 Scope

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

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

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

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

2 Normative references

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

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

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

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

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

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

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

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

IEC 60664-1:2007/2020, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests*

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

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

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

IEC 61025, *Fault tree analysis (FTA)*

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

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

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

IEC 61936-1:~~2010~~2021, *Power installations exceeding 1 kV AC and 1,5 kV DC - Part 1: Common rules AC*
~~IEC 61936-1:2010/AMD1:2014~~

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

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

IEC 62477-1:~~2012~~2022, *Safety requirements for power electronic converter systems and equipment - Part 1: General*
~~IEC 62477-1:2012/AMD1:2016~~

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

IEC 62619:~~2017~~2022, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

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

IEC ~~TS~~ 62933-5-1:~~2017~~2024, *Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid integrated EES systems - General specification*

IEC 62933-5-3:2023, *Electrical energy storage (EES) systems - Part 5-3: Safety requirements for grid-integrated EES systems - Performing unplanned modification of electrochemical based system*

ISO/IEC 31010, *Risk management - Risk assessment techniques*

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

Bibliography

~~IEC 60050-151, International Electrotechnical Vocabulary (IEV) — Part 151: Electrical and magnetic devices~~

~~IEC 60050-482, International Electrotechnical Vocabulary (IEV) — Part 482: Primary and secondary cells and batteries~~

IEC 60364-4-41, Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock

IEC 60364-4-42, Low-voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects

IEC 60364-4-43, Low-voltage electrical installations - Part 4-43: Protection for safety - Protection against overcurrent

IEC 60617 (all parts), Graphical symbols for diagrams

IEC 60721 (all parts), Classification of environmental conditions

IEC 60896-21, Stationary lead-acid batteries - Part 21: Valve regulated types - Methods of test

IEC 60896-22, Stationary lead-acid batteries - Part 22: Valve regulated types - Requirements

IEC 61000-6-1:2016, Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity standard for residential, commercial and light-industrial environments

IEC 61000-6-2:2016, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments

IEC 61000-6-5:2015, Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for equipment used in power station and substation environment

IEC 61140, Protection against electric shock - Common aspects for installation and equipment

IEC 61427-1, Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 1: Photovoltaic off-grid application

IEC 61427-2, Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 2: On-grid applications

IEC 61508 (all parts), Functional safety of electrical/electronic/programmable electronic safety-related systems

IEC 61511-1:2016, Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming requirements

IEC 62040-1, Uninterruptible power systems (UPS) - Part 1: Safety requirements

IEC 62040-2, Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements

IEC 62116:2014, *Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures*

IEC 62351 (all parts), *Power systems management and associated information exchange - Data and communications security*

IEC TS 62351-2:2008, *Power systems management and associated information exchange - Data and communications security - Part 2: Glossary of terms*

IEC 62381:2012, *Automation systems in the process industry - Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)*

IEC TS 62443-1-1:2009, *Industrial communication networks - Network and system security - Part 1-1: Terminology, concepts and models*

IEC 62443-2-4, *Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers*

IEC 62485-1, *Safety requirements for secondary batteries and battery installations - Part 1: General safety information*

IEC 62531:2012, *Property Specification Language (PSL)*

IEC TS 62686-1:2015, *Process management for avionics - Electronic components for aerospace, defence and high performance (ADHP) applications - Part 1: General requirements for high reliability integrated circuits and discrete semiconductors*

IEC 62909-1, *Bi-directional grid connected power converters - Part 1: General requirements*

~~IEC 62932-1:2020, Flow battery energy systems for stationary applications — Part 1: Terminology and general aspects~~

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

IEC White Paper, *Electrical Energy Storage*

~~ISO 1182, Reaction to fire tests for products — Non-combustibility test~~

ISO 917:2024, *Refrigerants - Designation and safety classification*

ISO 9241 (all parts), *Ergonomics of the human-system interaction*

ISO 13732-1: 2006, *Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces*

ISO 13850:2015, *Safety of machinery - Emergency stop function - Principles for design*

ISO 13857:2008, *Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 13943:2008, *Fire safety - Vocabulary*

ISO/IEC14543-2-1:2006, *Information technology - Home electronic system (HES) architecture - Part 2-1: Introduction and device modularity*

"Analysing system safety in lithium-ion grid energy storage", D. Rosewater and A. Williams, Journal of Power Sources 300(2015) 460-471

ANSI/CAN/UL 9540:2023, *Standard for Energy Storage Systems and Equipment*

ASTM E918:2020, *Standard Practice for Determining Limits of Flammability of Chemicals at Elevated Temperature and Pressure*

BS EN 15967:2022, *Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours*

CISPR 11:2015+AMD1:2016+AMD2:2019 CSV, *Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement*

UL, *Firefighter Safety and Photovoltaic Installations Research Project*: November 29, 2011

UL 9540A:2019, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*

N. Leveson and J. Thomas, *STPA Handbook*, 2018

NFPA 400:2019. *Hazardous Materials Code*

NFPA 704:2017, *Standard System for the Identification of the Hazards of Materials for Emergency Response*