SAFETY COLLABORATIVE

## Highlights

***Final actions on proposed changes to the ICC 2018 International Fire Code (IFC) that will be included in the 2021 IFC have been published and are subject to an online consensus vote and then certification of the online vote by the Validation Committee and report to the ICC Board of Directors. See https://www.iccsafe.org/codes-tech-support/codes/code-development/current-code-development-cycle/ for more information.***

***The public review of ASME TES-1 is open and will close January 8, 2019. See https://cstools.asme.org/csconnect/PublicReviewPage.cfm?SearchType=PublicReview&SortBy=DesignationTitle&StartRow=11 for more information.***

***The second draft report on NFPA 855 is scheduled to be posted in January 2019. See https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=855&tab=nextedition for more information.***

***IEEE 1578-18, Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management, has been approved.***

***UL is proposing UL 9540A as a Joint National Standard for Canada and the United States, ANSI/CAN/UL 9540A. The draft standard is out for preliminary with comments due December 20, 2018.***

***ANSI/CAN/UL 1974-18, Evaluation for Repurposing Batteries, was published October 25, 2018.***

# CODES AND STANDARDS UPDATE NOVEMBER 2018

The goal of the DOE OE Energy Storage System Safety Roadmap[1] is to *foster confidence in the safety and reliability of energy storage systems*. There are three interrelated objectives to support the realization of that goal: research, codes and standards (C/S) and communication/coordination. The objective focused on C/S is *"To apply research and development to support efforts that refocused on ensuring that codes and standards are available to enable the safe implementation of energy storage systems in a comprehensive, non-discriminatory and science-based manner."*

The following activities support that objective and realization of the goal:

a. Review and assess C/S which affect the design, installation, and operation of energy storage systems (ESS).

b. Identify gaps in knowledge that require research and analysis that can serve as a basis for criteria in those C/S.

c. Identify areas in C/S that are potentially in need of revision or enhancement and can benefit from activities conducted under research and development.

d. Develop input for new or revisions to existing C/S through individual stakeholders, facilitated task forces, or through laboratory staff supporting these efforts.

The purpose of this Codes and Standards Update is to support the above activities by providing information on efforts being conducted by U.S. standards developing organizations (SDOs) and other entities that are focused on ESS safety.

The information is organized relative to the scope of each document in relation to ESS from the "macro to the micro" (e.g., from overarching covering considerable scope, to installation specific, to ESS and then ESS components). Note that more macro documents are also likely to adopt by reference more micro documents.

***Changes in current activity from the prior edition are shown in bold italics.*** **Time-sensitive items (e.g., those having a schedule/due date) are highlighted in yellow.**

To subscribe to the ES Safety Collaborative and receive ongoing ESS safety- related communications visit https://public.govdelivery.com/accounts/USDOESNLEC/subscriber/new?topic_id=USDOESNLEC_195

[1] DOE OE Energy Storage Systems Safety Roadmap, PNNL-SA-126115 I SAND2017-5140 R https://www.sandia.gov/ess-ssl/publications/EnergyStorage_safetyroadmap_2017.pdf

# OVERARCHING CODES AND STANDARDS

| | DNV GL – www.dnvgl.com/rules-standards/ |
|---|---|
| **Document:** | **DNVGL-RP-0043, Safety, Operation, and Performance of Grid-Connected Energy Storage Systems (GRIDSTOR)** |
| **ESS relevance:** | The objective of GRIDSTOR is to provide a comprehensive set of recommendations for grid-connected energy storage systems. It aims to be valid in all major markets and geographic regions, for all applications, on all levels from component to system, covering the entire life cycle. End users, operators, and other stakeholders can find specific guidance in the document and references to other relevant standards, codes, and guidelines. |
| **Current activity:** | Supporting the second edition of GRIDSTOR released in September 2017. See https://www.dnvgl.com/services/gridstor-recommended-practice-for-grid-connected-energy-storage-52177 for more information. |
| **Date of next edition:** | TBD |
| **Document:** | **HEATSTOR Joint Industry Project (JIP)** |
| **ESS relevance:** | The focus of HEATSTOR is on safety, operation, and performance aspects of heat storage systems. The objective of this document is to accelerate implementation of heat storage systems through creation of a globally recognized recommended practice for system safety, operation and performance. |
| **Current activity:** | The effort to develop HEATSTOR has been put on pause until further notice. |
| **Date of publication:** | TBD |

| | International Code Council (ICC) – www.iccsafe.org<br>https://www.iccsafe.org/codes-tech-support/codes/code-development/current-code-development-cycle/ |
|---|---|
| **Document:** | **2018 International Fire Code (IFC)** |
| **ESS relevance:** | Chapter 12 of the IFC covers energy systems and Section 1206 in that chapter covers electrical energy storage systems. |
| **Current activity:** | The public comment hearings following the published public comment agenda occurred October 24 to 29, 2018 in Richmond, Virginia. ***See https://www.iccsafe.org/codes-tech-support/codes/code-development/current-code-development-cycle/ for a report on the public comment hearing results. Those results are subject to an online governmental consensus vote that opened November 19, 2018 and will close December 7, 2018. The online posting of the final action on all code change proposals will occur following certification of the online vote by the Validation Committee and report to the ICC Board of Directors.***<br><br>***See https://www.sandia.gov/energystoragesafety-ssl/wp-content/uploads/2018/11/ICC-2018-ESS-code-changes-11-2018-002.pdf for an ESSC brief (November 2018) covering the results of the public comment hearings on proposed code changes to the IFC related to ESS safety.*** |
| **Date of next edition:** | 2021 |
| **Document:** | **2018 International Residential Code (IRC)** |
| **ESS relevance:** | A section of the IRC covers energy storage systems. |
| **Current activity:** | See current activity above under the IFC. |
| **Date of next edition:** | 2021 |

| | International Code Council (ICC) – www.iccsafe.org<br>https://www.iccsafe.org/codes-tech-support/codes/code-development/current-code-development-cycle/ |
|---|---|
| **Document:** | **2018 International Building Code (IBC)** |
| **ESS relevance:** | Provides a basis for adoption and application of other standards and ICC model codes. |
| **Current activity:** | See current activity above under the IFC. |
| **Date of next edition:** | 2021 |
| **Document:** | **2018 International Mechanical Code (IMC)** |
| **ESS relevance:** | Includes basic requirements for stationary fuel cell power systems and criteria for ventilation and exhaust of spaces. |
| **Current activity:** | See current activity above under the IFC. |
| **Date of next edition:** | 2021 |

| | IEEE – www.ieee.org<br>http://standards.ieee.org/about/nesc/ |
|---|---|
| **Document:** | **IEEE C2-17, National Electric Safety Code (NESC)** |
| **ESS relevance:** | Covers electrical safety for utility systems and equipment. |
| **Current activity:** | NESC Sub-Committees have held meetings to consider all change proposals and prepare recommendations. During those meetings the NESC battery section was reorganized into three sections (general, protection and control, and grid storage). The grid storage section is new and provisions for fire protection and spill control were added to that section. See http://standards.ieee.org/about/nesc/ and http://standards.ieee.org/about/nesc/nesc_2022_schedule.pdf for more information. |
| **Date of next edition:** | 2022. |
| **Activity:** | **IEEE PES Energy Storage and Stationary Battery Committee (ESSB)** |
| **ESS relevance:** | This is a growing subcommittee of the power and energy society (PES) that manages many of the standards related to energy storage and battery technologies. http://sites.ieee.org/pes-essb/ |
| **Current activity:** | An ESSB task force on codes and standards is organizing their future efforts associated with development of IEEE standards related to energy storage systems and batteries as well as laying out their involvement in the development of codes and standards by other organizations that are related to energy storage systems and batteries. The IEEE ESSB will hold their Winter General Meeting in Phoenix AZ, February 4-8, 2019. See http://sites.ieee.org/pes-essb/event/essb-meeting-2019-meeting-phoenix-az/ for more information.<br><br>The ESSB and IEEE Standard Association's Standards Coordinating Committee 21 have formed the joint Energy Storage Task Force (ESTF). The ESTF will coordinate standards development for energy storage systems that encompass DC through AC scope. A first deliverable from the ESTF was the approved PAR (IEEE project request) to create IEEE P1547.9, Guide for ES Interconnection. Work on that new proposed technical guide will begin in early 2019. |

| | National Fire Protection Association (NFPA) – www.nfpa.org |
|---|---|
| **Document:** | **NFPA 1-18, Fire Code** |
| **ESS relevance:** | Chapter 52 (new in the 2018 edition) includes requirements related to the installation of energy storage systems. Requirements recognize both established battery technologies and new energy storage technologies. Provisions apply to new and existing energy storage system applications. |
| **Current activity:** | The first draft public input closing date was June 27, 2018. Six public comments were submitted to Chapter 52 on energy storage systems, some of which are intended to align Chapter 52 with NFPA 855. The first draft meeting to act on public inputs was held September 18 and 19, 2018. The first draft report is scheduled to be posted on March 27, 2019 and will have a June 5, 2019 public comment closing date. See https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1&tab=nextedition for more information and to view the public comments and first draft committee information. |
| **Date of next edition:** | 2021 |
| **Document:** | **NFPA 70-17, National Electrical Code (NEC)** |
| **ESS relevance:** | Article 706 (new in the 2017 edition) applies to energy storage systems and Article 480 remains applicable to batteries, in addition to other criteria in the NEC relevant to electrical equipment and installations. |
| **Current activity:** | A compilation of the public comments was prepared in advance of a second draft meeting on October 22 to November 3, 2018. See https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70&tab=nextedition for more information. ***The NEC Correlating Committee will have a teleconference/web meeting on December 18, 2018 to review, among others, NFPA 791 public inputs and develop proposed revisions recommended by the correlating committee. See https://www.nfpa.org/assets/files/AboutTheCodes/791/791_A2020_NEC_AAC_FD_MeetingNotice_12_18%20-%20Copy%20(2).pdf for more information.*** |
| **Date of next edition:** | 2020 |
| **Document:** | **NFPA 5000-18, Building Code** |
| **ESS relevance:** | Provides a basis for adoption and application of other standards. |
| **Current activity:** | Public comment was due June 27, 2018. The first draft meeting is scheduled for December 5, 2018, and the first draft report is scheduled to be posted on February 27, 2019. |
| **Date of next edition:** | 2021 |

# CODES AND STANDARDS FOR ESS INSTALLATIONS

| | FM Global – http://www.fmglobal.com (https://www.fmglobal.com/research-and-resources/fm-global-data-sheets) |
|---|---|
| **Document:** | **FM Global Property Loss Prevention Data Sheet # 5-33, Electrical Energy Storage Systems** |
| **ESS relevance:** | The data sheet describes loss prevention recommendations for the design, operation, protection, inspection, maintenance, and testing of electrical energy storage systems, which can include batteries, battery chargers, battery management systems, thermal management and associated enclosures and auxiliary systems. The focus of this data sheet is primarily on lithium-ion battery technology. |
| **Current activity:** | Work to update the data sheet via an interim revision is planned for Fall 2018. |
| **Date of next edition:** | Publication of an interim revision is expected in 2019. |

| | IEEE – www.ieee.org |
|---|---|
| **Document:** | **IEEE 1635-18/ASHRAE Guideline 21-18, Guide for Ventilation and Thermal Management of Batteries for Stationary Applications** |
| **ESS relevance:** | Covers how stationary battery systems utilizing vented (flooded) lead-acid, valve-regulated lead-acid (VRLA) and nickel-cadmium (NiCad) batteries can be provided with appropriate ventilation and thermal management. |
| **Current activity:** | The revisions to the 2012 edition have been completed and the 2018 edition of the document has been published. |
| **Date of next edition:** | TBD |
| **Document:** | **IEEE 1578-18, Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management** |
| **ESS relevance:** | Covers how electrolyte spills can be contained and managed. Covered are vented lead-acid, valve regulated lead-acid, vented nickel-cadmium and partially recombintant Ni-Cd batteries. |
| **Current activity:** | The standard was approved October 23, 2018 and is available at https://standards.ieee.org/standard/1578-2018.html |
| **Date of next edition:** | TBD |

| | National Electrical Contractors Association (NECA)—www.necanet.org |
|---|---|
| **Document:** | **NECA 416-16, Recommended Practice for Installing Stored Energy Systems** |
| **ESS relevance:** | National Electrical Installation Standards (NEISs) are designed to improve communication among specifiers, purchasers, and suppliers of electrical construction services and are intended to be referenced in contract documents for electrical construction projects. NECA 416-16 describes installation practices for energy storage systems such as battery systems, flywheels, ultra-capacitors, and smart chargers used for electric vehicle (EV) vehicle-to-grid (V2G) applications. |
| **Current activity:** | Suggestions for revisions and improvements to this document are welcome and can be directed to NECA at www.neca-neis.org |
| **Date of next edition:** | TBD based on current activity. |

| | National Electrical Contractors Association (NECA)—www.necanet.org |
|---|---|
| **Document:** | **NECA 417 (new standard), Recommended Practice for Designing, Installing, Maintaining, and Operating Micro-grids** |
| **ESS relevance:** | The document is designed to improve communication among specifiers, purchasers, and suppliers of electrical construction services and is intended to be referenced in contract documents for electrical construction projects. NECA 417 will cover the design, installation, maintenance, and operation of microgrids. |
| **Current activity:** | ***A second ballot for NECA 417 closed on October 28, 2018. See*** *http://www.neca-neis.org/ballot/second-ballot-for-neca-417-201x-recommended-practice-for-designing-installing-operating-and-maintaining-microgrids* ***for more information.*** |
| **Date of first edition:** | The goal is to complete NECA-417 in 2018. |

| | National Fire Protection Association (NFPA) – www.nfpa.org |
|---|---|
| **Document:** | **NFPA 855, Standard for the Installation of Stationary Energy Storage Systems** |
| **ESS relevance:** | The standard covers the safety of all energy storage systems and their installation in the built environment. Chapters of the standard cover equipment, protection and installation, limitations on energy storage system capacity as a function of technology and location and then provide additional criteria focused on specific energy storage system technologies. |
| **Current activity:** | The first draft report was posted for public review and comment with a closing date of July 12, 2018 and NFPA received over 800 public comments. Second draft meetings were held July 24 to 26, August 21 to 23, and September 10, 2018 and the minutes of those meetings are available at https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=855&tab=nextedition ***The second draft report is scheduled to be posted in January of 2019.*** |
| **Date of first edition:** | **2020** |
| **Document:** | **NFPA 1078 (new standard), Standard for Electrical Inspector Professional Qualifications** |
| **ESS relevance:** | Addressed qualifications of those who would review and approve electrical plans and conduct electrical inspections. Such plan reviews and electrical inspections would include, but not be limited to, energy storage systems. |
| **Current activity:** | The first draft report was open for submission of public comments with a closing date of October 31, 2018. The second draft meeting will occur February 26-27, 2019 in Tampa, FL. See https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1078&tab=nextedition for more information. |
| **Date of first edition:** | 2021 |
| **Document:** | **NFPA 78 (new standard), Guide on Electrical Inspections (proposed edition).** |
| **ESS relevance:** | This document covers the minimum criteria to aid in organizing and conducting electrical inspections, including plan review and field inspection. Such plan reviews and electrical inspections would include, but not be limited to, energy storage systems. |
| **Current activity:** | The first draft report was open for submission of public comments with a closing date of October 31, 2018. ***The second draft meeting will occur February 26-27, 2019 in Tampa, FL.*** See https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=78&tab=nextedition for more information. |
| **Date of first edition:** | 2021 |

# CODES AND STANDARDS FOR A COMPLETE ESS

| | American Society of Mechanical Engineers (ASME) – www.asme.org |
|---|---|
| **Document:** | **TES-1 (new standard) Safety Standard for Thermal Energy Storage Systems** |
| **ESS relevance:** | Provides safety-related criteria for molten salt thermal energy storage systems. |
| **Current activity:** | ***A public review of the draft standard opened November 9, 2018 and will close January 8, 2019. The public review draft can be accessed either through ANSI or at ASME's public review site: https://cstools.asme.org/csconnect/PublicReviewPage.cfm?SearchType=PublicReview&SortBy=DesignationTitle&StartRow=11*** |
| **Date of first edition:** | TBD |
| **Document:** | ***PTC 53 (new standard) Performance Test Code for Mechanical and Thermal Energy Storage Systems*** |
| **ESS relevance:** | ***Provides test methods for conducting performance tests on mechanical and thermal energy storage systems intended for various energy storage applications.*** |
| **Current activity:** | ***Sections 1 to 3 of the standard have been published as a draft standard for trial use. See https://www.asme.org/products/codes-standards/ptc-53-2018-thermal-energy-storage-systems-draft for more information. The PTC 53 Committee is currently pursuing the approval process for the Sections 4 to 7 of the standard, which contains the instrumentation and uncertainty requirements for the performance test. The Committee welcomes participation by any interested in aiding in the development of the standard. Contact Donnie Alonzo (alonzod@asme.org) at ASME for more information.*** |
| **Date of first edition:** | ***It is anticipated that the publication of PTC 53 will be complete before the end of 2019.*** |

| | National Electrical Manufacturers Association – www.nema.org |
|---|---|
| **Document:** | **ESS-1-2018 Standard for Uniformly Measuring and Expressing the Performance of Electrical Energy Storage Systems** |
| **ESS relevance:** | Provides safety-related criteria for electrical ESSs. |
| **Current activity:** | The standard is going through the BSR-9 process for ANSI approval. |
| **Date of next edition:** | ***The standard should be published in January 2019.*** |

| | National Fire Protection Association (NFPA) – www.nfpa.org |
|---|---|
| **Document:** | **NFPA 791-2018, Recommended Practice and Procedures for Unlabeled Electrical Equipment** |
| **ESS relevance:** | Could form a basis for assessing an energy storage system that is not labeled. Note that recommended practices are guides and are not documents that can be enforced by jurisdictions. |
| **Current activity:** | The NFPA 791 Technical Committee met on October 4, 2018 to discuss and vote on the 34 public comments received. ***The Technical Committee final ballot results covering the 19 first revisions, based on their consideration of those 34 public comment, that have been approved by the committee have been posted. See https://www.nfpa.org/assets/files/AboutTheCodes/791/791_A2020_EEE_AAA_FD_BallotFinal.pdf for more information.*** |
| **Date of next edition:** | 2021 |

| Underwriters Laboratories Inc | Underwriters Laboratories (UL) – https://ulstandards.ul.com/develop-standards/ |
|---|---|
| **Document:** | **ANSI/CAN/UL 9540, Energy Storage Systems and Equipment** |
| **ESS relevance:** | Product safety standard for an energy storage system. |
| **Current activity:** | UL is preparing a proposed 2nd edition of UL 9540 based on the proposal requests submitted. Once final input is received from the proposal submitters, the proposed second edition should be ready to be sent for preliminary review in ***December 2018/January 2019.*** See https://csds.ul.com/Home/ProposalsDefault.aspx for more information on the upcoming preliminary review proposal for UL 9540 once it is available in CSDS. |
| **Date of next edition:** | TBD – UL standards are under continuous maintenance and are updated as warranted |
| **Document:** | **UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems (BESSs)** |
| **ESS relevance:** | This test method evaluates the fire characteristics of a battery energy storage system that undergoes thermal runaway. The data generated can be used to determine the fire and explosion protection required for an installation of a battery energy storage system. |
| **Current activity:** | A third edition of the standard was issued June 15, 2018. A Certification Requirement Decision (CRD) has been published for UL 9540A to clarify current practice for the cell portion of the test method. See https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=34477 for more information with regards to the CRD.<br><br>***UL is proposing UL 9540A as a Joint National Standard for Canada and the United States, ANSI/CAN/UL 9540A. The draft standard is out for preliminary review starting November 26, 2018 with comments due December 20, 2018. See https://csds.ul.com/Home/ProposalsDefault.aspx and select UL 9540A Ed. 4 to obtain access to the preliminary review proposal in CSDS.*** |
| **Date of next edition:** | TBD – UL standards are under continuous maintenance and are updated as warranted |

# CODES AND STANDARDS FOR ESS COMPONENTS

| CSA Group | CSA GROUP (CSA) – www.csagroup.org |
|---|---|
| **Document:** | **CSA C22.2 No. 107.1-2016, Power Conversion Equipment** |
| **ESS relevance:** | Applies to alternating current (AC) and direct current (DC) type power conversion equipment, which can be associated with an energy storage system. |
| **Current activity:** | The standard is under continuous maintenance and updated as warranted. |
| **Date of next edition:** | TBD |
| **Document:** | **CSA C22.2 No. 340-201 (new standard), Battery Management Systems** |
| **ESS relevance:** | The standard covers the design, performance, and safety of battery management systems (electronic or electromechanical systems that control or regulate a battery or batteries, which may include external communication capabilities). |
| **Current activity:** | ***A standard seed document is under development by a Task Force. The seed document will be used as a starting point to develop the first standard draft by the development committee. To join the development committee contact Mohsen Sepehr at mohsen.sepehr@csagroup.org.***<br><br>Note that IEEE is also planning to develop a document on battery management systems (BMS). The CSA standard will be a consensus safety standard and the IEEE document (a publically available specification or PAS) will be a non-normative guide that details more procedural aspects of implementing a BMS and the techniques to achieve best functionality of a BMS. The CSA Group and IEEE are aware of each other's activities and have established liaisons to one another. |
| **Date of first edition:** | TBD |

| IEEE Advancing Technology for Humanity | IEEE – www.ieee.org |
|---|---|
| **Document:** | **IEEE 1679.1-17, Guide for the Characterization and Evaluation of Lithium-Based Batteries in Stationary Applications** |
| **ESS relevance:** | Provides appropriate information about the safety attributes and operating conditions related to stationary applications of lithium-based batteries. It provides recommendations for how to characterize lithium-ion battery performance and safety in stationary applications. The guide is very general and nonprescriptive, offering common challenges and solutions with the caveat to "consult the manufactures recommendations" for specific devices or technologies. The guide points to existing standards (e.g., UL 1642) and existing regulatory requirements (e.g., adoption of NFPA 70) wherever possible. |
| **Current activity:** | An active working group is engaged in considering updates to the standard. |
| **Date of next edition:** | TBD |
| **Document:** | **IEEE P1679.2 (new standard), Guide for the Characterization and Evaluation of Sodium-Beta Batteries in Stationary Applications** |
| **ESS relevance:** | Provides appropriate information about the safety attributes and operating conditions related to stationary applications of sodium-beta batteries. It provides recommendations for how to characterize sodium-beta battery performance and safety in stationary applications. The guide is very general and nonprescriptive, offering common challenges and solutions with the caveat to "consult the manufactures recommendations" for specific devices or technologies. |
| **Current activity:** | A revised version of the standard was sent out for recirculation and closed August 8, 2018. |
| **Date of first edition:** | The unapproved draft is available from IEEE. |

| IEEE Advancing Technology for Humanity | **IEEE – www.ieee.org** |
|---|---|
| **Document:** | **IEEE P1679.3 (new standard), Guide for the Characterization and Evaluation of Flow Batteries in Stationary Applications** |
| **ESS relevance:** | Provides appropriate information about the safety attributes and operating conditions related to stationary applications of flow batteries. It provides recommendations for how to characterize flow battery performance and safety in stationary applications. The guide is general and nonprescriptive, offering common challenges and solutions with the caveat to "consult the manufactures recommendations" for specific devices or technologies. |
| **Current activity:** | Active working group, next meeting will be at the IEEE ESSB 2019 Winter General Meeting in Phoenix AZ, February 4-8. http://sites.ieee.org/pes-essb/event/essb-meeting-2019-meeting-phoenix-az/. Contact the working group chair to get involved: Vilayanur ("Vish") Viswanathan, vilayanur.viswanathan@pnnl.gov |
| **Date of first edition:** | TBD |
| **Document:** | **IEEE P2686 (new standard) Recommended Practice for Battery Management Systems in Energy Storage Applications** |
| **ESS relevance:** | This recommended practice includes information on the design, installation, and configuration of battery management systems in stationary applications, including both grid-interactive, standalone cycling and standby modes. This document covers battery management hardware, software, and configuration. Hardware capabilities in large systems include: grounding and isolation; passive and active balancing; and wired or wireless sensors. Software capabilities include: algorithms for optimal operation with reduced risk; best practices for verification and validation; alarms; and communication with external systems. Common settings are discussed along with setting selection methods. Battery types that this document covers include lithium-ion, sodium-beta, advanced lead-acid, and flow batteries. General factors for other types are provided.<br>Note that the CSA will also develop a document on battery management systems. The IEEE recommended practice will focus on non-normative design options and best-practices rather than requirements. The CSA Group and IEEE are aware of each other's activities and have established liaisons to one another. |
| **Current activity:** | The kickoff meeting for the newly approved working group will be held at the IEEE ESSB 2019 Winter General Meeting in Phoenix AZ, February 4-8, 2019. http://sites.ieee.org/pes-essb/event/essb-meeting-2019-meeting-phoenix-az/. Contact the working group chair to get involved: David Rosewater, dmrose@sandia.gov |
| **Date of first edition:** | TBD |

| Underwriters Laboratories Inc.® | Underwriters Laboratories (UL) – https://ulstandards.ul.com/develop-standards/ |
|---|---|
| **Document:** | **UL 810A, Electrochemical Capacitors** |
| **ESS relevance:** | Addresses the safety of electrochemical capacitors, which can be used as an energy source in energy storage systems. |
| **Current activity:** | The first edition of the standard was reaffirmed via a CSDS bulletin on February 3, 2017. |
| **Date of next edition:** | TBD - UL standards are under continuous maintenance and are updated as warranted. |
| **Document:** | **UL 1642, Lithium Batteries** |
| **ESS relevance:** | Lithium cell/battery requirements for battery systems that would be employed in energy storage systems. |
| **Current activity:** | New test requirements for soft-case pouch cells for a Narrow Bar Crush Test or Dent Test instead of the Impact Test were sent out August 24, 2018 for preliminary review with comments due September 28, 2018. See https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=34818 for more information on the proposal dated August 24, 2018. Comments were received during preliminary review and are being considered before proceeding to ballot. |
| **Date of next edition:** | TBD - UL standards are under continuous maintenance and are updated as warranted. |
| **Document:** | **UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources** |
| **ESS relevance:** | Applies to the subject technology when used in conjunction with an energy storage system. |
| **Current activity:** | A second UL 1741 proposal review work area was opened September 17, 2018 that proposed changes to Section 13.1 of the standard related to disconnect device actuator options. See https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=34907 for more information on the proposal dated September 17, 2018. A Second Edition of UL 1741 was issued on October 31, 2018. The revisions include rapid shutdown requirements to better align with the Standard for Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction, UL 61730-1. |
| **Date of next edition:** | TBD - UL standards are under continuous maintenance and are updated as warranted. |
| **Document:** | **ANSI/CAN/UL 1973, Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications** |
| **ESS relevance:** | Battery systems that would be employed in energy storage systems |
| **Current activity:** | The second edition of the standard was issued February 7, 2018. A Call for Proposals for UL 1973 was sent out to STP members and standard subscribers with any new proposals due by October 15, 2018. Numerous proposals were received. These proposals are being included in a preliminary review document that will be sent out for comment only to the STP and standard subscribers in the future. |
| **Date of next edition:** | TBD – UL standards are under continuous maintenance and are updated as warranted. |

| Underwriters Laboratories Inc.® | **Underwriters Laboratories (UL) – https://ulstandards.ul.com/develop-standards/** |
|---|---|
| **Document:** | **ANSI/CAN/UL 1974-18, Evaluation for Repurposing Batteries** |
| **ESS relevance:** | This standard covers the sorting and grading process of battery packs, modules and cells, and electrochemical capacitors that were originally configured and used for other purposes, such as electric vehicle (EV) propulsion, and that are intended for a repurposed use application, such as for use in stationary energy storage systems and other applications. The process of sorting and grading these devices is essentially determining their state of health and other parameters to identify continued viability and the rating mechanisms the repurposing manufacturer may use for those that are determined suitable for continued use. This standard also covers application specific requirements for battery packs utilizing repurposed batteries and components. |
| **Current activity:** | ***The first edition of the Joint National Standard for Canada and the United States, ANSI/CAN/UL 1974 was published October 25, 2018. See https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=35079 for more information on the published standard.*** |
| **Date of next edition:** | TBD – UL standards are under continuous maintenance and are updated as warranted. |

Every effort is made by the Pacific Northwest National Laboratory (PNNL) and Sandia[1] staff to ensure the accuracy of the information presented in this report. PNNL and Sandia very much appreciate the input from staff of the standards developing organizations (SDOs) covered in the report as well as volunteers who are involved in one or more of the SDO initiatives covered in this document. Suggestions for revision, additions, and enhancements to this document are welcome and encouraged.

We at PNNL and Sandia, on behalf of the U.S. Department of Energy, Office of Energy, Energy Storage System Program whose support has made this report possible, want this document to be “the” source of information about codes and standards related to ESS safety. With your help we can make that happen and as outlined on page one achieve the codes and standards related objective in the ESS Safety Roadmap and the goal of fostering confidence in the safety and reliability of ESSs. For more information about the ESS Safety Roadmap efforts visit http://www.sandia.gov/ess/. For questions related to or to provide input on this document, please contact david.conover@pnnl.gov.

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